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John H. Cochrane

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ABSTRACT

The *investment return* is defined as the real return that results from marginally increasing investment at date t, and then reaping the extra output and decreasing investment at date t+1 to leave the production plan for other dates unchanged. This paper constructs investment returns from investment data and a production function, and compares investment returns to stock returns, in order to explain forecasts of stock returns by business cycle related variables, and to explain forecasts of future economic activity by stock returns.

John H. Cochrane
Department of Economics
University of Chicago
1126 E. 59th Street
Chicago, IL 60637
(312)702-3059

Recent empirical work in finance contains a great deal of evidence that asset returns are linked to business cycles. The term premium, the corporate or junk bond premium, lagged returns, dividend price ratios, and investment all forecast stock returns and real variables, and stock returns forecast future investment and GNP growth. Risk premia vary over time in other markets as well: the holding period term premium in the bond market and the forward premium in the foreign exchange market vary over time and appear correlated with business cycles.[1]

This paper applies a production based asset pricing model as described in Cochrane (1988) to explain these links between stock returns and business cycle variables. The central concept in this approach is the *investment return*. The investment return is the marginal return to physical investment. If investment is marginally increased at time t, output will rise at t+1, and investment can be decreased at t+1, leaving the capital stock unchanged at t+2 and beyond. The investment return is the extra output and disinvestment at t+1 divided by the marginal investment at t. Firms will adjust investment to remove arbitrage opportunities between investment returns and stock returns, so changes in stock returns should be mirrored in investment returns.

In this paper, investment returns are constructed from investment data and an assumed production function and compared to real returns on the CRSP value weighted NYSE portfolio. The comparison investigates 1) whether investment returns and value weighted returns are highly correlated, 2) whether forecasts of value weighted returns are equal to forecasts of

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[1]References include the following: for forecasts of stock returns based on lagged returns: Fama and French (1988a) Lo and MacKinlay (1988), Cochrane and Sbordone (1988), Poterba and Summers (1988); based on other variables: Fama (1988), Fama and French (1988b) (1989); for quantity variable forecasts based on term premia: Stock and Watson (1989), Estrella and Hardouvelis (1989); based on stock returns: Fama (1981), Barro (1989a) (1989b); for time variation in holding period return premia: Fama and Bliss (1987); in foreign exchange premia: Hansen and Hodrick (1983).

investment returns, 3) whether forecasts of future GNP growth and investment to capital ratios based on value weighted returns are the same as corresponding forecasts based on investment returns, and 4) whether the projection of value weighted returns and investment returns on investment to capital ratios are the same.

The investment return calculated with an adjustment cost technology in this paper is approximately a monotone function of investment growth: when investment at t is high, investment returns from t to t+1 are low, because marginal investment runs into a stiff adjustment cost; when investment at t+1 is high, investment returns from t to t+1 are *high*, because *dis*investment at t+1 benefits from the high adjustment cost. Hence, relations between asset returns and investment growth in the data drive the relations between asset returns and investment returns that are the empirical results of this paper, and these results are not sensitive to the particular form of the adjustment cost technology.

This approach can be understood as a direct measurement of the real investment opportunity set. The investment returns on all active production processes constitute the investment opportunity set, so equilibrium asset returns should mirror changes in this opportunity set.

This approach can also be viewed as a production based analog to the consumption based asset pricing model, formed from a return version of the q theory of investment (for example, Abel and Blanchard (1986)). The first order conditions of present value maximizing firms imply that firms should adjust their investment plans until no arbitrage opportunities are left between investment returns and asset returns. Then, as one can reverse consumers' first order conditions for optimal consumption decisions given asset returns, to express equilibrium asset returns as a function of a given process for consumption, so one can reverse producers' first order conditions for optimal investment decisions given asset returns, to express equilibrium asset returns as a function of a given process for investment. This interpretation creates the consumption based asset pricing model from consumers' first order conditions, or a "production based asset pricing model" from producers' first order conditions.

The q theory of investment is not known for its good empirical fit. However, the experience of the consumption based asset pricing literature suggests that, as Euler equations describing returns are more empirically successful than present value relations describing prices, so the return version of the q theory may be more empirically successful than the conventional present value version. One reason is that most empirical implementations of present value models (present value of dividends or present value of marginal benefits of investment) exclude time varying risk premia for tractability, yet the data display convincing evidence of time varying risk premia (see the first footnote, and Cochrane (1989a) for discussion of this point). Also, returns emphasize high frequency aspects of the data that the models may be better able to capture in the presence of slow moving changes in technology or preferences.

The goal of this production based approach is to provide an alternate partial equilibrium framework that is analogous to the consumption based asset pricing model but sidesteps its problems, and ties asset returns directly to cyclically important variables such as investment. Just as consumer's first order conditions describe a relation that should hold between asset returns and consumption no matter what producers do, so producer first order conditions describe a relation that should hold between asset returns and production variables like investment no matter what consumers do.

However, it is only a partial equilibrium model, and is thus distinct from empirically oriented general equilibrium asset pricing models with nontrivial production sectors.[2] To the extent that the model in this paper is successful, it can make statements like "expected asset returns are low because expected investment growth (more accurately, investment return) is low," as a successful consumption based model (Ferson and Constantinedes

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[2]Examples are Balavers, Cosimano and McDonald (1989), Breeden (1986), Brock (1980) (1982), Bossearts and Green (1989), Donaldson and Mehra (1984) and Sundaresan (1984). Partial equilibrium consumption based models are often called "general equilibrium" following Lucas (1978). In these models, consumption is given as an endowment. Since actual economies have storage and production, these models in fact only exploit the partial equilibrium relation between consumption and asset returns in empirical applications.

(1989) is the closest analog) might make a statement like "expected asset returns are low because expected consumption growth (more accurately, marginal utility growth) is low." Neither model tells you *why* expected consumption or investment growth are low, in terms of shocks that are exogenous to the economy.

I. Producer's first order conditions and investment returns

This section shows formally that producers' first order conditions imply that there should be no arbitrage between asset returns and investment returns. It introduces a parametric form for production technology, and shows that with that technology, the investment return is equal to the return on the firm's own stock. These statements of producer's first order conditions are derived in a simple environment with discrete time, a finite number of states, and complete markets. None of these elements are essential, but they simplify the mathematics. The crucial assumption is that markets are complete enough that any investment can be financed externally, so that managers need not bear any risk. The setup is quite similar to that in Abel and Blanchard (1986), Ross (1978) and roughly similar statements can be found in a large number of papers and textbooks, for example Fama and Miller (1972). Braun (1989) makes the connection to q theory explicit.

A. Asset Prices and Contingent Claim Prices

Uncertainty comes from a state variable s_t, which generates a state tree. s_t can take one of S values, $\{\lambda_1, \lambda_2, \ldots, \lambda_S\}$. The cumulative history of shocks at time t is denoted $s^t = \{s_0, s_1, s_2, \ldots, s_t\}$. $P(s^t)$ is the time 0 price to a claim to a unit of a single consumption good $c(s^t)$ delivered at time t in state s^t. An asset is a claim to a contingent stream of "dividends" $\{d(s^1), d(s^2) \ldots\}$, where the list extends over all dates and states. The asset's price at time t in state s^t (i.e. with $c(s^t)$ as numeraire) is thus

$$P^A(s^t) = \sum_{\{s^\tau \text{ that follow } s^t\}} (P(s^\tau)/P(s_t))\, d(s^\tau) \, . \qquad (1)$$

Let

$$p(s^{t+1}) = P(s^{t+1})/P(s^t)$$

denote the one period ahead contingent claims price, i.e. the price at time t in state s^t of a unit delivered in a state s^{t+1} that follows s^t (s^{t+1} is formed by $s^{t+1} = \{s^t, s_{t+1}\}$). Let

$$R^A(s^{t+1}) = \frac{P^A(s^{t+1}) + d(s^{t+1})}{P^A(s^t)}$$

denote a one period asset return from date t state s^t to a state s^{t+1} that follows s^t. Then, (1) implies that

$$1 = \sum_{s_{t+1}} p(s^{t+1}) R^A(s^{t+1}) . \qquad (2)$$

At time t in state s^t there are S contingent claims prices $p(s^{t+1})$, corresponding to all the possible draws of s_{t+1} that form s^{t+1} from s_t. Thus given s^t, $p(s^{t+1})$ and $R^A(s^{t+1})$ are S dimensional vectors. (2) says that all return vectors lie on a plane in $\mathbb{R}^S$, characterized by its orthogonality to the vector of contingent claims prices.

Equations (1) and (2) are conventionally written in terms of scaled prices

$$Q(s^t) = P(s^t)/\rho^t\pi(s^t); \quad q(s^{t+1}) = p(s^{t+1})/\rho\pi(s_{t+1}|s^t)$$

where $\pi(s^t)$ is the time-0 or unconditional probability of state s^t, and $\pi(s_{t+1}|s^t)$ is the conditional probability that s_{t+1} (and hence s^{t+1}) occur given s^t. It is also common to delete the reference to state in writing random variables, so $Q(s^t)$ (or $Q_t(\omega)$) is commonly written Q_t, etc. With this notation, (2) is equivalent to

$$1 = \sum_{s_{t+1}} \rho\ \pi(s_{t+1}|s^t)\ q(s^{t+1})\ R^A(s^{t+1}) \qquad (3)$$

or

$$1 = \rho\ E_t \left(q_{t+1}\ R^A_{t+1} \right) \qquad (4)$$

and (1) is similarly equivalent to

$$P^A_t = E_t \left(\sum_{\tau=1}^{\infty} \rho^\tau \prod_{j=1}^{\tau} \frac{Q_{t+\tau}}{Q_t}\ d_{t+\tau} \right). \qquad (5)$$

These representations may be found in any textbook such as Ingersoll (1988). Hansen and Richard (1987) derive (4) with an infinite dimensional state space and incomplete markets. The crucial assumption is the absence of arbitrage.

B. Producers' first order conditions

The firm chooses a production plan for sales, investment, production, capital stocks and other inputs $(c(s^t),\ I(s^t),\ y(s^t),\ k(s^t),\ l(s^t))$ (the list extends across all dates and states) to maximize its contingent claim value (equivalent to expected present value as (1) is equivalent to (5))

$$\max \sum_{\text{(all states)}} P(s^\tau)\ c(s^\tau) \qquad \left(= E \sum_{\tau=0}^{\infty} \rho^\tau Q_\tau c_\tau \right) \tag{6}$$

subject to the constraints

$$\text{Production:} \qquad y_t = f(k_t, l_t, s_t) \tag{7}$$

$$\text{Resources:} \qquad y_t = c_t + I_t \tag{8}$$

$$\text{Capital accumulation:} \qquad k_{t+1} = g(k_t, I_t) \tag{9}$$

k_0 given, and k_t, $c_t \geq 0$ for all t. Here and below, the conventional notation for a random variable is used where possible to simplify notation: $k(s^t)$ is denoted k_t, etc. The capital accumulation functions $g(\cdot)$ allow for adjustment costs to investment. Subtracting an adjustment cost from output yields very similar results.

The first order conditions to this problem imply

$$1 = \sum_{s_{t+1}} p(s^{t+1})\ R^I(s^{t+1}) \tag{10}$$

where R^I is the investment return from state s^t to state s^{t+1},

$$R^I(s^{t+1}) = \left(f_k(t+1) + \frac{g_k(t+1)}{g_I(t+1)} \right) g_I(t) , \tag{11}$$

(The notation (t) means "evaluated with respect to the appropriate arguments at time t in state s^t," and the subscripts denote partial derivatives, e.g., $g_I(t) = \partial g(k_t,\ I_t)/dI_t$.) (10) is equivalent to

$$1 = \rho E_t\left(q_{t+1}R^I_{t+1} \right) . \tag{12}$$

Comparing the producer's first order conditions (10) or (12) and the orthogonality relation between asset returns and contingent claims prices (2) or (4), the producer's first order conditions direct the firm to adjust investment so that the investment returns lie in the space of asset returns defined by (2). This means that the firm should operate the technology up to the point where it can no longer make sure profits by arbitrage between asset market returns and its investment return. Three equivalent statements are that the firm should adjust investment until 1) the benchmark that prices asset returns also correctly prices investment returns; 2) investment returns match asset returns of similar risk characteristics; and 3) the firm can no longer short a portfolio of assets that has returns less than or equal to the investment return in each state of nature, create the investment return, and make a profit in at least some states. When there are several technologies, producer's first order conditions specify (10) or (12) for each investment return separately.

To derive (10) or (12), consider a marginal change in investment at time t and at time t+1, arranged so the production plan is unchanged for t+2 and beyond. The marginal cost of increasing I_t by dI_t is a lost unit of sales dI_t. The increased investment gives rise to increased capital $dk_{t+1} = g_I(t)dI_t$. This increased capital gives rise to increased output

$$dy_{t+1} = f_k(t+1)dk_{t+1} = f_k(t+1)g_I(t)dI_t,$$

Also, I_{t+1} must be simultaneously decreased to hold k_{t+2} unchanged:

$$dk_{t+2} = g_k(t+1)dk_{t+1} + g_I(t+1)dI_{t+1} = 0$$

so

$$dI_{t+1} = -\frac{g_k(t+1)}{g_I(t+1)}\, dk_{t+1} = -\frac{g_k(t+1)}{g_I(t+1)}\, g_I(t)\; dI_t.$$

Both the increased output and decreased investment at t+1 can be sold. These benefits occur in every state s^{t+1} that follows s^t, so marginal cost = marginal benefit is

$$P_t dI_t = \sum_{s_{t+1}} P_{t+1}\left(f_k(t+1) + \frac{g_k(t+1)}{g_I(t+1)} \right) g_I(t)\; dI_t.$$

Dividing by P_t and dI_t and using the definitions of $p(s^{t+1})$ and $q(s^{t+1})$yields (10) and (12) , which thus just say that the marginal benefits of the marginal investment equal the marginal cost.

C. A Functional Form For Technology and Investment Returns

The empirical section of this paper uses the following parametric form of the technology.

Production: $$y_t = mp_t\, k_t + mpl_t\, l_t \tag{13}$$

Resources: $$y_t = c_t + I_t$$

Capital accumulation : $$k_{t+1} = (1 - \delta)\left[k_t + \left(1 - \frac{\alpha}{2}\left(\frac{I_t}{k_t}\right)^2\right)I_t\right]. \tag{14}$$

mp_t is the marginal product of capital, δ is the depreciation rate, and α is the adjustment cost parameter.

The one period investment returns are, from their definition (11),

$$R^I(t\to t+1) = \left(1 - \delta\right)\left(mp_{t+1} + \frac{1 + \alpha\left(\frac{I_{t+1}}{k_{t+1}}\right)^3}{1 - \frac{3}{2}\alpha\left(\frac{I_{t+1}}{k_{t+1}}\right)^2}\right)\left(1 - \frac{3}{2}\alpha\left(\frac{I_t}{k_t}\right)^2\right) \tag{15}$$

The notation $R(t\to t+1)$ is used to distinguish a quarterly return from an annual return, denoted $R(t\to t+4)$. Note that the investment return is a decreasing function of time t investment and an increasing function of time t+1 investment, as explained in the introduction. The investment return has roughly the same sensitivity to investment at t and at t+1, though with opposite sign, so the investment return is roughly proportional to investment growth. (More precisely, a Taylor expansion of the investment return with respect to investment at time t and t+1 has approximately the same coefficients with opposite signs.)

D. Firm value and Q theory

With this technology, the investment return is also the return to owning a unit of capital. The model so far only allows us to compare investment returns and some portfolio of asset returns, picked to mimic the pattern of the investment return across states of nature. With this result, we can compare investment returns directly to the returns on the firm's own stock.

The firm can transform a marginal unit of the consumption good at t into $g_I(t)$ units of installed capital at t+1, via the investment equation $k_{t+1} = g(I_t, k_t)$. Thus the price at time t of a claim to a unit of time t+1 installed capital must be

$$P_t^{k_{t+1}} = \frac{1}{g_I(I_t, k_t)} = \frac{1}{\left(1-\delta\right)\left(1-\frac{3}{2}\alpha\left(\frac{I_t}{k_t}\right)^2\right)} \tag{16}$$

(16) can inverted to express investment as a function of the price of capital:

$$I_t = k_t\left(\frac{2}{3}\alpha\left(1-\frac{1}{(1-\delta)\,P_t^{k_{t+1}}}\right)\right)^{1/2}. \tag{17}$$

(17) is the price version of the q-theory of investment: it expresses optimal investment I_t as an increasing function of the market price of the firm's capital divided by replacement cost. (Replacement cost is $1/(1+\delta)$.)

Now, what is the (market) return available from buying some capital and holding it for a period? Buying one unit of capital costs $P_t^{k_{t+1}}$. In return, you get the produce of that capital at period t+1, $f_k(t+1)$. An extra unit of capital at t+1 becomes $g_k(t+1)$ units of capital at t+2, which may be sold at time t+1 for $P_{t+1}^{k_{t+2}}$. Thus the return from buying capital and holding it for a period is

$$\text{Return} = \frac{f_k(t+1) + g_k(t+1)\,P_{t+1}^{k_{t+2}}}{P_t^{k_{t+1}}}.$$

Substituting $P_t^{k_{t+1}} = 1/g_I(t)$ and $P_{t+1}^{k_{t+2}} = 1/g_I(t+2)$ from (16), we obtain the investment return (11) again. Thus, *the investment returns are also the market returns to owning capital for a period.* If we model a firm as a claim to the capital of a single technology or a claim to a constant linear combination of technologies, the (marginal) investment return will be the same as the return on a ownership share of the firm.

II. The cyclical behavior of stock returns and investment returns

To examine the cyclical behavior of stock returns in the simplest version of the above model, the CRSP value weighted portfolio is modeled as a claim to the capital stock corresponding to gross fixed private domestic investment.[3] The real value weighted return and the investment return should be the same:

$$R^{VW}(t\to t+1) = R^{I}(I_t/k_t,\ I_{t+1}/k_{t+1},\ mp_{t+1}). \tag{18}$$

In particular, the empirical work focuses on three issues: 1) whether forecasts of value weighted returns are the same as forecasts of investment returns 2) whether value weighted returns have the same relation to contemporaneous investment to capital ratios (I/k_t, I/k_{t+1}) as investment returns and 3) whether forecasts of future investment and GNP from value weighted returns are the same as corresponding forecasts from investment returns.

However, we can expect an error term in implementing (18). First, we do not have direct data on the production function shock mp_{t+1}, so a constant value is used instead.[4] Second, the value weighted return may be in fact a

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[3]The bond portion of claims to firms in the value weighted NYSE are ignored. Since bond returns vary a great deal less than expected stock returns, and since the standard deviation of investment returns is an essentially free parameter, it is hoped that not much error is introduced.

[4]It is possible in principle to measure these shocks, unlike utility shocks. For example, in the given model,

$$mp_t = (y_t - mpl_t\ l_t)/k_t$$

and mpl x l may be measured as the wage bill. This idea is not pursued below. However, note from equation (16) that the terms in the investment to capital ratio measure changes in prices, while the mp term measures a stochastic component of earnings. To the extent that price changes are more claim to other technologies as well as that corresponding to gross private domestic investment. Variation in the investment returns of these other technologies or factors would show up in the error term. Third, investment is measured with error, and this measurement error contributes to the error term.

$$R^{VW}(t\to t+1) = R^{I}(I/k_{t}, I/k_{t+1}, mp) + (mp_{t+1}, \text{measurement error, etc. term}) \quad (19)$$

Unfortunately, there is no reason to believe that any of these error term components are serially uncorrelated, uncorrelated with investment to capital ratios or investment returns, or uncorrelated with instruments (return forecasting variables). In the regressions described above, there is then a danger that a coefficient ascribed to the investment returns with no productivity shock (the first term in (19)) is in fact due to spurious correlation with the error term. Lacking convincing statistical assumptions, this possibility is acknowledged, but no correction is made for it. The consumption based model suffers from the same problem: unobserved preference shocks, components of consumption that enter nonseparably in the utility function (for example, the service flow from durables), and measurement error all contribute to the error term, but there is no reason to expect the error from these sources to obey the orthogonality restrictions that the forecast error obeys.

A. Construction of investment returns

The investment data are real gross private domestic investment. For each given choice of parameters, a capital stock series is constructed by accumulating past investment, using the capital accumulation rule (14). Then, investment to capital ratios are formed, and quarterly returns (from t-1 to t) are calculated from investment to capital ratios at t-1 and t according to (15). Overlapping quarterly observations of annual investment returns from t-4 to t are constructed by accumulating quarterly returns.

Investment is a quarterly aggregate, but value weighted returns are

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important to changes in returns and expected returns than dividend changes, leaving out changes in marginal products may have a small effect on the results.

point-to-point. As a crude adjustment for this difference, the value weighted returns in the rest of this section are shifted so that they go from approximately the center of the initial quarter to the center of the final quarter. This dating convention is illustrated in Fig. 1. Other variables have conventional dating: returns dated t used as forecasting variables are from the beginning to the end of quarter t, real variables dated t are aggregates for quarter t.

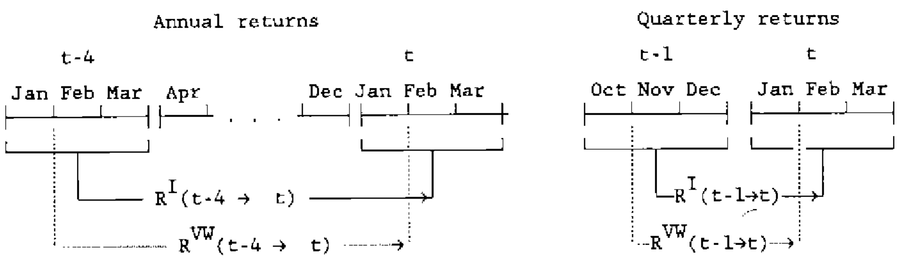

Fig. 1. Dating convention for real value weighted returns (R^{VW}) and investment returns (R^I).

Three parameters govern the relation between investment returns and the investment to capital ratio: the adjustment cost parameter α, depreciation δ and the productivity of capital mp. When the adjustment cost parameter α is zero, the annual investment return collapses to $R^I(t\text{-}4 \rightarrow t) = (1+\delta)^4(1+mp)^4$, and the quarterly return to $R^I(t\text{-}1 \rightarrow t) = (1+\delta)(1+mp)$, so these parameters' main effect is to control the mean return. The adjustment cost parameter α controls the sensitivity of investment returns to investment to capital ratios, and thus the variance of investment returns.

However, the parameters have almost no effect on the *relative* sensitivity of investment returns to investment to capital ratios at different dates, and thus the *correlation* of investment returns with other variables. Some numerical examples of this insensitivity are presented below.

Given that the parameters (α, δ, mp) control the mean and standard deviation of investment returns, but have little impact on its timing or correlation with other variables, the parameters of the investment return are chosen as follows: 1) depreciation δ is chosen arbitrarily, and then 2) the marginal product mp and the adjustment cost α are chosen together to make mean investment return equal the mean real value weighted return and to equate the standard deviation of the fitted values of regressions of real value weighted and investment returns on eight leads and lags of the investment to capital ratio. The resulting parameters are given in the note to table I.

The reason for this choice of standard deviation is that the regression of value weighted returns on investment to capital ratios leaves a much larger residual than the projection of investment returns on investment to capital ratios. This residual may be attributed to other factors, or to marginal productivity shocks (see equation (19)). Thus, this choice of standard deviation is designed to produce a series of about the same standard deviation as the investment return component of value weighted returns, the first term of equation (19). Since most of the results are driven by the *correlation* of investment and value weighted returns, or their regressions on various variables, this scaling is not crucial to the results.

A puzzle of the q theory is that adjustment cost estimates seem implausibly high. They imply that very large fractions of GNP (often greater than 1) are lost to adjustment costs. This is analogous to the consumption based puzzle that large coefficients of risk aversion seem to be required. With the technology (13)-(14), the fraction of investment lost to adjustment costs is $(\alpha/2)(I/k)^2$. α is around 13 (see note to Table I), I/k is about the same as depreciation, .1, so the fraction of investment lost to adjustment costs is about 7%. The fraction of output lost is I/y x 7%, or around 1%. Thus the puzzle of implausibly high adjustment costs is not present in these parameters.

Insert fig. 2 about here

Fig. 2 presents a plot of quarterly observations of annual real returns on the value weighted NYSE portfolio and corresponding annual investment returns, and shows that they are well correlated.

Insert fig. 3 about here

The arbitrary choice of depreciation rate ($\delta = .1$ in fig. 2 and below) has almost no effect on the resulting series. To demonstrate, fig. 3 presents investment returns for three values of depreciation, $\delta = 0.05$, $\delta = 0.1$, and $\delta = 0.2$. In each case the other parameters are picked as before to match the mean value weighted return and the standard deviation of its projection on investment to capital ratios. (The resulting parameters are given in the note to table I.) Fig. 3 shows that the corresponding investment returns are nearly identical, though the parameters vary widely in economic terms. In particular, the timing of the peaks and troughs is almost completely unaffected by the large changes in parameters.

Insert fig. 4 about here

In fig. 4, the adjustment cost parameter α is varied, while keeping the mean investment return equal to the mean value weighted return with the marginal product mp. (The parameters are given in the note to table I.) As claimed above, fig. 4 shows that α controls the standard deviation of investment returns, with essentially no effect on their cyclical timing and thus their correlation with other variables. Thus the correlation between investment returns and real value weighted returns evident in fig. 2 is essentially independent of parameter choices, as claimed above.

B. Correlation between investment and value weighted returns.

Table I presents some regressions and correlations designed to quantitatively assess the correlation between investment returns and real value weighted returns apparent in fig. 2.

Insert table I about here

The message of table I is that the correlation visible to the eye in fig. 2 is statistically significant at conventional levels. The correlation coefficient between value weighted and investment returns ranges from .241 for quarterly returns to .385 for annual returns and is as high as .449 for first quarter annual returns.

Table I also includes regressions and correlations of value weighted returns with investment growth and GNP growth. Both have about the same correlation with value weighted returns as the investment return, and graph of investment and GNP growth against value weighted returns look very much like fig. 2. Thus the correlation of fig. 2 is not a sensitive result of the nonlinear function relating investment returns to investment data. The point of the paper is to explain this correlation, rather than to find a particular nonlinear transformation of investment that produces a suddenly high correlation with stock returns.

C. Forecasts of investment returns and value weighted returns

Table II compares forecasts of real value weighted returns and forecasts of investment returns, at both annual and quarterly horizons. The forecasting variables are chosen from the literature that documents the forecastability of stock returns (see footnote 1). These are the term premium, the corporate premium, the lagged real value weighted return, and the dividend price ratio. (See the data appendix for sources.)

Insert table II about here

For each forecasting variable a preliminary regression was run to determine if the variable aggregated over the previous year or previous quarter provided a better forecast of value weighted returns. This preliminary regression is presented in part 1 of table II, and suggests the use of an annual horizon for the term premium and dividend price ratio and a quarterly horizon for lagged returns and the corporate premium.[5] In addition, the investment to capital ratio in the previous quarter is used as a forecasting variable.

Parts 2 and 3 of table II present single regressions of quarterly and annual returns on the forecasting variables. The coefficients of value weighted returns on each of the forecasting variables are significant at

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[5]Of course this procedure leads to a danger of overfitting, so the probability values of the value weighted return forecasts are optimistic. However, even if one set of variables was used without looking at the results, it could not be made independent of the literature-wide fishing expedition that has produced these forecasting variables, so this procedure was followed to make sure the better forecasting variable was not overlooked.

conventional levels, except lagged returns for annual returns.[6] The investment return coefficients are of the same sign and roughly of the same magnitude as the value weighted return coefficients, with the exception of the dividend price ratio. To test whether the coefficients are in fact equal, the difference between the value weighted return and the investme return is regressed on the forecasting variables, in the column marked "VW-Inv." As the table shows, we cannot reject that the coefficients are equal for all the forecasting variables except the dividend price ratio.

To assess the importance of the particular adjustment cost technology used to form investment returns, value weighted returns were regressed on contemporaneous and lagged investment to capital ratios, a fitted return was calculated from this regression, and used in place of the investment return in the column marked "VW - Fit." Interestingly, the fitted return performs *worse* than the investment return for all variables other than the dividend price ratio, for which it is nearly identical. Thus, though the fitted return (by construction) improves on the investment return for the objective of a high correlation between *ex-post* returns and for matching the projection of returns on investment to capital ratios, it then does *worse* in matching *ex-ante* returns. This observation provides some evidence that the investment return calculated through the adjustment cost technology is more than a proxy for the projection of value weighted returns on investment to capital ratios.

Parts 4 and 5 of table II present multiple regression forecasts of returns, using all the forecasting variables together. They also report the joint probability values and R^2s from multiple regressions on all the forecasting variables except the dividend price ratio. (The individual coefficients of these regressions are omitted to save space, since they were similar to those reported for the multiple regression including the dividend price ratio, except that the investment to capital ratio enters more strongly when the dividend price ratio is absent.)

All together, the forecasting variables are jointly significant

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[6]Poterba and Summers (1988) and Cochrane and Sbordone (1988) note that the variance ratio of stock returns is one at annual horizons but lower for both shorter and longer horizons, which is the same observation.

predictors of value weighted returns: the χ^2 test for the joint significance has a probability value of 0.03% for quarterly value weighted returns and 0.01% for annual value weighted returns, with R^2s of .12 an .22. Only the dividend price ratio is an individually significant predictor of value weighted returns. However, the other variables are jointly significant, both in multiple regressions that include the dividend price ratio and those that exclude it.

When the difference between value weighted and investment returns is regressed on all the forecasting variables, the individual variables except the dividend price ratio are even less significant. The exception is the investment to capital ratio with annual returns, which enters with a 3.94% probability value. More importantly, the coefficients on all variables except the dividend price ratio are now jointly insignificant, so we cannot reject that the investment return and value weighted return forecasts based on all variables except the dividend price ratio are the same. As with the single regressions, the fitted return formed by projecting value weighted returns on investment to capital ratios performs worse than the investment returns in explaining forecasts of the value weighted return in multiple regressions.

Parts 4 and 5 of table II also document the similarity of multiple regression forecasts of value weighted returns and investment returns by the correlation of and regressions between the two forecasts. Without the dividend price ratio, the correlation of the two forecasts is .875 quarterly and .938 annual, and statistically significant. Fig. 5 plots these forecasts of quarterly real value weighted and investment returns and demonstrate their correlation to the eye. Interestingly, the correlations of return forecasts are much higher than the correlations of the returns themselves.

Insert fig. 5 about here

However, the dividend price ratio significantly forecasts the difference between value weighted and investment returns, and lowers the correlation between the two forecasts. Fig. 6 presents forecasts of quarterly investment and value weighted returns including the dividend price ratio.

Insert fig. 6 about here

The pattern of these results suggests that all variables except the dividend price ratio have a common business cycle component that forecasts value weighted and investment returns equally, but the dividend price ratio contains another, longer term component that forecasts a long term component in value weighted returns not found in investment returns[7]. The fact that each of the variables significantly forecast value weighted returns in single regressions and jointly in multiple regressions, but only the dividend price ratio is individually significant in multiple regressions, suggests that the variables except the dividend price ratio are all forecasting the same component of returns, but the dividend price ratio forecasts a different component. The long run interpretation of the dividend price ratio forecasts is suggested by the difference between fig. 5 and fig. 6. In both figures, the cyclical movements in the value weighted return forecasts are matched by cyclical movements in the investment return forecast, but in fig. 6, with the dividend price ratio added, the value weighted return forecast waves slowly around the investment return forecast, in response to long horizon changes in the dividend price ratio.

D. Regressions of investment and value weighted returns on investment to capital ratios

Table III presents single and multiple regressions of value weighted returns, investment returns, and the difference between value weighted returns and investment returns on investment to capital ratios. These regressions address all three issues--forecasts of returns based on investment to capital ratios, the association of returns with subsequent investment to capital ratios, and the projection of returns on contemporary investment to capital ratios.

Insert table III about here

The first column of each part of table III (columns 1, 6, 11, 15 and 21) and figs. 7 and 8 present the slope coefficients from single regressions of value weighted returns and investment returns on investment to capital ratios.

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[7] Fama and French (1988b) suggested this interpretation of dividend price ratio forecasts of returns.

Insert fig.s 7 and 8 about here

As shown in fig. 7 and 8, the pattern of single regression coefficients is similar, but the value weighted return coefficients are slightly shifted in time. The size of the shift is about the same for annual as for quarterly returns. The shift is about two quarters for lagged investment to capital ratios, near t-8, declines to one quarter near t and vanishes for leads of the investment to capital ratio, by t+3 or t+4. However, the single regressions of value weighted less investment returns on investment to capital ratios (columns 11 and 13) show that the only evidence against equality of value weighted and investment return coefficients comes at I/k(t) and I/k(t+1) quarterly and I/k(t-2), I/k(t-1) and I/k(t) for annual returns. Thus, only the part of the shift of fig. 6 and 7 near I/k(t) is statistically significant.

Since investment to capital ratios are serially correlated, they should forecast investment and hence value weighted returns. The single regressions in table III show that they do: I/k(t-2) forecasts quarterly value weighted returns from t-1 to t with a probability value of 2.12% (col. 1), and I/k(t-5) forecasts annual returns from t-4 to t with a probability value of 4.34% (column 5).[8] Furthermore, we do not reject that the forecasts of investment and value weighted returns from lagged investment to capital ratios are the same in the single regressions of value weighted less investment returns (columns 11, 13).

Also as a result of serial correlation in investment to capital ratios, investment returns are associated with future investment to capital ratios in single regressions, though they only depend on investment to capital ratios at times between t-4 (annual) or t-1 (quarterly) and t in a functional or multiple regression sense. In fact, the highest predicted single regression

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[8]The return series in these forecasting regressions is shifted forward in time one month relative to the usual timing in return forecasting regressions. Normally, the return from Jan 1 to March 31 would be regressed on fourth quarter investment to capital ratio, whereas in these regressions, the return from February 1 to April 30 is regressed on the fourth quarter I/k ratio, as explained in fig. 1. Experiments revealed slightly higher forecast power in the usual timing, but not enough difference to warrant an extra set of tables. Also, equally weighted return forecasts are more significant with either timing.

coefficients do not occur until several quarters past t. (See figs. 7 and 8). Table III shows that the single regressions of value weighted returns on future investment to capital ratios are indeed highly significant (columns 1, 15), and that the equality of the investment return and value weighted return coefficients on future investment to capital ratios is not rejected (columns 11, 13).

The first set of multiple regressions in each part of table III is designed to capture the shape of the relation between value weighted returns and investment to capital ratios (columns 2, 3, 16, 17 and 18) and compare that to the shape predicted by the model for investment returns (columns 7, 8 and 22, 23). Columns 8 and 23 present the partial derivatives of the investment return function with respect to investment to capital ratios, which are close to the multiple regression coefficients. The multiple regression of value weighted less investment returns on investment to capital ratios (columns 12 and 14) tests the equality of the investment return and value weighted return multiple regression coefficients

Value weighted returns are first regressed on investment to capital at t-1 and t (quarterly, column (2)) and t-4 and t (annual, column (16)), to try to recover what should be the most important coefficients. These regressions recover the right signs and approximately the right relative magnitudes, but are slightly lower in absolute magnitude than the corresponding investment return coefficients. This is a result of the fact that the parameters of the investment return were chosen to match the standard deviation of projections on eight leads and lags of investment to capital ratios, but investment returns are mostly related to I/k(t) and I/k(t-1) (quarterly) or I/K(t-4) (annual), while the projection of value weighted returns on I/k is more spread out.

Annual value weighted returns are then regressed on all the investment to capital ratios of which they should be a function, from t-4 to t (column 17). Here, we find that the t-4 to t-1 investment to capital ratios enter negatively as they should, but not with the relative magnitudes predicted by the model. The model predicts a much larger coefficient for t-4 than for t-3, t-2 and t-1 (see columns 22 and 23), but t-1 has the largest coefficient in the value weighted return regression.

The model predicts that *only* investment to capital ratios at t-4 through t (annual) or t-1 to t (quarterly) should enter in a multiple regression. Thus columns 3 and 18 add two future and two past investment to capital ratios. With the possible exception of one future coefficient in each regression that enters at about the 10% level, the other investment to capital ratios do not enter. Also, the fact that investment to capital ratios at times other than t-4,..., t (annual) and t-1, t (quarterly) do not enter the single regressions of value weighted less investment returns (columns 11, 13) provides confirmation on this point.

The multiple regressions of value weighted less investment returns on investment to capital ratios in part 3 (columns 12, 14) test whether the differences in multiple regression coefficients are statistically significant. The χ^2 statistics reject the hypothesis that all the multiple regression coefficients are equal. However, most of this rejection is due to the coefficients contemporaneous to returns, as seen in the joint χ^2 statistics for only the other coefficients.

Thus, the single and multiple regressions in part 3 of table III suggest that the major difference between the regressions of value weighted and investment returns on investment to capital ratios is the *shape* of the relation between returns and contemporaneous investment to capital ratios (I/k(t-4)..I/k(t) annual and I/k(t-1), I/k(t) quarterly), rather than in differences of the projection of returns on investment to capital ratios before or after the return period, which would reflect different forecasts of investment and value weighted returns or different associations of value weighted and investment returns with subsequent investment to capital ratios.

The set of multiple regressions marked "forecasts" in each part of table III investigates forecasts of returns from several investment to capital ratios taken together. The first forecasting multiple regressions (columns 4 and 19) show that all the forecastability comes from the investment to capital ratio immediately prior to the return period: t-2 for quarterly returns and t-5 for annual returns, in that investment to capital ratios for prior periods are not individually or jointly significant given these.

Hence, forecasts of returns from earlier individual investment to capital ratios are just due to the serial correlation of investment to capital ratios.

The next forecasting multiple regressions (columns 5 and 20) take the argument one step further: they show that the t-2 (quarterly) and t-5 (annual) investment to capital ratios in turn get their forecast power from their ability to forecast investment to capital ratios contemporary to returns, t-1 and t quarterly and t-4, ..., t annual. Hence, investment to capital ratios forecast returns because they forecast future investment to capital ratios and *only* because they forecast future investment to capital ratios.

Part 3 of table III confirms this view, in that investment to capital ratios before t-1 (quarterly) and t-4 (annual) do not forecast the difference between value weighted returns and investment returns in single or multiple regressions.

Table III was replicated with equally weighted returns and with investment to GNP ratios in the place of investment to capital ratios. The pattern of results in both cases was so similar that the tables are omitted to save space.

E. Forecasts of GNP growth from investment returns and value weighted returns

Insert table IV and figs. 9, 10 about here

Table IV presents forecasts of GNP growth from lagged returns. The first and second parts of table IV present the slope coefficients of single regressions of GNP growth on lagged value weighted and investment returns. These coefficients are also displayed in fig.s 9 and 10. The pattern of the coefficients is roughly the same, though the overall magnitude of the coefficients of GNP growth on investment returns is larger. The figures also suggest a shift of the single regression coefficients, as was the case of single regression coefficients of returns on investment to capital ratios. Value weighted returns from t-3 to t are individually significant for quarterly GNP and value weighted returns from t-4 to t are individually significant for annual GNP, confirming Fama's (1981) and Barro's (1989a)

(1989b) results.

The last column in the first two parts of table IV presents single regression coefficients of GNP growth on value weighted less investment returns, to test whether the single regression coefficients on the two returns individually are the same. There is some evidence that they are not at the 10% level, but only two out of twenty coefficients are significant at the 5% level. The 10% rejections are concentrated around t-3 and t-2 where the shift between the two coefficients is largest, rather than near t-1 or t where the magnitudes of the coefficients and the magnitude of their difference are largest. In particular, the large difference between the coefficients near t visible in figs. 9 and 10 is not statistically significant.

Parts 3 and 4 of table IV present multiple regressions of GNP growth on lagged investment returns and value weighted returns. (Multiple regressions using up to eight lags were run, but the additional lags were insignificant.) In both cases the nearest lags are the most significant predictors of GNP. The regressions of GNP growth on investment return less value weighted return do not reject that the coefficients are individually and jointly equal.

III. Concluding Remarks

The simple implementation of a production based asset pricing model in this paper predicted that stock returns and investment returns should be the same. This idea was used to explain the forecastability of real value weighted stock returns, and the fact that stock returns forecast real variables including investment and GNP. Projections of returns on contemporaneous investment to capital ratios were also included as a diagnostic.

Forecasts of investment returns and value weighted returns appeared to be the same for most of the forecasting variables. In this sense the shifting investment opportunities measured by the investment returns explain the forecastability of stock returns.

Forecasts of future investment to capital ratios and GNP growth from investment returns and value weighted returns also appeared to be the same. Investment returns are only functionally related to contemporaneous investment to capital ratios, and their ability to forecast future investment to capital ratios and GNP growth in single regressions is due only to serial correlation in investment to capital ratios and correlation of investment to capital ratios with subsequent GNP growth. Hence, the equality of value weighted and investment return forecasts of future economic activity means that the ability of stock returns to forecast future economic activity is attributed only to their correlation with contemporaneous investment returns and disappears in a multiple regression context.

Other successes include findings that ex-post investment returns and value weighted returns are highly correlated and that the projection of investment and value weighted returns on investment to capital ratios matches in many respects.

However, investment returns did not explain the component of value weighted returns forecastable by dividend price ratios, as dividend price ratios seemed to forecast a long horizon component in value weighted returns not present in investment returns. This component of value weighted returns might reflect a long term movement in productivity, which is an unmeasured component of investment returns in this paper's empirical implementation.

Also, the shape of the function relating value weighted returns to investment to capital ratios was significantly different from that of the investment returns. The single regression coefficients exhibited a statistically significant one quarter shift near time t, and the pattern of multiple regression coefficients, though qualitatively the same, was quantitatively different, and the difference was statistically significant. Uncertainties in the timing of investment may account for some of the shift. For example, if investment purchased this quarter does not give rise to productive capital until next quarter, this could account for a one quarter shift. The difference in the pattern of the projection of annual returns on investment to capital ratios suggests a technologies in which the multiperiod return depends more strongly on events in the middle of the return horizon rather than just on the two ends.

There are several promising directions in which this model can be extended. With a model for the benchmark return, the parameters of the investment return can be estimated by generalized method of moments, and overidentifying restrictions tested; alternate forms for technology may improve the fit, including gestation lags and adjustment costs to changing the level of investment; and variations in marginal products may be estimated. Most importantly, the implications for cross sectional variation in returns, lost here by aggregation to a single technology, may be explored using components of investment or industry or firm investment data.

APPENDIX

Data Sources and Transformations

The following basic series were used. The Citibase series are quarterly 1947:1-1987:4, in 1982 dollars, the others are monthly, 1926:1- 1987:4.

Source	Series name	Description
CITIBASE	GIF82	Gross private domestic investment--fixed investment
	GCD82	Personal consumption expenditures--durable goods
	GCN82	Personal consumption expenditures--nondurable goods
	GCS82	Personal consumption expenditures--services
CRSP	VWRET	Total return on value weighted NYSE portfolio
	VWRETX	Return excluding dividends on value weighted NYSE
Ibbotson-	USTR	Treasury bill return
Sinquefield	GBTR	Government bond portfolio return
	CBTR	Corporate bond portfolio return
	CPI	Consumer price index

The investment series was divided by 4 to yield quarterly investment rather than annual rate. The following transformations were employed:

1) Investment to capital ratio (I_t/k_t): The capital accumulation rule (14) implies the following transition rule for the investment to capital ratio $i_t = I_t/k_t$:

$$i_{t+1} = \frac{I_{t+1}}{I_t} \frac{i_t}{(1 - \delta)\left[1 + i_t - \frac{\alpha}{2} i_t^3\right]} . \qquad (A.1)$$

The investment to capital ratio was assumed to be at the "steady state" value i* in 1947:1, where i* is defined by the fixed point of (A.1) with investment growth set to its mean value, and then (A.1) was used to find investment to capital ratios at future dates.

2) Real value weighted returns (R^{VW}): The monthly real value weighted return was formed from VWRET - CPI, and was accumulated to quarterly returns with the timing illustrated in fig. 2.

3) Term premium, corporate premium and dividend price ratio. Term is GBTR - USTR, Corp is CBTR - USTR. VWRET and VWRETX were both accumulated for a year. Then d/p = (annual VWRET - annual VWRETX)/ (1 + annual VWRETX) forms dividends brought forward at the market return (VWRET), divided by end of period price. (This is shown in the appendix to Cochrane (1989b).)

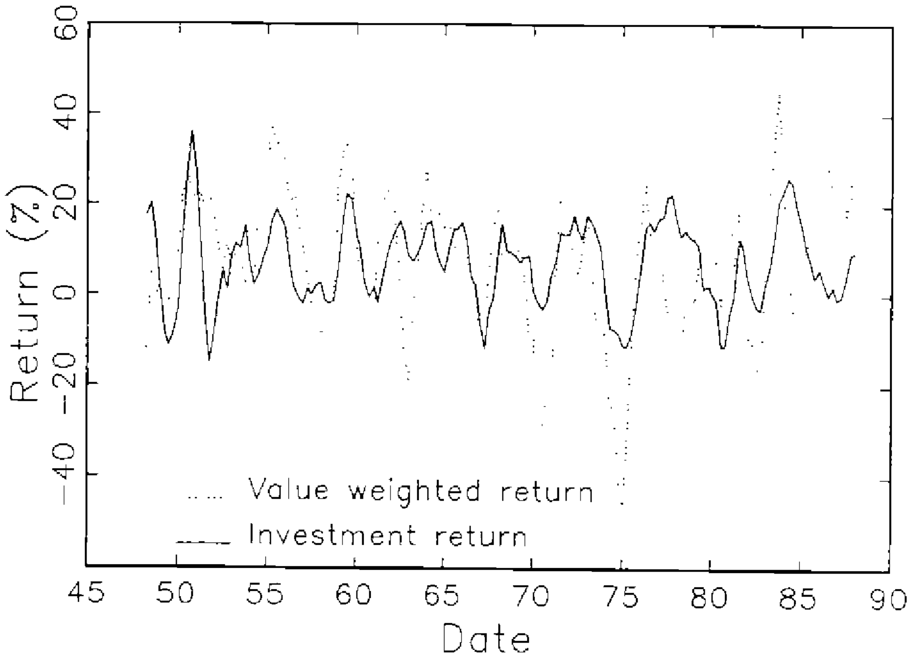

Fig. 2: Quarterly observations of annual real returns on the value weighted NYSE portfolio and annual investment returns. Investment returns are calculated from investment to capital ratios. The parameters (α, δ, mp) of the investment technology are chosen to equate the mean investment and value weighted returns, and to equate the standard deviation of the projections of investment and value weighted returns on eight leads and lags of the investment to capital ratio.

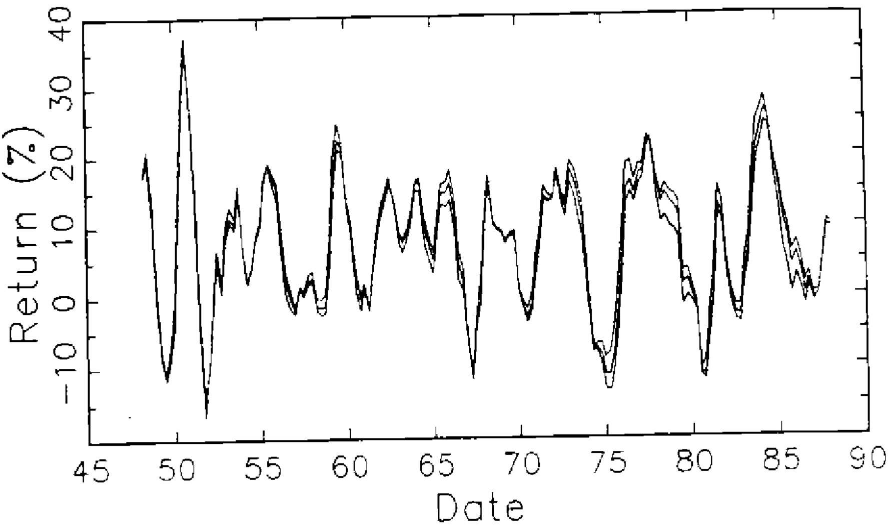

Fig. 3: Quarterly observations of annual investment returns with depreciation δ = .05, .1 and .2. The other parameters are selected as in fig. 2 and presented in the note to table I. The point of the graph is that investment returns are insensitive to the choice of depreciation rate δ.

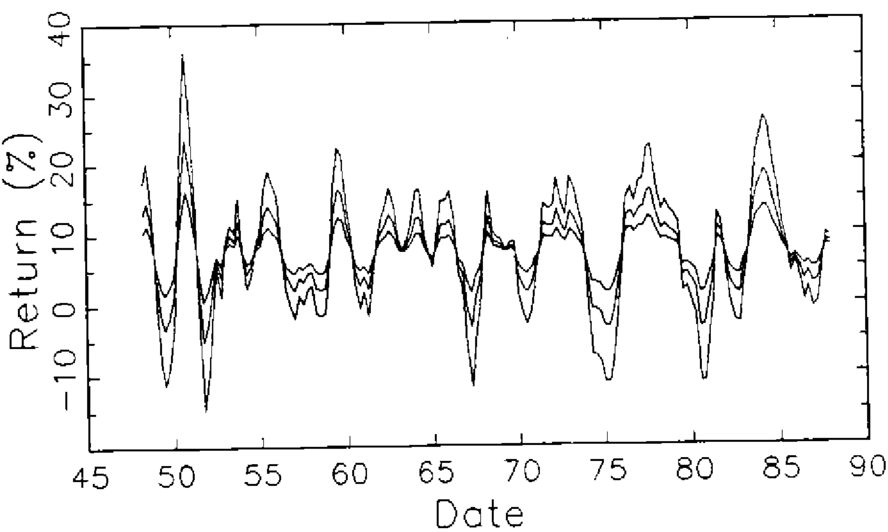

Fig. 4: Quarterly observations of annual investment returns with three different choices of the adjustment cost parameter α. In each case the marginal product mp is chosen to match the mean investment return and the mean real value weighted return. The point of the graph is that α controls the standard deviation but not the timing of investment returns.

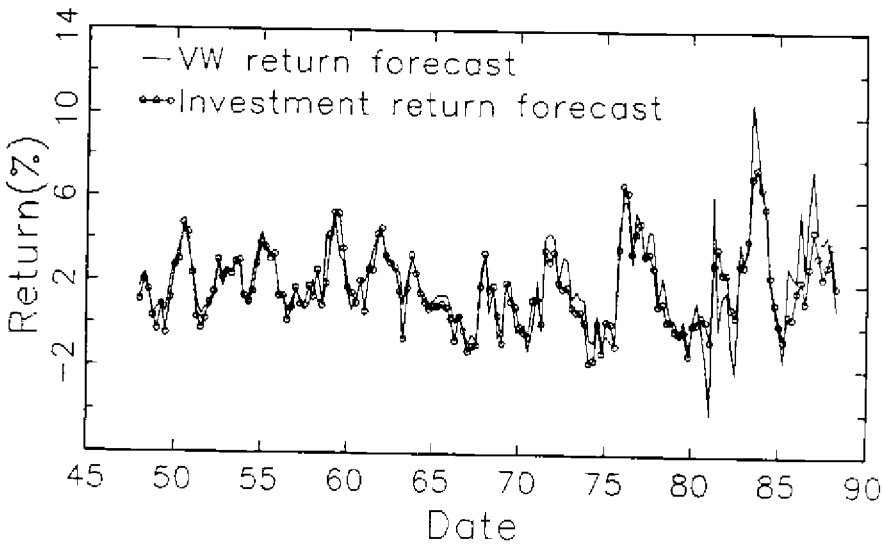

Fig. 5 Forecasts of quarterly value weighted and investment returns from linear regressions of returns on the term premium, corporate premium, lagged return and investment to capital ratio. The regressions are presented in table II.

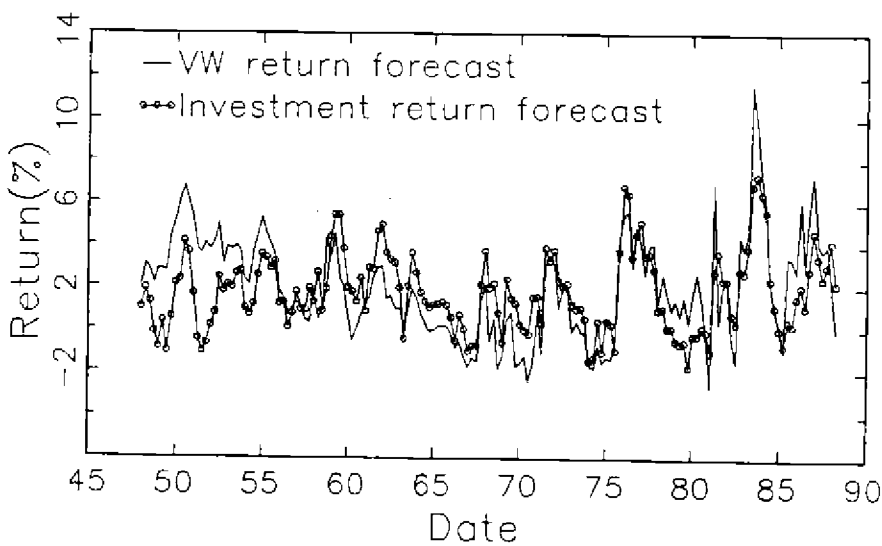

Fig. 6 Forecasts of quarterly value weighted and investment returns from linear regressions of returns on the term premium, corporate premium, lagged return, investment to capital ratio *and dividend price ratio*. The regressions are presented in table II.

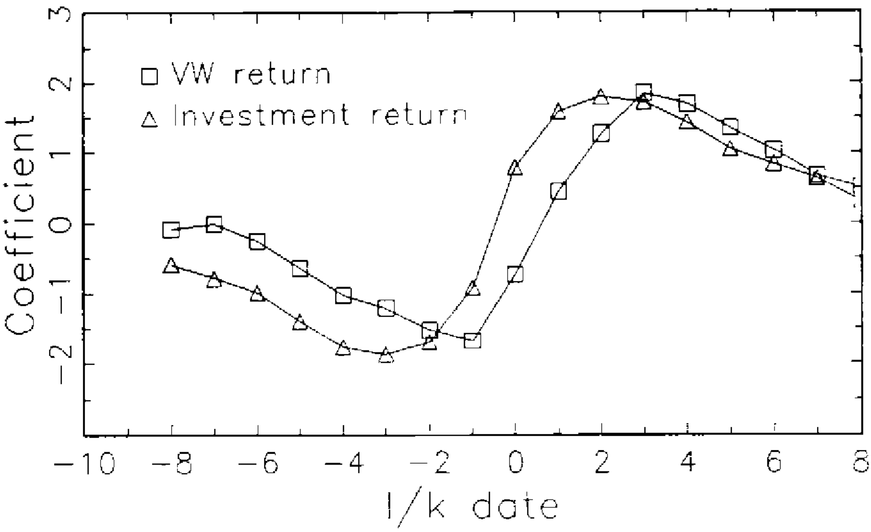

Fig. 7. Single regression slope coefficients of quarterly investment return and quarterly real value weighted returns (from t-1 to t) on investment to capital ratios at t-8 to t+8, with one standard error bands on the value weighted return coefficients. The regressions are presented in table III, column 1.

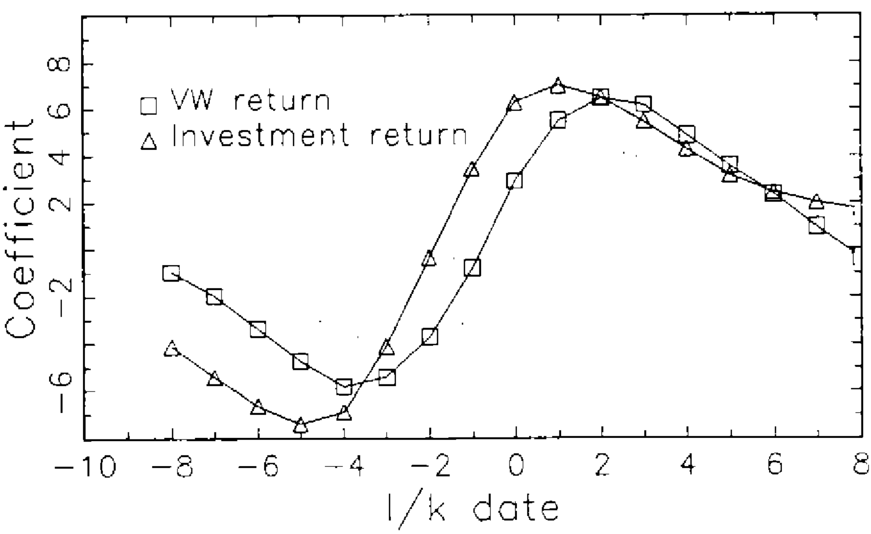

Fig. 8: Single regression slope coefficients of annual investment returns and annual real value weighted returns (from t-4 to t) on investment to capital ratios at t-8 to t+8, with one standard error bands on the value weighted return coefficients. The regressions are presented in table III, column 6.

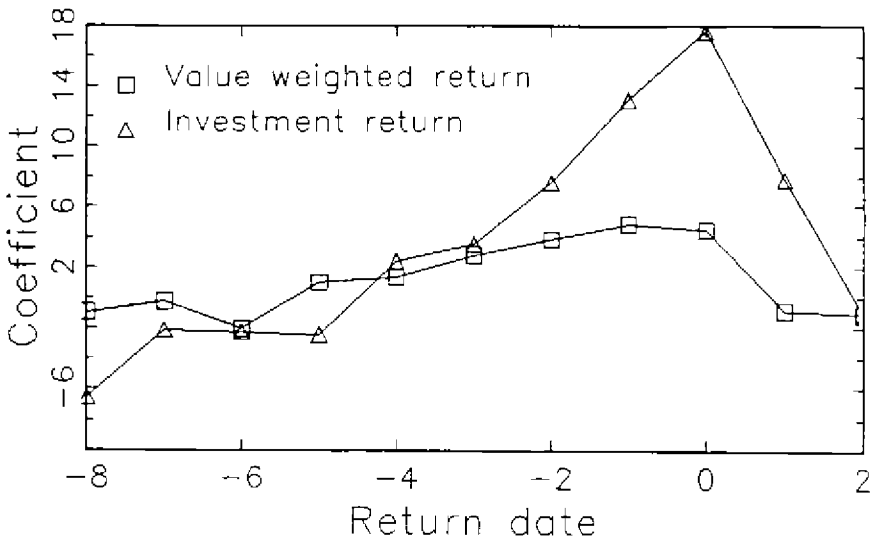

Fig. 9 Single regression slope coefficients of quarterly real GNP growth on past and future quarterly real value weighted returns and investment returns. The regressions are presented in table IV.

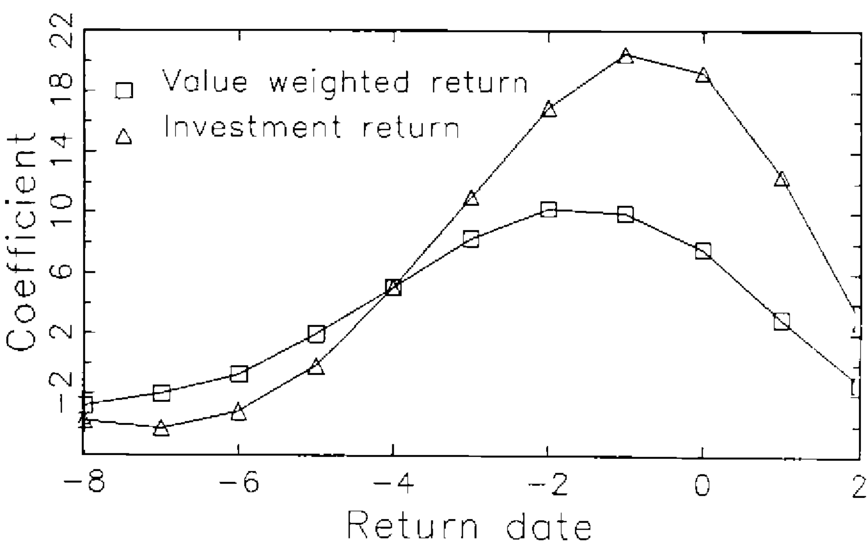

Fig. 10 Single regression coefficients of annual real GNP growth on past and future annual real value weighted returns and investment returns. The regressions are presented in table IV.

Table I. Regressions and correlation of real value weighted returns on investment returns, investment growth and GNP growth

1. Quarterly returns

Right hand variable	Coeff.	t stat.	p value(%)	R^2	Correlation	Std. error
Investment returns	0.506	3.163	0.186	0.058	0.241	0.069
Investment growth	0.586	3.103	0.226	0.056	0.237	0.068
GNP growth	1.941	3.914	0.013	0.086	0.294	0.074

2. Annual returns with no overlap (first quarter to first quarter, etc.)

Sample	Coeff.	t stat.	p value(%)	R^2	Correlation	Std. error
First quarter	0.719	2.885	0.634	0.202	0.449	0.128
Second quarter	0.614	2.578	1.384	0.166	0.407	0.139
Third quarter	0.489	1.851	7.173	0.094	0.306	0.141
Fourth quarter	0.722	2.569	1.412	0.164	0.404	0.137

3. Overlapping annual returns, with corrected standard errors

Right hand variable	Coeff.	t stat.	p value(%)	R^2	Correlation	Std. error
Investment return	0.622	2.820	0.541	0.148	0.385	0.113
Investment growth	0.716	3.060	0.259	0.130	0.360	0.103
GNP growth	2.147	3.921	0.012	0.163	0.404	0.097

4. Overlapping biannual returns, with corrected standard errors

Right hand variable	Coeff.	t stat.	p value(%)	R^2	Correlation	Std. error
Investment return	0.591	2.355	1.979	0.124	0.352	0.130
Investment growth	0.744	2.516	1.288	0.116	0.340	0.116
GNP growth	2.100	3.790	0.021	0.157	0.396	0.119

(continues on next page)

(Table I, continued)

Note to table I:

"Coeff." gives the single regression slope coefficient of real value weighted returns on the variable indicated in the first column. "P value" gives the percent probability value of a two sided test, based on the t-statistic. "Correlation" gives the correlation between real value weighted returns and the variable indicated in the first column. "Std. error" gives the standard error of the correlation coefficient.

The standard errors in part 3 and 4 are constructed as in Hansen (1982) and Newey and West (1987) to correct for serial correlation due to overlap. Annual returns use 8 positive and negative covariances (twice the overlap) and biannual returns use 16. The data sample is 1947:1 - 1987:4.

Investment return parameters are picked so that the mean investment return is equal to the mean value weighted return, and so that the standard error of the projection of value weighted and investment returns on eight leads and lags of the investment to capital ratio are the same. These are the same investment returns plotted in fig. 2. The parameters and statistics for resulting percent returns are:

	δ	α	mp	Mean VW	Mean Inv.	S.d. VW	S.d. Inv.
Quartlery:	0.1	13.044	0.152	1.69	1.70	7.24	3.42
Annual:	0.1	13.219	0.156	7.33	7.34	15.53	9.37
Biannual:	0.1	13.409	0.156	14.64	14.65	21.49	12.46

The parameters for the eperiments in δ and α reproted in fig. 3 and 4 are these annual parameters and

Fig. 3			Fig.4		
δ	α	mp	δ	α	mp
0.05	50.946	0.088	0.1	9.914	0.147
0.2	2.842	0.318	0.1	6.610	0.141

Table II. Comparison of value weighted return forecasts and investment return forecasts

1. Percent probability values for univariate forecasts of quarterly (Q) and annual (A) real value weighted returns, using quarterly vs. annual forecasting variables

Value weighted return horizon:	Q	Q	A	A
Forecast variable horizon:	Q	A	Q	A
Term	5.07	0.53	0.66	1.12
Corp	0.94	1.68	1.23	18.88
Ret	2.51	61.41	50.97	52.45
d/p	1.44	0.26	0.16	0.28

2. Single regression forecasts of quarterly returns (from t-1 to t)

Forecasting Variable	VW Return		Invest. Return		VW - Inv	VW - Fit
	Coeff.	p value	Coeff.	p value	p value	p value
Term t-2	0.16	0.53	0.10	0.05	24.10	4.95
Corp t-2	0.35	0.94	0.16	0.23	12.44	5.95
Ret t-2	0.16	2.51	0.15	0.00	88.56	28.35
d/p t-2	1.32	0.26	0.11	70.70	1.22	1.53
I/k t-2	-1.53	2.12	-1.71	0.00	79.96	53.09

3. Single regression forecasts of annual returns (from t-4 to t)

Forecasting Variable	VW Return		Invest. Return		VW - Inv	VW - Fit
	Coeff.	p value	Coeff.	p value	p value	p value
Term t-5	0.35	1.12	0.35	2.51	99.57	37.89
Corp t-5	0.68	1.23	0.59	0.32	70.99	18.23
Ret t-5	0.12	50.97	0.24	0.66	48.86	46.90
d/p t-5	5.02	0.28	0.80	48.47	0.02	0.02
I/k t-5	-4.74	4.34	-7.40	0.00	25.35	83.91

(continues on next page)

(Table II continued)

4. Multiple regression forecasts of quarterly returns (from t-1 to t)

Forecasting Variable	VW Return Coeff.	VW Return p value	Invest. Return Coeff.	Invest. Return p value	VW - Inv p value	VW - Fit p value
Term t-2	0.09	11.02	0.06	3.47	55.26	20.09
Corp t-2	0.17	20.71	-0.04	52.47	11.86	18.13
Ret t-2	0.03	69.18	0.10	0.03	33.79	90.50
d/p t-2	1.08	1.06	-0.28	25.15	0.54	0.58
I/k t-2	-0.77	26.33	-1.53	0.00	28.04	10.88
Joint χ^2 p value		0.03		0.00	2.32	1.30
Joint χ^2 no d/p		2.32		0.00	24.79	15.33
R^2		0.12		0.29	0.07	0.08
Regression w/o d/p:						
Joint χ^2 p value		0.61		0.00	49.24	26.85
R^2		0.09		0.28	0.02	0.04

Correlation of VW, investment return forecast: 0.664, s.e.: 0.088
Correlation of forecasts without d/p: 0.875, s.e.: 0.035

Regression: VW ret. forecast = 0.12 + 0.88 Investment ret. forecast
p value (%) = 19.5 0.20 R^2 = 0.44
Without d/p: VW ret. forecast = -0.02 + 1.02 Investment ret. forecast
p value (%) = 69.6 0.04 R^2 = 0.77

5. Multiple regression forecasts of annual returns (from t-4 to t)

Forecasting Variable	VW Return Coeff.	VW Return p value	Invest. Return Coeff.	Invest. Return p value	VW - Inv p value	VW - Fit p value
Term t-5	0.26	18.17	0.23	2.36	92.19	48.01
Corp t-5	0.41	12.91	0.06	51.05	18.64	31.04
Ret t-5	-0.30	8.02	-0.05	46.05	13.44	74.83
d/p t-5	4.60	0.05	-0.57	39.89	0.00	0.00
I/k t-5	-2.83	14.81	-7.10	0.00	3.94	19.85
Joint χ^2 p value		0.01		0.00	0.00	0.07
Joint χ^2 no d/p		1.29		0.00	7.09	29.02
Joint χ^2 no d/p,I/k		1.01		5.42	30.68	22.06
R^2		0.22		0.52	0.18	0.17
Regression w/o d/p:						
Joint χ^2 p value		4.03		0.00	58.61	51.27
R^2		0.11		0.51	0.03	0.02

Correlation of VW, investment return forecast: 0.610 s.e.: 0.112
Correlation of forecasts without d/p: 0.938 s.e.: 0.179

Regression: VW ret. forecast = 0.396 + 0.642 Investment ret. forecast
p value (%) = 0.45 2.54 R^2 = 0.37
Without d/p: VW ret. forecast = 0.318 + 0.715 Investment ret. forecast
p value (%) = 0.00 1.61 R^2 = 0.88

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(Table II continued)

Note to table II:

"Coeff" gives OLS regression slope coefficients. "p value" gives the percent probability values of two sided t-tests of the corresponding slope coefficients. "Joint χ^2 p value" gives the percent probability values for a χ^2 test of the joint significance of the forecasting variables. "Joint χ^2 w/o d/p" gives the percent probability value of a χ^2 test for the joint significance of all variables except the dividend price ratio. The rows labelled "w/o d/p" give partial results for corresponding multiple regressions using all variables except the dividend price ratio.

Forecasting variable definitions: Term is the Government bond less treasury bill return. Corp is the corporate bond return less the treasury bill return. VW ret. is the real value weighted return, with conventional timing (Ret. (t) is the return from the beginning of quarter t to the end of quarter t, as with corp). d/p is the dividend price ratio. Term and d/p are based on returns for the year ending in the indicated quarter (t-5 or t-2). VW ret. and Corp are returns for the quarter t-5 or t-2. I/k is the investment/capital ratio in the indicated quarter. See the data appendix for sources.

Return variables: The annual value weighted and investment return variables are overlapping quarterly observations of annual returns. The variable labelled "Fit" is the fitted value of an OLS regression of the value weighted return on contemporaneous and lagged investment to capital ratio. The regression coefficients used to form "fit" are given in table II columns 2 and 17.

Annual return standard errors are adjusted using a Hansen (1982) - Newey-West (1987) correction, using 8 covariances, or twice the overlap. All correlation standard errors include this correction. Each regression uses as much of the sample 1947:1- 1987:4 as possible.

Table III. Regressions of returns on investment to capital ratios

1. Quarterly real value weighted returns (t-1 to t)

	Single		Multiple				Multiple (forecasts)			
Column no.:	(1)		(2)		(3)		(4)		(5)	
	Coeff	P val	Coeff	P val	Coeff	P val	Coeff	P val	Coeff	P val
I/k(t-4)	-1.04	8.30			-0.75	59.05	-1.47	33.32	-1.17	42.21
I/k(t-3)	-1.21	5.16			1.39	58.46	3.03	21.31	2.11	40.14
I/k(t-2)	-1.53	2.12			1.78	57.66	-3.24	4.46	1.51	63.24
I/k(t-1)	-1.69	1.42	-5.33	0.01	-6.14	7.19			-9.10	0.73
I/k(t)	-0.74	28.21	4.05	0.19	0.17	96.10			5.71	0.12
I/k(t+1)	0.45	52.24			1.29	68.72				
I/k(t+2)	1.26	5.29			2.49	9.45				
I/k(t+3)	1.84	0.14								
I/k(t+4)	1.68	0.22								
R^2			0.09		0.17		0.05		0.11	
Joint χ^2 p value (%)			0.05		0.06		45.04		29.81	
Vbls. in joint χ^2			All		All		-4,-3		-4,-3,-2	

2. Quarterly investment returns (t-1 to t)

	Single		Multiple			Multiple (forecasts)			
Column no.:	(6)		(7)		(8)	(9)		(10)	
	Coeff	P val	Coeff	P val	Grad	Coeff	P val	Coeff	P val
I/k(t-4)	-1.77	0.00	-0.01	87.97		-0.53	36.13	-0.02	85.32
I/k(t-3)	-1.88	0.00	0.08	63.17		-1.22	22.72	0.08	59.56
I/k(t-2)	-1.71	0.00	-0.10	61.74		-0.21	75.84	-0.10	61.18
I/k(t-1)	-0.92	0.05	-8.47	0.00	-8.70			-8.45	0.00
I/k(t)	0.79	1.27	8.46	0.00	8.63			8.42	0.00
I/k(t+1)	1.59	0.00	0.00	98.41					
I/k(t+2)	1.79	0.00	-0.03	77.46					
I/k(t+3)	1.72	0.00							
I/k(t+4)	1.42	0.00							
R^2			0.98			0.25		0.98	
Joint χ^2 p value (%)			0.00			0.73		94.93	
Vbls. in joint χ^2			All			-4,-3		-4,-3,-2	

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(Table III continued)

3. Value weighted returns - investment returns

	Quarterly (t-1 to t)				Annual (t-4 to t)			
	Single		Multiple		Single		Multiple	
Column no.:	(11)		(12)		(13)		(14)	
	Coeff	P val	Coeff	P val	Coeff	P val	Coeff	P val
I/k(t-7)					3.45	13.94	2.72	37.97
I/k(t-6)					3.25	14.48	-1.98	44.86
I/k(t-5)					2.66	25.35	2.41	38.48
I/k(t-4)	0.74	21.58	-0.74	60.07	1.06	64.86	5.33	14.74
I/k(t-3)	0.66	29.04	1.31	60.85	-1.31	49.47	-2.67	40.00
I/k(t-2)	0.17	79.96	1.88	55.97	-3.37	1.96	-1.91	49.33
I/k(t-1)	-0.76	27.58	2.34	50.02	-4.22	0.35	-4.52	10.61
I/k(t)	-1.53	1.89	-8.29	1.93	-3.37	6.51	-3.41	30.01
I/k(t+1)	-1.14	8.01	1.28	69.26	-1.51	46.74	4.64	9.89
I/k(t+2)	-0.53	39.93	2.53	9.48	-0.00	99.90	2.07	42.30
I/k(t+3)	0.12	82.45			0.70	75.25		
I/k(t+4)	0.27	60.88			0.58	80.20		
I/k(t+5)	0.30	57.65			0.41	85.92		
I/k(t+6)	0.19	74.62			-0.09	95.78		
I/k(t+7)	0.04	94.63			-1.04	65.17		
I/k(t+8)	0.20	75.14			-2.10	34.66		
R^2			0.14				0.16	
Joint χ^2 p value (%)			0.01	2.06			0.00	3.51
Vbls. in joint χ^2			All	No t-1,t			All	No t-4..t

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(Table III continued)

4. Annual real value weighted returns (t-4 to t)

	Single		Multiple						Multiple (forecats)			
Column no.:	(15)		(16)		(17)		(18)		(19)		(20)	
	Coeff	P val	Coeff	P val	Coeff	P val	Coeff	P val	Coeff	P val	Coeff	P val
I/k(t-7)	-1.98	41.80					2.73	34.49	0.67	83.40	3.04	29.34
I/k(t-6)	-3.37	16.85					-1.77	49.03	4.11	15.11	-3.30	16.49
I/k(t-5)	-4.74	4.34					2.21	42.24	-8.97	0.63	3.58	18.92
I/k(t-4)	-5.83	0.51	-7.24	0.33	-1.11	74.06	-3.99	26.50			-4.30	22.58
I/k(t-3)	-5.45	0.26			-2.98	39.94	-2.67	39.07			-2.42	45.29
I/k(t-2)	-3.72	2.56			-2.07	43.39	-2.07	44.07			-2.62	32.66
I/k(t-1)	-0.78	64.49			-9.96	1.09	-4.52	11.07			-8.61	1.91
I/k(t)	2.91	11.08	4.98	1.43	15.20	0.03	5.67	6.59			15.23	0.03
I/k(t+1)	5.51	0.66					4.57	10.21				
I/k(t+2)	6.48	0.29					2.11	42.18				
R^2			0.18		0.26		0.30		0.09		0.28	
Joint χ^2 p value (%)			0.90		0.85		0.76		19.62		44.54	
Vbls. in joint χ^2			All		All		All		-7,-6		-7,-6,-5	

5. Annual investment returns (t-4 to t)

	Single		Multiple			Multiple (forecasts)			
Column no.:	(21)		(22)		(23)	(24)		(25)	
	Coeff	P val	Coeff	P val	Grad	Coeff	P val	Coeff	P val
I/k(t-7)	-5.42	0.00	0.01	96.84		-1.83	39.49	0.00	99.19
I/k(t-6)	-6.62	0.00	0.21	46.38		2.77	10.31	0.22	41.25
I/k(t-5)	-7.40	0.00	-0.20	30.18		-8.60	0.01	-0.21	28.31
I/k(t-4)	-6.89	0.00	-9.31	0.00	-9.45		-9.32	0.00	
I/k(t-3)	-4.13	0.00	-0.00	99.00	-0.09		0.00	98.87	
I/k(t-2)	-0.35	60.04	-0.15	54.05	-0.09		-0.14	52.44	
I/k(t-1)	3.44	0.01	-0.00	99.87	-0.09		-0.01	98.66	
I/k(t)	6.28	0.00	9.08	0.00	9.36		9.04	0.00	
I/k(t+1)	7.01	0.00	-0.07	78.30					
I/k(t+2)	6.48	0.00	0.04	90.10					
R^2			0.99			0.46		0.99	
Joint χ^2 p value (%)			0.00			26.06		63.52	
Vbls. in joint χ^2			All			-7,-6		-7,-6,-5	

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(table III continued)

Note to table III:

"Coeff" gives the OLS regression slope coefficients. "P val" gives percent probability values for two sided t-tests of the slope coefficients. "Grad" give the partial derivative of the investment return with respect to investment to capital ratios, evaluated at the "steady state" investment to capital ratio (see the data appendix). "Joint χ^2 p value (%)" gives the percent probability value of a χ^2 test for joint significance of the coefficients listed in "Vbls. in joint χ^2."

Annual return standard errors used to calculate probability values include a Hansen (1982) - Newey-West (1987) correction for serial correlation due to overlap, using with eight covariances (twice the overlap). Data sample is 1947:1 - 1987:4, less leads and lags.

Table IV. Return forecasts of GNP growth

1. Single regressions of quarterly GNP growth on quarterly returns

Return used to forecast GNP

Return date	Value weighted			Investment			VW - Investment		
	Coeff.	t	p val	Coeff.	t	p val	Coeff.	t	p val
t-8	-0.99	-0.90	36.71	-6.58	-2.67	0.83	0.65	0.55	58.19
t-7	-0.30	-0.24	80.69	-2.23	-0.85	39.68	0.25	0.21	83.16
t-6	-2.10	-1.67	9.71	-2.36	-0.84	40.34	-1.53	-1.30	19.44
t-5	0.97	0.84	40.31	-2.50	-0.94	34.76	1.58	1.31	19.21
t-4	1.33	1.06	29.19	2.40	0.86	39.23	0.75	0.63	52.78
t-3	2.80	2.40	1.74	3.54	1.38	17.02	1.93	1.80	7.30
t-2	3.85	3.48	0.06	7.63	2.99	0.32	1.99	1.76	8.02
t-1	4.87	4.21	0.00	13.11	5.21	0.00	1.69	1.30	19.66
t	4.45	3.58	0.04	17.67	6.91	0.00	0.44	0.36	71.63
t+1	-0.87	-0.71	47.59	7.82	2.61	0.98	-2.64	-2.06	4.06
t+2	-1.12	-1.00	31.83	-1.19	-0.39	69.74	-0.84	-0.66	51.20

2. Single Regressions of annual GNP growth on annual returns, using overlapping quarterly data and corrected standard errors.

Return used to forecast GNP

Return date	Value weighted			Investment			VW - Investment		
	Coeff.	t	p val	Coeff.	t	p val	Coeff.	t	p val
t-8	-2.84	-1.81	7.18	-3.79	-0.97	33.17	-1.54	-0.62	53.45
t-7	-2.04	-1.26	21.00	-4.26	-1.08	28.36	-0.38	-0.14	88.68
t-6	-0.76	-0.46	64.50	-3.17	-0.83	40.52	0.57	0.23	81.53
t-5	1.95	1.16	24.74	-0.18	-0.05	95.76	2.29	1.05	29.52
t-4	5.05	2.79	0.60	5.03	1.77	7.93	3.45	1.79	7.61
t-3	8.30	4.22	0.00	11.06	4.35	0.00	4.42	2.16	3.27
t-2	10.28	4.89	0.00	16.97	6.99	0.00	4.06	1.83	6.97
t-1	9.98	4.60	0.00	20.48	7.86	0.00	2.33	1.00	32.10
t	7.60	3.42	0.08	19.24	6.08	0.00	0.24	0.10	92.10
t+1	3.01	1.35	18.00	12.47	3.28	0.13	-2.00	-0.71	47.86
t+2	-1.32	-0.62	53.80	2.87	0.68	49.89	-2.72	-0.86	39.10

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(table IV, continued)

3. Multiple regressions of quarterly GNP growth on quarterly returns

Return used to forecast GNP

Return date	Value weighted			Investment			VW - Investment		
	Coeff.	t	p val	Coeff.	t	p val	Coeff.	t	p val
t-4	1.03	0.88	38.29	3.14	1.01	31.26	0.74	0.63	52.68
t-3	2.10	2.05	4.19	-0.23	-0.08	93.91	1.71	1.66	9.83
t-2	3.02	2.91	0.41	1.57	0.56	57.92	1.72	1.52	13.00
t-1	4.39	3.96	0.01	13.27	5.13	0.00	1.58	1.18	23.87
R^2			0.16			0.19			0.04
Joint χ^2 p value (%)			0.00			0.00			11.21

4. Multiple regressions of annual GNP growth on annual returns using overlapping quarterly data and Newey-West corrected standard errors.

Return used to forecast GNP

Return date	Value weighted			Investment			VW - Investment		
	Coeff.	t	p val	Coeff.	t	p val	Coeff.	t	p val
t-4	-0.27	-0.13	89.79	6.69	1.59	11.46	0.09	0.03	97.22
t-3	2.33	1.54	12.58	-2.49	-0.54	58.90	2.66	1.25	21.19
t-2	4.05	2.78	0.61	-5.24	-1.34	18.17	3.13	1.76	8.10
t-1	5.79	2.45	1.53	25.53	5.79	0.00	-1.13	-0.40	69.02
R^2			0.33			0.47			0.06
Joint χ^2 p value (%)			0.00			0.00			18.87

Note to table IV:

"Coeff." gives the OLS regression slope coefficient of real GNP growth (GNP_t/GNP_{t-1}) on the indicated return at the indicated date. "t" gives the t statistic. "p val" gives the percent probability value of a two sided test using the t statistic. "Joint χ^2 p value (%)" gives the percent probability value of the χ^2 test for joint significance of all returns used to forecast GNP growth. Annual return standard errors include a Hansen (1982) - Newey-West (1987) correction for serial correlation due to overlap, using eight covariances (twice the overlap).

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