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STOCK VALUES AND FUNDAMENTALS: LINK OR IRRATIONALITY?

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Abstract

In this paper, econometric techniques are employed to analyze the continuous and remarkable growth which has characterized international stock markets since 1995. The Campbell and Shiller dividend discount model, a dynamic version of Gordon's formula commonly employed by financial analysts to rate individual firms, is the main tool of the paper. Given the information set available at any time, the future values of the real interest rate and the expected growth of dividends are evaluated and employed as explanatory variables for the current dividend yield. The results of the econometric analysis demonstrate that current dividend yields are not in line with the expected trend in the underlying variables, for all the countries considered. A decline in the real interest rate or an increase in the expected growth of dividends, or a combination of the two, could reconcile fundamentals and current dividend yields. The assessment of whether or not such divergences are rational cannot be made safely on the basis of expectations of the fundamentals derived from the econometric scheme. These, in fact, rest on the hypothesis of rational expectations for agents utilizing the full information set of past information; of course, information related to a larger set, including survey data, or the effects of shifts in economic regimes are excluded in this setup.

JEL classification: G12, G15.

Keywords: asset pricing, dividend yield, dividend discount model.

Contents

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1. Introduction and main findings[1]

This paper analyzes the continuous and remarkable growth which has characterized international stock exchanges since 1995. If the values of the stock indices at the beginning of 1995 are set at 100, the levels as at December 1999 were 308 in the US, 259 in Italy, 258 in Germany, 305 in France, 210 in the UK and 110 in Japan. Excluding Japan, where the stock market has only recently recovered from the losses of 1997-98, the indices grew by 167.6 percent, or an average annual compuonded rate of 25 percent (Figure 1). This value is well above the return on any bond issued in any industrial country (Figure 4).

The size of the capital gains in the stock exchanges led many commentators and monetary authorities, in particular the Federal Reserve, to publicly announce that the stock indices, especially those in the US, contain an irrational component since the fundamentals did not support such high gains. Since 1997, a sizeable correction has often been considered imminent.

This sentiment has found support in a number of studies that use traditional valuation schemes to consider the actual values of stocks that are not in line with the expected fundamentals (see Kennedy *et al*., 1998). They observe that dividend yields (the dividend to price ratio of a stock) have fallen significantly in the last two years, to levels that are close to the values preceding the crash of October 1987; analogously, the price to earnings ratios (hereafter price/earning) have increased rapidly to values that are higher than their average over the last twenty years.[2] These trends evidence that stock owners are willing to accept a very low expected return (the dividend yield is indeed a measure of the real dividend; see Section 3).

This paper analyzes stock market trends utilizing an econometric specification of a dynamic pricing scheme for stocks. To illustrate the model, a preliminary analysis is based

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[2] According to market analysts the equilibrium value of the price to earnings ratio should be close to fifteen. Japan is an exception, with historic figures much above this benchmark.

on the so-called Gordon's formula (1962), commonly employed by financial analysts to rate individual firms; it may be considered a static specification of the dynamic pricing scheme which equates the equilibrium values of the dividend yield, the real interest rate, the risk premium and the expected growth of dividends. In the econometric representation of the pricing scheme proposed by Campbell and Shiller (1988b and 1989; henceforth referred to as CS), the current set of information is employed, in any period, to evaluate the future values of the real interest rate and the expected growth of dividends which will be employed as explanatory variables for the current dividend yield; this scheme is consistent with Gordon's hypothesis that the price of a stock coincides with the present value of the future dividend stream. In this paper the original scheme of CS, which analyzes the relationships among the dividend yield, real interest rate, expected growth of dividends and past values of the dividend yield, has been modified to account for the relation between stock values and inflation too, under the hypothesis that changes in the latter do not influence the real interest rate and the expected growth of dividends with the same timing and intensity.

The static Gordon's formula evidences, for all countries except Japan, that the actual dividend yields are too low to be justified by fundamental variables considered in this paper. To equate the dividend yield, real interest rate, expected dividend growth and risk premium, either the risk premium or the real interest rate has to fall, or else economic growth has to accelerate. This conclusion is strengthened by the dynamic Gordon's formula in the version of CS, which confirms the existence of a relationship between stock values and fundamentals, however marginally, in only two of the twelve cases examined.

2. Static analysis of the relation between stock prices and fundamentals

The efficient market hypothesis, widely adopted in the financial literature, implies that a stock price expressed in real terms, P_t, is given by

(1) $$P_t = bE\left(P_{t+1} + D_{t+1} | I_t\right)$$

where b is the real discount rate, D_t is the real dividend distributed to stockholders in period t, $E(\cdot)$ is the expectation operator and I_t is the publicly available information set in period

t, which includes at least past and current dividends. Equation (1) can be solved recursively forward to yield:

$$(2) \qquad P_t = \sum_{j=1}^{n} b^j E\left(D_{t+j}|I_t\right) + b^n E\left(P_{t+n}|I_t\right).$$

In order to rule out the existence of speculative bubbles we assume that $\lim_{n\to\infty} b^n E\left(D_{t+j}|I_t\right) = 0$; thus, for $n \to \infty$ (2) becomes

$$(3) \qquad P_t = \sum_{j=1}^{\infty} b^j E\left(D_{t+j}|I_t\right)$$

which states that the current stock price coincides with the discounted value of the future dividend stream.

This evaluation scheme is used in the next Section in order to examine recent trends in the stock market. Before running these econometric efficiency tests, it can be useful to have a preliminary outlook of the relationship between stock values and fundamentals through the following identity, introduced by Gordon (1962):

$$(4) \qquad dy_t = D_t/P_t \equiv r_t - g_t + \sigma_t$$

where dy_t is the dividend yield, r_t is the real interest rate, g_t is the expected growth of dividends (which can be assumed to be proportional to the expected rate of growth of the economy), σ_t is the risk premium embedded in the stock investment.[3] It is worth noting that, from a theoretical standpoint, (4) holds true only if the stock market is in equilibrium: all of the variables in (4) should not deviate from the long term values. In other words, this relation is not expected to hold instantaneously in any one period, but it has to hold, on average, for a sufficiently large number of periods. Hence, at time t, the relation will record an error, ε_t, which will encompass the disequilibrium entity needed to maintain the identity:

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[3] The price of a stock is given by the infinite discounted sum of the future dividend stream $P_t = \sum_{i=1}^{\infty} \frac{D_{t+1-i}}{(1+r)^{i-1}}$; assuming a constant rate of growth of dividends g, so that $D_{t+p} = D\left(1+g\right)^p$, we have $P_t = \frac{D}{r-g}$. Introducing uncertainty on the expected dividend stream and rearranging the terms we obtain equation (4).

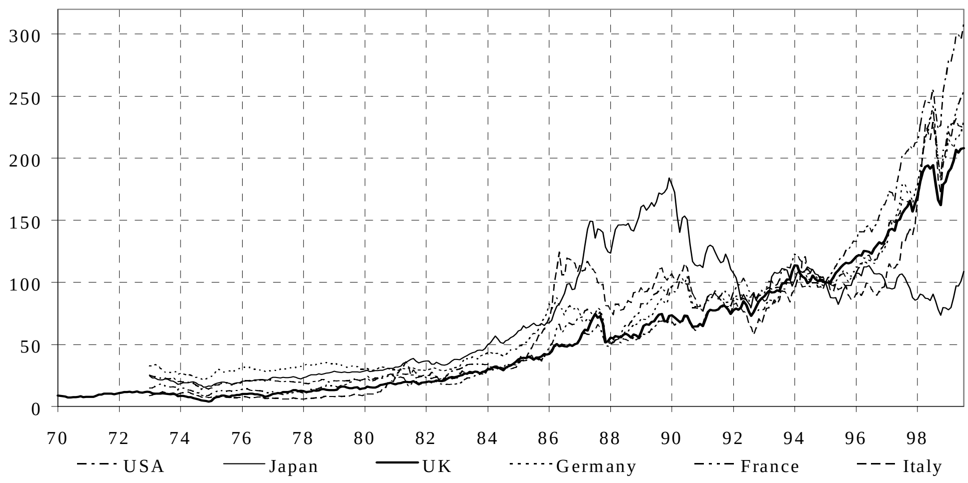
(5) $$dy_t = D_t/P_t \equiv r_t - g_t + \sigma_t + \varepsilon_t.$$

The calculation of the individual terms of (5) is likely to produce useful insights. In fact, given three of the four variables, it is possible to calculate the implied value of the fourth; these, compared to current values, can proxy market disequilibrium, incorporating the component ε_t too. For example, given the risk premium, the expected rate of growth of dividends and the real interest rate, it is possible to obtain the implied value of the dividend yield.

Figures 1 to 3 show historical monthly values from January 1973 of stock market indices, dividend yields (dy) and price/earnings ratios (pe) for the G6 countries. As frequently noted last year by market participants and some monetary authorities, a similarity may be established between the period preceding the October 1987 crash and current stock market conditions.

Figure 1

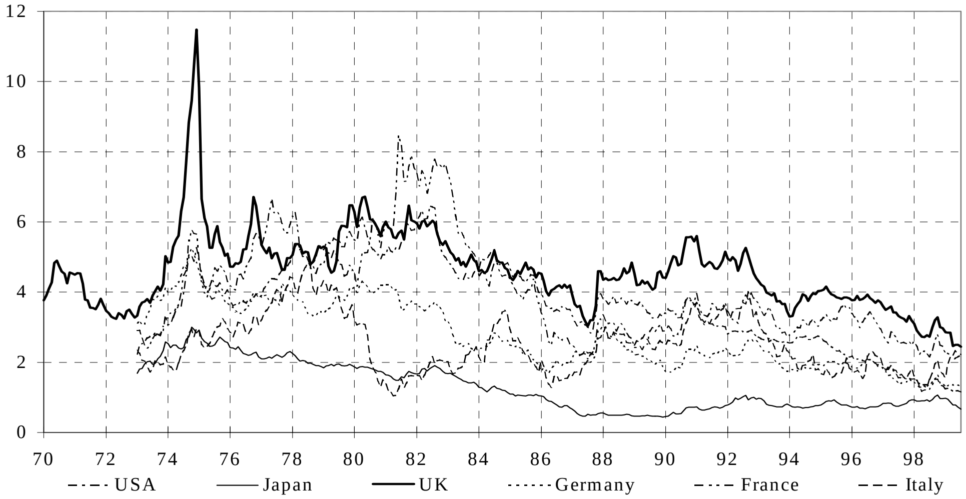
STOCK MARKET INDICES



Source: Datastream – monthly averages; Jan 1995 = 100

Figure 2

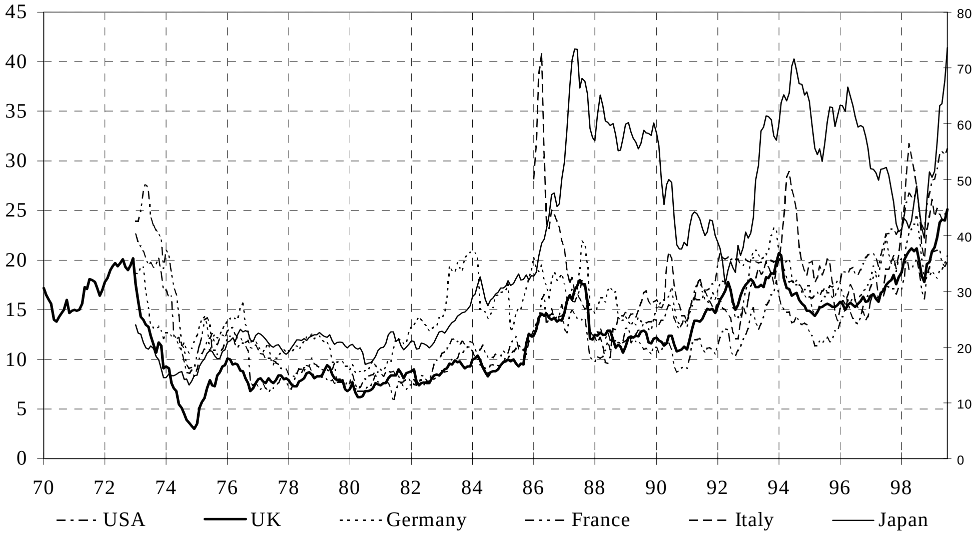
DIVIDEND YIELDS



Source: Datastream – monthly averages

Figure 3

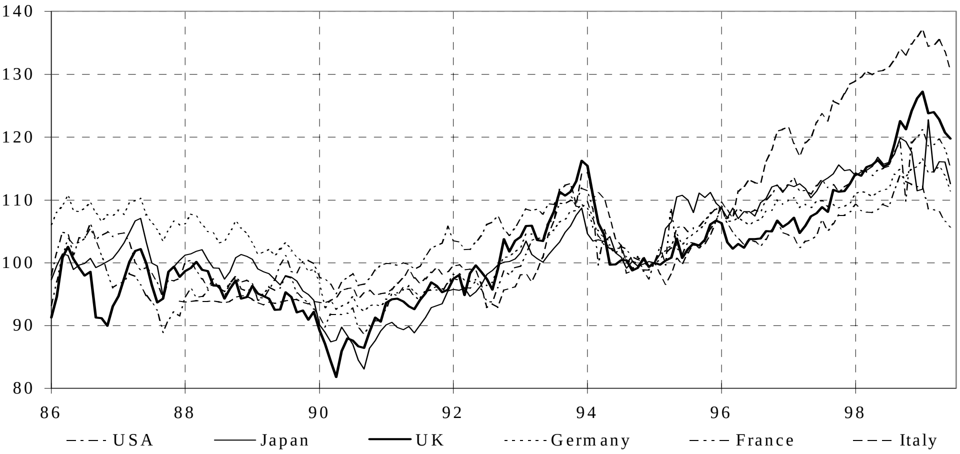
PRICE TO EARNINGS RATIOS



Source: Datastream – monthly averages; the series for Japan is on the right axis.

Figure 4

BOND INDICES IN LOCAL CURRENCY



Source: Datastream – monthly averages; Jan 1995 = 100

As in 1987, a dramatic decrease in the dividend yield and a corresponding increase in the price/earnings ratio can be evidenced; both elements signal excessive movements of stock prices with respect to their fundamental variables, i.e. earnings or dividends.

The exceptional rise in stock markets is also highlighted by a comparison with bond indices, shown in Figure 4. At the end of last year, no bond index above 140, but all the stock market indices averaged far above, at levels close to 250.

We calculate the values of some relevant variables consistent with the current level of the dividend yield with equation (5). The expected growth rate of dividends (g) is calculated with the following formula, which is widely used in corporate finance:[4]

[4] In equation (6), D is the dividend, P price and E earnings, for a given stock. $dy/ep = (D/P)/(E/P) = D/E$ is the pay-out ratio, the distributed earnings quota, and hence $1 - dy/ep$ is the plow-back ratio, the share reinvested in the enterprise. r is a proxy for the *return on equity ratio* (ROE). The expected growth can be calculated by multiplying the plow-back ratio by the ROE.

$$g = \left[1 - \frac{D/P}{E/P}\right] r. \quad (6)$$

The values obtained through (6) are substituted with those derived in an analogous analysis by Kennedy *et al*. (1998), so as to have comparable results. The risk premium is computed as the average difference between stock returns and bond returns from 1983 to 1998. Historic values for all four variables (dividend yield (dy), expected growth rate of dividends (g), risk premium (σ) and real interest rate (r)[5]), benchmark variables of our analysis based on the Gordon formula, are shown in Table 1. A preliminary estimate of the coherence between dividend yields and fundamentals is shown in Table 2.

Table 1

INTERNATIONAL STOCK MARKETS: CURRENT AND HISTORICAL DATA

	Dividend yield	Real interest rate		Risk premium	Expected rate of growth of dividends	
	(1)	(2)	(3)	(4)	(5)	(6)
	December 1998	long term	short term	average 1983-98	IMF avg. 1998-99	earnings× real rate
US	1.33	3.04	3.54	3.46	2.50	2.16
Japan	0.97	0.57	0.01	4.27	2.00	0.60
Germany	1.44	3.17	2.67	4.44	2.25	2.51
UK	3.03	1.96	3.80	4.29	2.25	1.26
France	2.43	3.64	3.06	5.65	2.15	1.98
Italy	1.78	2.27	1.67	4.28	2.20	1.43

Note: the Table reports quarterly data for the variables in (1) recorded at the end of 1997. The dividend yield is given by the ratio of dividends to prices of each national stock market. The short term real interest rate is given by the 3 month euromarket rate deflated by the current CPI inflation rate. The long term real interest rate is given by the interest rate on 10 year government bonds deflated by the current CPI inflation rate. The risk premium is given by the average differential between ex-post stock returns and ex-post government bond returns from 1983 to 1998. The potential growth of dividends is computed in two ways: (5) IMF estimates and (6) multiplying non distributed earnings by the long term interest rate.

[5] The real interest rate at time t is calculated as the difference between the nominal interest rate and the change in the consumer price index on a year on year basis ending at time t.

Table 2

GORDON'S STATIC FORMULA: IMPLIED DIVIDEND YIELD

(based on OECD forecasts for the expected rate of growth of dividends)

	implied value	value as of December 1998
	(a)	(b)
United States	2.54	1.33
Japan	0.57	0.97
Germany	2.92	1.44
United Kingdom	1.71	3.03
France	3.49	2.43
Italy	2.07	1.78

Note: data in the first column are dividend yields resulting from equation (4): we fixed the risk premium, the expected growth rate and the real interest rate at their current values and calculated the implied dividend yields as a residual. The second column reports historical dividend yields as of December 1998.

Table 3

GORDON'S STATIC FORMULA: IMPLIED REAL INTEREST RATE

(based on OECD forecasts for the expected rate of growth of dividends)

	implied value	value as of December 1998
United States	1.88	3.04
Japan	0.96	0.57
Germany	1.73	3.17
United Kingdom	3.31	1.96
France	2.64	3.64
Italy	2.07	2.27

Note: data in the first column are dividend yields resulting from equation (4): we fixed the risk premium, the expected growth rate and the dividend yield at their current values and calculated the implied dividend yields as a residual. The second column reports historical dividend yields as of December 1998.

With the exception of Japan, where the dividend yield should fall dramatically to reach negative values, significant increases of this variable should be observed. Even if the phenomenon is particularly relevant in Italy and the United States, the expected increase is also significant in Germany and the United Kingdom and, to a lesser extent, in France. Repeating the exercise with the real interest rate as a benchmark variable, the current dividend yields would embed expectations of lower values for this variable in the G6 area (Table 3), with the exception of Japan. Expected real rates should decrease in Italy and the United States, and less markedly in the United Kingdom, France and Germany.

Table 4

GORDON'S STATIC FORMULA: IMPLIED GROWTH RATE

	implied value	historical 1998-99
	(a)	(b)
United States	3.66	2.3
Japan	1.61	1.3
Germany	3.69	2.4
United Kingdom	0.90	1.8
France	3.15	2.1
Italy	2.49	1.8

Note: data in the first column are dividend yields resulting from equation (4): we fixed the risk premium, the real interest rate and the dividend yield at their current values and calculated the implied dividend yields as a residual. The second column reports historical dividend yields as of December 1998.

The expected change in the real interest rate seems at odds with the trends in the fundamentals of these economies; in particular, the expected real interest rates in Italy should fall significantly below the levels recorded in the past decade. The same conclusion can be inferred from the trends in the expected growth of dividends; this latter variable, which tracks expected GDP growth, should increase to values that are out of line with current business cycle momentum (Table 4). All the results shown in Tables 2-4 must be interpreted cautiously, as they are based on a simple accounting framework (and not on a dynamic model of stock prices) as well as on simplified estimates of risk premia; however, they lead to the conclusion that the current dividend yields discount a sizeable decline in real interest rates or an increase in the expected growth of the leading economies.

3. Dynamic analysis of the relation between stock values and fundamentals

3.1 *The traditional macroeconomic setup*

The dynamic model of Gordon presented in the next Section is an attempt to overcome the difficulties encountered in the macro-finance literature by more directly analyzing the second order moments of the relevant variables. The macro-finance models traditionally assume that there exists an investor who trades freely in asset i to obtain $(1 + R_{i,t+1})$ and has a discount factor equal to b. After taking the logs of the relevant variables, the first order condition can be expressed as:

$$0 = E_t(r_{i,t+1}) + E_t(m_{t+1}) + \frac{1}{2}[\sigma_i^2 + \sigma_m^2 + 2\sigma_{im}] \tag{7}$$

where $E_t(\cdot)$ denotes expectations conditional on the information set I_t avalaible at time t, m_{t+1} is the logarithm of the intertemporal marginal rate of substitution $b\frac{U'(c_{t+1})}{U'(c_t)}$, σ_i^2 and σ_m^2 are the unconditional variances of the i-th's asset return and of the marginal rate of substitution, respectively, and σ_{im} is the covariance between these two variables. For a riskless asset, f, the above relation becomes:

$$r_{f,t+1} = -E_t(m_{t+1}) - \frac{1}{2}\sigma_m^2. \tag{8}$$

Subtracting the latter from the former one yields the expression for the risk premium or the excess return of an asset:

$$E_t[r_{i,t+1} - r_{f,t+1}] + \frac{1}{2}\sigma_i^2 = -\sigma_{im} \tag{9}$$

which states that the risk premium is related to the covariance term.

Working with power utility functions of the following type:

$$U[C_t] = \frac{C_t^{1-\gamma} - 1}{1-\gamma} \tag{10}$$

where C_t denotes consumption and γ is the coefficient of relative risk aversion, the expression for the risk premium may be written as:

$$E_t[r_{i,t+1} - r_{f,t+1}] + \frac{\sigma_i^2}{2} = \gamma\sigma_{ic}. \tag{11}$$

Unfortunately, in this kind of model one needs a coefficient of relative risk aversion that is too high, generally greater than 10, to produce significant results.

Epstein and Zin (1989, 1991) and Weil (1989) developed a more flexible version of the basic power utility model, restrictive insofar as the elasticity of intertemporal substitution, ψ, is the reciprocal of the relative risk aversion. In their models the utility function is specified as:

$$U_t = \left\{(1-\delta)C_t^{\frac{1-\gamma}{\theta}} + \delta(E_t U_{t+1}^{1-\gamma})^{1/\theta}\right\}^{\frac{\theta}{1-\gamma}} \tag{12}$$

in which

$$\theta = \frac{1-\gamma}{1-\frac{1}{\psi}} \tag{13}$$

so that when $\gamma = \frac{1}{\psi} \rightarrow \theta = 1$ and the basic power utility result is obtained as a specific case. Following Campbell (1998), the expression for the risk premium in this setup is:

$$E_t[r_{i,t+1}] - r_{f,t+1} + \frac{\sigma_i^2}{2} = \theta\frac{\sigma_{ic}}{\psi} + (1-\theta)\sigma_{iW} \tag{14}$$

where σ_{iW} is the covariance between asset i and the market portfolio. This model nests the consumption Capital Asset Pricing Model with power utility, when $\theta = 1$, as well as the traditional static Capital Asset Pricing Model, when $\theta = 0$. In this case, as pointed out by

Campbell (1998), there are also difficulties in bringing the empirical evidence in line with the model's predictions. What the two previous models have outlined is that an important job to be confronted is that of appropriately modeling the second order moments of stock prices and macroeconomic variables, since these are the main determinants of theoretical risk premia. One attempt in this direction has been made by Campbell and Shiller (1988, 1989), as illustrated in the next Section; they developed a framework linking changes in dividend yields to movements in interest rates and expected growth.

3.2 *Dynamic Gordon's formula and Campbell and Shiller's model*

This Section presents the results of a market efficiency test. As in the financial assets valuation literature, it measures the excess variability of observed stock indices with respect to projections based on fundamentals (dividends, earnings, real interest rate, inflation).

If $x*$ is the present value of an infinite flow of dividends and x is the market value of the stock, the tests for the excess variability of the stock market are based on the comparison of the variability of the observed series $Var(x)$ and that of the forecast $Var(x*)$, the latter being obtained from the model of Gordon (1962) presented in the last Subsection.[6]

A large number of studies has demonstrated that, at least for leading countries, the variability of the observed series is substantially greater than the variability of the projections based on the dividend-yield model (i.e. the dynamic version of Gordon's model), contradicting the theoretical relation that $Var(x*) \geq Var(x)$.

West (1988) develops an alternative test for the excess variability in stock markets, which can also quantify the phenomenon. To illustrate the model, consider x, a stationary variable with zero mean. The test is based on the comparison of the linear projection of x, $\mathbf{P}$, i.e. its

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[6] The relevance of the tests aimed to identify an excess volatility in stock prices can be presented with the following example. Let us consider a variable $x*$, with expected value $x = E(x*)$, so that $x* = x + u$, where $u \sim (0, \sigma^2)$ is the forecast error with zero mean and homoskedastic variance. By definition, the error is uncorrelated with the expectation $x = E(x*)$; hence $Var(x*) = Var(x) + Var(u)$. From this follows:

$$Var(x*) \geq Var(x)$$

The variance of the expected variable x has $Var(x*)$ as an upper bound. In other terms, if x is the optimal forecast of $x*$, when $x*$ is regressed on the vector $[1, x]'$ the coefficient of x should equal 1. Testing whether $Var(x)$ is larger than $Var(x*)$ corresponds to testing the hypothesis that the regression coefficient, $Cov\,(x, x*) / \sqrt{Var\,(x)\,Var\,(x*)}$, would be less than 1. See also LeRoy and Porter (1981).

expected value conditional on the information set I, and the expected value conditional on the information set $H \subset I$, where I contains at least the present and past values of x. Given a discount factor b $(0 < b < 1)$, one can show that

(15) $$E\left[x_{tH} - \mathbf{P}\left(x_{tH}|H_{t-1}\right)\right]^2 \geq E\left[x_{tI} - \mathbf{P}\left(x_{tI}|I_{t-1}\right)\right]^2$$

where $x_{tI} = \lim_{k\to\infty} \mathbf{P}\left(\sum_{j=0}^{k} b^j D_{t+j}|I_t\right)$ and $x_{tH} = \lim_{k\to\infty} \mathbf{P}\left(\sum_{j=0}^{k} b^j D_{t+j}|H_t\right)$.

Equation (15) indicates that the variance of the forecast for x, conditional on the availability of an information set H, that is a subset of I, exceeds the same variance conditional on I.[7] In other words, less information produces greater variability.

An important extension of the model developed by West, which has led to a large number of other papers (for an example see Shiller, 1989, and Kupiec, 1993), can be obtained by relaxing the hypothesis of constancy of the expected returns, as put forward in Campbell and Shiller (1988; 1989).

The relationship between price, dividend and return is given by $P_t = \frac{P_{t+1}+D_{t+1}}{1+r_{t+1}}$. Taking the natural logarithm of the previous formula, we get (lowercase letters denote logarithm and caps indicate estimated parameters):

(16) $$r_{t+1} = \log\left(P_{t+1} + D_{t+1}\right) - \log\left(P_t\right) = p_{t+1} - p_t + \log\left[1 + \left(d_{t+1} + p_{t+1}\right)\right]$$

and expanding with Taylor's formula around the average dividend yield, we obtain

(17) $$r_{t+1} \approx k + bp_{t+1} + (1-b)\,d_{t+1} - p_t$$

where $b \equiv 1/\left(1 + \exp\left(d - p\right)\right)$ with $(d-p)$ equal to the logarithm of the average dividend-yield and $k \equiv -\log(b) - (1-b)\log(1/b - 1)$. Solving recursively equation (17), taking the expected value and ruling out speculative bubbles through $\lim_{n\to\infty} b^n E\left(p_{t+n}|I_t\right) = 0$, we have

[7] It must be recalled that the linear projection produces the minimum mean quadratic error in the class of linear operators.

(18) $$p_t = \frac{k}{1-b} + E\left[\sum_{j=0}^{\infty} b^j \left[(1-b)\, d_{t+1+j} - r_{t+1+j}\right] \mid I_t\right].$$

The equation may also be written in terms of the logarithm of dividend-yield:

(19) $$d_t - p_t = \frac{k}{1-b} + E\left[\sum_{j=0}^{\infty} b^j \left[r_{t+1+j} - \Delta d_{t+1+j}\right] \mid I_t\right].$$

The latter model, known as the dividend yield model is just a dynamic version of Gordon's scheme (1962). To estimate (19) consider the vector of demeaned variables $z' = [d-p, r, \Delta d]$ or, in the case of the enriched model which also includes the inflation rate, π, as a determinant of stock values, $z' = [d-p, r, \Delta d, \pi]$;[8] the dynamics of z_t can be represented with the following first order VAR scheme:

(20) $$z_{t+1} = Az_t + w_{t+1}$$

where $w \sim (0, \sigma^2)$.

Defining

(21) $$e_1' = [1,0,0]\,,\ e_2' = [0,1,0]\,,\ e_3' = [0,0,1]$$

we obtain, trivially:

$$\begin{aligned} e_1' z &= d - p \\ e_2' z &= r \\ e_3' z &= \Delta d. \end{aligned}$$

[8] The inflation rate is included since we assume that it has a non neutral impact on stock prices in real terms through the tax treatment of earnings and dividends and through the existence of a premium on the real interest rate.

Conditional forecast of VAR models has the following form:

(22) $$E\left[z_{t+j} \mid I_t\right] = A^j z_t.$$

Using equation (19) of the dividend yield model and equation (22) of the forecast model scheme, we obtain:

(23) $$d_t - p_t \approx e_1' z_t = \sum_{j=0}^{\infty} b^j \left[e_2' - e_3'\right] A^{j+1} z_t$$

or, alternatively, computing the infinite sum of terms $b^j \left(e_2' - e_3'\right) A^{j+1}$, the econometric estimation of the market efficiency condition (19) is calculated with the equivalent simpler specification:

(24) $$e_1' z_t = \left(e_2' - e_3'\right) A \left(I - bA\right)^{-1} z_t.$$

The latter, though equivalent to (19), evidences the similarity between the empirical VAR scheme and the theoretical requirement of Gordon's scheme that the dividend yield may be explained by the present value of the infinite sum of future real rates and expected growth of dividends; such values are obtained in (24) as the solution of a geometric progression.[9] It follows from (24) that the estimated dividend yield, i.e. the value obtainable by the expected changes in the fundamentals, can be expressed as the difference between an interest-driven component

(25) $$(d-p)_{r_t} = e_2' \hat{A} \left(I - b\hat{A}\right)^{-1} z_t$$

and a dividend-driven component

9 It is known that the progression $(I + bA + b^2A^2 + b^3A^3 + ...)z_t$, which represents all the future values of the variables contained in the vector z_t according to the VAR scheme from time t to infinity, has as a limit value $I(I - bA)^{-1}z_t$.

(26) $$(d-p)_{d_t} = e_3' \hat{A} \left(I - b\hat{A}\right)^{-1} z_t.$$

The validity of the model necessitates that a given number of restrictions on the parameters be satisfied. If (24) holds for the variables belonging to z at each time t, then the following relation must also hold true, being an hypothesis that may be verified via a non-linear Wald test:[10]

(28) $$e_1' = \left(e_2' - e_3'\right) A \left(I - bA\right)^{-1}.$$

Another way to interpret the above expression regards the inability to forecast stock returns. If (28) is not rejected then stock returns cannot be forecasted and the hypothesis of market efficiency cannot be statistically rejected.

4. Data and preliminary estimation of the dynamic model of Gordon

As mentioned in the last Section, the VAR scheme is a tool used to evaluate, consistent with the behaviour of economic agents, the expected values of the relevant variables (real interest rate and expected growth of dividends) from the instant at which the evaluation is initiated to infinity. The knowledge of such values is fundamental since the price of a stock coincides with the expected value of the future flow of dividends. Thus, the VAR model attempts to replicate the process by which markets generate expectations: to this aim, expectations are conditional upon the set of information available at that precise instant only. To obtain a preliminary idea of the empirical relevance of the model, we formulated a dynamic version of the Gordon's model, with static expectations, i.e. with the current values of all the variables as the best forecast of their future values. Based on such hypothesis we estimated six vector error-correction models (VECM) which, after being solved, evidence the long-run

[10] In Section 4 we test a modified version of (28) obtained by post-multiplying the left-hand and the right-hand member by $(I - bA)$; this gives a set of linear restrictions, namely

(27) $$e_1' \left(I - bA\right) = \left(e_2' - e_3'\right) A$$

which is equivalent to stating that the one period dividend yield is unpredictable. Conversely (28) says that the VAR forecast of the future real dividend yield is equal to the logarithm of the current dividend yield.

relationship between the relevant variables, dividend yield, real interest rate, output growth and inflation. The general form of such equations, expressed in terms of first differences is:[11]

(29) $$\Delta z_t = \mu + \sum_{j=1}^{p} \Gamma_j \Delta z_{t-j} + \alpha\beta' \bar{z}_{t-1} + \varepsilon_t$$

where μ is a vector of constants, $\bar{z}' = [z', 1] = [d - p, r, g, 1]$ is a vector containing the logarithm of the dividend yield, the real interest rate and the deviation of GDP from its exponential trend, a constant, proxy for the risk premium, Δ is the first difference operator, α is the $(4 \times r)$ loading matrix (i.e. a measure of the average speed of convergence towards long run equilibrium) and β is the $(4 \times r)$ cointegration vector matrix, where r is the number of cointegration equations between the four variables, $\varepsilon_t \sim MN(0, \Sigma)$. The terms in first differences in (29) identify the short-run dynamics of the dividend yield, i.e. the adjustment process which follows a stock market shock; the terms in levels in (29), identified by the coefficients of the matrix β, capture the long-run relation among the variables.

First, we performed a Johansen cointegration test in order to identify the number of cointegration equations: for all of the six countries we found one cointegration equation at the 5 per cent significance level; see Table 3.1. The estimates of the cointegration vector are here reported. Second, we tested the restriction implied by the Gordon formula (4), i.e. that the cointegration vector is equal to $[1, -1, 1, k]$; the p-value for this test is shown in the last row of Table 6.[12] The existence of one cointegration equation supports the relation between dividend yields and fundamentals which, however, departs from the simple version of the Gordon rule.

---

[11] The VAR is defined as $z_t = \mu + \sum_{j=1}^{p} C_j z_{t-j} + \varepsilon_t$. With simple algebraic passages, we obtain its *ECM representation* where $\alpha\beta' = -(I - C_1 - C_2 - ... - C_p)$ and $\Gamma_j = -(C_{j+1} + ... + C_p)$. α and β have dimension $(p \times r)$ where r is the cointegration rank, see [15].

[12] With one cointegration vector the matrix $\alpha\beta'$ becomes $\begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix} [\beta_1, \beta_2, \beta_3, \beta_4]$. The restriction tested in the last row of Table 3.1 corresponds to imposing $\beta_1 = 1, \beta_2 = -1$ and $\beta_3 = 1$.

Table 6

NORMALISED COINTEGRATION VECTOR

	USA	Japan	Germany	UK	France	Italy
$d-p$	1.000	1.000	1.000	1.000	1.000	1.000
r	-0.900	-0.292	**0.251**	-0.157	**0.415**	**0.214**
g	1.603	0.122	**-0.122**	0.312	**-0.196**	**-0.291**
constant	-1.301	-0.617	-2.662	-3.769	-5.347	-3.309
rank	1**	1*	1**	1**	1*	1*
LR test						
$r=0$	39.30	29.80	44.78	51.97	30.25	32.40
$r=1$	11.31	12.76	18.41	18.82	10.96	14.24
$r=2$	0.15	0.00	1.29	6.84	2.43	2.11
restriction$^{(a)}$ p-value	0.63	0.01	0.00	0.13	0.00	0.00

Note – coefficients in bold have the opposite sign. – The statistics for the LR ratio at the 5 (1) % significance level are 29.68 (35.65), 15.41 (20.04) and 3.76 (6.65), respectively. – */** the null hypothesis of rank equal to 1 is not rejected at the 5/1% significance level. – $^{(a)}$The restriction tests the null hypothesis that the cointegration vector was $[1, -1, 1, k]$ with k free.

Summarizing the results of Table 6: with the exception of the United States, Japan and the United Kingdom, the estimated long-run coefficients relative to g do not have the sign predicted by Gordon's model; in Germany, France and Italy the real interest rate also does not have the correct sign; with the exception of Japan, the risk premium (proxied by the constant term) is large, ranging in value from 1.3 to 5.3. Moreover, the relation implied by the Gordon formula (4) is rejected in all but the United States and the United Kingdom; for the other four countries the model reveals the existence of a puzzling relationship between dividend yields and fundamentals, albeit such result might be dependent upon the assumption of static expectations.

In the next Section, the assumption of static expectations will be replaced by an econometric model aimed to reproduce the mechanism by which economic agents predict fundamentals.

5. The results of the Campbell and Shiller model

In this Section tests for market efficiency are carried out with the model proposed by Campbell and Shiller (1988b). In the authors' specification, this scheme adopts a VAR model composed of three variables: the dividend yield, the short-term real interest rate and the rate of growth of dividends. Efficiency holds only if the restrictions reported in (28) are satisfied, implying that the current value of the stock index equals the present value of the flow of future dividends; this hypothesis is analysed through a Wald test.[13] Unlike the original work of CS, we enlarge the information set so as to include the inflation rate; under these conditions, the test is no longer based upon nine linear restrictions of the parameters but on twelve linearized restrictions. It is useful to recall that the CS model can also be used to decompose the dividend yield series into components due to each of the explanatory variables. One can thus isolate the individual contributions to the overall series; the most important of these is the component of the the expected rate of growth of dividends. The latter and the test of the validity of the restrictions in (28) are briefly reported in Figures 5-10 and in Table 7, respectively. From Table 7 one may conclude that the efficiency hypothesis is acceptable in just one sixth (2 out of 12) of the cases: for Germany in the restricted and unrestricted model (in the latter, stock prices depend not only on dividends and earnings, but also on inflation); in the remaining cases the hypothesis is rejected at the 1 percent level of confidence. Figures 5-10 show the log-dividend yields along with their forecasts based on the unrestricted model given by the future trend of dividends, as indicated in (26); the Figures also report a one-standard deviation confidence interval for the estimated dividend yields.

[13] Note that if time series in z are integrated of order one then $|I - bA| \approx 0$ since b is approximately 0.95. In this case the null hypothesis given by (28) is not easily testable and we should test (27). However non stationarity of the VAR does not guarantee non singularity and this implies that the VAR forecast is not accurate.

Table 7

TEST OF THE STOCK MARKET EFFICIENCY RESTRICTIONS

	Restricted model[a]	Unrestricted model[b]
United States[i]	24.57 (0.00)	19.09 (0.00)
Japan[i]	41.55 (0.00)	30.12 (0.00)
Germany[ii]	**37.98** (0.03)	**35.84** (0.01)
United Kingdom[iii]	42.28 (0.00)	35.64 (0.00)
France[ii]	73.32 (0.00)	49.81 (0.00)
Italy[i]	35.53 (0.00)	34.21 (0.00)

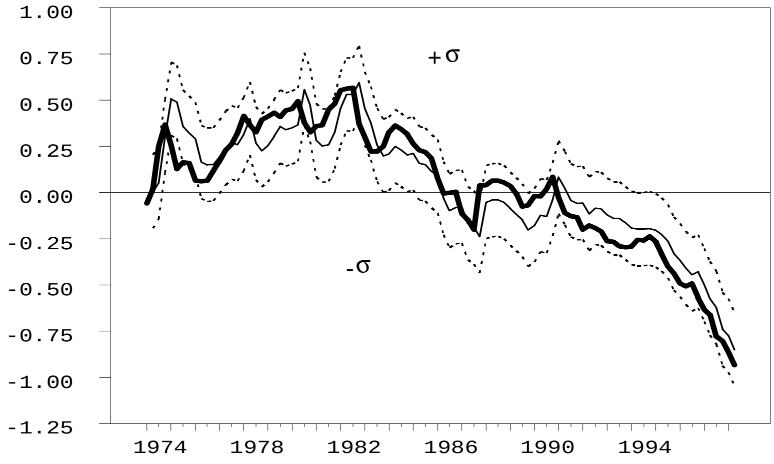
Notes: ([i]) VAR with 2 lags; the degrees of freedom are 6 and 8 for the restricted and unrestricted model, respectively. ([ii])VAR with 6 lags; the degrees of freedom are 18 and 24 for the restricted and unrestricted model, respectively. ([iii])VAR with 1 lag; the degrees of freedom are 3 and 4 for the restricted and unrestricted model, respectively. The test for market efficiency is a Wald-type test given by (27); it is asymptotically distributed as a χ^2. The model is estimated on quarterly averages observed between January 1974 and June 1998; for Japan the model adopts a different measure for the expected growth of dividends. The variables are demeaned. In parentheses we report the p-value of the test; the values reported in bold indicate that the efficiency hypothesis is accepted at the 1 percent significance level. ([a]) The restricted model assumes as determinant of the stock indices just the historical values of the dividend-yield and the short-term real interest rate, as well as the expected growth of output. ([b]) The unrestricted model, unlike the restricted one, also includes the change in the inflation rate as a determinant of stock indices.

According to the Campbell and Shiller model, dividend yields are low in all six countries. It is important to recall that the results reported in Table 7 and in Figures 5-10 must not necessarily give the same results, since the test in the Table denotes a concept of average significance of the relationship between stock indices and fundamentals while Figures 5-10 show the trends in observed and fitted values.

Although the overall conclusion supports the hypothesis according to which the relationship between dividend yields and fundamentals is weak, it is important to point out the existence of three different situations: i) in the US and UK, the current dividend yields fall within the confidence band; ii) in Japan and France, they fall outside the band, but they are close to the lower edge; in Italy and Germany there is a sizeable gap between the current values and the lowest extreme of the confidence band.

Figure 5

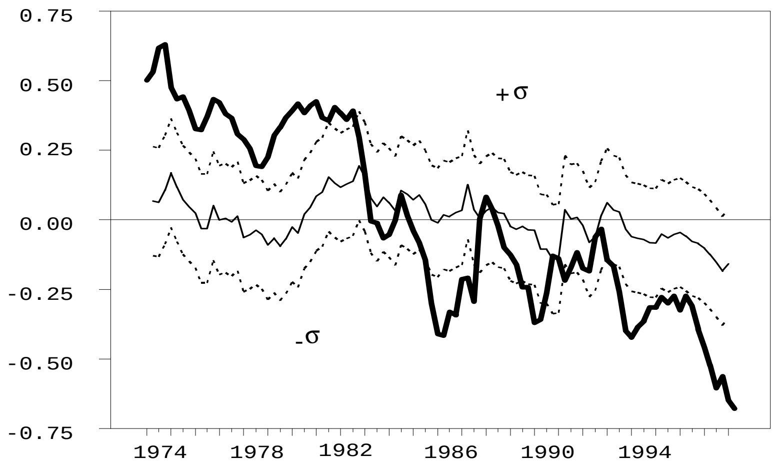
UNITED STATES



current (bold) and forecast (plain) log demeaned series with one standard deviation confidence band

Figure 6

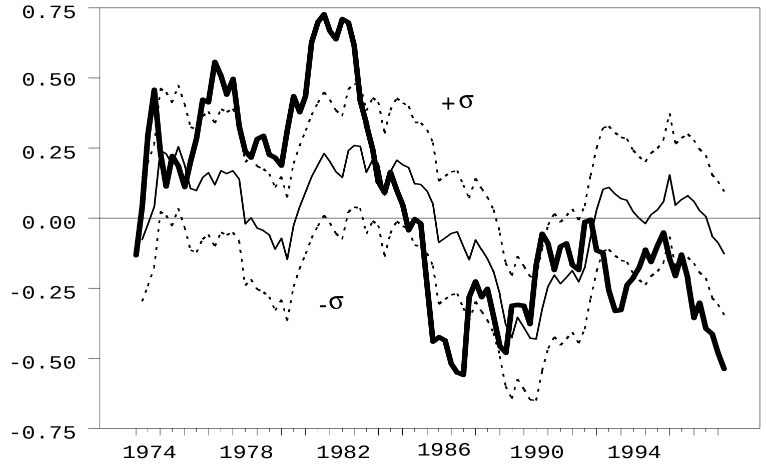
GERMANY



current (bold) and forecast (plain) log demeaned series with one standard deviation confidence band

Figure 7

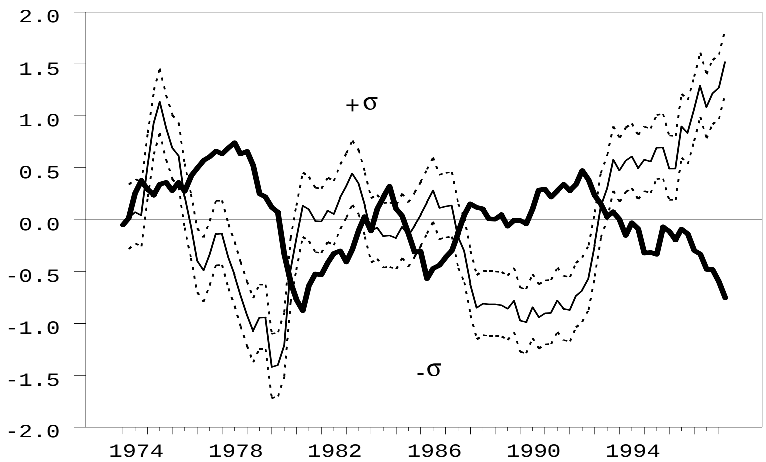
FRANCE



current (bold) and forecast (plain) log demeaned
series with one standard deviation confidence band

Figure 8

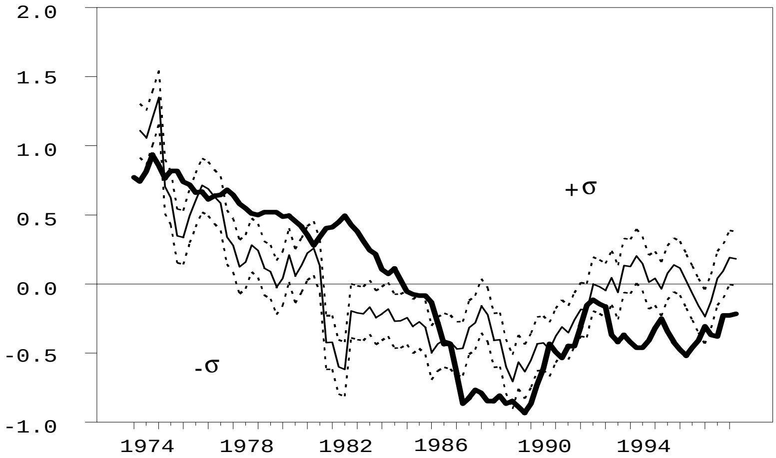
ITALY



current (bold) and forecast (plain) log demeaned
series with one standard deviation confidence band

Figure 9

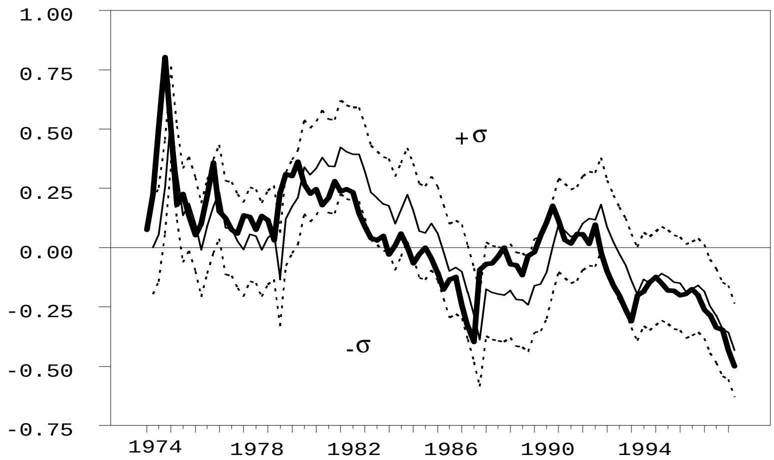
JAPAN



current (bold) and forecast (plain) log demeaned series with one standard deviation confidence band

Figure 10

UNITED KINGDOM



current (bold) and forecast (plain) log demeaned series with one standard deviation confidence band

Appendix I

Methodological issues

Reduction of a p-th order into a 1-st order difference equation

Every p-lag VAR model can be written as a 1-lag VAR using the companion matrix notation. Namely, every three demeaned variable VAR model with p lags

$$z_t = A_1 z_{t-1} + A_2 z_{t-2} + \cdots + A_p z_{t-p} + \varepsilon_t \tag{30}$$

where the z's and ε are (3×1) vectors and the A's are (3×3) matrices can be written as a first order difference equation

$$\begin{bmatrix} z_t \\ z_{t-1} \\ \vdots \\ \vdots \\ z_{t-p+1} \end{bmatrix} = \begin{bmatrix} A_1 & A_2 & \cdots & A_{p-1} & A_p \\ \underset{3\times3}{I} & \underset{3\times3}{0} & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & 0 & 0 \\ 0 & 0 & \cdots & I & 0 \end{bmatrix} \begin{bmatrix} z_{t-1} \\ z_{t-2} \\ \vdots \\ \vdots \\ z_{t-p} \end{bmatrix} + \begin{bmatrix} \varepsilon_t \\ \underset{3\times1}{0} \\ \vdots \\ \vdots \\ 0 \end{bmatrix} \tag{31}$$

or, letting

$$Z_t = \begin{bmatrix} z_t \\ z_{t-1} \\ \vdots \\ \vdots \\ z_{t-p+1} \end{bmatrix}, \mathbf{A} = \begin{bmatrix} A_1 & A_2 & \cdots & A_{p-1} & A_p \\ \underset{3\times3}{I} & \underset{3\times3}{0} & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & 0 & 0 \\ 0 & 0 & \cdots & I & 0 \end{bmatrix} \text{ and } E_t = \begin{bmatrix} \varepsilon_t \\ \underset{3\times1}{0} \\ \vdots \\ \vdots \\ 0 \end{bmatrix}$$

we can also write (31) as a 1-lag VAR model, namely

$$Z_t = \mathbf{A} Z_{t-1} + E_t. \tag{32}$$

Linear Wald test with p=1

With p=1, the transformed Wald test given by (18), namely $e_1' (I - b\mathbf{A}) = (e_2' - e_3')\,\mathbf{A}$, can be written as

(33) $$\begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}' \left(\underset{3\times 3}{I} - b \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \right) = \begin{pmatrix} 0 \\ 1 \\ -1 \end{pmatrix}' \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

and simplifying

(34) $$\begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}' \begin{bmatrix} 1 - ba_{11} & -ba_{12} & -ba_{13} \\ -ba_{21} & 1 - ba_{22} & -ba_{23} \\ -ba_{31} & -ba_{32} & 1 - ba_{33} \end{bmatrix} = \begin{pmatrix} 0 \\ 1 \\ -1 \end{pmatrix}' \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

(35) $$(1 - ba_{11}, -ba_{12}, -ba_{13}) = (a_{21} - a_{31}, a_{22} - a_{32}, a_{23} - a_{33})$$

which is equivalent to the following non-homogenous system

(36) $$\begin{array}{c} ba_{11} + a_{21} - a_{31} = 1 \\ ba_{12} + a_{22} - a_{32} = 0 \\ ba_{13} + a_{23} - a_{33} = 0. \end{array}$$

Consider the following vec operator which transforms a $(n \times n)$ matrix into a $(n^2 \times 1)$ vector by stacking the rows, namely

$$vec\,(A) = [a_{11}, a_{12}, a_{13}, a_{21}, a_{22}, a_{23}, a_{31}, a_{32}, a_{33}]' = \beta$$

let $r = (1, 0, 0)$ and

$$R = \begin{bmatrix} b & 0 & 0 & 1 & 0 & 0 & -1 & 0 & 0 \\ 0 & b & 0 & 0 & 1 & 0 & 0 & -1 & 0 \\ 0 & 0 & b & 0 & 0 & 1 & 0 & 0 & -1 \end{bmatrix}$$

a $[3p \times (3p \times 3)]$ matrix. Then restriction (36) can be written as

$$R\beta = r \tag{37}$$

which is the usual notation for linear restrictions. Then we can carry out the usual Wald test

$$\chi^2(3p) = (r - R\beta)' \left[R\Sigma_z R'\right]^{-1} (r - R\beta). \tag{38}$$

Linear Wald test with p=2

With $p = 2$, (32) becomes

$$\begin{aligned}
&\begin{pmatrix} 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}' \left(\underset{6\times 6}{I} - b \begin{bmatrix} a_{11}^1 & a_{12}^1 & a_{13}^1 & a_{11}^2 & a_{12}^2 & a_{13}^2 \\ a_{21}^1 & a_{22}^1 & a_{23}^1 & a_{21}^2 & a_{22}^2 & a_{23}^2 \\ a_{31}^1 & a_{32}^1 & a_{33}^1 & a_{31}^2 & a_{32}^2 & a_{33}^2 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \end{bmatrix} \right) \\
&= \begin{pmatrix} 0 \\ 1 \\ -1 \\ 0 \\ 0 \\ 0 \end{pmatrix}' \begin{bmatrix} a_{11}^1 & a_{12}^1 & a_{13}^1 & a_{11}^2 & a_{12}^2 & a_{13}^2 \\ a_{21}^1 & a_{22}^1 & a_{23}^1 & a_{21}^2 & a_{22}^2 & a_{23}^2 \\ a_{31}^1 & a_{32}^1 & a_{33}^1 & a_{31}^2 & a_{32}^2 & a_{33}^2 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \end{bmatrix}
\end{aligned} \tag{39}$$

where a_{ij}^k indicates the element of the i-th row and j-th column in the A_k matrix; after manipulation

$$\begin{aligned}
&\left(1 - ba_{11}^1, -ba_{12}^1, -ba_{13}^1, -ba_{11}^2, -ba_{12}^2, -ba_{13}^2\right) \\
= &\left(a_{21}^1 - a_{31}^1, a_{22}^1 - a_{32}^1, a_{23}^1 - a_{33}^1, a_{21}^2 - a_{31}^2, a_{22}^2 - a_{32}^2, a_{23}^2 - a_{33}^2\right)
\end{aligned} \tag{40}$$

which can be written as the following non-homogenous system

$$
\begin{aligned}
ba_{11}^1 + a_{21}^1 - a_{31}^1 = 1 \\
ba_{12}^1 + a_{22}^1 - a_{32}^1 = 0 \\
ba_{13}^1 + a_{23}^1 - a_{33}^1 = 0 \\
ba_{11}^2 + a_{21}^2 - a_{31}^2 = 0 \\
ba_{12}^2 + a_{22}^2 - a_{32}^2 = 0 \\
ba_{13}^2 + a_{23}^2 - a_{33}^2 = 0.
\end{aligned} \tag{41}
$$

Defining $vec(\mathbf{A}) = \beta$, $r = (1,0,0,0,0,0)$ and

$$
R = \begin{bmatrix}
b & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \\
0 & b & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\
0 & 0 & b & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 \\
0 & 0 & 0 & b & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 \\
0 & 0 & 0 & 0 & b & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & -1 & 0 \\
0 & 0 & 0 & 0 & 0 & b & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & -1
\end{bmatrix}
$$

a $[3p \times (3p \times 3)]$ matrix, then (41) can be written as $R\beta = r$ and the null hypothesis can be tested through a Wald test given by (38).

Appendix II

Confidence interval for the VAR

The VAR given by (32) is easy to use in forecasting. Forecasts in period T for horizon $h = 1$ may be obtained recursively as

$$z_{T+1|T} = A_1 z_T + A_2 z_{T-1} + \cdots \cdot + A_p z_{T+1-p} \tag{42}$$

and for longer horizons $h \geq 1$ they may be obtained recursively as

$$z_{T+h|T} = A_1 z_{T+h-1|T} + A_2 z_{T+h-2|T} + \cdots \cdot + A_p z_{T+h-p|T} \tag{43}$$

where $z_{T+j|T} = z_{T+j}$ for $j \leq 0$. The forecast errors are

$$\begin{gathered} z_{T+1} - z_{T+1|T} = u_{T+1} \\ z_{T+2} - z_{T+2|T} = u_{T+2} + A_1 u_{T+1} \\ \vdots \\ z_{T+h} - z_{T+h|T} = u_{T+h} + \Phi_1 u_{T+h-1} + \cdots + \Phi_{h-1} u_{T+1} \end{gathered} \tag{44}$$

where

$$\Phi_s = \sum_{j=1}^{s} \Phi_{s-j} A_j, \quad s = 1, 2, \ldots, \tag{45}$$

where $\Phi_0 = I_3$ and $A_j = 0$ for $j > p$. The MSE matrix of an h-step forecast is

$$\Sigma_z(h) = E\left\{ \left[z_{T+h} - z_{T+h|T} \right] \left[z_{T+h} - z_{T+h|T} \right]' \right\} = \sum_{j=0}^{h-1} \Phi_j \Sigma \Phi_j'. \tag{46}$$

The conditional covariance given by (46) is unbounded in the case of integrated process as $h \to \infty$. Hence, uncertainty increases without bounds for forecasts in the distant future. If the process is stationary, it can be proved that (46) approaches a constant, namely

(47) $$\lim_{h\to\infty} \Sigma_z(h) = \sum_{j=0}^{\infty} \Phi_j \Sigma \Phi_j' = V$$

which is bound by the unconditional covariance Σ_z of z_t.

The confidence interval is given by

(48) $$\left[e_1' z_{T+h|T} - \alpha_{1-\gamma/2}\sigma_1(h), e_1' z_{T+h|T} + \alpha_{1-\gamma/2}\sigma_1(h)\right],\ h = 1, 2, \ldots$$

where $\alpha_{1-\gamma/2}$ is the $\left(1-\frac{\gamma}{2}\right)100$ percentage interval point of the standard normal distribution and $\sigma_1(h)$ denotes the square root of the first element of $\Sigma_z(h)$, that is the standard deviation of the h-step forecast error for the variable $e_1' z_t$.

References

Bollerslev, T., R. F. Engle and D. Nelson (1994), "ARCH Models," in Mc. Fadden (ed.), *Handbook of Econometrics*, Vol. 4.

Bollerslev, T. and R. F. Engle and J. M. Wooldridge (1988), "A Conditional Capital Asset Pricing Model with Time Varying Covariances," *Journal of Political Economy*, No. 96, pp. 116-31.

Campbell, J. Y. and R. J. Shiller (1987), "Cointegration and Tests of Present Value Models," *Journal of Political Economy*, No. 95, pp. 1062-88.

Campbell, J. Y. and R. J. Shiller (1988a), "Interpreting Cointegrated Models," NBER Working Paper, No. 2568.

Campbell, J. Y. and R. J. Shiller (1988b), "Stock Prices, Earnings, and Expected Dividends," *Journal of Finance*, No. 43, pp. 661-76.

Campbell, J. Y. and R. J. Shiller (1989), "The Dividend Price Ratio and Expectations of Future Dividends and Discount Factors", *Review of Financial Studies*, No. 1, pp. 195-228.

Campbell, J. Y. (1991), "A Variance Decomposition for Stock Returns," *Economic Journal*, No. 101, pp. 157-79.

Campbell, J. Y. (1998), "Asset Prices, Consumption, and the Business Cycle," paper prepared for the *Handbook of Macroeconomics*, mimeo.

Epstein, L. and S. Zin (1989), "Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: An Theoretical Framework," *Econometrica*, No. 57, pp. 937-68.

Epstein, L. and S. Zin (1991), "Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: An Empirical Investigation," *Journal of Political Economy*, No. 99, pp. 263-86.

Fama, E. and K. R. French (1988), "Dividend Yields and Expected Stock Returns," *Journal of Financial Economics*, No. 22, pp. 3-25.

Gordon, M. J. (1962), *The Investment, Financing and Valuation of the Corporation*, Illinois, Homewood.

Kupiec, P. H. (1993), "Do Stock Prices Exhibit Excess Volatility, Frequently Deviate from Fundamental Values, and Generally Behave Inefficiently?," *Financial Markets, Institutions & Instruments*, No. 2, New York University Salomon Center.

LeRoy, S. F. and R. D. Porter (1981), "Stock Price Volatility: Tests Based on Implied Variance Bounds," *Econometrica*, No. 49, pp. 97-113

Lűtkepohl, H., 1993, *Introduction to Multiple Time Series Analysis*, second edition, Springer Verlag.

Mehra, R. and E. C. Prescott (1985), "The Equity Premium: A Puzzle," *Journal of Monetary Economics*, No. 15, pp. 145-61.

Kennedy, M., A. Palerm, C. Pigott and F. Terribile (1998), "Asset Prices and Monetary Policy," OECD, Economics Department, Working Paper, No. 188.

Poterba, J. M. and L. H. Summers (1988), "Mean Reversion in Stock Prices, Evidence and Implications," *Journal of Financial Economics*, No. 22, pp. 27-59.

Shiller, R. J. (1989), *Market Volatility*, Boston, MIT Press.

Weil, P. (1989), "The Equity Premium Puzzle and the Risk-Free Rate Puzzle," *Journal of Monetary Economics*, No. 24, pp. 401-21.

West, K. (1988), "Dividend Innovations and Stock Price Volatility," *Econometrica*, No. 56, pp. 37-61.

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