A Semi-empirical Approach to Relative Valuation[1]

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Abstract

A fundamental-based, semi-empirical approach for describing the behaviour of the equity price index is derived. The method is centred on the contention that, under a constant discount rate and in a market that is efficient and in equilibrium, the forward-looking risk premium is equivalent to the expected dividend yield, and both are equal to zero. Extending this special-case scenario to one that involves time-wise variations in the discount rate leads to a coordinate transformation, which addresses how the index should behave correspondingly.

Applying the same type of analysis to both, corporate earnings and the nominal gross domestic product (GDP), leads to a similar transformation. This, consequently, makes way for objective comparisons between the equity index, corporate earnings and the GDP, thereby raising the notion of relative valuation in this context. A practical demonstration of this is finally provided for the US and UK economies and equity markets.

1. Introduction

Relative valuation, in contrast to absolute, is an important concept in investment and finance. The significance of this is seen basically in day-to-day investment activities, whereby gaps or spreads in yields, interest rates and other rates of growth, in general, are exploited (Fabozzi, 1999).

The main advantage of relative valuation over the absolute is that it paves the way for comparisons – i.e. given certain stocks, which one(s) should one invest in, or is the equity index over/undervalued relative to what the earnings, GDP, etc. indicate. In this context, therefore, relative valuation eliminates the need for an absolute measure, which is, arguably, an impossible feat to achieve.

Relative-valuation measures typically involve multiples, and these have been applied, time after time, to comparing, among others, growth stocks (Peters, 1991), bonds (Benari, 1988), funds (De Long and Shliefer, 1992), as well as indices across different countries (Arnott and Henricksson, 1989). In addition, such measures have even been used to provide a process by which financial health could be assessed (Barth *et al*, 1998). Given that the above represent only a small fraction of the literature on how and why relative valuation is put into use, it is, therefore, inevitable that this notion has a lot to offer when it comes to practical investment.

Here, as well, we intend to apply the concept of relative valuation for comparison purposes. The aim, as it turns out, is to propose and develop an objective way for comparing three basic elements with each other - namely, the state of the economy, as represented by the nominal GDP, corporate earnings and, finally, the equity price index. Multiples representing

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these are most likely available and used commonly by both, economists and investment/financial analysts, to tie together the economy and the stock market. Such a measure of relative valuation could, thus, enable one to assess whether the stock market is over, under or fairly valued in comparison with earnings and/or GDP.

Our primary focus here is to derive a fundamental method for describing the time-dependent behaviour of the stock market, earnings and the GDP in relation to changes in the rates of discount. What these discount rates encompass – i.e. short or long-term bonds or other types of yields and interest rates – and how implementing different ones should alter the final results, are important issues that will be raised and discussed as we proceed.

Furthermore, as we go along, we will note two attributes that might raise doubts on our methods and conclusions. Firstly, the relationships derived here will look different from those typically found in the literature. This is because ours are extracted from an approach that follows a different route altogether. Secondly, as with any other semi-empirical work, ours might also be suspected of data mining, presenting spurious relations, etc. To overcome such claims and to help justify ours, we will try our best here to supply proofs and charts at every step of the way. In addition, we shall keep this paper as objective as possible by limiting it to factual observations and leaving out any speculative explanations. Hence, let us proceed with the derivation.

2. The Approach

We plan to develop our method in two ways – one focusing on equity [Section 2a] and the other on GDP and corporate earnings [Section 2b]. The latter two occupy the same section because their underlying principles happen to be the same. The results of the above will then be amalgamated to bring out the relative valuation measures. For the sake of brevity, we will omit all derivations that already exist in the literature cited.

2a. The Equity Model

It is useful to begin with our previous contention that, in a constant-discount rate environment and where the market is efficient, in equilibrium and at steady state the equity risk premium is equal to zero (Cohen, 2000). This clearly represents a highly idealised scenario, but, never the less, it can and shall be generalised here to account for unsteadiness.

Let us begin by recalling that in a perfect state, as defined above, all rates of growth – that is, in price, dividends and earnings – will be equal to each other, as well as to a constant. This, obviously, leads to the zero-dividend-yield criterion.

It can further be shown that upon letting the discount rate, R, be equal to some time-independent constant, R^*, we obtain the following expression:

$$\left(\frac{\partial \ln S}{\partial t}\right)_{R=R^*=constant} = R^* \qquad (1)$$

where S is the price and the quantity on the left-hand side represents the percent rate of growth in price [i.e. capital gains], conditional on the discount rate being constant at R^* - that is $R = R^* = constant$. Note that Equation 1 is simply the market's rate of return, incorporating the zero-dividend-yield condition discussed in Cohen (2000). It thus follows from 1 that the [logarithm of] price, ln S, could be written as a function of time, t, as well as R^* - i.e.

$$\ln S = \ln S(R^*, t) \qquad (2)$$

Holding the discount rate constant in the above clearly imposes a daunting constraint on S. This, however, may easily be relaxed with the help of a simple mathematical procedure involving the notion of the exact differential. The details of this procedure shall be omitted from here simply because they are described in almost any intermediate-level text on differential calculus.

Very briefly, the approach is as follows. In place of writing ln $S(R^*,t)$ as we have done in 2, we express it as

$$\ln S = \ln S(R,t) \qquad (3)$$

which generalises S so that it accounts for a time-variable discount rate, $R = R(t)$, instead of the constant.

The rationale behind Equation 3 is that the effects of the market, and the economy in general, on S are presumed to enter separately through two fundamental elements: one which is R and the other comprising everything else that falls outside the reign of R. As the second variable appears as time, t, it renders Equation 3 general and, hence, along with $R(t)$, it should capture all the economic and market effects on the price, S. In other words, expressing S in the form of Equation 3 essentially removes all the restrictions imposed on it earlier.

Bearing in mind the above, we take the <u>total</u> time differential of Equation 3 and obtain:

$$\frac{\Delta \ln S(R,t)}{\Delta t} = \left(\frac{\partial \ln S}{\partial t}\right)_R + \left(\frac{\partial \ln S}{\partial R}\right)_t \frac{\Delta R}{\Delta t} \qquad (4)$$

While the first partial differential [the term in the parentheses] has been shown to be equal to R [see Equation 1], the second is simply the stock duration, which is the sensitivity of the price to changes in the discount or interest rate. Moreover, the second term, which includes variations in the discount rate, embodies the risk premium as well.

Being a differential of an exact function, therefore, the two components in Equation 4 are coupled to each other via the following:

$$\left(\frac{\partial}{\partial R}\left(\frac{\partial \ln S}{\partial t}\right)_R\right)_t = \left(\frac{\partial}{\partial t}\left(\frac{\partial \ln S}{\partial R}\right)_t\right)_R = 1 \qquad (5)$$

This can be integrated twice to yield the general solution to Equation 4, whereby

$$\ln S = Rt + \alpha_0 + \alpha_1 R + \tilde{\Psi}(R) \qquad (6)$$

with α_0 and α_1 being integration constants and $\tilde{\Psi}(R)$ a yet unknown function of <u>only</u> R.

Alternatively, we recast 6 as:

$$\ln S - Rt = \alpha_0 + \Psi(R) \qquad (7)$$

where $\Psi(R)$ is another function of R. The latter representation conveniently absorbs both $\tilde{\Psi}(R)$ and $\alpha_1 R$ into a single function, namely $\Psi(R)$.

It is, therefore, interesting to note from Equation 7 that plotting $\ln S - Rt$ against R should, in theory, produce a single curve, depending <u>only</u> on R. This transformation, as a result, brings in all the effects of time on $\ln S - Rt$ through R.

As per our derivation so far, we find it necessary to bring up two points. First, even though Equation 7 is extracted from what appears to be formidable and perhaps too theoretical an approach, it is indeed very easy to apply and, also, as it shall be demonstrated shortly, it does possess real and practical uses. Second, questions relating to the discount rate have undoubtedly been raised by now. For instance, what is the discount rate, how should it be defined and, more importantly, how should one deal with it? The answer to these, as it will turn out in Section 3, happens to be surprisingly straightforward. Beforehand, though, let us go ahead and apply the same logic to both, the nominal GDP and earnings.

2b. Applications to GDP and Earnings

It is well accepted that movements in the equity price index are closely tied to corporate earnings and, even more generally, to the economy. Common sense further dictates that a bull market typically comes with a strong economy and a bear market a weak economy. One probable explanation for this is simply that the market comprises a subset of the economy – i.e. corporate earnings constitute a [small] fraction of the GDP. This, therefore, should enable one to derive a GDP relationship that is analogous to the one for equity, as well as corporate earnings.

Before we begin, however, we need to introduce a couple of analogies to the equity price index. This is possible with the help of the earnings discount model. For this, let us define V_G and V_E, respectively, as the “values” associated with the nominal GDP and corporate earnings. Based on the above, therefore, V_G could be represented by

$$V_G(t) \equiv \frac{G_f(t)}{R} \qquad \text{(8a)}$$

and V_E by

$$V_E(t) \equiv \frac{e_f(t)}{R} \qquad \text{(8b)}$$

where $G_f(t)$ and $e_f(t)$, respectively, are the time-t expectation of the nominal GDP and corporate earnings one year ahead, at t+1. Thus, with R being the discount rate, an earnings-discount-type valuation model is being imposed on the economy as well.[3, 4] It should further be stressed that the one-year-ahead nominal GDP, i.e. $G(t+1)$, will from now on be implemented instead of the expected purely for convenience, as we shall assume that the two are equal in an efficient economy. For corporate earnings, on the other hand, Datastream’s aggregate I/B/E/S forecasts will be presumed sufficient for our purposes.

Now, with the above analogy in place, it is not difficult to demonstrate that the same rules that dominate the price index should apply to V_G and V_E as well, yielding expressions similar to Equation 7, but with V_G and V_E substituted for S. This, consequently, leads to:

$$\ln V_G - Rt = \beta_0 + \Phi(R) \qquad \text{(9a)}$$

and

$$\ln V_E - Rt = \gamma_0 + \Xi(R) \qquad \text{(9b)}$$

where β_0 and γ_0 are integration constants and $\Phi(R)$ and $\Xi(R)$ are functions of R only.

Aside from noting that the same transformation presiding over the equity model applies to here as well, $\Phi(R)$ and $\Xi(R)$ may not necessarily be the same as $\Psi(R)$. Never the less, a comparison of these shall be undertaken later. Prior to this, however, we need to address the issues of the discount rate, “structural or regime shifts” and “reversibility.”

3. The Discount Rate

As mentioned at the end of Section 2a, the question of “what is the discount rate?” has to be faced sooner or later. Putting it more precisely, what should one use for R in Equations 7 and 9 in order to be able to test their validity?

Obviously, several choices exist. These include some measure of risk premium added to some short/long-term interest rate, bond yield, etc. Clearly, therefore, this makes room for a lot of subjectivity, but, nonetheless, we will attempt, hopefully, to settle this matter here.

Let us begin by recalling that, in a perfect market and conditional on $R = R^* = constant$, all discount rates and rates of return will be constant and equal to each other. Moreover, because of the risk premium being zero, these will all

[3] Note that if we let R in Equation 8b be the US government 10-year nominal bond yield, we effectively recover Greenspan’s model.

[4] Conditions under which an earnings-discount-type model applies have been discussed earlier (Cohen, 2000).

converge to the rate of interest, which is constant too.

The zero-risk-premium constraint, which eliminates all uncertainties on future projections, will, additionally, render all yield and term structure curves flat by removing the spreads between the long and short-term interest rates and yields. We, therefore, will have remaining here only one constant rate of interest, which we shall denote by r^*. All this, of course, sets up the stage for a highly idealised, as well as unrealistic, base-case scenario, which clearly extends the Golden rule of economics to finance.

Bearing this in mind, it will be useful now to hypothesise that any real-life scenario could be considered as merely a perturbation away from the base case. This line of reasoning will prove to be important, as it will enable us to extend the highly superficial situation to a real one.

To deal with this, we refer to either Equation 7 or 9. For convenience, we shall work with Equation 7, although the logic that follows could equally as well apply to Equation 9.

Let us begin with the assumption that this idealised, base-case scenario, where the interest rate is equal to the constant discount rate, is in place. In addition, recall that the left-hand side of Equation 7, which is $\ln S - Rt$, is a function of the single parameter, R, i.e. $\Psi(R)$. Putting the two together gives

$$\ln S - R^* t = \alpha_0 + \Psi(R^*) \tag{10}$$

and

$$\ln S - r^* t = \alpha_0 + \Psi(r^*) \tag{11}$$

Moreover, the condition R^* = r^* makes way for the equality

$$\ln S - R^* t = \ln S - r^* t \tag{12}$$

simply because

$$\Psi(R^*) = \Psi(r^*) \tag{13}$$

We now move away from this idealised state by bringing in time-variable rates instead. This can be accomplished by perturbing R^* by some increment ΔR and r^* by Δr, whereby both, ΔR and Δr are free to vary in t. This, as a result, modifies Equations 10 and 11 to:

$$\ln S - [R^* + \Delta R]t = \alpha_0 + \Psi(R^* + \Delta R) \tag{14}$$

and

$$\ln S - [r^* + \Delta r]t = \alpha_0 + \Psi(r^* + \Delta r) \tag{15}$$

respectively, It is important here to recognise that the function Ψ is dependent only on the single parameter, whether it is R or r. Insofar as the effect of time on Ψ is concerned, it enters indirectly through either, R or r [i.e. $R(t)$ and $r(t)$].

Generalising this scenario even further by choosing two different points in time - i.e. t_1 and t_2 - such that $\Delta R(t_1)$ equals $\Delta r(t_2)$, enables us to equate 14 and 15 and get:

$$\ln S - [R^* + \Delta R]t_1 = \ln S - [r^* + \Delta r]t_2 \tag{16}$$

simply because $R^*+\Delta R$ is chosen to be equal to $r^*+\Delta r$. The significance of the above is that it makes no difference, whatsoever, as to what one incorporates for R in Equations 7 and 9. For this matter, R could be either the discount rate, if known, or any of the several available choices for the interest rate, be it short term or long. Empirical evidence of this will, of course, be provided, but we need to discuss first the concepts of structural shifts and reversibility, and how they enter this work.

5a. Reversibility and Structural Shifts

The equity price, GDP and earnings representations provided in Equations 7 and 9a-b lead to some important conclusions regarding “reversibility” and “structural shifts.” Realising that structural shifts tend to alter the behaviour of the economy and the markets, an important objective here, as in any economic and financial analysis, would, thus, consist of defining ways for detecting and, possibly, classifying them.

To do this here, we start with the observation that $\ln S - Rt$, $\ln V_G - Rt$ and $\ln V_E - Rt$ must depend solely on R via the functions $\Psi(R)$, $\Phi(R)$, and $\Xi(R)$, respectively. The effects of time, as mentioned earlier, enter indirectly through R. Whether or not this functional dependence on R is the same in all situations is not of concern at this time, but it shall be dealt with shortly.

An important outcome of such dependence is the notion of “reversibility,” which may be explained as follows. Consider, for instance, Figure 1, where we display the behaviours in time of two UK benchmark government bond yields, basically the 02-year and 20-year, all obtained from Datastream. The time frame here covers the period Q1-80, to Q4-99.

Let us now, for the sake of example, identify and highlight 3 points where the yields cross the value of 6%. We could have very well selected other points instead. The choice makes no difference to what follows next.

Returning to Figure 1, we observe that point 1 denotes the period around Q2-94 where the 02-year yield crossed the 6% mark. Similar arguments apply to Points 2 and 3 as well, whereby Point 2, which belongs to the 20-year and Point 3 to the 2-year yield, crossed the 6% value at around Q1-98 and Q3-99, respectively.

Obviously, even though the yields are identical on these dates, which fall some years apart, one does not expect the corresponding value for *S*, GDP and corporate earnings to remain in any way the same. Strictly speaking, therefore, *S* and GDP are irreversible functions of *R*, as they, apparently, move in ways different than *R*.

The notion of reversibility, never the less, comes into play when we consider, instead, the transformations prescribed by Equations 7 and 9. Here we expect the transformed relations, $\ln S - Rt$, $\ln V_G - Rt$ and $\ln V_E - Rt$ to reposition with *R*, as the equations suggest. Therefore, if *R* were, say, equal to 6% in Q2-94, varies randomly over time and in Q3-99, after about five years, reverts back to 6%, the transformed relations should also revert back to their Q2-94 values. This concept will, from now on, be referred to as reversibility and shall play a dominant role in our work.

Alternatively, a structural or regime shift implies the contrary. If, for instance, a plot of the three above-mentioned points fall on notably different characteristic lines, then a structural shift, separating these points, might have occurred in between. Empirical evidence of both phenomena, namely reversibility and regime shift, is provided next.

5b.1. Evidence of Reversibility and Structural Shifts in the UK

We have argued so far that one could incorporate any of the available interest rates in Equations 7 and 9a-b. If our hypothesis were correct, then on plotting $\ln X - Rt$ against *R*, where *X* could equally represent *S*, V_G or V_E, we should expect to obtain a single curve, or, more generally, a series of curves, each pertaining to some particular structural regime in the market and/or the economy. Although this graphical technique shall be applied here only to the US and the UK, we should note that other economies and markets also tend to display similar behaviours.

First, let us refer to Figures 2-4, which illustrate $\ln S - Rt$, $\ln V_G - Rt$ and $\ln V_E - Rt$, respectively, plotted against *R* for the FTSE 100 price index and the UK economy. We have implemented here for R a series of benchmark government bond yields, specifically, 2, 3, 5, 7, 10, 15 and 20 years. These bond yields are being utilised here purely for consistency, because Datastream provides similar series for a number of other markets. It should be mentioned as well that all data are quarterly, beginning in 1980, when Datastream started to provide them, to the present. It is also important to note that frequency is not an issue here because it does not alter any of the results that follow next.

We refer first to Figures 2a and 2b, depicting $\ln S$ and $\ln S - Rt$, respectively, *versus* R. For R we have incorporated the above-mentioned yields. On comparing Figure 2a to 2b, we do observe a convergence of the data points in the latter, where the proposed coordinate transformation is applied. This is consistent with what the theory suggests. However, there also appears to be some scatter. This, we believe, is caused by having various types of investors, with a variety of discount rates, represented by a single equity price, S.

The scatter observed in Figure 2 is markedly diminished if we were to graph $\ln V_G - Rt$ *versus* R instead, with R again representing the bond yields. This is shown in Figure 3, where data convergence is clearly more noticeable than in the previous case. This, we presume, is due to V_G taking into account the differences in investors – that is, in arriving at V_G, an investor who, let us suppose, discounts at 5% will compute a V_G different from one who discounts at, let us say, 10%.

Last, but not least, the same logic applies to Figure 4 as well, where $\ln V_E - Rt$ is shown plotted against R. Simply stated, therefore, V_E and V_G take into consideration that different investors, acquiring dissimilar discount rates, will value earnings and GDP differently. In contrast, the price index, S, does not merely because it represents a single value aggregated over all types of investors.

As for reversibility and structural shifts, they are evident in all of the graphs, more so in Figures 3 and 4, where streak-like patterns emerge. Each of these streaks corresponds to what we believe to be a distinct structural regime. Two of these are circled in Figures 3 and 4, which, for convenience, are also shown expanded in Figures 5 and 6.

To further elucidate how data convergence is achieved via the proposed coordinate transformation, we have included Figure 7 as well, which displays the logarithm of the earnings plotted against the various yield rates. This should be compared with its counterpart, $\ln V_E - Rt$, shown in Figure 6. We note here that data convergence is indeed remarkable under the proposed transformation. This, therefore, strongly supports the underlying hypothesis regarding reversibility and structural shifts.

It thus follows that reversibility occurs along any of the streaks in Figures 3 and 4, where movements in interest rates, in some cases over many years, do not appear to throw any of the data points out of its course. This, we presume, is due to all these points being part a distinct structural regime. A more detailed examination of this will follow once we assess the situation for the US.

5b.2. Evidence of Reversibility and Structural Shifts in the US

Figures 8-10 depict the three parameters, namely, $\ln S - Rt$, $\ln V_G - Rt$ and $\ln V_E - Rt$, all plotted against R. To reduce the clutter, yearly data instead of quarterly are displayed.

We note here that, as in the UK case, the relevant conclusions are identical. These are, basically, (1) the graphs exhibit data convergence, and (2) reversibility and regime shifts are again evident, particularly in Figures 9 and 10 where the scatter is markedly less.

Apart from these similarities with the UK, an important feature further presents itself in Figures 8 and 10, where prices and earnings are concerned. In both, there seems to be a branching of data, especially at yield rates lower than 7%. The branches, which are circled and whose time frames are indicated, certainly belong to two distinct structural regimes. We shall say more on this when we discuss both, the role of relative valuation in, and its relationship to, this work.

6. Relative Valuation

Within the framework of our analysis, relative-valuation measures could be arrived at by, simply, superimposing the data in Figures 2-10. This will be demonstrated here for both, the UK and US. It is important, though, to bear in mind that this is not an exercise in "forecasting." It is merely a methodology by which intrinsic values could be compared objectively against one another.

6a. Relative Valuation in the UK

The relative-valuation measures for the UK are examined here by overlaying Figures 3-5 on top of each other. For example, superimposing Figure 3 on 2 depicts how the FTSE 100 price index matches against the economy, both historically and currently. Similarly, laying Figure 4 on 2 and 4 on 3, respectively, illustrates how the economy compares against the equity market and corporate earnings. Again, to reduce overcrowding, the data are presented on a yearly basis, focusing only on the 2, 7 and 20-year benchmark UK government bond yields.

Let us begin with Figure 11, which superimposes the price index on the nominal GDP, both in their special coordinate transformations. We note here that, over the long run, the two parameters appear to move together. This provides some justification to the principle that equity prices and the GDP are related. Moreover, Figures 12 and 13, respectively, which overlay the price index on the earnings and the earnings on the GDP, tell a similar story, whereby the three elements, at least in the UK, are in balance and move together in the long run.

6b. Relative Valuation in the US

Section 6a above summarises the situation for the UK. The US, as we shall see here, leads to a different conclusion.

Figure 14 displays an overlay of the S&P 500 price index over the GDP. We note here that from 1980, which is the start of the data, to 1990, the points fall, more or less, on each other. This basically indicates that during this period, the two parameters were moving in conjunction with one another, as economic theory dictates.

In contrast to the above, however, we observe that from 1991 on, a breakdown in the relationship occurs, whereby the two begin to move in separate directions. First, between 1991-1993 [refer to Figure 8], which coincides with a recessionary period in the US, we note that the equity price index did not keep up with the GDP. From 1994 onward, however, the price index outperforms the GDP, and has been doing so since. This suggests either that, from 1994, the S&P 500 index has been overpriced relative to the GDP and/or its components, on aggregate, have been outperforming the average economy – the latter insinuating that, as of 1994, S&P 500 market has failed to represent the economy, both adequately and fairly.

Figure 15 illustrates the S&P 500 superimposed over corporate earnings. The situation in this case is somewhat clearer than in the previous figure. Here, for instance, we observe that the post-1994 increases in equity prices have followed the sudden jump in the corporate earnings seen in Figure 10. Even here, there appears to be a post-1994 out performance of the price index relative to earnings.

Finally, we superimpose corporate earnings over the GDP in Figure 16. Avoiding all speculative explanations and again focusing on data from 1991 to the present, we note that between 1991 and 1993, corporate earnings moved in conjunction with nominal GDP. Post 1994, however, a shift in corporate earnings caused it to outperform the GDP, with the latter still continuing in its pre-1994 course. This is consistent with our observation in Figure 14 where, on average, the S&P 500 equity market does not adequately represent the economy.

7. Summary and Conclusions

A semi-empirical approach, which enables one to compare the nominal GDP, corporate earnings and equity index relative to one another, has been derived. Basically, the method utilises the notion of the exact differential to extract a coordinate transformation through which these comparisons, in the context of relative valuation, could be performed as objectively and as directly as possible.

On applying the methodology to the UK and US markets and economies, we reach certain conclusions, some of which are:

(a) In this framework, a comparison of the UK equity index, corporate earnings and the nominal GDP, as shown in Figures 11-13, suggests that the three are, more or less, in balance with one another. In other words, there is no evidence of gross over/under valuation of any of these in relation to each other.

(b) The situation in the US, however, is very different. Our work indicates that pre 1990, the three elements poise well relative to one another, as Figures 13-15 portray. Post 1995, however, an upward shift in corporate earnings pushes its valuation above that of the nominal GDP's. Moreover, during this period, the equity index surpasses even the corporate earnings in terms of relative valuation. This peculiar behaviour could very well provide some clear evidence of what has been described as the "new economy," which has presumably begun in the US at around 1995. Ironically, this "new economy" appears to apply to the equity market alone, and not to the whole economy, as represented by the GDP.

8. References

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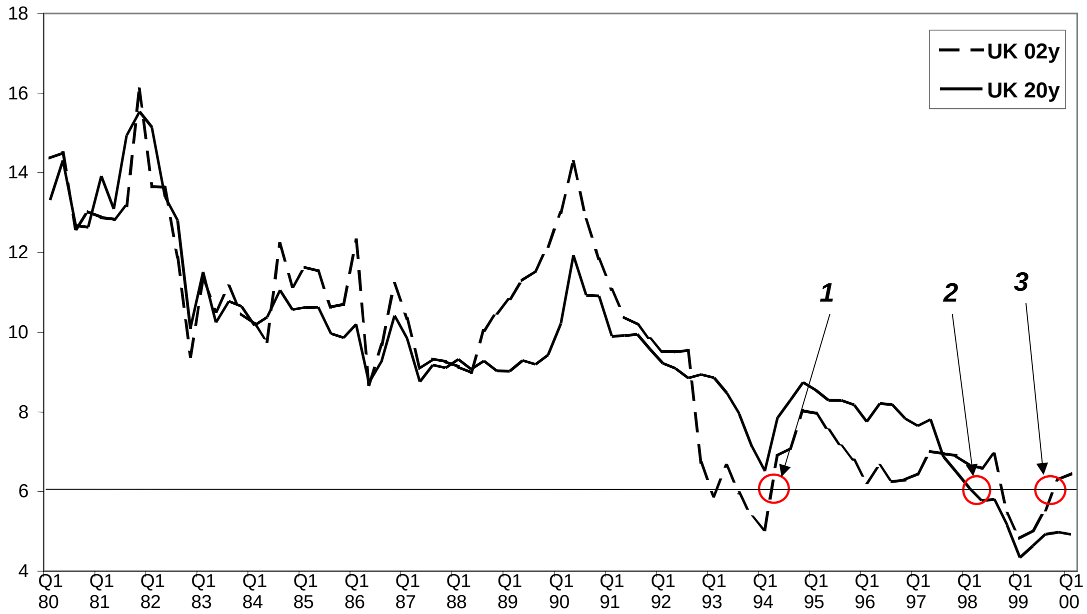

Figure 1 – Behaviour of the benchmark UK government bond yields between Q1-80 to Q1-00. The circled regions, which are numbered, are the locations where the two yields cross the 6% line.

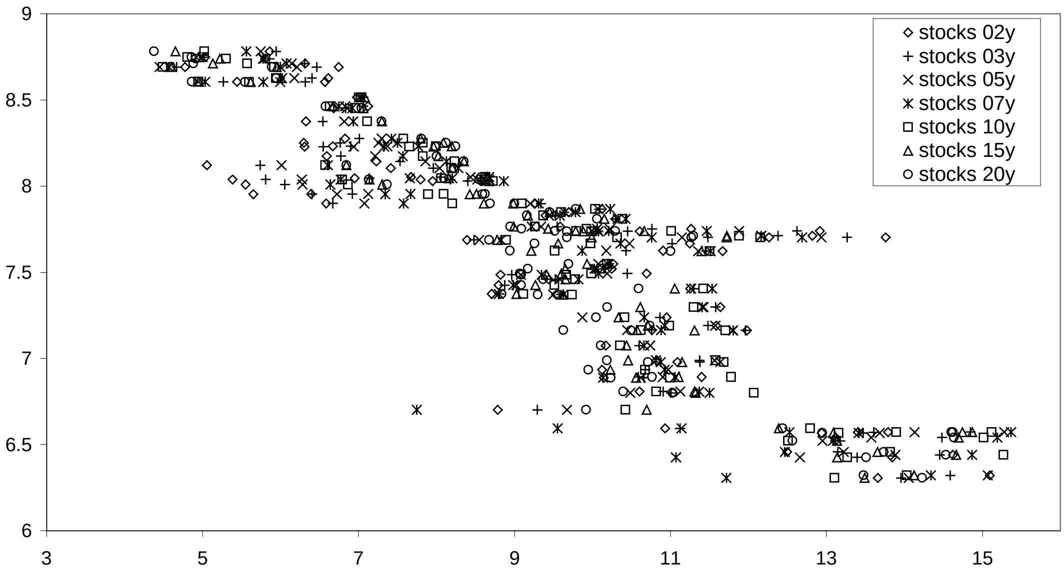

Figure 2a – The FTSE 100 equity price index in untransformed coordinates, i.e. ln *S*, plotted against the benchmark UK government bond yields. Data range from Q1-80 to Q1-00.

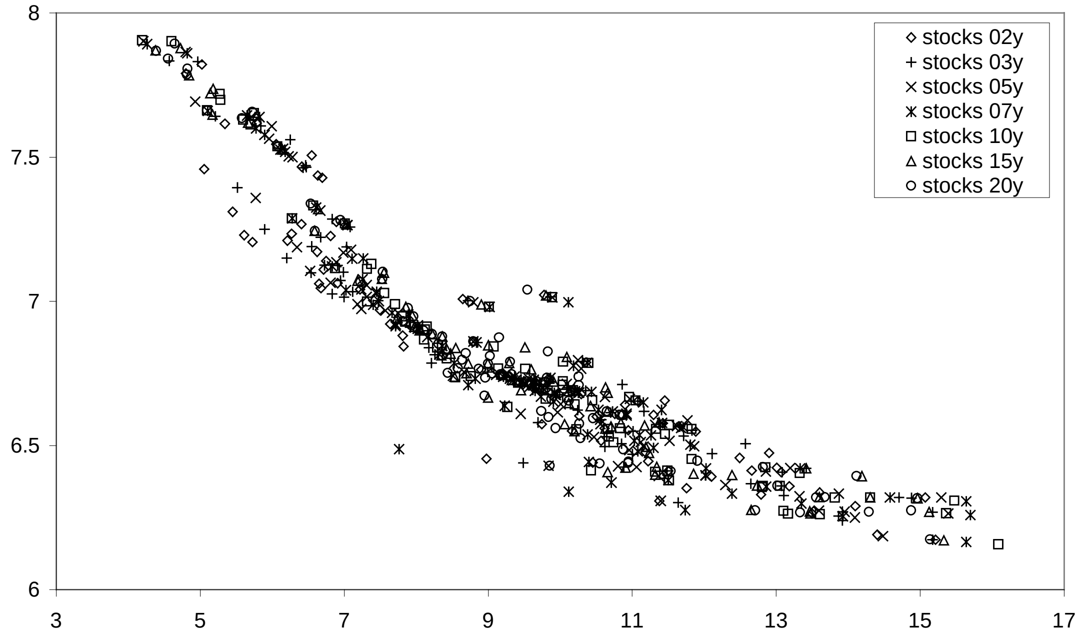

Figure 2b – The FTSE 100 equity price index in transformed coordinates, ln $S - Rt$, plotted against the benchmark UK government bond yields. Data range from Q1-80 to Q1-00. Note convergence of data relative to Figure 2a.

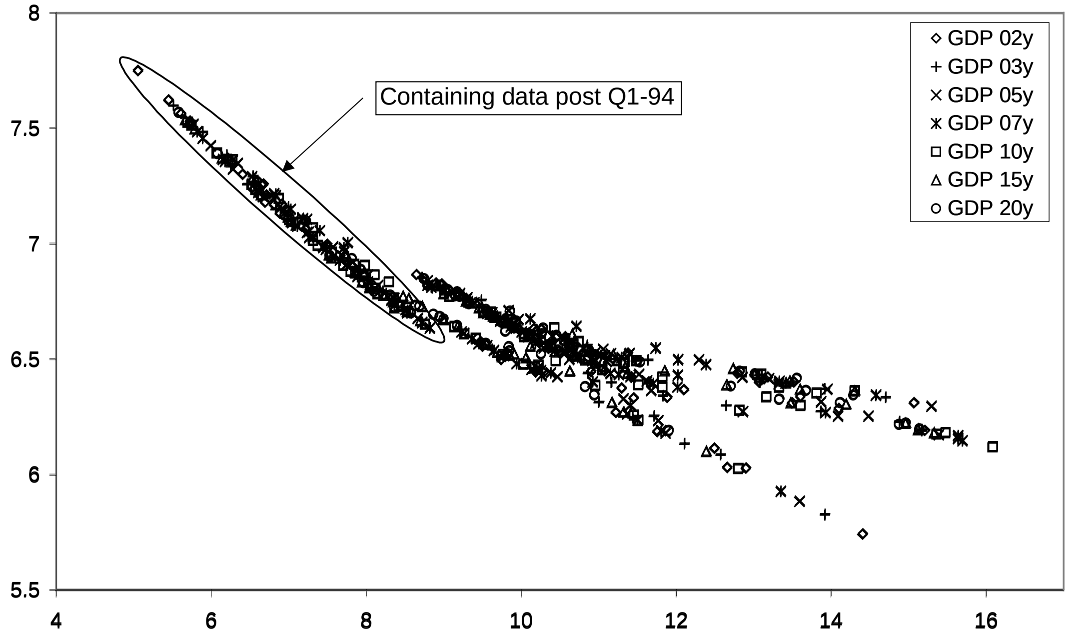

Figure 3 – The UK nominal GDP in transformed coordinates plotted against the benchmark UK government bond yields. Data range from Q1-80 to Q1-00. The circled region presumably belongs to a distinctive structural regime.

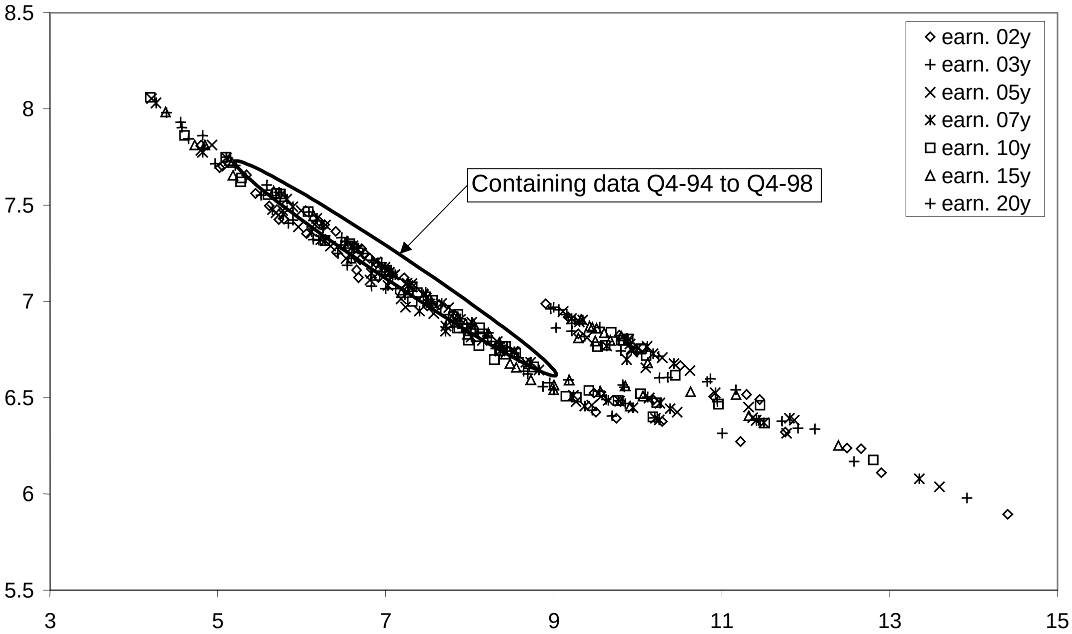

Figure 4 – The FTSE 100 corporate earnings in transformed coordinates plotted against the benchmark UK government bond yields. Data range from Q1-80 to Q1-00. The circled region presumably belongs to a distinctive structural regime.

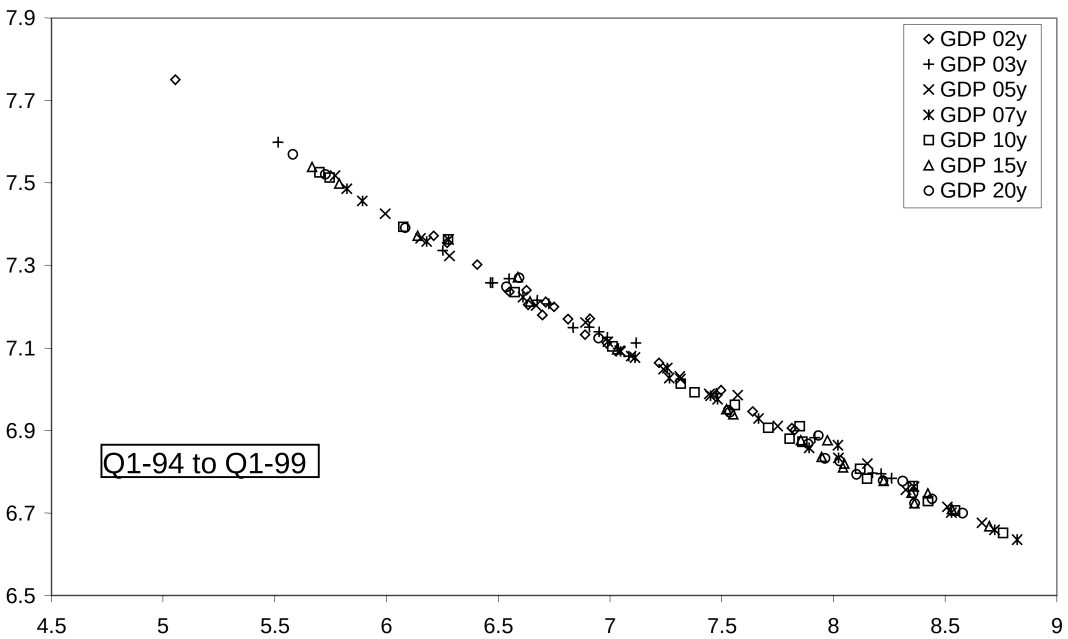

Figure 5 – Expanded view of the structural regime highlighted in Figure 3.

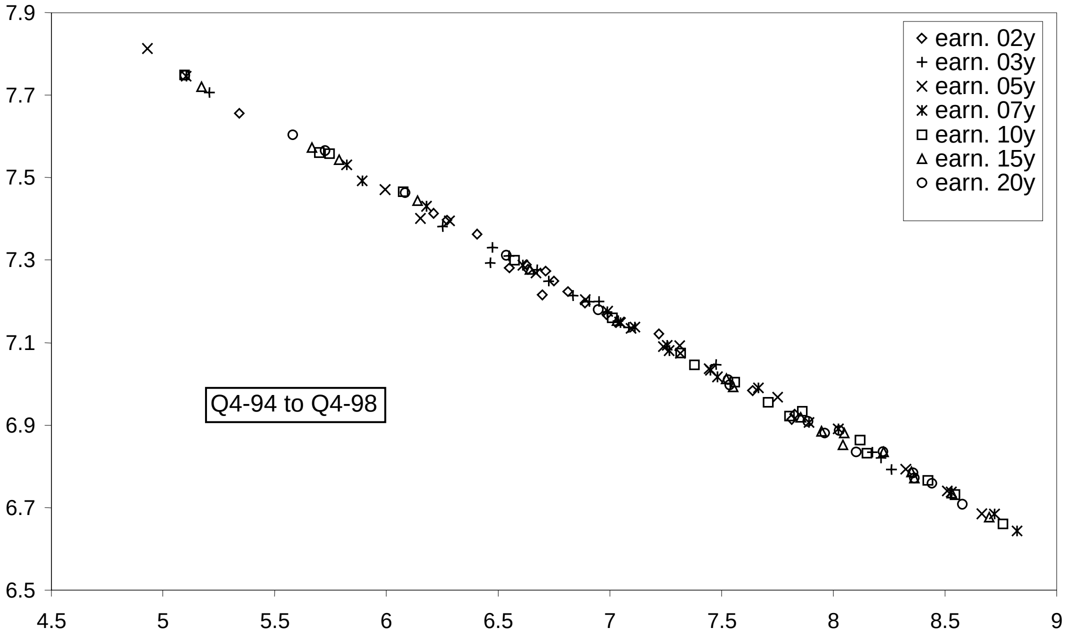

Figure 6 – Expanded view of the structural regime highlighted in Figure 4.

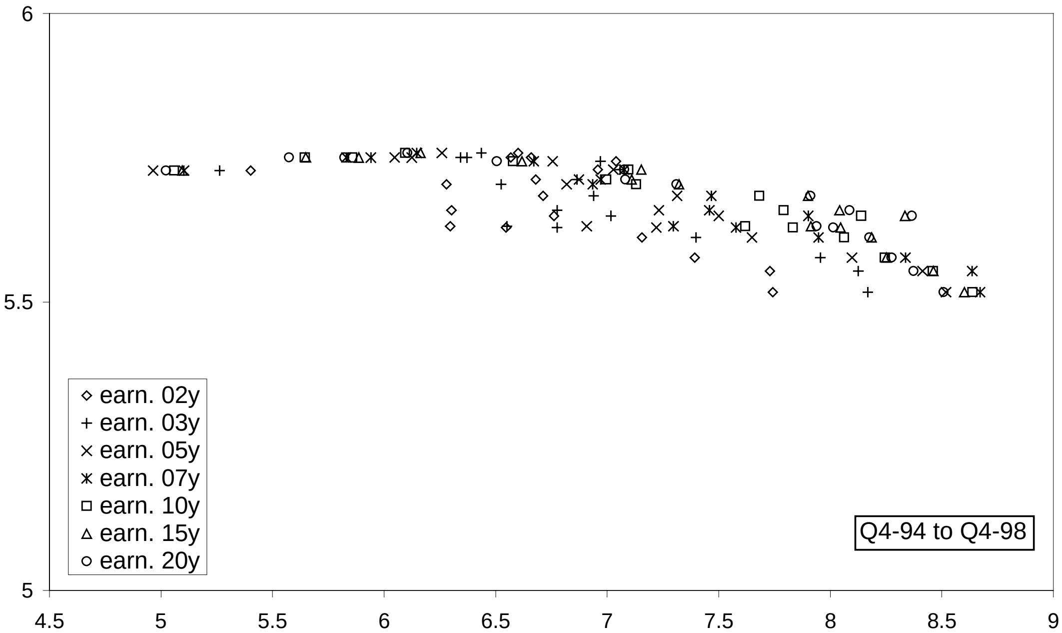

Figure 7 – The same structural regime shown in Figure 6, but plotted in untransformed coordinates – i.e. ln e_f *versus* the bond yields. Note the loss of data convergence in comparison with its counterpart in Figure 6.

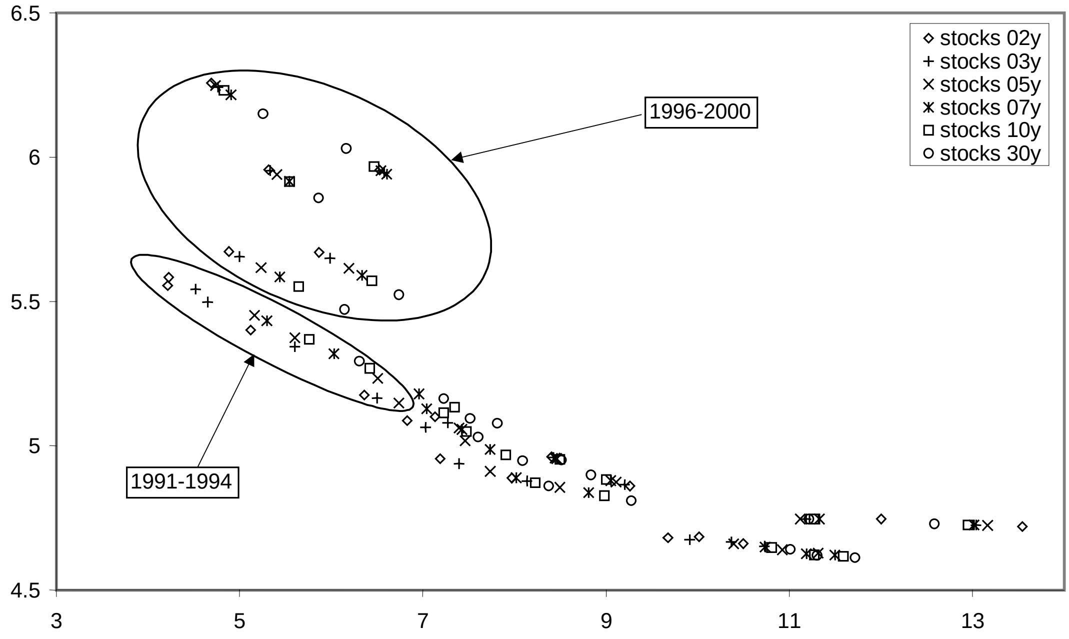

Figure 8 – The S&P 500 equity price index in transformed coordinates plotted against the benchmark US government bond yields. Data range from Q1-80 to Q1-00. The circled regions highlight distinct structural regime over two time frames.

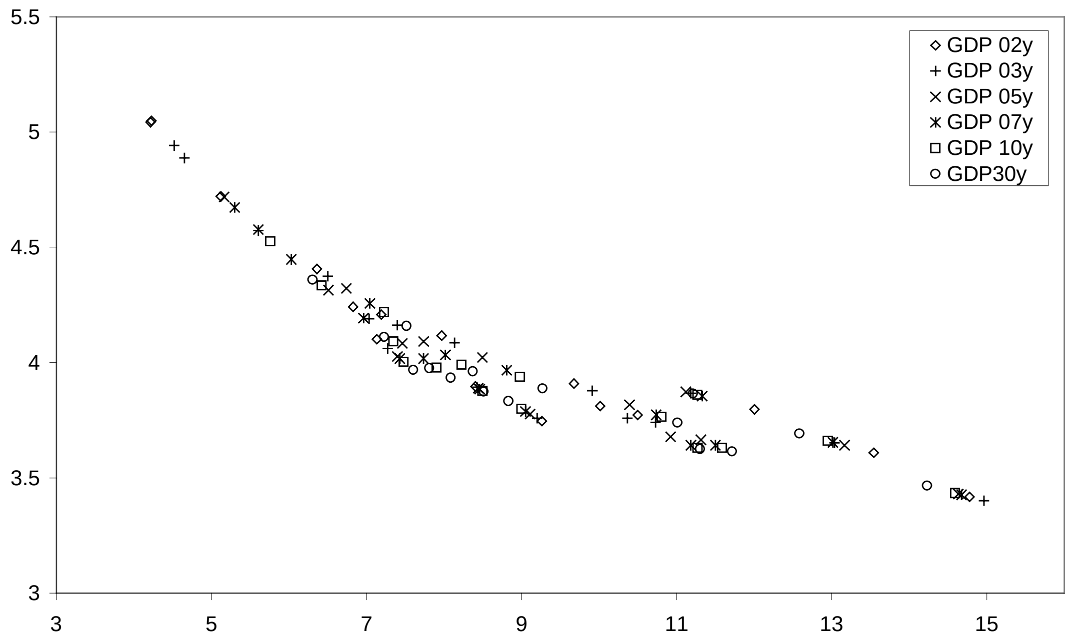

Figure 9 - The US nominal GDP in transformed coordinates plotted against the benchmark US government bond yields. Data range from Q1-80 to Q1-00.

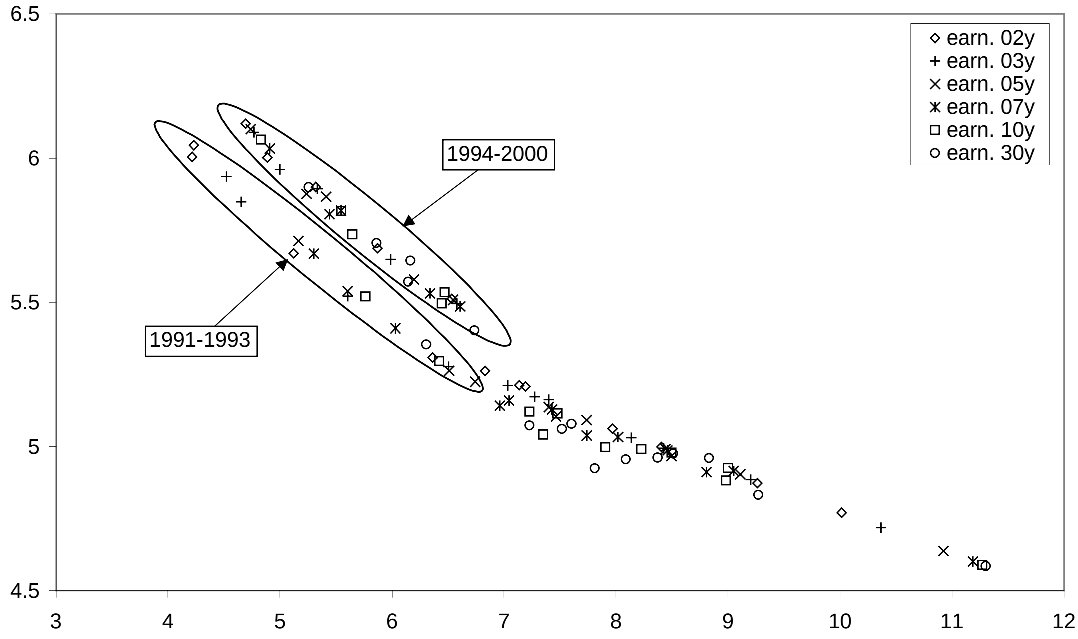

Figure 10 - The S&P 500 corporate earnings in transformed coordinates plotted against the benchmark US government bond yields. Data range from Q1-80 to Q1-00. The circled regions presumably belong to distinctive structural regimes.

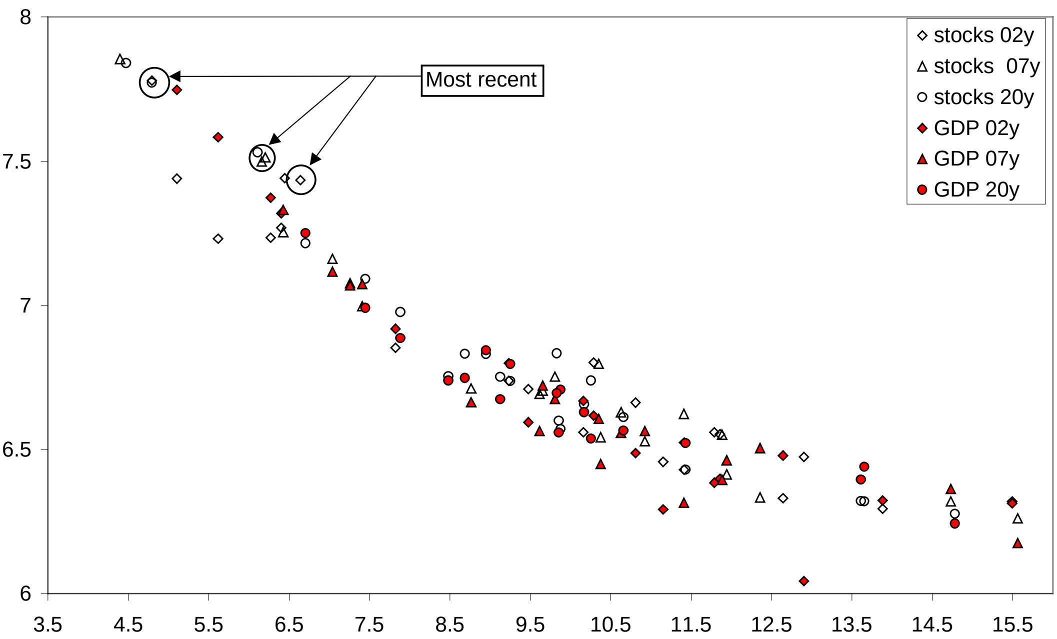

Figure 11 – Overlay of Figure 2 on 3, showing the FTSE 100 equity price index in comparison with the UK nominal GDP. Both parameters are in transformed coordinates. The most recent data points are highlighted.

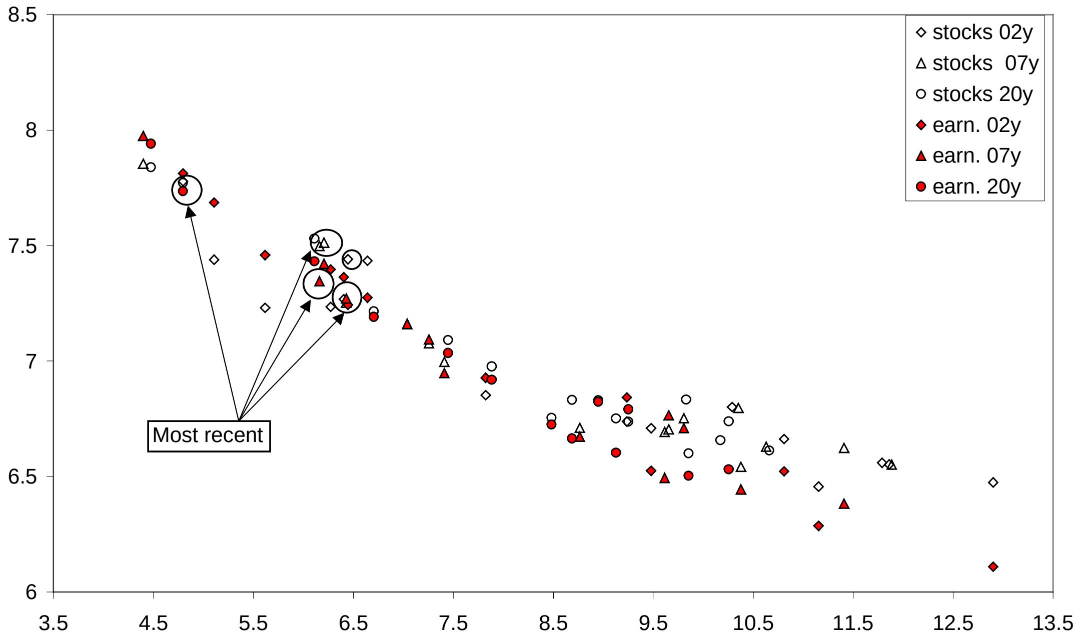

Figure 12 – Overlay of Figure 2 on 4, showing the FTSE 100 equity price index in comparison with the corporate earnings. Both parameters are in transformed coordinates. The most recent data points are highlighted.

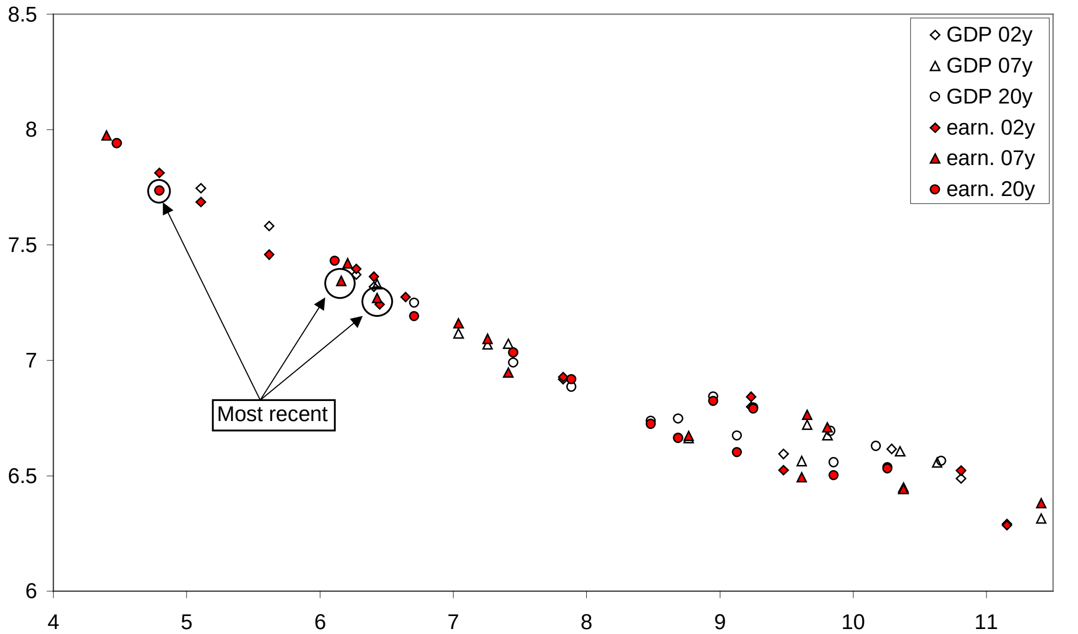

Figure 13 – Overlay of Figure 3 on 4, showing the UK nominal GDP in comparison with the FTSE 100 corporate earnings. Both parameters are in transformed coordinates. The most recent data points are highlighted.

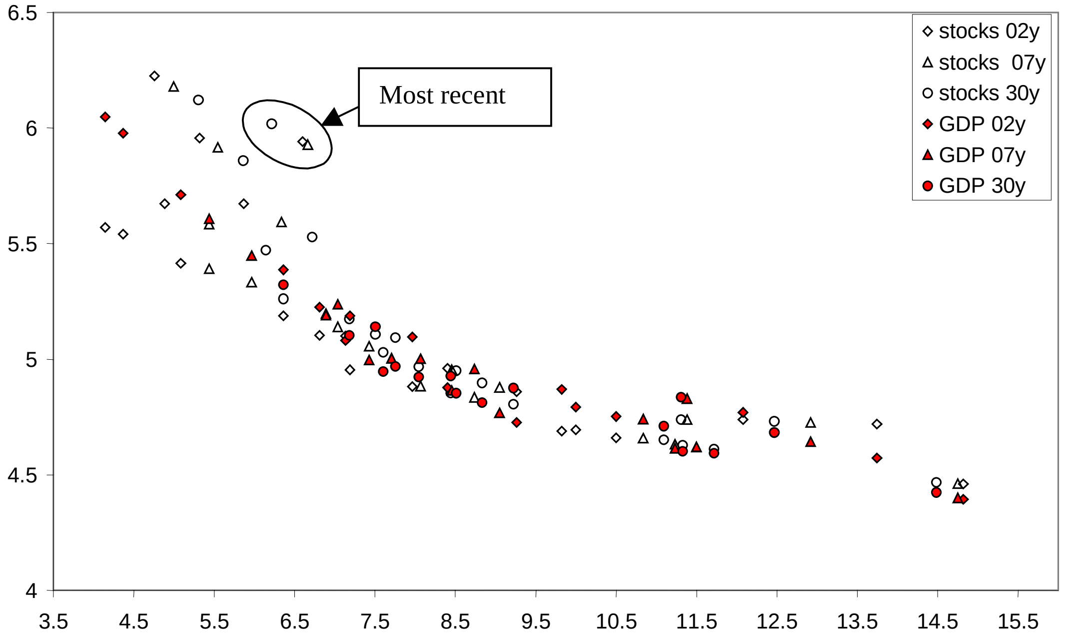

Figure 14 – Overlay of Figure 8 on 9, showing the S&P 500 equity price index in comparison with the US nominal GDP. Both parameters are in transformed coordinates. The most recent data points are highlighted.

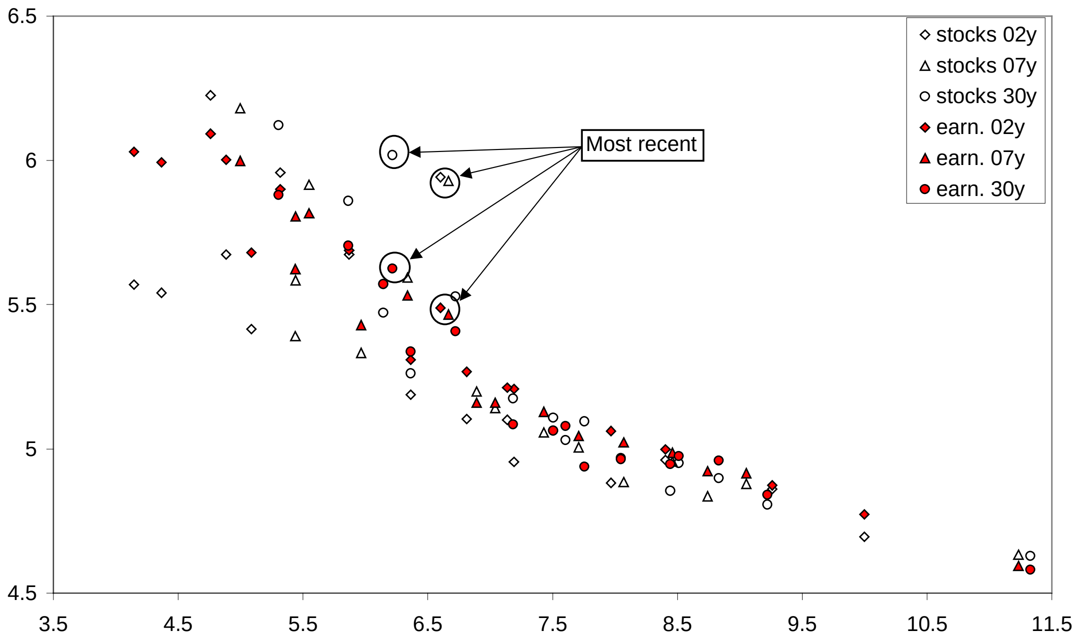

Figure 15 – Overlay of Figure 8 on 10, showing the S&P 500 equity price index in comparison with the corporate earnings. Both parameters are in transformed coordinates. The most recent data points are highlighted.

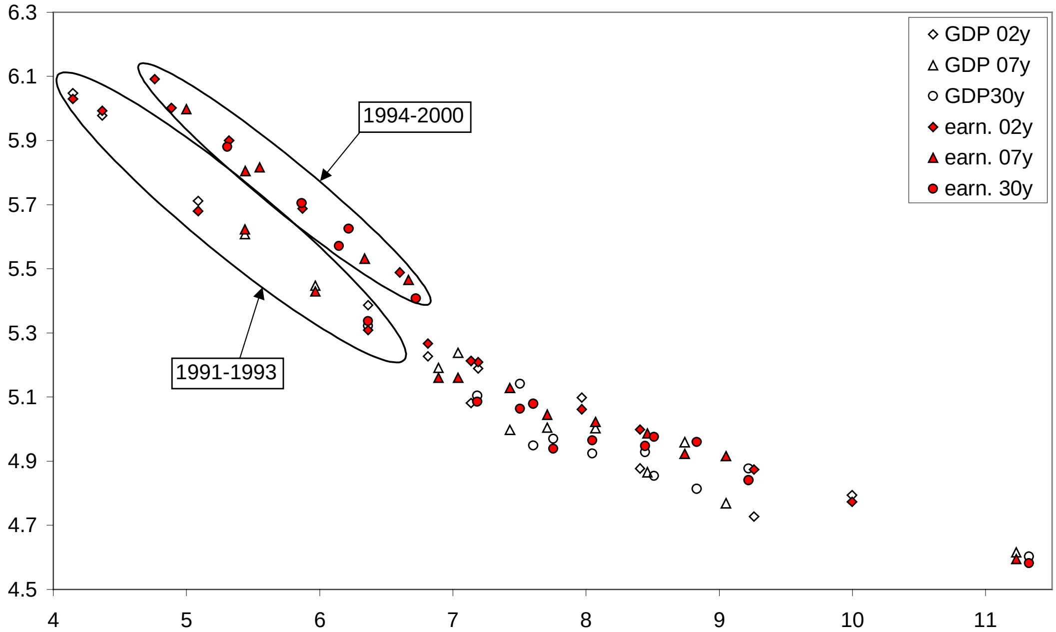

Figure 16 - Overlay of Figure 9 on 10, showing the US nominal GDP in comparison with the S&P 500 corporate earnings. Both parameters are in transformed coordinates. The two structural regimes circled in Figure 7 are again highlighted here.