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NEW ECONOMY, THE EQUITY PREMIUM AND STOCK VALUATION

"We are living in a new era, and it is of the utmost importance for every businessman and every banker to understand this new era and its implications. […] Stock prices have reached what looks like a permanently high plateau."

Irving Fisher on the eve of the stock market crash in 1929[3]

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[1] This paper was written while Andrew Bosomworth was working in the Directorate General Operations of the European Central Bank.

[2] European Central Bank, Directorate General Operations.

[3] As quoted in "Is the New Economy really new?", Jaakko Honko Lecture given by Ms Sirkka Hämäläinen, member of the Executive Board of the ECB, at the Helsinki School of Economics on 29 January 2001.

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1. Introduction

Stock markets in the US registered extraordinary growth rates in the second half of the 1990s. Both index levels and p/e ratios increased at unexpected paces and reached all-time highs. Between 1995 and 2000 the Dow Jones Industrial Average Index more than doubled its level, the S&P500 more than tripled it and the Nasdaq increased more than fivefold. P/e ratios increased by approximately 70% in the case of the Dow, 100% on the S&P500 and 300% on the Nasdaq. The picture on the other side of the Atlantic was not much different with the DAX growing approximately fourfold.

However, the most striking puzzle is not the growth in prices per se, but the widening gap between the market and the theoretical valuation of firms which could be observed in the same period. The aim of this paper is to show how the advent of the New Economy impacted on stock prices through a comparison of theoretical and market valuations of firms. In particular, we show that the expectations of a new era of low inflation and sustained economic growth apparently induced market participants to reduce the ex ante conditional equity risk premium. The lower premium, in turn, is a prime suspect for explaining the stock market developments in the second half of the 1990s. We argue, however, that the macroeconomic foundations of the downward revision of the equity premium were rather weak. Hence, from this point of view, at least part of the rise in stock prices observed in the second half of the 1990s in the United States represented a deviation from equilibrium. The recent correction of stock prices is consistent with this interpretation

The paper is divided into six sections. Section 1 is the introduction. Section 2 is devoted to the assessment of the nature of productivity acceleration in the last US expansion. Section 3 deals with the equity risk premium and concludes that the gap between some fundamentals-based stock valuations and stock market prices might well be explained by the reduction in the ex ante conditional equity risk premium. This interpretation is tested against the data in Section 4. The analysis shows support for the hypothesis of a structural break in an equation linking stock returns to consensus estimates of expected earnings per share, long-term bond yields, the estimated equity risk premium and the estimated growth rate of earnings in perpetuity. Section 5 presents some data regarding the dispersion of stock returns and price-earnings ratios across business sectors, suggesting that fluctuations in equity risk premia may have been more pronounced in some business sectors. Finally, Section 6 provides some concluding remarks.

2. Macroeconomic evidence

The acceleration in average labour productivity in the US economy registered in the second half of the 1990s is a fundamental feature of the so-called New Economy. There is substantial evidence that the productivity take off was tightly linked to major technological advances. New macroeconomic paradigms have been proposed due to the apparent inappropriateness of old economic rules in interpreting the new environment. These macroeconomic developments were accompanied by stock market booms; as a consequence, an important chapter within the set of amendments to the old paradigms was that related to stock valuations. In particular, the death of the business cycle anticipated by some observers should have allowed a structural reduction of the ex ante conditional equity risk premium – a development which would have provided a rational explanation for the boom in US stock prices seen prior to March 2000.

The spread of information technologies and their favourable effects on productivity growth, and on the economy at large, have been more rapid and sizeable in the United States than in the euro area. In particular, the impressive reduction in unemployment observed in the United States, one of the major benefits of innovation, was not matched in the euro area. Such virtuous IT-driven dynamics may also be at work in the euro area, but *there is nevertheless as yet no evidence of a broadly based New Economy.*[4] In light of these considerations, this paper focuses mainly on US economic developments in the second half of the 1990s.

2.1 Recent US economic performance: relevant figures

The 1990s represent the latest of the six major expansions of the US economy since 1950. By the end of 2000 it was the longest at 39 quarters, compared to 35 quarters for the 1961-1969 expansion and 31 quarters for 1982-1990. But it was also the slowest with an average growth rate of 3.7%. Even in the second half of the 1990s, when the economy accelerated substantially, the mean growth rate was only 4.1%, lower than the average for any of the previous five expansions.[5]

What appears to be a distinctive feature of the latest expansion is the combination of low inflation, low and decreasing unemployment and rapid real wage growth. Even though this might in part be due to favourable supply shocks, such as declining energy prices for much of the period, the major factor behind this development was the acceleration in labour productivity. Staiger, Stock and Watson (2001), far from proclaiming the death of the Phillips curve, show the prominent role of the univariate trend in productivity growth in explaining the apparent price and wage puzzles of the 1990s.

[4] See the Opening remarks by Professor Otmar Issing at the Hearing of the Committee on Economic and Monetary Affairs of the European Parliament, Brussels, 24 January 2001.

[5] The fastest expansion was observed in the early 1950s with a mean growth rate of 7.6%. The second fastest was also the shortest: just 10 quarters at the beginning of the 1970s with a mean growth rate of 6.1%. The expansion of the 1960s posted a 5.0% average growth, while the expansion in the second half of the 1970s reached a rate of 4.4%. The mean growth rate in the Reagan expansion of the 1980s was 4.2%.

The second half of the 1990s witnessed a strong acceleration in the growth rate of the average labour productivity (ALP) in the US economy. The importance of this development cannot be overemphasised. First of all, it represents a significant change with respect to the previous "dismal age" of productivity growth (1972-1995) and this much awaited development deserves in itself attention. Moreover, it is the critical element in the observed exceptional virtuous circle of the second half of the 1990s expansion. In a very schematic representation, the essential causal sequence goes as follows: productivity growth supported GDP growth and allowed for non-inflationary wage growth. In turn, low inflation allowed the Federal Reserve to maintain relatively low interest rates. Rapid economic growth, low interest rates and investors' strong faith in the implications of the New Economy spurred growth in profits and in stock market valuations. Low interest rates and high stock prices, together with employment growth, in turn boosted household consumption and corporate investment. In the schematic presentation outlined above, the acceleration in productivity growth represents the core of the economic developments in the second half of the 1990s. In order to assess the latter and its implications for the stock market, an analysis and understanding of the productivity dynamics is of crucial importance.

2.2 The acceleration in productivity growth: facts

The quantification of the acceleration in productivity growth varies with the data sets, econometric techniques, and the working assumptions which are adopted to carry out the estimation exercise. The shared view in academic literature is that after a marked slowdown between the 1970s and early 1990s, growth in ALP gained more than a full percentage point and reached a level of approximately 2½% , thus outpacing the so-called "golden age" of productivity from 1913 to 1972.

Growth in ALP, $\dot{ALP}$, is defined as the growth rate of output (*y*) minus the growth rate of the labour input (*h*). In its simplest formulation, $\dot{ALP}$ can be decomposed into the sum of two elements: (1) the growth rate, *a*, of Total Factor Productivity (TFP, i.e. output per unit of factor input); (2) the capital deepening term (*k*-*h*), i.e. the growth rate of the capital input (*k*) minus the growth rate of the labour input.

(1) $\dot{ALP} \equiv y - h = a + \beta(k - h)$

where β is the elasticity of output with respect to capital. TFP grows if a technical change occurs in the economy, i.e. if an upward shift in the production function takes place resulting in more output being produced from the same inputs. Growth in the capital deepening term, instead, derives from a variation in the inputs. For example, an acceleration in the investment dynamics not matched by an equivalent acceleration of the labour input would increase the growth rate of ALP through the capital deepening component. Investment booms typically increase ALP growth through the capital deepening channel. From 1995 to 1999, at the aggregate economy level, both major components of ALP outpaced those observed during the so-called "golden age" of productivity growth from 1913 to 1972.

Technological innovations and their applications were the major factor behind the acceleration of productivity in the second half of the 1990s. The rapid growth of technical advances in the IT-producing industries allowed for a considerable acceleration in the growth rate of TFP in the IT producing sector. Oliner and Sichel (2000) show that the average yearly growth rate of TFP in the computer sector (which accounts for around 1½% of total output in their calculations) increased from slightly above 11% during the period 1974-1995 to 16.6% during the period 1996-1999. The semiconductor sector, which accounts for less than 1% of total output in their calculations, shows a greater acceleration starting from even higher levels: 22% during the period 1991-1995 and 45% during the period 1996-1999.

At the same time, the boom in investments in IT equipment[6] registered in the economy at large contributed to the acceleration in ALP growth through the capital deepening effect. The TFP and capital deepening channels are actually linked. In fact, the productivity growth in the IT-producing industries allowed for a substantial acceleration in the pace of IT price decline.[7] Prices of computer hardware including peripherals, for example, decreased at average annual rates of 14.7% during the period 1987-1995 and 31.2% during the period 1996-1999. In turn, these reduction in the relative prices of IT equipment triggered a massive investment boom in these assets, both by firms and households.

In other words, the technical advances in the IT-producing sector triggered the acceleration in ALP both directly through an acceleration of TFP in that sector, and indirectly through the induced investment boom in the rest of the economy. The impact of IT on the TFP growth in the rest of the economy is smaller, but, as shown in the following section, the estimation of its size is still the subject of intense research activity.

2.3 The New Economy and Solow's paradox

Did the acceleration in productivity growth solve the Solow's paradox of 1987; i.e. that "we see computers everywhere but in the productivity statistics"? The answer to this question is "only partially".

Oliner and Sichel (2000) show that TFP growth rates outside the computer and semiconductor sectors were much lower, even though an acceleration in the second half of the 1990s can be observed, from an average yearly growth rate of 0.2% during the period 1991-1995 to 0.5% during the period 1996-1999. However, their decomposition singles out only computers and semiconductors and leaves the rest of the economy as a large aggregate. It is thus difficult to check in what sectors the spillover effects have been more significant. In particular, the spillover to the durable goods manufacturing sector is statistically diluted in the rest of the economy.

Gordon (2000), instead, distinguishes between the durable goods manufacturing sector, which accounts for 12% of total output in the non-farm private business sector, and the rest of the economy. The interesting result of this exercise is that when the durable goods manufacturing sector is stripped out from

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[6] The average annual growth rate of investment in IT equipment in the US was 46% between 1995 and 2000.

[7] Due to the *hedonic* regression technique, adopted in US national accounts to measure computer prices since 1986, *computer price* means the *price of computer characteristics and attributes* like a given level of speed, memory, disk drive access speed and capacity, presence and speed of a CD-ROM drive, and so on.

the data, the size of the acceleration in ALP in the remaining 88% of the non-farm private business sector is much smaller than the aggregate figure.[8] Moreover, Gordon proposes a decomposition of the acceleration in productivity growth into its cyclical and trend components. The pro-cyclicality of productivity is supported by a large body of literature. Gordon's finding is that there is *no structural acceleration in TFP* when the computer hardware manufacturing (but not the computer-related semiconductor manufacturing) is stripped out. In fact, the structural acceleration in TFP is *negative* if the entire durable goods manufacturing sector is excluded. All in all, it appears that the acceleration in ALP growth in the non-durable segment of the economy can be explained entirely by cyclical developments and the investment boom in IT products, leaving no "structural" residual to be explained.

The decomposition exercise is a necessary step to fully understanding the productivity dynamics of the second half of the 1990s, but it presents some risks and its conclusions should be taken *cum grano salis*. First, the separation of cycle from trend components is a particularly challenging exercise, above all if carried out in the midst of an expansion. Second, industries with positive and negative productivity growth rates make up the economy. If few sectors with high productivity growth rates are stripped out, the growth dynamic of the remaining part of the economy will obviously be lower than the aggregate. However, even in this residual part of the economy there may well be industries that experienced a non-negligible pick up in productivity growth. This implies that IT spillovers could also have reached some industries belonging to that 88% of the non-farm private business sector that, in aggregate, does not show an acceleration in trend TFP. It is anyway true that, by definition, these possible spillovers are not big enough to offset the slowdown in trend TFP growth in the other industries included in the aggregate. Thus the conclusion that IT had only a very limited if not zero impact on the growth rate of trend TFP in the non-durable goods manufacturing part of the economy cannot easily be discarded. The data are far from conclusive in their support of the view that the acceleration in productivity growth was structural and equally distributed across the entire US economy.

Jorgenson and Stiroh (2000) reach an equivalent conclusion: "[…] the evidence already available is informative on the most important issue. This is the "new economy" view that the impact of IT is like phlogiston, an invisible substance that spills over into every kind of economic activity and reveals its presence by increases in industry-level productivity growth across the US economy. This view is simply inconsistent with the empirical evidence".[9]

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8 Between Q4 1995 and Q4 1999 the ALP annual growth rate in the non-farm private business sector was 2.75%. If computer hardware manufacturing is excluded the figure decreases to 2.3%, and if the entire durable goods manufacturing is excluded, the growth rate is 1.99%. Previous growth rates for output per hour were 1.18% (1870-1913), 1.86% (1913-1972), 1.04% (1972-1995).

9 Even though the impact of IT on the impressive revival of productivity growth in the second half of 1990s is indisputable, the type of analyses briefly presented above dampens the widespread enthusiasm brought by the advent of the New Economy. The current juncture depicts a less buoyant scenario with productivity growth declining since Q3 2000 and the Q1 2001 preliminary figure showing a negative quarterly growth rate of -1.2% annualised for the non-farm business sector; the lowest quarterly figure for eight years. Moreover, orders for information and communication technology goods are continuing their rapid downward movement: in the three months to April 2001 there was a reduction of almost 36% in annual terms compared with the preceding three months.

2.4 The business cycle

One of the major structural breaks in US GDP dynamics of the last half a century appears to have little to do with the recent expansion and the New Economy. McDonnell and Perez-Quiros (2000) show that the break dates back to 1984 and relates to the drop in the variance of real output fluctuations, measured as quarterly growth rates. In particular, between Q2 1953 and Q3 1983 some 30% of quarterly growth rates exceeded 1.5%, while between Q1 1984 and Q2 1999 this proportion decreases to only 3.2%. Growth rates below 0% represent 22% of the observations in the earlier period and only 4.8% in the later one. If the sample for this analysis is limited to the six major expansions of the post-World War II era, the picture does not change. In fact, Leamer (2000) shows that the last two expansions had the lowest standard deviations of quarterly real GDP growth (2.4% for the expansion of the 1980s and 1.9% for the expansion of the 1990s, in both cases much lower than the average of 4.1% for the previous four expansions).

McDonnell and Perez-Quiros identify the reason for this development as being the reduction in volatility within the durable goods sector. One important result of this analysis is that, even though the statistical support for the hypothesis of muted quarter-on-quarter fluctuations is strong, *the authors do not find evidence that this phenomenon has smoothed the business cycle*. The amplitude of GDP fluctuations around the cycle has decreased, but there appears to be no structural break in the cycle itself. In other words, evidence of less robust expansions and less severe recessions in the most recent period cannot be found in the data and reports of the death of the business cycle seem at best premature.

2.5 Preliminary conclusions

In summary, a deeper look at the acceleration of productivity registered in the second half of the 1990s calls for some caution. One should avoid euphoric conclusions derived from a superficial analysis of the data. Many aspects have yet to be completely measured and understood, but it seems that there little reason to pronounce the death of the business cycle.

3. The equity risk premium

3.1 The valuation puzzle

The advent of the New Economy was accompanied by a boom in financial markets. The causal relationship between the two events appears to be quite tight. In this section, we want to single out the New Economy's impact on the estimation of the ex ante conditional equity risk premium and, through this channel, on stock prices.

A useful way of describing stock market developments is based on a comparison of market prices and theoretical stock prices. Bond and Cummins (2000) calculate the time series of Tobin's average qs – defined as the ratio of the stock market value of a firm to the replacement cost of its tangible assets – for a sample of 300 firms from 1982 to 1998. These values are then compared to the respective theoretical qs –

defined as the ratio of the present discounted value of stock market analysts' consensus earnings forecasts to the replacement cost of a firm's tangible assets. Expected earnings are discounted using the current yield on the thirty-year US Treasury bonds *plus an 8% risk premium*.

Both series (the q calculated from actual prices and the one calculated discounting expected profits) show clear growing trends, albeit of different gradients. One explanation for the growth of market qs might well be the increasing value of intangible assets, which are incorporated in market prices (the numerator of the market qs), but not in the denominator. However, the accumulation of the same intangible assets should also explain the growth of the expected earnings and, hence, the growth of the theoretical qs. One would therefore expect the importance of intangible assets to affect both ratios. Similarly, (over-optimistic) expectations about future earnings should impact both ratios in the same way.

The puzzling result of the comparison of the two q time series is that market valuation of firms grew at a much higher speed than the valuation based on expected earnings. Moreover, the gap between the two widened over time, particularly in the second half of the 1990s.

An explanation of the puzzle, which takes into account the New Economy interpretation of recent economic developments, is that too high a value of the equity risk premium is used in the estimation of the theoretical q series. As investors came to believe in the new paradigm, some elements traditionally incorporated in the premium may have become of less concern and the premium may have to be reduced relative to the constant 8% incorporated in the estimate. Thus, the stream of future earnings would be discounted at a lower rate, thereby narrowing the gap between the market-based and the theoretical-based valuation of firms. Hence, the puzzling gap between market values and theoretical values would only be an apparent one – if "appropriately" discounted the two valuations would appear much closer.

As shown in the previous sections, the macroeconomic justification of the reduction in the risk premium is weak. So, in the remainder of this section we argue that the rise in market valuations triggered by the New Economy phenomenon may have represented a deviation from equilibrium. This source of mispricing would have affected all sectors of the stock market, not only those usually related to the New Economy.

3.2 Some theoretical background

The equity premium is defined as the difference between the expected return on the market portfolio of common stocks and the risk-free interest rate. The premium can be interpreted as a backward or forward-looking concept. In the former case – the ex-post equity premium – historical data are considered and their averages provide the estimate for the unconditional premium. The value of the latter – ex ante equity premium – is conditional on the current state of the economy. Long-term investors are likely to use the ex post premium on the assumption that over very long horizons the equity premium will not change significantly with respect to the past. However, shorter term investors are likely to prefer an estimation of the risk premium conditional on the current state of the economy.

The unconditional ex post stock return can be estimated in three alternative ways. First, as the past average dividend yield plus the average rate of capital gain. Second, as the past average dividend yield plus the average growth rate of dividends (if the latter is co-integrated with the stock price and is stationary). Third, the past average dividend yield plus the average growth rate of earnings (if the latter is co-integrated with the stock price and stationary).

Each measure reflects the same result: stock returns exceed the risk-free rate. The puzzle derives from the fact that stock returns are high relative to that implied by theory.

More formally, in any asset pricing model the following inequality must hold:

$$(2) \quad \frac{\sigma_t(m_{t+1})}{E_t m_{t+1}} \geq \frac{E_t(r_{i,t+1} - r_{f,t+1})}{\sigma_t(r_{i,t+1} - r_{f,t+1})}$$

where E_t is the conditional expectations operator conditioning on today's information, r_i is the return on a risky asset i, r_f is the return on the risk-free asset, m is the stochastic discount factor. The ratio on the right-hand side of (2) is the Sharpe ratio – the asset's risk premium divided by its standard deviation. The Sharpe ratio thus sets a lower boundary for the volatility of the discount factor. Our interest in this inequality is that it is the basis of the so called equity risk premium puzzle. In fact, given a level for the risk premium and its volatility, other variables and parameters must adjust to fulfil the inequality. Empirical exercises, for example Campbell and Cochrane (1999), show that the equity premium generates a high level of the Sharpe ratio which implies too high a minimum standard deviation for the discount factor. In turn, the latter determines a value for the coefficient of relative risk aversion (which enters into the discount factor) that is much higher than has traditionally been considered plausible. This is Mehra and Prescott's (1985) equity premium puzzle. Moreover, the high risk aversion coefficient would imply too high a β for a "reasonable" level of the risk free rate or too high a risk free rate for a "reasonable" level of β. All these inconsistencies derive from the too high equity risk premium.

Many solutions to the puzzle have been proposed. Some are based on the relationship between macroeconomic developments and financial market developments. Rietz (1988) suggests the fear of a catastrophic event as the reason for the higher remuneration required by investors for holding stocks rather than the risk-free asset. This approach has the merit of explaining high stock returns, notwithstanding their relatively low volatility. One difficulty with this argument is its need for an asymmetric impact of the potential catastrophe on stock markets and short-term government securities markets. Empirical evidence, instead, tends to show that major disasters hit stock and bond holders in equivalent ways.

In the context of the standard representative-agent consumption-based asset pricing model, Campbell and Cochrane (1999) propose an alternative explanation based on the concept of the surplus consumption ratio, which is defined as the fraction of consumption that exceeds the level of habit (or subsistence). The ratio appears to be a good explanatory variable for the risk premium. In particular, empirical evidence leads them to the conclusion that investors fear stocks (and thus require high returns) because they do badly in occasional serious recessions, which are times of low surplus consumption ratios.

Here we are not interested in commenting on the equity premium puzzle and its potential solutions *per se*. The interesting fact is that the vast research on the puzzle led to the conclusion that expectations for the business cycle, and fears of recessions in particular, are likely to have been among the key explanatory variables for the equity premium in the past. On the basis of this literature we conclude that perceived structural changes in the business cycle based on increasing acceptance of a permanent increase in TFP may have had a strong impact on the equity premium and, consequently, on stock valuations. In order to test this hypothesis, we constructed a simple model of the stock market's valuation and tested for structural breaks in the data in the mid 1990s.

4. A simple stock market model and tests for parameter stability

In this section, we show that the gap between theoretical and market prices widened substantially in the second half of the 1990s. Given the considerations developed in the previous and the current sections, we conclude that the explanation for this phenomenon is likely to lie in changes in the perceived equity risk premium.

We shall construct a simple stock market model and test for a structural break in the data around the middle of the 1990s. Specifically, we shall show that *if a constant equity premium is assumed, the specification of the model which explains the data in the first sub-period (up to December 1995) does not fit the data in the second sub-period (from January 1996 to March 2000) and vice versa. The results of this analysis corroborate our hypothesis that a possible perceived reduction in the ex ante equity risk premium has contributed to explaining the high valuation of stock markets in the post-1995 period. In other words, the adjustment of the premium along the lines of the New Economy macroeconomic expectations would narrow the gap between the theoretical prices and the market prices.*

Since the effects of such a change in the premium are likely to affect all sectors (more on this in Section 5 of the paper), we shall look for evidence of a reduction in the premium through the analysis of large market indices (S&P500 and DAX).

4.1 The data and the model

The current earnings yield of a stock market, defined as the ratio of expected earnings per share to the stock market index, has often been compared with the current yield on government bonds in order to make judgements about the valuation of stocks relative to bonds[10]. The theory behind the close

[10] See Humphry-Hawkins Report, 22 July 1997, http://www.federalreserve.gov/BOARDDOCS/hh/1997/july/ReportSection2.htm and Topical Study Number 44, Dr. Edward Yardeni, Deutsche Bank, Alex. Brown, 26 July 1999.

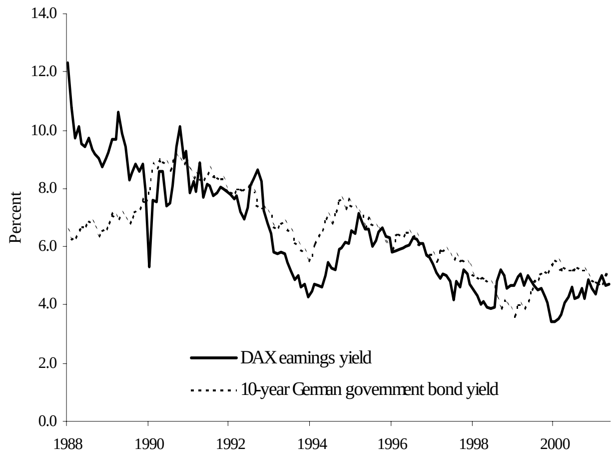
relationship between equity earning yields and bond yields relates to the constant dividend discount model:

(3) $$P = \frac{D}{r - g}$$

where P is the present value of the stock, D is the current dividend that is expected to grow at a constant rate (g) in perpetuity, and r is the discount rate equal to a risk-free rate plus an equity risk premium. The charts below depict the earnings yield (E/P) and the risk-free rate.

United States – earnings yields and bond yields

Germany – earnings yields and bond yields



Source: Datastream.

Note: earnings yield defined as ratio of I/B/E/S consensus estimate of earnings over the coming twelve months to the stock market index.

In order to build a simple model of a stock market index we begin by substituting the consensus estimate of expected earnings per share over the coming twelve months, *EPS*[11], as provided by I/B/E/S, for dividends in equation 3, giving:

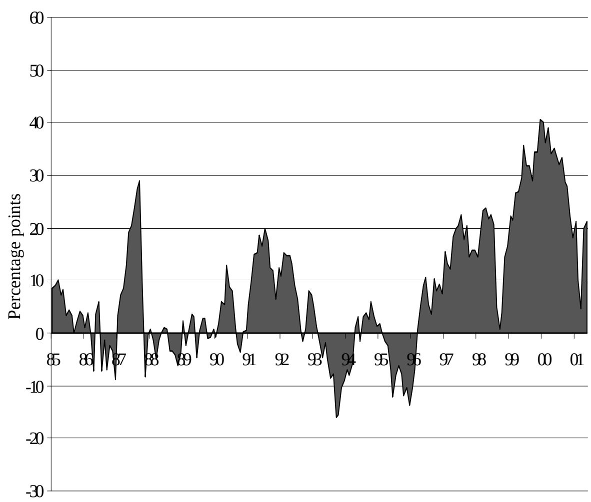
(4) $$p \cong \frac{EPS}{r - g}.$$

r–g is the capitalisation rate as defined above. Specifically, we define r as the 10-year government bond yield plus an equity risk premium. We define the risk premium using the above-mentioned methodology proposed by Bond and Cummings (2000) as the difference between the average past dividend yield plus

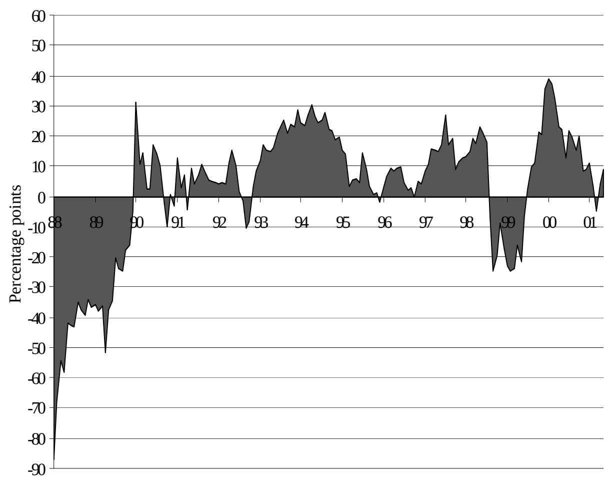
[11] We look at earnings rather than dividends since the latter variable presents several empirical difficulties. In fact, the proportion of firms paying dividends has gradually decreased due to the growing preference for share repurchases as a means of rewarding shareholders. So, the model we test must be interpreted as a proxy for the dividend discount model since dividends are supplanted by earnings.

the average rate of capital gain less the average 10-year government bond yield. Equity dividend and capital gain data are taken from Datastream stock market indices since January 1973. For the United States, the ex post risk premium is 6.3% and for Germany it is 5.5%.[12] We define the earnings growth potential in perpetuity (*g*) as the average past growth rate in nominal GDP during the period under consideration. For the United States this is 5.8% and for Germany 5.4%. For the United States, the data cover the period from January 1985 to May 2001, for Germany they cover January 1988 to May 2001. We then calculate the difference between the approximated level of the stock market index (*p*), estimated from equation 4 as explained above, and the actual level and express it as a percentage of the actual level. These differences are shown in the charts below. Positive (negative) values indicate that the actual market value exceeds (is less than) the model value approximated by the ratio of expected earnings to *r-g*.

S&P500 percentage difference to EPS/r-g



DAX percentage difference to EPS/r-g



Source: I/B/E/S, Datastream and ECB calculations

In the case of the S&P500, the differences show a clear widening trend beginning in the mid-1990s. Before that, the model seems to match the actual data surprisingly well. This trend is much less evident in the case of the DAX. In both markets, the differences decline dramatically in late 1998. This can be attributed to the impact of the Russian and LTCM crises on interest rates and actual stock market values. Both interest rates and stock market values decline, whereas growth in consensus expected earnings over the coming twelve months remain broadly unchanged due to the relatively slow frequency with which they are updated. The different frequency in the adjustments of market prices on one side and published expectations on the other leads to a reduction in the degree to which the actual stock market value exceeded the modelled.

[12] The risk premium is calculated as the average past dividend yield plus the average past capital gain less the average past nominal 10-year government bond yield. For the United States theses numbers are 6.3 = 3.5 + 11.1 - 8.3. For Germany they are 5.5 = 2.7 + 10.1 - 7.3. Data cover the period from January 1973 to May 2001. Source: Datastream.

Our hypothesis is that the increase in actual stock market values relative to those implied by the earnings model, particularly for the S&P500, was attributable to a reduction in the ex ante risk premium applied by investors to the aggregate valuation of the market. In our simple earnings model, changes in the differences between the market value and the modelled value could in principle come from: a) differences between expected earnings contained in the data base used and those reflected in actual stock market prices; b) changes in the risk-free discount rates that are not reflected in stockmarket prices; c) changes in the potential rate of earnings growth; or d) changes in the ex ante risk premium. We think it is a reasonable assumption that changes in expected earnings would be equally reflected in analysts' earnings estimates as well as actual stock market prices. The same should apply for risk-free interest rates. We also assume that the nominal rate of GDP growth, our proxy for measuring the long-run earnings growth potential, should be broadly unaffected by structural increases in TFP since this could primarily affect the relative proportions of real growth and inflation rather than the absolute level of nominal growth. Since our model only captures the ex post risk premium, this leaves changes in the unobservable ex ante conditional risk premium as the sole possible suspect that may account for the differences.

4.2 Estimation of the model[13]

We confirm the initial visual impression by estimating the coefficients of the following equation:[14]

(5) $$DP = \alpha + \beta * D\left(\frac{EPS}{r-g}\right) + \mu$$

where *P* equals the stock market index (S&P500 for United States and DAX for Germany) and the other parameters are as defined in equation 4. *D* is the first difference operator. The time series for the first differences of the US and German stock indices are indicated as DSP and DDAX respectively, while those of the theoretical prices as DTHEOSP and DTHEODAX respectively.

Since the related tests show that the market and theoretical time series for stock prices are integrated of order 1, it was necessary to switch to first differences in order to deduct the stochastic trend and to carry out the analysis. For both countries the cross-correlogram suggested introducing the series of theoretical prices in the model with a lead of two months. This is not surprising, given the relative slowness with which earnings forecast are updated in the database. When DSP is regressed on DTHEOSP(+2) over the entire period, the β coefficient turns out to be significantly different from zero at 5% significance and the residuals are not correlated. However, the CUSUM and CUSUM of squares tests and the recursive estimates point to the instability of the estimated β. In particular, the CUSUM test signals the existence of a possible break around the end of 1995. In order to verify it, we split the sample into two sub-periods: one up to December 1995 and the other between January 1996 and March 2000. The regression of DSP on DTHEOSP(+2) in the first sub-period produces an estimate of the β coefficient which is not

[13] This Section draws on the work of Marco Lagana'.

[14] The results of the estimates and of some of the tests on the residuals are reported in the appendix.

significantly different from zero at 5% significance. However, an acceptable result is obtained if the DTHEOSP variable is not shifted forward. The opposite happens with the second sub-period: the coefficient estimate is significant and the CUSUM well behaved only if the DTHEOSP series is shifted forward by two periods.

These results thus corroborate our hypothesis of a structural break in the relationship between theoretical and market prices for the S&P500 in the middle of the 1990s. Given the considerations discussed in the previous paragraphs, we conclude that this phenomenon is likely to be due to a reduction in the ex ante perceived risk premium.

Equivalent results are obtained from the analysis of the DAX, even though the evidence of a soundness of the estimates in the second sample appears to be smaller due to the high volatility of the series.

5. What can be inferred from recent developments in stock prices across business sectors?[15]

The analysis so far has shown that the reduction of the ex ante equity risk premium should be taken into consideration when explaining aggregate stock market developments in the second half of the 1990s. We shall now try to assess whether this reduction has been unequal across the sectors of the economy. In order to do that, we shall consider the dispersion of stock returns across business sectors in the euro area and the United States using a detailed breakdown into up to 105 business sectors (the “Level 5” breakdown published by Datastream). The conclusion of this analysis is that in the second half of the 1990s the dispersion of stock returns adjusted for changes in stock market volatility tended to increase both in Europe and in the United States. However this result does not represent conclusive evidence for the acceptance of the hypothesis of unequal changes in the risk premium across sectors.

Roulet and Solnik (2000) show that, under simplifying assumptions, the cross-sectional dispersion of stock returns across countries can provide a measure of the average correlation between country stock returns, or accordingly of the average correlation of country stock returns with global stock returns. We apply this approach to business sectors instead of countries, with two main adaptations. First, unlike Roulet and Solnik (2000), we take account of the relative weights, in terms of stock market capitalisation, of the sub-components (in our case business sectors). Second, we adjust for changes in volatility, thereby following the insights of Forbes and Rigobon (1999). For each month from 1972 to 2000 we calculate historical volatility of daily returns in the overall index over the month and divide this by the historical volatility of daily returns over the entire sample. This ratio of current to average historical volatility is used as an adjusting factor for the estimates of coefficients of dispersion.

In the following, we are careful not to interpret the volatility-adjusted dispersion of stock returns across business sectors as a measure of correlation across business sectors, since the simplifying assumptions

15 This Section draws on the work of Benjamin Sahel.

under which this would be possible, as listed by Roulet and Solnik (2000) are not necessarily verified. Volatility-adjusted dispersion should rather be seen as reflecting a combination of influences.

The main observations are as follows.

Between 1980 and 2000, the volatility-adjusted and value-weighted dispersion of stock returns across business sectors declined by about one-third in the euro area (see panel (A) below). Dispersion showed some increases in the year to August 1986 related to rapid advances in stock prices in the euro area financial sector which were later reversed. Apart from this episode, there was a fairly steady decline between 1980 and 1995 both in euro terms and in US dollar terms. However, dispersion showed a tendency to increase between 1995 and 2000.

In the United States, dispersion across business sectors showed no clear trend between end-1973 and end-1999 (see panel B below). However, two observations are worthy of note. First, the level around which US dispersion stood over this period (50% per annum) is similar to the level reached by euro area dispersion at the end of the period. This suggests that euro area stock markets have become broadly similar to US stock markets with regard to sectoral dispersion. This could reflect not only convergence in the sectoral composition of the euro area and US stock markets, but also some increase in the degree of "business sector efficiency" of euro area stock markets to levels in line with US stock markets.[16] Second, US dispersion increased considerably between the second half of 1999 and end-2000, reaching levels which were higher than the previous peak in 1981. A closer look at the components shows that this development reflected an increasing discrepancy between volatility-adjusted stock returns in technology sectors compared with other sectors of the US stock market over the period from the second half of 1999 to end-2000.

One interpretation would be that this increase in dispersion across business sectors reflected unequal fluctuations in the equity risk premium between business sectors over this period, which was particularly apparent in the United States but also, at least to some extent, in the euro area. However, the increased dispersion of returns might be due to other factors, such as unequal fluctuations in earnings expectations. Hence, the evidence presented up to now does not lead to conclusive results and further research on this aspect is required.

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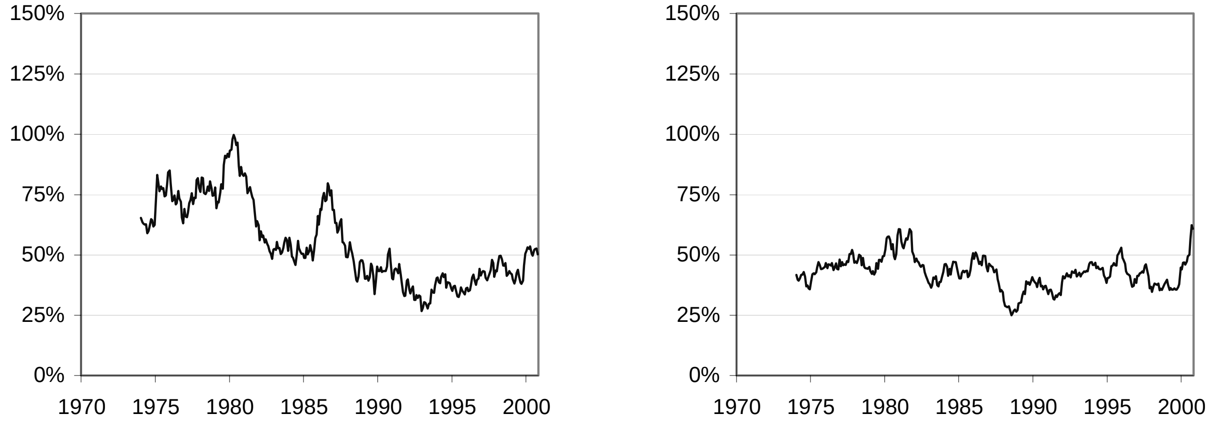
[16] "Business sector efficiency" can be defined as follows: Assume that two economic areas A and B have stock markets with identical sectoral composition, in the sense that the share of each business sector in the stock market is identical and that average returns and volatility of stock returns are the same. Further assume that corporate earnings expectations, including the degree of uncertainty associated thereto, are (broadly) identical in both economic areas. Then "business sector efficiency" can be said to be higher in the area A than in the area B if the dispersion of stock returns across business sector is lower in area A than in area B.

Volatility-adjusted dispersion of stock market returns across business sectors from end-1973 to end-2000 (a)

(A) In the euro area **(B) In the United States**

(percent, annualised, moving average over one year, weighted according to stock market capitalisation, in US dollar terms)



Source: Datastream and author's calculations

(a) Using the "Level 5" breakdown into up to 105 business sectors published by Datastream.

6. Conclusions

A deeper look at the revival of productivity growth registered in the second half of the 1990s shows that much has yet to be fully measured and understood. However, it seems premature to say the least to pronounce the death of the business cycle. On the contrary, it may well be that perceived structural changes in the business cycle based on the increasing acceptance of a permanent increase in TFP have had a strong, and possibly exaggerated, impact on the equity premium and, consequently, on stock prices.

We have shown that a very simple model of stock valuation fits the S&P500 data relatively well up to the mid-1990s, when the gap between market and theoretical values starts to widen substantially. A simple test for parameter stability confirmed the first visual impression. We conclude that the most likely factor behind the failure of the model to explain market developments in the second half of the 1990s lies in the gradual reduction of the ex ante conditional equity risk premium from the historical ex post premium used in the model. Given that this reduction in the premium has weak macroeconomic foundations, we conclude that the rise in market valuations driven by this factor probably represented a deviation from equilibrium.

7. ANNEX

RESULTS OF THE REGRESSIONS

Dependent Variable: DSP

Method: Least Squares

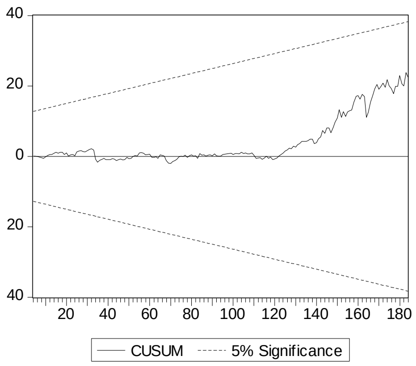
Sample(adjusted): 2 184 from January 1985 to March 2000

Included observations: 183 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.160690	2.110609	4.340307	0.0000
DTHEOSP(2)	-0.495468	0.102018	-4.856661	0.0000

R-squared	0.115291	Mean dependent var	6.955191
Adjusted R-squared	0.110404	S.D. dependent var	29.56270
S.E. of regression	27.88307	Akaike info criterion	9.504785
Sum squared resid	140721.3	Schwarz criterion	9.539862
Log likelihood	-867.6879	F-statistic	23.58715
Durbin-Watson stat	2.151037	Prob(F-statistic)	0.000003

CUSUM test on the stability of the residuals



Dependent Variable: DSP

Method: Least Squares

Sample(adjusted): 2 134 from January 1985 to December 1995

Included observations: 133 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.255532	1.202443	1.875791	0.0629
DTHEOSP	0.302546	0.089610	3.376248	0.0010

R-squared	0.080050	Mean dependent var	3.464662
Adjusted R-squared	0.073028	S.D. dependent var	13.74949
S.E. of regression	13.23793	Akaike info criterion	8.018973
Sum squared resid	22956.80	Schwarz criterion	8.062436
Log likelihood	-531.2617	F-statistic	11.39905
Durbin-Watson stat	2.127331	Prob(F-statistic)	0.000967

Dependent Variable: DSP

Method: Least Squares

Sample(adjusted): 135 186 from January 1996 to March 2000

Included observations: 52 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	14.61178	7.139183	2.046702	0.0460
DTHEOSP	0.193235	0.220752	0.875349	0.3856

R-squared	0.015093	Mean dependent var	15.65712
Adjusted R-squared	-0.004605	S.D. dependent var	50.63958
S.E. of regression	50.75604	Akaike info criterion	10.72964
Sum squared resid	128808.8	Schwarz criterion	10.80469
Log likelihood	-276.9707	F-statistic	0.766235
Durbin-Watson stat	2.329507	Prob(F-statistic)	0.385570

Dependent Variable: DSP

Method: Least Squares

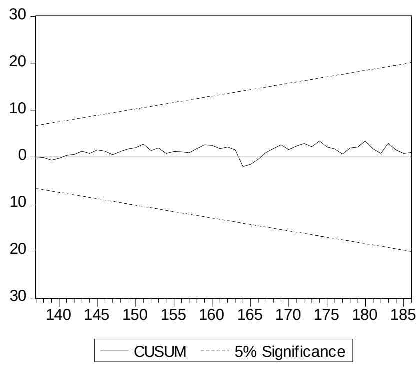
Sample(adjusted): 135 184 from January 1996 to March 2000

Included observations: 50 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	21.61602	6.573695	3.288260	0.0019
DTHEO(2)	-0.771091	0.204310	-3.774127	0.0004

R-squared	0.228842	Mean dependent var	16.24000
Adjusted R-squared	0.212776	S.D. dependent var	51.14491
S.E. of regression	45.37865	Akaike info criterion	10.50714
Sum squared resid	98842.64	Schwarz criterion	10.58362
Log likelihood	-260.6785	F-statistic	14.24403
Durbin-Watson stat	2.392468	Prob(F-statistic)	0.000442

CUSUM test on the stability of the residuals



Dependent Variable: DDAX

Method: Least Squares

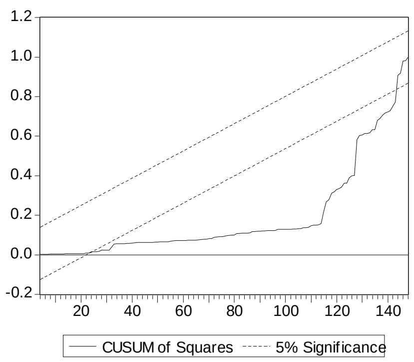
Sample(adjusted): 2 148 January 1988 to March 2000

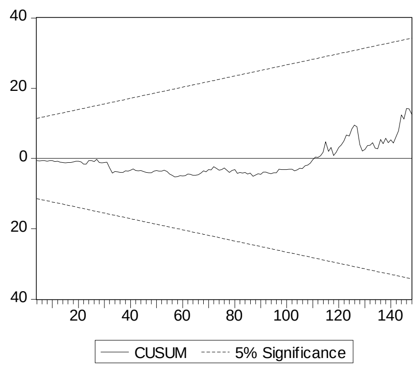
Included observations: 147 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	36.59406	17.48013	2.093466	0.0380
DTHEODAX(2)	0.251790	0.096526	2.608528	0.0100

R-squared	0.044824	Mean dependent var	44.07558
Adjusted R-squared	0.038236	S.D. dependent var	213.1783
S.E. of regression	209.0631	Akaike info criterion	13.53666
Sum squared resid	6337568.	Schwarz criterion	13.57735
Log likelihood	-992.9446	F-statistic	6.804420
Durbin-Watson stat	2.021138	Prob(F-statistic)	0.010046

CUSUM test and CUSUM square test on the stability of the residuals





Dependent Variable: DDAX

Method: Least Squares

Sample(adjusted): 2 98 from January 1988 to December 1995

Included observations: 97 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	15.89435	9.414867	1.688218	0.0946
DTHEODAX(2)	-0.005778	0.079058	-0.073082	0.9419

R-squared	0.000056	Mean dependent var	15.85546
Adjusted R-squared	-0.010470	S.D. dependent var	92.09666
S.E. of regression	92.57750	Akaike info criterion	11.91437
Sum squared resid	814206.5	Schwarz criterion	11.96746
Log likelihood	-575.8471	F-statistic	0.005341
Durbin-Watson stat	2.012341	Prob(F-statistic)	0.941894

Dependent Variable: DDAX

Method: Least Squares

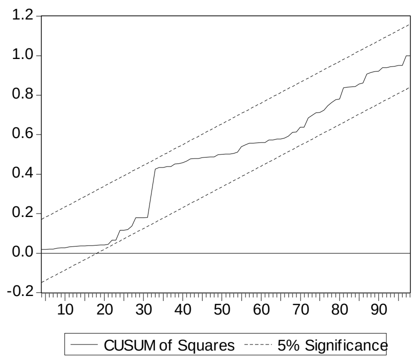
Sample(adjusted): 2 98 from January 1988 to December 1995

Included observations: 97 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	14.77501	9.124120	1.619336	0.1087
DTHEODAX	0.186726	0.075807	2.463163	0.0156

R-squared	0.060031	Mean dependent var	15.85546
Adjusted R-squared	0.050137	S.D. dependent var	92.09666
S.E. of regression	89.75826	Akaike info criterion	11.85252
Sum squared resid	765371.8	Schwarz criterion	11.90561
Log likelihood	-572.8472	F-statistic	6.067174
Durbin-Watson stat	1.994934	Prob(F-statistic)	0.015572

CUSUM square test on the stability of the residuals



Dependent Variable: DDAX

Method: Least Squares

Sample: 99 150 from January 1996 to March 2000

Included observations: 52

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	80.93465	49.27796	1.642411	0.1068
DTHEODAX	0.058416	0.191296	0.305370	0.7614

R-squared	0.001862	Mean dependent var	85.08962
Adjusted R-squared	-0.018101	S.D. dependent var	338.4844
S.E. of regression	341.5342	Akaike info criterion	14.54248
Sum squared resid	5832280.	Schwarz criterion	14.61752
Log likelihood	-376.1044	F-statistic	0.093251
Durbin-Watson stat	1.999579	Prob(F-statistic)	0.761352

Dependent Variable: DDAX

Method: Least Squares

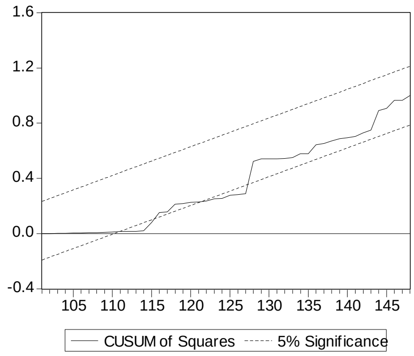
Sample(adjusted): 99 148 from January 1996 to March 2000

Included observations: 50 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	75.28100	48.88319	1.540018	0.1301
DTHEODAX(2)	0.316840	0.186225	1.701383	0.0953

R-squared	0.056876	Mean dependent var	98.82260
Adjusted R-squared	0.037228	S.D. dependent var	337.8687
S.E. of regression	331.5200	Akaike info criterion	14.48443
Sum squared resid	5275465.	Schwarz criterion	14.56091
Log likelihood	-360.1108	F-statistic	2.894703
Durbin-Watson stat	2.056706	Prob(F-statistic)	0.095341

CUSUM square test on the stability of the residuals



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