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In 2005 all ECB publications will feature a motif taken from the €50 banknote.

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ABSTRACT

This paper assesses the possible contemporaneous relationship between stock index prices, earnings and long-term government bond yields for a large number of countries and over a time period that spans several decades. In a cointegration framework, our analysis looks at three hypotheses. First, is there a long-term contemporaneous relationship between earnings, stock prices and government bond yields? Second, does a deviation from this possible long-run equilibrium impact stock prices such that the equilibrium is restored? Third, do government bond yields play a significant role in the long-run relationship or does the latter only involve stock prices and earnings? We also study the short-term impact of changes in long-term government bond yields on stock prices and discuss our short-term and long-term results in light of the recent developments regarding the so-called Fed model.

Key words: stock indexes, earnings, long-run relationships, interest rates, inflation, market valuation.

JEL classification: C13, C22, F31, G14

Non-technical summary

This paper assesses the possible contemporaneous relationship between stock index prices, earnings and long-term government bond yields for a large number of countries and over a time period that spans several decades. Although neither endorsed nor suggested by the Fed, the name ‘Fed model’ was coined by market practitioners in the late 1990’s to designate a possible valuation model that determines the acceptable earnings yield for a stock index with respect to the prevailing long-term government bond yield. More specifically, proponents of this model argue that there is an equilibrium relationship between the earnings yield of a stock index and the 10-year government bond yield. In a nutshell, when the earnings yield is below (above) the 10-year government bond yield, the stock market is supposed to be overvalued (undervalued). Thus the ‘fair value’ for the stock index should be equal to the earnings level divided by the prevailing 10-year government bond yield. The main rationale of this model is the (possibly flawed) use of a discounted cash-flow model. In a simplified setting, decreasing (increasing) government bond yields imply a smaller (larger) discount factor, hence a smaller (larger) denominator in the valuation formula, hence a higher (lower) stock price. Since a couple of years, there has however been a growing criticism of this simplified valuation model. Critics argue that the logic behind the valuation argument is flawed in the sense that an element is missing (the risk premium, which is known to be time-varying) and that the concept of ‘inflation illusion’ should be taken into account. Indeed, lower bond yields suggest lower anticipated inflation, hence firms should witness smaller growth rates for their earnings per share because of a likely decrease in corporate pricing power. Therefore, when the discount factor is decreased in the valuation formula, the earnings per share growth rate should also be decreased. This implies that higher stock prices are not necessarily warranted. Thus, this approach stresses that the growth rate and discount factor variables are interrelated in the valuation formula.

The goal of the paper is thus to assess explicitly the contemporaneous relationship between stock indexes, earnings and long-term government bond yields for a large collection of countries (Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Japan, Switzerland, The Netherlands, United Kingdom and the United States) and over a time period that spans 30 years. In particular, the analysis looks at three hypotheses using the cointegration framework. First, is there a long-term contemporaneous relationship between earnings, stock prices and government bond yields? Second, does a deviation from this possible long-run equilibrium impact stock prices such that the equilibrium is restored? Third, do government bond yields play a significant role in the long-run relationship or does the latter only involve stock prices and earnings? Furthermore, we also study the short-term impact of changes in long-term government bond yields on stock prices and discuss our short-term and long-term results in light of the recent developments in the literature.

Our empirical results show that a long-run relationship between stock indexes, earnings and long-term government bond yields indeed exists for many countries (including the United States and the United Kingdom) but that the long-term government bond yield is *not* statistically significant in this relationship, i.e. the long-term government bond yield does not affect the 'equilibrium' stock market valuation. Focusing next on the short-term effects, we nevertheless show that rising/decreasing bond yields do impact contemporaneous stock market returns and thus have an important short-term impact on the stock market. The fact that the bond yield is left out of the picture in the long-run relationship is in agreement with the academic literature that stresses the importance of valuation ratios (such as the P/E ratio) when appraising long-run stock market performance.

1. Introduction

Although neither endorsed nor suggested by the Fed, the name 'Fed model' was coined by market practitioners in the late 1990's to designate a possible valuation model that determines the acceptable earnings yield for a stock index with respect to the prevailing long-term government bond yield. More specifically, proponents of this model argue that there is an equilibrium relationship between the earnings yield of a stock index and the 10-year government bond yield. In a nutshell, when the earnings yield is below (above) the 10-year government bond yield, the stock market is supposed to be overvalued (undervalued). Thus the 'fair value' for the stock index should be equal to the earnings level divided by the prevailing 10-year government bond yield. The main rationale of this model is the (possibly flawed) use of a discounted cash-flow model. In a simplified setting, decreasing (increasing) government bond yields imply a smaller (larger) discount factor, hence a smaller (larger) denominator in the valuation formula, hence a higher (lower) stock price. Note that this supposes that the other variables in the valuation formula are not affected by the modifications of the discount factor. A closely connected model, which is described below, is the Stock Valuation Model of Yardeni (2003).

Since a couple of years, there has however been a growing criticism of this simplified valuation model. Critics argue that the logic behind the valuation argument is flawed in the sense that an element is missing (the risk premium, which is known to be time-varying) and that the concept of 'inflation illusion' should be taken into account. Indeed, lower bond yields suggest lower anticipated inflation, hence firms should witness smaller growth rates for their earnings per share because of a likely decrease in corporate pricing power. Therefore, when the discount factor is decreased in the valuation formula, the EPS growth rate should also be affected and should also be decreased.[1] This implies that higher stock prices are not necessarily warranted. Thus, this approach stresses that the growth rate and discount factor variables are interrelated in the valuation formula. It also reminds us that the impact of expected inflation on stock prices is difficult to quantify as it affects both the numerator and the denominator of a discounted cash-flow model. Note that, according to that approach, rising interest rates are not necessarily a bad thing for the stock market outlook, which was already suggested by Modigliani and Cohn (1979). Among others, Asness (2000), Ritter and Warr (2002), Asness (2003), Campbell and Vuolteenaho (2004) and Cohen, Polk, and Vuolteenaho

[1] As summarized in Lansing (2004): "Investors and homebuyers appear to be adjusting their discount rates to match the prevailing nominal interest rate. However, for some unexplained reason, they do not simultaneously adjust their forecasts of future nominal cash flows, i.e., earnings distributions or imputed rents".

(2005) provide a treatment of these issues, and we review some of their arguments in Section 2. If interest rates are more or less left out of the picture, the main determinants of long-term stock market performance are then found to be valuation ratios such as the P/E ratio, in agreement with e.g. Philips (1999), Campbell and Shiller (1998, 2001) or Asness (2003).

The goal of the paper is to assess the contemporaneous relationship between stock indexes, earnings and long-term government bond yields for a large number of countries and over a time period that spans several decades. Regarding the econometric methodology, we use cointegrated VAR models (also called VECM models) which allow both short-term and long-term dynamics. The latter is the most important for our study as the presence of a valid long-term cointegrating relationship between stock index prices, earnings and long-term government bond yields for many countries would lend credence to the Fed model. Note that we do not consider time-varying models (for the risk premium) as we focus on the contemporaneous long-run relationship between stock prices, earnings and long-term bond yields. Hence, our analysis is closer to Harasty and Roulet (2000) and what some practitioners would like to test than the time-varying models of Campbell and Shiller (1988 and 1989). To address these issues, we test the following hypotheses:

Hypothesis 1: For a given country, there is a long-term contemporaneous relationship between earnings, stock prices and government bond yields.

Hypothesis 2: The long-term relationship of hypothesis 1 implies that a deviation from the long-run equilibrium impacts stock prices such that the equilibrium is restored.

Hypothesis 3: Although there is a long-term relationship, government bond yields do not play a significant economic role.

Regarding the well documented literature on this topic, our analysis is unique in the sense that we focus on a large collection of countries (Australia, Austria, Belgium, Canada, Denmark, France, Germany, Italy, Japan, Switzerland, The Netherlands, United Kingdom and the United States) and that we use the same cointegrating methodology for all markets. Besides the modelling of the short-term and long-term dynamics, the cointegration framework allows the rigorous testing of the hypotheses detailed above. Thus, a distinct and important feature of our analysis is that, while most empirical analysis in this literature focus on the United States given the very long historical data available, we undertake a truly international comparison and deal with 13 countries over a time span of 30 years. Moreover, the rationale of the Fed model and the possible relationship between earnings, stock prices and long-term government bond yield is studied both at the nominal and real level.

The rest of the paper is structured as follows. Section 2 discusses the arguments for and against the Fed model. We then present our dataset in Section 3. The cointegration econometric framework is detailed in Section 4 and the empirical application is discussed in Section 5. Finally, Section 6 concludes.

2. The earnings yield, the bond yield and the Fed Model

This section describes the Fed model and its inputs. We also discuss present value models and provide a discussion as to why the Fed model could be meaningful or meaningless.

2.1. From the discount dividend model to the Fed model

For an investor long one share in a given stock, the expected return from period t to $t+1$, HPR^e_{t+1}, can be expressed as the sum of the expected dividend, D^e_{t+1}, and the expected change in the stock price, $P^e_{t+1} - P_t$:

$$HPR^e_{t+1} \equiv \frac{P^e_{t+1} - P_t}{P_t} + \frac{D^e_{t+1}}{P_t} = \frac{P^e_{t+1} - D^e_{t+1}}{P_t} - 1. \tag{1}$$

Let us assume that the expected return is a constant h, i.e. $HPR^e_{t+1} = h$ (we briefly discuss time-varying models below). Rearranging the previous equation, we then have:

$$P_t = \left[\frac{P^e_{t+1} - D^e_{t+1}}{1+h}\right] \tag{2}$$

Solving Equation (2) N periods forward, we get the usual specification for P_t:

$$P_t = \left[\sum_{i=1}^{N}\left(\frac{1}{1+h}\right)^i D^e_{t+i}\right] + \left[\left(\frac{1}{1+h}\right)^N P^e_{t+N}\right]. \tag{3}$$

When $N \rightarrow \infty$, the second term on the right hand side of Equation (3) tends to zero and we are left with:

$$P_t = \sum_{i=1}^{N} \left(\frac{1}{1+h} \right)^i D^e_{t+i}. \tag{4}$$

If dividends are expected to grow at a constant rate d, Equation (4) can be simplified as:

$$P_t = \frac{D^e_{t+1}}{h-d} = \frac{(1+d)D_t}{h-d} \tag{5}$$

which holds true if and only if $h > d$. This is the classical stock valuation model of Gordon (1962). Equation (5) can also be written as:

$$P_t = \frac{\delta(1+d)E_t}{h-d} \tag{6}$$

where δ is the payout ratio (assumed constant here) and E_t are the earnings of the firm at time t. Finally, the required rate of return is usually expressed as $r_f + RP$, where r_f is for example the 10-year government bond yield and RP is the risk premium demanded by investors (in excess of r_f) to hold the stock. This finally yields:

$$P_t = \frac{\delta(1+d)E_t}{r_f + RP - d}. \tag{7}$$

Such present value relationships provide the framework for stock yield - bond yield relationships as used in the Fed model.[2] In this simplified framework, declining interest rates or bond yields lead to higher stock prices, provided that the growth rate of earnings is not affected. In the same vein, an upward revision in expected earnings (or their long-term growth rate) leads to a stock price appreciation for the firm, provided that the discount rate does not increase when the growth rate of earnings increases. Besides the pure 'mechanical' relationship implied by Equation (7), market participants also constantly arbitrage the stock and bond markets. When new money has to be invested and interest rates are low, it is expected that this money inflow will mostly find its way in the stock market (this is especially true if dividend yields are high). The opposite should be true when interest rates are high. As such, there exists a substitution effect between stocks and bonds which is strongly shaped by the relationship of the dividend yield to the bond yield. Another example is the so-called 'carry trade', where market participants take advantage of low interest rates to buy stocks on margin: stock markets indirectly benefit from a low-rate environment as portfolio

[2] Note that we formally characterize present value relationships and their econometric framework in Section 4.

managers incur low borrowing costs when buying shares. When interest rates rise, these portfolio managers sell their shares to put a cap on their rising borrowing costs.

While some of these arguments are inherently flawed because of the money illusion effect (this is discussed below), another potential problem stems from the fact that the risk premium is partially left out of the picture in this simplified framework. More precisely, possibly time-varying risk premia à la Campbell and Shiller (1988 and 1989) are not taken into account as these relationships focus on the contemporaneous links between the variables. Besides practitioners' discussions, many academic studies have also focused on these possible contemporaneous relationships. For example, the relationship between stock prices, dividends and government bond yields has been keenly studied by British academics. As indicated in Mills (1991): "the relationship between equity prices, dividends and gilt edged stocks was once felt by market practitioners in the UK to be of primary importance for forecasting future movements in prices...". Besides taking a new look at this relationship, Mills (1991) also advocates using a cointegration framework to model the stock price index (P_t), the associated dividend index (D_t) and 20-year government bond yields (R_t).[3] Although not set in the cointegrating framework, the so-called GEYR ratio is very similar. Indeed, the GEYR ratio, or gilt-equity yield ratio, is defined as the ratio of the coupon yield on long-term government bonds to the dividend yield on the stock index. Proponents of the GEYR ratio argue that it fluctuates around a central value, and that any deviation from this 'equilibrium' state indicates that the stock market is under- or over-priced with subsequent stock price adjustments being somewhat forecastable. Therefore the current GEYR ratio, i.e. $GEYR_t$, should have predictive power for forecasting future stock index returns. See Levin and Wright (1998), Harris and Sanchez-Valle (2000b) or Harris and Sanchez-Valle (2000a) for some recent discussions and empirical applications.[4]

Outside the UK, the direct comparison of bond yields and appropriately defined 'equity yields' has recently been highlighted with the growing popularity of the so-called Fed and SVM models. Widely popularized by market practitioners and finance journals (e.g. the Wall Street Journal, Barron's,...), the Fed model states that the ratio of the 10-year government bond yield to the expected earnings yield for the S&P500 index should be relatively stable through time. When this ratio is below (above) its long-term average, it is believed that the stock market is undervalued (overvalued)

[3] More precisely and for UK data, Mills (1991) concludes that these three series expressed in logs, i.e. $p_t = ln(P_t)$, $d_t = ln(D_t)$ and $r_t = ln(R_t)$, are cointegrated (with 1 cointegrating vector). We come back to the issue of cointegration in Section 4 as we detail our econometric methodology.

[4] Switching to logs, we have that $ln(GEYR) = ln(R) - ln(D) + ln(P)$, or $ln(GEYR) = r - d + p$. Readers familiar with the cointegration framework will immediately recognize that proponents of the GEYR ratio indeed state that r, d and p are cointegrated with 'constrained' weights for the long-term relationship set equal to $(1, -1, 1)$ (i.e. the Mills, 1991, methodology).

as the earnings yield is particularly high (low). Recent modifications of the Fed model include the SVM-1 and SVM-2 models introduced by Yardeni (2003). These models give a ‘fair value’ for the S&P500 based on the 10-year bond yield and earnings and also motivate asset allocation decisions based on the perceived degree of over and undervaluation of the S&P500 with respect to its ‘fair value’.[5] Lander, Orphanides, and Douvogiannis (1997) present the Fed model as:

$$\frac{E_t}{P_t} = a + R_t \tag{8}$$

where a is an intercept (or a constant risk premium) and R_t is a nominal bond yield. As underlined by Vila-Wetherilt and Weeken (2002), Equations (8) and (6) are strongly related if we assume $\delta = 1$ and $d = 0$. This discussion shows that the Fed model is very similar to the GEYR framework, with (anticipated) earnings instead of dividends and 10-year government bonds instead of gilts. We next look at the pros and cons of this simplified approach and show that the so-called Fed model features some serious shortcomings.

2.2. Why the Fed model could or could not be relevant?

The rationale underlying the Fed model has been discussed in the academic literature for the last five years. For example, Lander, Orphanides, and Douvogiannis (1997), Asness (2003) or Campbell and Vuolteenaho (2004) point out that this model does have some merit, although they mostly disagree on how the model should be interpreted. First, portfolio managers do arbitrage the equity and bond markets and carry trades are much used. As equities and bonds are competing assets, it is obvious that fund managers want to invest in the highest yielding asset (taking into account the risk). Secondly, this model is broadly speaking in agreement with the principle of the discounted present value of future cash flows. Thirdly, the recent empirical evidence supports the rationale of the Fed model, and more precisely the fact that the equity yield has somewhat tracked the government bond yield over the last thirty years.[6] As indicated in Campbell and Vuolteenaho (2004), “the Fed model has been quite successful as an empirical description of stock prices. Most notably, the model describes the rise in stock yields, along with inflation, during the 1970’s and early 1980’s, and the

[5]Note that the Yardeni (2003) SVM-1 model is exactly the model specified by Equation (7) when $RP = d$ and $\delta = 1$. Yardeni (2003) recently introduced the so-called SVM-2 model to alleviate concerns regarding the $RP = d$ and $\delta = 1$ constraints and discuss the risk premium problem. This second model still hinges on the comparison of the 10-year government bond yield and earnings yield.

[6]It should be stressed that, for the United States (a country for which reliable data has been available since 1871), the relationship between the earnings yield and the bond yield does not seem to hold before the seventies.

decline in stock yields during the past 20 years". Fourthly, it paves the way for a time-varying stock market risk premium, which is an enhancement of classical Gordon type models.

Despite its apparent fit to the data, the Fed model has also been severely criticized, mainly because it suffers from serious theoretical shortcomings. Indeed, there is some confusion regarding the role of inflation as the earnings yield (expressed in *real terms* by definition) is here simply equaled to a *nominal bond yield*. This is neatly summarized in Lansing (2004) who echoes Asness (2000) and Modigliani and Cohn (1979) and shows that such reasoning leads to 'expectational errors'. This is also at odds with the empirical evidence that shows that equities could be a good hedge against inflation, as pointed among others by Marshall (1992), Boudoukh and Richardson (1993), Anari and Kolari (2001) and Spyrou (2004). More recently, the money illusion effect has also been studied by Campbell and Vuolteenaho (2004) and Cohen, Polk, and Vuolteenaho (2005). They show that, although the Fed model tends to fit the recent data quite well, this model is on very shaky grounds with few theoretical justifications for its relevance. In the same vein, Ritter and Warr (2002) highlight two possible problems regarding the Fed model. On the one hand, the discount rate is not adjusted for risk, which yields capitalization rate errors (as defined by Ritter and Warr, 2002). On the other hand, when focusing solely on the earnings growth without any adjustment for the firms' wealth given specific cases (e.g. due to changing inflation environment), a debt capital gain error is made. Therefore the potential capital gain that may result from the reduction of the real value of the firm's debt in presence of inflation is not taken into account. Hence the role of inflation and its supposed impact on stock prices is messy at best in the Fed model.

This confusion also extends to the role of interest rates in the determination of stock prices and anticipated returns. For example, Philips (1999), Campbell and Shiller (1998, 2001) or Jones, Wilson, and Lundstrum (2002) show that valuation ratios are the main determinants of future stock price performance; prevailing bond yields do not enter the relationships. In contrast, the Fed model takes as input the nominal bond yield to set the 'right' stock index price (if the nominal bond rate would decrease to 1% for instance, the 'right' P/E ratio would be at 100). Besides, for the recent period from 2001 to 2003, fears of deflation have depressed the stock markets, while decreasing interest rates should have spurred the markets according to the Fed model.

To summarize, the discussion presented in the introduction and in this section points out that, although the Fed model may sometimes provide some relevant intuition, it is hard to see how nominal interest rates (and the influence of inflation) can be related to the prevailing price earnings ratio and future stock market performance. Actually, there is a wide consensus that valuation ratios (such as the price earnings ratio) strongly matter for the future long-term stock market outlook, but again interest rates are left out of the picture. In this framework, the long-run equilibrium relationship should only involve earnings and stock prices, interest rates should not be an input in the model. We focus on this research agenda in Sections 4 and 5.

3. The dataset

The empirical part of the paper focuses on thirteen countries: Australia, Austria, Belgium, Canada, Denmark, France, Japan, Germany, Italy, Switzerland, The Netherlands, United Kingdom and United States. As far as stock index prices, earnings and long-term interest rates are concerned, reliable data has been available for this group of 13 countries since the early seventies. Therefore, the sample period of our analysis ranges from January 1973 to December 2003 (quarterly data). Taking into account the international and historical perspectives of this paper, we rely on data vendors that ensure that the data is harmonized across countries. For the equity variables (stock indexes and corresponding earnings), the primary source is Thomson Financial Datastream (TFD). More precisely, we use the stock and earnings harmonized indexes (as computed by Datastream) to facilitate the comparison between countries (for example, the stock indexes are the so-called total market indexes of the given country). In the same vein, the source for the long-term interest rate is the IMF International Financial Statistics. The selected long-term interest rate is equivalent to the yield-to-maturity of long-term government bonds, i.e. a 10-year yield. To switch from nominal stock prices and earnings to real stock prices and real earnings, we first download the consumer price index (CPI) series for each country from the harmonized OECD dataset.[7] In a second step, the stock index and earnings series are deflated accordingly. Therefore and for each country, we have six quarterly series: the nominal stock index, the real stock index, the nominal earnings index, the real earnings index, the long-term government bond yield and the inflation index normalized at 1 in 1973:01.

As far as our data is concerned, it is worth stressing that the global indexes supplied by TFD take into account all the stocks of the given country. They are thus more relevant than the more narrowly-defined (and better-known) S&P500, CAC-40 or DAX-30 indexes (henceforth called the standard indexes). However the correlation of the global indexes with the more narrowly-defined indexes is very high (typically larger than 0.9). Nevertheless, it should be noted that, in contrast to the standard

[7]As these series are not seasonally adjusted, we compute seasonally adjusted CPI series using the Census X-12 ARIMA method run by the EViews 4.0 software.

indexes, TFD only reports positive earnings in its earnings index series. This could give rise to a potential bias. This is however a minor drawback given the very high correlation between the two kind of indexes and the fact that both types of series display extremely similar dynamics (note that we are consistent in the sense that we only deal with the TFD indexes in this paper, we bring forth this issue as readers usually focus on the better-known indexes). Furthermore, because we use the TFD indexes, we avoid potential biases that could arise from changes in the index composition over time. Secondly, in contrast to Lander, Orphanides, and Douvogiannis (1997), we use the current earnings and not the expected earnings because of the data availability issue for so many countries and for such a large time frame. Indeed, expected earnings (such as provided by the I/B/E/S database) have only been available from 1987 for the United States and from the mid-nineties for most European countries. As our paper features data spanning three decades from a very large number of countries, we thus cannot use the expected earnings.

4. The Fed model in the cointegration framework: econometric methodology

The literature review presented in Section 2 hints at a possible long-term stable relationship between earnings, stock prices and/without government bond yields. To summarize the main arguments presented in that section: proponents of the Fed model argue that government bond yields enter the long-term relationship, while opponents think that the long-run relationship only involves earnings and stocks prices. On a short-term basis, it is however widely believed that changes in bond yields do influence stock prices. From an empirical point of view, it turns out that this short-term and long-term research agenda can be tested within the cointegration econometric framework. Originally developed by Engle and Granger (1987) and popularized by many researchers and textbooks since then, the cointegration framework allows an assessment of possible long-term relationships between given economic or financial variables. Moreover cointegrated VAR models also allow for separate short-term dynamics, hence the short-term and long-term effects can be disentangled.

While cointegration analysis has long been applied in empirical finance, to our knowledge no cointegration studies of the Fed model have yet been put forward. Indeed, most papers on the GEYR or Fed model that rely on econometric estimation usually directly specify an econometric relationship between the variables.[8] Their models are thereafter estimated using ordinary least squares (OLS) regression. Others predefine the weights for the variables and then assess the forecasting properties of the combination of variables (e.g. the forecasting performance of the P/E ratio, as in Campbell and Shiller, 1998, 2001). With respect to the relationship between earnings and stock prices, a sizeable literature now exists, spurred by tests of the present value relationships as pioneered by Campbell and Shiller (1987, 1988). While the early paper of Campbell and Shiller (1987) did not get meaningful cointegration results (using stock prices and dividends as input variables), MacDonald and Power (1995) validate the present value relationship between earnings and stock prices for the US market. They suggest that earnings, and not dividends, should be included in the analysis (more precisely, they argue that both dividends and retained earnings, which sum to earnings, should be taken into account). More recently, the international analysis conducted by Harasty and Roulet (2000) also supports the cointegration hypothesis (they consider three variables in their single-equation cointegrated model: stock prices, earnings and 10-year interest rates).

4.1. Cointegrated VAR models

In the following, we use the cointegration methodology applied to the stock market variables involved in the Fed Model, i.e. an earnings index, a stock index and a long-term government bond yield for each country considered in the analysis. This econometric framework (which involves unit root tests, cointegration tests, specifications of VECM(k) models, estimation of these models including impulse-response analysis or variance decompositions) is now well established and detailed in many textbooks such as Enders (1995), Brooks (2002) or Harris and Sollis (2003). More specifically, we proceed as follows using the EViews 4.1 and PcGive 10.3 econometric softwares which provide an integrated framework for analyzing dynamical systems that feature possible cointegrating relationships. For each country in our dataset, we first test that the variables are integrated of order 1 (augmented Dickey-Fuller unit root tests with constant and/or trend included in the specification; augmented Dickey-Fuller tests on the first difference of the variables). Then we proceed with cointegration tests of the Johansen type. We use the trace and Max Eigenvalues tests, while the number of lags (k^* say) included in the multivariate model at this stage is set such that the last included k^*+1 lagged variables in the VAR specification are jointly non significant. Moreover, we also check for autocorrelation and absence of normality in the residuals and look at the AIC criteria.[9]

[8] Mills (1991) however tests for cointegration in his study on the GEYR ratio.

[9] Because cointegration tests are known to have relatively low power in small samples and can depend on the chosen k^*, we also perform the cointegration tests for $k = k^* + 1$ and $k = k^* - 1$.

If there is cointegration for a given country, we then proceed with the specification and estimation of the VECM(k^*) model which allows the modelling of both the short-run and long-term dynamics for the 3 variables involved in the system.

Let us illustrate the methodology. For each country, the input variables are $e_t = ln(E_t)$, the log earnings index, $p_t = ln(P_t)$, the log stock index and $r_t = ln(R_t)$, the log government bond yield. An alternative specification would take $p_t = ln(P_t)$, $e_t = ln(E_t)$ and R_t, and not $r_t = ln(R_t)$, as inputs. We however prefer to work with the log government bond yield as taking the log of the supposed Fed model relationship $E_t/P_t = R_t$ gives $e_t - p_t - r_t$.[10] As detailed in the equations given below, this is thus the supposed long-run relationship if the Fed model is valid. Provided that there is one cointegration relationship among the three variables, the VECM(k^*) can be written as:[11]

$$\Delta e_t = \gamma_e + \alpha_e(e_{t-1} + \beta_p p_{t-1} + \beta_r r_{t-1}) + \sum_{j=1}^{k^*-1} \delta_{e,j} \Delta e_{t-j} + \sum_{j=1}^{k^*-1} \delta_{p,j} \Delta p_{t-j} + \sum_{j=1}^{k^*-1} \delta_{r,j} \Delta r_{t-j} + \varepsilon_{e,t} \quad (9)$$

$$\Delta p_t = \gamma_p + \alpha_p(e_{t-1} + \beta_p p_{t-1} + \beta_r r_{t-1}) + \sum_{j=1}^{k^*-1} \delta'_{e,j} \Delta e_{t-j} + \sum_{j=1}^{k^*-1} \delta'_{p,j} \Delta p_{t-j} + \sum_{j=1}^{k^*-1} \delta'_{r,j} \Delta r_{t-j} + \varepsilon_{p,t} \quad (10)$$

$$\Delta r_t = \gamma_r + \alpha_r(e_{t-1} + \beta_p p_{t-1} + \beta_r r_{t-1}) + \sum_{j=1}^{k^*-1} \delta''_{e,j} \Delta e_{t-j} + \sum_{j=1}^{k^*-1} \delta''_{p,j} \Delta p_{t-j} + \sum_{j=1}^{k^*-1} \delta''_{r,j} \Delta r_{t-j} + \varepsilon_{r,t} \quad (11)$$

Note that we do not constrain the constant to be only in the cointegration relationship as both e_t and p_t exhibit a positive drift. In the cointegration literature, the α_e, α_p and α_r coefficients are called the adjustment speeds, as they determine how each variable is affected by the possible disequilibrium in the lagged long-run relationship $e_{t-1} + \beta_p p_{t-1} + \beta_r r_{t-1}$. Because the variables are expressed in logs, the adjustment speeds can also be interpreted as the proportion of the long-run disequilibrium error that is corrected at each time step (one quarter in our sample).

4.2. Assessing the Fed Model in the cointegration framework

The coefficients of the long-run relationship (i.e. β_p and β_r) and the coefficients for the adjustment speeds (i.e. α_e, α_p and α_r) are of particular interest in our setting. For example, if the Fed Model is

[10] As pointed out by a referee, a third possibility would be the use of $p_t = ln(P_t)$, $e_t = ln(E_t)$ and $r_t = ln(1+R_t)$. Indeed, adding a constant in $E_t/P_t = R_t$ yields $E_t/P_t = c + R_t$. This last expression is approximately equal to $E_t/P_t = (1+c)\cdot(1+R_t) - 1$, yielding $ln(E_t/P_t) = a + b \cdot ln(1+R_t)$. Running the empirical analysis with $ln(1+R_t)$ instead of $ln(R_t)$ yielded however similar results.

[11] In theory, there could be up to 2 cointegration relationships. Anticipating on the empirical results, we always have 0 or 1 cointegration relationship, hence we do not detail the specification which features 2 cointegration relationships.

valid, one expects β_p and β_r to be negative, and α_p to be positive (i.e. an earnings increase leads to positive stock returns and an increase in long-term government bond yields leads to negative stock returns). If the Fed model is only partially valid in the sense that long-term government bond yields do not really matter while the bulk of the adjustment comes from the earnings and stocks prices, then β_p should be significantly negative and β_r should not be significant; α_p should again be positive. Indeed, α_p should be significantly positive if causality runs from the disequilibrium in the long-term relationship to the stock index. An important asset of the VECM model (and in contrast to the 2-step Engle-Granger cointegration methodology used in MacDonald and Power, 1995, and Harasty and Roulet, 2000) is that statistical hypotheses on the model coefficients can easily be tested. Indeed, it can be shown that most hypotheses which do not involve cointegration tests can be assessed using the familiar $\chi^2()$ tests. Therefore, this cointegration framework allows the assessment of the Fed Model in a straightforward way and leads us to present three testable hypotheses regarding the validity or partial validity of the Fed model:

Hypothesis 1: There is a cointegration relationship between earnings, stock prices and government bond yields.

Hypothesis 2: The cointegrating relationship of hypothesis 1 implies that a deviation from the long-run equilibrium impacts positively or negatively stock prices such that the equilibrium is restored.

Hypothesis 3: Although there is a cointegration relationship, government bond yields do not play a significant 'economic' role in the long-term relationship: only earnings and stock prices matter for forecasting the future long-term direction of the market.

Note that hypothesis 2 is key to the adjustment process. For example, it predicts that, if stock prices are too high with respect to the equilibrium level fixed by the earnings and bond yields, they decrease in the near future. Hypothesis 3 modifies hypothesis 2 in the sense that the bond yield no longer influences the 'return to equilibrium' of stock prices.

What about the short-term dynamics? It is most conveniently assessed using either impulse response analysis or variance decompositions. In the empirical part of the paper, we rely on variance decompositions (using several different variable orderings) to study the impact of $ln(E)$, $ln(P)$ and $ln(R)$ on future stock prices. Finally, we also estimate the single-equation ECM model (also called conditional ECM model) for the stock price adjustments. This model is the outcome of the 2-step Engle-Granger cointegration methodology where (a) the long-run relationship is estimated and its residuals are recorded; (b) the following single-equation ECM is estimated:

$$\Delta p_t = \gamma_p + \alpha_p res_{t-1} + \delta_{e,0}\Delta e_t + \delta_{r,0}\Delta r_t + \sum_{j=1}^{k^*-1}\delta_{e,j}\Delta e_{t-j} + \sum_{j=1}^{k^*-1}\delta_{p,j}\Delta p_{t-j} + \sum_{j=1}^{k^*-1}\delta_{r,j}\Delta r_{t-j} + \varepsilon_t, \quad (12)$$

where res_t are the residuals from the estimation of long-run relationship in the first step. Note that we use the same Greek letters for the coefficients as in the VECM model, but of course they will take different numerical values. Regarding the short-term dynamics of the model, coefficient $\delta_{r,0}$ is important as it shows how *contemporaneous* changes in the bond yield affect the stock prices (we suspect that this coefficient will turn out to be significantly negative). Finally, coefficient $\delta_{p,1}$ is also called the coefficient for the momentum effect in stock prices as it is the coefficient for the AR(1) effect in the equation (it should not be statistically different from zero if the stock market is weakly efficient).

5. Empirical analysis

5.1. Long-term analysis

We report the cointegration and VECM estimation results for all countries in Table II (nominal data) and Table III (real data).[12] Prior to the cointegration analysis, we also ran augmented Dickey-Fuller unit root tests on the nominal and real series, and on their first differences. Full results are displayed in Table I. Broadly speaking, the unit root results are similar to those previously documented in the literature (e.g. Harasty and Roulet, 2000). Indeed, all series exhibit a unit root, although, when a constant and a trend are both included, a few series fail the test at the 5% level. Nevertheless a visual inspection of those cases do not invalidate the analysis and we therefore proceed similarly for all countries.[13]

From the original group of 13 countries (nominal data), 9 feature exactly one cointegration relationship, while 4 countries (Austria, Belgium, Germany and Japan) do not exhibit any cointegration. For the cointegration analysis applied to the real stock prices, real earnings and long-term government bonds, there are 7 countries which feature 1 cointegration relationship. In this case, there are thus 6 countries (Australia, Austria, Belgium, Germany, Italy and Japan) that do not exhibit any

[12] Regarding the cointegration tests, we report outcomes of the trace tests. The Max Eigenvalues tests deliver the same results and are not reported to save some space in the tables.

[13] Unit root tests on the first differences of the series tend to confirm the unit root hypothesis for the original series.

cointegration. We never observe 2 cointegration relationships. The significance level of the cointegration is reported in the *P* column, while the number of lags in the VECM system is given in the *Lags* column. For the nominal data, we decided to keep Australia and Italy at 10% and 11% respectively as we work with quarterly data and thus do not have that many observations. At the stricter 5% level, we would thus have the same 7 countries that pass the test (nominal and real data). For the countries that do exhibit cointegration, we give in the tables the long-run coefficients (β_p, β_r) and the adjustment speeds ($\alpha_{ln(E)}$, $\alpha_{ln(P)}$ and $\alpha_{ln(R)}$ for the nominal data; $\alpha_{ln(E_r)}$, $\alpha_{ln(P_r)}$ and $\alpha_{ln(R)}$ for the real data). Regarding the hypotheses detailed above, we also test that the government bond yield is not significant in the long-run relationship (test of hypothesis 3). The H0:$\beta_r = 0$ column of each table reports the P-value for the $\chi^2(1)$ LR test that the β_r coefficient in the cointegration relationship is not significant. Finally we also report the estimation results from the constrained cointegration analysis, i.e. the estimation results from the VECM where the β_r coefficient is constrained to be equal to zero. This yields a new cointegrating vector that only takes the log earnings (or real earnings) and stock prices as inputs.

The evidence reported in Table II seems to support the view that, for many countries, there exists a long-run stable equilibrium relationship between earnings, stock prices and government bond yields. This supports hypothesis 1 of Section 4.2 and is also consistent with previous results, such as MacDonald and Power (1995) for US data only and Harasty and Roulet (2000). Nevertheless and as mentioned above, for four countries (Austria, Belgium, Germany and Japan), there is no cointegration. Note however that Belgium exhibited cointegration on the 1973:03 - 1999:04 sample, and that Japan is a very difficult market to model given 15 years of bull market followed by 15 years of bear market, with some deflation. For the countries that exhibit one cointegration relationship, we plot the long-run equilibrium relationship (called *cr*) between log earnings, stock prices and government bond yields vs time (nominal data) in the bottom of Figures 1 to 4. For each of these figures, the top figure shows the earnings yield, while the middle figure presents the ratio of the earnings yield to the long-term government bond yield. A look at the long-run relationships visually confirms that the cointegrating vector is stationary, and that the troughs and peaks in the relationship roughly correspond to market peaks and bottoms (we come back to this issue below). Note that the cycles are quite long, which supports the view that a meaningful cointegration analysis needs a large time sample. These graphs also show that the long-run relationship is not dissimilar to either the ratio of the earnings yield to the long-term government bond yield (middle figure) or the earnings yield (top figure), but at the same time it is distinctively different.

We now look at hypothesis 2 and assess whether the estimated long-run relationship implies that a deviation from the equilibrium posited by that relationship positively or negatively impacts the stock prices so that the equilibrium is restored. As far as hypothesis 2 is concerned, the evidence is mostly conclusive, although some coefficients are not significant. Indeed, coefficient β_p is negative and $\alpha_{ln(P)}$ is positive, although not significant in some cases. Note that if β_p was exactly equal to -1 (and strictly speaking $\beta_r = 0$), then the log earnings yield would exactly enter the cointegration relationship. Along with a positive $\alpha_{ln(P)}$, this would indicate that high (low) P/E ratios would lead to poor (good) future stock market performance. Although we do not have $\beta_p = -1$, a normalized $\beta_e = 1$ along with a negative β_p and positive $\alpha_{ln(P)}$ indicates that high stock prices with respect to earnings do lead to poor future stock market performance. This supports hypothesis 2 and the conventional wisdom prevailing for stock market performance and high/low stock prices to earnings ratios. To further highlight the possible stock index adjustment to the level of the cointegration relationship, we plot XY graphs (along with the estimated regression line) of 3-, 12-, 24- and 60-month forward-looking returns vs the value of the cointegration relationship (at the time the return is computed). Campbell and Shiller (1998, 2001) present similar graphs for forward-looking returns vs P/E ratios. If the valuation argument is correct, we expect that low (high) values for the cointegration relationship indicate overvalued (undervalued) markets. Thus these values should lead to negative (positive) forward-looking returns and hence the XY scatter plots and the estimated regression line should trend upwards. We plot these XY graphs for four selected countries (Australia, France, United Kingdom and United States) in Figures 5 to 8. As expected, the estimated line has a positive slope and the shape of the XY scatter plot is in agreement with our valuation argument. Table IV displays similar results, albeit in a table presentation. In that table, we compute the mean, min and max 24-month forward-looking returns for the bottom and top quintiles of the cointegration relationship. As such we present in a table the XY couples graphed in the utmost left and right of Figures 5 to 8 (for the 24-month forward-looking returns). The numerical results also show that, when the cointegration relationship takes low/high values (defined as being in the bottom/top quintile here), the outlook for the stock market is rather poor/good. Given the weights of the long-run equilibrium relationship, the bottom/top quintile of the cointegration relationship is also associated with low/high earnings yields (see fourth column of each panel).

We now focus on hypothesis 3 and whether long-term government bond yields are economically and/or statistically relevant in the equilibrium relationship. For all countries that exhibit cointegration (except the United States) and in contrast to Harasty and Roulet (2000), the long-term interest rate coefficient in the cointegrating space is not significantly different from zero (according to the LR test). For the real data, the government bond yield is never significant in the long-run relationship, with P-values for the H0:$\beta_r = 0$ test very close to 1. Our sample is however much longer and features many more economic cycles than Harasty and Roulet (2000), which is of paramount importance for cointegration studies. Furthermore, XY plots of the forward-looking returns (as defined above) vs the *constrained* cointegration relationship (i.e. the cointegration relationship where the bond yield is left out) are extremely similar to the previous XY plots. These new plots are given in the bottom Figures 5 to 8 for four countries (Australia, France, United Kingdom and United States, the evidence is similar for the other countries). In the bottom panels of Table IV, we present the same numerical results as discussed in the previous paragraph, but in this case we refer to the bottom and the top quintiles of the constrained long-run relationship. As for the XY graphs, results for the unconstrained and constrained relationships are very similar. Note also (see the fifth column of each panel) that the average long-term bond yield is actually larger in the top quintile than in the bottom quintile of the long-run relationship. Therefore government bond yields do not seem to be relevant as far as the long-run valuation relationship between stock prices, earnings and bond yields is concerned. Note that, beside the statistical relevancy, we can also see that the bond yield does not matter much in an economic sense. Indeed, the coefficients are not significant and they take low values for all countries (the United States seems to be the exception, with a coefficient equal to -0.47). This discussion leads us to accept hypothesis 3 and also invalidates the 'second' part of the Fed model, i.e. the bond yield should not enter the long-run equilibrium relationship as posited in Equation (8). In contrast to $E_t/P_t = a + R_t$, we thus have that the appropriately defined (by the cointegration) linear combination of $ln(E_t)$ and $ln(P_t)$ is stationary, and the R_t term is not needed. Regarding the literature discussed in Section 2, our estimation results are similar to Asness (2003). His results do not however hinge on the cointegration framework and are limited to US data. These results are also in agreement with Siegel (2002) (the equity yield and/or dividend yield is a strong determinant of future long-run stock market performance).

Finally and although it is always a difficult and daring exercise to speak of a 'fair value' for the stock market, we can nevertheless rewrite the cointegration relationship such that P becomes the left-side variable and is thus the 'fair value predicted by the model'. This can be done with both the unconstrained and constrained long-run relationships. Let us illustrate with the United States. For this country, the unconstrained equilibrium relationship is $ln(E) - 0.736ln(P) - 0.469ln(R) + 2.186$. Set equal to 0 and expressed with respect to P, one has $P^* = exp((ln(E) - 0.469ln(R) +$

$2.186)/0.736)$. This P^* can thus be interpreted as the equilibrium stock market value given the prevailing earnings (E) and long-term interest rate (R). The constrained relationship is $ln(E) - 0.609ln(P) + 0.536$, which yields $P^{**} = exp((ln(E) + 0.536)/0.609)$. We plot these P^* and P^{**}, along with the actual P, for the United States (full sample) in Figure 9, and for France, the United Kingdom and United States (zoom on the 1985:01 - 2003:04 sample) in Figures 10 to 12. An assessment of these figures shows that the fit is pretty good and that, as expected by the discussion of hypothesis 3, P^* and P^{**} are quite close. This evidence reinforces the idea that the long-term interest rate should not enter the long-run relationship between stock prices and earnings. A look at the R^2 (given in the last column of the two tables) nevertheless shows that any stock market forecasting exercise will have a hard time at being economically (or financially) significant, at least on a quarterly basis. Indeed, the R^2 is between 5% and 13%, with Denmark being the exception with a higher R^2 of 16% (nominal data). These R^2 levels are consistent with results previously given in the literature, taking into account the fact that the left-hand side variable of the VECM is a stock return.

5.2. Short-term dynamics

To characterize the short-term dynamics, we first focus on the variance decomposition of the log stock index to ascertain if the bond yield could partially explain the variance of $ln(P)$ in the short-run. In a second step, we estimate the single-equation ECM (as given by Equation (12)) to look at the possible contemporaneous influence of changes in the bond yield on $ln(P)$.

The results from the variance decomposition are presented in Tables V and VI. In both tables, the left panel is for the nominal data, while the right panel is for the real data. Because the results are similar for the nominal and the real data, we focus on the discussion of the nominal data. Not surprisingly, the variance of the stock price is mainly explained by its own innovations; innovations in the earnings do not matter much on a short-term basis. Regarding the long-term bond yields, albeit their influence was weak in the long-run relationships, they appear to influence the variance of the stock prices in the short-run, whatever the variable ordering. Broadly speaking, this result could be consistent with arbitrage effects and/or carry trades that could take place in the short run. Moreover, and even if bond yields do not matter much for long-term stock market valuation, increasing bond yields tend to raise the cost of borrowing (for example for investors who bought stocks on margin), which could lead some investors to unwind speculative positions.

Since most of the long-term interest rate fluctuations are known to be explained by the inflation rate, the size of the bond yield's impact on the short-run variance of the stock price might be connected to the country's history in terms of expected inflation stabilization. Taking into account the results of Tables V and VI, three categories of countries may be highlighted regarding the impact of the bond yield on stock prices: very low but stable impact, very large but stable impact and a intermediary category with moderately large impact. In the first category, we only have Switzerland, which is consistent with the long and stable history of this country in terms of monetary policy's objective.[14] Not surprisingly, we put the United States, the United Kingdom and Canada in the second category. Indeed, these countries were affected by instabilities in the monetary policy's objectives over the sample. In turn, these inflation uncertainties affected the investors expectations. This is particularly true for the United States as suggested by Favero and Mosca (2001) and Clarida, Gali, and Gertler (2000). By anchoring its exchange rate to the US dollar, the Canadian monetary policy imported the same instability. For the third category of remaining countries, the impact is moderately large. Repeated devaluations up to 1987 and stability since then characterize France. Italy has enjoyed stability since the launch of the European single currency, but has a long history of financial problems. For Australia and Denmark, the impact is quite low (between 7% and 9%). At around 14%, the result for the Netherlands is somewhat surprising, although this is consistent with Harasty and Roulet (2000).

The estimation results given in Table VII also contribute to this discussion. This table pertains to the estimation of the single-equation ECM as expressed in Equation (12). For the short-term analysis, the Δr_t column is particularly interesting, as it gives the impact of the contemporaneous change in the bond yield on the change in the stock price.[15] For Switzerland and the Netherlands, the contemporaneous effect is weak and not significant. For the other countries, the impact is statistically significant, although the range of the Δr_t coefficient is quite large. Canada and the United Kingdom feature the largest effect, while Australia, France and Italy are not far behind Canada. The impact is the lowest for Denmark and the United States.[16] This table also shows that there is no 'momentum' effect (save for Denmark, in the terminology of Harasty and Roulet, 2000) for the stock market,

[14] Note also that Switzerland is the country with the lowest (among our sample of 13 countries) real long-term interest rate over the sample period.

[15] A key feature of the single-equation ECM is that it features contemporaneous terms on the right-hand side. While this formulation explicitly details the contemporaneous effects, it is hard to use in a forecasting framework as scenarios for the right-hand side variables must be made prior to computing the forecasts (the VECM only features lagged variables on the right-hand side). Moreover, it is subject to a 2-step estimation. However, the single-equation approach is often used by financial institutions which use that kind of model in conjunction with a scenario analysis.

[16] For the United States, one must keep in mind that the long-term somewhat mattered in the long-run relationship.

i.e. no significant AR(1) effect for the stock returns, which is consistent with the weak form of the Efficient Market Hypothesis (EMH).

6. Conclusion

For thirteen countries and over a time span of three decades, this paper looks at the possible long-run relationship between earnings, stock prices and interest rates (proxied by long-term government bond yields). The starting point of our analysis is the nowadays much discussed Fed model which relates the equity yield of a stock index to the prevailing 10-year government bond yield. In its strictest form, the Fed model argues that the 'fair value' equity yield for the index should be equal to the 10-year government bond yield. In the first part of the paper, we show, as some other authors previously did, that the rationale of the Fed model is seriously flawed from a theoretical point of view. Indeed, the Fed model relates a real quantity (the stock index earnings yield) to a nominal bond yield. In the same vein, the important issue of inflation (and what is called inflation illusion) is not addressed as the Fed model would (wrongly) mechanically drive down stock prices when inflation goes up. Correspondingly, very low inflation would (wrongly) warrant very low earnings yields, hence extremely high P/E ratios.

In the second part of the paper, we address this issue from an empirical perspective. More precisely, we estimate cointegrated models for the thirteen countries in our dataset and ascertain if there exists a long-run relationship between the earnings index, the stock index and the long-term government bond yield. Our empirical results show that such a long-run relationship indeed exists for many countries (including the United States and the United Kingdom) but that the long-term government bond yield is *not* statistically significant in this relationship. Put simply, the long-term government bond yield does not affect the 'equilibrium' stock market valuation. Focusing next on the short-term effects, we nevertheless show that rising/decreasing bond yields do impact contemporaneous stock market returns and thus have an important short-term impact on the stock market. The fact that the bond yield is left out of the picture in the long-run relationship is in agreement with the academic literature that stresses the importance of valuation ratios (such as the P/E ratio) appraising for long-run stock market performance. It is also bad news for market pundits who argue that very low interest rates warrant very low earnings yields, hence very high stock prices not supported by adequate earnings.

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Table I
Unit root tests.

Country	$ln(E)$		$ln(E_r)$		$ln(P)$		$ln(P_r)$		$ln(R)$
	c	c+t	c	c+t	c	c+t	c	c+t	c
Australia	0.38	0.16	0.11	0.06	0.87	0.07	0.74	0	0.73
Austria	0.88	0.57	0.70	0.53	0.90	0.36	0.74	0.29	0.77
Belgium	0.21	0.05	0.47	0.31	0.92	0.40	0.86	0.16	0.83
Canada	0.58	0.02	0.04	0.09	0.95	0.08	0.91	0.16	0.82
Denmark	0.31	0.05	0.43	0.02	0.91	0.04	0.93	0.01	0.92
France	0.22	0.49	0.58	0.37	0.88	0.24	0.87	0.07	0.80
Germany	0.85	0.35	0.82	0.54	0.85	0.20	0.77	0.14	0.53
Italy	0.76	0.90	0.80	0.52	0.79	0.83	0.67	0.31	0.84
Japan	0.39	0.84	0.38	0.75	0.59	0.96	0.70	0.88	0.79
Switzerland	0.82	0.13	0.68	0.17	0.95	0.10	0.93	0.07	0.26
The Netherlands	0.62	0	0.56	0	0.91	0.28	0.90	0.11	0.78
United Kingdom	0.27	0.35	0.11	0	0.81	0.62	0.78	0.34	0.90
United States	0.56	0.05	0.62	0.30	0.96	0.10	0.94	0.09	0.70

P-values for the ADF unit root tests for the log earnings index, log real earnings index, log stock index, log real stock index and log government bond yield. The P-values reported in the table refer to the null hypothesis of a unit root in the given series. The time period is 1973:01 - 2003:04 (quarterly data) for all countries. The column c indicates that a constant was included in the unit root test, while the column $c+t$ indicates that both a constant and time trend were included in the ADF test.

Table II
Cointegration analysis (VECM): earnings, stock prices and government bond yields.

Country	Time period	Lags	P	Coint. vector β'	$\alpha_{ln(E)}$	$\alpha_{ln(P)}$	$\alpha_{ln(R)}$	H0:$\beta_r = 0$	R^2
Australia	1973:03 - 2003:04	1	0.10	$(1\ -0.69\ -0.20)$	-0.12 (0.03)	0.16 (0.07)	-0.03 (0.04)	0.24	0.06
Australia	1973:03 - 2003:04	1	0.10	$(1\ -0.64\ 0)$	-0.10 (0.03)	0.12 (0.06)	-0.05 (0.04)		
Austria	1973:03 - 2003:04	-	-	-	-	-	-	-	-
Belgium	1973:03 - 2003:04	-	-	-	-	-	-	-	-
Canada	1973:04 - 2003:04	2	0.04	$(1\ -0.74\ -0.08)$	-0.15 (0.03)	0.03 (0.03)	0.03 (0.03)	0.76	0.05
Canada	1973:04 - 2003:04	2	0.04	$(1\ -0.72\ 0)$	-0.15 (0.03)	0.02 (0.03)	0.02 (0.02)		
Denmark	1973:04 - 2003:04	2	0.01	$(1\ -0.75\ 0.04)$	-0.18 (0.04)	0.08 (0.02)	-0.02 (0.03)	0.93	0.16
Denmark	1973:04 - 2003:04	2	0.01	$(1\ -0.77\ 0)$	-0.18 (0.04)	0.08 (0.02)	-0.02 (0.03)		
France	1973:03 - 2003:04	1	0.04	$(1\ -0.80\ -0.14)$	-0.13 (0.03)	0.07 (0.05)	-0.04 (0.03)	0.93	0.10
France	1973:03 - 2003:04	1	0.04	$(1\ -0.76\ 0)$	-0.13 (0.03)	0.06 (0.04)	-0.04 (0.02)		
Germany	1973:03 - 2003:04	-	-	-	-	-	-	-	-
Italy	1973:03 - 2003:04	1	0.11	$(1\ -0.88\ 0.02)$	-0.13 (0.03)	0.06 (0.05)	-0.01 (0.02)	0.92	0.05
Italy	1973:03 - 2003:04	1	0.11	$(1\ -0.88\ 0)$	-0.13 (0.03)	0.06 (0.05)	-0.01 (0.02)		
Japan	1973:03 - 2003:04	-	-	-	-	-	-	-	-
Switzerland	1973:03 - 2003:04	1	0.05	$(1\ -0.69\ -0.10)$	-0.24 (0.05)	0.06 (0.08)	-0.07 (0.07)	0.41	0.03
Switzerland	1973:03 - 2003:04	1	0.05	$(1\ -0.67\ 0)$	-0.23 (0.05)	0.05 (0.08)	-0.10 (0.06)		
The Netherlands	1973:03 - 2003:04	1	0.03	$(1\ -0.61\ -0.21)$	-0.18 (0.05)	0.06 (0.05)	-0.06 (0.03)	0.59	0.08
The Netherlands	1973:03 - 2003:04	1	0.03	$(1\ -0.56\ 0)$	-0.16 (0.04)	0.06 (0.05)	-0.07 (0.03)		
United Kingdom	1973:01 - 2003:04	1	0	$(1\ -0.67\ -0.12)$	-0.13 (0.02)	0.17 (0.05)	-0.06 (0.03)	0.55	0.11
United Kingdom	1973:01 - 2003:04	1	0	$(1\ -0.63\ 0)$	-0.12 (0.02)	0.17 (0.05)	-0.07 (0.03)		
United States	1973:03 - 2003:04	1	0.01	$(1\ -0.74\ -0.47)$	-0.06 (0.02)	0.18 (0.05)	0.06 (0.05)	0.03	0.13
United States	1973:03 - 2003:04	1	0.01	$(1\ -0.61\ 0)$	-0.05 (0.02)	0.13 (0.04)	-0.02 (0.04)		

Cointegration analysis results (quarterly nominal data). The variables included in the model are the log earnings index ($ln(E)$), the log stock index ($ln(P)$) and the log government bond yield ($ln(R)$). The cointegration vector β gives the coefficient of each variable in the long-run relationship (first weight, for $ln(E)$, normalized at 1). 'Lags' gives the number of lags included in the VECM specification, while the $\alpha_{ln(E)}$, $\alpha_{ln(P)}$ and $\alpha_{ln(R)}$ columns give the adjustment speeds (to the long-run disequilibrium) for each variable and their standard errors. The H0:$\beta_r = 0$ column reports the P-value for the $\chi^2(1)$ LR test that the β_r coefficient in the cointegration relationship is not significant. As this hypothesis is usually not rejected, we also report the constrained VECM results where $\beta_r = 0$ is enforced (second line of results for each country). The last column gives the R^2 of the regression for the stock price adjustments in the VECM. Cointegration tests were done using the Johansen methodology. A - indicates that there is no cointegration for that country, while the P column gives the percentage level at which the no-cointegration hypothesis (0 cointegration vector) is rejected.

Table III

Cointegration analysis (VECM): real earnings, real stock prices and bond yields.

Country	Time period	Lags	P	Coint. vector β'	$\alpha_{ln(E_r)}$	$\alpha_{ln(P_r)}$	$\alpha_{ln(R)}$	H0:$\beta_r = 0$	R^2
Australia	1973:03 - 2003:04	-	-	-	-	-	-	-	-
Austria	1973:03 - 2003:04	-	-	-	-	-	-	-	-
Belgium	1973:03 - 2003:04	-	-	-	-	-	-	-	-
Canada	1973:04 - 2003:04	2	0.05	$(1\ -0.70\ -0.15)$	-0.12 (0.03)	-0.003 (0.03)	0.05 (0.02)	0.78	0.06
Canada	1973:04 - 2003:04	2	0.05	$(1\ -0.61\ 0)$	-0.12 (0.03)	-0.01 (0.03)	0.04 (0.02)		
Denmark	1973:04 - 2003:04	2	0.01	$(1\ -0.57\ 0.08)$	-0.20 (0.05)	0.09 (0.03)	-0.02 (0.03)	0.87	0.16
Denmark	1973:04 - 2003:04	2	0.01	$(1\ -0.63\ 0)$	-0.20 (0.05)	0.09 (0.03)	-0.02 (0.03)		
France	1973:03 - 2003:04	1	0.03	$(1\ -0.66\ 0.01)$	-0.16 (0.03)	0.05 (0.05)	-0.03 (0.03)	0.96	0.09
France	1973:03 - 2003:04	1	0.03	$(1\ -0.67\ 0)$	-0.16 (0.03)	0.06 (0.05)	-0.03 (0.03)		
Germany	1973:03 - 2003:04	-	-	-	-	-	-	-	-
Italy	1973:03 - 2003:04	-	-	-	-	-	-	-	-
Japan	1973:03 - 2003:04	-	-	-	-	-	-	-	-
Switzerland	1973:04 - 2003:04	2	0.09	$(1\ -0.59\ 0.02)$	-0.22 (0.05)	-0.06 (0.08)	-0.06 (0.05)	0.89	0.03
Switzerland	1973:04 - 2003:04	2	0.09	$(1\ -0.59\ 0)$	-0.22 (0.05)	-0.06 (0.08)	-0.05 (0.06)		
The Netherlands	1973:04 - 2003:04	2	0.05	$(1\ -0.44\ -0.06)$	-0.27 (0.06)	-0.02 (0.07)	-0.04 (0.05)	0.81	0.10
The Netherlands	1973:04 - 2003:04	2	0.05	$(1\ -0.43\ 0)$	-0.26 (0.06)	-0.02 (0.07)	-0.04 (0.04)		
United Kingdom	1973:01 - 2003:04	2	0	$(1\ -0.36\ -0.02)$	-0.24 (0.04)	0.13 (0.08)	-0.02 (0.05)	0.86	0.07
United Kingdom	1973:01 - 2003:04	2	0	$(1\ -0.34\ 0)$	-0.24 (0.04)	0.13 (0.08)	-0.02 (0.05)		
United States	1973:03 - 2003:04	1	0.04	$(1\ -0.54\ -0.32)$	-0.08 (0.03)	0.13 (0.06)	0.11 (0.06)	0.14	0.08
United States	1973:03 - 2003:04	1	0.04	$(1\ -0.40\ 0)$	-0.09 (0.03)	0.12 (0.06)	0.03 (0.06)		

Cointegration analysis results (quarterly real data). The variables included in the model are the log real earnings index ($ln(E_r)$), the log real stock index ($ln(P_r)$) and the log government bond yield ($ln(R)$). The cointegration vector β gives the coefficient of each variable in the long-run relationship (first weight, for $ln(E_r)$, normalized at 1). 'Lags' gives the number of lags included in the VECM specification, while the $\alpha_{ln(E_r)}$, $\alpha_{ln(P_r)}$ and $\alpha_{ln(R)}$ columns give the adjustment speeds (to the long-run disequilibrium) for each variable and their standard errors. The H0:$\beta_r = 0$ column reports the P-value for the $\chi^2(1)$ LR test that the β_r coefficient in the cointegration relationship is not significant. As this hypothesis is usually not rejected, we also report the constrained VECM results where $\beta_r = 0$ is enforced (second line of results for each country). The last column gives the R^2 of the regression for the stock price adjustments in the VECM. Cointegration tests were done using the Johansen methodology. A - indicates that there is no cointegration for that country, while the *P* column gives the percentage level at which the no-cointegration hypothesis (0 cointegration vector) is rejected.

Table IV
Forward-looking returns.

	Bottom quintile of *cr*					Top quintile of *cr*				
Country	$\overline{y24m}$	Min $y24m$	Max $y24m$	$\overline{E/P}$	$\bar{R}$	$\overline{y24m}$	Min $y24m$	Max $y24m$	$\overline{E/P}$	$\bar{R}$
Australia	7%	-40%	32.3%	6.8%	9.6%	30%	-4.3%	72.1%	11%	12.5%
France	-2%	-46%	50.4%	6.4%	8.2%	14.2%	-31.4%	62.5%	11.7%	11.2%
United Kingdom	7.7%	-39.8%	42.6%	7.4%	10%	37.1%	7.2%	87.5%	13.3%	11.9%
United States	-8.1%	-58.9%	15.3%	5.3%	7.2%	18.6%	-27.9%	49.6%	10.6%	8.6%
	Bottom quintile of *cr*2					Top quintile of *cr*2				
Country	$\overline{y24m}$	Min $y24m$	Max $y24m$	$\overline{E/P}$	$\bar{R}$	$\overline{y24m}$	Min $y24m$	Max $y24m$	$\overline{E/P}$	$\bar{R}$
Australia	7.6%	-40%	33.3%	7.3%	9.1%	28%	-4.1%	66.5%	10.6%	13%
France	3.2%	-37.3%	50.4%	6.4%	8%	12.2%	-31.4%	62.5%	11.5%	11.2%
United Kingdom	6.9%	-39.8%	46.1%	8%	10.3%	33.9%	0%	87.5%	12.6%	11.7%
United States	0.1%	-30.8%	19.7%	6.4%	7.2%	21.5%	-27.9%	50.8%	11.1%	11.4%

Mean, min and max 24-month forward-looking return, mean earnings yield and mean long-term government bond yield when the cointegration relationship *cr* is in its bottom quintile (left panel) and top quintile (right panel). The bottom panels present the same outputs but for the constrained cointegration relationship *cr*2 (i.e. where the coefficient for the government bond yield is constrained at zero).

Table V

Variance decompositions for the log stock index and log real stock index (I).

	Australia											
	$ln(P)$, explained by innovations in						$ln(P_r)$, explained by innovations in					
	$ln(E)$		$ln(P)$		$ln(R)$)		$ln(E_r)$		$ln(P_r)$		$ln(R)$)	
Quarters ahead	I	II	I	II	I	II	I	II	I	II	I	II
1	1.9	0	95.6	97.5	2.5	2.5						
4	6.9	2.3	87.2	91.8	5.9	5.9						
20	29.3	19.3	63.7	73.7	7	7						
	Canada											
	$ln(P)$, explained by innovations in						$ln(P_r)$, explained by innovations in					
	$ln(E)$		$ln(P)$		$ln(R)$)		$ln(E_r)$		$ln(P_r)$		$ln(R)$)	
Quarters ahead	I	II	I	II	I	II	I	II	I	II	I	II
1	1.6	0	84.8	86.4	13.6	13.6	1	0	84.3	85.3	14.7	14.7
4	1.7	0	73.8	75.4	24.5	24.6	0.6	0.2	73.3	73.7	26.1	26.1
20	4.4	1.1	69.3	72.7	26.3	26.2	0.4	1.8	69.3	67.8	30.3	30.3
	Denmark											
	$ln(P)$, explained by innovations in						$ln(P_r)$, explained by innovations in					
	$ln(E)$		$ln(P)$		$ln(R)$)		$ln(E_r)$		$ln(P_r)$		$ln(R)$)	
Quarters ahead	I	II	I	II	I	II	I	II	I	II	I	II
1	1.8	0	96.6	97.8	2.2	2.2	1.4	0	95.8	97.2	2.8	2.8
4	0.6	1.8	91.8	90.6	7.6	7.6	0.5	1.5	89.8	88.8	9.7	9.7
20	23.5	31.4	67.2	59.3	9.3	9.3	20.6	28.8	67.9	59.7	11.5	11.5
	France											
	$ln(P)$, explained by innovations in						$ln(P_r)$, explained by innovations in					
	$ln(E)$		$ln(P)$		$ln(R)$)		$ln(E_r)$		$ln(P_r)$		$ln(R)$)	
Quarters ahead	I	II	I	II	I	II	I	II	I	II	I	II
1	3.6	0	94.5	98	1.9	2	3	0	94	97.1	3	2.9
4	2.5	0.4	88	90.2	9.5	9.4	1.7	0.4	85.2	86.5	13.1	13.1
20	14.7	5.5	76.8	86	8.5	8.5	8.9	2.6	79.2	85.5	11.9	11.9
	Italy											
	$ln(P)$, explained by innovations in						$ln(P_r)$, explained by innovations in					
	$ln(E)$		$ln(P)$		$ln(R)$)		$ln(E_r)$		$ln(P_r)$		$ln(R)$)	
Quarters ahead	I	II	I	II	I	II	I	II	I	II	I	II
1	3.2	0	95.2	98.4	1.6	1.6						
4	0.9	1.4	90.9	90.4	8.2	8.2						
20	0.9	5.2	84.2	79.9	14.9	14.9						

Variance decompositions (1, 4 and 20 quarters ahead) for the log stock index (left panel) and for the log real stock index (right panel) in the VECM models. There are two variable orderings: I, for $ln(R)$, $ln(E)$ and $ln(P)$; II, for $ln(R)$, $ln(P)$ and $ln(E)$ (and correspondingly for the right panel: I, for $ln(R)$, $ln(E_r)$ and $ln(P_r)$; II, for $ln(R)$, $ln(P_r)$ and $ln(E_r)$).

Table VI
Variance decompositions for the log stock index and log real stock index (II).

	Switzerland											
	$ln(P)$, explained by innovations in						$ln(P_r)$, explained by innovations in					
	$ln(E)$		$ln(P)$		$ln(R))$		$ln(E_r)$		$ln(P_r)$		$ln(R))$	
Quarters ahead	I	II	I	II	I	II	I	II	I	II	I	II
1	5.9	0	93.3	99.1	0.9	0.9	4.6	0	94	98.6	1.4	1.4
4	4.5	0.3	92.9	97	2.6	2.7	1.5	1.6	93.9	93.8	4.6	4.6
20	11.3	1.5	85.8	95.7	2.8	2.8	0.6	2	92.9	91.5	6.5	6.5
	The Netherlands											
	$ln(P)$, explained by innovations in						$ln(P_r)$, explained by innovations in					
	$ln(E)$		$ln(P)$		$ln(R))$		$ln(E_r)$		$ln(P_r)$		$ln(R))$	
Quarters ahead	I	II	I	II	I	II	I	II	I	II	I	II
1	0.1	0	99.2	99.3	0.7	0.7	0	0	99.4	99.4	0.6	0.6
4	0.8	0.5	90.9	91.3	8.3	8.3	0.4	0.4	87	87	12.6	12.6
20	10.7	9.1	75.7	77.4	13.6	13.5	0.2	0.2	83.8	83.8	16	16
	United Kingdom											
	$ln(P)$, explained by innovations in						$ln(P_r)$, explained by innovations in					
	$ln(E)$		$ln(P)$		$ln(R))$		$ln(E_r)$		$ln(P_r)$		$ln(R))$	
Quarters ahead	I	II	I	II	I	II	I	II	I	II	I	II
1	0.3	0	79.8	80.1	19.9	19.9	0.4	0	74.4	74.8	25.2	25.2
4	0.7	1.2	76.2	75.7	23.1	23.1	0.8	0.1	63.2	63.9	35.9	35.9
20	16	19.2	60.9	57.8	23.1	23	2.3	3.6	59.9	58.6	37.8	37.8
	United States											
	$ln(P)$, explained by innovations in						$ln(P_r)$, explained by innovations in					
	$ln(E)$		$ln(P)$		$ln(R))$		$ln(E_r)$		$ln(P_r)$		$ln(R))$	
Quarters ahead	I	II	I	II	I	II	I	II	I	II	I	II
1	1.9	0	95.1	97	3	3	2.2	0	93.8	96	4	4
4	2.4	0.4	82.9	84.9	14.7	14.7	1.8	0.1	83.6	85.3	14.6	14.6
20	29.7	21.9	46.9	54.7	23.4	23.4	14.9	7.8	64.5	71.7	20.6	20.5

Variance decompositions (1, 4 and 20 quarters ahead) for the log stock index (left panel) and for the log real stock index (right panel) in the VECM models. There are two variable orderings: I, for $ln(R)$, $ln(E)$ and $ln(P)$; II, for $ln(R)$, $ln(P)$ and $ln(E)$ (and correspondingly for the right panel: I, for $ln(R)$, $ln(E_r)$ and $ln(P_r)$; II, for $ln(R)$, $ln(P_r)$ and $ln(E_r)$).

Table VII
Cointegration analysis (single-equation ECM): nominal and real data.

	Nominal data					Real data				
Country	Time period	d_{t-1}	Δr_t	Δp_{t-1}	R^2	Time period	$d_{r,t-1}$	Δr_t	$\Delta p_{r,t-1}$	R^2
Australia	1973:03 - 2003:04	0.20 (0.07)	-0.28 (0.14)	0.06 (0.09)	0.11	-	-	-	-	-
Canada	1973:04 - 2003:04	0.06 (0.03)	-0.46 (0.11)	0.14 (0.10)	0.20	1973:04 - 2003:04	0.03 (0.03)	-0.49 (0.11)	0.14 (0.10)	0.21
Denmark	1973:04 - 2003:04	0.08 (0.03)	-0.14 (0.08)	0.20 (0.09)	0.20	1973:04 - 2003:04	0.07 (0.03)	-0.14 (0.08)	0.17 (0.09)	0.19
France	1973:03 - 2003:04	0.14 (0.05)	-0.33 (0.17)	0.07 (0.10)	0.17	1973:03 - 2003:04	0.11 (0.06)	-0.36 (0.17)	0.06 (0.10)	0.16
Italy	1973:03 - 2003:04	0.04 (0.05)	-0.32 (0.18)	0.15 (0.10)	0.10	-	-	-	-	-
Switzerland	1973:03 - 2003:04	0.14 (0.09)	-0.13 (0.12)	0.03 (0.10)	0.10	1973:04 - 2003:04	-0.01 (0.09)	-0.09 (0.12)	-0.04 (0.10)	0.14
The Netherlands	1973:03 - 2003:04	0.07 (0.05)	-0.11 (0.13)	0.07 (0.09)	0.09	1973:04 - 2003:04	-0.03 (0.07)	-0.12 (0.14)	0.02 (0.10)	0.11
United Kingdom	1973:01 - 2003:04	0.12 (0.04)	-0.73 (0.12)	0.12 (0.09)	0.30	1973:01 - 2003:04	0.05 (0.08)	-0.76 (0.12)	0.04 (0.10)	0.30
United States	1973:03 - 2003:04	0.21 (0.05)	-0.18 (0.09)	0.11 (0.09)	0.17	1973:03 - 2003:04	0.18 (0.07)	-0.20 (0.09)	0.13 (0.09)	0.13

Results from the single-equation ECM analysis (quarterly nominal and real data). We report relevant results for the single-equation ECM pertaining to the stock index adjustments (see Equation (12) in the main text). Column d_{t-1} gives the adjustment speed to the long-run disequilibrium; column Δr_t reports the contemporaneous influence of the log government bond yield; column Δp_{t-1} gives the momentum effect (i.e. impact of lagged stock price changes); column R^2 shows the R^2 of the single-equation ECM. All numbers in parenthesis are standard errors.

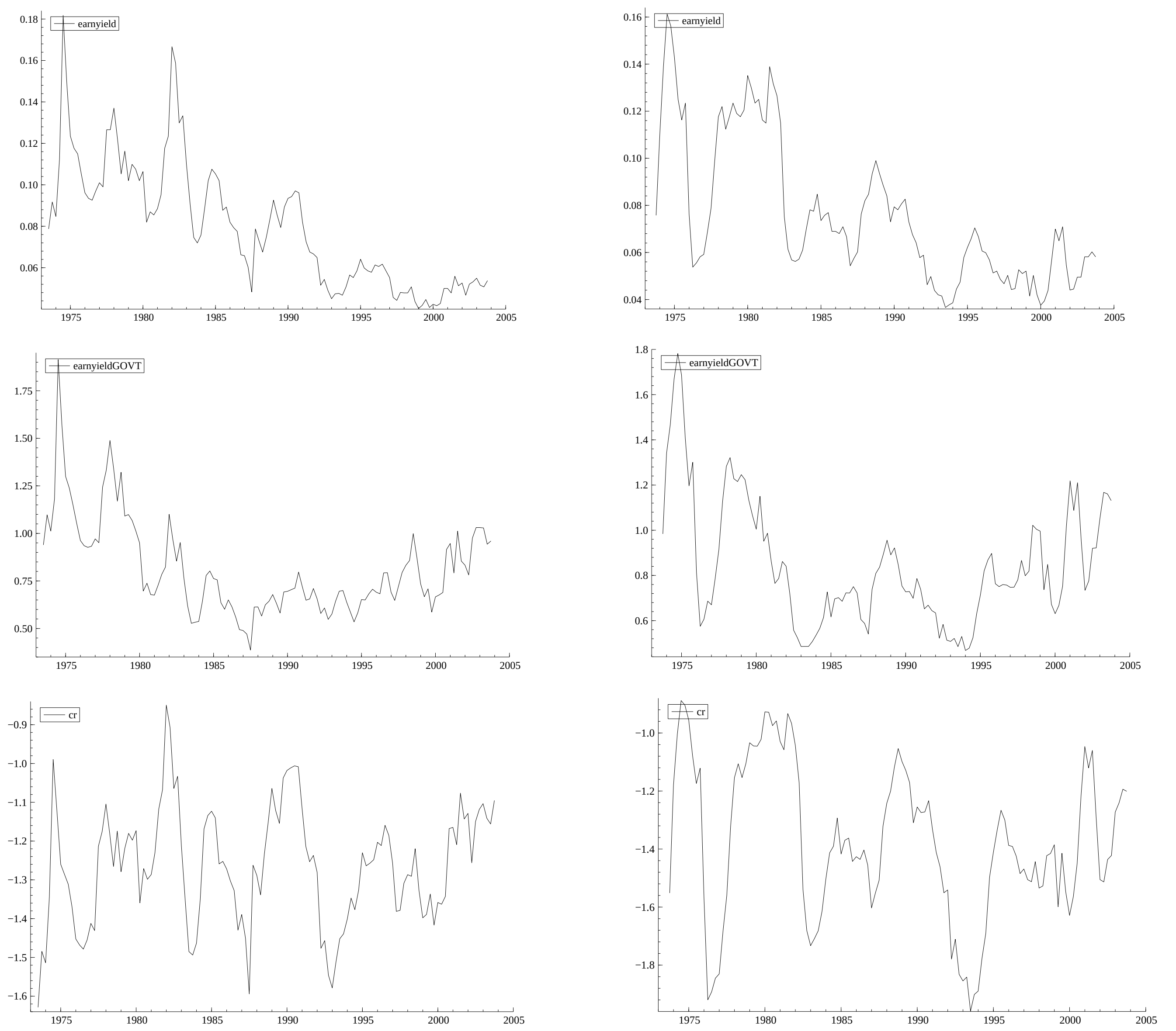

Figure 1. Australia and Canada. From top to bottom: earnings yield, earnings yield/government bond yield and cointegration relationship (nominal data). Left figures are for Australia, right figures for Canada.

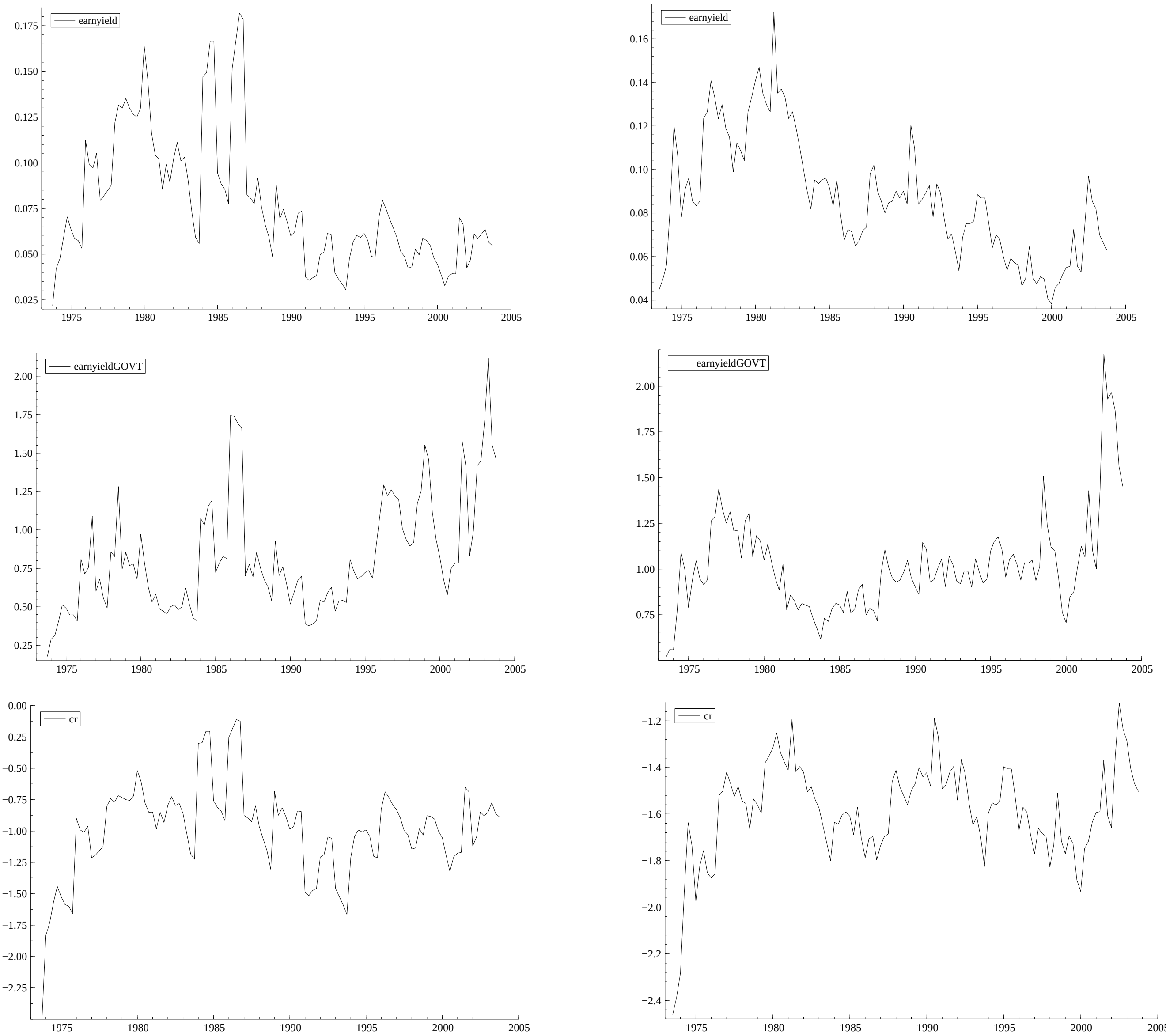

Figure 2. Denmark and France. From top to bottom: earnings yield, earnings yield/government bond yield and cointegration relationship (nominal data). Left figures are for Denmark, right figures for France.

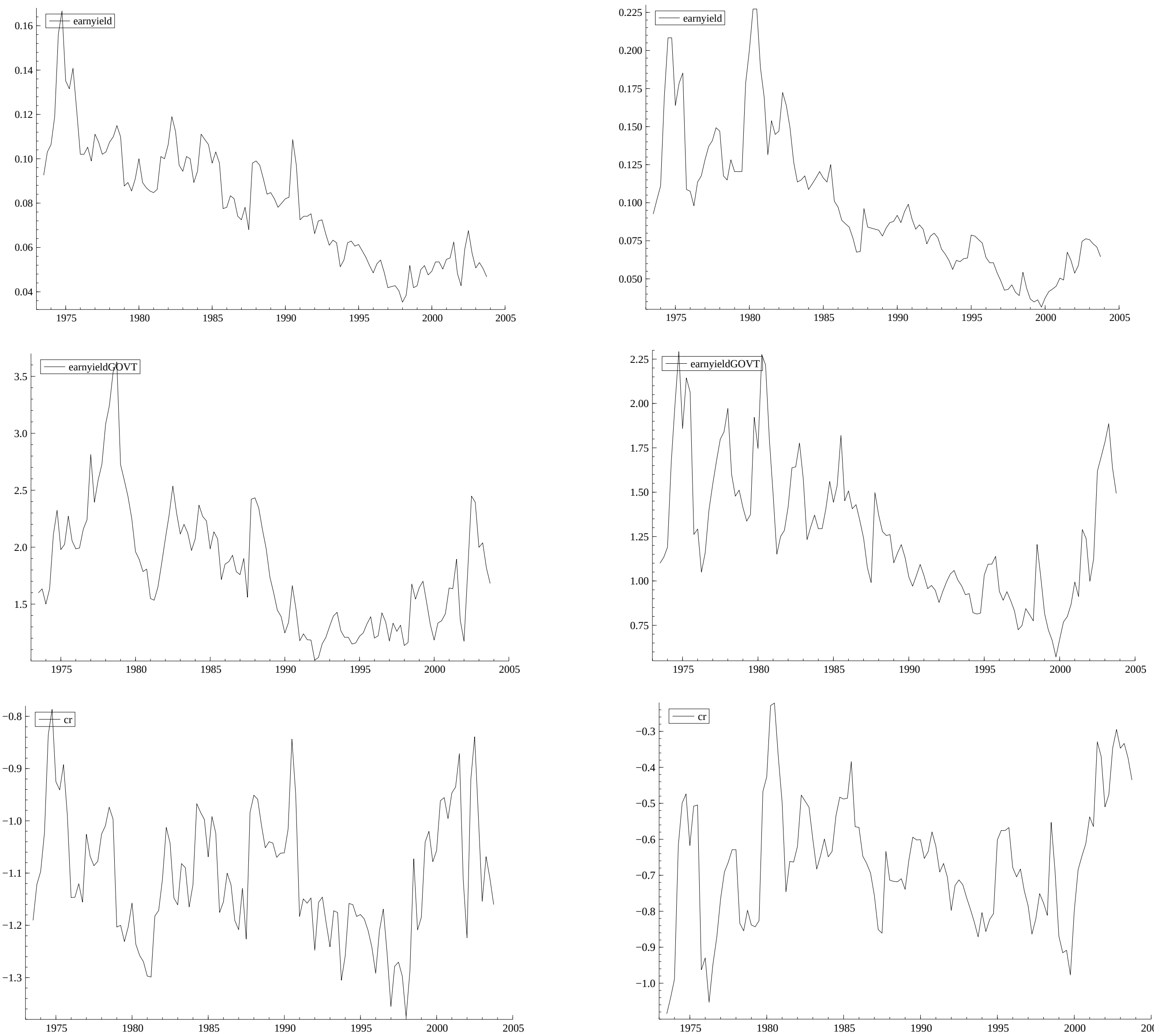

Figure 3. Switzerland and The Netherlands. From top to bottom: earnings yield, earnings yield/government bond yield and cointegration relationship (nominal data). Left figures are for Italy, right figures for The Netherlands.

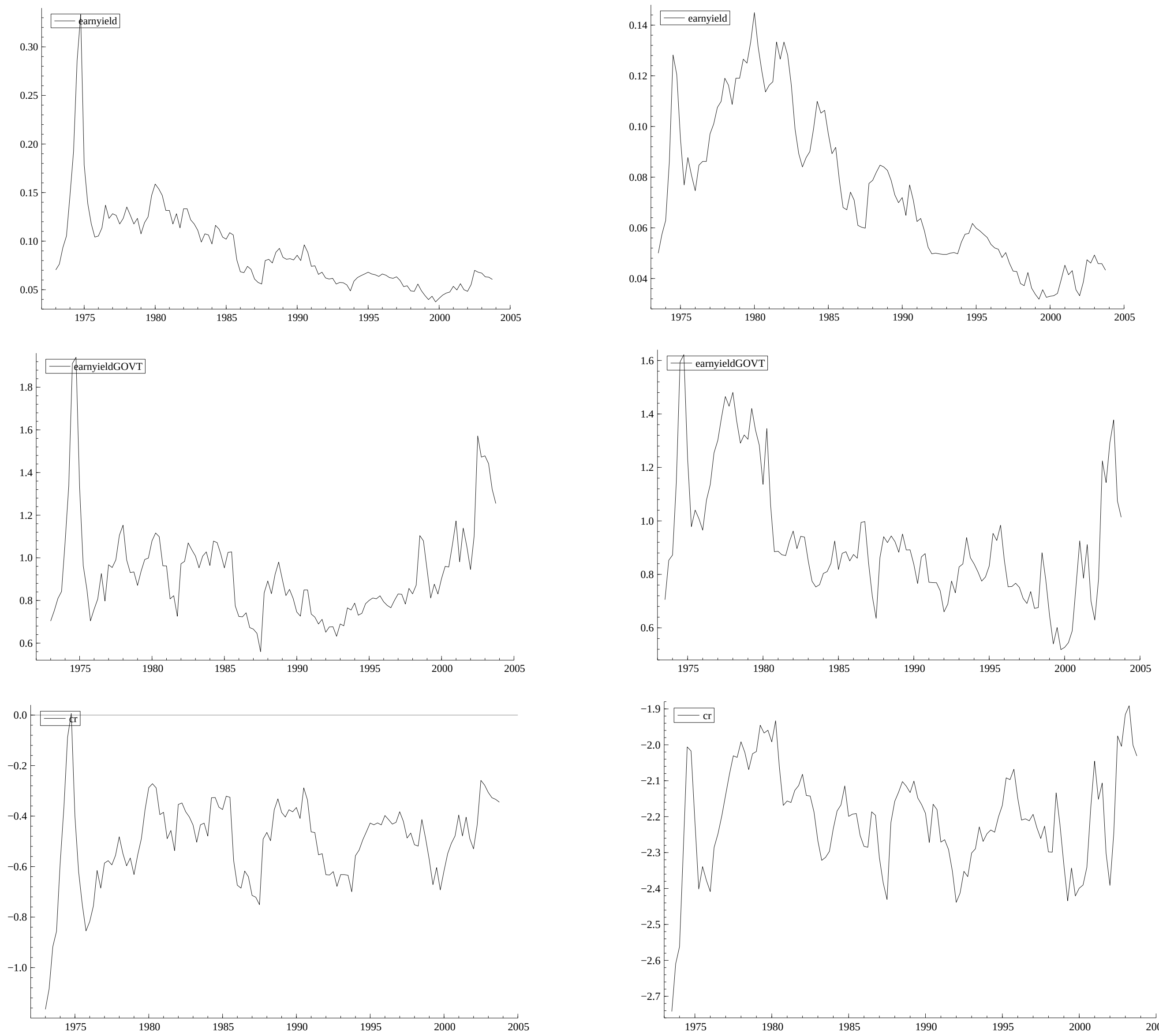

Figure 4. United Kingdom and United States. From top to bottom: earnings yield, earnings yield/government bond yield and cointegration relationship (nominal data). Left figures are for United Kingdom, right figures for United States.

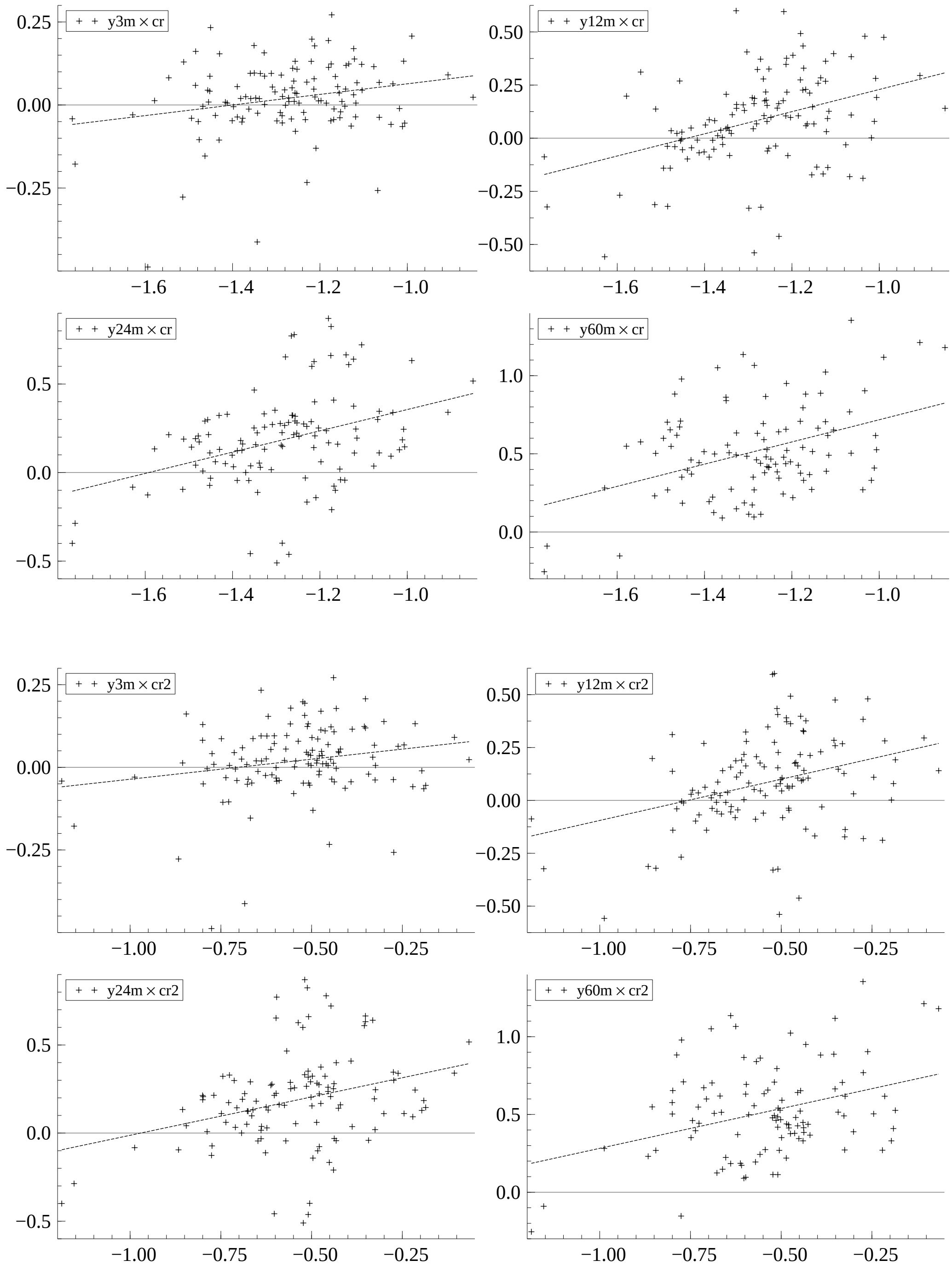

Figure 5. Australia (forward-looking returns vs cointegration relationship). Top four graphs: from top left to bottom right: 3-month, 12-month, 24-month and 60-month forward-looking returns on the stock index vs the estimated cointegration relationship (*cr*). The straight line is the fitted line from the an OLS regression. The bottom four graphs are defined similarly, but for the forward-looking returns vs the constrained cointegration relationship (*cr*2, i.e. the coefficient for the government bond yield is constrained at zero).

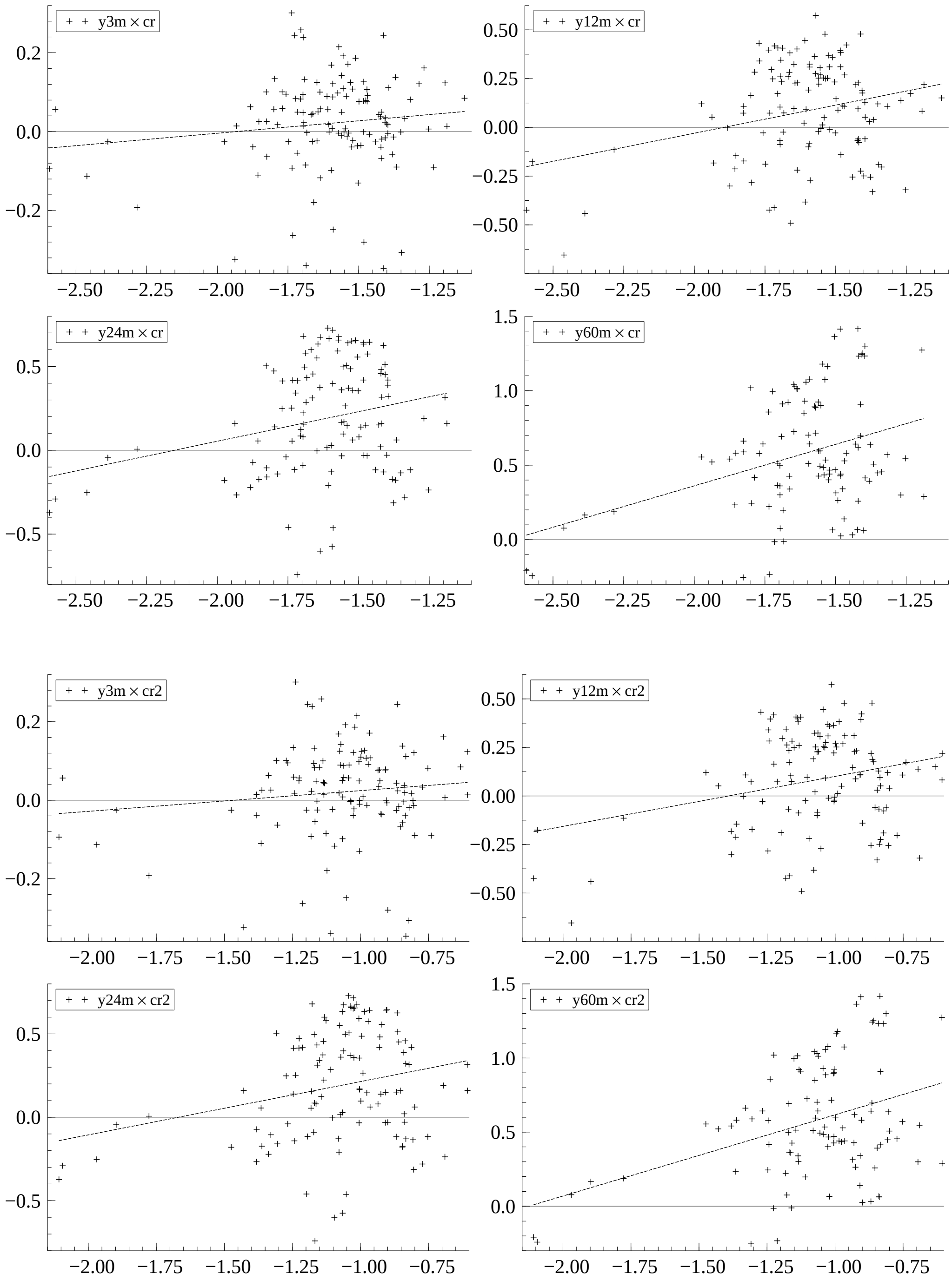

Figure 6. France (forward-looking returns vs cointegration relationship). Top four graphs: from top left to bottom right: 3-month, 12-month, 24-month and 60-month forward-looking returns on the stock index vs the estimated cointegration relationship (*cr*). The straight line is the fitted line from the an OLS regression. The bottom four graphs are defined similarly, but for the forward-looking returns vs the constrained cointegration relationship (*cr*2, i.e. the coefficient for the government bond yield is constrained at zero).

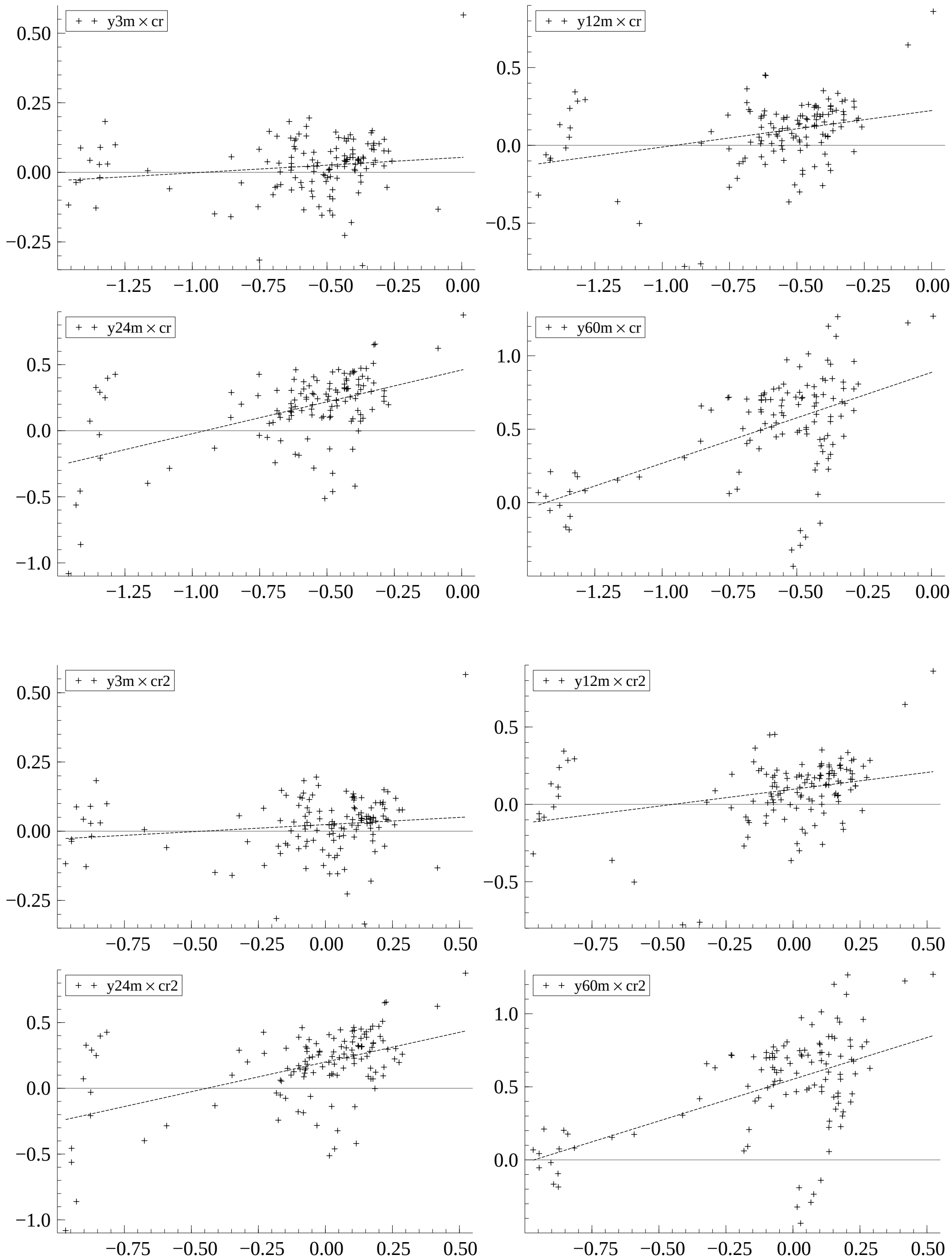

Figure 7. United Kingdom (forward-looking returns vs cointegration relationship). Top four graphs: from top left to bottom right: 3-month, 12-month, 24-month and 60-month forward-looking returns on the stock index vs the estimated cointegration relationship (*cr*). The straight line is the fitted line from the an OLS regression. The bottom four graphs are defined similarly, but for the forward-looking returns vs the constrained cointegration relationship (*cr*2, i.e. the coefficient for the government bond yield is constrained at zero).

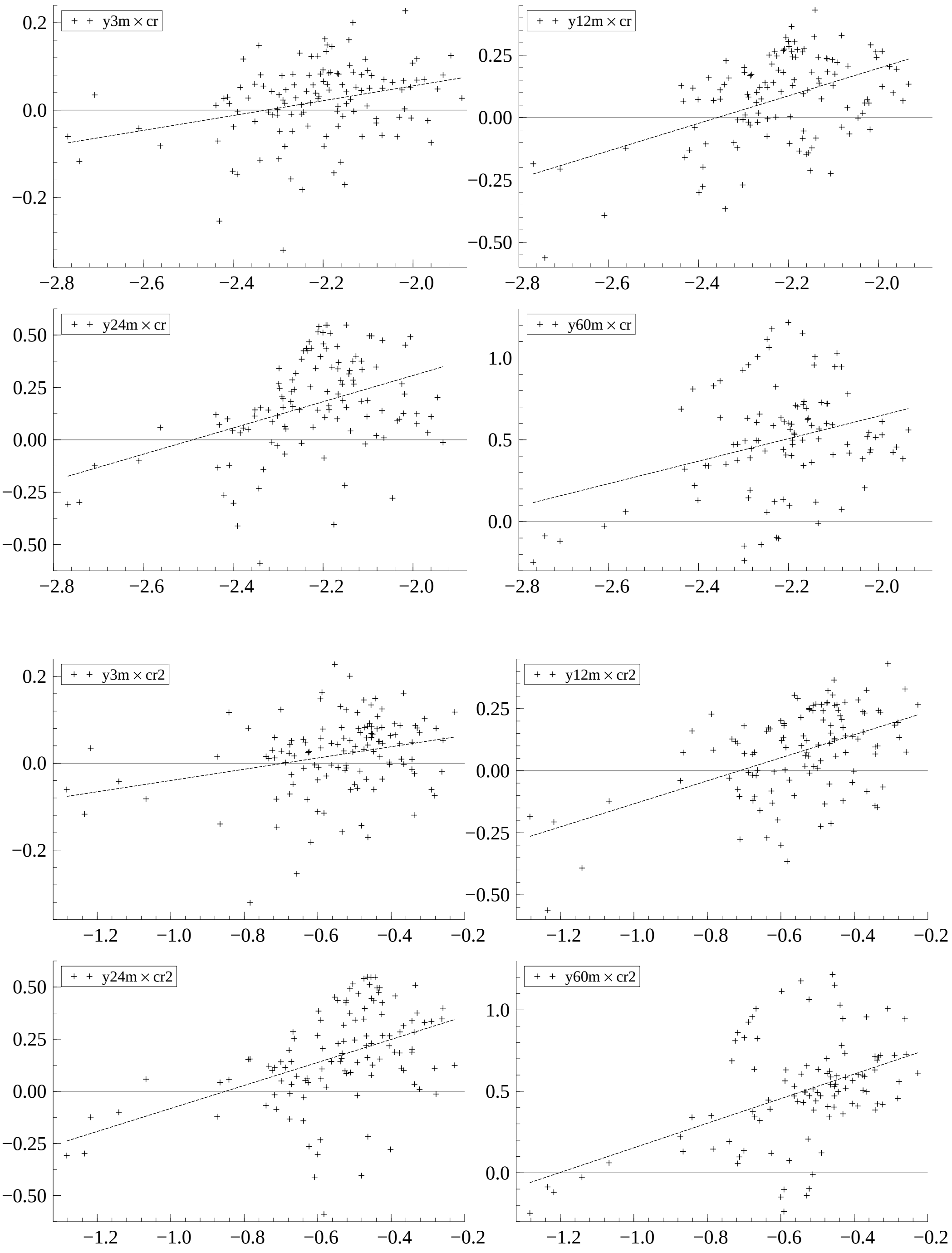

Figure 8. United States (forward-looking returns vs cointegration relationship). Top four graphs: from top left to bottom right: 3-month, 12-month, 24-month and 60-month forward-looking returns on the stock index vs the estimated cointegration relationship (*cr*). The straight line is the fitted line from the an OLS regression. The bottom four graphs are defined similarly, but for the forward-looking returns vs the constrained cointegration relationship (*cr*2, i.e. the coefficient for the government bond yield is constrained at zero).

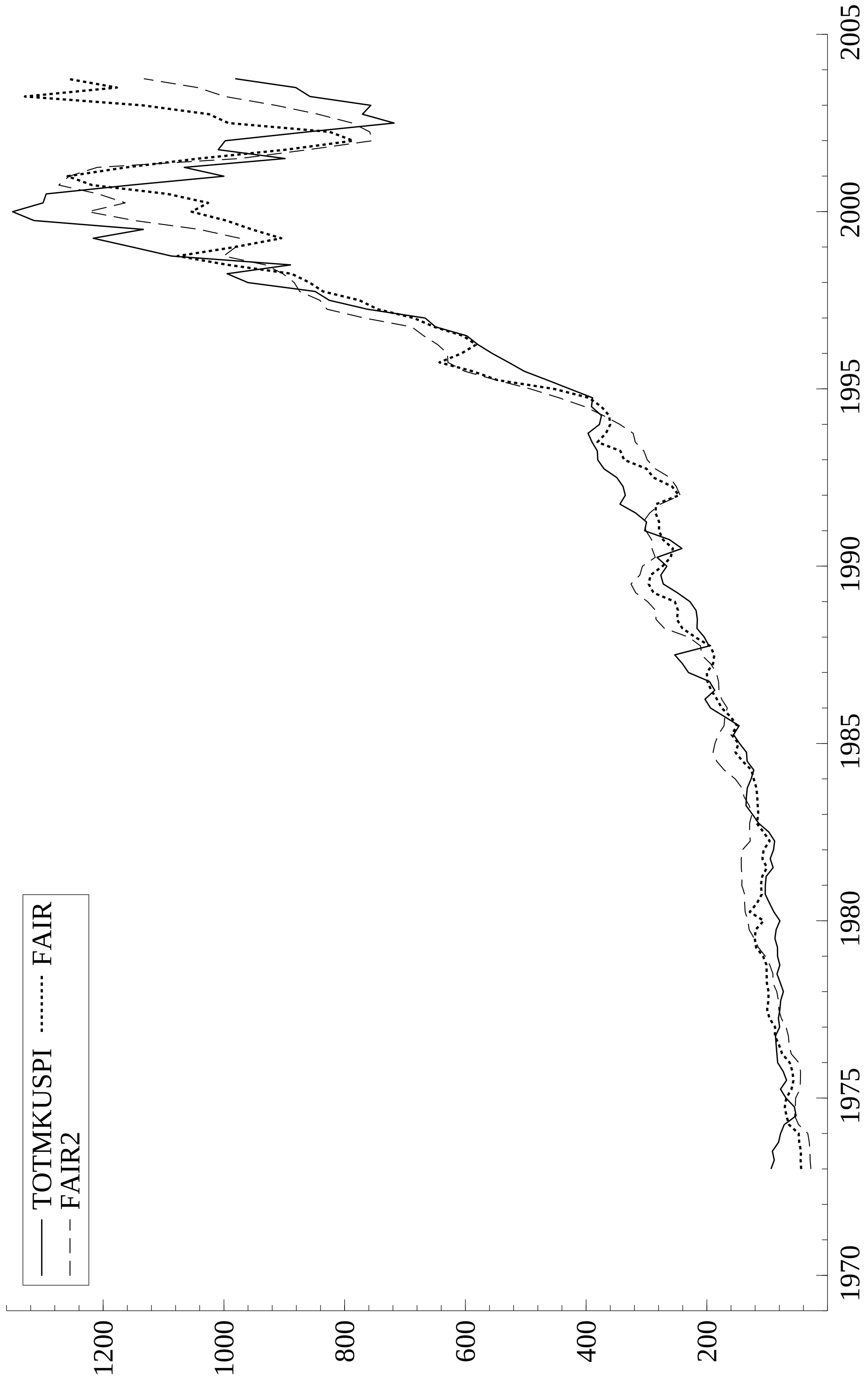

Figure 9. United States (stock index and fair values), 1973:03 - 2003:04. Actual stock index (TOTMKUSPI) and fair values as forecasted by the VECM model: FAIR is the forecast based on the original VECM model, FAIR2 is the forecast based on the constrained VECM model (the coefficient of the government bond yield is constrained at zero in the long-run relationship).

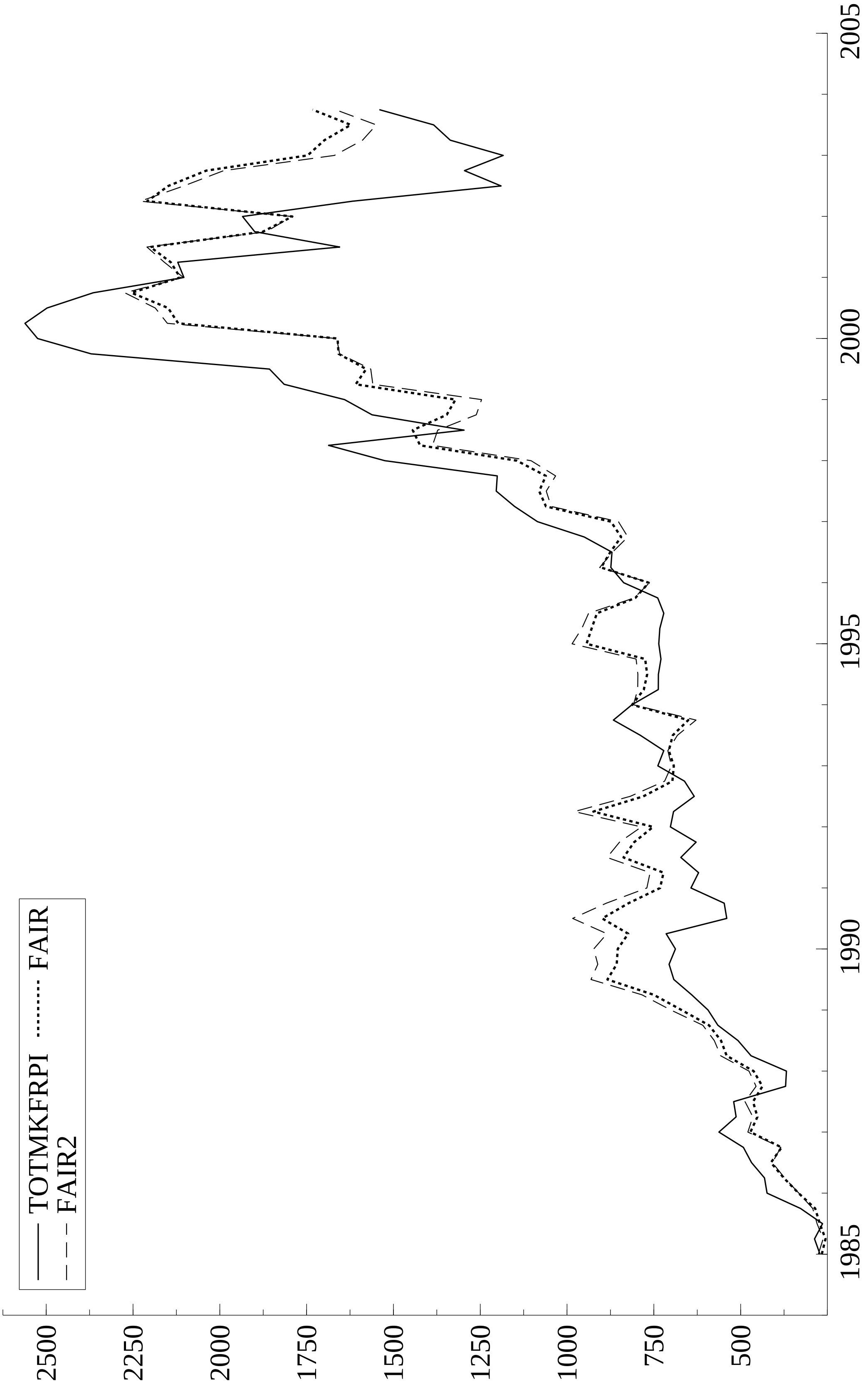

Figure 10. France (stock index and fair values) 1985:01 - 2003:04. Actual stock index (TOTMK-FRPI) and fair values as forecasted by the VECM model: FAIR is the forecast based on the original VECM model, FAIR2 is the forecast based on the constrained VECM model (the coefficient of the government bond yield is constrained at zero in the long-run relationship).

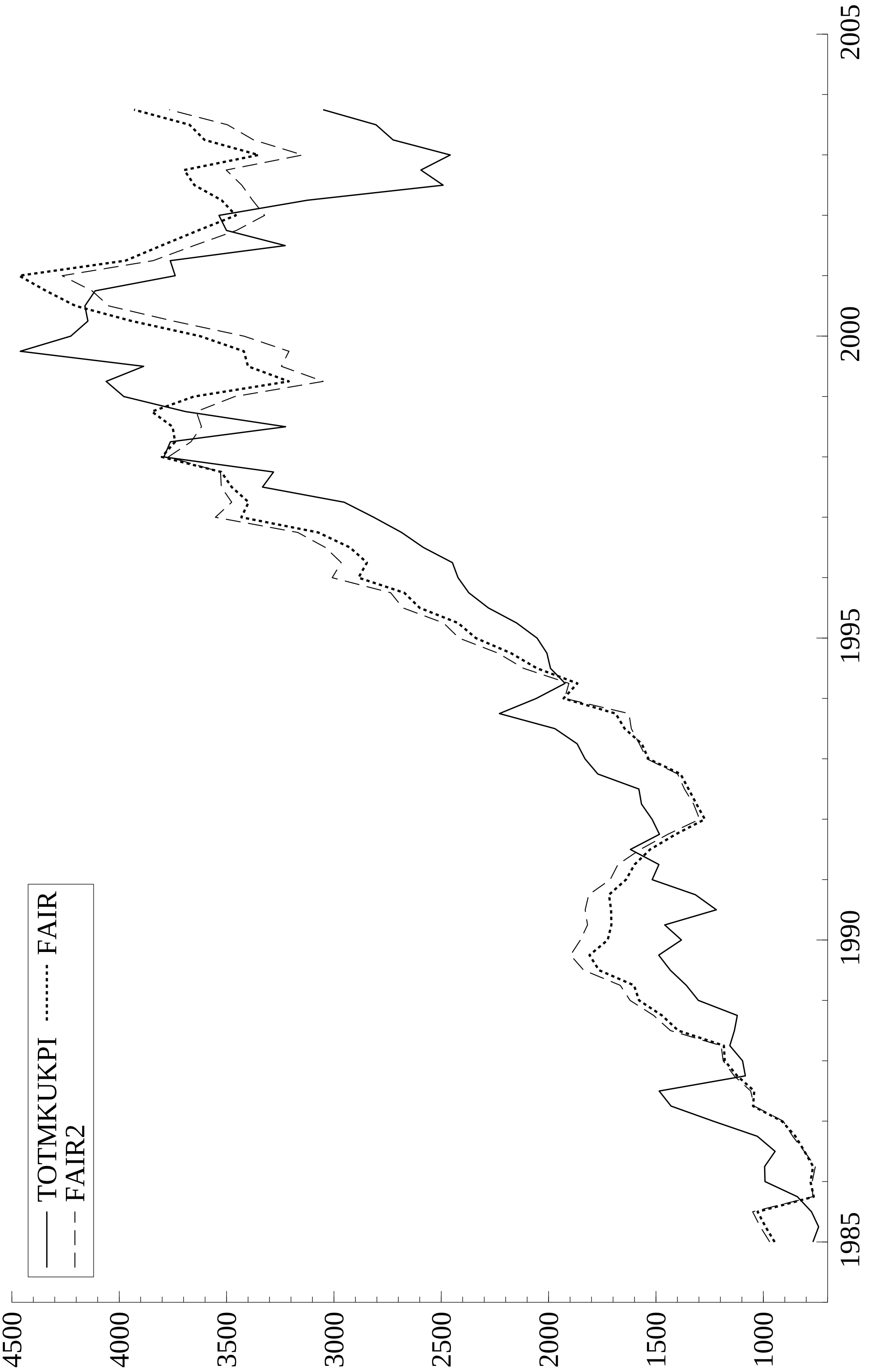

Figure 11. United Kingdom (stock index and fair values) 1985:01 - 2003:04. Actual stock index (TOTMKUKPI) and fair values as forecasted by the VECM model: FAIR is the forecast based on the original VECM model, FAIR2 is the forecast based on the constrained VECM model (the coefficient of the government bond yield is constrained at zero in the long-run relationship).

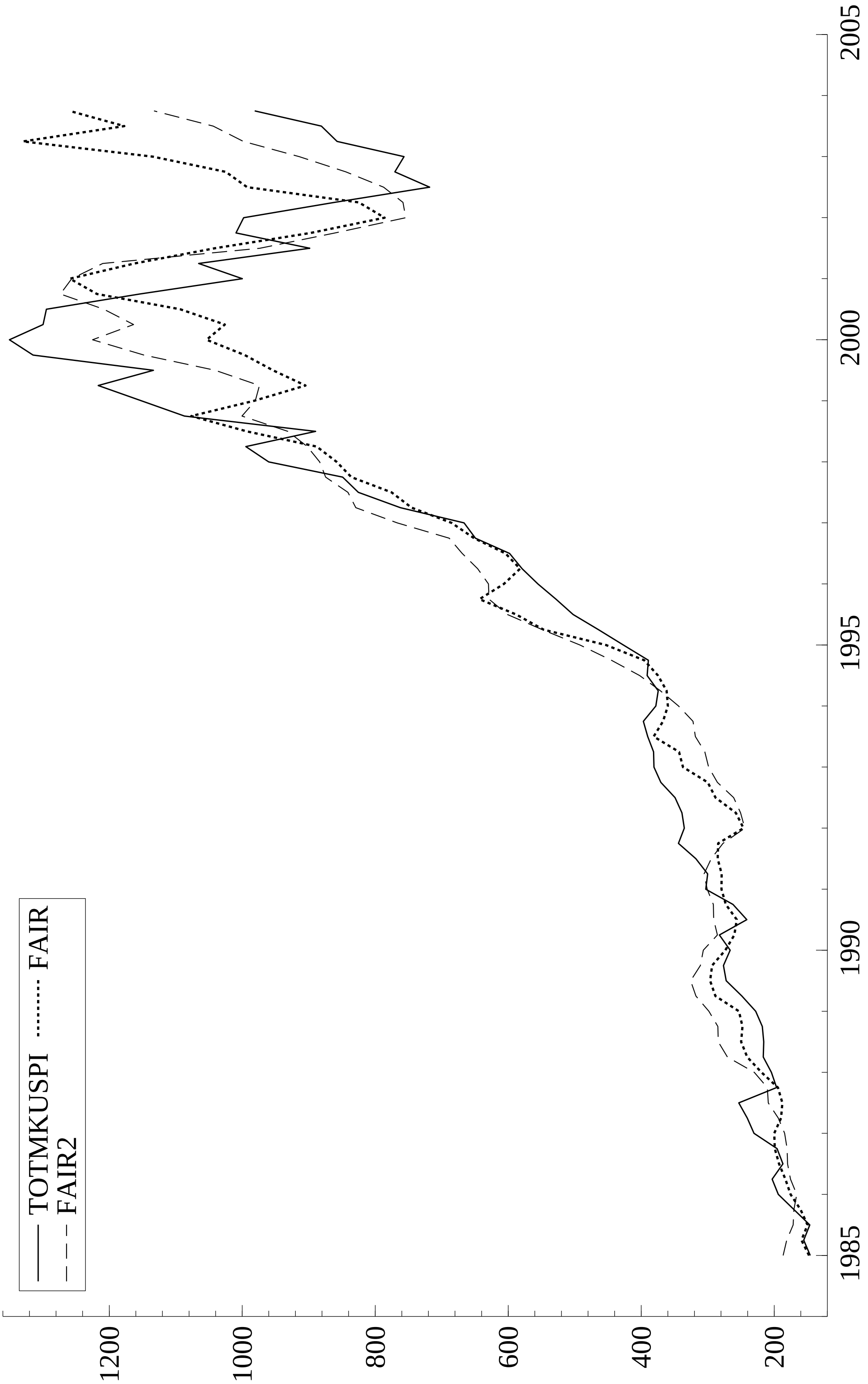

Figure 12. United States (stock index and fair values), 1985:01 - 2003:04. Actual stock index (TOTMKUSPI) and fair values as forecasted by the VECM model: FAIR is the forecast based on the original VECM model, FAIR2 is the forecast based on the constrained VECM model (the coefficient of the government bond yield is constrained at zero in the long-run relationship).

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