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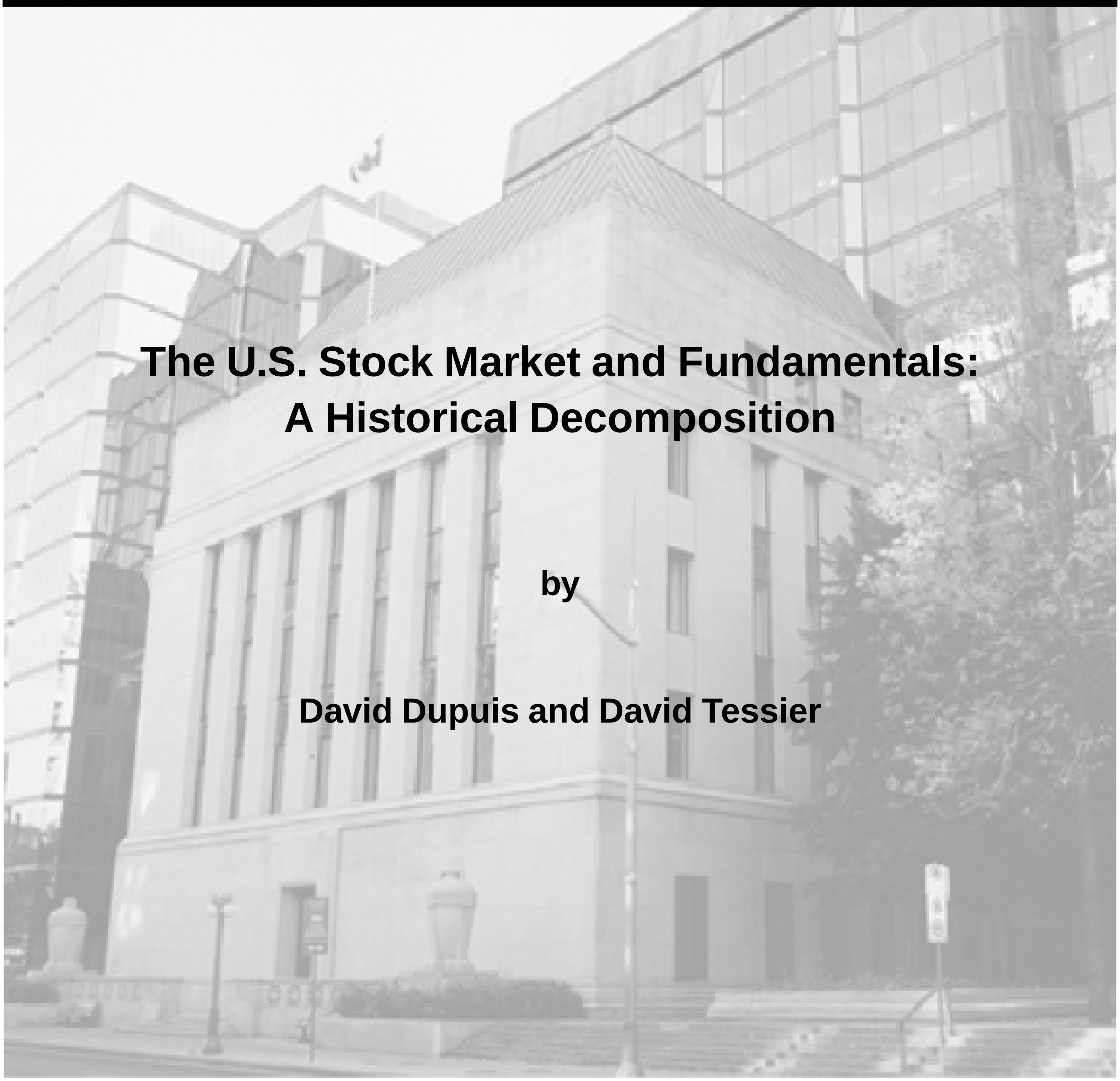

The U.S. Stock Market and Fundamentals: A Historical Decomposition

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Abstract

The authors identify the fundamentals behind the dynamics of the U.S. stock market over the past 30 years. They specify a structural vector-error-correction model following the methodology of King, Plosser, Stock, and Watson (1991). This methodology identifies structural shocks with the imposition of long-run restrictions. It allows the authors to calculate an equilibrium measure of stock market value based on the permanent components of the time series. A better understanding of the components that drive stock market movements could provide insight into the potential effects of the recent technological revolution on the dynamics of the stock market's equilibrium value, as suggested by Hobijn and Jovanovic (2001).

JEL classification: G1
Bank classification: Financial markets

Résumé

Les auteurs tentent de cerner les forces fondamentales qui ont façonné l'évolution du marché boursier américain au cours des 30 dernières années. Ils élaborent un modèle structurel à correction d'erreurs en s'inspirant de la méthode de King, Plosser, Stock et Watson (1991), qui fait appel à l'imposition de restrictions de long terme pour l'identification des chocs structurels. En procédant ainsi, les auteurs peuvent obtenir une mesure de la valeur d'équilibre d'une action à partir des composantes permanentes des séries chronologiques. Forts d'une meilleure compréhension des facteurs à l'origine des mouvements du marché boursier, nous serions plus à même d'évaluer les effets potentiels de la récente révolution technologique sur l'évolution de la valeur d'équilibre des actions, comme le font valoir Hobijn et Jovanovic (2001).

Classification JEL : G1
Classification de la Banque : Marchés financiers

1. Introduction

The performance of U.S. equity markets in the post-“irrational exuberance” period has been mixed. Some argue that the bursting of the equity bubble was unavoidable, while others believe that factors such as faster productivity growth, greater monetary and fiscal discipline, globalization, and widespread use of high-tech equipment justified, at least in part, the higher valuation of the late 1990s. Given the impact that equity markets have on consumption, investment, monetary policy, and financial stability, an accurate measure of the stock market’s equilibrium or fundamental value is vital to gauge potential risks to the economy. In addition to determining the spread between observed equity prices and their fundamental component, it is also important to identify the source of fluctuations in the fundamental value. For example, some argue that innovations in information technology have driven stock prices to historically high levels (Hobijn and Jovanovic 2001), while others argue that such high prices were the result of a decline in the equity premium and in the rate at which investors discount expected future real dividends (Cochrane 1994; Fama and French 2001). We argue that both dividends and discount rates are significantly related to any fundamental movements in equity value.

Financial markets are usually thought to be efficient, which means that fluctuations are the result of equilibrium movements.[1] In this context, observed stock prices are a fair representation of the market’s fundamental value. However, the large drop in stock prices in October 1987—difficult to explain in terms of changes in fundamentals—and the large swings that have occurred over the past five years appear to be inconsistent with the definition of the efficient-market hypothesis. The definition is further challenged by empirical findings that stock prices can incorporate a large forecastable component, which could drive stock market valuation away from its equilibrium or fundamental value.[2]

This paper describes a way to assess the evolution of observed equity prices in light of historical shifts in the fundamentals. Considering the factors that could affect the fundamental value of equity prices, the present-value model appears to be the prevailing framework. It predicts that equity prices can be formulated as the discounted value of expected future cash flows, and thereby

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1. Markets are deemed efficient when prices rationally incorporate available information, which implies the unpredictability of returns based on past returns or other related variables. Variables that incorporate rational use of information tend to follow a random walk (martingales) and can be characterized as displaying no mean-reversion. This hypothesis has prevailed for many years as the dominant paradigm in empirical finance. However, the hypothesis of market efficiency has been challenged (see Fama 1991 for a detailed review).
2. See, for example, Shiller (1981), Summers (1986), Campbell and Shiller (1988a and b), Fama and French (1988a and b), and Cochrane (1994).

equity price variability reflects changes in the discount factor (proxied by the real interest rates) and/or changes in expected future dividends. Equity prices tend to rise on news of high future dividends, or on news of lower discount rates. If we suppose that this framework represents a good approximation for the determination of equity prices, the fundamental value would therefore have to be consistent with the historical evolution of real dividends and real interest rates. Following this argument, we define the fundamental value as the component of stock prices that results from the cumulative effects of permanent shocks to discount rates and dividends, identified using a structural vector-error-correction model (SVECM). As a residual to this fundamental component, the so-called transitory component provides a general assessment of the degree of over- or undervaluation. Defined in this way, the fundamental value represents the path of equity prices that would be expected on the basis of permanent shifts in dividends and discount rates.

It is interesting to relate the fundamental value of equity prices to the notion of permanent shocks: we believe that the uncertainty surrounding the persistence of shocks is an important source of mispricing. Indeed, we perceive investors as having to judge period by period, among other criteria, whether the observed changes in the economic fundamentals are permanent or just transitory, with the a priori that long-lasting movements in fundamentals have much larger effects on prices than temporary movements.[3] If a firm reports good earnings, its stock prices will rise permanently if its earnings are expected to be permanent. Conversely, there will be little change if the movement in earnings is perceived to be temporary. From this perspective, the great uncertainty that surrounded the sustainability of the higher growth of labour productivity in the late 1990s in the United States could have been a main contributor to the large swings that characterized equity markets over that period.[4]

A major difficulty in identifying the stock market's fundamental value is that it depends on expectations of future cash flows and discount rates, which are unobservable. In contrast, by focusing on permanent changes in either real dividends or discount factors, we do not have to impose any hypothesis on future variables. Indeed, regardless of the way the agents form their expectations, we know—by definition—that a permanent shock to dividends or discount rates will affect every component of the stream of future variables and thus implies reassessment of equity prices. In that context, the transitory component would emerge as a result of the mispricing that is caused by the uncertainty surrounding the lasting effects of the shocks. Hence, to the extent that the investors gradually revise their expectations, the permanent shocks to fundamentals are not immediately incorporated in the observed prices, and this creates a temporary spread between

3. Because dividends and discount rates in all future periods enter the present-value formula, a movement in any one period will be a small component of the prices.

4. These uncertainties were all the more prominent in the high-technology industries.

equity prices and their fundamental value. The prices can also be maintained above their fundamental value from the perspective of short-run capital gains.

To analyze the fundamental components of equity prices, we adopt a methodology developed by King, Plosser, Stock, and Watson (1991) (KPSW hereafter). It allows us to (i) identify permanent contributions of dividends and real interest rates to fluctuations in equity prices, and (ii) assess the degree of over- or undervaluation, through the relative magnitude of permanent and transitory components. By identifying structural shocks with the imposition of long-run restrictions, this methodology is similar to the one proposed by Blanchard and Quah (1989), except that it incorporates the information contained in the cointegrating vector. In a first step, we formally test for the presence of cointegration and our results support the existence of an equilibrium relationship between equity prices, dividends, and real interest rates. In a second step, we employ the cointegration relationship to specify a structural vector autoregression (SVAR) in error-correction form.

Our empirical findings have two main results. First, they can account for the tendency of stock prices to move more than one-for-one with dividends. Second, they provide additional evidence of an important transitory component in stock prices. Hence, according to the variance decomposition at short horizons, transitory innovations play a major role in the quarterly fluctuations of asset prices, whereas the dynamics of dividends and real interest rates are largely dominated by their respective permanent shocks. For the long-run variance decomposition, we find that 76 per cent of the low-frequency dynamics in stock prices are explained by permanent shocks to dividends and that the remaining 24 per cent are explained by permanent shocks to real interest rates. These results are consistent with previous literature on stock market volatility (Shiller 1981; LeRoy and Porter 1981), in which movements in dividends appear too smooth to justify the higher degree of volatility in stock prices. Although stock prices and dividends are tied together in the long run—through a significant cointegration relationship—their short-run behaviour is quite different, because transitory shocks have a much larger impact on stock prices (70 per cent) than on dividends (a mere 1 per cent). This finding provides evidence that short-run fluctuations in stock prices display no association with fundamentals, and it reinforces our view that the transitory component of stock prices provides a general assessment of the degree of over- or undervaluation.

Based on this measure, our model shows that, at its peak early in 2000, the Wilshire 5000 was overvalued by approximately 8 per cent.[5] By the end of 2002Q4, amid corporate governance scandals and heightened geopolitical tensions, the broad market was undervalued by 14 per cent.

5. Nevertheless, overvaluation reached a peak of 17 per cent in mid-1999.

This paper is organized as follows. In section 2, we describe the basic model and base our variable selection on financial theory. In section 3, we test for cointegration in the pre-selected set of fundamental variables. In section 4, we describe the methodology we use to identify structural shocks and discuss the most important results. Section 5 offers some conclusions.

2. The Basic Model

A natural starting place for stock market valuations is to define fundamentals using the efficient-market present-value model, which assumes that a firm's stock price represents the fully discounted stream of future cash flows:

$$P_t^* \equiv E_t\left[\sum_{i=t+1}^{\infty} \frac{D_i}{(1+r_i)^i}\right], \tag{1}$$

where D_i is expected dividends and the discount factor, r_i, corresponds to the real expected return and depends on investor tastes for current versus risky future consumption.[6] In principle, if the efficient-market hypothesis holds, the observed real stock market price, P_t, equals its fundamental value, P_t^*.

However, heterogeneous expectations about economic conditions and the lack of evidence regarding the efficient-market hypothesis imply that the fundamental value is likely to differ from the actual price. The efficient-market hypothesis has been challenged by extensive evidence that shows the forecastability—especially over long horizons—of expected returns. An important implication of the long-horizon forecastability of stock returns is the presence of a transitory component, and its quantitative importance has been confirmed in many empirical studies, either in a univariate (Fama and French 1988a; Poterba and Summers 1988) or a multivariate framework

6. Regarding the controversy surrounding whether dividends or earnings best represent expected cash flow, we argue that, since earnings are highly subject to "creative accounting," they are not the best signal of future expected cash flow. Despite what theory dictates, however, the choice of dividends might, a priori, appear problematic. In 1999, only 20.8 per cent of companies listed on the major stock exchanges paid dividends, down from 66.5 per cent in 1978. Fama and French (2001) show that the practice of paying dividends has fallen across all categories of firms. However, this trend may be misleading for our purposes. Fama and French also show that dividend-paying firms accounted for 89.4 per cent of the aggregate book value and 88.5 per cent of the market value of assets and common stock from1971–98. Even from1993–98, when the ratio of firms paying dividends declined substantially, dividend-paying firms still accounted for 80.3 per cent of the aggregate book value and 76.7 per cent of the market value of assets. Given the important role played by dividend-paying firms in market valuation, it would therefore appear legitimate to explain movements in the fundamental value of the stock market by shocks to expected dividends flow. A recent proposal by the Bush administration to eliminate double taxation of dividends could also play a role in reversing the recent trend of dividends payout.

(Fama and French 1988b; Cochrane 1994).[7] For instance, in Cochrane, transitory shocks account for an estimated 57 per cent of the variance of annual stock returns.

In an insightful paper, Summers (1986) argues that the presence of a significant temporary component and the forecast power of yields are consistent with common models of market inefficiency, in which stock prices fail to rationally reflect fundamentals and tend to show long temporary price swings away from fundamental value. Consequently, he proposes an alternative formulation to the efficient-market hypothesis, in which the observed prices incorporate a fundamental value ($P_t{}^*$) and a stationary (mean-reverting) process:

$$P_t = P_t{}^* + u_t. \tag{2}$$

To the extent that stock prices are usually characterized by non-stationary stochastic trends, we can easily interpret this equation as a decomposition of stock prices into permanent and transitory components.[8] Therefore, a straightforward way to characterize the fundamental value $P_t{}^*$ is to relate it to its permanent component. The transitory component then represents all departures of the actual price from its fundamental value, and Summers interprets this as evidence of fads or irrational bubbles.[9] Empirically, this conjecture is illustrated by, among others, Shiller (1981) and Poterba and Summers (1988); they show that stock prices move too much to be justified by news about fundamentals. Following this argument, the transitory component would provide a general assessment of the degree of over- or undervaluation.

In contrast with previous studies, we propose a way to decompose the permanent component into different sources. As suggested by the present-value model, changes in expected cash flows and/or changes in expected returns are the ultimate source of long-run equity-price movements. Consequently, we define the fundamental value as the path of stock market prices that would be expected on the basis of permanent shifts in dividends and discount rates. In a more formal way, the fundamental value consists of the trend that results from the cumulative impact of all identified permanent shocks.

To properly identify the permanent shocks that constitute the building blocks for our measure of the fundamental value, we adopt the SVECM procedure developed by KPSW (1991). The

7. To the extent that a transitory component can be characterized as a stationary process involving mean-reversion, this reversal should be predictable.
8. There is a large body of theoretical and empirical evidence for unit roots in the behaviour of stock prices.
9. Fads or irrational bubbles occur in markets when demand is largely determined by expectations of short-term capital gains, with little attention paid to long-run fundamentals.

identification scheme used to recover the different shocks is based on long-run restrictions. The approach we propose is similar to the one adopted by Cochrane (1994) to study the importance of transitory shocks on the dynamics of stock prices. By focusing on a simple bivariate model that includes stock prices and dividends, Cochrane defines the permanent component of stock prices as the trend component resulting from permanent shocks to dividends, whereas price shocks that keep dividends constant are almost entirely transitory.[10] Cochrane assumes, however, that equity prices and dividends are cointegrated, and he therefore includes the price-dividend ratio in the specification of VAR in first-difference.[11]

The rationale for cointegration as a consequence of the present-value model is discussed in Campbell and Shiller (1987, 1988a). If we suppose that this formulation holds, stock prices represent a rational forecast of future values of dividends and, consequently, a permanent increase in dividends should lead to permanent higher equity prices, in line with the definition of cointegration. In this paper, our objective is to generalize Cochrane's approach by allowing time-varying discount rates, which means that we allow for the possibility of cointegration between the discount rate (proxied by the real interest rate), real dividends, and stock prices. The discount rate is excluded in most empirical models because it is assumed to be constant, in contrast with growing empirical evidence that suggests that real interest rates potentially behave as a near-integrated series.[12] This point is also emphasized theoretically by Campbell and Cochrane (1999), who show, through a calibrated model, that a wide variety of dynamic asset-pricing phenomena are characteristic of a slowly time-varying risk premium.

3. The SVECM

The possibility of cointegration suggests that our model should be specified as a VAR in VECM form:

10. Cochrane shows that the present-value model, together with the hypothesis that managers smooth dividends, predicts and interprets these features.

11. His rationale is that if dividend growth and the discount rate were stationary, the dividend-discount model implies that the price-dividend ratio is also stationary. Furthermore, to the extent that this ratio significantly increases the forecast performance of future returns, the inclusion of a dividend/price ratio improves the VAR specification.

12. Phillips (1998b) shows that the real interest rate tends to incorporate a significant long-memory component; in section 4 we describe how to specify such a series in the context of VAR.

$$\begin{bmatrix} \Delta D_t \\ \Delta r_t \\ \Delta P_t \end{bmatrix} = \sum_{i=1}^{k-1} \Gamma_i \begin{bmatrix} \Delta D_{t-1} \\ \Delta r_{t-1} \\ \Delta P_{t-1} \end{bmatrix} + \alpha\beta' \begin{bmatrix} D_{t-1} \\ r_{t-1} \\ P_{t-1} \end{bmatrix} + \mu + e_t \tag{3}$$

where e_t is a white-noise process.

The variables we consider, in line with the present-value framework, include the log of the inflation-adjusted Wilshire 5000 (*P*); the real long-term corporate bond yield (*r*), given by the inflation-adjusted Moody's 30-year BAA bond yield; and the log of inflation-adjusted NIPA dividends (*D*) (Figure 1).[13,14] The sample covers the period 1973Q1 to 2002Q3.

Unit-root tests indicate that all the variables can be characterized as non-stationary or integrated of order 1, justifying the fact that the model is specified in first-differences. For equity prices and dividends, these results are consistent with the usual findings in the literature. There is little consensus, however, regarding the stationarity of real interest rates. Phillips (1998a) explains the lack of consensus by showing that real interest rates can best be characterized as a long memory process for which unit-root tests have very low power. What, then, is the best strategy to use with time series that are not well represented as either I(0) or I(1)? In a VAR specification with series that appear to be near-integrated (or very persistent), Phillips (1998b) shows that an optimal strategy is to specify these series as first-differenced. This ensures that impulse-response functions and variance decompositions will have appropriate asymptotic properties. Indeed, using extensive Monte Carlo experiments, Phillips demonstrates that working with near-integrated series in levels leads to impulse-response functions that converge to random variables.

For the cointegration tests, we adopt Johansen's procedure, which estimates the number of long-run relationships through the rank of the matrix $\alpha\beta'$. The lag length of the model is determined using the Hannan-Quinn and Shwartz criteria. Lags are then added to the pre-selected lag length to ensure that SVECM residuals are white noise, and this procedure results in an eight-lag model. Both the *Lambda-max* and -*Trace* tests indicate the presence of only one vector (Table 1). The estimates are given in Table 2.

13. Our sample is constrained by the Wilshire 5000, for which data are available only from 1970Q1.
14. Inflation-adjusted series are deflated by the GDP deflator.

Table 1: Johansen Cointegration Test

Null hypothesis[a,b]	*L-max*	Critical value[c]	*L-trace*	Critical value[c]
Rank = 0	27.55	18.60	36.13	26.79
Rank = 1	**8.15**	**12.07**	**8.57**	**13.33**

a. The null hypothesis is rejected if the computed value is greater than the critical one.
b. The cointegration rank corresponds to the number of cointegrating vectors.
c. Threshold of 10 per cent.

Table 2: The Cointegrating Vector

Dividends	Corporate bond yield	Wilshire 5000
-1.266	2.970	1.000

Because we are interested in capturing permanent shifts in the fundamentals, the SVECM we use to decompose stock prices will be identified by imposing restrictions on the long-run effects of shocks. We then identify permanent and transitory shocks using the KPSW (1991) procedure. Their methodology allows for structural interpretation in a cointegrated VAR.[15] A common though incorrect inclination is to interpret the cointegrating vector coefficients. One cannot assume, however, that the coefficients in the cointegrating vector represent partial derivatives. Wickens (1996) shows that reduced-form cointegrating vectors should not be interpreted without further structural assumptions. Intuitively, given the endogeneity characterizing the set of variables, a shock to each variable induces movements in the others.

With only one identified cointegrating vector, the stochastic trend in equity prices can be expressed as a linear combination of the two other stochastic trends. This reduced-form cointegrating vector is combined with long-run restrictions to identify two permanent shocks: one to dividends and one to the real interest rate.[16] Because there is a significant cointegrating relationship, the remaining shock is transitory. To the extent that the fundamental value is proxied

15. Details of the KPSW identification methodology are given in Appendix A.
16. The use of long-run restrictions to identify structural shocks in a VAR model without cointegration was first proposed by Blanchard and Quah (1989).

by the trend defined by these two permanent shocks, the transitory component can be seen as a measure of under- or overvaluation.

In structural VAR models, variable ordering matters and, since economic theory involves mainly long-run relationships between variables, relating restrictions to long-run structures is considered to be less ad hoc than its contemporaneous counterpart. In the context of long-run restrictions, variables are put in decreasing order of long-run exogeneity. Because we are interested in long-run exogenous movements in fundamentals, dividends and real interest rates must be ordered before the variable for stock prices. We show in section 4 that our results are invariant to the ordering of the two fundamentals.[17]

4. Analysis of the Structural Shocks[18]

4.1 The estimated long-run impact of structural shocks

As the KPSW methodology implies, we partition the structural shock into permanent and transitory components, $\eta_t = (\eta_t^p, \eta_t^t)$. Given the presence of only one cointegrating vector, our model features two permanent and one transitory shocks. The permanent component is partitioned into the fundamental variables identified in our model, implying that $\eta_t^p = \eta_t^d + \eta_t^r$, where η_t^d represents the dividends shock and η_t^r the interest rate shock. To analyze the long-run impact of structural shocks, we subject our model to a one-standard-deviation shock in dividends and interest rates. Table 3 shows the impact of these shocks on the three variables in the model.

The results suggest that a permanent increase of 2.5 per cent in the level of dividends leads to a permanent increase of 3.5 per cent in the value of the stock market as measured by the broad Wilshire 5000 index, and to a permanent fall in real interest rates of about 0.1 per cent. Consequently, the results are invariant to the ordering between dividends and interest rates, because the indirect effect of a dividend shock on the equity market, coming through interest rates, appears to be small.

Our results support one feature of the data in that stock prices overreact to long swings in dividends—stock prices move more than one-for-one with dividends. Indeed, a long-run 1 per cent increase in the level of dividend is associated with a permanent increase of 1.4 per cent in

17. Independent of the economic environment, the final decision on whether to pay dividends is made by a firm's management. We therefore suppose that dividends are the most exogenous variable in our set.
18. We use a modified version of the catsmisc.src procedure in CATS, as provided by Gauthier (2000), to operationalize the KPSW methodology.

stock prices, whereas this elasticity is 1.5 per cent in Barsky and DeLong (1993). This result is consistent with portfolio-management theory, which suggests that, given a pre-determined level of risk aversion, capital will flow from riskier to more secure assets as their yield spread narrows.

Table 3: Long-Run Matrix of Structural Shocks[a]

	η^d	η^r
Log of real dividends	2.52	0.00
Real corporate bond rate	-0.09	0.63
Log of real Wilshire 5000	3.47	-1.88

a. Impulse-response functions for the structural shocks are shown in Figure 5.

4.2 The variance decomposition

Table 4 shows the results of the variance decomposition. In terms of the long-run variance decomposition, we find that 76 per cent of the low-frequency dynamics in stock prices is explained by permanent shocks to dividends, and the remaining 24 per cent is explained by permanent shocks to real interest rates. For short horizons, most (70 per cent) of the quarterly fluctuations in asset prices are attributable to transitory innovations, and they still represent 40 per cent after one year, 35 per cent after two years, and close to 20 per cent after five years. These results suggest that the periods of mispricing could last more than just a few quarters in our model. Furthermore, the dynamics of dividends and real interest rates are largely dominated by their respective permanent shocks and indicate that short-run fluctuations in stock prices display no association with fundamentals. This reinforces our view that the transitory component of stock prices provides a general assessment of the degree of over- or undervaluation. These results are consistent with previous literature on stock market volatility (Shiller 1981; LeRoy and Porter 1981), in which movements in dividends appear too smooth to justify the higher degree of volatility in stock prices.

Table 4: Forecast-Error Variance Decomposition

A. Fraction of the dividends that forecast-error variance attributed to the three structural shocks

Horizon	η^d	η^r	η^t
1	0.99	0.00	0.01
4	0.98	0.01	0.01
8	0.96	0.03	0.01
20	0.98	0.01	0.01
∞	1.00	0.00	0.00

B. Fraction of the corporate bond yield that forecast-error variance attributed to the three structural shocks

Horizon	η^d	η^r	η^t
1	0.00	0.93	0.07
4	0.01	0.78	0.21
8	0.10	0.78	0.12
20	0.06	0.90	0.04
∞	0.02	0.98	0.00

C. Fraction of the Wilshire 5000 that forecast-error variance attributed to the three structural shocks

Horizon	η^d	η^r	η^t
1	0.05	0.25	0.70
4	0.02	0.60	0.38
8	0.02	0.64	0.34
20	0.35	0.47	0.18
∞	0.76	0.23	0.01

4.3 The historical decomposition

Figure 2 shows the historical decomposition of real dividends. Most of the movements in dividends that occurred through the 1980s and 1990s are identified as permanent shocks. First, the important progression in dividends over the 1982–87 period is associated with a permanent drop in U.S. interest rates. This permanent drop (Figure 3) was made possible by the successful inflation-control strategy of the U.S. monetary authority. Sharpe (1999) and Gauthier (2000) document the important role that the low-inflation environment played for stock market prices over the period.[19]

Correspondingly, the permanent increase in dividends that occurred in the 1990s matches the impressive productivity gains made in the United States through high-tech capital deepening. Part of this shock was reversed in the late 1990s with the bursting of the U.S. stock market bubble.

As reported in Figure 4, our results show that close to 50 per cent of the trend in real stock market prices in the past decade is explained by movements in the real dividends stochastic trend, and that the interest rate stochastic trend is responsible for approximately 25 per cent of these movements. As productivity and profits grew stronger and as inflation remained tame, real aggregate dividends increased in spite of a growing number of firms withholding on such payments. Our model also captures well the slowdown in profits and payout of dividends that occurred early in 2001, as a result of the latest U.S. recession.

The contribution of the transitory shock on stock prices (Figure 4) indicates that our model captures key historical events. For example, the October 1987 stock market correction is estimated to be in the order of 19 per cent. In addition, we find that, following the U.S. recession of 1991–92, and the round of business downsizing and consolidation it brought about, the U.S. stock market was undervalued by roughly 19 per cent at the end of 1992 and remained depressed throughout the ensuing jobless economic recovery. Marking a pause in the formidable market expansion of the 1990s, our results suggest that the 1998 Asian crisis was associated with a market correction of 7 per cent. During the strong bull market that followed, the broad Wilshire 5000 reached an overvaluation level of 17 per cent, which is sizable considering the breadth of the index. Last but not least, following the "dot.com" stock market correction and the bear market that ensued, our model suggests that, by the end of the fourth quarter of 2002, amid corporate governance scandals and heightened geopolitical tension, the Wilshire 5000 was undervalued by 14 per cent.

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19. According to the principle of money neutrality, equity prices should offer good protection against inflation, because, in the long run, nominal dividends should grow at the rate of inflation.

These results contrast relative assessments made on the basis of price-earnings (P/E) ratios. For example, the P/E ratio of the Standard and Poor's (S&P) index stood at 32.2 by the end of 2003Q4, 90 per cent above its historical average, which suggests that equity prices were likely overvalued.[20] Because recent earnings have been unusually volatile, however, they might not accurately depict current equity valuation. To control for excessive volatility in earnings, Neely (2002) suggests that P/E ratios be calculated based on an exponential earnings trend. This measure captures the rise in earnings consistent with the size of the economy. Neely shows that the two methods of calculating P/E ratios have usually tracked each other closely, except for periods of heightened earnings volatility.[21] Although the current P/E ratio calculated using the exponential growth trend is not as extreme as the standard P/E ratio, at 26 per cent above historical average, it is still high.[22]

Campbell and Shiller (2001) also conclude that equity prices are likely overvalued on the basis of the dividend-price and price-smoothed-earnings ratios.[23] Yet, to them, the very fact that valuation ratios moved so far outside their historical range over the 1998–2001 period poses a challenge to the traditional view that equity prices reflect rational expectations and that they are substantially driven by mean reversion. Our results appear to support this view, in that there appears to be a permanent shift in fundamentals over the 1998–2001 period, despite clear market overvaluation. While Campbell and Shiller do not expect a complete return to traditional valuation levels, they feel that their findings suggest a poor long-term outlook for the stock market.

5. Conclusion

Given the absence of an explicit equilibrium value for equity prices, this paper has described a way to assess the evolution of observed equity prices in light of historical shifts in fundamentals. We define the fundamental value as the component of stock prices that results from the cumulative effects of permanent shocks to discount rates and dividends, identified using an SVECM. As a residual to this fundamental component, the so-called transitory component provides a general assessment of the degree of over- or undervaluation. Defined in this way, the fundamental value represents the path of equity prices that would be expected on the basis of permanent shifts in dividends and discount rates.

20. Wilshire 5000 data were not available; nonetheless, the S&P represents 79 per cent of the Wilshire 5000's market capitalization.
21. Periods of divergence between the two ratios include the current and the 1991–95 period; they are plagued by unusually low earnings.
22. The P/E ratio is calculated from 12-month trailing earnings.
23. Earnings are smoothed, following Graham and Dodd (1934), by averaging over five to 10 years.

Our empirical findings have two main results. First, they can account for the tendency of stock prices to move more than one-for-one with dividends. Second, they provide additional evidence of an important transitory component in stock prices. Hence, according to the variance decomposition at short horizons, transitory innovations play a major role (70 per cent) in the quarterly fluctuations of asset prices, whereas the dynamics of dividends and real interest rates are largely dominated by their respective permanent shocks. For the long-run variance decomposition, we find that 76 per cent of the low-frequency dynamics in stock prices are explained by permanent shocks to dividends and that the remaining 24 per cent are explained by permanent shocks to real interest rates.

Although our model does not allow us to directly forecast future equity prices, our results suggests that, at its peak early in 2000, the Wilshire 5000 index was overvalued by roughly 8 per cent. Of the incredible performance of the stock market over the 1995–2000 period, 35 per cent is attributable to the progression of real dividends. Another 20 per cent is associated with lower average real interest rates, made possible by low and stable inflation. Because the performance of the U.S. financial markets in the post-“irrational exuberance” period has been mixed, our model suggests, given our fundamentals, that the Wilshire 5000 was undervalued by 14 per cent by the end of 2002Q4.

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Figure 1: The Data

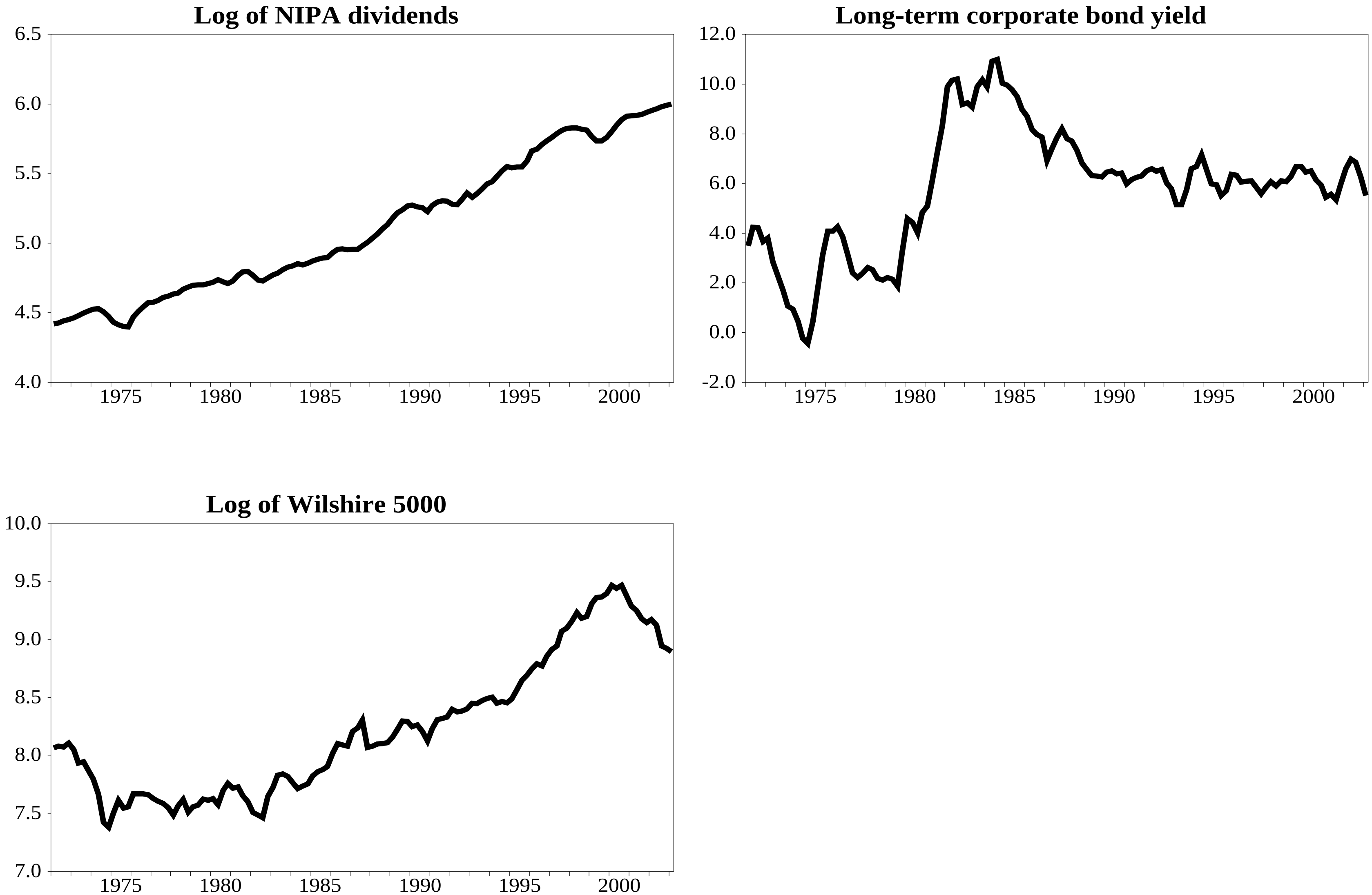


Figure 2: Stochastic Components of Dividends

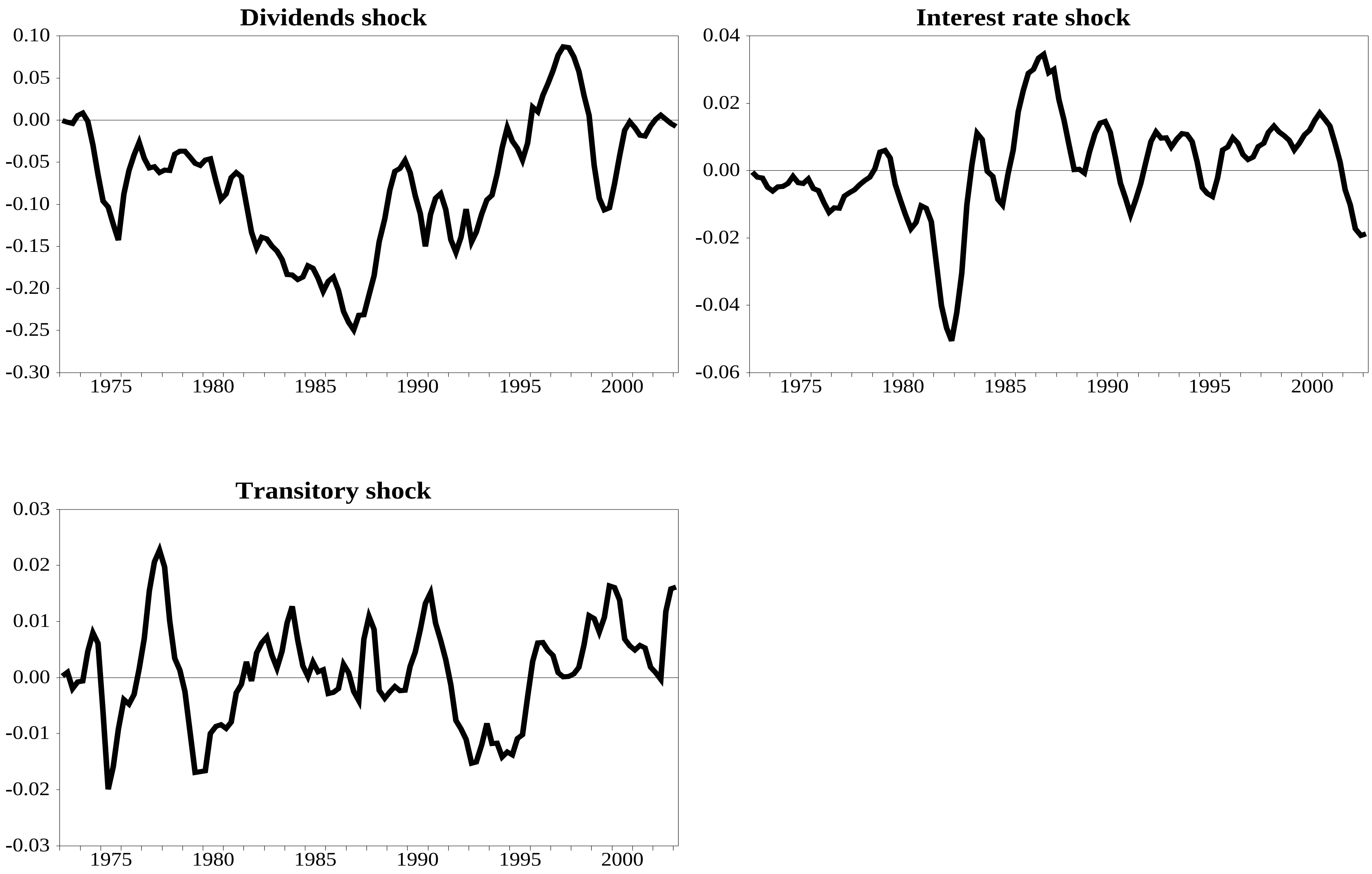


Figure 3: Stochastic Components of Interest Rates

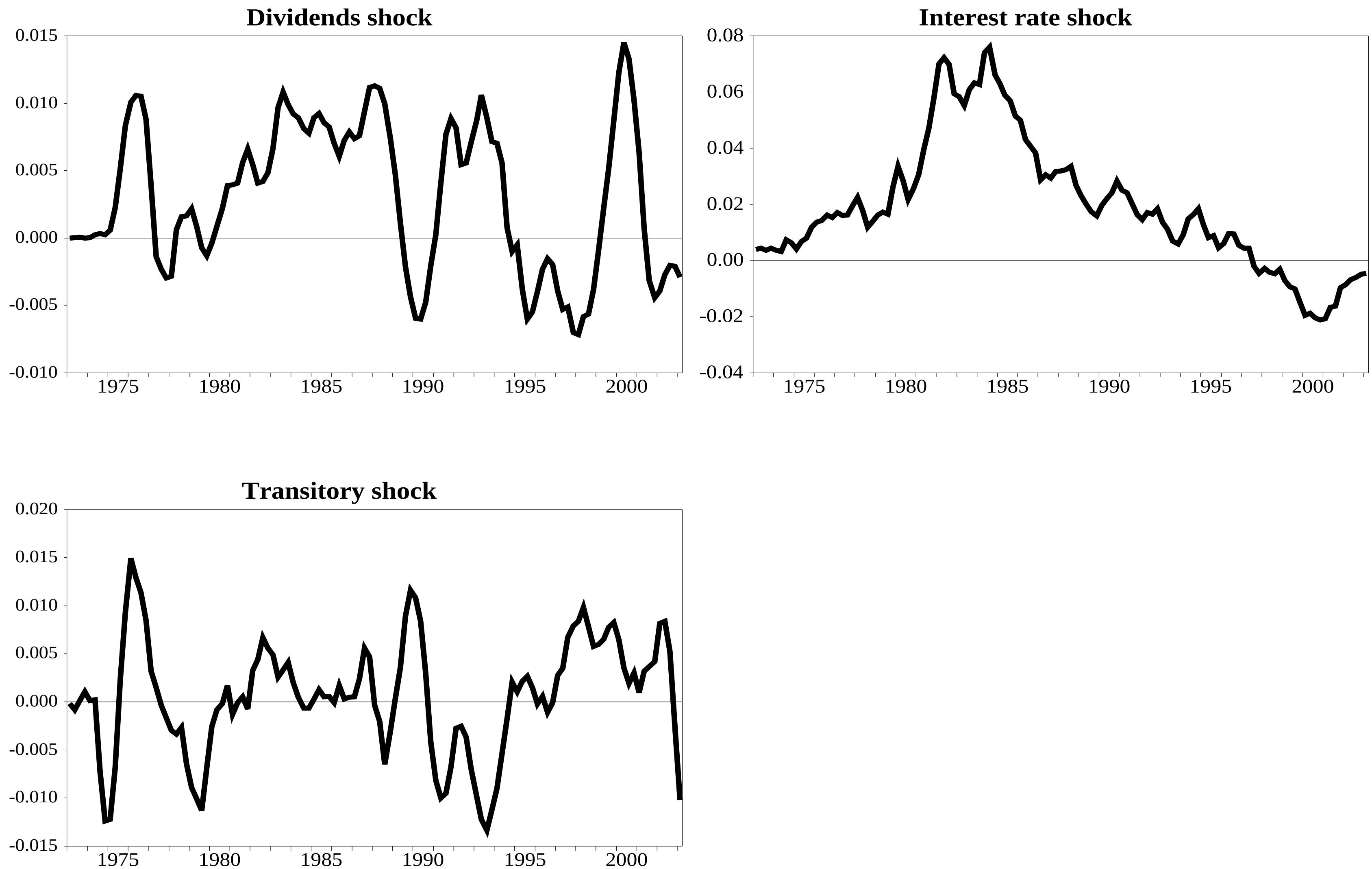


Figure 4: Stochastic Components of the Wilshire 5000

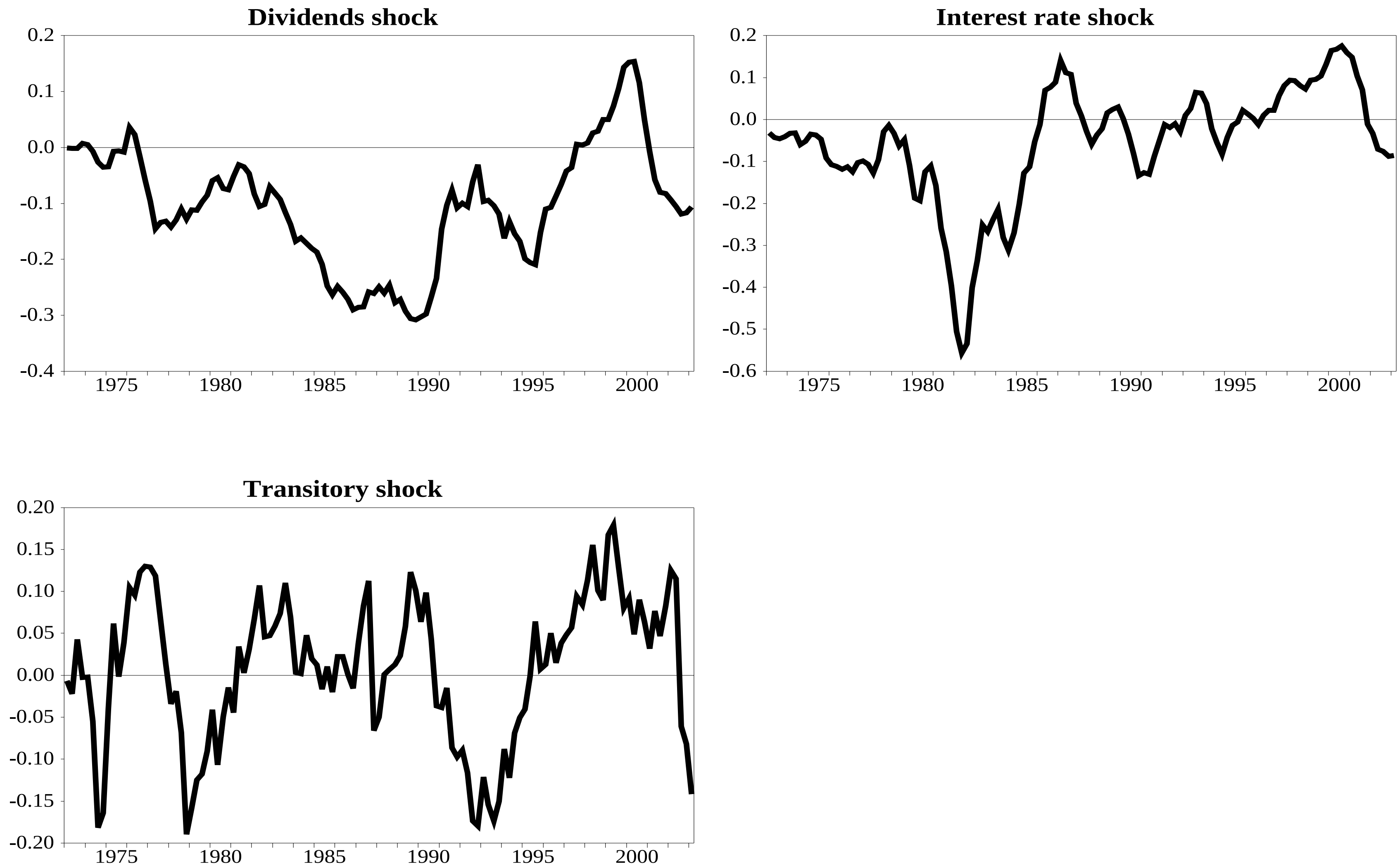
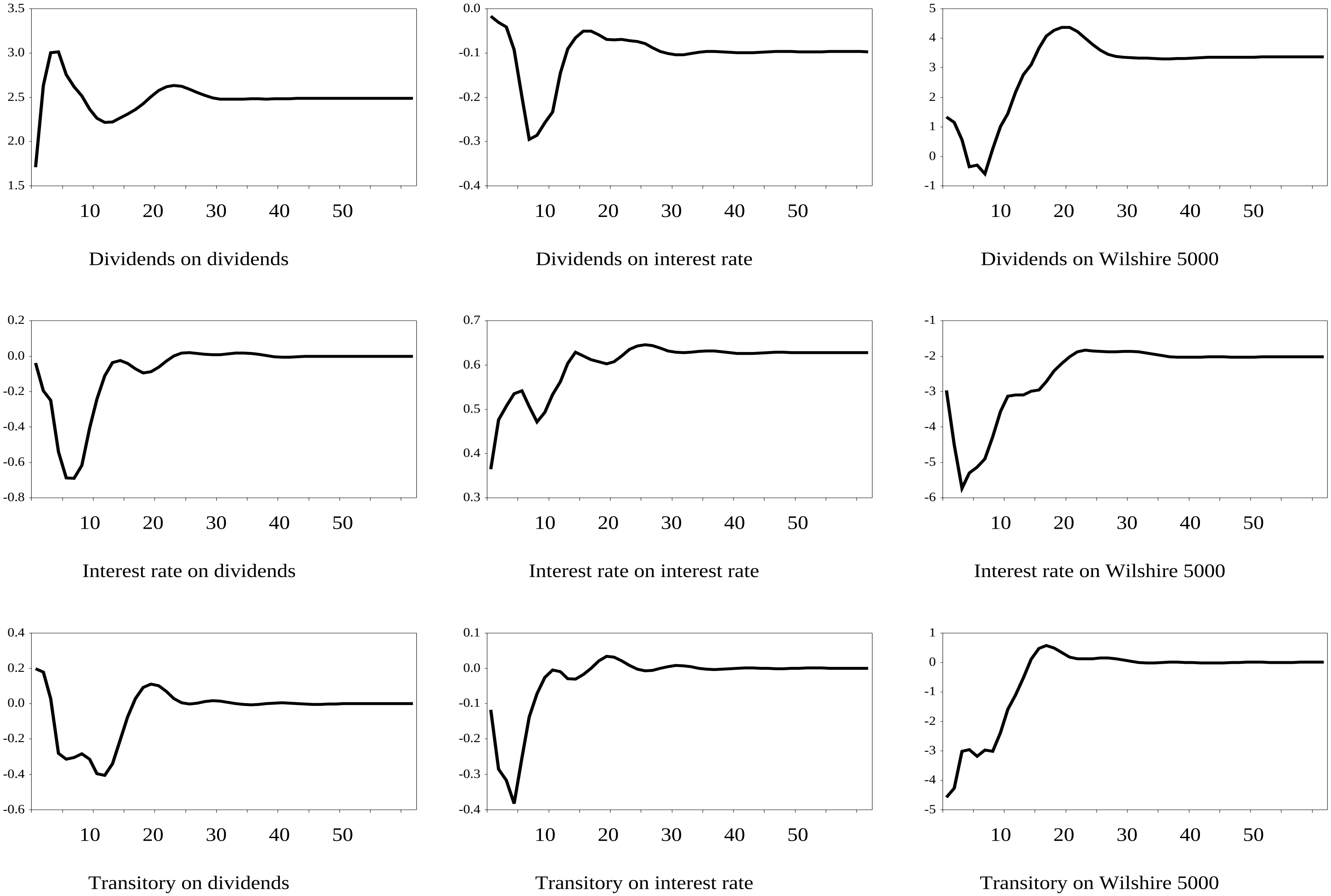


Figure 5: Impulse-Response Functions



Appendix A: KPSW's Identification Methodology

The reduced-form VECM can be inverted to obtain the following moving average representation:

$$X_t = e_t + C_1 e_{t-1} + \ldots = \sum_{i=0}^{\infty} C_i e_{t-i} = C(L)e_t, \tag{A1}$$

where e_t is a (nx1) vector of innovations. We want to identify the following structural model:

$$X_t = \Gamma_0 \varepsilon_t + \Gamma_1 \varepsilon_{t-1} + \ldots = \sum_{i=0}^{\infty} \Gamma_i \varepsilon_{t-i} = \Gamma(L)\varepsilon_t, \tag{A2}$$

where both the structural shocks, ε_t, and Γ_i matrices are unknown.

The first identification constraint is that $Var(\varepsilon_t) = \Sigma_\varepsilon$ is block-diagonal, the two blocks corresponding to the partition $\varepsilon_t = (\varepsilon_t^{p\prime}, \varepsilon_t^{t\prime})'$ where ε_t^p is the vector of (kx1) permanent shocks, and ε_t^t is a vector ((n-k) x 1) of transitory shocks.

The other identification restrictions are:

$$\Gamma(1) = [\tilde{A}\Pi \ 0], \tag{A3}$$

where $\tilde{A}$ is a known (nxk) full-rank matrix the columns of which are orthogonal to the cointegration vectors; i.e., $\beta'\tilde{A} = 0$. Π is a lower triangular (kxk) matrix, and 0 is a nx(n-k) matrix of zeros. Given that Π is usually not diagonal, the ordering of the variables is important, since the lower a variable in the system, the bigger the number of permanent shocks that can influence it in the long run.

We will now show that these restrictions are sufficient to identify the structural model. Equations (A1) and (A2) are related by:

$$\Gamma_0 \varepsilon_t = e_t, \tag{A4}$$

$$C(L) = \Gamma(L)\Gamma_0^{-1}, \tag{A5}$$

$$\text{and } C(1) = \Gamma(1)\Gamma_0^{-1}. \tag{A6}$$

Let D be any (kxn) solution of $C(1) = \tilde{A}D$. Since $C(1)e_t = \Gamma(1)\varepsilon_t = \tilde{A}\Pi\varepsilon_t^p$, we can write:

$$\tilde{A}De_t = \tilde{A}\Pi\varepsilon_t^p \tag{A7}$$

$$\text{and } D\Sigma_e D' = \Pi\Sigma_{\varepsilon'}\Pi'. \tag{A8}$$

Let $\overline{\Pi} = chol(D\Sigma_e D') = \Pi\Sigma_{\varepsilon'}^{1/2}$. Since Π is a triangular matrix, and $\Sigma_{\varepsilon'}$ is diagonal, we obtain a unique solution for Π and $\Sigma_{\varepsilon'}$. By (A7), we can thus identify the permanent shocks:

$$\varepsilon_t^p = \Pi^{-1}De_t = Ge_t. \tag{A9}$$

We can easily show (see KPSW) that the dynamic multipliers of η_t^p are identified by:

$$\Gamma(L) = C(L)\Sigma_e G'\Sigma_{\varepsilon_t^p}^{-1}. \tag{A10}$$

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