Pricing Stock Market Volatility: Does It Matter Whether the Volatility Is Related to the Business Cycle?

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Abstract

Given two virtually separate literatures on return predictability and the risk-return relation, this paper reconciles the two literatures by investigating the underlying mechanism of the return predictability literature through exploiting the risk-return relation. In developing an empirical model to examine the business cycles-risk-return relationship, we consider the fact that market volatility increases during recessions and other short periods of liquidity crises such as the 1987 stock market crash and the 1998 Russian default. Then, the impacts that expected market volatilities, each due to two different sources, have on expected returns are investigated. Specifically, we decompose stock prices into fundamental and transitory components and then derive a bivariate model of stock returns and output growth within Campbell and Shiller's (1988) log-linear present value framework. Our empirical results show that business cycles-related market volatility has predictive power for expected return movements, while business cycles-unrelated volatility does not. We confirm the underlying mechanism of the return predictability literature, i.e. the business cycles-risk-return relationship. On the other hand, the temporary high variances during liquidity crises are not compensated by higher expected returns. Finally, a few episodes of transitory components are identified, including the 1973-4 OPEC oil shock, the 1987 crash and the 1998 Russian default. These results provide new evidence for the risk-return literature and support for the business cycles-risk-return mechanism.

Key Words**:** Business Cycles, Expected Returns, Stock Return Volatility, Volatility Feedback, Markov-Switching, Transitory Component

JEL Classification: C32, G12, C51

1 Introduction

Understanding stock market returns is important for both practitioners and academics since market returns play a central role in the capital asset pricing model. One line of effort has linked the predictability of market returns to various variables, such as dividend-price ratio (Campbell and Shiller (1988), Fama and French (1988)), book-to-market ratio (Lewellen (1999)), yield spreads between long-term and short-term interest rates (Campbell (1987), Fama and French (1989)) and the level of consumption relative to income and wealth (Lettau and Ludvigson (2001)). The predictive power of these variables is explained by their relation to business conditions. Then, the story relies on the following mechanism: bad business conditions cause higher market risk and higher expected returns.

Campbell and Diebold (2005) is another example of a work that sheds light on the business conditions-risk-return mechanism. They find that expected business conditions significantly impact expected excess returns, using half a century of Livingston survey data on expected business conditions. The significant influence of business conditions on stock return movement is explained as: expected business conditions may forecast higher market risk and hence may be linked to expected excess returns. However, not much research, if any, is done on the underlying mechanism between the three elements: business conditions, market risk and market returns.

On the other hand, there has been a great deal of research on the relation between stock market risk (conditional variance) and its expected return (conditional mean), each yielding conflicting results. Some report a positive relation between the two by employing either the stochastic volatility-in-mean model or volatility feedback model. For example, Bollerslev, Engle, and Wooldridge (1988) use a generalized autoregressive conditional heteroscedasticity in mean (GARCH-M) model and Smith (2006) employs a log- autoregressive (AR) stochastic volatility-in-mean model. In the volatility feedback literature, various specifications of the conditional variance are employed, such as the integrated autoregressive moving average (ARIMA) variance (French, Schwert, and Stambaugh(1987)), GARCH variance (Bekaert and Wu (2000), Campbell and Hentschel (1992)), and Markov-switching variance (Kim, Morley and Nelson (2004) and Mayfield (2004)). The volatility feedback model is built on the following intuition: given that volatility is persistent, an unexpected increase in the current level of volatility causes agents to increase their estimates of future required returns, resulting in a lower stock price today.

Others provide different evidence of a negative relation between the conditional mean and variance of stock returns, using an ARCH-type variance (Nelson (1991)) or a (modified) GARCH-M model (Glosten, Jagannathan, and Runkle (1993)). Turner, Startz, and Nelson (1989) also find a negative relation within the volatility feedback framework with Markov-switching variances while Whitelaw (1994) uses conditional moments estimated as functions of predetermined financial variables. The negative relation can be explained by a “leverage" effect: that is, a drop in the value of the stock (negative return) increases financial leverage, which makes the stock riskier and increases its volatility (Black (1976), Christie (1982), Glosten, Jagannathan, and Runkle (1993), and Yu (2005)).

Given these two virtually separate literatures on return predictability and the risk-return relation, this paper reconciles the two literatures by investigating the underlying mechanism of return predictability through exploiting the risk-return relation. In developing an empirical framework to examine the business conditions-risk-return relationship, we consider the fact that market volatility increases during recessions and other short periods of liquidity crises such as the 1987 stock market crash and the 1998 Russian default. Then, the impacts that expected market volatilities, each due to two different sources, have on expected returns are investigated. Specifically, we decompose stock prices into fundamental and transitory components and then derive a bivariate model of stock returns and output growth within Campbell and Shiller's (1988) log-linear present value framework.

Our empirical results show that business conditions-related market volatility has predictive power on expected return movements, while business conditions-unrelated volatility does not. We confirm the underlying mechanism of the return predictability literature, i.e. the business conditions-risk-return relationship. On the other hand, the temporary high variances during liquidity crises are not compensated by higher expected returns. Furthermore, a few episodes of transitory components are identified including the 1973-4 OPEC oil shock, the 1987 crash and the 1998 Russian default. These results provide new evidence for the risk-return literature and support for the business conditions-risk-return mechanism.

The rest of the paper is organized as follows. Section 2 describes the model specification, deriving a bivariate model of stock returns and output growth. Section 3 describes the data and presents estimation results. Concluding remarks are in Section 4.

2 Model Specification

In this section, we derive a bivariate model of stock returns and output growth in order to assess the mechanism of the business conditions-risk-return relationship. We first derive a univariate model for stock returns within the log-linear present value framework in the first two subsections, Sections 2.1 and 2.2. In doing so, we consider two sources of market volatility: shocks to the fundamental component and those to the transitory component of stock prices. We then make a link to output growth in Section 2.3. Some issues in the estimation procedure are discussed in the last subsection, Section 2.4.

2.1 Assumptions for Stock Return Equation

In developing an empirical model of stock returns, we rely on three simple assumptions. First, we consider the following two sources of shocks which are subject to Markov-switching variances:

$$e_t \sim N(0,\sigma^2_{e,t}),\ \sigma^2_{e,t} = \sigma^2_{e,0}(1-S_{1,t}) + \sigma^2_{e,1}S_{1,t},\ \sigma^2_{e,0} < \sigma^2_{e,1}, \tag{1}$$

$$v_t \sim N(0,\sigma^2_{v,t}),\ \sigma^2_{v,t} = \sigma^2_{v,0}(1-S_{2,t}) + \sigma^2_{v,1}S_{2,t},\ \sigma^2_{v,0} < \sigma^2_{v,1}, \tag{2}$$

$$Pr[S_{i,t} = 1 \mid S_{i,t-1} = 1] = p_i,\ and\ \ Pr[S_{i,t} = 0 \mid S_{i,t-1} = 0] = q_i,\ i = 1, 2, \qquad (3)$$

where e_t denotes new information about future dividends that has permanent effect on stock prices; v_t is a transitory shock to stock prices and is not related to future dividends; $S_{i,t}$, $i = 1, 2,$ takes on discrete values of 0 or 1 according to the prevailing volatility regime; q_i and p_i are transition probabilities governing the evolution of $S_{i,t}$, $i = 1, 2,$. We find support for the existence of transitory shocks in Kim and Kim (1996), Summers (1986) and Poterba and Summers (1988).

Secondly, we assume that stock prices consist of the following two components:

$$p_t = p_t^* + z_t, \qquad (4)$$

where p_t is the natural log of stock price; p_t^* is the fundamental component of stock price, which is assumed to evolve slowly over time; z_t is a transitory component defined as:

$$\phi(L) z_t = \tau S_{2,t} + v_t, \qquad (5)$$

where we allow for the possibility that historical liquidity crises are caused not by fundamental but transitory components, considering the first term ($\tau S_{2,t}$) in Equation (5). Stock return is then given by:

$$r_t \equiv \Delta p_t^* + \Delta z_t. \qquad (6)$$

Finally, we assume that the expected return for a given period $t + j$ is a linear function of the market expectation about the volatility of news given as:

$$E[\Delta p_{t+j}^* \mid I_t] = \beta_1 E[\sigma_{e,t+j}^2 \mid I_t] + \beta_2 E[\sigma_{v,t+j}^2 \mid I_t], \qquad (7)$$

where I_t is the conditioning information set available at time *t*; β_1 reflects the marginal effect of market volatility arising from the fundamental component on the expected return, while β_2 is the transitory component counterpart for the effect on the stock price.

2.2 Derivation of the Stock Return Equation within the Log-Linear Present Value Framework

Campbell and Shiller (1988) use a first-order Taylor series approximation to derive the following log-linear present value relationship for the fundamental component of stock price:

$$p_t^* = \frac{k}{1-\rho} + E\left[\sum_{j=0}^{\infty} \rho^j [(1-\rho) d_{t+1+j} - \Delta p_{t+1+j}^*] \mid I_t\right], \tag{8}$$

where d_{t+1+j} is the log dividend at time $t+1+j$ claimed at the beginning of the period; ρ and k are linearization parameters defined by $\rho \equiv 1/\left(1+\exp(\overline{d-p})\right)$, where $\left(\overline{d-p}\right)$ is the average log dividend-price ratio, and $k \equiv -log(\rho) - (1-\rho) log\left((1/\rho) - 1\right)$. Empirically, in US data the average dividend-price ratio has been about 4% annually, implying that ρ should be about 0.997 for monthly data. Furthermore, as summarized in Campbell, Lo and Mackinlay (1997), the approximation error in Equation (8) is quite small, especially when it is applied to monthly data.

As discussed in Campbell (1991), the log-linear present value model given in Equation (8) can be rearranged to show that a realized return for the fundamental component is determined by the expected return for the fundamental component, revisions in its expected returns, and another revision part in future dividends:

$$\Delta p_t^* = E[\Delta p_t^* \mid I_{t-1}] + f_t + e_t, \tag{9}$$

where

$$f_t \equiv -\left(E\left[\sum_{j=1}^{\infty} \rho^j \Delta p_{t+j}^* \mid I_t^{'}\right] - E\left[\sum_{j=1}^{\infty} \rho^j \Delta p_{t+j}^* \mid I_{t-1}\right]\right), \tag{10}$$

and

$$e_t \equiv \left(E\left[\sum_{j=0}^{\infty} \rho^j \Delta d_{t+j} \mid I_t^{'}\right] - E\left[\sum_{j=0}^{\infty} \rho^j \Delta d_{t+j} \mid I_{t-1}\right]\right), \tag{11}$$

where revisions are made with the additional information during period *t* which is collected in the information set $I_t^{'}$; e_t denotes new information about future dividends that arrives during trading period *t* as in Equation (1).

Meanwhile, in order to find a tractable expression for our information revision term in Equation (10), we rewrite Equation (7) following Hamilton (1989) as:

$$\begin{aligned} E[\Delta p_{t+j}^{*} \mid I_t] = {} & \beta_1\left(\sigma_{e,0}^2 + (\sigma_{e,1}^2 - \sigma_{e,0}^2) Pr[S_{1,t} = 1]\right) + \beta_2\left(\sigma_{v,0}^2 + (\sigma_{v,1}^2 - \sigma_{v,0}^2) Pr[S_{2,t} = 1]\right) \\ & + \beta_1 \lambda_1^j (\sigma_{e,1}^2 - \sigma_{e,0}^2)\left(Pr[S_{1,t} = 1 \mid I_t] - Pr[S_{1,t} = 1]\right) \\ & + \beta_2 \lambda_2^j (\sigma_{v,1}^2 - \sigma_{v,0}^2)\left(Pr[S_{2,t} = 1 \mid I_t] - Pr[S_{2,t} = 1]\right), \end{aligned}$$

(12)

where $\lambda_i \equiv p_i + q_i - 1,\ i = 1,2.$ Then, given recurring volatility regimes (i.e., $|\lambda_i| < 1,\ i = 1,2$), it is straightforward to show that the discounted sum of future expected return is

$$\begin{aligned} & E\left[\sum_{j=0}^{\infty} \rho^j \Delta p_{t+1+j}^{*} \mid I_t\right] \\ & = \frac{\beta_1}{1-\rho}\left(\sigma_{e,0}^2 + (\sigma_{e,1}^2 - \sigma_{e,0}^2) Pr[S_{1,t} = 1]\right) + \frac{\beta_2}{1-\rho}\left(\sigma_{v,0}^2 + (\sigma_{v,1}^2 - \sigma_{v,0}^2) Pr[S_{2,t} = 1]\right) \\ & \quad + \frac{\beta_1}{1-\rho\lambda_1}(\sigma_{e,1}^2 - \sigma_{e,0}^2)\left(Pr[S_{1,t} = 1 \mid I_t] - Pr[S_{1,t} = 1]\right) \\ & \quad + \frac{\beta_2}{1-\rho\lambda_2}(\sigma_{v,1}^2 - \sigma_{v,0}^2)\left(Pr[S_{2,t} = 1 \mid I_t] - Pr[S_{2,t} = 1]\right), \end{aligned} \tag{13}$$

which, in turn, implies the information revision term, or volatility feedback term, is

$$f_t = \delta_1\left(E[\sigma_{e,t}^2 \mid I_t^{'}] - E[\sigma_{e,t}^2 \mid I_{t-1}]\right) + \delta_2\left(E[\sigma_{v,t}^2 \mid I_t^{'}] - E[\sigma_{v,t}^2 \mid I_{t-1}]\right), \tag{14}$$

where $\delta_i \equiv -\dfrac{\beta_i}{1-\rho\lambda_i},\ i = 1,2.$ Substituting Equation (14) into Equation (9), we get:

$$\begin{aligned} \Delta p_t^{*} = {} & \beta_1 E[\sigma_{e,t}^2 \mid I_{t-1}] + \beta_2 E[\sigma_{v,t}^2 \mid I_{t-1}] \\ & + \delta_1\left(E[\sigma_{e,t}^2 \mid I_t^{'}] - E[\sigma_{e,t}^2 \mid I_{t-1}]\right) + \delta_2\left(E[\sigma_{v,t}^2 \mid I_t^{'}] - E[\sigma_{v,t}^2 \mid I_{t-1}]\right) + e_t, \end{aligned} \tag{15}$$

where $\delta_i \equiv -\frac{\beta_i}{1-\rho\lambda_i}$; $\lambda_i \equiv p_i + q_i - 1,\ i = 1,2;$ ρ is slightly less than 1 (0.997) in practice.

Finally, substituting Equation (15) into Equation (6), we get the following univariate model of stock return along with the transitory component dynamics in Equation (5) and the assumption equations (1)-(3):

$$\begin{aligned} r_t &= \beta_1 E[\sigma_{e,t}^2 \mid I_{t-1}] + \beta_2 E[\sigma_{v,t}^2 \mid I_{t-1}] \\ &+ \delta_1 \left(E[\sigma_{e,t}^2 \mid I_t^{'}] - E[\sigma_{e,t}^2 \mid I_{t-1}] \right) + \delta_2 \left(E[\sigma_{v,t}^2 \mid I_t^{'}] - E[\sigma_{v,t}^2 \mid I_{t-1}] \right) + \Delta z_t + e_t. \end{aligned} \tag{16}$$

2.3 Link to the Output Equation

In order to test the underlying mechanism of return predictability literature, i.e. the relationships among business cycles, market volatility and expected return, we consider the following assumption: the high volatility of news about future dividends is subject to bad business conditions. This assumption helps identify the high volatility state for the fundamental component, which is summarized by the following output equation:

$$y_t = \mu S_{1,t-1} + \psi_1 y_{t-1} + \psi_2 y_{t-2} + u_t, \tag{17}$$

$$\begin{bmatrix} u_t \\ e_t \end{bmatrix} \sim i.i.d.N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_u^2 & \rho_{u,e}\sigma_u\sigma_{e,t} \\ \rho_{u,e}\sigma_u\sigma_{e,t} & \sigma_{e,t}^2 \end{bmatrix} \right),$$

where y_t denotes the monthly output growth rate and is described in the context of Hamilton's (1989) business cycle model with $\mu_{S_{1,t-1}} = \mu_0(1-S_{1,t-1}) + \mu_1 S_{1,t-1}$.[2] Here, we note that recessions come with a one-period lag following a high volatility regime in the stock market, since participants in the stock market are forward-looking. This forward-looking possibility in a bivariate system of stock returns and output is first introduced in Hamilton and Lin (1996). They consider a single

[2] In order to consider the impact of the well-known `Great Moderation' since 1984, a dummy variable is used in estimating the standard deviations of the output equation in the later section.

underlying state while we consider two state variables, a high volatility state associated with recessions and another high volatility state which is not functionally related to economic conditions. One advantage of this approach over Hamilton and Lin's (1996) is that it offers a better description of the time series properties of stock return volatility, since not all the high volatility regimes are related to recessions. Several occurrences of anecdotal evidence are the heightened volatility following the October 1987 stock market crash and the more recent turmoil following Russian default in September 1998.

Equations (16) and (17) along with equations (1)-(3) and (5) complete a bivariate model of stock returns and output We note that the proposed bivariate model collapses to Kim, Morley and Nelson’s (2004) model if a single source of market volatility is of concern.

2.4 Issues in Estimation Procedure

We have developed two models of stock returns in the previous section: a univariate model given by Equation (16) along with equations (1)-(3) and (5); and a bivariate model of stock returns and output given by equations (16) and (17) along with equations (1)-(3) and (5).

In order to estimate the stock return Equation (16), we need to consider a discrepancy between the investors' and the econometrician's data set. In particular, the investors' information set $I_t^{'}$ includes information that is not summarized in the researcher's data set. This is because, market participants continuously observe trades that occur during the period, while the researcher's data set is collected discretely at the beginning of each period. To handle this estimation difficulty, we proxy $E[\sigma_{e,t}^2 \mid I_t^{'}]$ and $E[\sigma_{v,t}^2 \mid I_t^{'}]$ with their actual values, $\sigma_{e,t}^2$ and $\sigma_{v,t}^2$. This is a plausible assumption justified by the results in Kim, Morley and Nelson (2004) and Henry and Scruggs (2007). Then, Equation (16) is replaced by the following equation:

$$\begin{aligned} r_t = {} & \beta_1 E[\sigma^2_{e,t} \mid I_{t-1}] + \beta_2 E[\sigma^2_{v,t} \mid I_{t-1}] \\ & + \delta_1 \left(\sigma^2_{e,t} - E[\sigma^2_{e,t} \mid I_{t-1}] \right) + \delta_2 \left(\sigma^2_{v,t} - E[\sigma^2_{v,t} \mid I_{t-1}] \right) + \Delta z_t + e_t. \end{aligned} \tag{18}$$

We also note that the transitory component of stock price in Equation (5) is assumed to have AR(2) dynamics.[3]

The proposed univariate and bivariate models for stock returns are estimated by employing Kim's (1993) procedure for unobserved component models with Markov-switching heteroscedasticity.[4]

3 Estimation Results

In this section, we describe the data and report the estimation results of the models developed in the previous section. We use excess stock returns on a market portfolio, constructed using the CRSP value-weighted portfolio and the 30-day US Treasury bill rate. The excess returns are plotted in Figure 1.A. For reference purposes, the NBER recession dates are shown as shaded areas. As a measure of the business condition, we use a composite index of coincident indicators over the period January 1959 to December 2006.[5]

For comparison with earlier literature, we report the estimation result of Kim, Morley and Nelson's (2004) model in Table 1. Their model is equivalent to our proposed models if a single source of market volatility is considered. Standard errors are in parentheses. β_1 estimate is significant, showing a positive relation between market volatility and expected return. Conditional variance estimates are included in Figure 1.A. Figure 1.B presents the time series of $Pr[S_{1,t} = 1 \mid I_t]$, that is, the conditional probabilities of being in a high volatility state. The estimated probabilities of the high volatility regime captures historical liquidity crises as well as recession periods.

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[3] This assumption is made for simplicity and does not affect any of the substantive points at issue.
[4] Readers are referred to Kim (1993) and Kim and Kim (1996) for details.
[5] The starting point of the sample period is determined according to the availability of the coincident indicators.

Table 2 reports the estimates of the proposed univariate model given by Equation (18) along with equations (1)-(3) and (5) in Column (1). β_i, $i = 1, 2$, are the parameters of interest. β_1 shows the impact of the fundamental component of expected market volatility on expected returns, while β_2 is the transitory component counterpart for the stock price. Interestingly, β_1 is significant while β_2 is not. In other words, the expected market volatility of the fundamental component is compensated by higher expected returns but the same is not true for the transitory component, showing that risk-return trade-off holds only for shocks related to the fundamental component. This result is confirmed by a likelihood ratio (LR) test of the null of $H_0 : \beta_2 = 0$ using the results in Column (2).[6] Column (3) imposes zero constraints on the low variance of transitory shocks ($\sigma_{v,0}$) as well as on β_2. The results in Column (3) give us very close log-likelihood value with one in either Column (1) or Column (2). The transitory component, therefore, is either on or off and reasonably labeled as a `transient fad'.[7]

Figures 2.A-C are drawn based on the results for the proposed univariate model, Column (3) in Table 2. Figure 2.A depicts the conditional variance estimates along with excess stock return. Figure 2.B presents the time series of $Pr[S_{i,t} = 1 | I_t]$, $i = 1, 2$, that is, the conditional probabilities of a high volatility state for either the fundamental or transitory component. The regime probabilities for the fundamental component identify NBER cycles well, while its transitory component counterpart identifies historical liquidity crises and is not persistent. Figure 2.C depicts the estimates of the fad components of stock prices along with their one-standard-error confidence bands. During the sample period, only a few episodes of fad components are significantly identified, including the 1973-1974 OPEC oil shock, the 1987 stock

[6] The p-value of the LR test statistic is 0.388.

[7] For the diagnostic checks of all the models proposed in this paper, a Q test is performed for the standardized residuals and their squares. We do not reject the null hypothesis that the standardized residuals of the model are white noise.

market crash, and the 1998 Russian default.[8]

Table 3 reports the estimates of the proposed bivariate model given by Equations (18) and (17) along with equations (1)-(3).[9] β_1 shows the impact of business cycles-related-expected market volatility on expected return, while β_2 is the business cycles-unrelated counterpart. Most interestingly, business cycles-related volatility has significant explanatory power on the movements of expected return, while the unrelated volatility does not. In other words, risk-return trade-off holds only for shocks related to business cycles. This result is confirmed by a likelihood ratio (LR) test of the null of $H_0 : \beta_2 = 0$ using the results in Column (2).[10] Column (3) imposes the constraints that the low variance of transitory shocks ($\sigma_{v,0}$), as well as β_2, equals zero. The results in Column (3) give us very close log-likelihood value with one in either Column (1) or Column (2).

Figures 3.A-C are drawn based on results from the proposed bivariate model, Column (3) in Table 3. Conditional variance estimates are included in Figure 3.A. We observe high variances during recessions and also during other short periods of liquidity crises such as the 1987 stock market crash and the 1998 Russian default, justifying the need for decomposing market volatility into two different fractions. Figure 3.B presents the time series of $Pr[S_{i,t} = 1 | I_t]$, $i = 1, 2$, that is, the conditional probabilities of a high volatility state for either business cycles-related or business cycles-unrelated shocks. The regime probabilities of the business cycles-related-shocks well identify NBER recession periods shown in the shaded area, while the business cycles-unrelated counterpart identifies historical liquidity crises and is not persistent. Figure 3.C depicts the estimates of business cycles-unrelated components of stock prices along with their one-standard-error confidence bands. During the

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[8] The first two episodes are detected as significant transitory components by Kim and Kim (1996) and as unusually high volatility periods by Schwert (1990). The sample periods in these papers do not include the 1998 liquidity crisis.

[9] In order to consider the impact of the well-known `Great Moderation' since 1984, a dummy variable is used in estimating the standard deviations of the output equation.

[10] The p-value of the LR test statistic is 0.367.

sample period, a few episodes of fad components are significantly identified, including the 1973-1974 OPEC oil shock, the 1987 stock market crash, and the 1998 Russian default, in similar fashion to results from the proposed univariate model.

There are a few issues that merit discussion. First, the similar results between the proposed univariate and bivariate models justify the assumption in Section 2.3 that the high volatility of news about future dividends is subject to bad business conditions. Second, we can compare our implication on an expected equity premium with earlier literature's. Welch (2000) provides survey results on an expected equity premium, in which the respondents are 226 academic financial economists. The consensus on an arithmetic equity premium is about 7% per year over 10- and 30-year horizons. Our proposed univariate and bivariate model provides, respectively, the estimate of 7.0% and 6.7% per year, while Kim, Morley and Nelson's (2004) model gives the annual equity premium by 6.0%. Our model seems to provide a better support for the consensus of many academic financial economists, compared to the earlier volatility feedback literature. In other words, the marginal effect of expected market volatility on expected returns in the earlier volatility feedback literature seems understated due to the failure to sort out the volatility of transitory shocks.

4 Concluding Remarks

In this paper, we investigate the underlying mechanism of the return predictability literature through exploiting risk-return relations. In developing an empirical model to examine the business cycles-risk-return relationship, we consider the fact that market volatility increases during recessions and other short period of liquidity crises such as the 1987 stock market crash and the 1998 Russian default. Then, the impacts that expected market volatilities, each due to two different sources, have on expected returns are investigated. Specifically, we decompose stock prices into fundamental and transitory components and then derive a bivariate model of stock returns and output growth within Campbell and Shiller's (1988) log-linear present value framework.

Our empirical results show that business cycles-related market volatility has predictive power on expected return movements, while business cycles-unrelated volatility does not. We confirm the mechanism underlying the return predictability literature, i.e. the business cycles-risk-return relationship. On the other hand, the temporary high variances during liquidity crises are not compensated by higher expected return. Furthermore, a few episodes of transient fads are identified, including the 1973-4 OPEC oil shock, the 1987 crash and the 1998 Russian default. These results provide new evidence for the risk-return literature and support for the business cycles-risk-return mechanism.

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Table 1 Estimates of Kim, Morley and Nelson's (2004) Model [1,2]

$$r_t = \beta_1 E[\sigma^2_{e,t} \mid I_{t-1}] + \delta_1 \left(\sigma^2_{e,t} - E[\sigma^2_{e,t} \mid I_{t-1}]\right) + e_t,\ e_t \sim N(0, \sigma^2_{e,t}),$$
$$\sigma^2_{e,t} = \sigma^2_{e,0}\left(1 - S_{1,t}\right) + \sigma^2_{e,1} S_{1,t},$$
$$\Pr\left[S_{1,t} = 1 \mid S_{1,t-1} = 1\right] = p_1,\ \Pr\left[S_{1,t} = 0 \mid S_{1,t-1} = 0\right] = q_1.$$

Parameters	Estimates
β_1	0.033 (0.010)
$\sigma_{e,0}$	3.346 (0.115)
$\sigma_{e,1}$	5.950 (0.441)
p_1	0.882 (0.037)
q_1	0.978 (0.008)
Log Likelihood Value	-1592.674

Note: [1] Standard errors in parentheses. [2] $\delta_1 = -\beta_1 / (1 - \rho\lambda_1)$, $\lambda_1 = p_1 + q_1 - 1$, $\rho = 0.997$.

Table 2 Estimates of the Proposed Univariate Model [1,2]

$$
\begin{aligned}
r_t &= \beta_1 E[\sigma_{e,t}^2 \mid I_{t-1}] + \beta_2 E[\sigma_{v,t}^2 \mid I_{t-1}] \\
&\quad + \delta_1\left(\sigma_{e,t}^2 - E[\sigma_{e,t}^2 \mid I_{t-1}]\right) + \delta_2\left(\sigma_{v,t}^2 - E[\sigma_{v,t}^2 \mid I_{t-1}]\right) + \Delta z_t + e_t,\ e_t \sim N(0,\sigma_{e,t}^2),
\end{aligned}
$$

$$\sigma_{e,t}^2 = \sigma_{e,0}^2\left(1-S_{1,t}\right) + \sigma_{e,1}^2 S_{1,t},$$

$$\Pr\left[S_{1,t}=1 \mid S_{1,t-1}=1\right] = p_1,\ \Pr\left[S_{1,t}=0 \mid S_{1,t-1}=0\right] = q_1,$$

$$z_t = \tau S_{2,t} + \phi_1 z_{t-1} + \phi_2 z_{t-2} + v_t,\ v_t \sim N(0,\sigma_{v,t}^2),$$

$$\sigma_{v,t}^2 = \sigma_{v,0}^2\left(1-S_{2,t}\right) + \sigma_{v,1}^2 S_{2,t},$$

$$\Pr\left[S_{2,t}=1 \mid S_{2,t-1}=1\right] = p_2,\ \Pr\left[S_{2,t}=0 \mid S_{2,t-1}=0\right] = q_2.$$

Parameters	Column (1)	Column (2) [3]	Column (3) [4]
Fundamental Component of Stock Price			
β_1	0.097 (0.048)	0.069 (0.019)	0.049 (0.012)
β_2	-0.032 (0.038)	-	-
$\sigma_{e,0}$	2.358 (0.327)	2.534 (0.264)	3.142 (0.132)
$\sigma_{e,1}$	3.442 (0.468)	3.676 (0.402)	4.511 (0.355)
p_1	0.920 (0.021)	0.929 (0.018)	0.919 (0.022)
q_1	0.964 (0.010)	0.970 (0.006)	0.980 (0.007)
Transitory Component of Stock Price			
ϕ_1	0.647 (0.114)	0.641 (0.122)	0.849 (0.141)
ϕ_2	0.026 (0.069)	0.012 (0.064)	-0.134 (0.136)
τ	-6.577 (2.165)	-5.576 (2.431)	-6.995 (4.971)
$\sigma_{v,0}$	1.331 (0.430)	1.240 (0.532)	-
$\sigma_{v,1}$	5.177 (1.008)	5.253 (0.962)	6.320 (1.528)
p_2	0.606 (0.123)	0.640 (0.136)	0.562 (0.142)
q_2	0.950 (0.029)	0.964 (0.025)	0.981 (0.019)
Log Likelihood Value	-1554.053	-1554.426	-1555.903

Note: [1] Standard errors in parentheses. [2] $\delta_i = -\beta_i / (1-\rho\lambda_i)$, $\lambda_i = p_i + q_i - 1$, $\rho = 0.997$, $i = 1, 2$. [3] Column (2) is estimated under the null hypothesis of $H_0 : \beta_2 = 0$. [4] Column (3) is estimated under the null hypothesis of $H_0 : \beta_2 = 0$ and $\sigma_{v,0} = 0$.

Table 3 Estimates of the Proposed Bivariate Model [1,2]

$$
\begin{aligned}
r_t &= \beta_1 E[\sigma^2_{e,t} \mid I_{t-1}] + \beta_2 E[\sigma^2_{v,t} \mid I_{t-1}] \\
&\quad + \delta_1\left(\sigma^2_{e,t} - E[\sigma^2_{e,t} \mid I_{t-1}]\right) + \delta_2\left(\sigma^2_{v,t} - E[\sigma^2_{v,t} \mid I_{t-1}]\right) + \Delta z_t + e_t,\ e_t \sim N(0,\sigma^2_{e,t}),\\
\sigma^2_{e,t} &= \sigma^2_{e,0}\left(1-S_{1,t}\right) + \sigma^2_{e,1} S_{1,t},\\
&\Pr\left[S_{1,t}=1 \mid S_{1,t-1}=1\right] = p_1,\ \Pr\left[S_{1,t}=0 \mid S_{1,t-1}=0\right] = q_1,\\
z_t &= \tau S_{2,t} + \phi_1 z_{t-1} + \phi_2 z_{t-2} + v_t,\ v_t \sim N(0,\sigma^2_{v,t}),\\
\sigma^2_{v,t} &= \sigma^2_{v,0}\left(1-S_{2,t}\right) + \sigma^2_{v,1} S_{2,t},\\
&\Pr\left[S_{2,t}=1 \mid S_{2,t-1}=1\right] = p_2,\ \Pr\left[S_{2,t}=0 \mid S_{2,t-1}=0\right] = q_2,\\
y_t &= \mu_0\left(1-S_{1,t-1}\right) + \mu_1 S_{1,t-1} + \psi_1 y_{t-1} + \psi_2 y_{t-2} + u_t,\ u_t \sim N(0,\sigma^2_u).
\end{aligned}
$$

Parameters	Column (1)	Column (2) [3]	Column (3) [4]
Business Cycles Related Component of Stock Price			
β_1	0.038 (0.014)	0.051 (0.015)	0.048 (0.013)
β_2	0.062 (0.054)	-	-
$\sigma_{e,0}$	2.741 (0.380)	2.839 (0.410)	3.014 (0.178)
$\sigma_{e,1}$	4.531 (0.406)	4.517 (0.541)	4.690 (0.362)
p_1	0.917 (0.025)	0.906 (0.024)	0.907 (0.023)
q_1	0.983 (0.005)	0.978 (0.006)	0.979 (0.005)
Business Cycles Unrelated Component of Stock Price			
ϕ_1	0.715 (0.125)	0.775 (0.283)	0.829 (0.124)
ϕ_2	0.021 (0.087)	-0.060 (0.276)	-0.106 (0.124)
τ	-6.637 (4.937)	-3.904 (3.724)	-3.410 (1.990)
$\sigma_{v,0}$	1.569 (0.580)	1.054 (1.267)	-
$\sigma_{v,1}$	5.455 (1.779)	6.479 (1.380)	6.407 (1.401)
p_2	0.486 (0.048)	0.462 (0.307)	0.431 (0.143)
q_2	0.986 (0.011)	0.963 (0.041)	0.958 (0.032)
Log Likelihood Value	-1664.071	-1664.477	-1664.593

Note: [1] Standard errors in parentheses. [2] $\delta_i = -\beta_i/(1-\rho\lambda_i)$, $\lambda_i = p_i + q_i - 1$, $\rho = 0.997$, $i = 1,2$. [3] Column (2) is estimated under the null hypothesis of $H_0: \beta_2 = 0$. [4] Column (3) is estimated under the null hypothesis of $H_0: \beta_2 = 0$ and $\sigma_{v,0} = 0$.

Table 3 Estimates of the Proposed Bivariate Model (cont'd)

Parameters	Column (1)	Column (2)	Column (3)
Output Equation			
μ_0	0.203 (0.021)	0.200 (0.023)	0.198 (0.020)
μ_1	-0.118 (0.034)	-0.116 (0.033)	-0.112 (0.033)
ψ_1	0.071 (0.046)	0.075 (0.050)	0.079 (0.043)
ψ_2	0.187 (0.041)	0.190 (0.041)	0.193 (0.040)
$\sigma_{u,pre-1984}$	0.342 (0.015)	0.343 (0.015)	0.344 (0.015)
$\sigma_{u,post-1984}$	0.238 (0.010)	0.237 (0.010)	0.238 (0.010)
$\rho_{u,e}$	0.030 (0.057)	0.029 (0.080)	0.034 (0.049)

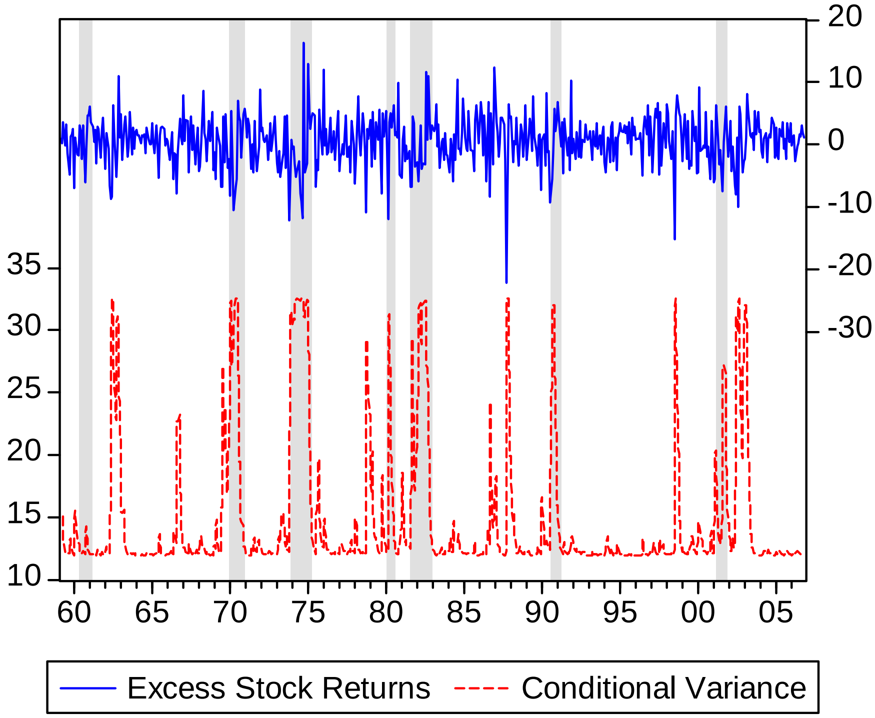

Figure 1.A Excess Stock Returns and Conditional Variance [Kim, Morley and Nelson's (2004) Model]

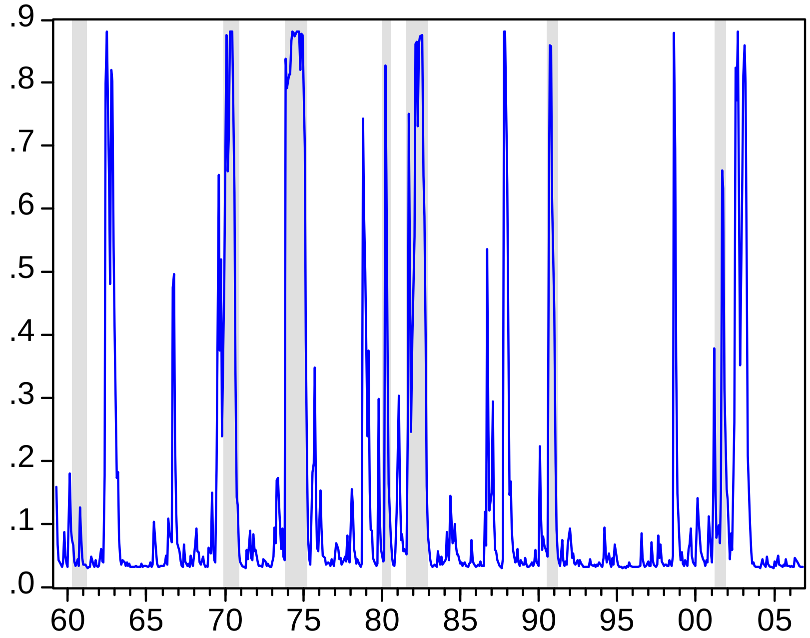

Figure 1.B Probability of a High Volatility Regime [Kim, Morley and Nelson's (2004) Model]

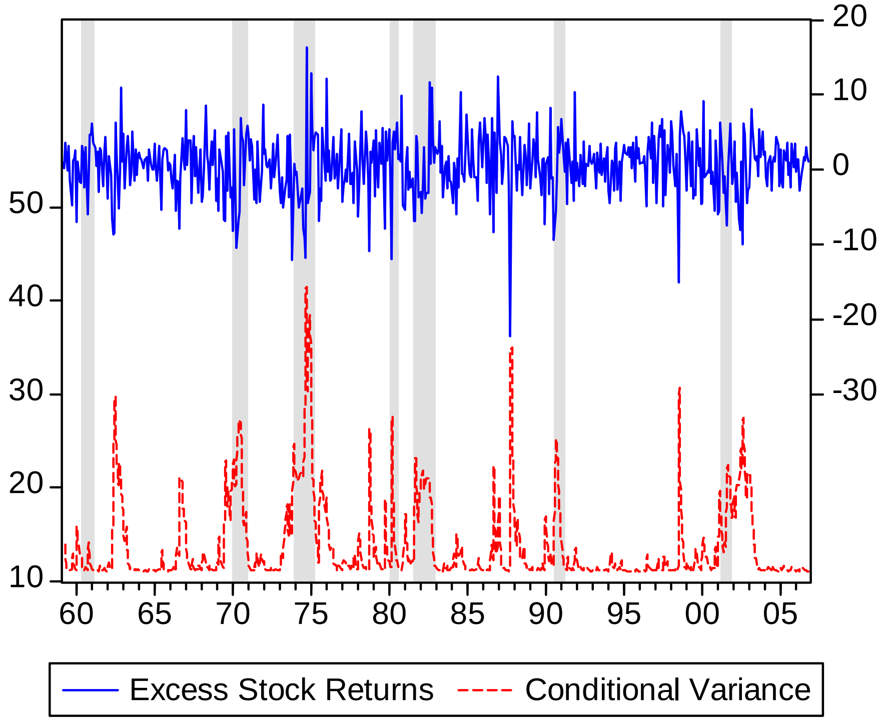

Figure 2.A Excess Stock Returns and Conditional Variance [Proposed Univariate Model]

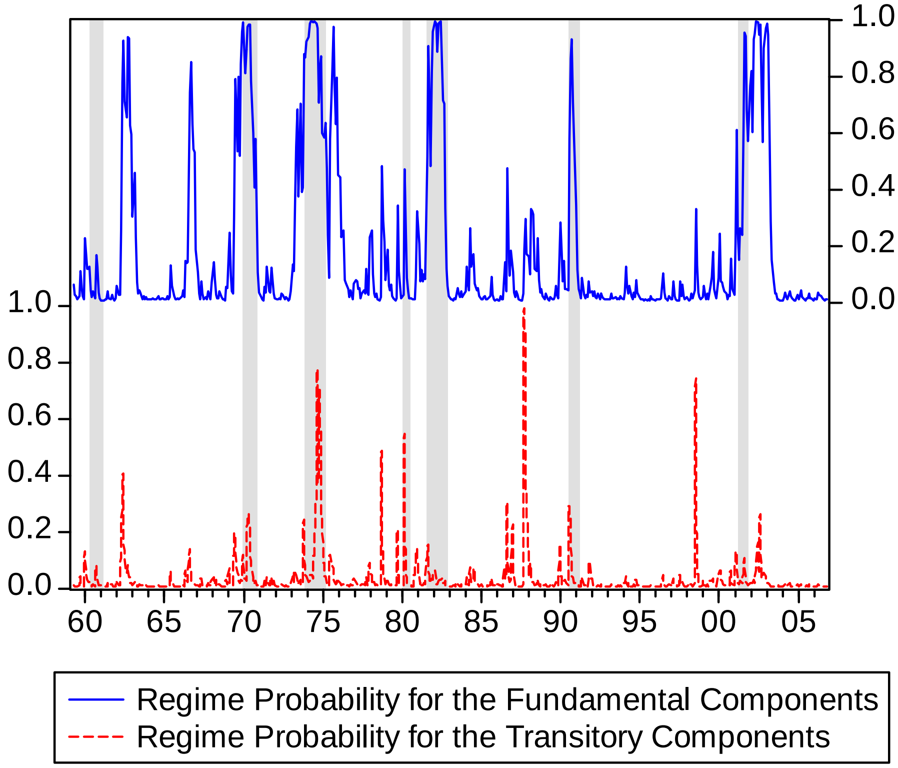

Figure 2.B Probability of a High Volatility Regime [Proposed Univariate Model]

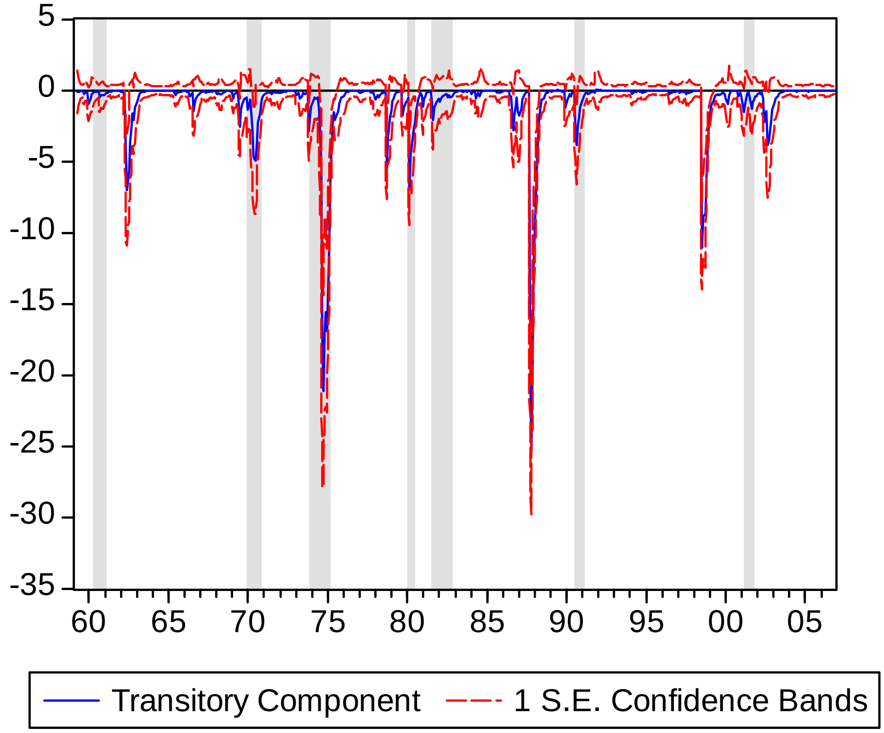

Figure 2.C Estimates of Transitory Component of Stock Price [Proposed Univariate Model]

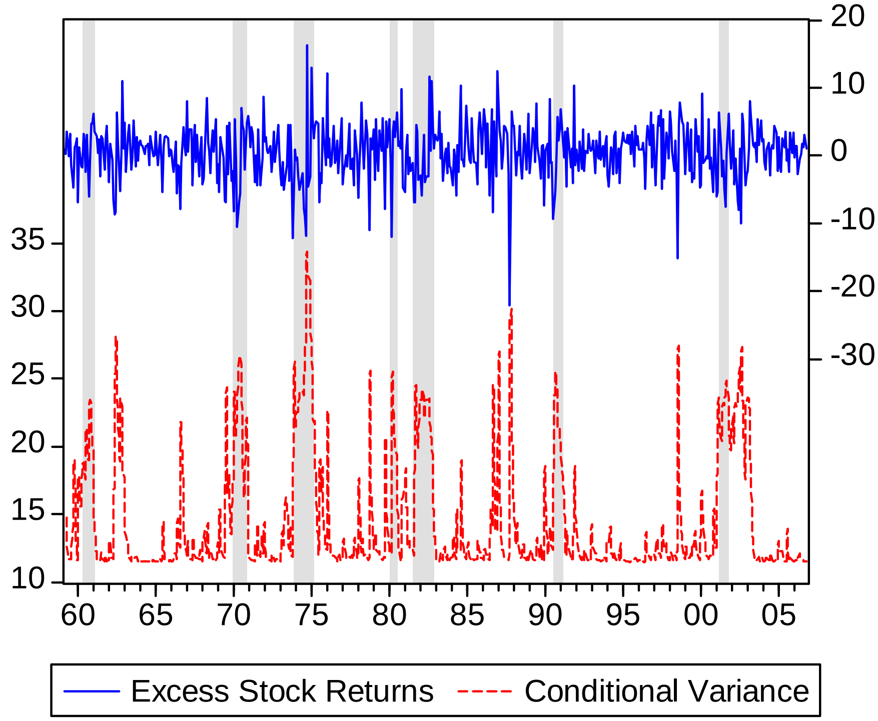

Figure 3.A Excess Stock Returns and Conditional Variance [Proposed Bivariate Model]

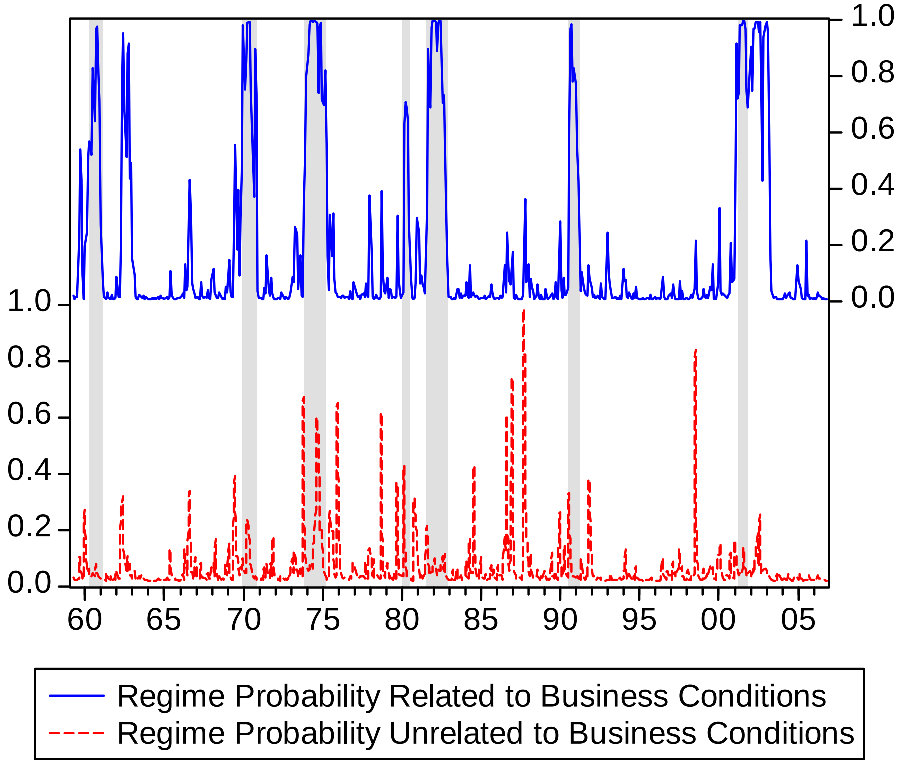

Figure 3.B Probability of a High Volatility Regime [Proposed Bivariate Model]

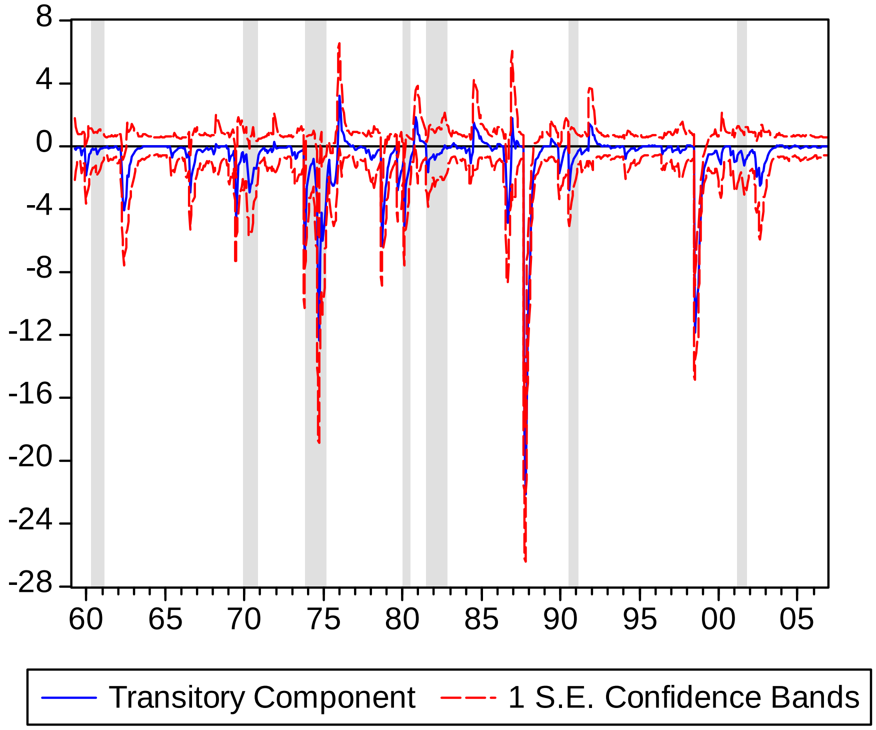

Figure 3.C Estimates of Business Cycles Unrelated Component of Stock Price
[Proposed Bivariate Model]