The effect of regime-switching volatility on the Equity Premium Puzzle

Abstract

We assess the role of regime-switching volatility on the presence of the equity premium puzzle. In particular, we investigate how this premium varies with the prevailing conditions in both financial markets and the macro economy. We measure the implied coefficient of relative risk aversion across high- and low-volatility states for both stock market returns and consumption growth. The relatively large numbers reported in the literature appear to be driven by extreme risk aversion during periods when we experience economic recession and bear stock markets simultaneously. On the other hand, bull markets are generally associated with lower levels of risk aversion.

Keywords: Equity premium puzzle; Market conditions; Regime switching.

JEL Classification: G10; C32

1. Introduction

Economists generally accept that, even after adjusting for risk, average stock returns are substantially higher than average returns on short-term debt instruments. The failure of financial theory to explain the magnitude of these excess returns has led to this phenomenon being labeled as the "equity premium puzzle" by Mehra and Prescott (1985). Standard asset pricing models can only match the data if investors are extremely risk averse. In particular, the coefficient of relative risk aversion must be implausibly large for traditional models to reconcile the large differential between real equity returns and real returns available on short-term debt instruments.[1] Of course, we expect different financial assets to deliver large variations in returns, but typically financial economists have explained such differentials by attributing them to differences among the covariances of asset returns and investors consumption, e.g. the Consumption Capital Asset Pricing Model of Lucas (1978) and Breeden (1979). The more traditional version of CAPM assumes a perfect correlation between the stock market return and the consumption path of the typical investor. This allows us to measure asset risk as its covariance with the market return. However, in their path breaking work, Mehra and Prescott (1985), using annual US data from 1889 to 1978, showed that the covariance of equity returns with consumption growth was insufficient to explain the observed equity premium of over 6%. In fact, they could only account for a premium of approximately 0.35%. Much of the resulting empirical literature has focused on the US markets where longer data series exist, but Campbell (1996, 2003) focuses on some smaller stock markets and finds evidence that an equity premium is also a feature of these markets.

Our analysis investigates the robustness of the equity premium across high- and low-volatility regimes for both stock market returns and consumption growth. The prevailing economic conditions can have a strong influence on stock market performance. Schwert (1989) finds increased volatility of equity returns during economic recessions, while Campbell et al. (2001) show that this result extends to more recent time periods. Lettau et al (2006) show that, at low frequency, the equity premium is related to macroeconomic risk, as measured by the volatility of consumption growth. Sill (2006)

[1] Kocherlakota (1996) and Mehra and Prescott (2003) provide excellent surveys of the topic.

develops a link between macroeconomic volatility and stock market returns. Given that there is substantial empirical evidence that both financial and economic markets are characterized by time-varying volatility, we argue that the risk aversion of investors may also vary across regimes and hence over time. Campbell and Cochrane (1999) find that the coefficient of risk aversion varies, in a nonlinear manner, with the state of surplus consumption. Many studies take long run averages that encompass differing market conditions and consequently the implied levels of risk aversion may hide important differences in risk attitudes across regimes. This is the area that we wish to address.

The paper is structured as follows. Section 2 presents the theoretical model, while our regime-switching econometric model is developed in Section 3. Section 4 discusses our data and results. Concluding remarks are contained in Section 5.

2. Measuring Risk Aversion and the Equity Premium

The equity premium puzzle can be presented in different ways. We adopt the approach of Campbell (1996, 2003) but allow both stock market returns and consumption growth to follow conditionally heteroskedastic processes. It is this time-variation in the conditional second-order moments that allow us to evaluate the effect of market conditions on the coefficient of relative risk aversion. We outline the key equations below. We start with a representative agent who maximizes a time-separable utility function:

$$Max E_t \sum_{j=0}^{\infty} d^{\,j} U(C_{t+j}), \tag{1}$$

$$\text{s.t. } W_{t+1} = (W_t - C_t)(1 + R_{p,t}) \tag{2}$$

where d is a discount factor, C_{t+j} is the investor's future consumption stream and $u(C_{t+j})$ is the period utility derived from such consumption. The budget constraint states that next period's wealth must be equal to current wealth less current consumption times the return on a portfolio of financial assets. This problem yields the following Euler equation to describe the optimal consumption and investment path of the investor;

$$U'(C_t) = dE_t[(1 + R_{i,t+1})U'(C_{t+1})] \tag{3}$$

with $1+R_{i,t+1}$ representing the gross rate of return available on asset i. The investor equates the loss in current consumption with the expected gain in discounted consumption next period.

We employ a time-separable power utility function:

$$Max\sum_{j=0}^{\infty} d^{\,j}\,\frac{C_{t+j}^{1-g}}{1-g} \tag{4}$$

where g is the coefficient of relative risk aversion. The features of this utility function are well known and its validity has been questioned in the literature. However, we retain this specification for two reasons. Firstly, it facilitates comparison with other studies, e.g. Campbell (1996, 2003). Secondly, Kocherlakota (1996) reports that modifications to preferences such as those proposed by Epstein and Zin (1991), habit formation due to Constantinides (1990) or "keeping up with the Joneses" as proposed by Abel (1990) fail to resolve the puzzle.

Combining equations (3) and (4), we get the familiar expression,

$$1=E_t\left[(1+R_{i,t+1})d\left(\frac{C_{t+1}}{C_t}\right)^{-g}\right]. \tag{5}$$

Following Campbell (1996), we assume that the joint conditional distribution of asset returns and consumption is lognormal, with time-varying volatility. Taking logs of equation (5), we get

$$0=E_t r_{i,t+1}+\log d-gE_t[\Delta c_{t+1}]+0.5(s_{it}^{2}+g^{2}s_{ct}^{2}-2g s_{i,ct}) \tag{6}$$

where $r_{i,t}=\log(1+R_{i,t})$, $c_t=\log(C_t)$, s_{it}^{2} and s_{ct}^{2} denote the conditional variance of log returns and log consumption growth respectively, and $s_{i,ct}$ represents their conditional covariance. The log risk premium is

$$E_t\left[r_{i,t+1}-r_{f,t+1}\right]+\frac{s_{it}^{2}}{2}=g s_{ict} \tag{7}$$

where the variance term on the left-hand side of equation (7) is Jensen's Inequality adjustment term due to using expectations of log returns. Therefore the log risk premium is a function of the coefficient of relative risk aversion multiplied by the covariance of stock returns with consumption growth.

3. **Econometric Model**

In this section, we present the empirical model employed to study the interdependence between returns in the stock market and consumption growth during both calm and turbulent periods. Let r_{1t} and r_{2t} represent the stock market return and consumption growth, respectively. These can be decomposed into an expected component, m_i, $i = 1,2$ and an unexpected shock, $u_{it}, i = 1,2$,

$$r_{it} = m_i + u_{it}, E(u_{it}) = 0, i = 1,2 \text{ and } E(u_{1t}, u_{2t}) \neq 0. \quad (8)$$

We allow the idiosyncratic shocks to returns and consumption growth, $z_{it}, i = 1,2$, to switch between two states – high- and low-volatility[2] and the impacts of these shocks on asset returns are measured by $s_{it}, i = 1,2$. Then the forecast errors are written as:

$$u_{it} = s_{it} z_{it}, i = 1,2. \quad (9)$$

Thus, the structural impact coefficients s_{it}, $i = 1,2$ are given by the following:

$$s_{it} = s_i(1 - S_{it}) + s_i^* S_{it}, \; i = 1,2 \quad (10)$$

where $S_{it} = (0,1), i = 1,2$ are state variables that take the value of zero in normal times and one in turbulent states. Variables with an asterisk belong to the high-volatility regime. To complete the model, we need to specify the evolution of regimes over time. Following the regime-switching literature, the regime paths are Markov switching and consequently are endogenously determined. Specifically, the conditional probabilities of remaining in the same state are defined as follows:

$$\begin{aligned} \Pr[S_{it} = 0 / S_{it} = 0] &= q_i, i = 1,2 \\ \Pr[S_{it} = 1 / S_{it} = 1] &= p_i, i = 1,2 \end{aligned} \quad (11)$$

The combination of S_{1t} and S_{2t} yields a new latent variable that takes four values:

$$S_t = 1 \text{ if } S_{1t} = 0 \text{ and } S_{2t} = 0$$

$$S_t = 2 \text{ if } S_{1t} = 0 \text{ and } S_{2t} = 1$$

$$S_t = 3 \text{ if } S_{1t} = 1 \text{ and } S_{2t} = 0$$

$$S_t = 4 \text{ if } S_{1t} = 1 \text{ and } S_{2t} = 1$$

[2]This heterogeneity in the heteroskedasticity of the idiosyncratic shocks ensures the identification of our system (see also Rigobon, 2003).

This latent variable determines the correlation between the shocks and switches in accordance with the transition through states of returns and consumption growth. For example, in the case that both returns and consumption are in the low-volatility regime (bull markets and economic boom), the covariance between the forecast errors is given by

$$Cov(u_{1t}, u_{2t}) = r_1 s_1 s_2$$

while when both are in the high-volatility regime (bear markets and economic recession):

$$Cov(u_{1t}, u_{2t}) = r_4 s_1^* s_2^*,$$

where ?i refers to the correlation coefficient between stock returns and consumption growth in state *i*.

It is the assumption of independence between states that significantly simplifies the 4X4 transition matrix, which is now the product of the probabilities that drive $S_{it}, i = 1,2$ and gives rise to four states of nature for the system as a whole.

Furthermore, we relax the assumption of constant expected returns in (8). Our specification allows returns and consumption to be time varying and dependent only on the state of the shock.[3] In this respect, our model suggests that part of the stock market return represents a risk premium that changes with the level of volatility. In particular, expected returns are modeled as follows:

$$m_{it} = m_i(1 - S_{it}) + m_i^* S_{it}, \; i = 1,2 \tag{12}$$

An additional assumption of normality of the structural shocks enables us to estimate the full model, given by equations (8)-(12), via maximum likelihood following the methodology for Markov-switching models described in Hamilton (1989).

4. Data and Empirical Results

4.1 Data

Our dataset comprises of postwar quarterly equity and macroeconomic data for the US. The source for equity data is the Center for Research in Security Prices (CRSP) at the University of Chicago and is based on the monthly CRSP NYSE/AMEX Value-weighted indices adjusted for dividends. Data on population, seasonally adjusted

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[3] Guidolin and Timmermann (2005) find, for UK assets, that returns are statistically different across regimes though Ang and Bekaert (2002) fail to reject the equality of mean returns between regimes for US equity.

aggregate consumption of non-durables and services in both current and constant prices are available at CITIBASE. Finally, CPI and 30-day T-bill rate comes from the CRSP Stocks, Bonds, Bills and Inflation (SBBI) file. To facilitate comparison, we use the dataset of Campbell (2003), which starts at 1947:2 and extends to 1998:4.[4]

4.2 Results

Table 1 reports estimates of our model parameters. There are a number of striking features.

[TABLE 1 ABOUT HERE]

Firstly, with respect to the stock market, bull markets are predominantly characterized by positive mean returns of around 3.1% per quarter and low volatility, while bear markets exhibit large negative returns with more than twice the volatility of the bull market. This observation is consistent with the well documented 'leverage effect', whereby a fall in stock prices increases the proportion of debt funding in the firm, resulting in more risky equity (see Black, 1976; Bae et al., 2007 amongst others). Likewise we capture the asymmetric effects of positive and negative shocks with the standard deviation of the high volatility regime (associated with negative shocks) being more the double than its counterpart in the low-volatility regime (associated with positive shocks). Therefore a feature of equity returns is that crisis (or turbulent) periods generate negative returns to investors and increased uncertainty. Secondly, we calculate the unconditional probability of the series being in each of the regimes using the formula $(1-p) / (2-p-q)$, where p, q are the probabilities that the respective regime will prevail over two consecutive periods, i.e. the transition probability from say the high volatility regime to the same regime[5]. As we can see, the high volatility regime prevails for only 12% of the time and lasts on average 1.2 quarters[6]. On the other hand, tranquil markets are much more persistent with an average span in excess of 2 years.

[4] Data are downloadable from http://kuznets.fas.harvard.edu/~campbell/data/newdata.zip
[5] The subscript is dropped for notational simplicity.
[6] The duration that gives the length of time that a regime persists is calculated by the formula Duration = $1/(1-p)$.

With consumption growth, a similar pattern emerges. Specifically, we find two distinct regimes,[7] one corresponding to increased growth (boom) and the other to economic recession. Similar to stock market behavior, the recession regime exhibits higher volatility, due to increased uncertainty over the future path of economic growth. Within episodes of economic expansion, uncertainty is reduced. Approximately, 64% of the sample is associated with economic boom, with the remainder being in the high-volatility, low-growth regime. Compared to the stock market, economic conditions are more persistent. Recessions are of shorter duration than booms (7.4 versus 13 quarters) but each regime endures for longer than its counterpart in the financial market.

[FIGURES 1 & 2 ABOUT HERE]

Figure 1 presents the estimated filtered probabilities of being in the high-volatility regime for both stock returns and consumption growth. This corresponds to the bear state for equity returns and to recession for the economic growth measure. The stock market spends a relatively small fraction of time in this bear state. Consistent with Table 1, we see that such states do not persist for very long. In contrast, economic recessions tend to be more persistent. The timing of recessions implied are broadly consistent with the business cycle data supplied by the NBER, even if our model suggests more prolonged periods of recession, particularly in the early 1980's. Both the 69-70 and 73-75 recessions are well captured. Similarly, the boom years of the mid-1990s are also in clear evidence.

Figure 2 presents the conditional volatilities of stock market returns and consumption growth as well as the conditional correlation between the two series. As expected both series exhibit periods of high, sustained volatility. Stock market returns are relatively more volatile. We can clearly see bear markets in the mid-1970s and in the aftermath of the 1987 crash, while more recent years coinciding with the 1990's bull market appear more tranquil. The conditional volatility of consumption is lower but more persistent. As usual, the periods of high volatility coincide with economic downturns. The conditional correlation between the two series exhibits considerable time variation and moves in relation to the conditions (states) that prevail in the financial and / or economic markets at a particular time. It is most often in the 0.7-0.8 range but declines during periods of high volatility. Stock market shocks eclipse those of the macro

[7] Lettau et al. (2006) also use two regimes to model consumption growth.

economy to such an extent that large equity return movements reduce the degree of co-movement. When stock prices fall, the disconnect with consumption growth may be due to investors fleeing to other safer assets such as government bonds or gold, while using other savings the buffer consumption during what we have seen are relatively short-lived but steep drops in equity returns. This finding is consistent with the 'composition effect' of Duffee (2005) who shows that the covariance between stock returns and consumption growth is procyclical. In particular, he shows that rising stock prices increase the relative contribution of stock market wealth to total wealth and therefore has a larger effect on consumption volatility.

4.3 Implications for the equity premium puzzle

Our hypothesis is that investors' attitude to risk may be influenced by the prevailing conditions in both stock markets and the macro economy. We investigate this conjecture based on the application of equation (7), where ? is also allowed to vary across regimes and hence over time. Figure 2 presents the inputs required to compute the coefficient of risk aversion.

Given that excess returns are almost unpredictable, we use the long-run mean as our expected return in equation (6).[8] On the other hand, there is substantial evidence that the covariance matrix of excess returns is predictable and persistent (see Bollerslev et al., 1988 *inter alia*). Therefore, the other inputs are directly estimated in the model. Results are reported in Table 2. The first row presents the results ignoring regime shifts. As usually found, the estimated coefficient of relative risk aversion is much larger than suggested by economic theory (see also Campbell 1996, 2003).[9] Consequently, this is often interpreted as an equity premium puzzle. However, accounting for regime switching in both stock market and economic volatility gives us a key insight into what is driving this result. Taking account of regimes, estimates of the risk aversion parameter are considerably reduced in certain combinations of market conditions. When stock

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[8] This approach has been advocated by Jobson and Korkie (1981), amongst others, in relation to the application of Modern Portfolio Theory.

[9] Mehra and Prescott (1985) impose an upper limit of 10 on 'reasonable' values of the coefficient of RRA. However, others such as Kandel and Stambaugh (1991) argue that this parameter could be much higher (up to 30) in financial markets and still imply reasonable economic behaviour.

market conditions are good, investors are more tolerant of risk, regardless of economic conditions. With already high stock market growth, financial market participants are more ready to accept a bet on the stock market. The estimated risk aversion parameters are 141 and 70 for booms and recessions, respectively. Interestingly, when faced with rising stock markets and an economic downturn, investors are more willing to accept risk. This results from the larger correlation between equity returns and consumption growth in this regime, whereby changes to consumption are more closely linked to stock market wealth than in the case where we have economic boom coincident with bull markets. While still outside the economically accepted range, these numbers certainly move the relative risk parameter in the right direction.

However, when the stock market experiences an episode of high volatility, the story is markedly different. When we have 'bear' stock markets, the risk aversion exhibited by individuals is always above the long-run average. Turbulent stock markets combined with favorable economic conditions, increase the investors' level of risk aversion to 382. The most striking result is realized when we simultaneously experience downturns in the financial markets and the macro economy. In this scenario, agents become extremely risk averse and our estimated coefficient increases to over 1145. In essence, this tells us that when individuals already have low consumption growth and are faced with highly volatile bear stock markets, they will not invest in risky assets unless they receive very large compensation. The level of risk aversion displayed in this case implies that individuals with low and uncertain incomes are extremely unlikely to invest in equity markets. When consumption is low, they are likely to seek more stable investment opportunities such as government bonds. These results may not resolve the equity premium puzzle but they highlight the driving factors behind the large risk aversion parameter reported in Campbell (1996, 2003).

We repeat the analysis for the hypothetical situation where the correlation between stock returns and consumption growth is unity. This is done for two reasons. Firstly, it is the correlation implied by the C-CAPM and secondly, it gives the model the best chance of explaining the premium in all regime combinations. The final column of Table 2 presents our results. The estimated coefficients are further reduced but still higher than that usually determined as being economically plausible. However, it shows that the extreme risk aversion displayed in the actual data during economic downturns and periods of stock market volatility is driven mainly by an almost complete dis-connect between stock returns and consumption in this state of the world due to consumption smoothing on behalf of economic agents.

Figure 3 presents a time-varying measure of the coefficient of relative risk aversion. It is computed as a weighted average of the estimated coefficients within each regime, where the weights are the probabilities of being in a particular state at each point in time. There is significant time variation even though the graph is dominated by a period of extreme risk aversion in the mid-60s and another around the 1987 stock market crash. We can see a number of spikes when economic and stock market conditions were jointly in depression and combined to make investors extremely intolerant of risk. In general, risk aversion moves more closely with stock market rather than economic conditions (see Figures 1 and 3). The extent of the time variation should caution against using long-run averages of the parameter as a test of whether or not models adequately capture economic behavior. Panel B depicts the time variation of the parameter under the assumption that stock returns and consumption growth are perfectly correlated. The range of movement is considerably dampened but still exhibits significant variation over time. However, the time variation is no longer closely related to the probability of experiencing high volatility in the stock market. Therefore the relative poor performance of models to match actual real world data appears to be attributable to the weak relationship between financial market returns and consumption. This, of course, is consistent with the notion of consumption smoothing and spreading of risk across states of the world that is standard in the financial economics literature.

5. Conclusions

We re-investigate the presence of an equity premium puzzle in the US stock market. Our approach allows for regime switches in both the volatility of stock market returns and consumption growth. We find that the equity premium puzzle commonly found by traditional tests is driven by periods of extreme risk aversion associated with simultaneous economic and financial market downturns. Low consumption growth tends to increase investors' risk aversion regardless of stock market conditions. While our analysis does not resolve the equity premium puzzle, it emphasizes the importance of properly accounting for time-varying second-order moments. Market conditions influence the risk attitudes of market participants. Imposing perfect correlation between stock market returns and consumption gives us a key insight into the source of asset pricing models failure to match actual data. It appears to be driven by investors' penchant for consumption smoothing and risk-sharing across states of the world.

References

Abel, A.B., 1990. Asset Prices under Habit Formation and Catching up with the Joneses. American Economic Review, 80, 38-42.

Ang, A., Bekaert, G., 2002. International asset allocation with regime shifts. Review of Financial studies, 15, 1137-1187.

Bae, J., Kim, C-J., Nelson, C.R., 2007. Why are stock returns and volatility negatively correlated. Journal of Empirical Finance, 14, 41-58.

Black, F., 1976. Studies of stock price volatility changes. Proceedings of the Meetings of the American Statistical Association, Business and Economics Statistics Division, 177-181.

Bollerslev, T., Engle, R.F., Wooldridge, J.M., 1988. A capital asset pricing model with time-varying covariances. Journal of Political Economy, 96, 116-131.

Breeden, D.T., 1979. An Intertemporal Asset Pricing Model with Stochastic Consumption and Investment Opportunities. Journal of Financial Economics, 7, 265-296.

Campbell, J.Y., 1996. Consumption and the Stock Market: Interpreting International Experience. Swedish Economic Policy Review, 3, 251-299.

Campbell, J.Y., 2003. Consumption-Based Asset Pricing, *Handbook of the Economics of Finance*, George Constantinides, Milton Harris, and Rene Stulz eds., North-Holland, Amsterdam, Vol 1B, 803-887.

Campbell, J.Y., Cochrane, J.H., 1999. By force of habit: A consumption-based explanation of aggregate stock market behavior. Journal of Political Economy, 107 (2), 205-251.

Campbell, J.Y., Lettau, M., Malkiel, B.G., Xu, Y., 2001. Have individual stocks become more volatile? An empirical exploration of idiosyncratic risk. Journal of Finance, 56 (1), 1-43.

Constantinides, G., 1990. Habit Formation: A Resolution to the Equity Premium Puzzle. Journal of Political Economy, 98, 519-543.

Duffee, G.R., 2005. Time variation in the covariance between stock returns and consumption growth. Journal of Finance, 60 (4), 1673-1712.

Epstein, L., Zin, S.E., 1991. Substitution, Risk Aversion and the Temporal Behaviour of Consumption Growth and Asset Returns: An Empirical Investigation. Journal of Political Economy, 99, 263-286.

Guidolin, M., Timmermann, A., 2005. Economic implications of bull and bear regimes in UK stock and bond returns, Economic Journal, 115, 111-143.

Hamilton, J.D., 1989. A new approach to the economic analysis of nonstationary time series and the business cycle, Econometrica, 57, 357-384.

Jobson, J.D. Korkie, B., 1981. Putting Markowitz Theory to Work. Journal of Portfolio Management, 70-74.

Kandel, S., Stambaugh, R.F., 1991. Asset returns and intertemporal preferences. *Journal of Monetary Economics*, 27, 39-71.

Kocherlakota, N.R., 1996. The Equity Premium: It's still a Puzzle. Journal of Economic Literature, 34, 42-71.

Lettau, M., Ludvigson, S., Wachter, J., 2006. The declining equity premium: what role does macroeconomic risk play? Review of Financial Studies, forthcoming.

Lucas, R., 1978. Asset Prices in an Exchange Economy. Econometrica, 46, 1429-1445.

Mehra, R. Prescott, E., 1985. The Equity Premium: A Puzzle. Journal of Monetary Economics, 15, 145-161.

Mehra, R. Prescott, E., 2003. The equity premium in retrospect. NBER working paper 9525.

Rigobon, R., 2003. Identification through heteroskedasticity. The Review of Economics and Statistics, 85(4), 777-792.

Schwert, G. W., 1989. Why does stock market volatility change over time? Journal of Finance, 44 (5), 1115-1153 .

Sill, K., 2006. Macroeconomic volatility and the equity premium. Federal Reserve Bank of Philadelphia, working paper no. 06-1.

Table 1: Model estimates

Means	μ_1	μ^*_1	μ_2	μ^*_2
	3.122	-9.272	0.634	0.254
	(0.580)	(4.376)	(0.059)	(0.136)
Standard Deviations	s_1	s_1^*	s_2	s_2^*
	5.871	12.259	0.359	0.680
	(0.449)	(2.751)	(0.042)	(0.090)
Unconditional Probabilities	Q_1	Q_2	P_1	P_2
	88.44%	11.56%	63.84%	36.16%
Duration	9.1	1.2	13.0	7.4
Correlations	r_1	r_2	r_3	r_4
	0.709	0.749	0.125	0.022
	(0.271)	(0.259)	(0.126)	(0.014)

Notes: Standard errors in parentheses below coefficients.

Means:

μ_1 (μ_1*) refers to the realised mean return in the bull (bear) market, while μ_2 (μ_2*) refers to the realised mean growth rate of consumption in the economic boom (recession) state.

Standard Deviations:

s_1 (s_1*) refers to the realised standard deviation of return in the bull (bear) market, while s_2 (s_2*) refers to the realised standard deviation of consumption growth in the economic boom (recession) state.

Unconditional Probabilities and Duration:

Q_1 and Q_2 (P_1 and P_2) tell us the proportion of time that the stock market (consumption growth) is in the bear and bull state (economic boom and recession state) respectively. The Duration statistic tells us the average length of time (in quarters) for which a given regime prevails.

Correlations:

? refers to the correlation in each state. The states are:

1. Bull stock market and economic boom; 2. Bull stock market and economic recession;

3. Bear stock market and economic boom; and 4. Bear stock market and economic recession.

Table 2: Estimated coefficients of risk aversion

	Risk Premium	$r_{i,c}$	s_i	s_c	g_1	g_2
No regimes	8.399	0.206	15.631	1.073	242.29	50.04
Bull - Boom	8.399	0.709	11.742	0.717	140.55	99.65
Bull - Recession	8.399	0.749	11.742	1.359	70.19	52.57
Bear - Boom	8.399	0.125	24.518	0.717	381.79	47.72
Bear - Recession	8.399	0.022	24.518	1.359	1144.51	25.18

Notes: Numbers are annualized. g_1 is the coefficient of relative risk aversion implied by the estimated parameters using equation (7). g_2 is computed as if the actual correlation between stock market returns and consumption growth were unity.

Figure 1. Probability of returns and consumption being in the second regime

(Bear market, Economic recession)

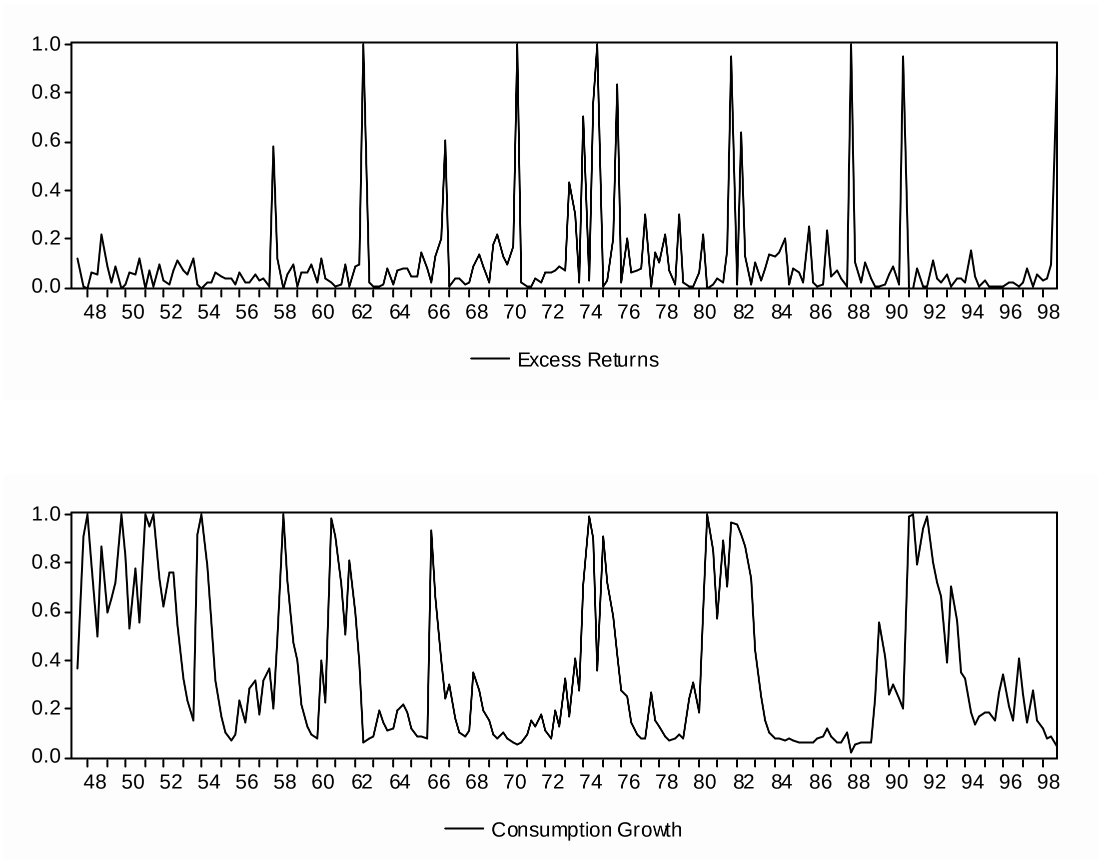

Figure 2. Conditional standard deviation and correlation of excess returns and consumption growth

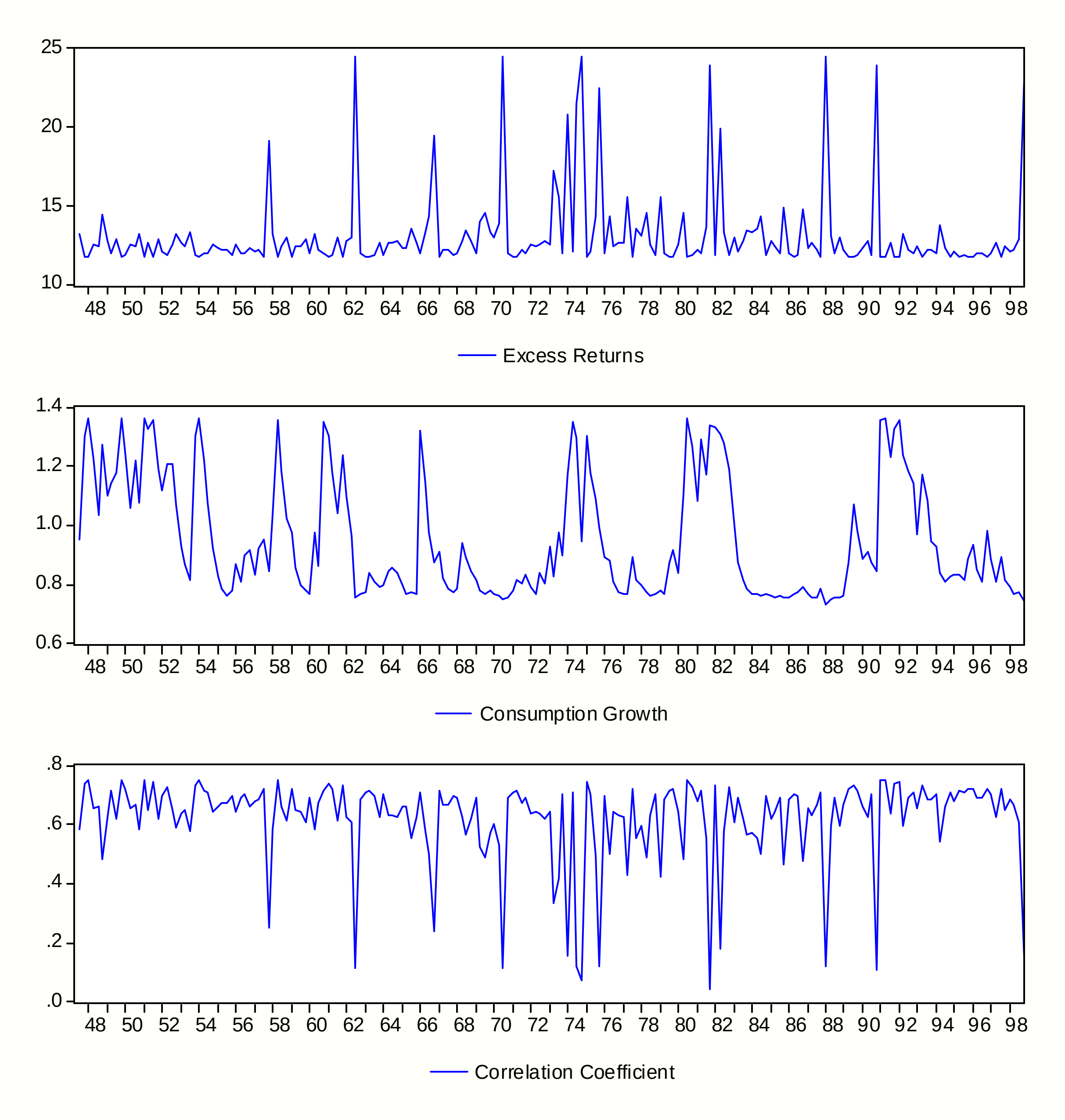

Figure 3. Conditional coefficient of relative risk aversion