**CRANFIELD UNIVERSITY**

**Pankaj Avinash Chandorkar**

# The Determinants of UK Equity Risk Premium

**Cranfield School of Management**
**Doctoral Program**

Submitted for the degree of Doctor of Philosophy
Academic Year: 2013 - 2016

Supervisor: Professor Sunil S. Poshakwale
October 2016

# CRANFIELD UNIVERSITY

Cranfield School of Management
Doctoral Program

**PhD Thesis**

Academic Year 2013 – 2016

**Pankaj Avinash Chandorkar**

# The Determinants of UK Equity Risk Premium

**Supervisor: Professor Sunil S. Poshakwale**
October 2016

This thesis is submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy
***(NB. This section can be removed if the award of the degree is based solely on examination of the thesis)***

# ABSTRACT

Equity Risk Premium (ERP) is the cornerstone in Financial Economics. It is a basic requirement in stock valuation, evaluation of portfolio performance and asset allocation. For the last decades, several studies have attempted to investigate the relationship between macroeconomic drivers of ERP. In this work, I empirically investigate the macroeconomic determinants of UK ERP. For this I parsimoniously cover a large body of literature stemming from ERP puzzle. I motivate the empirical investigation based on three mutually exclusive theoretical lenses. The thesis is organised in the journal paper format.

In the first paper I review the literature on ERP over the past twenty-eight years. In particular, the aim of the paper is three fold. First, to review the methods and techniques, proposed by the literature to estimate ERP. Second, to review the literature that attempts to resolve the ERP puzzle, first coined by Mehra and Prescott (1985), by exploring five different types of modifications to the standard utility framework. And third, to review the literature that investigates and develops relationship between ERP and various macroeconomic and market factors in domestic and international context. I find that ERP puzzle is still a puzzle, within the universe of standard power utility framework and Consumption Capital Asset Pricing Model, a conclusion which is in line with Kocherlakota (1996) and Mehra (2003).

In the second paper, I investigate the impact of structural monetary policy shocks on ex-post ERP. More specifically, the aim of this paper is to investigate the whether the response of UK ERP is different to the structural monetary policy shocks, before and after the implementation of Quantitative Easing in the UK. I find that monetary policy shocks negatively affect the ERP at aggregate level. However, at the sectoral level, the magnitude of the response is heterogeneous. Further, monetary policy shocks have a significant negative (positive) impact on the ERP before (after) the implementation of Quantitative Easing (QE). The empirical evidence provided in the paper sheds light on the equity market's asymmetric response to the Bank of England's monetary policy before and after the monetary stimulus.

In the third paper I examine the impact of aggregate and disaggregate consumption shocks on the ex-post ERP of various FTSE indices and the 25 Fama-French style value-weighted portfolios, constructed on the basis of size and book-to-market characteristics. I extract consumption shocks using Structural Vector Autoregression (SVAR) and investigate its time-series and cross-sectional implications for ERP in the UK. These structural consumption shocks represent deviation of agent's actual consumption path from its theoretically expected path. Aggregate consumption shocks seem to explain significant time variation in the ERP. At disaggregated level, when the actual consumption is less than expected, the ERP rises. Durable and Semi-durable consumption shocks have a greater impact on the ERP than non-durable consumption shocks.

In the fourth and final paper I investigate the impact of short and long term market implied volatility on the UK ERP. I also examine the pricing implications of innovations to short and long term implied market volatility in the cross-section of stocks returns. I find that both the short and the long term implied volatility have significant negative impact on the aggregate ERP, while at sectoral level the impact is heterogeneous. I find both short and long term volatility is priced negatively indicating that (i) investors care both short and long term market implied volatility (ii) investors are ready to pay for insurance against these risks.

Keywords:

Structural VAR, Consumption-CAPM, Monetary Policy, Stock Returns, Implied Volatility, Quantitative Easing, Bank of England, interest rate shocks, dis-aggregated consumption.

To my dear parents, Mr Avinash Chandorkar and Mrs Smita Chandorkar

# ACKNOWLEDGEMENTS

I would like to take this opportunity to acknowledge and appreciate the help provided many people without whom it would have been impossible to complete this research. First of all, I would like to thank my supervisor Professor Sunil Poshakwale. I consider myself to be very lucky to have him as my supervisor. I especially appreciate the pain he undertook in guiding me through this research journey. Without his critical feedbacks, it would have been impossible to conduct this research.

Second, I would like to extend my deepest appreciation to my panel members Dr Vineet Agarwal and Professor Huainan Zhao. Dr Vineet's critical feedback and eye for details helped me achieve a balance between theory and practice. I especially would like to thank Dr Vineet, for the long critical and insightful discussions.

Thirdly, I would like to specially thank Ms Tracey Nunn for helping me getting the data and the associated explanations from DataStream. Special thanks to Ms Mary Betts-Gray for helping me to develop the search strings and searching the journal articles from various databases. Special thanks to the staff at management research office for their administrative support.

Fourth, special thanks to my colleagues, especially, to Dr Anandadeep Mandal, Dr Katharina Windler, Dr Tahiru A. Liedong and Mrs Roxanne Kutzer who supported me morally during my PhD journey and motivated me whenever I was feeling low during the research process.

And last, but certainly not the least, I would like to thank my mother Mrs Smita Chandorkar and my father Mr Avinash Chandorkar, for their unconditional support and love.

# TABLE OF CONTENTS

# LIST OF FIGURES

# LIST OF TABLES

# LIST OF ABBREVIATIONS

| | |
|---|---|
| AR | Auto Regressive |
| ARCH | Autoregressive Conditional Heteroscedasticity |
| ARIMA | Autoregressive Integrated Moving Average |
| BOE | Bank of England |
| CAPM | Capital Asset Pricing Model |
| CCAPM | Consumption-based Capital Asset pricing Model |
| ERP | Equity Risk Premium |
| FED | Federal Reserve Bank |
| FTSE | Financial Times Stock Exchange |
| GARCH | Generalised Autoregressive Conditional Heteroscedasticity |
| ICAPM | Inter-temporal Capital Asset Pricing Model |
| IMRS | Inter-temporal Marginal Rate of Substitution |
| LTCM | Long Term Capital Management |
| MLE | Maximum Likelihood |
| MRS | Marginal Rate of Substitution |
| MSCI | Morgan Stanley Capital Index |
| NYSE | New York Stock Exchange |
| OECD | Organisation of Economic Co-operation and Development |
| OLS | Ordinary Least Square |
| QE | Quantitative Easing |
| RRA | Relative Risk Aversion |
| SDF | Stochastic Discount Factor |
| SVAR | Structural Vector Auto-regression |
| VAR | Vector Autoregression |

# 1 Introduction

The Equity Risk Premium (ERP), the difference between expected return on stocks or portfolio of stocks and a risk-free asset, is one of the most important cornerstones in Financial Economics. Over the past three decades, ERP has attracted the attention of policy makers, academics and practioners. ERP was central point of debate amongst the policy makers during the early part of 2000s when they were debating whether to invest social security funds in equity markets (Fama and French, 2002). For practioners, an estimate of ERP is critical when they make the portfolio allocation decisions, estimate the cost of capital and evaluate the performance of Exchange Traded Pooled-investment products. The academic interest on ERP received a huge momentum since the discovery of the famous "ERP Puzzle" in 1985 by Rajnish Mehra and Edward Prescott. Perhaps, the importance of ERP cannot be summarised more subtly than by the following quote *"The equity risk premium determines asset allocation, projections of wealth, and the cost of capital, but we do not have simple model that explains the premium"* (Siegel 2005, p.1). Furthermore, within the general equilibrium framework, asset pricing can be treated as a problem of determining the size of the expected ERP. As such the identification of factors determining the ERP ought to be important not only to practioners and policy makers but also for the macroeconomist, who study the implications of policy effects on macroeconomy through asset markets. Against this backdrop, the objective of this thesis is to empirically investigate the determinants of the UK ERP. This may help financial theorists to develop a general equilibrium model that can explain the variation and the level of ERP.

## 1.1 Thesis Structure

The thesis is organised in the research paper format. Each chapter is arranged in the form of a journal article. Table 1.1 describes the structure of thesis concisely. The objective of the first paper, “Literature Review”, is to critically evaluate the literature on ERP. It primarily surveys the literature that arises due the ERP puzzle. However, I do not limit only to the literature that stems from the ERP puzzle. I also cover the literature on various techniques of estimation of ERP. Apart from reviewing the literature, paper 1 discusses the ERP puzzle, in depth, in order to cover the theoretical background and sets the scene for understanding why it is interesting and essential to conduct a research on ERP.

The objective of Paper 2 is to understand the impact of UK monetary policy actions on the ERP. In particular, I assess the impact of monetary policy shocks on ERP, before and after the Quantitative Easing (QE)

In paper 3, I investigate the impact of aggregate and dis-aggregate personal consumption shocks on the UK ERP. The theoretical foundation for this paper is the Consumption-based Capital Asset Pricing Model (CCAPM) which I discuss in Paper 1 as well as in paper 3. Finally, Paper 4 examines the impact of short and long term implied market volatility on the UK ERP. The main message of Paper 4 is that the short and long term market implied volatility are one of the determinants of UK ERP and it is critical in pricing risky assets in the UK.

**Table 1.1: Thesis Structure**

| Paper | Title | Dissemination | Intended Contribution |
|---|---|---|---|
| 1 | Literature Review | | The aim of this chapter is to present an introduction and key debates in the literature regarding ERP. Also this chapter will discuss why is it necessary and interesting to do research in ERP |
| 2 | The impact of monetary policy shocks on the Equity Risk Premium before and after the Quantitative Easing in the United Kingdom | Published in the Investment Management and Financial Innovations | The contribution of this paper is to show how monetary policy shocks asymmetrically drive UK ERP before and after the implementation of QE programme in the UK. |
| 3 | The impact of aggregate and dis-aggregate consumption shocks on the UK ERP | This paper was presented at PhD Conference in Monetary and Financial Economics on 27th June 2016 held at UWE Bristol. The conference was supported by Royal Economic Society | The contribution of the paper is to provide evidence that not only the aggregate consumption shocks, but also disaggregate personal consumption shocks (durable, semi-durable and non-durable) drives UK ERP. |
| 4 | The impact of short and long term market implied volatility on the UK Equity Risk Premium. | Under review at The European Journal of Finance | The contribution of this paper is to show that innovations is short and long term market implied volatility help explain the UK ERP and act as a cross-sectional asset pricing factors. |
| | Discussion and contribution | | This section will link the results from different papers to deliver a coherent output of the work. |

Each paper contains related literature, methodology, results and discussion of key findings. Although, each paper is free-standing, in the sense they investigate the impact of different drivers of the ERP, yet all are related to the examination of the determinants of UK ERP. Thus, the contribution of the thesis can be viewed as a collection of contributions of each empirical paper.

The reason for adopting this structure rather than the traditional PhD thesis structure is that it offers number of advantages. First, each paper looks at UK ERP through different theoretical lens thus helping to contribute to the respective theoretical framework. Second, I gained a valuable experience in writing academic article in clear and concise fashion, a skill which is necessary for my future academic career. Third, this structure allows having a ready-made bank of manuscripts for submission to academic journals. Finally, and importantly, organising the thesis in this format is simple.

## 1.2 The notable elements and key findings

This thesis has number of notable features. In this work I examine the behaviour of the UK ERP based on three different theoretical foundations. This approach enables us to get three different, mutually supportive perspectives on the ERP. Additionally, I examine the response of ERP at both aggregate and industry level. At aggregate level I study ERP of the FTSE 100 and FTSE 250 index. At sectoral level I study the ERP of ten most widely followed FTSE All share industries in the UK. These include Basic Materials, Consumer Goods, Consumer Services, Financials, Industrials, Healthcare, Utilities, Oil and Gas, Technology and Telecommunications. Moreover, I examine the response the cross-sectional ERP of the 25 value-weighted Fama-French style portfolios sorted on size and book-to-market characteristics. This is primarily because of two reasons; (i) Investigating the response of the excess returns of these 25 size and book-to-market based portfolios is conventional in asset pricing literature and (ii) Contrary to studying the ERP of aggregate and sectoral portfolios, which capture sectoral differences, the ERP of these 25 size/book-to-market portfolio capture differences based on firm characteristics such size and book-to-market ratios which are not captured by the FTSE portfolios. As such, this enables to understand the cross-sectional asset pricing implications of the factors that I propose in the three empirical papers. The key findings of this research is as follows,

1) In the first paper I review the literature of ERP. I classify the review in four major categories. (i) A review of different techniques of estimating ERP. (ii) The literature that attempts to explain/solve the ERP puzzle using five different schools of thought namely, Habit Formation, Rare Disaster Events, Behavioural Finance, Incomplete Markets and Recursive Utility models. (iii) The literature identifying the factors that can affect ERP using linear factor models, both in domestic and international context. The key findings of this review are as follows (a) Although there is a substantial improvement in canonical CCAPM, the literature has failed to explain/solve the ERP puzzle. That is, the literature in limited in explaining why the observed ERP is inconsistent with the ERP implied by canonical CCAPM using theoretically reasonable preference parameters. (b) Although, in theory, ERP is a simple concept to estimate, yet different articles employ different estimation techniques with mixed results. (c) There are few studies which examine the interaction between monetary policy and ERP. However, there are virtually no studies that examine the impact of unconventional monetary policy (such as Quantitative Easing) on the ERP. Moreover, such studies are absent in the UK context.
2) Following above research gap, in the second paper I examine the impact of monetary policy shocks on the ERP, before and after the QE in the UK. The key finding of this paper is that ERP, both at aggregate and industry level, responds asymmetrically to monetary policy shocks before and after the implementation of QE in the UK. I find that monetary policy shocks exert negative (positive)

impact on the ERP before (after) the QE. This finding is critical for both policy makers and investors, especially in the wake of UK's exit from the European Union.

3) In the third paper, I build on the theoretical foundation of the CCAPM and investigate the impact of structural consumption shocks on the UK ERP. The key feature of this study is that I examine the differential impact of both aggregate and dis-aggregate consumption shocks on the ERP. These structural consumption shocks represent the deviation of agent's actual consumption path from a theoretically expected consumption path, under the assumption that consumption-wealth channel of the monetary policy exist. They can also be interpreted as idiosyncratic consumption risk after controlling for shocks in agent's income and wealth and accounting for exogenous monetary policy shocks. The notable finding of this paper is that the response of ERP is different to shocks in durable and semi-durable consumption than the response of ERP to non-durable consumption. Furthermore, the UK ERP reacts significantly to contemporaneous aggregate and dis-aggregate consumption shocks after controlling for the size, and value premiums of Fama and French, (1993) and the momentum premium of Carhart, (1997).
4) In the fourth and final paper I investigate the impact of market implied volatility on the UK ERP. There are two key findings of this paper. First the implied market volatility, rather than realised or conditional volatility, is the key driver of UK ERP. Second, it is important to differentiate the impact of short term and long term implied volatility on the ERP. Innovations in the long term implied volatility has more impact on the ERP than the innovations in short term implied

volatility. Additionally, I find that innovations in the long and short term market implied volatility are significant cross-sectional asset pricing factors in presence of other well-known cross-sectional asset pricing factors and business cycle indicators.

# Paper 1

# 2 Literature Review

"*What is wonderful about great literature is that it transforms the man who reads it towards the condition of the man who wrote"* *Edward Morgan Forster*

***Abstract***

This paper parsimoniously reviews the literature on equity risk premium (ERP) over the past twenty-eight years. In particular, the aim of this article is three fold. First to review the methods and techniques, proposed by the literature to estimate ERP. Second to review the literature that attempts to resolve the Mehra and Prescott's (1985) ERP puzzle by exploring five different types' of modifications to the standard utility framework. And third, to review the literature that investigates and develops relationship between ERP and various macroeconomic and market factors in domestic and international context. I find that ERP puzzle is still a puzzle, within the universe of standard utility framework and Consumption Capital Asset Pricing Model, a conclusion which is in line with Kocherlakota (1996) and Mehra (2003).

***JEL Classification*: *G10, G12***

## 2.1 Introduction

Economic theory has successfully manifested the ideology of risk and return of an asset since the seminal work of Markowitz (1952), which laid the foundation for the quantitative and qualitative perception of risk and return. Qualitatively speaking it is reasonable to say that the riskier the asset is, the more return it should provide to the investors in order to compensate for the risk. This qualitative notion of risk-return trade-off is indisputable. The quantification of this notion leads to some contentious issues/questions in financial economics such as how to measure and quantify risk, how to quantify the riskiness of a risky asset? What should be the risk-free rate (or perhaps what should be the risk-free asset?) Once a particular asset is categorised to be risk-free (either by market consensus or by regulatory authorities or by the combination of both), how much risk premium should a risky asset demand over that risk-free asset? Are there economic models that can plausibly explain how much premium a risky asset should demand over the risk-free asset under a rational expectation of consumption-investment behaviour? All these questions are not only related to the risk-return trade-off but they also lead us to developing a framework for appropriate and reasonable pricing of asset.

The Capital Asset Pricing Model (CAPM) of Sharpe, (1964) and Lintner, (1965) was arguably the first asset pricing model, built on Markowitz's (1952) mean-variance efficient portfolio theory, to link the risk and returns, thereby laying the foundation for quantification of the risk-return trade-off. CAPM attempts to price a risky asset via a pricing kernel which is based on the covariance of the return on the risky asset with an efficient market portfolio. Within the CAPM framework, the only source of systematic risk is the market risk. However, Roll (1977) provides a critique of CAPM which suggests that in order for CAPM to work empirically, we need to have an efficient market portfolio which will incorporate all the types of asset classes in an economy. It is fairly reasonable to say that such an efficient market portfolio does not exist in practice. Almost all the empirical tests in favour of CAPM exclusively use value-weighted or equally-weighted portfolio of NYSE or AMEX stocks as a proxy of mean-variance efficient market portfolio. The non-existence of mean-variance efficient market portfolio leaves a major drawback of CAPM. There are as many number of empirical evidences against CAPM [Basu, (1977), Banz, (1981), Fama and French, (1993, 1992)] as there are in favour of CAPM [Black, Jensen and Scholes, (1972), Fama and MacBeth, (1973) and Blume and Friend, (1973)].

In addition to this issue of non-existence of efficient market portfolio, Fama and French (1992;1993) show that the market risk in CAPM i.e. the beta, is not empirically consistent as they show that the price of risky assets not only depends on the beta of the asset but also on size and risk-related related variables such as book value and market value of firms. Further, one of the many limitations of CAPM is that it is a *static* model i.e. in CAPM investors are assumed to take portfolio decisions in single time frame, which is clearly an unrealistic assumption as investors do revalue and reshuffle their holdings in a portfolio more frequently.

Hence to overcome this limitation, Merton (1973) developed the Intertemporal version of CAPM (ICAPM). In particular Merton (1973) shows that in addition to market risk factor, asset prices are dependent on multiple risk factors that can affect future changes in investment opportunities. This was further supplemented by Samuelson and Merton (1974).

Following Roll's (1977) critique and Merton's (1973) I-CAPM , Lucas (1978) Breeden (1979), Rubinstein (1976), Shiller (1982) proposed a Consumption CAPM (C-CAPM) for pricing the risky asset using covariance of the return on risky asset with the consumption growth rate. C-CAPM is similar to traditional CAPM, in the sense the risk is captured by single beta factor. However, there is a fundamental difference in the way in which risk is perceived and measured in C-CAPM as opposed to in CAPM. In C-CAPM the indicator of risk is the covariance between the return on the risky asset with marginal utility of consumption, whereas in CAPM the indicator of the risk is the covariance of the return on the risky asset with return on the efficient market portfolio. It is important to appreciate this fundamental difference, as it may give an economic edge to C-CAPM over CAPM. This is because C-CAPM takes into account the macroeconomic risk in valuation of risky assets, whereas CAPM relies on the existence of hypothetical efficient market. C-CAPM also takes into consideration the rational optimising behaviour of economic agents by maximising the lifetime utility of consumption under the restriction of inter-temporal budget constraint. C-CAPM derives its roots from Arrow (1971),  Pratt (1964) and Euler's consumption equations. As such it not only avoids Roll's (1977) critique but also incorporates Merton's (1973) I-CAPM by aggregating multiple betas of I-CAPM into one beta.

In C-CAPM the rational saving and consumption behaviour of all the agents in an economy is aggregated as a single representative agent who is assumed to derive its lifetime utility from consumption. In C-CAPM the pricing factor/Stochastic Discount Factor (SDF) of the risky asset is the inter-temporal marginal rate of substitution i.e. the elasticity of substitution current consumption to future in response to interest rate. The linkage of consumption to asset prices in C-CAPM is based on Euler's equation of consumption. The asset pricing identity based on Euler's consumption equation is applicable to any asset i.e. to both risky and risk-free asset. In addition to this, unlike CAPM which is a static model, C-CAPM is an inter-temporal model and hence there is element of time-dimension. Therefore, it is fair to say that C-CAPM has the potential to explain the risk-return trade-off better than CAPM, as it captures the asset pricing implication of rational consumption-saving behaviour of economic agents

In summary, C-CAPM predicts that the equity premium is proportional to covariance of return on risky asset with aggregate consumption; the constant of proportionality being the risk aversion or the curvature of the agent's utility function. C-CAPM implies that assets that perform badly in "bad times", (as measured by consumption) must offer premium over assets that perform good in "bad times". Therefore, it is reasonable to conclude that C-CAPM provides a natural link between the inter-temporal consumer behaviour and asset pricing. Heuristically, C-CAPM provides foundation for demand of risky assets and the risk premium they command over a risk-free assets using risk aversion based on Expected Utility Hypothesis, which was coined by Von Neumann and Morgenstern (1944) and Savage (1954). In C-CAPM, the agent's time-varying marginal rate of substitution (MRS) acts as pricing kernel or the SDF.

However, just like any other asset pricing model in Financial Economics, C-CAPM also suffers from a major empirical drawback. The empirical inconsistency of C-CAPM was first highlighted by a famous research paper of Mehra and Prescott (1985) which demonstrate the Equity Risk Premium Puzzle.

Since the seminal work of Mehra and Prescott (1985) on the ERP puzzle, there has been an exponential rise in the interest towards ERP. Although different authors have suggested different approaches to solving the ERP puzzle and to some extent some of them are closer to solve the puzzle, yet the literature is limited in providing a definitive solution to this apparent mismatch between the theoretically plausible ERP implied by C-CAPM and the actual observed ERP. Kocherlakota (1996), Mehra (2003) and Siegel (2005) have provided surveys of the literature that attempt to resolve the ERP puzzle. The aim of this survey paper, however, is three folds. First, this paper attempts to cover the literature regarding estimation of the ERP. Second it provides an updated and more comprehensive survey of the literature that attempts to resolve the ERP puzzle. And third, it provides a survey of the literature identifying the determinants of ERP in both domestic and the international context. The major advantage of adopting the strategy of reviewing literature on ERP using the ERP puzzle is that it eventually helps in identifying the determinants of ERP.

This paper is organised as follows; section 2.2 briefly discusses the ERP puzzle which lays the groundwork for the further literature. Section 2.3 discusses various techniques used to estimate the ERP. Section 2.4 presents the literature on the resolution of ERP puzzle. Section 2.5 discusses the factors that affect ERP in both domestic and international contexts. Section 2.6 concludes the literature review. Having reviewed the literature, I subsequently present the aims and objectives of the research in this thesis.

## 2.2 The ERP puzzle

Mehra and Prescott, (1985) begin with an assumption that a standard representative household attempts to maximise its time-additive expected utility over consumption within Lucas's (1978) pure exchange economy. This is represented as

$$E\left[\sum_{t=0}^{\infty} \beta_t . U(C_t)\right], 0 < \beta < 1 \tag{2.1}$$

Where the utility function of this representative household is assumed to be a power utility function given by

$$U(C, \alpha) = \frac{C^{1-\alpha}}{1-\alpha}, 0 < \alpha < \infty \tag{2.2}$$

and where $\alpha$ is the curvature of the utility function which simultaneously controls inter-temporal substitution and risk aversion. The advantage of this utility function is that, it is strictly increasing, implying that the household prefers more consumption than low consumption ("greedy") and it is concave implying diminishing marginal utility of consumption and strict risk-aversion. It is also differentiable two times with $U''(.) < 0$

The household faces an inter-temporal choice where it can choose not to consume today and save and use the proceeds to buy an asset at price $P_t$ which has a total payoff of $x_{t+1}$ in time t+1 and use it to consume $C_{t+1}$ in the future. In other words, the loss in marginal utility $\{P_t.U'(C_t)\}$ of not consuming today and saving it and using it to buy an asset at price $P_t$ must be at the most same as the expected gain in the marginal utility of consumption because of the payoff $x_{t+1}$ $\{E[\beta.U'(c_{t+1}).x_{t+1}]\}$ in the future, discounted by investor's impatience $\beta = e^{-\delta}$. Thus we have,

$$P_t.U'(C_t) = E[\beta.U'(C_{t+1}).x_{t+1}] \quad \textbf{(2.3)}$$

Equation 2.3 is the first order condition of optimal consumption path which leads to the basic pricing identity for any asset.

$$E\left[\beta.\frac{U'(C_{t+1})}{U'(C_{t)}}.R_{\,t+1}\right] = 1 \quad \textbf{(2.4)}$$

Equation 2.4 can also be written as

$$E_t[m_t.R_t] = 1 \quad \textbf{(2.5)}$$

where, $m_{t+1} \equiv e^{-\delta}.\frac{U'(C_{t+1})}{U'(C_t)}$ is marginal rate of substitution or the pricing kernel or the stochastic discount factor that captures the household's preference to postpone $C_t$ to $C_{t+1}$. This suggests that the household evaluate the price of an asset by discounting the future stream of uncertain cashflows from that asset using their marginal rates of substitution as a stochastic discount factor. Equation 2.5 is the fundamental asset pricing equation which suggests that in the absence of arbitrage, there exist a strict positive SDF

($m(\omega) > 0 \; \forall \; \omega \in \Omega$) which is used to price all the tradable assets (risky and risk-free) and has finite variance (Cochrane, 2001). Equation 2.5 implies that risk averse household care about marginal utility of consumption and as such marginal utility is the appropriate indicator of risk. It suggests that assets which does not provide higher payoffs when marginal utility is higher, have low expected returns compared to assets that does provide higher payoffs when the marginal utility is higher and thus command more premium.

For a risk free asset, we have

$$R_f = \frac{1}{E(m)} \tag{2.6}$$

Now as C-CAPM implies that the pricing kernel or the SDF is the marginal rate of substitution, therefore for a household with time-additive expected utility we have

$$m = e^{-\delta}.\frac{U'(C_{t+1})}{U'(C_t)} \tag{2.7}$$

Implying that,

$$R_f = e^{\delta}.E\left[\frac{U'(C_{t+1})}{U'(C_t)}\right]^{-1} \tag{2.8}$$

Equation 2.5 also implies that for any risky asset *i*

$$1 = E(m).E(R_i) + Cov(R_i, m)$$

$$\Rightarrow E(R_i) = R_f - \frac{Cov(R_i, m)}{E(m)} \tag{2.9}$$

Now assuming that consumption growth rate $R_c$ and dividend growth rate $R_d$ of the risky asset follow the lognormal distribution and the utility function of the household is the standard power utility function given by equation 2.2.

We have,

$$\ln(1 + r_c) = R_c \equiv \ln\left[\frac{C_{t+1}}{C_t}\right] \approx N(\overline{r_c}, \sigma_{rc}^2)$$

$$\ln(1 + r_d) = R_d \equiv \ln\left[\frac{D_{t+1}}{D_t}\right] \approx N(\overline{r_d}, \sigma_{rd}^2) \tag{2.10}$$

And equation 2.2 implies that,

$$\frac{U'(C_{t+1})}{U'(C_t)} = \left(\frac{C_{t+1}}{C_t}\right)^{-\alpha} = exp\left[-\alpha. ln\left(\frac{C_{t+1}}{C_t}\right)\right]$$

Now, if a variable $x \sim N(a, s^2)$ then we know that,

$$E[e^{-kx}] = \exp\left[-ka + \frac{1}{2}. k^2. s^2\right]$$

Thus we have,

$$E\left[\exp\left(-\alpha. ln\left(\frac{C_{t+1}}{C_t}\right)\right)\right] = exp\left(-\alpha. \overline{r_c} + \frac{1}{2}. \alpha^2. \sigma_{rc}^2\right)$$

And from equation 2.8 we have

$$R_f = exp\left(\delta + \alpha. \overline{r_c} - \frac{1}{2}\alpha^2. \sigma_{rc}^2\right)$$

$$\Rightarrow \ln(R_f) \equiv r_f = \delta + \alpha. \overline{r_c} - \frac{1}{2}\alpha^2. \sigma_{rc}^2 \tag{2.11}$$

Similarly, the return on any risky asset *i*, can also be shown as,

$$\Rightarrow ln\left[E_t(R_{i,})\right] = \delta + \alpha.\overline{r_c} - \frac{1}{2}\alpha^2.\sigma_{rc}^2 + \alpha.cov(r_c, r_d) \qquad \textbf{(2.12)}$$

Equation 2.12 minus Equation 2.11 gives log of ERP

$$\ln\left[E\left(R_{i,t+1}\right)\right] - \ln\left(R_f\right) = \ln(ERP) = \alpha.cov(r_c, r_d) \qquad \textbf{(2.13)}$$

In equilibrium $r_D \to r_i$ and continuously compounded growth rate in consumption approaches to that of growth rate in dividends or return on equity. Thus, we have, $r_i \to r_c$

$$\therefore lnERP = \ln(R_e) - \ln\left(R_f\right) = \alpha.\sigma_{rc}^2 \qquad \textbf{(2.14)}$$

Equation 2.14 implies that the log of ERP is product of coefficient of relative risk aversion and variance of consumption growth rate.

Mehra and Prescott (1985) report following empirical data for the US economy for the period 1889-1978. The actual value of US ERP is 6.18% which is far more than 0.35%, the value that is implied by standard economic theories (Equation 2.14) of asset pricing. The risk free rate in Table 2.1 is the nominal yields on 3-month T-bills rate (for the period 1931-1978), Treasury Certificate (for period of 1920-1930) and sixty and ninety-day Prime Commercial Paper (prior to 1920).

**Table 2.1 Data of US Economy**

| | Risk Free Rate | Return on S&P 500 index | ERP | Consumption Growth Rate. |
|---|---|---|---|---|
| Mean | 0.8% | 6.98% | 6.18% | 1.8% |
| Standard Deviation | 5.67% | 16.54% | 16.67% | 3.6% |

Source: Mehra and Prescott (1985)

In order to get ERP of 6.18 % the coefficient of risk aversion (α) should be around 46 in equation 2.14, which is implausible based on Arrow (1971), Friend and Blume (1975) and Kydland and Prescott (1982) since they imply that $\alpha \leq 5$. This shows that consumption growth rate in the US is not volatile enough to generate ERP of 6.18%. This is the ERP puzzle. As Mehra (2003) emphasise that ERP puzzle is a quantitative puzzle not a qualitative, meaning that the puzzle does not disregard the risk-return trade-off, however the puzzle questions the mismatch between quantity of reward (premium) that one actually gets and the premium which is implied by theoretical models. It supports that fact that assets that pays off well in good times i.e. high consumption are less desirable than the assets which pays similar cashflows in the bad times i.e. low consumption. The puzzle motivates to improve the existing conventional economic theories and the preference structures of the agents to build more accurate models so that the mismatch between the actual observed ERP and the one implied by theory could be overcome. However, the puzzle does not focus why equities offer so high premium within the standard representative-agent-based utility maximisation framework.

Figure 2.1 gives a visual snapshot and the classification of the literature that I will evaluate in the following sections.

****Please insert Figure 2.1 about here****

## 2.3 Estimation techniques of ERP

Figure 2.2 briefly shows the literature on various estimation techniques of ERP. I begin the daunting task of surveying the ERP literature by first investigating the techniques of estimating ERP. I consider this to be important first step to understand ERP in depth. As much simple as it sounds, the estimation techniques are equally complicated. Text book definition of ERP is simple; it is the excess market return on a risk-free rate. And yet the literature has no clear consensus of estimation technique, which I will demonstrate in this section. In order to get an overview of the various estimation techniques of ERP, I have classified this literature in two mains categories. First is the Survey Method which involves conducting survey with different professionals such as Investors, Academics and Managers (Chief Financial Officers) about what they think ERP estimate should be for different time horizons. This method, although crude, provides model-free estimate of ERP. The second category is estimating ERP using historical data which involves estimating ex ante (expected or unconditional) ERP and ex post ERP. In the literature, the ex-ante ERP is estimated using accounting methods (using company-specific accounting data), standard economic models (such as C-CPAM), Time Series models (AR, ARCH, GARCH and ARIMA models) and using Fundamentals (aggregate data on valuation ratios, dividends, earnings) etc. The Ex-post ERP is relatively simple to estimate. It is estimated using average realised stock returns, normally using a suitable proxy for market portfolio such as S&P 500, FTSE All Share Index etc. and a risk-free rate, for example yields on 3-month T-bills or 10 –Year Government Bonds. Arithmetic or geometric averaging technique is used to get the average returns.

****Please insert Figure 2.2 about here****

### 2.3.1 Survey methods of estimating ERP

Welch, (2000) conducted a survey of 226 financial economists in the US to estimate arithmetic ERP. He finds that the average ERP for 10-year and 30-year horizon was 7% in real terms, and 6% - 7% for the horizon of one and six years respectively. The most pessimistic estimates of ERP over the horizon of 30 years were in the range of 2% -

3% and the most optimistic was in the range of 12% - 13%. Over 100 years of horizon, the estimate of ERP he finds was 6.5%. The risk free rate used was 30-year T-Bonds and 3-month T-bills. An updated version of this survey was conducted by Welch (2008) in which he surveyed about 400 financial economist in the US and showed that the ERP estimate at the end of 2007 was about 5% in the US. A similar survey technique was used by Graham and Harvey (2005). They survey 5014 Chief Financial Officers in the US to estimate a 10-year horizon ERP using yields on 10-year US T-Bonds as risk-free rate. The lowest estimate of ERP was 2.88% and the highest was 4.65%. In 2005 the implied ERP estimate of the S&P 500 index was 2.98% whereas the average ten-year risk premium for the whole period of the survey was 3.64%. An updated version of this survey by Graham and Harvey (2012) provides an estimate of 5.46%.

### 2.3.2 Historical Methods of estimating ERP

Freeman and Davidson (1999) estimate ex-ante ERP by employing standard C-CAPM model to show that ex-ante ERP is not an unbiased estimate of ex post ERP. They estimate following model using the UK data for the period of 1974-1987:

$$E(R_i) - R_f = \frac{\alpha . Cov\ (R_i, R_c)}{1 - \alpha . E(R_c)}$$

where, $E(R_i) - R_f$ = ERP (Difference between the return on risky asset i and risk-free asset $R_f$) $\alpha$ = risk aversion coefficient and $R_c$ is the growth rate of aggregate consumption and show that ERP estimated using standard economic model cannot be an unbiased estimate of ex-post ERP, a result similar to the US economy as studied by Mehra and Prescott (1985). On the other hand, O'Hanlon and Steele (2000) use accounting method to estimate ex-ante ERP in the UK by using accounting data of 172 UK companies between the period 1968-1995. The estimated ERP was in the range of

4%-6% using 3-month UK Gilts as risk free rate. Accounting methods was also implemented by Fitzgerald, Gray, Hall and Jeyaraj (2013) to estimate ERP in the US for the period 1999-2008. They employ firm specific data of 5144 firms in the US to show that average ERP was 5.3%.

Fama and French (2002) use the fundamental approach to estimate ex-ante ERP for the period 1872-2000 in the US by estimating average stock return using dividend growth model and earnings growth model.

$$A(R_{d,t}) = A\left(\frac{D_t}{P_{t-1}}\right) + A(GP_t)$$

Where A ($R_d$) is the average return on stocks using dividend growth model, whereas the first term on the right hand side is the average dividend yield and the second term is the average capital gains. They argue that if dividend-price ratio is stationary over a long period, then the average capital gain approaches to average dividend growth rate. So they estimate the average stock return using following relation

$$A(R_{d,t}) = A\left(\frac{D_t}{P_{t-1}}\right) + A(GD_t) ----dividend\ model$$

where $GD_t$ is the growth rate of dividends. The earnings model they employed was:

$$A(R_{e,t}) = A\left(\frac{D_t}{P_{t-1}}\right) + A(G_e) ----earnings\ growth\ model$$

where, $R_{e,\,t}$ is the average stocks returns using the earnings model and $G_e$ is the earnings growth rate. Their results can be summarised in table 2.2

**Table 2.2 Results of Fama and French, (2002)**

| Period | ERP Estimates (%) | | |
|---|---|---|---|
| | Dividend Model | Earnings Model | Actual |
| 1872-2000 | 3.54 | NA | 5.57 |
| 1872-1950 | 4.17 | NA | 4.4 |
| 1950-2000 | 2.55 | 4.32 | 7.43 |

They also show that by using 1-month T-bills rate as a risk-free rate instead of using 6-month commercial paper rate (which they use for the period 1872-1926), the ERP increases by 1%. A similar approach was taken by Claus and Thomas (2001), however they use the abnormal earnings approach to estimate ERP in the US, UK, France, Germany, Canada and Japan. They show that the average ERP for the six developed economies is no more than 3%. However, when they use the dividend growth model $k^* = \frac{D_1}{P_0} + g$ they find that the average ERP for the US, Canada, the UK, Germany, France and Japan is 7.34%, 5.89%, 7.91%, 6.58%, 7.90% and 5.83% respectively for the period 1985-1998.

Campbell (2008) also uses the fundamental valuation approach to estimate the ERP for the US, Canada and MSCI World index. He uses  a slightly modified version of earnings growth model used by Fama and French (2002). He estimates implied ERP assuming constant Return on Equity (RoE) of around 50%. This ERP is 3.3% for the MSCI World Index, 3.2% for the US and 3.1% for Canada. He uses the return on inflation-indexed bond as risk-free rate for US and Canada. When he uses the 3-year moving average for dividend pay-out ratio and 3-year moving average for RoE, then the estimates of ERP, using 0.75 weight on the long term estimate and 0.25 weight on the short term estimate, was 3.9% for the World Index, 4.1% for the US and 3.6% for Canada by the end of March 2007.

Advanced modelling techniques such Markov switching models, time series models and Bayesian techniques have also been employed to estimate ERP. Mayfield (2004) uses two state (low volatility and high volatility) Markov process with structural shifts in the volatility to estimate ERP. He estimates the following model:

$$R_{i,t} - R_{f,t} = \gamma\sigma_t^2 - \pi_t \ln(1 + J_t)(1 + K_t^*)^{-\gamma}$$

where $R_{i,t} - R_{f,t}$ is the ERP, $\gamma$ is coefficient of relative risk aversion, $\sigma^2$ is the variance of returns which takes two sets of values in low and high volatility states, $\pi_t$ is the instantaneous probability of change in the state, $J_t$ is the change in wealth associated with change in state and $K^*$ is change in optimal consumption level due to change in the wealth. The average ERP estimate in the low state was 12.4% and -17.9% in high volatility state. He also shows that ERP depends on volatility of returns and that about half of the estimated ERP is associated with future changes in volatility. On the other hand Pastor and Stambaugh (2001) use Bayesian technique to estimate ERP in stable and transition regimes. They show that ERP fluctuates between 3.9% and 6% in the US for the period 1834-1999. The inclusion of structural breaks improves the precision of the estimates and due to this ERP changes from 6.5% to 5.9% in the 1990s. They also show that across the sample, with the inclusion of structural breaks, ERP is related to volatility of returns and ERP has changed over time and is decreasing since 1930s with few jumps in 1970s.

Time series modelling technique with simulated method of moments requiring numerical solution, have been implemented by Donaldson , Kamstra and Kramer (2010) to estimate ERP in the US. The moments are simulated by AR (1), MA (1) and ARCH (1,1) technique. They show that, by simulating the dividend growth rates and interest rates, the estimated ERP for the period 1952-2004 broadly matches the US data and is around 3.5%. ±50bps.

An altogether different approach is adopted by Appelbaum and Basu (2010) to estimate ERP and consumption process. They estimate an empirically tractable ERP and consumption functions, independent of each other, and which were dependent only on the moments of the state variables. The consumption function involving the moments of the state variables, which they estimate is

$$C_t \equiv f(W_t, R_t, I_t, \sigma_R, \sigma_I) + \varepsilon_{c,t}$$

and the actual observed ERP function is

$$ERP_t \equiv f(W_t, R_t, I_t, \sigma_R, \sigma_I) + \varepsilon_{e,t}$$

where, $W_t$is the household's wealth, $R_t$ is the return on equity investment, $I_t$ is the household's income and $\sigma_R, \sigma_I$ are respectively the standard deviations of $R_t$and $I_t$. By estimating the parameters by non-parametric method in the above ERP function for the period of 1921-2001 they estimate the actual observed ERP in the US and show that the ERP is varies with time.

The above discussion highlights the inconsistent nature of ERP estimation techniques. The literature sometime suggests to use the returns on long term government bonds and at other, short term T-bills returns as a proxy of risk-free rate in estimation of ERP.

However, recent events like the European Sovereign Debt Crisis, the downgrade of US government debt in August 2011, the downgrade of UK and French sovereign bonds have shown that government bonds and bills cannot be considered entirely as risk-free. The issue is not just whether to consider government debt as risk-free or not, the issue is that there is no clear consensus in the literature as to what should be the maturity of the government debt to be qualified as a risk-free. In addition to this Mehra (2011) argued that it is not incontrovertible to argue that 3-months Government bills cannot proxy risk free rate based on the fact that households have little or no 3-months T-bills in their portfolio of savings which they can use to smooth the intertemporal consumption. "*Hence, T-bills and short-term debt are not reasonable empirical counterparts to the risk-free asset*" (Mehra 2011, p.150).

The foregoing literature shows that the literature produces different estimates of ERP by using the same variables such as dividend yields, consumption growth rates, etc. when using different modelling techniques. Interestingly the estimates of ERP from the survey method are not close to the one estimated by using either the fundamentals or time series models. And not only that, there is general consensus in the literature that ex-post ERP cannot be an unbiased estimate of ex-ante ERP and yet the profession continues to use historic ERP as an estimate of unconditional ERP. In the literature the most common way of estimating ex-post ERP is by arithmetic averaging of returns.

## 2.4 Resolution of ERP Puzzle

In this section I attempt to cover the literature that provides resolution to the ERP puzzle by modifying the preference parameters in the utility function. I have covered five types of modifications to the utility function based on habit formation, rare disaster events, behavioural finance approach, heterogeneous labour and equity markets and recursive utility preferences. Figure 2.3 briefly shows the classification of literature that attempts to explain the ERP puzzle.

****Please insert Figure 2.3 about here****

### 2.4.1 Habit Formation

The key idea of this modification to the standard power utility function is that individuals not only derive utility from their current levels of consumption but their utility is also affected by the past subsistence levels of consumption which is called the 'habit' consumption level. The utility function is defined over this comparison between the current levels and the habit level. Under this modification when an individual compares his/her current consumption level with his/her own habit level, then it is called the Internal Habit formation model and when he/she compare the current consumption levels with other's it is called the External Habit formation model. Constantinides (1990) introduced the Internal Habit formation model of the form

$$E_0 \int_0^{\infty} e^{-\rho t} \alpha^{-1} [c(t) - h(t)]^{\alpha} dt$$

where $\alpha$ is the risk aversion coefficient, $\rho$ is the subjective discount factor, c(t) is consumption in time t and h(t) is the habit level consumption given by:

$$h(t) \equiv e^{-at}.x_0 + b.\int_0^{\infty} e^{a(s-t)}.c(s)ds$$

He shows that ERP as high as in the actual US data can be shown with risk aversion coefficient as low as 2.81. His model also predicts that about 80% of the total level of consumption is the "habit" consumption which causes the high ERP.

On the other hand Abel (1990) and Campbell and Cochrane (1999) use external habit level of consumption in their utility function i.e. reference consumption level is endogenously decided by economy-wide aggregate consumption, to show that ERP is affected by external reference level of consumption. In their model, individuals compare their respective consumption with other agents in the economy. The utility function proposed by Abel (1990) is:

$$U(C_t, H_t) = E\sum_{t=0}^{\infty} \delta^t . \frac{\left[{C_t}/{H_t}\right]^{1-\alpha}}{1-\alpha} \ldots\ldots\ldots.for\ \alpha > 0$$

where $H_t$ is the reference level of consumption specified as:

$$H_t \equiv \left[C_{t-1}^{D}, C_{t-1}^{A,D}\right]^{\alpha} \ldots\ldots for\ \alpha \geq 0\ and\ D \geq 0$$

where $C_{t-1}$is the individual's past consumption, $C_{t-1}^{A,}$ is the past per capita aggregate consumption and $\delta$ is the subjective discount factor. When $\alpha > 0\ and\ D = 0$ then the utility function becomes external habit forming. Abel's (1990) model can be considered as a ratio model where the ratio of consumption to habit level consumption is used in the utility function, whereas Constantinide's (1990) model can be considered as difference model.

The utility function proposed by Campbell and Cochrane (1999) is:

$$U(C_t, H_t) = E\sum_{t=0}^{\infty} \delta^t . \frac{(C_t - X_t)^{1-\alpha} - 1}{1-\alpha}$$

They introduce a new variable called surplus consumption ratio in their utility framework which is given by:

$$S_t^a \equiv \frac{C_t^a - H_t}{C_t^a}$$

where superscript $a$ stands for aggregate level (external to the individual). In equilibrium each individual's consumption are identical which means $S_t^a = S_t \; and \; C_t^a = C_t$ This also means that as consumption falls towards habit level ($C_t \rightarrow H_t$), $S_t \rightarrow 0$ (extremely bad state) causing people to feel more risk averse which leads an increase in ERP. The parameter that controls ERP in their model is called as local curvature η given by:

$$\eta_t \equiv -\frac{C_t . U_{c,c}(C_t, H_t)}{U_c(C_t, H_t)} = \frac{\alpha}{S_t}$$

This means that as ($C_t \rightarrow H_t$), $S_t \rightarrow 0$ then $\eta_t \rightarrow \infty$ which then induces higher ERP (as observed in the actual US data), although $\alpha$ may be reasonably low. Møller (2009) empirically investigate Campbell and Cochrane's (1999) model by employing integrated GMM estimation to show that the model can explain the size of ERP in the US however it fails to explain the value premium. He also shows that Campbell and Cochrane's (1999) model can produce time-varying risk aversion.

On the other hand Yogo (2008) modifies the utility function in the above three studies by combining loss aversion with habit formation. He develops a new form of utility which is defined over "gains and loses" in consumption over habit level of consumption which he calls as reference level of consumption. He shows that this type of reference-dependent utility generates ERP which is closer to the actual US data (higher ERP). Similarly, Kim, Krausz and Nam (2013) attempts to explain the ERP puzzle by combining the habit formation model with Overlapping Generation (OLG) Model with borrowing constraints similar to Constantinides, Donaldson and Mehra (2002). They show that when one incorporates the habit formation in the OLG model, middle-aged consumers have more incentive to save than in a non-habit formation model, driving down the risk-free rate and pushing up the required return on equity and thus higher ERP. Auer (2013) employed Campbell and Cochrane's (1999) model to explain the ERP in G7 countries in two stages. In the first stage he extracts the conditional co-variance between excess returns and the risk-factors by using bi-variate GARCH model and in the next second stage he uses these conditional covariance as explanatory variable in the system of equations to estimate ERP in the G7 countries. He shows that habit forming model in CCAPM can explain more than 90% variance in the risk premia across the G7 countries.

Otrok, Ravikumar and Whiteman (2002) modifies the habit preferences in the utility by using what they call spectral utility function. They decompose the time series of consumption growth process in two components of low frequency volatility and high frequency volatility and use AR (1) process to model growth in consumption process with autocorrelation 0.3, 0 and -0.3. They show that with constant overall volatility of consumption, ERP increases by 1600bps when the autocorrelation changes from 0.3 to -0.3 whereas the ERP increases by 1800 bps with constant low frequency consumption variance although the overall volatility of consumption remains constant.

### 2.4.2 Rare Disaster Events

This sub-section demonstrates that higher ERP is caused by rare/disaster economic or financial events that may actually occur or are perceived to occur. *"Risk-averse equity owners demand a high return to compensate the extreme loses they may incur during an unlikely, but severe, market crash".* [Rietz (1988; p:118)]. His study was the first to link rare but unlikely economic disaster events with ERP and attempts to explain the ERP puzzle. He introduces a third state of the economy, known as depression-like crash state, in the two-state economy of Mehra and Prescott (1985). By introducing this third state and by considering various scenarios of the economic output in the crash state as a percentage of output in the normal state, he shows that as the probability of crash-states increases ERP also increases, albeit keeping the structural properties of CCAPM and expected utility hypothesis intact i.e. keeping low risk aversion coefficient. Salyer (1998) uses similar methodology as that of Rietz (1988) to show that in a crash-like scenario, the mean value ERP is indeed affected by these scenarios. In addition to this he also shows that the volatility of ERP comply with the restriction imposed by Hansen and Jagannathan (1991) on the first two moments of agent's IMRS and that the volatility of ERP cannot be explained by the introduction of crash-state. Barro (2006) studies the empirical validity of Rietz (1988**)** by considering 60 disaster events in 35 countries across the period 1890-2004. He develops following relationship:

$$ERP = \alpha.\sigma^2 + p.(1-q).[E(1-b)^{\alpha} - E(1-b)^{1-\alpha} - E(b)]$$

where, $p$ is the probability of economic disaster per year, $\sigma^2$ the volatility of growth rate with no disaster, $q$ contingent probability of government default, $b$ is the size of economic contraction (as measured by drop in per capita GDP) and $\alpha$ is the coefficient of relative risk aversion (RRA). He shows that average ERP, when the baseline value of $p$ of 1.7% per year and leverage ratio of one, was 7.2% across the countries and 3.6% when there was no leverage. He shows that ERP is nearly proportional to disaster probability but the strength of this proportionality depends on $\alpha$. ERP also depends on contingent probability of government default. A lower value of this mean risk-free asset is safer than equities in the event of an economic disaster.

Santa-Clara and Yan (2010) applied Merton (1976) jump-diffusion modelling to S&P 500 options prices and show that ERP has four components. These are, the variance of marginal utility of wealth, and the covariance of marginal utility of wealth with diffusive volatility, jump intensity and jump size. They show that ex-ante ERP in the US in the period 1996-2002 varies 0.3% - 54% and during crash-events, jump risk commands 45.5% to 100% of actual ERP. Average ex ante ERP implied by option prices is 11.8% while the ex post/actual ERP is 6.8% for realised volatility. Thus the required compensation is 70% more than actually observed. Bollerslev and Todorov (2011) studies the asymmetric impact of the negative and positive jumps in high frequency short-dated out-of-money S&P 500 options and prices of S&P 500 futures on US ERP. The effect of negative jump intensity of -20% or more had more impact on ERP (12 times) than a positive jump intensity of 20%. Investors in the US were compensated for the negative events such as LTCM failure, October 1987 crash, Russian default of 1998 etc. more than for the positive events.

Gabaix (2012) comprehensively studies the impact of crash-states on asset prices and equity premium. His framework consists of stochastic probabilities of disasters and recovery rates of both risky and risk-free assets in the event of disaster. He shows that the inclusion of disaster-like scenarios helps to find the cause of ERP as well as the time-varying nature of ERP due to time-varying nature of the severity of crash-events. Wachter (2013), on the other hand, studies the impact of time-varying disaster probabilities in agent’s consumption process, on the ERP and excess stock volatility. The assumption is that the consumption process follows a continuous stochastic jump-diffusion process with jump probabilities following the square root process of the form:

$$dC_t = \mu C_t dt + \sigma C_t dB_t + (e^{zt} - 1)C_t dN_t - -Consumption\ Process$$

$$d\lambda_t = \kappa(\bar{\lambda} - \lambda_t)dt + \sigma_\lambda \sqrt{\lambda_t}.\, dB_{\lambda,t} - -disaster\ probability\ process$$

Further, she assumes that agents maximise recursive utility preferences of Epstein and Zin (1989) (discussed in sub-section 4.5). She also incorporates a more realistic assumption of partial government default with some probability, in the event of disaster in the consumption process and estimated expression for ERP which can be decomposed in three components; component coming from the standard CCAPM model, component attributable to time-varying disaster event and component related to static disaster event. When the model was calibrated to the US data she shows that the time varying probability of disaster event in the consumption process leads to a better ERP estimate without assuming high value of relative risk aversion (she assumed $\alpha = 3$ ) which can be matched by the actual data.

On the other hand Julliard and Ghosh (2012) tested the above rare event hypothesis by estimating following Euler's equation of consumption on the set of 9 OECD countries in the period 1890-2009. They show that the rare disaster event hypothesis does not support the fact that these types of events cause higher values of ERP. In order for these crash events to explain ERP, one has to assume that economic and financial disasters occur every 6 – 10 years and higher probabilities are needed to be assigned to these events. Additionally, the likelihood of these types' events has to be increased by 4% - 6% than what is actually observed in the data.

Heuristically the rare disaster hypothesis, first proposed by Rietz (1988) to explain the ERP puzzle, suggests that market participants would like to incorporate the probability of rare but possible event that causes the asset prices to jump. In order to take into consideration this extra uncertainty, investors would demand extra premium from the assets whose conditional prices jump more than the risk-free assets. Intuitively, this makes sense, however in the context of C-CAPM one needs to justify larger moves in consumption growth process to explain the ERP with lower risk aversion. Big moves in the consumption process have not been observed in the consumption growth process in the US (Mehra and Prescott, 1988), as such modelling the consumption process with a jump component is suspicious. In addition to this the literature does not distinguish between what kind of crisis/disaster events cause any structural move in the ERP i.e. whether a currency crisis structurally shifts the ERP more than a sovereign debt crisis or a banking crisis.

### 2.4.3 Behavioural Finance

Advances in Behavioural Finance models have attempted to resolve the ERP puzzle. Particularly, there are two broad strands that attempt to explain the ERP puzzle. The first strand is based on the psychology of decision making process under uncertainty which is based on prospect theory of  Kahneman and Tverskys (1979) and Tversky and Kahneman (1992). Benartzi and Thaler (1995) use prospect theory to show that loss aversion (LA) among the investors and the frequency of evaluation of the performance of their investments causes high equity premium. They use following prospective utility function which is defined over gains and losses rather than on consumption, as is normally done in the standard literature;

$$V(x) = \begin{cases} x^{\alpha}, & if\ x \geq 0 \\ -\lambda.(-x^{\beta}), & if\ x < 0 \end{cases}$$

where V(x) is the value function defined on the returns of bonds and equities, λ is the coefficient of LA and α and β are parameters. The prospective utility of a risky investment *I* is then defined over this value function as:

$$U(I) = \sum \pi_i . V(x)$$

where π is the decision weight assigned to outcome *i* . They attempt to find what length of time (evaluation period) is required by the investors in order for them to be indifferent from investing in stocks and bonds. They show that the optimal evaluation period of one year is necessary to generate 6.5% ERP i.e. the more investors frequently assess the performance of their investments the more risk averse they get and demand higher premium from risky investments (stocks). They called it as 'Myopic Loss Aversion'. Barberis, Huang and Santos (2001) show that ERP is indeed caused by LA; however they used standard expected utility theory wherein the utility is defined over consumption and financial wealth. They show that it is not just LA that causes ERP but, the outcome of the previous investment decision also does i.e. prior loses make future loses more painful, and hence demand higher premium, however prior gains make future loses less painful. This means that the utility has to be defined not only on consumption but also on financial wealth.

The second strand is based on the work of Gul (1991) of Disappointment Aversion (DA). Essentially, utility with DA preferences argues that outcome of gamble can be disappointing if that outcome is below a certainty equivalent i.e. below some reference. Bad outcomes make investors more risk averse and hence these outcomes outweigh the good outcomes i.e. the outcomes which are above the certain level. Thus, investors are disappointment averse. Ang, Bekaert and Liu (2005) use the DA preferences in a CRRA utility defined over wealth, which is as follows;

$$U(W) = \frac{W^{1-\gamma}}{1-\gamma}$$

$$W = \alpha.W_0(e^y - e^r) + W_0 e^r$$

$$max_\alpha[U(W)]$$

and the utility with DA preference is $\mu_w$ given by:

$$U(\mu_W) = \frac{1}{k}\left(\int_{-\infty}^{\mu_W} U(W).dF(W) + A\int_{\mu_W}^{\infty} U(W).dF(W)\right)$$

where $W$ is wealth, $\gamma$ is the risk aversion and $A$ is coefficient of DA. They show that there exists a threshold level of $A$ denoted as $A^*$ such that if $A<A^*$ then investors do not prefer to invest in equities i.e. require higher premium to hold them. They calibrate their model to the US data for 1926-1998 to show that $A^*$of 0.37 corresponds to actual ERP of 6.55%. On the other hand Routledge and Zin (2010) extends the DA preferences to Generalised Disappointment Aversion (GDA) to show that their model can generate countercyclical risk aversion which leads to ERP in the range of 5.12% - 12.65%, which is very close to the reality.

Fielding and Stracca (2007) combine these two strands (Loss Aversion and Disappointment Aversion) to show that LA partially explains ERP puzzle and requires more frequent evaluation period in order for the investors to be enough risk averse to generate ERP close to the data. On the other hand, DA aversion gives a better explanation of ERP puzzle as it is independent of any evaluation period.

### 2.4.4 Incomplete Markets and Heterogeneous Agents.

This school of thought attempts to provide explanation to ERP puzzle based on the fact that capital markets are incomplete i.e. assuming that the economy is not frictionless and there are exogenous shocks to labour income which cannot be insured against. Aiyagari and Gertler (1991) study the impact of transaction costs and heterogeneity in labour income on ERP. They argue that equity trading is associated with three types of costs namely brokerage, bid-ask spread and time and knowledge required to identify which shares to buy or sell. They also argue that these costs are substantially more than the cost of transacting the risk-free assets and therefore agents prefer to trade risk-free assets over equities in the event of an exogenous shock to their labour income to smooth inter-temporal consumption. Therefore, equities demand “more” premium not just in the form of compensation for the volatility risk but also to compensate the extra trading cost over and above the trading costs of risk-free assets. They consider smooth aggregate income (i.e. no aggregate shocks) however exogenous shocks occur to individual income due to job losses. Similarly, Heaton and Lucas (1996) study the impact of transaction cost and borrowing constraints on ERP. Unlike Aiyagari and Gertler (1991), their theoretical model consists of both idiosycratic and aggreagte income shocks. Their model consisit of agents which can hedge the idiosyncratic shock by trading in both risk-free and risky assets to smooth the consumption. They impose constraint on trading and on borrowing and lending rates. In such a scenario they show that transaction costs can account for almost half of the observed ERP.

However, Constantinides and Duffie (1996) demonstrate that inclusion of income heterogeneity and consumer heterogeneity, in an environment of incomplete consumption insurance i.e. in an environment where the opportunities to smooth out the inter-temporal consumption is very less, leads to prudent asset pricing model even without taking into consideration any market frictions or constraints. They show that any risky security would demand a positive or a negative premium depending on the negative or positive covariance of its return with the Stochastic Discount Factor (SDF) or the pricing kernel, without taking into consideration any market frictions or borrowing constraints. Brav, Constantinides and Geczy (2002) empirically demonstrate the result of Constantinides and Duffie (1996) and further show that limited participation of households in the stock market and idiosyncratic shocks to income in a representative agent economy is able to explain higher ERP with lower risk aversion coefficeint of three. This is because they show that the SDF is an equally weighted values of individual marginal rates of substitution.

Constantinides, Donaldson and Mehra (2002) consider a completely different form of heterogeneity among consumers in their overlapping generation model. They argue that the attractiveness of equtiy depends on correlation of its return with consumption which changes during the life-cycle of a representative agent. Young consumers have uncertain wage income and low correlation of consumption with equity return. In addition to that their marginal utility of consumption is high. Hence, equties should be more attractive to young consumers than the middle-aged consumers who do not face the wage uncertainty and has relatively high correlation of consumption with equity returns. The marginal utility of consumption of the middle- aged consumers is less and hence if their future consumption is correlated to equity returns, they will demand more premium from equities. However, young consumers are constrained from participating in the stock market by imposing borrowing constraints against their future wage. This is because human capital alone is not sufficient as a colletral for the loan. Hence, equties are almost exclusively priced by low marginal middle-aged consumers and hence demand higher premium. The overall effect of borrowing constraint on young consumers is that it drives down the risk-free rate (as bond securuites are almost exclusivley demanded by middle-aged consumers) and increase the ERP.

Heterogeneity in the particiaption in the stock market and its potential impact on ERP was also studied by Mankiw and Zeldes (1991). They take into consideration the food consumption of consumers who particpate in the stock market. They show that the distinction of consumption of stockholders and non-stockholders is an important input in understanding ERP as their data show that stockholder's consumption is more volatile and more correlated to stock market performance than that of non-stockholders. Therefore, in such a system using aggregate consumption in the standard C-CAPM to infer that the ERP is unsually high is inappropriate. Extending the idea of Mankiw and Zeldes (1991), Bach and Møller (2011) analyse the impact of the consumption of asset holders and non-assert holders on the returns of risky and risk-free assets by intoducing the habit formation in capital markets which have limited participation.They show that the consumption pattern of asset holders greatly influence the returns and yields on bonds thus ebabling them to provide a better explanation to the ERP puzzle with economically plausible risk aversion of 8.

To summerise, we see that this literature attempts to explain the ERP puzzle by incorporating idiosyncratic risk in labour income that may have impact on agent's consumption process which then leads to higher risk aversion. In addition to this, due to heterogeneity in the stock market participation, the impact of consumption of stock holders on ERP is different than the impact of consumption of non-stockholders. However, the literature does not differentiate between the impact of government consumption, private sector consumption and household consumption on ERP as these three main agents of an economy show different consumption patterns.

### 2.4.5 Recursive Utility Model

One of the disadvantages of using the power utility function, as used by Mehra and Prescott (1985) (Equation 2.2), is that it creates a rigid link between risk aversion and Intertemporal Marginal Rate of Substitution (IMRS). In fact, risk aversion and IMRS turn out to be reciprocal of each other. That is, the responsiveness of changes in consumption within a given time frame (relative risk aversion) is tightly linked (reciprocal) to responsiveness of consumption across the time (IMRS). This rigid link generates higher risk relative aversion to changes in IMRS which then ultimately translates to higher ERP. Hall (1988) Epstein and Zin (1989; 1991) propose a recursive utility function of the type:

$$U_t = \left\{(1-\beta)C_t^{\rho} + \beta.(E_t[U_{t+1}^{1-\alpha}])^{\frac{\rho}{1-\alpha}}\right\}^{\frac{1}{\rho}}$$

where, $\beta \in (0,1)$ is the time-preference parameter, $\rho = 1 - \frac{1}{\psi}$, $\psi$ is the Elasticity of Intertemporal Substitution and $\alpha$ is the RRA, which breaks this link and provide an explanation to low risk free rate. In fact, Hall (1988) categorically denies any connection between risk aversion and intertemporal substitution in consumption. He argues that elasticity of intertemporal substitution shows the propensity of consumers to shift today's consumption to future (time preferences) depending on the current interest rates, whereas risk aversion implies the propensity of consumer to shift consumption across states of the economy (state preference) and hence risk aversion should not be interpreted as reciprocal of IMRS, although numerically it may imply like that. Bansal and Yaron (2004) utilise Epstein and Zin (1989) preferences with and without time varying consumption volatility. By incorporating a persistent growth component and conditional volatility component in both the consumption and dividend processes, they match the observed values of equity premium, volatility of equity returns and the level of risk free rate. Using the same recursive preferences, they show that there is a negative correlation between price-dividend ratio and consumption volatility. However, Mehra (2003), argues that this type of function is factually unobservable and therefore fails to provide a satisfactory explanation of higher ERP. Epstein and Zin (1990) introduce non-expected utility framework within which the risk premiums are proportional to the standard deviation of the consumption process (first order risk aversion) rather than the variance (second-order risk aversion).

## 2.5 Factors affecting ERP

So far we have seen how different authors have suggested different modifications to the standard utility functions in order to reconcile the observed ERP with the theoretically implied ERP, i.e. various resolutions to the ERP puzzle keeping the essence of standard representative agent-based utility maximising framework. This section, on the other hand, attempts to examine the literature that investigates and establishes a link between ERP with other macroeconomic factors (determinants) and stock market factors in both domestic and international context using time series modelling.

### 2.5.1 Domestic Factors affecting ERP

This sub-section deal with literature investigating the relationship between macroeconomic and stock market factors with ERP developed in one particular country. The relationship is developed by various modelling techniques such as linear and non-liner regression modelling, time series modelling like ARIMA, VAR and GARCH models, Markov regime switching models.

Keim and Stambaugh (1986) regress three variables viz. the spread on BBA-rated corporate bond yields and 1-month US T-bills yields, the change of S&P 500 with respect to its 45 years moving average level and the log price level of highly volatile stocks belonging to first quintile by size in the NYSE stock exchange, on the ERP of seven types of portfolio containing long term US Government bonds, High quality corporate bonds, BBA rated corporate bonds, BAA rated corporate bonds and first, third and fifth quintile, by size, of stocks on NYSE. They show that nearly 32% variation in the risk premium of the small stocks can be explained by the January-effect. The most important finding is that the risk premium on many assets, appear to change with time.

Labadie (1989) demonstrate that stochastic inflation affects ERP through two channels: the first channel is through the covariance of marginal rate of substitution (MRS) with equity price and covariance of MRS with purchasing power of money. And the second channel is through the inflation risk premium. Tristani (2009) incorporates this inflation risk premium to define the relative ERP as the actual observed ERP over and above the inflation risk premium. He studies the impact of monetary policy uncertainty on ERP and the natural rate of interest. He shows that the household's confidence in the Central Bank's ability to conduct monetary policy could affect ERP. The uncertainty of future monetary policy can affect the natural rate of interest, in equilibrium, by 10-20 bps while leading to increase in the ERP by 1.7%. Similarly Bernanke and Kuttner (2005) conduct an event study which examines the impact of unanticipated changes in monetary policy on ERP. Specifically, they study the impact of unexpected changes in the Federal Funds futures rate on ERP. Their findings suggest that a tighter monetary policy raises the expected ERP by making stocks riskier. They argue that this unwillingness of the investors to bear the risk arises due to expected fall in the consumption. Bansal and Coleman (1996) develop a monetary model of the economy in which assets other than narrowly defined money (risk-free government bonds) are used for transaction purposes or are used to back the instruments which are used for transactions viz. cash, cheques an credit. They assume that because these assets are used for transaction purposes, the return on them is reduced due to transaction service return (transaction cost) which affects the return on risk-free assets and hence the ERP. They calibrate their model to the US data for period 1959-1991. When the parameters are estimated using GMM, the risk free rate was 1.12% compared to the actual value of 4%. The ERP in the actual data was 5.02% whereas the model estimate was 2.42% with relative risk aversion of 1.49 and subjective discount factor of 0.998.

Another important variable which may have similar implications for ERP is the term structure of interest rate. Campbell (1987) studies the impact of term structure of interest rates on excess returns on bills, bonds and stocks in the US for the period 1959-1983. He shows that excess returns on the three types of assets viz. bills, bonds and equity (ERP) can be predicted using these four term structure variables. Boudoukh, Richanrdson and Whitelaw (1997) study this association of term structure with ERP in the US for the period of 1802-1990. They show that there is a significant non-liner relationship between the slope of the term structure of interest rate (difference between the yields on long term bonds and short term bonds) and equity premium. An interesting result of their study is that variations in ERP do not depend on variations in the variance of ERP and the ERP is negative only when the covariance of equity returns with marginal rate of substitution is positive. Similarly Kanas (2008) assesses the relationship between the ERP and the slope of term structure of interest rate by using data from the US, the UK and Japan. He shows that there is significant asymmetric regime-dependent non-liner relationship between ERP and the term structure. He employs 2-state (low volatility and high volatility of ERP) Markov switching model to show that in the state of low volatility of ERP, the ERP in next year is affected by the increase in the slope of the term structure whereas a decrease in the slope or negative slope of term structure has no impact on next year's ERP. A similar 2-state regime switching Markov process was used by Kanas (2009) to show a bi-directional relation between the Bond Maturity Premium (BMP) and ERP in the UK for the period 1900:2006. He shows that both lagged values ERP and BMP can predict each other in the low volatility regime (bi-directional relationship). However, the relation between the ERP and lagged BMP is positive while the relation between the BMP and lagged ERP is negative.

Pesaran and Timmermann (2000) utilise a recursive modelling methodology to predict the UK stock market returns. In particular, they use UK macroeconomic variables to predict the excess stock return (equity risk premium). They conclude that there is not only a statistically determinate relationship between the macroeconomic variables and the ERP but the lags of the variables also have significant impact on the excess return depending on the selection of models. Kizys and Spencer (2008) use tri-variate exponential GARCH-in-mean model to assess the impact of macroeconomic volatilities on UK ERP. They use volatilities in RPI inflation, industrial output and long term government bond yields to explain their impact on UK ERP. They show that the UK ERP is associated with covariance of growth in output and equity returns. However, the covariance of inflation with equity returns has no significant impact on the UK ERP.

Secondly, they also show that the UK ERP is highly affected due to the volatilities in the macroeconomic variables. In order to consider the impact of corporate earnings, dividends, aggregate consumption and market crash-like events as in Rietz (1988), Longstaff and Piazzesi (2004) show that ERP is composed of three elements viz. Consumption Risk Premium, Corporate Risk Premium and Event Risk Premium. They show that for the US data from 1929-2001, the consumption risk premium of 0.36%, event risk premium of 0.51% and corporate risk premium of 1.39% giving ERP of 2.26%, using risk aversion of five. Bhar and Malliaris (2011) also study the impact on dividends on the ERP of the US between the period 1965-2008 using three-state regime switching Markov process, in conjuction with other macroeconomic variables such as CPI inflation and unemployment and behaviour variable such as momentum. They show that dividends significantly affect ERP in all the three states along with momentum. However, unemployment and inflation affect ERP asymmetrically in the three states. In contrast to this Goyal and Welch (2003) analyse the predictive ability of dividend ratios (dividend yields and dividend-Price ratios) on ERP. They find that both dividend ratios have poor in-sample and out-of-sample predictibility of ERP. In fact they show that predictive ability of the dividend ratios on ERP was always unstable across the their sample period. Similarly Welch and Goyal (2008) study the impact of three main groups of variables. These are:

1) Stock Specific Variables: Dividends, dividend yield, earnings yield, stock variance, cross-section premium, book/market value raio, net equity expansion.
2) Interest Specific Variables: 3- months T- bills yields, long term yield, long term government bond rate, terp spread, yields on corporate AAA and BAA rated, defalut spread, default return spread, inflation

3) Investment to capital ratio.

They regress the above independent variables on ERP and study their ability to forecast ERP both in-sample and out-of-sample using their out-of-sample statistic. Contrary to Bhar and Malliaris (2011), they find that the above set of variables do not have significant predicitilbity on ERP if they use regression for each and every variable both in-sample and out-od-sample. However, Campbell and Thompson (2008) respond to Goyal and Welch (2008) by estimating the out-of-sample performance of the same predictor variables to check whether they can predict ERP. They show that the predictor variables used in Goyal and Welch (2008), indeed, can predict out-of-sample ERP under the restrictions imposed on the coeffcients of the regression model. The predictive power was less, nevertheless it was sufficient enough to be economically significant. In addition to that, Campbell and Thompson (2008) also show that the predictors variables almost always outperform the historical average of the ERP as a predictor variable for future ERP. Similarly, Rapach, Strauss and Zhou (2010) find contradicatory results to that of Welch and Goyal (2008). Lettau and Ludvigson (2001a; 2001b) empirically demonstrate the predictive power of aggregate consumption to wealth ratio on excess returns within the framework of conditional CAPM and C-CAPM. They show that the consumption-welath ratio, labour income and asset holdings are conitegrated and any deviation from this cointegrating relation can help predict the excess returns.

To asses the impact of frequency of volatality of macroeconomic variables such as GDP, aggregate personal consumption expenditure and fundamental valuation ratio such as price to dividend ratio on ERP, Lettau, Ludvigson and Wachter (2008) carried out the two-state Markov regime switching analysis. They find that ERP has been declining over time since the 1990s because of steady decline in the volatility of the macroeconomic factors i.e. reduced macroeconomic risk. Devaney (2008) study the impact of macroeconomic variables on ERP in the US for the period of 1870-2002. He estimate the following regression model pre and post World War II:

$$ERP = \beta_0 + \beta_1 . M1 + \beta_2 MFP + \beta_3 \delta Dy + \beta_4 pop + \varepsilon_t$$

where, M1 is the growth in M1 money supply, MFP is the multi-factor productivity, $\delta Dy$ is the change in the dividend yield and *pop* is the population growth rate, to show that the predictive power of the different macroeconomic variables on ERP is changing through time. Drechsler and Yaron (2011) study the relationship between the volatility of aggregate consumption growth rate with ERP by modelling the consumption process using jump-diffusion modelling. They show that "jumps" in the consumption growth process can better explain the behaviour of ERP. In addition to that they also show empirically that the variance risk premium, defined by the squared difference between the conditional variance of returns and the one implied by the CBOE's VIX index, better captures the uncertaintiy of individuals thus explaining the ERP.

Parker and Julliard (2005) show that the long-run consumption risk i.e. covariance of consumption with expected excess returns over the period of three years explain larger variation in the expected excess returns rather than contemporaneous consumption risk. They assume a representative agent follows non-seperable utility preference. Yogo (2006) studies the asymmetric impact of marginal utilities of durable consumption and non-durable consumption on the expected returns of small, value, growth and big stocks by constructing durable and non-durable consumption betas. He assumes that the representative agent follows the recurrsive utility preference. He finds that expected stock return is proportional to non-durable consumption growth relative to durable consumption growth and that ERP is countercyclical. Jacobs and Wang (2004), Tednogap (2007), Boguth and Kuehn (2013) study the pricing power of the first two moments of consumption growth rate process on stock returns and ERP. Jacobs and Wang (2004) study the impact of idiosyncratic risk associated with consumption growth rate process on ERP by decomposing the stochastic discount factor into weighted average of the first two moments of consumption growth. On the other hand, Tednogap (2007) modelles the consumption volatility using GARCH (1,1) specification. Boguth and Kuehn (2013) models the first and second moments of the consumption growth process by using Markov chain. They estimate the dynamics of the consumption process as a combination of time-varying service consumption and inverse of service consumption.

However, Söderlind (2006) show that covariance of consumption growth rate with equity return fails to expain the cross section of excess returns on 25 Fama and French (1993) even with the modifications proposed in the habit preferences and incomplete markets literature. He aslo shows that in order to satisfy the basic asset pricing identity implied by C-CAPM, one needs an exceptionally high value of relative risk aversion co-effcient even under most modifications proposed to refine the utility preferences. Santos and Veronesi (2006) theoretically shows that if the agent's income is composed of labour and dividend income which grows stochastically over time, then ratio of labour income to consumption can forecast ERP. In contrast to these studies Bansal, Dittmas and Lundbald (2005) show that single factor models such as C-CAPM and CAPM fails to explain the the risk premia in the cross section of 30 portfolios, formed accoring to size, book-to-market and momentum. They show that aggregate cosnumption and market portfolio cannot explain the risk premia in these 30 portfolio. They consruct cash-flow betas which explains 60% variation in the risk premia across these portfolios better than C-CAPM, CAPM and Fama and French (1992) three factor models.

On a different note, Jermann (2010), study the determinants of ERP by liking production and investment behaviour of a representative firm with its return in the stock market and risk- free rate of interest using the adjustment-cost functions and stochastic productivity as the main inputs. He link firm's cost and revenue functions to its return in the stock market and risk free rate to show their impact on ERP.

Differential tax treatment on the income from equity investments and fixed-income securities, in particular investment in government sucrities, can also have a major impact on ERP. Favourable tax treatment to dividends as opposed to interest income from the risk free securties can significantly alter the perception of investors towards equity investment and fixed-income investment. The impact of tax policies on ERP and on the ERP puzzle was studied by McGrattan and Prescott (2003). They empirically show that ERP is not unusually high i.e. it is not puzzling if one takes into consideration capital gains tax, brokerage and higher diversification costs. On the other hand Leibowitz (2003) argues that different tax rates applied to equity income and to the income from fixed-income security causes higher ERP as favourable tax policies towards equity acts as shield on the fixed-income security. He suggests that the after-tax ERP is unaffected by inflation.

### 2.5.2 International Studies on ERP

In this subsection I shall present evidence that overcomes the so called *'Survivorship Bias'* that was associated with ERP in the US. It is argued in the literature that because the US is the most successful developed economy that survived many of the global shocks, the US equity markets are able to provide more excess returns than any other developed economy. One of the pioneering study in this context was done by Bekaert and Hodrick (1992). They analyse the predictable components in the equity premium and foreign exchange markets in four major countries the US, the UK, Germany and Japan using pair-wise first-order vector auto-regression (VAR) of the type:

$$\boldsymbol{Y}_t = \alpha_0 + \beta \boldsymbol{Y}_{t-1} + \mu_t$$

where $\boldsymbol{Y}_t$ is the vector of equity premiums in domestic and foreign currency, nominal excess returns of foreign money market instrument on corresponding US nominal interest rate, dividend yields on foreign and domestic equity markets, $\beta$ is the 6 X 6 matrix of coefficients and $\mu_t$ is the innovation in the $\boldsymbol{Y}_t$. They find that equity premium can be predicted by dividend yields and forward exchange rate premium. A similar result i.e. the relation of equity premium and forward exchange premium was demonstrated by Korajczyk and Viallet (1992) nine developed nations. They also find that if the movements in stochastic discount factor as measured by the IMRS is explained by a diversified stock portfolio then movements in the forward exchange rate premium in time can be explained by movements in equity premium. However, the conditional mean returns on the forward exchange contracts have a component which cannot be explained by the returns on equity market portfolio.

Chan, Karolyi and Stulz (1992) study the impact of foreign equity market on the US ERP by employing GARCH-in mean modelling and by using Nikkei 225, MSCI EAFE and MSCI Japan indices. They find that the conditionally expected ERP on S&P 500 index was proportional to conditional covariance between S&P 500 and Nikkei 225, but not significantly proportional to variance of S&P 500 index. In addition, they also find that the strength of the proportionality decreased progressively when they used MSCI Japan and MSCI EAFE indices. Whereas, Ferson and Harvey (1994) use factor regression modelling for 18 countries to show the impact of eight different variables, namely USD return on MSCI world index in excess of short term interest rate, log return of USD index measured as trade weighted index with G10 countries, unexpected global inflation for G7 countries, G7 industrial production growth rates, change in inflationary expectation of G7 countries, monthly change in long-term inflationary expectation of G7 countries, treasury-Eurodollar spreads (TED) and weighted average of short-term interest rate in G7 and changes in oil prices. They demonstrate that global risk factors can explain between 15% -86% variance in the monthly ex-post returns and that world market portfolio is the largest influencing factor accounting for 16-71% of the variation in the ERP depending on the country. An interesting finding is that as the number of risk factors in the model increase, much of the performance of the Japanese and Hong Kong stock market compensate for the global economic risk. Longin and Solnik (1995) study the stability of the correlation of equity premium across the time period 1960-1990 in seven major stock exchanges using GARCH (1, 1) process. The information variables used in the GARCH (1, 1) process are dividend yields and short-term interest rates for the variance equation. They find that the matrix of correlations and covariance of equity premium is unstable through the time. Dropsy (1996) use seven different types of macroeconomic variables as information set to test their predictability on ERP of four major stock markets, the US, the UK, Germany and Japan. He employs three different types of modelling technique, linear regression, Non-linear neural network modelling (to test the out-of-sample predictability) and random walk model. He finds that the seven information variables predict ERP better by using linear regression model than the non-liner on the basis of Root Mean Squared Error, whereas the non-liner neural network model was better in predicting the out-of-sample ERP using the same seven conditioned variables. To study the impact of inflation on ERP in the international setting Beirne and De Bondt (2008) consider a simple liner regression model between the inflation and ERP in major developed economies of Japan, Australia, Euro area, Germany, France, The Netherlands, Switzerland, the UK, the US and Canada. They find that there is strong positive relation between the inflation and ERP in these countries. An interesting finding of their study suggests that ERP has been decreasing over time and that inflation affected ERP predominantly prior to the 1990s but the effect has been decreasing since then. The low levels of inflation in the period after the late 1990s are the key contributor in explaining the low levels of ERP. Sarkar and Zhang (2009) study the implications of time-varying correlation and covariance between ERP and consumption growth in G7 countries. They show that under some negative exogenous shock to labour income and positive shock to stock returns, the correlations and covariance are higher and that they are counter-cyclical.

## 2.6 Summary

The ERP is one of the important concepts in financial economics. It is a major input in factor models for asset pricing like the CAPM, determining the cost of capital which in turn is used for equity valuation of equities using free cash flow technique and in asset allocation. It is an immensely important parameter for wealth building especially for Pension Funds, as the mangers of these types funds have to achieve a delicate balance of protecting the capital of their investors whilst ensuring that they generate enough returns for their investors for their future retirement.

Since the seminal work of Mehra and Prescott (1985), which outlines the empirical inability of the standard economic theory of CCAPM to explain why investors in the US are more risk averse than predicted by the theory, economist have been on a quest to develop a model within the framework of CCAPM which can explain high ERP with low risk aversion and at the same time explain time variation in the ERP. The modifications to the standard utility function based on habit formation, rare disaster hypothesis, behavioural finance, incomplete markets and heterogeneous agents and recursive utility have come very close to explain the ERP puzzle, however none of the models have clearly proposed any definitive solution to it. As such it is not unreasonable to say that the ERP puzzle is still a puzzle, a conclusion that is in line with Kocherlakota (1996). In fact an attempt to resolve the puzzle leads to another puzzle, the so- called Risk Free rate puzzle as proposed by Weil (1989). Perhaps by examining the time variation in the volatility of the equity returns and risk free rate by using dynamic stochastic general equilibrium model or developing a function of ERP which has only two arguments, the stochastic volatilities of equity returns and risk free rate, will lead a step closer in resolving and explaining the ERP puzzle. This approach would ensure that ERP will depend only on the level and variation in the second moments of equity returns and risk free rate.

Most of the above models concentrate more on equity side of the ERP to explain the ERP puzzle and time variation in the ERP without giving much attention to the 'risk-free' side of ERP, except by Weil (1989) who advocate that the ERP puzzle is due to unusually low risk free rate (the risk-free rate puzzle) . Hence by investigating what risk free we use to estimate the ERP and whether or not the traditional risk free rate used by the literature is indeed "risk free" will lead to much better explanation to ERP puzzle.

Additionally, by examining the risk premiums offered by alternative investments may prove effective in explaining the risk premium offered by equity investment.

## 2.7 Aims and Objectives

In this sub-section I present the aims and objectives of the research. The examination of the above literature reveals three research gaps that warrant further research;

1) The extant research is limited in understanding the interaction between the monetary policy shocks and ERP in presence of unconventional monetary framework. That is, there is practically no empirical evidence in the literature that can show the impact of monetary policy shocks before and after Quantitative Easing (QE) on ERP in the UK. Such an empirical research seems useful given the fact that Bank of England has actively implemented QE, both in the wake of financial crisis of 2007-2009 and in the wake of UK's exit from the European Union. As such, the aim of the empirical paper 2 is to evaluate the impact of monetary policy shocks on the ERP before and after QE. Against this backdrop, the objective is to assess whether the response of ERP of aggregate and sectoral FTSE indices is different before and after QE. Additionally, I also investigate the impact of monetary policy shocks in the cross-section of ERPs of 25 Fama-French Style Portfolios constructed on the size and book-to-market characteristics. Such an investigation could reveal vital piece of information regarding transmission channels of monetary policy.

2) As seen in the review above, the empirical failure of classical CCAPM encouraged many researchers to develop advanced forms of CCAPM[1]. In these advanced versions, the risk of consumption on asset prices are estimated using pricing kernels which are usually expressed as a linear factors of combination of state variables and a consumption-based variable. However, these studies are confined in the way consumption risk is estimated, in the sense that they do not account for the impact of unexpected monetary policy changes on consumption. The classic consumption-wealth channel postulates that changes in consumption could be initiated by the changes in monetary policy which may have asset pricing implications. Further, since most of the classic and advanced form of CCAPM studies rely on the non-durable consumption, we do not have clear evidence in the literature regarding the impact of dis-aggregated consumption on the ERP. That is, we do not know whether the risk of durable, semi-durable and non-durable consumption has a differential impact of ERP. Against this backdrop, the aim of Paper 3 is not only to assess the impact of aggregate consumption risk, but also to investigate the impact of dis-aggregated consumption risk on the UK ERP. The objective is to investigate whether aggregate and dis-aggregated consumption shocks have a differential impact on the ERP of aggregate and sectoral FTSE indices. Further, I also investigate the impact of aggregate and dis-aggregate consumption shocks across the ERPs of 25 Fama-French style portfolios. Additionally, I also study the cross-sectional pricing ability of both aggregate and dis-aggregate consumption shocks in the cross-section of 25 size and book-to-market sorted portfolios.

[1] I will discuss these versions of CCAPM in the Paper 3 in more details.

3) Although the extant literature has established the impact of innovations in aggregate market volatility on stock returns, yet most of the studies are confined to either historical or conditional market volatility. In paper 4, I argue that the implied volatility is a better measure of aggregate market risk than realised or conditional volatility. This is because implied volatility is a forward looking measure of market risk. Further, I also argue that it is critical to assess the differential impact of innovations in both the short term and the long term implied market volatility on the ERP. Thus, the aim of paper 4 is to evaluate the impact of innovations in short and long term market implied volatility on UK ERP. For this I use the ex-post ERP of same FTSE indices (aggregate and sectoral indices) and 25 Fama-French style portfolios used in paper 3. Further I also investigate the cross-sectional pricing ability of innovations in the short and long term market implied volatility in the cross- section of these portfolios. The investigation in this paper is motivated on the theoretical grounds of Merton's (1973) ICAPM and Campbell's (1993) version of ICAPM. That is, innovations to short and long term market implied volatility are shown as state variables that can affect invertor's future investment opportunity set.

In summary, the aim of this research work is to identify the key determinants of the UK ERP based on three different theoretical lenses.

## List of Figures

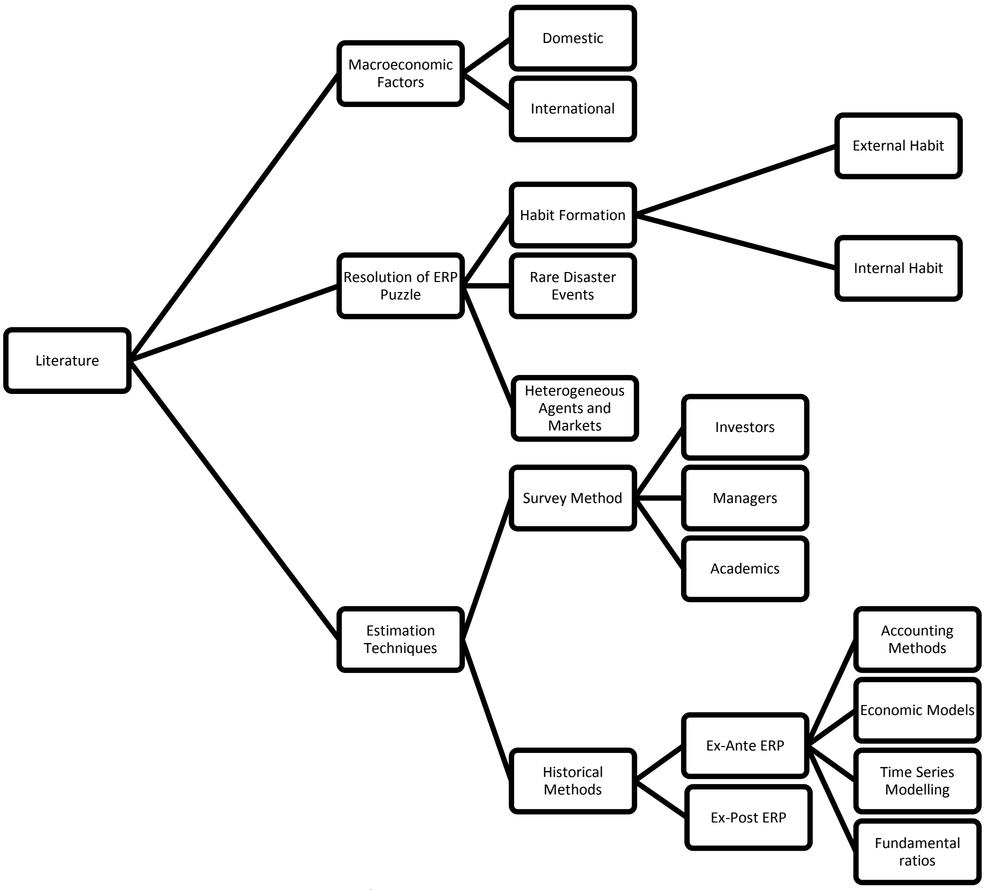



**Figure 2.1: Literature Classification**

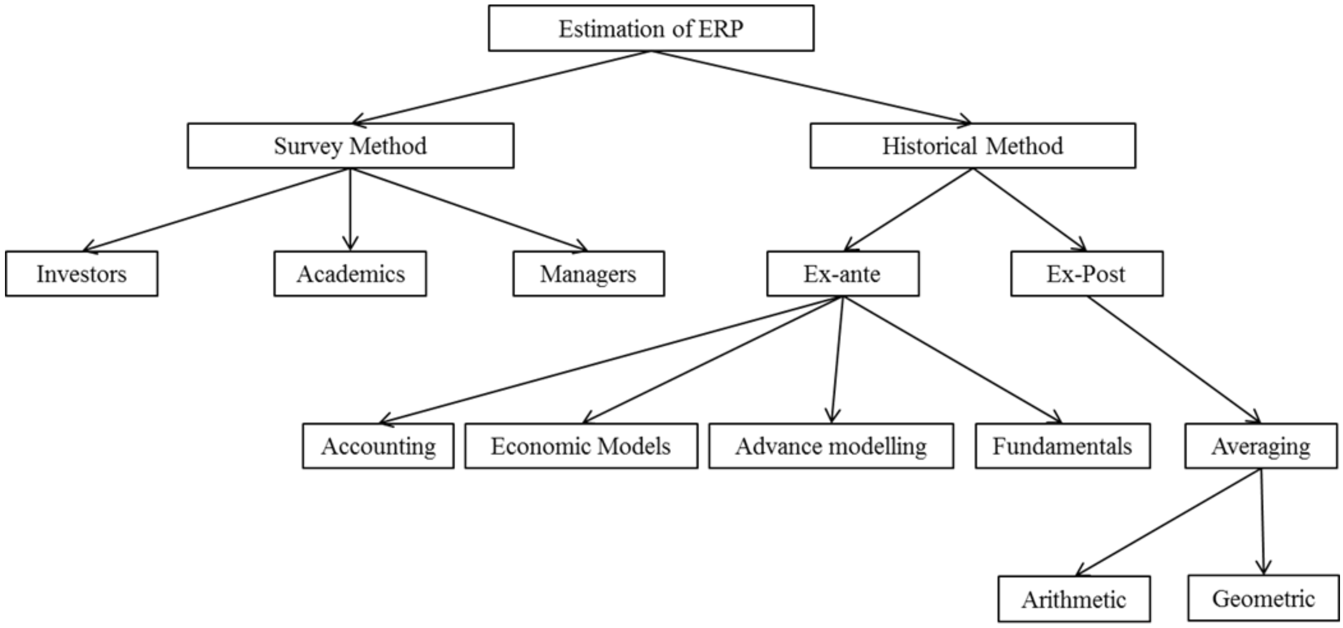



**Figure 2.2: Estimation Techniques of ERP**

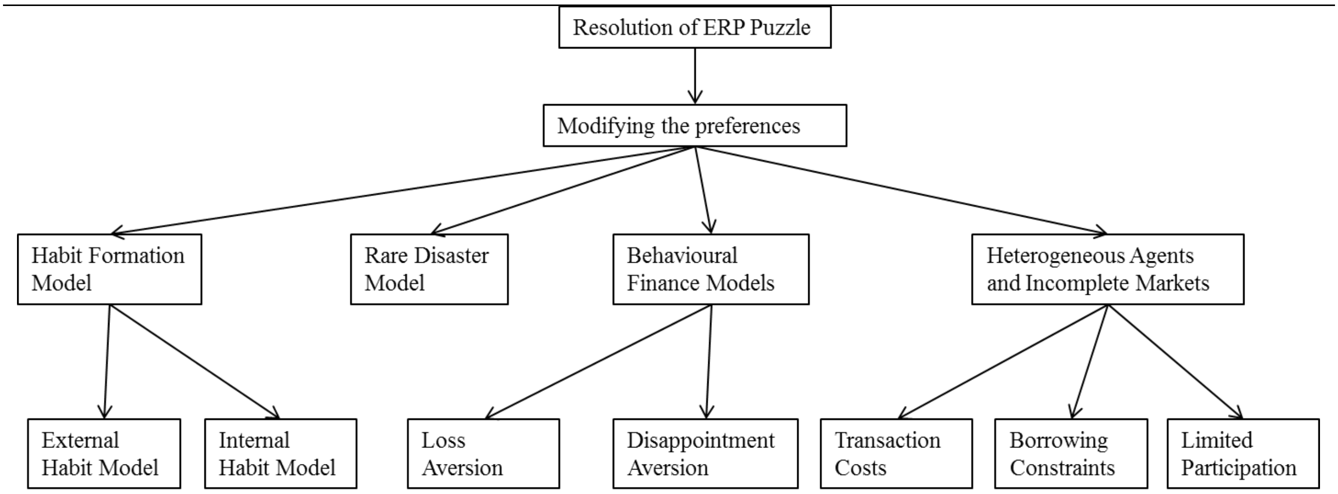



**Figure 2.3: Resolution of ERP puzzle**

# Paper 2

## 3 The impact of monetary policy shocks on the ERP before and after QE in the United Kingdom

*"The problem with QE is that it works in practice but it doesn't work in theory."*

Ben S. Bernanke, Former Chairman, Federal Reserve Bank

**Abstract**

In this paper I investigate the impact of structural monetary policy shocks on ex-post Equity Risk Premium (ERP) of aggregate and sectoral FTSE Indices and 25 Fama-French style value-weighted portfolios. I find that monetary policy shocks negatively affect the ERP but at the sectoral level, the magnitude of the response is heterogeneous. Further, monetary policy shocks have a significant negative (positive) impact on the ERP before (after) the implementation of Quantitative Easing (QE). The empirical evidence provided in the paper sheds light on the equity market's asymmetric response to the BOE's policy before and after the monetary stimulus.

**Keywords:** Monetary policy, Equity Risk Premium, Quantitative Easing, Monetary policy shocks, Structural Vector Autoregression

***JEL Classification*****:** *E5; E30; G0* and *G1*

### 3.1 Introduction

The monetary policy of the United Kingdom has two main objectives; price stability and financial stability, to ensure sustainable economic growth and the smooth functioning of financial system. Consequently, the Monetary Policy Committee (MPC) of Bank of England (BoE) has to maintain 2% target inflation as required by the

Treasury whilst the Financial Policy Committee (FPC), monitors the systemic risks to the financial markets. There are various channels through which the impact of monetary policy could be transmitted to the economy and these have been discussed in the extant literature [see for example, Bernanke and Blinder (1992), Bernanke and Kuttner (2005)]. Mishkin (1996) explains how stock markets act as one of the important channels of monetary policy transmission. Changes in the monetary policy, measured either using changes in money supply or changes in short term interest rates, should induce revaluations in the stock market. As such, contractionary or expansionary monetary policy should affect future expected returns through the changes in discount rates at which the future expected dividends are discounted. This paper investigates the impact of monetary policy shocks on the Equity Risk Premium (ERP) in the UK before and after the Quantitative Easing (QE) which was introduced in the wake of 2007-2008 financial crisis.

There is extensive research that examines the response of stock market returns to domestic monetary policy shocks particularly in the US. [see for example, Bernanke and Blinder (1992), Thorbecke (1997), Gilchrist and Leahy (2002), Rigobon and Sack (2003, 2004), Bernanke and Kuttner (2005), Ioannidis and Kontonikas (2008) and Castelnuovo and Nisticò (2010)]. However, research on the UK market is relatively sparse and dated. Bredin, Hyde, Nitzsche and O'reilly (2007) examine the behaviour of UK stock returns both at aggregate and industry level in response to UK domestic monetary policy shocks. They decompose the changes in the policy rate as expected and unexpected changes and report that the impact of monetary policy shocks on the UK stock market is heterogeneous i.e. the sensitivity of aggregate stock market to the shocks in the domestic policy changes is different as compared to the impact at the industry level. While the impact of monetary policy shocks on the stock market before the financial crisis of 2007-2008 has been studied under the conventional monetary policy framework, the impact on the ERP before and after unconventional monetary policy is still emerging.

Under the conventional monetary policy, BoE achieves its price stability objective by inflation targeting which is operationalised using a single monetary policy instrument, i.e., the interest rate. However, in the aftermath of the financial crisis, BoE was confronted with multiple challenges. On one hand it was required to maintain the target inflation and on the other hand, it had to provide liquidity to the interbank market. These objectives could not be achieved using single monetary policy instrument. As a consequence, the MPC was authorised by the Chancellor of the Exchequer to set up large scale Asset Purchase Facility (APF). Under this facility the BoE purchased high quality assets such as Treasury Bills and Bonds from the private sector financed by creating central bank reserves. In addition to buying government securities, the BoE also purchased private sector assets such as corporate bonds to provide much needed liquidity. [2] Thus the QE became the primary monetary policy tool for the BoE.

The channels through which the QE programme can affect asset prices are discussed by Krishnamurthy and Vissing-Jorgensen, (2011). Out of the seven possible channels that they postulate, the signalling channel seems to be more promising. Under this channel, the inclination of a central bank to keep the interest rate lower than that implied by the Taylor (1993) rule leads to lower yields on long-term bonds and higher prices of risky

[2] This form of unconventional monetary policy was first adopted by the Japanese Central Bank in the 1990s and is known as Quantitative Easing (QE) because the monetary policy is operationalised by purchasing large quantities of high quality assets which leads to the expansion of the balance sheet of the bank rather than through the traditional interest rate lever.

assets. In the case of the UK, Miles, (2011, 2012) discusses two main channels of transmission of QE effects to the broader asset markets. The first is the portfolio substitution channel which is also known as portfolio re-balancing channel.[3] Under this channel, the BoE buys gilts from the non-bank private sector investors, such as pension funds and insurance companies by financing the purchase using central bank reserves. However, these deposits are likely to be imperfect substitutes of the assets that are sold by the private sector to the BoE. Since pension funds and insurance companies have long-dated liabilites, they match the libaility duration by purchasing long term government bonds. This leads to declining yields on long dated bond thus reducing the term-premia. Additionally, declining yields on long term bonds encourage the private sector to raise new debt for financing new investments and/or dividend payments to equity holders[4].

The genesis of the portfolio rebalancing channel could also be found in the monetary portfolio model [the name was coined by Rozeff, (1974), developed by Friedman, (1961)]. In this model, investors are expected to attain equilibrium between different assets in their portfolio which includes money. Any exogenous monetary shock such as arising from changes to money supply would encourage investors to exchange cash for equities and/or bonds. This will affect real money balances and returns on equities and bonds.

The second channel through which the effects of QE could be transmitted to broader asset markets and ultimately to the wider economy is through the bank lending. Since

---

[3] The theoretical underpinning of portfolio re-balancing channel i.e. the idea of imperfect asset substitution has a long tradition in macroeconomics (see, Tobin, 1969).
[4] See, The Distributional Effects of Asset Purchases. Bank of England 12th July 2012. Available through http://www.bankofengland.co.uk/publications/Documents/news/2012/nr073.pdf

the BoE finances purchase of gilts from bank and non-bank instititions through reserves, there is an overall rise in deposits in the banking system. This leads to an overall increase in lending to the small and medium scale industries and household sector which in turn encourages investors to invest in riskier assets such as equities.

Figure 3.1, provides anecdotal evidence of the impact of QE on the UK stock prices. In particular, the figure shows the impact of QE announcments on the closing prices of FTSE 100 index. The effects are clearly visible following the BoE’s decisions in March 2009 to purchase £75 billion of assets, in October 2011 to increase the QE programme to £275 billion, and in July 2012 to further increase the asset purchases to £375 billion.

****Please insert figure 3.1 about here****

Extant research too, shows the efficacy of unconventional monetary policy and its impact on various asset prices. For example, Gagnon et al., (2010, 2011) show that QE not only reduces the yields of bonds bought under the scheme, but also yields of bonds which were not purchased under the Large Scale Asset Purchase programme. The findings reported by Gagnon et al., (2010, 2011) are further supplemented by Joyce, Lasaosa, Stevens and Tong (2011) who investigate the impact of QE programme on the UK asset prices. They find that following the QE, the yields of the investment and speculative grade corporate bonds decline by 70 basis points (bps) and 150 bps respectively. Additionally, they also investigate the impact of QE on equity prices around the announcement of the QE programme. They conclude that equity prices show an increase since the start of QE in March 2009. Further, Meier (2009) provides evidence of decline in yields following BoE’s asset purchase programme. Glick and Leduc (2012) suggest that the impact on yields is not restricted to the US and UK as their research shows that long term interest rates decline globally following the announcements of the QE programme by the FED and the BoE.

Although there is a consensus that QE leads to declining bond yields, it is not empirically shown how the QE affects the ERP. In this paper, I investigate and compare the response of ERP to the monetary policy shocks before and after the introduction of QE. The approaches to identify exogenous monetary policy shocks can be broadly classified in two categorised; event study and Structural Vector Autoregression (SVAR). Previous researches which use the event study approach have significant limitations. In an event study approach, the strategy of analysing impact of monetary policy shocks on asset market returns around a narrow window of time, does not explicitly account for the feedback rule. It is important that the model should include feedback based on changes in other macroeconomic variables such inflation, changes in unemployment, etc. to capture the impact of monetary policy shocks. The SVAR approach explicitly accounts for a feedback rule. One of the distinguishing features of monetary policy shocks identified using SAVRs is that, apart from being exogenous, they represent the deviations from expected policy response. These deviations may arise from discretionary policy due to abnormal events, changes in the composition of MPC, changes in either the weights associated with target variables, and/or changing the target variables itself. Further, as the systematic component of monetary policy can be captured by a standard monetary policy reaction function, the deviations from such a function can also be interpreted as a non-systematic component of monetary policy [see Christiano, Eichenbaum and Evans, (1996,1999) and Kilian, (2012)].

I, therefore, use SVAR approach which overcomes the limitation of the event study approach. Further, innovations in the short-term interest rates derived from SVAR are a more reliable proxy of monetary policy shocks [Bernanke and Blinder (1992) and Sims, (1992)]. Subsequently Gali (1992), Pagan (1995), Christiano, Eichenbaum and Evans, (1996,1999), Kim, (2001) and others have relied on identifying monetary policy shocks as innovations in the short term interest rates rather than money supply. In this article, I use shocks in interest rates as a proxy of monetary policy shocks. There is evidence which suggests surprises in interest rate instrument should be a preferred way to measure monetary policy shocks. For example, Eggertsson and Woodford, (2003) suggest that although at zero-lower bound a central bank can stimulate the economy by purchasing assets on open market and thereby (in theory) expanding the monetary base, yet such a policy cannot be entirely considered as a main policy instrument. They stress that optimal monetary policy can be operationalised by using short-term interest as a policy instrument. I, therefore, rely on this normative framework and extract the structural monetary policy shocks in the interest rate instrument of monetary policy using a SVAR approach.[5]

I investigate the impact of monetary policy shocks on the aggregate and disaggregate data. I calculate monthly ERP for the FTSE 100, FTSE 250, and ten sectoral FTSE ALL indices which include Basic Materials, Consumer Services, Consumer Goods, Financials, Healthcare, Industrials, Oil and Gas, Telecom, Utilities and Technology. Use of disaggregated data will enable us to confirm whether the impact of monetary

[5] SVAR approach is the workhorse of macroeconomics to analyse the rich dynamic effects of structural shocks in the monetary policy [see, Bernanke (1986), Thorbecke (1997), Bjørnland and Leitemo (2009), Lastrapes (1998); and Neri (2004)]

policy shocks is heterogeneous amongst the various industries. There are several reasons the impact may differ across industries. First, the demand for product and services may have different interest rate-sensitivity. Second, under the rational assumption that exchange rates may respond to monetary policy shocks, the sensitivity of demand for the tradable goods and services may change due to fluctuations in the exchange rate caused by the monetary policy shocks. Third, capital-intensive industries, cyclical industries and financial services industries may react differently due to different interest-rate sensitivities (Ehrmann and Fratzscher, 2004).

I also investigate the impact of monetary policy shocks on the 25 Fama-French style value weighted portfolios based on the firm characteristics such as size and book-to-market ratios. Since Bernanke and Kuttner (2005) show that the risk premia varies across the cross-section of the market (i.e. size and the value premia are different), I expect that monetary policy shocks may have heterogeneous impact on the portfolios formed on the basis of value and size. By investigating the impact of monetary policy shocks on the ERP of portfolios constructed on the basis of size and value characteristics, I will be able to validate other channels of monetary policy transmission vis-à-vis the balance sheet channel and the bank lending channel (Mishkin, 1996). The balance sheet channel implies that a positive monetary policy shock would severely dampen the revenues of firms, particularly small firms, and increase their cost of financing. On the other hand, the bank lending channel has more direct impact on small firms. Small firms depend more on bank loans than big firms. In the event of positive monetary policy shocks, credit becomes more expensive for small firms. In either case, positive monetary policy shock could lead to an increase in the ERP depending on the firm size.

The contribution to the existing literature is three-fold. First, as far as I am aware, there is no study that has shown the impact of monetary policy shocks before and after the implementation of QE. Second. as suggested by Doh, Cao and Molling, (2015), the impact of monetary policy shocks on ERP may reveal useful insights of the effects of macroeconomic events which are not captured by conventional macroeconomic factors such as inflation and output gap. Finally, since ERP is a key component for evaluating the cost of capital and asset allocation decisions, it is vital to understand how it responds to monetary policy innovations.

The results show that a positive monetary policy shock, i.e. when the actual interest rates are more than the expected interest rates has a negative impact on the ERP of most of the FTSE Indices. However, the magnitudes of the sensitivities of the ERP are different suggesting that monetary policy shocks have a heterogeneous impact on different industries. The findings are similar for the 25 Fama-French style value-weighted portfolios constructed on size and book-to-market ratios. The results are consistent with those reported by Bernanke and Kuttner (2005) for the US market. Additionally, I find that excess returns of the value stocks are statistically more sensitive to the monetary policy shocks than the growth stocks.

Most notably, I report evidence of asymmetric response to the monetary policy shocks before and after the QE. Before the introduction of QE, the ERP react negatively to the monetary policy shocks. However, after QE, the monetary policy shocks have a positive impact on the ERP. I find similar results for the 25 Fama-French style portfolios. These results suggest that QE has had a positive effect on equity returns.

The rest of the paper is organised as follows; Section 3.2 briefly discusses the related literature, Section 3.3 explains methodology, Section 3.4 describes the data, Section 3.5 reports empirical results, and Section 3.6 concludes.

## 3.2 Related Literature

In investigating the impact of monetary policy shocks on the stock market returns, the literature predominantly relies on two strategies. One group of researches relies on identifying the monetary policy shocks as a change in the interest rate decisions from the expected interest rates for a narrow window of time around the announcement day of monetary policy decisions and use these as monetary policy shocks in their further investigation. The expectation of monetary policy interest rate is derived from the interest rate implied by futures contract on either Fed Funds rate (in the case of the US) or from futures on short-term market interest rate such as LIBOR in the UK. This event study-based approach of investigating the impact of monetary policy shocks on stock market returns was pioneered by Cook and Hahn (1989). Examples of the other event study approach are Thorbecke (1997), Ehrmann and Fratzscher ( 2003; 2004; 2005), Bomfim (2003), Bernanke and Kuttner (2005), Bredin et al. (2007), Jansen and Tsai (2010), Ammer, Vega and Wongswan (2010) and  Kurov (2012). This approach may be consistent with the efficient market hypothesis; however, they rely on the assumption that monetary policy announcements are entirely unexpected. It is quite reasonable to assume that since the Financial Crisis of 2008-2009 monetary policy announcements have partly been anticipated.

Cook and Hahn (1989) employ event study methodology and show that changes in the federal funds rate in the US affect asset markets. Bomfim (2003) also uses the event-study to show that the conditional volatility of stock market in the US is low during the days preceding the monetary policy announcements. Guo, (2004) employ the same monetary policy shock data of Cook and Hahn (1989) to investigate the impact of innovations in the monetary policy target on the returns of portfolios formed various stock market characteristics such book-to-market and size. Their results suggest that small size stocks are more sensitive to the monetary policy innovations than big firms, however this size sensitivity almost vanishes in the 1990s due to improved business conditions and transparency in the monetary policy. Bernanke and Kuttner (2005) examine the impact of unanticipated changes in US monetary policy on the ERP and show that a tighter monetary policy raises the expected ERP by making stocks riskier.

Similarly Kurov (2012) examines the reaction of expected stock market returns to monetary policy announcements on the scheduled Federal Open Market Committee meeting days. Using the changes in the fed funds futures prices around the announcement days, he argues that the reaction of equity premium to monetary policy surprises is state-dependent. His results show that equity premium earned around the policy announcement days is higher in recessions than in good times. By employing event-study methodology Ammer, Vega and Wongswan (2010) show that US monetary policy shock affects, through credit and demand channel, the stock market returns of foreign firms from the countries which have both fixed peg and floating pegs to the US dollar. Though highly used, event studies focus on the short-term impact of monetary policy shocks and therefore are not very useful in examining the longer term impacts. Researchers therefore use impulse response functions and variance decomposition techniques in investigating the long term influence of monetary policy shocks on stock returns.

Other group of researchers identify monetary policy shocks as orthogonalised innovations from SVAR. Researchers have also suggested identifying monetary policy shocks as the innovations in the short-term interest rates, for example Sims (1992), or innovations in the monetary aggregates, for example Eichenbaum, (1992), Christiano, Eichenbaum and Evans (1996), Kim (1999). Other examples of studies that have followed the VAR-based strategy to extract the monetary policy shocks are Thorbecke (1997), Patelis (1997), Bjørnland and Leitemo (2009) Mumtaz and Zanetti (2013) and Bekaert, Hoerova and Lo Duca (2013). In this study I interpret the monetary policy shocks as the deviation of the short-term interest rate from its expected path i.e. the deviation from the monetary policy reaction function in the SVAR. The orthogonality in the innovations is achieved by standard Cholesky decomposition of the variance-covariance matrix, as suggested by Sims (1980).

Thorbecke (1997) employs both VAR and event study methodology to examine the impact of US monetary policy shock on the US stock returns. He shows that negative shocks of federal funds rate have large and significant effects on stock market returns through impulse response functions. Chen, (2007) investigates whether monetary policy has regime-dependent asymmetric effect on stock market returns. Amongst many monetary policy measures employed, he considers the impact of monetary policy shocks extracted as orthogonalised innovations to the Fed funds rate from a VAR- based model. His results show that the orthogonalised monetary policy shocks have regime-dependent asymmetric impact on stock returns in the US. Bjornland and Leitemo (2009) study the simultaneous interaction of US monetary policy and S&P 500 returns using VAR methodology. They show that stock prices fall by seven to nine percent in response to one percent tightening in the federal funds rate thereby implying rise in risk aversion. They also show that one percent rise in shock to the stock prices leads to approximately four bps rise in the federal funds rate. By employing the a simple structural VAR (SVAR), Bekaert, Hoerova and Lo Duca (2013) show that a lax monetary policy induces lower risk aversion in the stock market i.e. more risk appetite, however they do not study whether this translates in higher or lower ERP.

## 3.3 Methodology

### 3.3.1 Identification of Monetary Policy Shocks

I follow two-step procedure in order to investigate the impact of monetary policy shocks on ERP. In the first step I identify the structural monetary policy shocks and in the second I investigate their impact on the ERP before and after the QE implementation. The structural monetary policy shocks are identified by including a set of macroeconomic variables and a monetary policy instrument using the SVAR framework. The SVAR approach allows modelling of the non-recursive structures with parsimonious set of variables.

I model the economy using the following SAVR;

$$\boldsymbol{A}Y_t = \boldsymbol{A}^*(L)Y_{t-1} + \boldsymbol{B}u_t \tag{3.1}$$

where $\boldsymbol{Y}$ is a $n$ dimensional vector of macroeconomic variables including a monetary policy variable, $\boldsymbol{A}^*(L)$ is the p$^{th}$ order polynomial matrix in the lag operator $L$, $\boldsymbol{A}$ is the $n \times n$ matrix of contemporaneous coefficients, $\boldsymbol{B}$ is a $n \times n$ matrix relating the structural innovations $u_t$ to the reduced form innovations and $u_t \sim N(0, \Sigma)$ is a $n \times 1$ vector of structural shocks which assume ortho-normal co-variance matrix as an identity matrix i.e. $E[u, u'] = I$.

In order to estimate (3.1) I first estimate the reduced form of (3.1) which is

$$\boldsymbol{Y}_t = \boldsymbol{C}(L)\boldsymbol{Y}_{t-1} + \varepsilon_t \tag{3.2}$$

where $\varepsilon_t^i$ is the reduced form residuals such that $E(\varepsilon) = 0$

$$E(\varepsilon_t, \varepsilon_s) = \begin{cases} \Omega \text{ when } t = s \\ 0, \text{ when } t \neq s \end{cases} \tag{3.3}$$

$\Omega = \mathrm{E}[\varepsilon^t, \varepsilon^s\ ]$ is the residual covariance matrix. Condition (3.3) implies that there is no serial correlation among the reduced-form disturbances, however contemporaneous correlation is allowed. Following Amisano and Giannini, (1997) and Lutkephol, (2005) we have,

$$\boldsymbol{A}.\boldsymbol{\varepsilon_t} = \boldsymbol{B}u_t \tag{3.4}$$

The assumption of ortho-normal covariance matrix of the structural shocks leads to following condition

$$\boldsymbol{A}\Omega\boldsymbol{A}' = \boldsymbol{B}\boldsymbol{B}' \tag{3.5}$$

Thus there are $\frac{1}{2}n(n+1)$ equations and $n^2$ elements in $\boldsymbol{A}$ and $\boldsymbol{B}$ each, which leads to additional $2n^2 - \frac{1}{2}n(n+1)$ restrictions to just identify the elements in $\boldsymbol{A}$ and $\boldsymbol{B}$. I impose short-run restrictions on $\boldsymbol{A}$ and $\boldsymbol{B}$ with $\boldsymbol{A}$ to be a lower triangular matrix with ones along the diagonal and $\boldsymbol{B}$ to be a diagonal matrix in order to extract the structural orthogonal monetary policy shocks. The lower triangularity implies standard Cholesky decompositions of the variance-covariance matrix which has economic implications. The short-run restrictions implied by (3.4) were also used by Gali (1992) and Pagan (1995) to study and test the traditional IS-LM model to the post-war US data.

I consider five macroeconomic variables in the SVAR. Out of the five macroeconomic variables, four are the information variables and the fifth is the monetary policy variable. Thus we have,

$$\boldsymbol{Y}_t = [y_t, \pi_t, ump_t, x_t, mp_t] \tag{3.6}$$

where, the information variable $y_t$ is the output gap which is measured by the deviation of index of the industrial production from its trend, $\pi_t$ is the inflation gap, measured using the deviation of the actual inflation from the target inflation, $ump_t$ is the unemployment rate, $x_t$ is the trade-weighted effective exchange rate index and $mp_t$ is the monetary policy instrument. I use the BoE's base rate as the policy instrument to estimate the structural monetary policy shocks.

By ordering the variables in this fashion, I assume that all the four information variables contemporaneously affect the monetary policy variable; however, the monetary policy affects these variables only with lag. It takes some time for output gap, inflation gap, unemployment and changes in exchange rates to respond to monetary policy actions. These assumptions are consistent with Christiano, Eichenbaum and Evans, (1996). The structural monetary policy shocks are then the corresponding disturbances in (3.1). The last equation in the VAR resembles monetary policy reaction function or the feedback rule which can be considered as a modified Taylor (1993) rule. It also takes into account the Okun's (1962) law. I include trade-weighted exchange rate as an information variable since the BOE follows open-economy monetary policy [see (Ball, (1999a, 1999b) and Svensson (2000)].

Equation (3.4) can be expressed in the matrix form as;

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} . \begin{bmatrix} \varepsilon_t^{y} \\ \varepsilon_t^{\pi} \\ \varepsilon_t^{ump} \\ \varepsilon_t^{x} \\ \varepsilon_t^{mp} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 \\ 0 & 0 & 0 & 0 & b_{55} \end{bmatrix} . \begin{bmatrix} u_t^{y} \\ u_t^{cpi} \\ u_t^{ump} \\ u_t^{x} \\ u_t^{mp} \end{bmatrix} \quad \textbf{(3.7)}$$

Thus, from (3.7), the structural monetary policy shocks are estimated[6] as:

$$b_{55}.u_t^{mp} = a_{51}.\varepsilon_t^{y} + a_{52}.\varepsilon_t^{\pi} + a_{53}.\varepsilon_t^{ump} + a_{54}.\varepsilon_t^{x} + \varepsilon_t^{mp} \quad \textbf{(3.8)}$$

### 3.3.2 The impact of monetary policy shocks on the ERP

In the previous sub-section, I described the methodology to uncover the structural monetary policy shocks. I now examine the effect of these structural shocks on the UK ERP by estimating the following regression model;

$$E_{i,t} = \alpha_i + \beta_i u_t^{mp} + e_{i,t} \quad \textbf{(3.9)}$$

where, $E_{i,t}$ is the UK ERP (measured using the ex-pot excess returns on portfolio $i$ over the 1-month treasury bills rate), $\alpha_i$ is the constant which can also be interpreted as pricing error, $\beta_i$ is the sensitivity of the ERP of the $i^{\text{th}}$ portfolio to the monetary policy shocks $u_t^{mp}$ and $e_{i,t}$ is a white noise process. I investigate the impact of monetary policy shocks for three types of portfolios. In the first portfolio, I calculate excess returns for two popular and mostly tracked indices in the UK, the FTSE 100 index and the FTSE 250 index. These two indices serve as a benchmark for most of the fund managers. In the second portfolio, I compute excess returns for ten most widely used UK sectoral indices. In the third portfolio, I calculate the excess returns on value-weighted 25 Fama-French-style portfolios sorted on size and book-to-market. The goal here is to examine

---

[6] See, Christiano, Eichenbaum and Evans, (1996) and Kim, (2001)

whether the impact is consistent and significant. Model (3.9) is estimated using maximum likelihood technique employing Marquardt optimisation algorithm assuming that errors follow a normal distribution. This is because our initial estimation of model (3.9) using OLS showed the presence of ARCH effects in the residuals.

**3.4 Data Description**

Monthly data is obtained for the period of January 1988 to October 2014 from DataStream. To measure the output gap, I use the seasonally adjusted index of industrial production. The output gap is estimated as the deviation of the index of industrial production from its potential trend.[7] The inflation gap is estimated using the deviation of actual inflation from the target inflation. The UK adopted inflation target regime in October 1992 following the departure of the UK from the Exchange Rate Mechanism. The target annual inflation was in the range of 1% - 4% as measured by the inflation in the Retail Price Index excluding mortgage interest payments (RPIX). In May 1997, the Chancellor of the Exchequer set the initial target of 2.5%. In December 2003 the annual inflation target was once again changed to 2% measured in inflation of Harmonised Consumer Price Index (HCPI). In this study I use 2.5% annual inflation target in RPIX until November 2003 and a target of 2% annual in HCPI from December 2004. Unemployment rate is measured as unemployed workforce as a percentage of economically active workforce claiming unemployment benefits i.e., Job Seekers Allowance and National Insurance Credits. The trade-weighted exchange rate of the British Sterling Pound is measured using Effective Exchange Rate Index. I calculate the

[7] The trend of the index of the industrial production is estimated via the Hodrick Prescott filter using the "punishing" parameter ($\lambda$ =14400),

ERP as the difference between monthly returns[8] of FTSE 100 index, FTSE 250 index and the ten major sectors and the yield on 1-month UK treasury bills. The returns on the 25 Fama-French style portfolios are taken from Gregory, Tharyan and Christidis, (2013).

****Please insert table 3.1 about here****

Table 3.1 provides the descriptive statistics. Panel A shows that over the sample period, the average annualised growth rate in the industrial production is 0.08%. The average inflation is 3.13%. On average, the trade weighted effective exchange rate has declined with an average annual rate of -0.4%. The average base rate has been 5.5% for the sample period.

Panel B provides descriptive statistics of annualised ERP of FTSE 100, FTSE 250 and the ten sector indices. It can be seen from Panel B that on an average, Utilities is the best performing sector with average annual ERP of 8.96% while the Technology sector offers the lowest ERP of 1.16%. Overall, on average ERPs are positive for all portfolios. Panel C provides the descriptive statistics of the annualised ERPs of the 25 value-weighted Fama-French style portfolios based on size and book-to-market characteristics. For simplicity I maintain the same naming convention of the portfolios as in Gregory et.al. (2013). The average annualised ERP of small size portfolios is 6.82% while the average ERP of big size portfolios is 5.16%. On the growth and value dimensions, the average annualised ERPs of growth and value portfolios are 4.8% and 7.8% respectively. See Appendix 3.1 for the brief overview of the data.

[8] The returns are calculated using total returns index which include dividends.

## 3.5 Results

### 3.5.1 Stability of the VAR model

Before examining the impact of structural monetary policy on the ERP, it is important to check the stability of the estimated VAR model. The reduced form model (3.2) will be stable if all the eigenvalues of the $\boldsymbol{C}$ in 3.2 have modulus less than or equal to one. In other words the matrix $\boldsymbol{C}$ has no roots outside or on the complex unit circle (Lutkepohl 2005). That is

$$det(\boldsymbol{I}_m - \boldsymbol{C}z) \neq 0, \forall|z| \leq 1 \tag{3.10}$$

and VAR (p) is stable if, $det\left(\boldsymbol{I}_m - \boldsymbol{C}_1.z - \boldsymbol{C}_2.z - \cdots - \boldsymbol{C}_p.z^p\right) \neq 0, \forall|z| \leq 1$

****Please insert figure 3.2 about here****

Figure 3.2 shows the inverse roots of the characteristic AR polynomial equation $\boldsymbol{C}(L)$ in model 3.2. It can be seen from the figure that no root lays outside the unit circle. The VAR thus satisfies the stability condition. Moreover, the LM statistic under the null of no serial correlation up to lag 13 is 26.12 and is not significant indicating that the shocks in the reduced form VAR 3.2 are free from serial correlation.

#### 3.5.2 The impact of structural monetary policy shocks on ERP,

First I examine the impact of the contemporaneous structural monetary policy shocks over the entire sample. This gives us an overall understanding of how ERP of aggregate market, ten different sectors and 25 Fama-French portfolios respond to the structural monetary policy shocks over the entire sample period. I estimate the regression model (3.9) and report the results in Table 3.2.

****Please insert table 3.2 about here****

I find that the monetary policy shocks impact the ERP negatively. Although there is heterogeneity in the magnitude and the significance of the impact of monetary policy shocks on different FTSE indices, yet with the only exception of the utilities sector, ERPs of all other sectors react negatively. Whilst, Basic Materials, Financials, Consumer services, Industrials, Telecom and Technology sectors react significantly to the contemporaneous monetary policy shocks, the Utilities and Oil & Gas sectors do not respond to the monetary policy shocks. This could be attributed to the counter-cyclical nature of utility and oil & gas sectors. The results are qualitatively similar to that of Bredin et al., (2007) for the UK equity market.

Next I investigate the response of 25 Fama-French style value-weighted portfolios formed on the basis of size and book-to-market ratio. The results are reported in Table 3.3. The ERPs of Fama-French portfolios also react negatively to the structural monetary policy shocks. The ERPs of small cap stocks are more sensitive to the monetary policy shocks than the big cap stocks. The average sensitivity of the ERP of small stocks is -0.76 while the average sensitivity of ERP of big stocks is -0.55. We can see that the average responsiveness of the ERP to the monetary policy shocks decreases as one move from small size portfolios to large size portfolios. The results confirm that small companies are more vulnerable to monetary policy shocks and therefore need to offer higher excess returns. This is predominantly because small firms rely heavily on bank lending as compared to big firms. As seen from table 3.2, an exogenous monetary policy shock can affect the ERP of Financial sector which is mainly comprised of Banks. The monetary policy shocks may exert constraints on the ability of Banks to extend loans and line of credits to small firms. Further, small firms are more “financially constrained” in the sense that they may be required to post additional good quality collateral for accessing bank credit facilities or to refinance the existing debt.

****Please insert table 3.3 about here****

With regard to value and growth dimensions, the ERP of value stocks and growth stocks are expected to react differently. As shown by Kuttner, (2001), the short-end of the term structure reacts much more than the long-end of the term structure to the monetary policy shocks. Therefore, ERPs of companies whose revenues and earnings are sensitive to short-term interest rate fluctuations will respond much more to the monetary policy shocks. Based on this reasoning and the way growth and value portfolios are constructed, it is reasonable to expect that the ERP of value stocks should be more sensitive to monetary policy shocks than the ERPs of growth stocks. Another reason for this difference is that value stocks have higher expected cash flows relative to their market prices as compared to the growth stocks. Therefore, any significant changes to the cash flows due to monetary policy shocks will have a more significant impact on the ERPs of value stocks than the ERPs of growth stocks.

Results reported in table 3.3 clearly support the above reasoning. The ERP of value stocks are not only statistically sensitive to monetary policy shocks but also in terms of magnitude; the value stocks seem to be more sensitive to monetary policy shocks than that of growth stocks. The average sensitivity of the ERP of value stocks is -0.93 while the average sensitivity of ERP of growth stocks is -0.42. In summary, the ERPs of small size and value portfolios are more sensitive to the monetary policy shocks than the portfolios of big size and growth stocks.

### 3.5.3 The impact of structural monetary policy shocks on ERP, before and after Quantitative Easing

Next I examine the response of ERP to monetary policy shocks before and after the implementation of the QE. As discussed earlier, empirical evidence on the impact of unconventional monetary policy before and after QE on the UK's ERP is non-existent. For this purpose, I divide the sample into two groups using March 2009 as the breakpoint when the BOE launched the first round of QE. The pre-QE sample runs from January 1988 to February 2009 and the post-QE sample spans from March 2009 till October 2014.[9]

****Please insert Table 3.4 about here****

Table 3.4 shows that the response of ERPs of aggregate FTSE indices and various sectoral indices, before and after the QE. By comparing columns (B) and (D) of table 3.4 we can see a remarkable difference between the sensitivity of ERPs. Before QE, ERPs react negatively to the structural monetary policy shocks as all beta coefficients are negative. While after the QE, sensitivities of the ERPs to the monetary policy shocks are positive for almost all industries, except for the Healthcare which shows a negative response. However, it is not statistically significant.

The magnitudes of the sensitivity of the ERPs to the monetary policy shocks in the post-QE period are higher. The ERPs of the various FTSE indices after the QE show greater

---

[9] It is worth noting that though the BoE halted its QE programme in July 2012, the Bank is still maintaining its accommodative monetary policy stance. At the time of writing this paper the post-QE sample available was less (March 2009-October 2014).

response compared to the response before the QE. For example, before the QE, the sensitivity of ERP of the FTSE 100 index was -0.712% which suggests that a positive one percent change in the interest rate shock would decrease the ERP of the FTSE 100 index by an average of 0.712% (monthly). After the QE this sensitivity has increased to 2.4%. The paired sample t-statistics with unequal variances (not reported) for the hypothesis that the average $\beta_{i,before\ QE} = \beta_{i,after\ QE}$ is -8.10 suggesting that the average response of the ERP of these FTSE indices to the monetary policy shocks before and after QE is statistically significantly different at 1% level.

****Please insert Table 3.5 about here****

Table 3.5 reports the impact of monetary policy shocks on the ERPs of the 25 Fama-French style value-weighted portfolios. We can see a similar pattern of reaction of ERPs of these portfolios before and after QE. Before QE, the ERPs respond negatively. However, after QE, the ERPs are positive. The paired sample t-statistics with unequal variances for the hypothesis that the average $\beta^{i}_{before\ QE} = \beta^{i}_{after\ QE}$ is -14.23 suggesting that the average response of the ERP of these 25 portfolios to the monetary policy shocks before and after QE is statistically significantly different at 1% level. The average responses of the ERPs of small size portfolios (2.05) and value portfolios (3.39) to monetary policy shocks are still more than the ERPs of the big size (1.98) and growth portfolios (1.45) after QE.

One possible explanation for the asymmetric response is that increased liquidity may have inflated the prices of risky assets such as equities. Consequently, any withdrawal of the liquidity from the markets induced by unexpected interest rate changes could potentially impact the prices of the risky assets and by extension the risk premium provided by these assets i.e. the ERP. Another possible explanation is that during QE, the BOE purchased high quality fixed income securities financed by central bank reserves thus effectively replacing relatively illiquid money with liquid cash reserves. This led to decline in both short and long term bond yields and thus leading to higher excess equity returns.

With an aim to examine the direct impact of monetary policy shocks when QE announcements were made, I run the following regression using maximum-likelihood estimation with heteroscedasticity consistent robust standard errors and covariance (Bollerslev and Woolridge, 1992) for the entire sample;

$$E_{i,t} = \mu_i + \beta_i u_t^{mp} + \gamma_i\left(D.\, u_t^{mp}\right) + e_{i,t} \tag{3.11}$$

where, $E_{i,t}$ is the ERPs of the various FTSE indices and that of the 25 Fama-French portfolios, $u_t^{mp}$ is the monetary policy shocks (interest rate shocks) extracted from the SVAR (3.1), $D$ is a binary dummy variable that takes a value 1 for the months when the MPC announced an increase in the QE and 0 otherwise. There were seven occasions when the MPC announced an increase in the QE. The parameter $\gamma_i$ captures the impact of interaction between monetary policy shocks and the month in which the changes to the QE were announced on ERP of the $i^{th}$ portfolio. The parameter $\beta_i$ is the sensitivity of ERP of the $i^{th}$ portfolio to monetary policy shocks. The results are reported in Table 3.6.

****Please insert Table 3.6 about here****

By comparing columns (B) and (C) in table 3.6, we can clearly see the asymmetric impact of monetary policy shocks during the QE announcements as the $\gamma_i's$ are positive and significant except for Utilities and Telecom sectors. Column (D) shows the Wald's

F-statistic for the null hypothesis $\beta_i = \gamma_i = 0$. Except for Consumer Goods and Utilities, the Wald statistic is statistically significant for the rest thus confirming the asymmetric response of ERPs to the monetary policy shocks.[10] These results support the previous results reported in table 3.4.

****Please insert Table3.7 about here****

Panel (C) of table 3.7 show the impact of monetary policy shocks on the ERPs of the 25 Fama-French portfolios for the months when there was an announcement of QE programmes i.e. the parameter $\gamma_i$ in model (3.11). The results show statistically significant response to the QE programmes ($\gamma_i$>0). Panel D presents the Wald's F-statistic for the null hypothesis that $\beta_i$ and $\gamma_i$ are jointly equal to zero. The null hypothesis is rejected for almost all the portfolios suggesting that the response of ERP of these 25 portfolios is asymmetric. These results support the earlier findings reported in table 3.5.

## 3.6 Summary

The paper empirically investigates the impact of UK domestic monetary policy shocks on the ERPs of aggregate market, ten industries as well as the 25 Fama-French style portfolios. I extract structural monetary policy shocks as residuals of the feedback rule from SVAR and study the asset pricing implications before and after the implementation of QE. The paper contributes to the existing literature by offering

---

[10] However, our results should be interpreted with caution since there may be other unobserved factors such as investor sentiments (see Brown and Cliff, 2005, Kumar and Lee, 2006 and Baker and Wurgler, 2006, 2007) which could influence the response of equity markets to the monetary policy shocks. That being said, those other factors could also be influenced by unexpected tightening/easing of monetary policy (Kurov, 2010).

evidence of asymmetric response of ERP to monetary policy shocks before and after the implementation of unconventional monetary policy.

I find that for the entire sample period, the structural domestic monetary policy shocks have a statistically significant negative impact. Results suggest that a positive structural monetary policy shock i.e. when the actual interest rates are more than the expected interest rates, induces negative impact on the ERP of almost all of the sectoral indices. However, the magnitude of the response to the monetary policy shocks is heterogeneous confirming the pro-cyclical and counter cyclical nature of different industries. Empirical evidence for the ERPs of 25 Fama-French portfolios constructed on size and book to market characteristics also show similar heterogeneous impact. Overall the ERPs of small size stocks are more sensitive to the structural monetary policy shocks than the ERP of big size shocks suggesting the presence of the balance sheet and the bank lending channels of the monetary transmission. Similarly, ERPs of value portfolios are more sensitive to the monetary policy shocks than portfolios of growth stocks.

Last but not the least; I investigate the impact of monetary policy shocks on the ERPs of FTSE indices before and after QE. The empirical results show that before the implementation of QE, the monetary policy shocks have negative impact on the ERPs of aggregate market, various industries as well as Fama-French portfolios. However, for the post-QE period, the impact is positive. The empirical evidence provided in the paper sheds light on the equity market's asymmetric response to the BoE's policy before and after the monetary stimulus.

**Dissemination:** This paper is accepted for publication in the *Investment Management and Financial Innovations* Journal (2016), 13(4), (Forthcoming, press) (Along with Prof. Poshakwale).

## List of Figures


**Figure 3.1: FTSE 100 adjusted closing prices and the QE decisions**

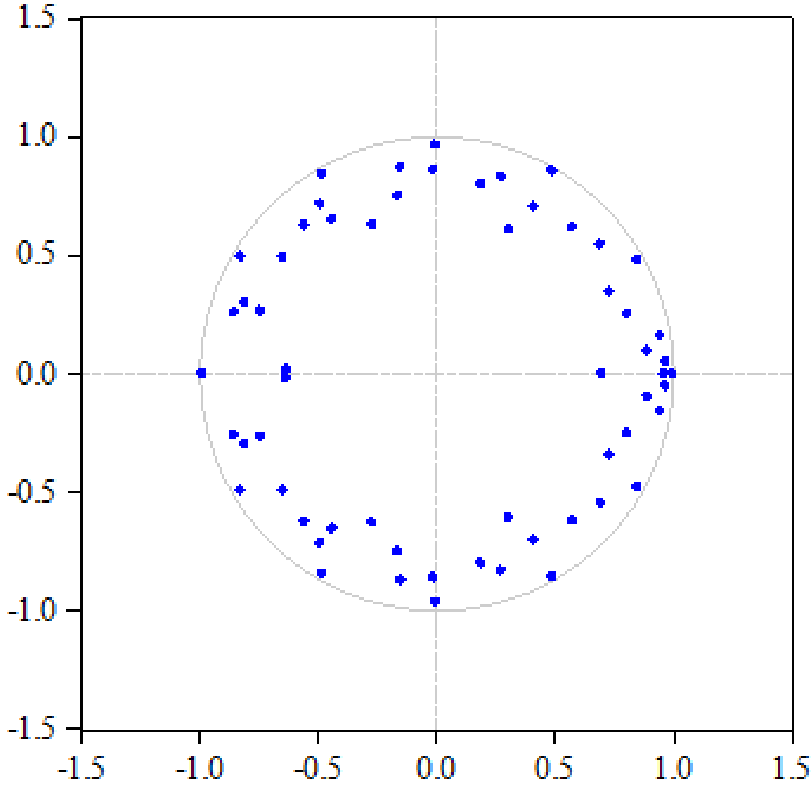



**Figure 3.2: Inverse roots of AR characteristic polynomial**

# List of Tables

**Table 3.1 Descriptive Statistics**

Note: $\Delta y$ is the growth rate of index of industrial production, $\pi$ is inflation, Uemp is unemployment, $\Delta x$, growth rate of sterling effective exchange rate and R is the base rate. Sample period: January 1988- October 2014

Panel A

| Descriptive | $\Delta y$ | $\pi$ | Uemp | $\Delta x$ | R |
|---|---|---|---|---|---|
| Mean (%) | 0.084 | 3.13 | 5.01 | -0.40 | 5.5 |
| Median (%) | 1.10 | 3.37 | 4.50 | -0.16 | 5.06 |
| Standard Deviation (%) | 3.20 | 1.41 | 2.178 | 5.37 | 3.82 |
| Kurtosis | 2.98 | 8.69 | -0.58 | 4.55 | 0.25 |
| Skewness | -0.73 | 1.15 | 0.77 | -1.01 | 0.72 |
| No. of Months | 322 | 322 | 322 | 322 | 322 |

Panel B

Note: E100 is the excess return of FTSE 100 index. Similarly, E250 is for FTSE 250 index, EOnG is of FTSE All Share Oil and Gas, EBM is of FTSE All share Basic Materials, Eind is of FTSE All Share Industrials, ECGDs is of FTSE All Share Consumer Goods, Ehlth is of FTSE All Share Healthcare, ECSvs is of FTSE All Share Consumer services, Etel is of FTSE All Share Telecoms, Eutl is of FTSE All share utilities, Efin is of FTSE All share Financials and Etech is of FTSE All Share technology.

| *Descriptive* | E100 | E250 | EOnG | EBM | Eind | ECGDs | Ehlth | ECSvs | Etel | Eutl | Efin | Etech |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean (%) | 3.56 | 5.76 | 5.02 | 2.61 | 3.31 | 4.48 | 5.38 | 1.98 | 3.75 | 8.96 | 3.63 | 1.16 |
| Median (%) | 7.37 | 10.77 | 9.77 | 8.47 | 8.58 | 7.75 | 5.56 | 6.21 | 10.77 | 11.75 | 8.39 | 9.82 |
| Standard Deviation (%) | 14.46 | 17.17 | 18.93 | 23.97 | 19.98 | 19.97 | 14.17 | 16.64 | 19.52 | 15.51 | 19.99 | 29.86 |
| Kurtosis | 0.64 | 2.5 | 0.825 | 4.30 | 2.24 | 0.81 | 0.53 | 1.36 | 0.85 | 0.37 | 2.42 | 3.28 |
| Skewness | -0.47 | -0.77 | -0.30 | -0.91 | -0.84 | -0.34 | -0.035 | -0.58 | -0.49 | -0.12 | -0.55 | -0.62 |
| No. of Months | 322 | 322 | 322 | 322 | 322 | 322 | 322 | 322 | 322 | 322 | 322 | 322 |

Table 3.1 Continued…

Panel C

Note: This panel provides annualised descriptive statistics of the ERPs of the 25 value-weighted Fama-French style portfolios constructed on the basis of size and book-to-market characteristics. The naming convention is same as in Gregory, Tharyan and Christidis, (2013). For example, "SH" denotes small cap-high book-to-market (BTM), "S4" denotes small and 4th lowest BTM, "B4" denotes big and 4th highest BTM, "BH" denotes big size and highest BTM, "M3L" middle 3rd size and largest BTM and "M32" middle 3rd size and 2nd BTM

| Portfolio | Mean (%) | Median (%) | Standard Deviation (%) | Kurtosis | Skewness | No. of months |
|---|---|---|---|---|---|---|
| SL | 4.01 | 8.61 | 21.91 | 2.25 | -0.22 | 322 |
| S2 | 6.50 | 10.06 | 18.80 | 0.72 | -0.08 | 322 |
| S3 | 6.96 | 11.72 | 17.82 | 2.25 | -0.02 | 322 |
| S4 | 7.96 | 8.74 | 17.90 | 2.76 | -0.22 | 322 |
| SH | 8.69 | 10.29 | 17.66 | 4.25 | 0.09 | 322 |
| S2L | 3.08 | 7.53 | 23.10 | 2.66 | -0.16 | 322 |
| S22 | 5.29 | 9.33 | 21.00 | 2.03 | -0.72 | 322 |
| S23 | 6.37 | 8.46 | 18.61 | 1.55 | -0.24 | 322 |
| S24 | 7.07 | 6.12 | 19.32 | 1.30 | -0.06 | 322 |
| S2H | 7.50 | 12.97 | 22.26 | 5.95 | 0.33 | 322 |
| M3L | 4.41 | 12.99 | 22.89 | 5.92 | -0.81 | 322 |
| M32 | 3.56 | 9.17 | 20.58 | 1.79 | -0.25 | 322 |
| M33 | 6.29 | 11.58 | 19.67 | 3.62 | -0.84 | 322 |
| M34 | 5.69 | 8.90 | 20.71 | 1.64 | -0.17 | 322 |
| M3H | 9.87 | 9.22 | 21.93 | 3.37 | 0.05 | 322 |
| B4L | 7.91 | 15.17 | 20.55 | 4.35 | 0.07 | 322 |
| B42 | 4.82 | 2.37 | 18.92 | 3.42 | -0.31 | 322 |
| B43 | 8.76 | 7.57 | 18.49 | 1.66 | -0.39 | 322 |
| B44 | 6.77 | 15.19 | 21.43 | 2.08 | -0.25 | 322 |
| B4H | 7.58 | 10.52 | 22.17 | 3.17 | -0.26 | 322 |
| BL | 4.51 | 5.79 | 14.45 | 0.30 | -0.14 | 322 |
| B2 | 4.32 | 7.71 | 15.11 | 0.71 | -0.40 | 322 |
| B3 | 5.58 | 6.51 | 17.10 | 1.46 | -0.32 | 322 |
| B4 | 5.98 | 10.48 | 17.30 | 1.54 | -0.37 | 322 |
| BH | 5.39 | 9.91 | 18.80 | 1.53 | -0.26 | 322 |

**Table 3.2: The impact of monetary policy shocks on ERP using base rate as monetary policy instrument**.
Note: The model estimated is (3.9). The dependent variable is the ERP of the FTSE indices (in percent). The independent variable is the structural base rate shock in the UK. Adjusted sample size Feb 1989 – Oct 2014 (no. of observations 309). The coefficients denote monthly sensitivities of the ERP of the FTSE indices to monetary policy shocks (in decimals) *** significant at 1%, ** significant at 5% and * significant at 10%. Figures in the parentheses are z-statistics.

| FTSE Indices | $\alpha_i$ | $\beta_i$ | S.E of Regression |
|---|---|---|---|
| FTSE 100 | 0.56*** | -0.609** | 0.042 |
| | (2.60) | (-2.36) | |
| FTSE 250 | 0.78*** | -0.521** | 0.049 |
| | (2.89) | (-2.07) | |
| Basic Materials | 0.459 | -0.756** | 0.069 |
| | (1.23) | (-2.45) | |
| Consumer Services | 0.591** | -0.648*** | 0.048 |
| | (2.28) | (-2.58) | |
| Financials | 0.65** | -0.743** | 0.058 |
| | (2.05) | (-2.16) | |
| Consumer Goods | 0.625** | -0.474* | 0.058 |
| | (2.10) | (-1.67) | |
| Healthcare | 0.626*** | -0.468* | 0.040 |
| | (2.89) | (-1.86) | |
| Industrials | 0.55* | -0.615** | 0.057 |
| | (1.90) | (2.15) | |
| Oil and Gas | 0.501* | -0.439 | 0.054 |
| | (1.74) | (-1.13) | |
| Utilities | 0.895*** | 0.181 | 0.044 |
| | (3.66) | (0.69) | |
| Telecom | 0.596** | -0.709** | 0.056 |
| | (2.13) | (-2.28) | |
| Technology | 0.475 | -0.948*** | 0.087 |
| | (1.4) | (-2.46) | |

**Table 3.3: The Impact of monetary policy shocks on the ERP of the 25 value-weighted Fama-French portfolios**

Note: The model estimated is (3.9). The dependent variable is the ERP of the 25 Fama-French portfolios in percent. The independent variable is the domestic monetary policy shock in the UK. Adjusted sample size Feb 1989 – Oct 2014 (no. of observations 309) *** significant at 1%, ** significant at 5% and * significant at 10%. Figures in the parentheses are z-statistics.

| | $\alpha_i$ | | | | | | Z-stat | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | 0.701* | 0.50* | 0.76** | 0.92*** | 0.76*** | 0.73 | (1.91) | (1.66) | (2.22) | (2.78) | (3.47) |
| BM2 | 0.882*** | 0.74** | 0.82** | 0.78** | 0.71*** | 0.78 | (3.08) | (2.18) | (2.49) | (2.27) | (2.91) |
| BM3 | 0.95*** | 0.73** | 0.83*** | 0.85*** | 0.72*** | 0.82 | (3.37) | (2.22) | (2.93) | (3.08) | (3.03) |
| BM4 | 0.97*** | 0.88*** | 0.54* | 0.67** | 0.58*** | 0.73 | (3.75) | (2.6) | (1.94) | (2.39) | (2.72) |
| Value | 0.96*** | 0.92*** | 0.76** | 0.97*** | 0.67** | 0.86 | (3.74) | (3.0) | (2.22) | (3.09) | (2.52) |
| Average | 0.89 | 0.75 | 0.81 | 0.84 | 0.69 | | | | | | |
| | $\beta_i$ | | | | | | Z-Stat | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | -0.64*** | -0.76*** | -0.2 | -0.23 | -0.26 | -0.42 | (-2.66) | (-2.70) | (-0.81) | (-0.72) | (-0.97) |
| BM2 | -0.48** | -0.49* | -0.95*** | -0.64** | -0.92*** | -0.69 | (-2.02) | (-1.81) | (-3.33) | (-2.17) | (-3.13) |
| BM3 | -0.77*** | -0.62** | -0.59** | -0.78*** | -0.59** | -0.67 | (-3.39) | (-2.20) | (-2.14) | (-2.63) | (-2.34) |
| BM4 | -0.99*** | -1.04*** | -0.34 | -0.73 | -0.43 | -0.71 | (-4.92) | (-3.98) | (-1.25) | (-2.59) | (-1.53) |
| Value | -0.92*** | -0.85*** | -1.24*** | -1.07*** | -0.56** | -0.93 | (-4.85) | (-2.59) | (-4.31) | (-3.56) | (-2.24) |
| Average | -0.76 | -0.752 | -0.664 | -0.69 | -0.552 | | | | | | |

**Table 3.4 The impact of structural monetary shocks on ERP: Pre and Post Quantitative Easing**

Note: The model estimated is (3.9). The dependent variable is the ERP of the FTSE indices (in percent). The independent variable is the domestic monetary policy shock in the UK. Two different samples are used. The pre-QE adjusted sample is from Feb-1989 to Feb-2009 and the post QE sample is March -2009 to till Oct-2010. The data is monthly. *** significant at 1%, ** significant at 5% and * significant at 10%. The coefficients denote monthly sensitivities of the ERP of the FTSE indices to monetary policy shocks (in decimals). Figures in the parentheses are z-statistics.

| | 1989:02 - 2009:02-Pre-QE (241 observations) | | 2009:03 – 2014:10: Post QE (68 observations) | |
|---|---|---|---|---|
| ERP of FTSE Indices | (A) $\alpha_i$ | (B) $\beta_i$ | (C) $\alpha_i$ | (D) $\beta_i$ |
| FTSE 100 | 0.566** | -0.712*** | 1.095*** | 2.367*** |
| | (2.38) | (-2.61) | (2.66) | (2.72) |
| FTSE 250 | 0.645** | -0.605** | 1.864*** | 2.142*** |
| | (2.08) | (-2.24) | (3.91) | (21.8) |
| Basic Materials | 0.521 | -0.829*** | 0.632 | 2.617*** |
| | (1.39) | (-2.62) | (0.63) | (9.03) |
| Consumer Services | 0.461 | -0.751*** | 1.07*** | 1.73* |
| | (1.50) | (-2.78) | (2.65) | (1.80) |
| Financials | 0.634* | -0.858** | 1.21** | 3.16** |
| | (1.75) | (-2.31) | (2.28) | (2.50) |
| Consumer Goods | -0.248 | -0.639* | 1.38*** | 1.78*** |
| | (-0.65) | (-1.74) | (4.60) | (2.48) |
| Healthcare | 0.453* | -0.536** | 1.19** | -0.113 |
| | (1.76) | (-1.96) | (3.00) | (-0.89) |
| Industrials | 0.321 | -0.764** | 1.27*** | 2.14*** |
| | (0.94) | (-2.37) | (2.79) | (5.17) |
| Oil and Gas | 0.551* | -0.552 | 0.498 | 1.97** |
| | (1.70) | (-1.35) | (1.01) | (2.20) |
| Utilities | 0.569*** | -0.324 | 1.15*** | 0.54 |
| | (30.64) | (-1.01) | (3.11) | (0.64) |
| Telecom | 0.399 | -0.771** | 1.30*** | 0.085 |
| | (1.52) | (-2.29) | (2.67) | (0.09) |
| Technology | -0.05 | -1.10*** | 1.936*** | 2.09* |
| | (0.91) | (-3.67) | (2.97) | (1.85) |

Table 3.5: The Impact of structural monetary policy shocks on the ERP of the 25 value-weighted Fama-French portfolios: Pre and Post Quantitative Easing.

Note: The model estimated is (3.9). The dependent variable is the ERP of the 25 Fama-French style portfolios. The independent variable is the structural domestic monetary policy shock in the UK. Two different samples are used. The Before-QE adjusted sample is from Feb-1989 to Feb-2009 and the After QE sample is March -2009 to till Oct-2010. The data is monthly. *** significant at 1%, ** significant at 5% and * significant at 10%.

| Before QE | | | | | | | After QE | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\alpha_i$ | | | | | | | $\alpha_i$ | | | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | Small | Size 2 | Size 3 | Size 4 | Large | Average |
| Growth | 0.5 | 0.48 | 0.34 | 0.70$^{*}$ | 0.62$^{**}$ | 0.528 | Growth | 1.09$^{**}$ | 1.45$^{**}$ | 1.99$^{***}$ | 1.53$^{***}$ | 1.07 | 1.426 |
| BM2 | 0.65$^{*}$ | 0.41 | 0.49 | 0.54 | 0.69$^{***}$ | 0.556 | BM2 | 1.39$^{***}$ | 2.19$^{***}$ | 2.19$^{***}$ | 1.45$^{**}$ | 0.63 | 1.57 |
| BM3 | 0.66$^{**}$ | 0.28 | 0.57$^{*}$ | 0.69$^{**}$ | 0.69$^{***}$ | 0.578 | BM3 | 2.80$^{***}$ | 1.83$^{***}$ | 1.58$^{***}$ | 1.99$^{***}$ | 1.27 | 1.894 |
| BM4 | 0.83$^{***}$ | 0.57 | -0.91 | 0.42 | 0.39 | 0.26 | BM4 | 2.04$^{***}$ | 1.82$^{***}$ | 1.54$^{***}$ | 1.93$^{***}$ | 1.2 | 1.706 |
| Value | 0.75$^{***}$ | 0.80$^{**}$ | 1.23$^{***}$ | 0.87$^{**}$ | 0.67$^{**}$ | 0.864 | Value | 2.03$^{***}$ | 2.02$^{***}$ | 1.51$^{**}$ | 2.03$^{***}$ | 0.89 | 1.696 |
| Average | 0.678 | 0.508 | 0.344 | 0.644 | 0.612 | | Average | 1.87 | 1.862 | 1.762 | 1.786 | 1.012 | |

| $\beta_i$ | | | | | | | $\beta_i$ | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | Small | Size 2 | Size 3 | Size 4 | Large | Average |
| Growth | -0.66$^{**}$ | -0.95$^{***}$ | -0.25 | -0.38 | -0.39 | -0.526 | Growth | -0.72$^{***}$ | 2.20$^{*}$ | 2.13 | 2.12$^{**}$ | 1.51$^{*}$ | 1.45 |
| BM2 | -0.58$^{**}$ | -0.54$^{*}$ | -1.05$^{***}$ | -0.73$^{**}$ | -1.02$^{***}$ | -0.784 | BM2 | 2.01 | 2.41$^{*}$ | 1.54$^{***}$ | 1.89$^{***}$ | 1.66 | 1.902 |
| BM3 | -0.78$^{***}$ | -0.73$^{**}$ | -0.72$^{**}$ | -0.96$^{***}$ | -0.70$^{***}$ | -0.778 | BM3 | 2.81$^{**}$ | 1.79 | 2.02$^{*}$ | 2.29$^{*}$ | 3.44$^{***}$ | 2.47 |
| BM4 | -1.01$^{***}$ | -1.07$^{***}$ | -0.42 | -0.85$^{***}$ | -0.63$^{**}$ | -0.796 | BM4 | 2.64$^{***}$ | 1.64 | 3.37 | 3.04 | 1.63$^{**}$ | 2.464 |
| Value | -0.95$^{***}$ | -0.87$^{**}$ | -1.25$^{***}$ | -1.13$^{***}$ | -0.68$^{***}$ | -0.976 | Value | 3.51$^{***}$ | 4.93$^{**}$ | 3.69$^{**}$ | 3.13$^{*}$ | 1.69$^{**}$ | 3.39 |
| Average | -0.796 | -0.832 | -0.738 | -0.81 | -0.684 | | Average | 2.05 | 2.594 | 2.55 | 2.494 | 1.986 | |

**Table 3.6 The impact of monetary policy shocks on ERP using base rate as monetary policy instrument**.
Note: The model estimated is (3.11). The dependent variable is the ERP of the FTSE indices (in percent). The independent variables are the structural base rate shock and the interaction between them and the QE announcement months in the UK. Adjusted sample size Feb 1989 – Oct 2014 (no. of observations 309). *** significant at 1%, ** significant at 5% and * significant at 10%. Figures in the parentheses are z-statistics.

| ERP of FTSE Indices | $\mu_i$ | $\beta_i$ | $\gamma_i$ | Wald's F-stat (Null: $\beta_i = \gamma_i = 0$) |
|---|---|---|---|---|
| | (A) | (B) | (C) | (D) |
| FTSE 100 | 0.51*** | -0.64*** | 8.93*** | 13.31*** |
| | (2.59) | (-2.64) | (4.68) | |
| FTSE 250 | 0.74*** | -0.54 | 8.99*** | 12.52*** |
| | (3.20) | (-1.56) | (4.97) | |
| Basic Materials | 0.40 | -0.78* | 15.09** | 4.19** |
| | (1.31) | (-1.69) | (2.47) | |
| Consumer Services | 0.54** | -0.68** | 6.71*** | 7.98*** |
| | (2.46) | (-2.05) | (3.72) | |
| Financials | 0.60** | -0.77** | 12.46*** | 16.40*** |
| | (2.46) | (-2.36) | (5.39) | |
| Consumer Goods | 0.59** | -0.50 | 3.20 | 1.84 |
| | (2.16) | (-1.45) | (1.40) | |
| Healthcare | 0.59*** | -0.50* | 4.53*** | 15.01*** |
| | (2.85) | (-1.92) | (5.46) | |
| Industrials | 0.50* | -0.65* | 8.23*** | 5.02*** |
| | (1.79) | (-1.78) | (2.76) | |
| Oil and Gas | 0.39 | -0.51* | 10.18*** | 14.37*** |
| | (1.38) | (-1.89) | (5.20) | |
| Utilities | 0.90*** | 0.19 | -0.35 | 0.19 |
| | (4.44) | (0.61) | (-0.07) | |
| Telecom | 0.57** | -0.73** | 3.00 | 3.03** |
| | (2.26) | (-2.37) | (0.99) | |
| Technology | 0.39 | -1.00* | 9.65*** | 31.49*** |
| | (1.20) | (-1.83) | (7.83) | |

**Table 3.7 The Impact of monetary policy shocks on the ERP of the 25 value-weighted Fama-French portfolios**.

NOTE: The model estimated is (3.11). The dependent variable is the ERP of the 25 Fama-French portfolios in percent. The independent variable is the domestic monetary policy shock in the UK. Adjusted sample size 1988:08 – 2014:10 (no. of observations 315) *** significant at 1%, ** significant at 5% and * significant at 10%. Figures in the parentheses are z-statistics.

| Panel A | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $\mu_i$ | | | | | | Z-stat | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | 0.68*** | 0.48* | 0.73*** | 0.86*** | 0.73*** | 0.696 | (2.74) | (1.74) | (2.72) | (3.1) | (3.82) |
| BM2 | 0.89*** | 0.41 | 0.74** | 0.73** | 0.66*** | 0.686 | (3.89) | (1.2) | (2.55) | (2.46) | (2.83) |
| BM3 | 0.93*** | 0.69** | 0.78*** | 0.81*** | 0.68*** | 0.778 | (4.21) | (2.35) | (2.85) | (2.83) | (2.61) |
| BM4 | 0.96*** | 0.84*** | 0.51* | 0.65** | 0.53** | 0.698 | (4.32) | (3.12) | (1.69) | (2.5) | (2.46) |
| Value | 0.94*** | 0.84*** | 1.15*** | 0.93*** | 0.59** | 0.89 | (4.3) | (2.91) | (4.19) | (3.51) | (2.3) |
| Average | 0.88 | 0.652 | 0.782 | 0.796 | 0.638 | | | | | | |
| Panel B | | | | | | | | | | | |
| | $\beta_i$ | | | | | | Z-stat | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | -0.65 | -0.77** | -0.21 | -0.26 | -0.3 | -0.438 | (-1.18) | (-1.99) | (-0.48) | (-0.67) | -1.15 |
| BM2 | -0.48 | -0.03 | -0.98** | -0.68 | -0.94*** | -0.622 | (-1.14) | (-0.08) | (-2.23) | (-1.47) | (-3.53) |
| BM3 | -0.78* | -0.64 | -0.63 | -0.81** | -0.61* | -0.694 | (-1.75) | (-1.33) | (-1.58) | (-2.20) | (-1.90) |
| BM4 | -1.00** | -1.06** | -0.37 | -0.78** | -0.49* | -0.74 | (-2.43) | (-2.34) | (-0.89) | (-1.98) | (-1.95) |
| Value | -0.92** | -0.85** | -1.25*** | -1.09*** | -0.61 | -0.944 | (-2.15) | (-2.39) | (-2.85) | (-2.85) | (-1.61) |
| Average | -0.766 | -0.67 | -0.688 | -0.724 | -0.59 | | | | | | |
| Panel C | | | | | | | | | | | |
| | $\gamma_i$ | | | | | | Z-stat | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | 4.28** | 6.29*** | 4.87*** | 7.52*** | 3.96** | 5.74 | (2.3) | (3.1) | (4.31) | (5.65) | (2.37) |
| BM2 | -0.72 | 7.87*** | 12.29*** | 11.12*** | 10.08*** | 7.64 | (-0.21) | (3.38) | (3.91) | (3.03) | (6.02) |
| BM3 | 6.36 | 4.70*** | 8.06*** | 7.07*** | 9.24*** | 6.548 | (1.52) | (2.58) | (2.76) | (3.78) | (3.39) |
| BM4 | 7.46* | 8.63* | 9.75*** | 14.29** | 7.84*** | 10.03 | (1.76) | (1.8) | (3.67) | (2.23) | (3.58) |
| Value | 9.54 | 20.73** | 13.99** | 13.72*** | 8.60*** | 14.5 | (1.53) | (2.2) | (1.98) | (3.08) | (3.41) |
| Average | 5.384 | 9.644 | 9.792 | 10.74 | 7.944 | | | | | | |

| Panel D | | | | | |
|---|---|---|---|---|---|
| | Wald's Statistics ($H_0$: $\beta_i = \gamma_i = 0$) | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large |
| Growth | 2.87* | 5.87*** | 10.25*** | 16.53*** | 3.15** |
| BM2 | 0.71 | 5.79*** | 9.24*** | 5.11*** | 21.03*** |
| BM3 | 2.46* | 3.56** | 4.68*** | 8.33*** | 6.82*** |
| BM4 | 4.18** | 4.01** | 6.76*** | 4.69*** | 7.85*** |
| Value | 3.33** | 5.23*** | 5.87*** | 7.99*** | 6.28*** |

## Appendix 3.1

| Notation | Definition/Brief Explanation |
|---|---|
| $\Delta y$ | Growth Rate of Index of industrial Production. $\Delta y = \ln\left(\frac{y_t}{y_{t-1}}\right) * 100$ |
| $\pi$ | Inflation. This is measured using annual log changes in RPIX index until November 2003. From December 2003, inflation is measured as annual log changes in Harmonised Consumer Price Index |
| Uemp | Annual unemployment rate is measured as unemployed workforce as a percentage of economically active workforce claiming unemployment benefits i.e., Job Seekers Allowance and National Insurance Credits |
| $\Delta x$ | Growth rate (log changes expressed in %) of trade-weighted Sterling Effective Exchange Rate index |
| $mp$ | Measure of monetary policy. This is Bank of England's Base Rate |
| E100 | Equity Risk Premium of FTSE 100 index. This is measured as difference between total return on FTSE 100 index and one-month UK treasury bill rate. |
| E250 | Equity Risk Premium of FTSE 250 index. This is measured as difference between total return on FTSE 250 index and one-month UK treasury bill rate |
| EonG | Equity Risk Premium of Oil and Gas sector. This is measured as difference between total return on FTSE All Share Oil and Gas Index and one-month UK treasury bill rate |
| EBM | Equity Risk Premium of Basic Materials sector. This is measured as difference between total return on FTSE All Share Basic Materials index and one-month UK treasury bill rate |
| Eind | Equity Risk Premium of Industrial sector. This is measured as difference between total return on FTSE All Share Industrial Index and one-month UK treasury bill rate |
| ECsvs | Equity Risk Premium of Consumer Services sector. This is measured as difference between total return on FTSE All Share Consumer Services index and one-month UK treasury bill rate |
| ETel | Equity Risk Premium of Telecommunication sector. This is measured as difference between total return on FTSE All Share Telecommunications index and one-month UK treasury bill rate |
| Eutl | Equity Risk Premium of Utilities sector. This is measured as difference between total return on FTSE All share Utilities index and one-month UK treasury bill rate |
| ECgds | Equity Risk Premium of Consumer Goods sector. This is measured as difference between total return on FTSE All Share Consumer Goods index and one-month UK treasury bill rate |
| ETech | Equity Risk Premium of Technology sector. This is measured as difference between total return on FTSE All Share Technology index and one-month UK treasury bill rate |
| EFin | Equity Risk Premium of Financial sector. This is measured as difference between total return on FTSE All share Financial index and one-month UK treasury bill rate |
| EHlth | Equity Risk Premium of Healthcare sector. This is measured as difference between total return on FTSE All Share Healthcare index and one-month UK treasury bill rate |

# Paper 3

## 4 The impact of aggregate and dis-aggregated consumption shocks on the UK ERP

*"Consumption is the sole end and purpose of all production; and the interest of the producer ought to be attended to, only so far as it may be necessary for promoting that of the consumer."*

The Wealth of Nations, Adam Smith


**Abstract**

I examine the impact of aggregate and disaggregate consumption shocks on the ex-post Equity Risk Premium (ERP) of FTSE indices and the 25 Fama-French style value-weighted portfolios. I extract consumption shocks using Structural Vector Autoregression (SVAR) and investigate its time-series and cross-sectional implications for ERP in the UK. Aggregate consumption shocks seem to explain significant time variation in the ERP. At disaggregated level, when the actual consumption is less than expected, the ERP rises. Durable and Semi-durable consumption shocks have a greater impact on the ERP than non-durable consumption shocks.



**Keywords:** Equity Risk Premium, Consumption Wealth Channel, Consumption Shocks, Structural Vector Autoregression, Asset Pricing.

***JEL Classification***: E0, E2, E6 and G0


### 4.1 Introduction

The classical Consumption-Based Capital Asset Pricing Model (CCAPM), first proposed by Rubinstein (1976), Lucas (1978), and Breeden (1979) provided an alternative way for pricing assets. In the CCAPM, a representative agent seeks to maximise the time-additive discounted utility as a function of stochastic consumption.

In CCAPM a representative agent is assumed to smooth-out lifetime consumption by optimally allocating wealth between consumption and savings in different time periods. The classical form of CCAPM attempts to explain the ERP by the risk associated with the inter-temporal marginal rate of substitution of consumption. However, Mehra and Prescott (1985) find that the classic from of CCAPM does not accurately match the model implied ERP with the actual observed ERP thus giving rise to the well-known 'ERP puzzle'.

Subsequently, many new consumption-based models have been proposed in which the canonical non-linear pricing factor has been replaced by approximate linear pricing factor which is a linear combination of consumption growth rate and some state variables [See for example, Lettau and Ludvigson (2001a), Lettau and Ludvigson (2001b), Jacobs and Wang (2004)]. Lettau and Ludvigson (2001b) show that agent's consumption (c), asset wealth (a) and income (y) are cointegrated and transitory deviations defined as '*cay*' is able to predict excess returns. Jacobs and Wang (2004) show that when the stochastic discount factor is expressed as linear function of the first two moments of consumption growth rate, then these moments can act as pricing factors. These factors help explain the variations in the cross-sectional excess stock returns even without any conditioning information. Della Corte, Sarno and Valente, (2010) provide a mixed evidence of predictive ability of '*cay*' over a period of one hundred years in four major economies. Sousa (2010) extends the work of Lettau and Ludvigson (2001b) and show that the transitory deviations in the long-run relationship between consumption, asset wealth, housing wealth and income *("cday"* variable) is able to better predict US and UK quarterly excess stock returns. His result suggests that housing wealth has persistent impact on consumption than financial wealth and therefore the long-term risk in these variables help drive the excess stock returns.

Further, the Long-run Risk model of Bansal and Yaron, (2004) imply that if shocks to the level and volatility of consumption are persistent and are observable, then their impact should be reflected in the asset prices. Extending their Long-run Risk model, Bansal, Dittmar and Kiku, (2009) further show that incorporating the long-run relation between consumption and dividends can significantly explain the cross-sectional variance of asset risk premia at long-term investment horizons.

The extant literature ignores the role of monetary policy which has a significant impact on the investors' consumption choices. The classical consumption-wealth channel postulates that the current and future consumption levels are significantly influenced by the monetary policy through the stock market and/or housing wealth[11]. Further, the deviations in agent's consumption path can also be influenced by exogenous shocks in inflation. Therefore, in this paper I investigate the impact of consumption shocks arising from interest rate and inflation as well changes in the agent's wealth and income, on the UK ERP.

Specifically, in this article, I examine the impact of private consumption shocks at the aggregate and dis-aggregate levels on the ERP of the FTSE 100, FTSE 250 indices as well as the ten most widely followed sectors in the in the UK. I also examine the impact on ERPs of 25 Fama-French value-weighted portfolios based on size and book-to-market characteristics. It is believed that findings of the research will be particularly useful since FTSE indices are widely used as benchmarks by both retail and institutional

[11] See Ando and Modigliani, (1963); Modigliani, (1963, 1971).

investors. Further, the consumption shocks extracted using the Structural Vector Autoregression (SVAR) model represent an unexpected rise or fall in aggregate personal consumption. These structural shocks can be interpreted as unanticipated deviations of the actual consumption from the expected consumption under the assumption that consumption-wealth channel of transmission of monetary policy exist. Therefore, a positive consumption shock would suggest higher consumption than expected and a negative consumption shocks would indicate lower than expected consumption. The variability in the actual consumption compared to the expected consumption would indicate severity in the consumption shocks. Furthermore, these structural shocks can also be viewed as surprise changes in the actual consumption path from a theoretically expected consumption path. I model these consumption shocks on the changes in interest rates and inflation which carry information about the evolution of the expected news regarding stochastic discount factor, that is used to discount the wealth portfolio, and expected future economic volatility (Bansal et al. 2014).

A natural question arise here is why would one expect aggregate personal consumption explain the variations in the excess stock returns? After all, as pointed by Campbell and Cochrane (2000), the return on market portfolio, as a pricing factor, is measured with more accuracy than aggregate consumption. Cochrane (2008), suggests that true nature of systematic risk is embedded in the macroeconomy. “Good” and “Bad” times can be well characterised by marginal value of wealth or consumption, as wealth or consumption reflects the true “well-being” of agents. Thus, the risk associated with macroeconomic variables such as consumption or wealth represents systematic risk i.e. not firm or stock specific and therefore cannot be diversified by forming optimal portfolios. Moreover, risk factor associated with consumption represents a measure of business cycle fluctuations. This is particularly relevant for investors with long-term investment horizon in the equity markets who are exposed to macroeconomic risk which cannot be diversified. As such, we can expect consumption shocks as an appropriate state variable and (possibly) a natural choice of risk factor in a factor asset pricing model. Ludvigson (2013) also argues that, systematic risks, to which asset prices are exposed, are macroeconomic in nature. Although risk factors derived from portfolio-based factor models such as the CAPM, the Fama and French (1993;2015) and Carhart (1997) help explain the variation in the asset prices, both at aggregate level and within the cross-section, yet most of these portfolio-based models fail in capturing response of asset prices to a macroeconomic shocks arising from both within the economy and from outside the economy. This approach of explaining the variations in the expected stock returns can be dubbed as "*using stock returns to explain stock returns*" (Burmeister, Roll and Ross, 1994. p 7).

****insert figure 4.1 here****

Figure 4.1 illustrates the importance of investigating the impact of consumption-related pricing factor on excess stock returns. It shows the three main components of Gross Domestic Product (GDP) as a percentage of GDP over the past 59 years in the UK; namely personal/private consumption (C), government consumption (G) and Gross Fixed Investment (I). It is quite evident from the figure that aggregate personal/private consumption is the major contributor to the GDP. The average quarterly share of personal consumption for the period of 1955 to 2014 is 58.11%. The private consumption as a percentage of GDP has always been above 60% since the mid-1990s. Therefore, it is evident that personal/private sector consumption is the "engine of growth" in the UK and hence consumptions shocks are systemically important.

I also study the impact of disaggregated consumption shocks on the UK ERP. I investigate whether durable, semi-durable and non-durable consumption shocks are able to explain significant variations in the ERPs of the various FTSE indices, both at aggregate and industry level. There are far fewer studies which provide evidence at the disaggregate level. I make an important contribution to the extant literature by providing the evidence of the impact of consumption shocks on the ERP at both aggregate and disaggregate levels. Such evidence will provide useful insights about the impact of business cycle on the ERP.

There are several reasons why I believe that dis-aggregated consumption shocks should have a significant impact on the ERP. First, the canonical C-CAPM links consumption to asset returns using preferences which aggregates the optimising behaviour of the agents using aggregate non-consumption and ignore the services provided by the durable consumption. Piazzesi, Schneider and Tuzel, (2007) show that a Constant Elasticity of Substitution (CES) non-separable preference defined over both non-durable and housing services consumption (which can be interpreted as durable consumption) can help rationalise asset pricing models and also explains the behaviour of the ERP.

Second, as shown by Yogo (2006), the ERP is time-varying and counter-cyclical. The expected ERP rises when durable consumption falls relative to non-durable consumption. The expected returns on stocks are higher at business cycle troughs than at peaks. This may be partly because within the C-CAPM framework the marginal utility of consumption is a measure of risk aversion. Yogo, (2006) assumes the utility of durable and non-durable consumption is non-separable. When the elasticity of substitution between the durable and non-durable goods and service is more than the intertemporal marginal rate of substitution, then as durable consumption falls, the marginal utility of consumption rises. Thus, it is critical to examine separately the impact of durable and non-durable consumption shocks on the ERP.

Further, Power, (2004) argues that durable and semi-durable consumption in the UK are strongly pro-cyclical. The expenditure on durable and semi-durable consumption is higher during economic booms and falls dramatically during recessions. Moreover, durable consumption is more volatile than non-durable consumption.  This is partly because the services offered by durable and semi-durable goods are typically consumed over longer period of time than those offered by non-durable consumption goods and services and partly because expenditure on durable and semi-durable goods is discretionary and deferrable (Black and Cusbert, 2010).

Figures 4.2 and 4.3 illustrate above argument and exemplify the cyclical properties of dis-aggregated consumption. Figure 4.2 shows the time series plots of log levels of durable, semi-durable and non-durable consumption in the UK while figure 4.3 shows the time-series plots of growth rates of durable consumption, semi-durable consumption and non-durable consumption respectively. The shaded regions in the plots represent periods of recession in the UK which is measured as period of decline in the real GDP in two consecutive quarters. It can be seen that the durable consumption growth is more volatile than semi-durable consumption growth which in turn is more volatile than non-durable consumption growth.

****insert figure 4.2 here****

****insert figure 4.3 here****

Detemple and Giannikos (1996) argue that durable consumption has two key attributes. First is known as the usage function which represents services provided over longer period of time than non-durable goods. Durable goods not only provide utility in the current period, but they also provide gratification over future period of time. The second attribute is that durable goods provide immediate feeling of status which provides symbolic value. They show that in presence of this multi-attribute durable good, equilibrium interest rates and asset risk premia are linked not only to marginal utilities of non-durable but also of status and services that are provided by durable goods.

Using the data from 1988Q1 to 2014Q4 for the UK, I examine the impact of durable, non-durable and semi-durable consumptions shocks on the UK ERP. The main findings are as follows. First, I find that aggregate personal consumption shocks have a negative impact on the ERPs of the various FTSE indices both at aggregate and sectoral level. A fall in actual consumption relative to the expected consumption increases the ERP confirming countercyclical nature of stock returns. Aggregate consumption shocks seem to explain approximately 21.4% variations in the ERPs of FTSE 100 and FTSE 250 indices and about 14% variations in the ERPs of the ten sectoral indices. The ERPs of cyclical industries seems to be more sensitive to the aggregate consumption shocks. Furthermore, the traditional Fama and MacBeth, (1973) analysis shows that the exposure to aggregate consumption shocks can explain about 28% variation in the ERPs of the various FTSE indices and these excess returns seems to increase linearly with the increase in the exposure to aggregate consumption shocks.

Second, the results for the 25 value-weighted Fama-French style portfolios are fairly similar. Aggregate personal consumption shocks have a negative impact on the ERPs of the 25 portfolios. On the basis of size characteristic, the ERPs of portfolios of small stocks are relatively more sensitive to aggregate consumption shocks than the ERPs of large stocks. The ERPs of portfolio of value stocks are more sensitive to the aggregate personal consumption shocks than the ERPs of portfolio of growth stocks. Aggregate personal consumption shocks can explain approximately 44% variation in the ERPs of the 25 Fama-French portfolios after controlling for the size, value premiums of Fama and French (1992, 1993) and momentum premium of Carhart (1997).

Third, the shocks to durable, semi-durable consumption have a negative impact on the ERPs of the various FTSE indices as well as sectoral indices. On the contrary, the shocks to non-durable consumption exert a positive impact on the ERPs of FTSE indices. This implies that durable and semi-durable consumption exhibits more pro-cyclical properties than non-durable consumption. Furthermore, the cross-sectional regression results suggest that the ERP increases with the increase in the exposure to the shocks in durable and semi-durable consumption. On the contrary, the ERP decreases with the increase in exposure to non-durable consumption shocks. The results are broadly similar for the 25 Fama-French portfolios.

The remainder of the paper is organised as follows; Section 4.2 explains the theoretical background and the empirical approach employed. Section 4.3 describes the data used. Section 4.4 discusses the empirical results and section 4.5 concludes.

## 4.2 Theoretical background and Empirical Framework

### 4.2.1 Theoretical Background

Under the canonical CCAPM, expected excess returns on risky assets are related to consumption risk. As discussed in the introduction, a representative agent prefers not to have choppy future consumption levels and maximise the expected future utility of consumption discounted by the agent’s impatience. This is represented as;

$$U(C_t, C_{t+1}) = u(C_t) + \beta . E_t[u(C_{t+1})] \quad \textbf{(4.1)}$$

where, the period utility function $u(.)$ is concave and increases with the increase in the level of consumption, $0 < \beta < 1$ captures the agent's impatience. The utility function in (4.1) imply that agents strictly prefer increasing consumption ("greedy") however the marginal utility of consumption diminishes over time ($u'' < 0$). Under the assumption that the agent can freely trade assets to smooth the consumption, along with the objective of maximising the utility of consumption in presence of inter-temporal budget constrain, the agent's first order condition for an optimal consumption and portfolio choice is given by

$$P_t . U'(C_t) = E[\beta . U'(C_{t+1}) . x_{t+1}] \quad \textbf{(4.2)}$$

where, $x_{t+1}$ is the total payoff from the asset with price $P_t$ and $C_t$ is the consumption level at time *t*. Equation 4.2 implies that loss in utility by giving up the current consumption and using the proceeds to buy an asset at price $P_t$ must be at the most equal to discounted future augmented utility. In other words, the marginal cost of losing the consumption must be equal to marginal gain in the utility of consumption due to the expected random payoff $x_{t+1}$ from the purchased asset. This is the Euler equation, which can be written as;

$$1 = E_t(m_{t+1} R_{t+1}) \quad \textbf{(4.3)}$$

where $R_{t+1}$ is the gross rate of return and $m_{t+1} = \beta . \frac{u'(C_{t+1})}{u'(C_t)}$ is the stochastic discount factor which is equal to the intertemporal marginal rate of substitution. Since the marginal investment in the asset results in same level of increase in the expected future utility, and since the excess return on any risky asset (ERP) is the return on zero-cost portfolio, it can be written as

$$0 = E_t[u'(C_{t+1}).R_{t+1}^e] \quad \textbf{(4.4)}$$

where, $R_{t+1}^e$ is the ERP of the risky asset. Equation (4.4) implies that excess returns on any risky asset are sensitive to its co-movement with consumption level of the agent. Therefore, a shock to consumption level that may arise due to a change in agent's income or wealth or due to some exogenous factors should be reflected in the ERP. It is worth pointing here that I have not made any assumption regarding the specific nature of functional form of the agent's preferences i.e. whether it is time separable or non-separable, except that it is concave and increasing. In the next subsection, I discuss the methodology of extracting the consumption shocks.

### 4.2.2 Identification of Consumption Shocks

I use a two-step approach. In the first step, I use the SVAR approach for extracting the consumption shocks. In the second step, I examine the implications of these shocks for the asset prices in the UK. For this purpose, I use the two-stage Fama and MacBeth (1973) cross-sectional regressions to estimate the factor risk premiums arising from exposure to these consumption shocks.

I begin with identifying the domestic consumption shocks. For this I borrow the SVAR framework of Ludvigson et.al. (2002) which examines the consumption-wealth channel of the transmission of monetary policy in the US. MacDonald, Mullineux and Sensarma (2011) also employ similar approach for examining the consumption-wealth channel in the UK. The theoretical underpinnings of this framework is deeply rooted in the Life-Cycle theory of consumption proposed by Modigliani, (1963) and Ando and

Modigliani, (1963). The consumption-wealth channel describe the response of aggregate consumption to monetary policy changes through changes in aggregate wealth. For example, an accomodative monetary policy can boost the market value of both the financial and housing wealth which can be subsequently used to increase household consumption either by withdrawing the equity from the housing wealth or by liquidating the financial wealth[12].

I model the UK economy using the following SVAR;

$$\boldsymbol{A}Z_t = \boldsymbol{A}^*(L)\boldsymbol{Z}_{t-1} + \boldsymbol{B}u_t \tag{4.5}$$

where, $\boldsymbol{Z}$ is n dimensional vector of macroeconomic variables, $\boldsymbol{A}^*(L)$ is the pth order polynomial matrix in the lag operator $L$, $\boldsymbol{A}$ is the $\mathrm{n} \times \mathrm{n}$ matrix of contemporaneous coefficients, $\boldsymbol{B}$ is a $\mathrm{n} \times \mathrm{n}$ matrix relating the structural innovations $\mathrm{u_t}$ to the reduced form innovations and $\mathrm{u_t} \sim \mathrm{N}(0, \Sigma)$ is a $\mathrm{n} \times 1$ vector of structural shocks assumed to have ortho-normal co-variance matrix similar to an identity matrix i.e. $\mathrm{E}[\mathrm{u}, \mathrm{u}'] = \mathrm{I}$. In order to estimate (4.5) we first estimate the following reduced form VAR

$$\boldsymbol{Z}_t = \boldsymbol{C}(L)\boldsymbol{Z}_{t-1} + \varepsilon_t \tag{4.6}$$

where $\varepsilon_\mathrm{t}^\mathrm{i}$ is the reduced form residuals such that $\varepsilon_\mathrm{t}^\mathrm{i} \sim (0, \Omega)$ and $\Omega = \mathrm{E}[\varepsilon, \varepsilon' ]$ is the residual covariance matrix and $\boldsymbol{C} = \boldsymbol{A}^{-1}\boldsymbol{A}^*$ .Following Amisano and Giannini, (1997) and Lutkepohl, (2005) we have,

$$\mathbf{A}\varepsilon_t = \mathbf{B}u_t \tag{4.7}$$

[12] The Bank of England has maintained its accommodative monetary policy stance by keeping the base rate at its historic low levels since March 2009.

The assumption of ortho-normal covariance matrix of the structural shocks leads to following condition

$$\mathbf{A}\Omega\mathbf{A}' = \mathbf{B}\mathbf{B}' \qquad \textbf{(4.8)}$$

The short-run restrictions implied by (4.7) were also imposed by Gali, (1992) and Pagan, (1995) to study and test the traditional IS-LM model to the post-war US data.

Similar to Ludvigson et.al. (2002), I use five macroeconomic variables in (4.5) i.e., inflation, aggregate income, aggregate consumption, aggregate wealth and Bank of England's base rate. Thus we have,

$$\boldsymbol{Z}_t = [\pi_t,\ y_t, c_t, w_t, r_t]' \qquad \textbf{(4.9)}$$

where, $\pi_t = \ln\left[\frac{P_t}{P_{t-1}}\right]$ is the inflation measured using log changes in Consumer Price Index, $y_t = \ln I_t$ is the log of aggregate income, $c_t = \ln C_t$ is the aggregate household consumption, $w_t = \ln W_t$ is the gross aggregate wealth, $r_t$ is the Bank of England's base rate. In order to identify the $\boldsymbol{A}$ and the $\boldsymbol{B}$ matrices in (4.7), it is necessary to impose restrictions on the elements that are theoretically motivated. I impose the short-run restirctions suggested by Ludvigson et.al. (2002). The restrictions on matrix $\boldsymbol{A}$ are driven by the following assumptions; (i) the base rate responds contemporaneously to consumption and income, (ii) wealth is not contemporaneously affected by consumption however, the opposite is true and finally (iii) the Bank of England is assumed not to react contemporaneously to changes in wealth, though simultaneous reaction between wealth and base rate is allowed. This final assumption implies that Bank of England does not target wealth directly. With these set of assumptions the matrix of contemporaneous coefficients *A* takes the form;

$$\boldsymbol{A} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & 0 \\ a_{41} & a_{42} & 0 & 1 & a_{45} \\ a_{51} & a_{52} & a_{53} & 0 & 1 \end{bmatrix} \quad \textbf{(4.10)}$$

While the matrix ***B*** is assumed to be an identity matrix. Thus (4.7) becomes;

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & 0 \\ a_{41} & a_{42} & 0 & 1 & a_{45} \\ a_{51} & a_{52} & a_{53} & 0 & 1 \end{bmatrix} . \begin{bmatrix} \varepsilon_t^{\pi} \\ \varepsilon_t^{y} \\ \varepsilon_t^{c} \\ \varepsilon_t^{w} \\ \varepsilon_t^{r} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} . \begin{bmatrix} u_t^{\pi} \\ u_t^{y} \\ u_t^{c} \\ u_t^{w} \\ u_t^{r} \end{bmatrix} \quad \textbf{(4.11)}$$

The structural consumption shocks $u_t^c$ can be computed from (4.11) once the unknown parameters in ***A*** are estimated.

### 4.2.3 Asset Pricing Implication

In the previous section I described the methodology to extract the structural consumption shocks. I now outline the procedure to investigate whether these consumption shocks are priced in aggregate and cross-sectional stock returns. For this I estimate the factor loadings of our test portfolios on the consumption shocks by estimating the following quarterly time series regression model;

$$E_{t,i}^{e} = \alpha_i + \beta_c^i u_t^c + \varepsilon_t \quad \textbf{(4.12)}$$

where, $E_{t,i}^{e}$ is the Equity Risk Premium (ERP) of the $i^{th}$ test portfolio measured using the total return on the portfolios over and above risk-free interest rate, α is the constant, $\beta_c^i$ is the factor loading of the $i^{th}$ portfolio on the consumption shocks $\mathrm{u}_\mathrm{t}^\mathrm{c}$ and $\varepsilon$ is assumed to be a white-noise process. It is important to note that since $\mathrm{u}_\mathrm{t}^\mathrm{c}$ in equation (4.12) is not an excess return on freely traded portfolios, the sample mean of the factor does not correspond to its risk premia. Therefore, under such conditions, the estimated constant term ($\alpha_i$) in equation (4.12) cannot be considered as pricing error in explaining the ERPs of a particular portfolio. As such the Gibbons, Ross and Shanken, (1989)'s approach for testing the null hypothesis that all the ($\alpha_i$)s are jointly significantly different from zero is not strictly applicable here.

I investigate the factor loading for three types of portfolios. First is the total excess return on two popular and mostly tracked indices in the UK, the FTSE 100 index and the FTSE 250 index. These two indices serve as a benchmark for most UK fund managers. The second is the excess returns on ten most widely used sectoral indices in the UK. These indices are popular with the tracker Exchange Traded Funds (ETFs) which provide opportunities to the investors to get sectoral exposure. Third, I also investigate the factor loadings for the excess returns on value-weighted 25 Fama-French-style portfolios sorted on size and book-to-market. The goal here is to examine whether the consumption shocks is consistent and significant within the cross-sectional variation in the excess returns. I study the impact of consumption innovations on the excess returns of these 25 portfolios primarily because they have been extensively used in empirical asset pricing literature. Moreover, they also reflect two most important aspects of asset returns; the "size premium" and the "value premium".

In order to estimate the factor risk premium due to the exposure to the consumption shocks in (4.12), I employ two step cross-sectional regression approaches of Fama and MacBeth, (1973). The first step is to estimate the time-series regression (4.12) and recover the factor loadings $\widehat{\beta_c}$. In the second step, I estimate the cross-sectional regression of ERP on these loadings $\widehat{\beta_c}$ obtained from the first step to examine the exposure of the excess returns to the factor loading over time. Thus, the second stage regression is;

$$E_{t,i}^{e} = \gamma_0 + \gamma_1 \widehat{\beta_c} + \epsilon_1 \tag{4.13}$$

where, $\gamma$s are the regression coefficients that are used for calculating the factor risk premium due to the exposure to the consumption shocks under the assumption that $\epsilon$ is white noise. The t-statistics associated with the factor risk premium is computed using Newey and West (1987) heteroskedasticity and autocorrelation corrected standard errors.

## 4.3 Data

In order to estimate the SVAR and extract the structural consumption shocks I use quarterly UK data from 1988Q1 to 2014Q4 taken from DataStream. To estimate the impact consumption shocks, I use personal durable, semi-durable and non-durable consumption which is measured using seasonally adjusted UK household consumption and covers spending on goods and services except for: buying or extending a house, investment in valuables (paintings, antiques etc.) or purchasing second-hand goods. See Appendix 4.1 for more details about the measurements and components of durable, semi-durable and non-durable consumption by the Office of National Statistics.

I use following variables in constructing SAVAR. Total Gross Wealth which is the total gross value of accumulated assets by households; the sum of four components: property wealth, physical wealth, financial wealth and private pension wealth. Aggregate personal income that is measured using income approach of secondary distribution of income accounts and uses the disposable income of households and Non-Profit Institutions Serving Households (NPISH). Inflation is calculated using the log difference of the harmonised consumer price index. I use Bank of England's (BOE) base interest rate as a proxy of the UK's monetary policy.

The ERP of the FTSE indices are estimated using the difference between the returns on the total return indices, which includes dividends, and the 3-month UK treasury bills rate. The ERP of the 25 value-weighted Fama-French style portfolios sorted on size and book-to-market ratios is calculated using the difference between the returns on these portfolios and the 3-month UK treasury bills rate.[13]

Table 4.1 provides the descriptive statics. Panel A shows ERPs of aggregate and disaggregated FTSE indices. The Utility sector offers highest average excess returns amongst all UK sectors and outperforms the aggregate FTSE 250 average returns. On the hand, the Technology sector provides the lowest excess returns and highest volatility. All excess returns are negatively skewed. The Jarque-Bera statistics are significant for all returns except for Healthcare, Telecommunication, and Utility sectors. Panel B presents descriptive statistics of 25 Fama-French portfolios excess returns. For the ease of reading, we maintain the same naming conventions as in Gregory, Tharyan and Christidis (2013). We find that the third middle portfolio (EM3H) offers the highest excess returns whilst the small and growth portfolio (ESL) shows the highest volatility. Overall, all returns are negatively skewed and show excess kurtosis except for EM3H portfolio.

See Appendix 4.2 for the brief overview of the data.

---

[13] Return data of the 25 Fama-French portfolios and pricing factors i.e., size premium (SMB), value premium (HML) and momentum premium (UMD) for the UK are taken from Gregory, Tharyan and Christidis, (2013).

****insert table 4.1 about here****

## 4.4 Results

### 4.4.1 The impact of aggregate consumption shocks on ERPs of different industries

The results of time series regression specified in equation (4.12) are presented in table 4.2. The results show the factor loadings on consumption shocks on the ERPs of various FTSE indices (Column B of Table 4.2). The beta coefficients are significantly negative for the ERP of all the FTSE indices. Aggregate personal consumption shocks seem to have negative impact on the ERP of the aggregate FTSE indices (FTSE 100 and FTSE 250). The ERP of FTSE 250 index is more vulnerable to consumptions shocks than the ERP of FTSE 100 index ($|-5.40| > |-4.82|$). This is presumably because companies in the FTSE 250 index are more focused to the UK domestic economy than the companies in the FTSE 100 index. On the sectoral basis, the ERPs of cyclical industries such Financial firms seem to be most vulnerable to consumption shocks (beta= -7.45) than any other industry. This is, presumably, because consumption in the UK is largely financed by consumer credit. Similarly, other cyclical industries such as Technology, Industrials and Consumer Services seem to be more vulnerable to consumption shocks than the non-cyclical industries such as Utilities, Consumer Goods and Healthcare. On an average, consumption shocks can explain almost 14% variation in the ERPs of cyclical industries and 12.11% variation in the ERPs of non-cyclical industries. Overall, these results lend support to the hypothesis that ERPs of different industries react heterogeneously to consumption shocks.

****insert table 4.2 about here****

****insert table 4.3 about here****

I check the robustness of these results by investigating whether aggregate consumption shocks remain significant in driving the ERP in presence of the size premium (*SMB)* and the value premium (*HML)* of Fama and French, (1992,1993) and the momentum factor (*UMD)* of Carhart, (1997). For this I estimate the following regression model;

$$E^{e}_{t,i} = \alpha_i + \beta^{i}_{c}u^{c}_{t} + \beta^{i}_{s}.SMB_t + \beta^{i}_{v}.HML_t + \beta^{i}_{m}.UMD_t + \varepsilon_t \qquad \textbf{(4.14)}$$

where; $E^{e}_{t,i}$ is the ERP of $i^{th}$ portfolio, $u^{c}_{t}$ represents the consumption shocks derived from the SVAR model, $SMB$ is the return on a portfolio which is long in small size stocks and short in big size stocks, $HML$ is the return on portfolio which is long on high book-to-market ratio and short on low book-to-market ratio and finally $UMD$ is the momentum factor which is derived from the difference in returns form "winners" and "losers" portfolio.

Table 4.3 shows the impact of aggregate consumption shocks on the ERP after controlling for the size, value and momentum premiums. Consistent with results reported in table 4.2, the aggregate personal consumption shocks exert a negative impact on the ERP. In cases of ERPs of FTSE 100 and Consumer goods, Utilities and Telecom sectors aggregate personal consumption shocks eclipses the size, value and the momentum premiums. In each of these cases the respective adjusted R-squares are high with statistically significant F-Statistics. Overall, consumptions shocks appear to have a significant impact on the ERPs with the sole exception of Oil and Gas industry.

****insert table 4.4 about here****

To estimate the price of risk associated with the exposure to the risk of aggregate consumption shocks I employ the second-stage Fama and MacBeth, (1973) cross-sectional regressions approach. Since, the factor in equation (4.12) is not a return on a traded portfolio, we can rely on the two-stage approach developed by Fama and MacBeth, (1973). Table 4.4 reports the results of Fama-MacBeth two stage regressions. In column (1) I present the price of risk i.e. the factor risk premium arising due to exposure to the aggregate personal consumption shocks. In column (2) I assess the pricing ability of the aggregate consumption shocks in presence of size premium (SMB), value premium (HML) and the momentum premium (UMD). The t-statistics associated with the estimates are corrected for heteroscedasticity and autocorrelation (Newey and West, 1987). From column (1) it can be seen that exposure to the aggregate personal consumption is priced positively at 5% significance. A one-unit increase in the exposure to the aggregate personal consumption shocks leads to an increase in the ERP of the FTSE indices by 0.14%. The exposure to aggregate consumption shocks can explain 28.12% variation in the ERP of the FTSE indices. The F-statistics is significant at 10%. This suggests that ERP of the FTSE indices increases linearly as the exposure to the aggregate consumption shocks increases. However, from column (2) we can see that the pricing ability of aggregate consumption shocks decreases once we control for size, value and momentum premiums.

### 4.4.2 The impact of consumption shocks on ERPs of 25 Fama-French portfolios

This section investigates whether consumption shocks can explain significant variation in the ERPs of the 25 Fama-French style portfolios in the UK, sorted on the size and book-to-market characteristics. For this I estimate the quarterly time series regression (4.12) with the ex-post ERPs of the 25 portfolios as dependent variables. The results of this time series regressions are reported in table 4.5. Panels (A) and (B) reports the intercept and slope coefficients in equation (4.12) along with their associated t-statistics which are computed using Newey-West heteroskedastic and autocorrelation corrected -robust standard errors. Panel C reports the adjusted $R^2$ of each time-series regression which shows how much variation in the ERPs of the respective portfolios can be explained by consumption shocks. Panel C also reports the F-statistic of each individual regression.

****insert table 4.5 about here****

On the basis of size dimension, I find that, on an average, consumption shocks are able to explain 9.67% variation in the ERPs of the small size portfolios and 15.25 % variation in the ERP of the big stocks. On the basis of value dimension, I find that consumption shocks are able to explain, on average, 11.80% and 14.33% variation in the ERP of the growth and value portfolios respectively. From panel B, it can be observed that there is a fair degree of heterogeneity in the response of ERP of these portfolios to aggregate consumption shocks. Furthermore, we can also observe that the aggregate personal consumption shocks exert a negative impact on the ERP of these 25 portfolios. The ERPs of both small and large portfolios are highly statistically significant at 1% level.

Similar to small size stocks, we can see that most of the sensitivities of the ERPs of big size portfolios to consumption shocks are statistically significant irrespective of book-to-market ratios. The average sensitivity of the ERP of the big size portfolios is -1.45. Although the average variation in the sensitivities of the ERP of portfolios on the basis of size dimension is not large, yet we can see that the small firms are slightly more sensitive to consumption shocks than big firms. Consequently, when there is negative consumption shock i.e. when the actual consumption is well below the theoretical consumption implied by the SVAR model, small firm stocks seem to be most adversely affected compared to big stocks.

On value dimension, the average absolute sensitivity of the ERP of the value stock is 1.92 and for the growth stock it is 1.71. The ERPs of value stocks in both small size and big size category seems to be more sensitive to aggregate consumption shocks than their respective growth counterparts in the both the size categories. This is, presumably, because when there is negative consumption shock, the prices of value stocks fall much sharper than the growth stocks thereby raising their expected returns. As such the ERPs of the value stocks are more sensitive to consumption shocks than the ERPs of growth stocks. Another plausible explanation for this phenomenon is that value stocks are more sensitive to ultimate consumption risk (long run consumption co-variance risk) proposed by Parker and Julliard, (2005). An analogues explanation for this phenomenon can be provided on the basis of the intuition of results by Hansen et.al (2008). They show that the cash flows from value stocks are relatively more vulnerable to long term macroeconomic risk arising from shocks to consumption growth rate. The cash flows from the value stocks seem to positively co-vary with consumption while cash flows from growth stocks seem to co-vary with consumption negligibly, in the long run. Therefore, it may not be unreasonable to deduce that ERP of value stocks are more sensitive to consumption shocks.

I then repeat the analysis to check the robustness of the underlying essence of the results in table 4.5. For this I examine whether the aggregate personal consumption shocks have a significant impact on the ERPs of the 25 Fama-French portfolios in presence of the size premium, value premium and momentum factor by estimating the following regression.

$$E_{t,i}^{e} = \alpha_i + \beta_c^i u_t^c + \beta_s^i . SMB_t + \beta_v^i . HML_t + \beta_m^i . UMD_t + \varepsilon_t \qquad \textbf{(4.15)}$$

****insert table 4.6 about here****

The results are reported in table 4.6. Panel A of Table 4.6 shows the impact of the aggregate consumption shocks on the ERP of these 25 portfolios ($\beta_c^i$). Panels B, C and D show the impact of size, value and the momentum factors. It can be seen from Panel A that underlying essence of the results in table 4.5 is robust after controlling for the size, value, and momentum factors. Aggregate personal consumption shocks exert negative impact on the ERPs of the 25 value weighted Fama-French style portfolios. In all the cases the momentum factor is not statistically significant and does not have a significant impact on the ERPs of these portfolios. The average absolute loadings on consumption shocks are higher than the average loadings on size, value and momentum premiums. This suggests that, on average, ERP of these portfolios are more sensitive to consumption shocks than to size, value and momentum premiums. However, unlike the results in table 4.5, the ERPs of small stocks are not more sensitive to aggregate consumption shocks than the ERPs of large stocks after controlling for the size premium. The average absolute sensitivity of the ERP of small stocks is 1.28 while the average absolute sensitivity of the ERP of the large stocks is 1.41. Similarly, the difference in the sensitivity of the ERP of value and growth portfolios to consumption shocks has decreased after controlling for the value premium. From the panel of adjusted R-squared we find the, on average, the aggregate consumption shocks can explain 58.11% and 20.57% variation in the ERP of small stocks and large stocks respectively. On the basis of value, consumption shocks can explain, on average, 50.95% and 46.90% variation in the ERP of value and growth stocks.

****insert table 4.7 about here****

Table 4.7 reports the pricing implications of the aggregate consumption shocks for the cross-section of the 25-Fama-French style portfolios using the traditional Fama-MacBeth two stage regressions. Column (1) presents the pricing of aggregate consumption without controlling for any of the cross-sectional asset pricing factors. The first stage factor loadings for this column are from table 4.5. Column (2) reports the pricing ability of the aggregate consumption shocks in presence of the exposure to the market risk premium. Column (3) reports the pricing of consumption shocks in presence of the size, value and momentum premiums. In column (4) I control for all the cross sectional asset pricing factors. The reported t-statistics are corrected for heteroscedasticity and auto-correlation. Although, I do not find evidence of significant pricing ability of aggregate consumption shocks in the cross-section of ERPs of the 25 portfolios, yet from column (4) we note that the ERPs of the 25 portfolios are positively related to the sensitivity of aggregate personal consumption shocks after controlling for the cross-sectional asset pricing factors.

### 4.4.3 The impact of disaggregated consumption shocks on the ERP of FTSE indices

In the previous sub-sections, I examined the impact of structural shocks in aggregate consumption on the ERPs of various FTSE indices (at aggregate and industry level) and the ERPs of the 25- Fama-French style portfolios. The key element in the examination was the structural shocks to *aggregate consumption.* In this sub-section I now broaden the scope of the investigation and examine the impact of structural dis-aggregated consumption shocks i.e., durable, semi-durable and non-durable shocks on the ERPs of the aggregate and sectoral FTSE indices and the value-weighted 25 Fama-French style portfolios sorted on size and book-to-market characteristics. I follow the same two-step procedure as outlined in section 4.2.2. In the first step we derive the durable, semi-durable and non-durable shocks separately. In the second step we investigate their impacts on the ERP.

To derive the structural shocks of durable, semi-durable and non-durable consumption, we replace the aggregate consumption in the vector of endogenous variables in (4.5) and estimate three separate SVARs corresponding to durable, semi-durable and Non-durable consumption. Thus, vector of variables in (4.5) are changed as follows;

$$Z_{1,t} = [\pi_t,\ y_t, dc_t, w_t, r_t]' \quad \textbf{(4.16)}$$

$$Z_{2,t} = [\pi_t,\ y_t, sdc_t, w_t, r_t]' \quad \textbf{(4.17)}$$

$$Z_{3,t} = [\pi_t,\ y_t, ndc_t, w_t, r_t]' \quad \textbf{(4.18)}$$

where $dc_t, sdc_t, ndc_t$ are the logs of durable, semi-durable and non-durable consumption respectively. The estimated durable, semi-durable and non-durable structural consumption shocks are further used to examine their impact on the ERPs of the FTSE indices and the 25 Fam-French portfolios;

$$R^e_{t,i} = \alpha_{1,i} + \beta_{dc} u^{dc}_t + \varepsilon_{1,t} \quad \textbf{(4.19)}$$

$$R^e_{t,i} = \alpha_{2,i} + \beta_{sdc} u^{sdc}_t + \varepsilon_{2,t} \quad \textbf{(4.20)}$$

$$R^e_{t,i} = \alpha_{3,i} + \beta_{ndc} u^{ndc}_t + \varepsilon_{3,t} \quad \textbf{(4.21)}$$

where, $R^e_{t,i} = R_{i,t} - R_{f,t}$ is the ERP of the test portfolios, $\alpha_{n,i}$ $(n = 1,2,3)$ are the constants (intercepts), $\beta_{dc}, \beta_{sdc}$ and $\beta_{ndc}$ are factor loadings on the structural durable, semi-durable and non-durable consumption shocks($u^{dc}_t, u^{sdc}_t$ and $u^{ndc}_t$) and $\varepsilon_{n,t}$ $(n = 1,2,3)$ are assumed to follow a white noise process.

I then study the pricing implications of disaggregated consumption shocks separately using the second stage Fama and MacBeth, (1973) cross-sectional regressions.

$$R^e_{t,i} = \gamma^{dc}_0 + \gamma_{dc}.\widehat{\beta_{dc}} + \mu_1 \quad \textbf{(4.22)}$$

$$R^e_{t,i} = \gamma^{sdc}_0 + \gamma_{sdc}.\widehat{\beta_{sdc}} + \mu_2 \quad \textbf{(4.23)}$$

$$R^e_{t,i} = \gamma^{ndc}_0 + \gamma_{ndc}.\widehat{\beta_{ndc}} + \mu_3 \quad \textbf{(4.24)}$$

where $R^e_{t,i}$ is ERPs of the test portfolios over the sample period and $\gamma_{dc}, \gamma_{sdc}$ and $\gamma_{ndc}$ are the prices of risks due to the exposure to the estimated factor loading $\widehat{\beta_{dc}}, \widehat{\beta_{sdc}}$ and $\widehat{\beta_{ndc}}$ on durable, semi-durable and non-durable consumption from (4.21), (4.22) and (4.23) respectively.

****insert table 4.8 about here****

The impact of disaggregated consumption shocks on the ERP of FTSE indices are presented in Table 4.8. Panels A, B and C report the results of quarterly regressions (4.19), (4.20) and (4.21) and the sensitivities of the ERPs to shocks in durable, semi-durable and non-durable consumption. On average, the shocks in durable, semi-durable and non-durable consumption are able to explain 25.65%, 25.17% and 28.91%-time variation in the ERPs of the aggregate FTSE indices. On the other hand, the average time variation in the ERPs of ten FTSE industry portfolios explained by the durable, semi-durable and non-durable consumptions are 17.59%, 17.28% and 19.69% respectively. The shocks in durable, semi-durable and durable consumption can explain 17.31%, 16.90% and 19.30%-time variation in the ERPs of cyclical industries as compared to 17.99%, 17.86 % and 20.28% variation in the ERPs of non-cyclical industries.

Similar to the findings reported earlier where I used the aggregate consumption shocks, we find that the impact of durable and semi-durable consumption shocks on the ERP of the FTSE indices is negative. This suggests that an unexpected fall in the durable and semi-durable consumption will increase the ERP. This is probably because the marginal utility of durable and semi-durable consumption rises more during a recession as opposed to the marginal utility derived from the non-durable consumption. This would imply that stocks must provide higher risk premium to compensate the investor for bearing additional risk of durable and semi-durable consumption shocks.

On the contrary, I find that the non-durable consumption shocks are positively related to the ERP which suggests that an unexpected fall in non-durable consumption leads to fall in the ERP. This could be because non-durable consumption does not show strong pro-cyclical properties as compared to durable or semi-durable consumption. Therefore, an unexpected deviation of non-durable consumption from its theoretically expected path may not exert the similar impact to the one by the durable of semi-durable consumption shocks. This could also explain why the expected ERP estimated using canonical C-CAPM is different from the actual ERP since empirical applications of C-CAPM mostly use non-durable consumption data. Another possible explanation for this asymmetric impact is that since durable and semi-durable consumption provide services and utility for longer periods of time, these can be postponed especially during recession and/or due to unexpected change in income. Hence, the consumption of durable and semi-durable goods are relatively discretionary than non-durable consumption. Therefore, the relationship of non-durable consumptions shocks with ERP is different than the relationship between durable and semi-durable consumption shocks with the ERP.

To check the robustness of these results I repeat the analysis by including control factors i.e., the size premium, value premium and the momentum factor. I estimate the following regressions:

$$R^{e}_{t,i} = \alpha_{1,i} + \beta^{i}_{dc}.u^{dc}_{t} + \beta^{i}_{s}.SMB_{t} + \beta^{i}_{v}.HML_{t} + \beta^{i}_{m}.UMD_{t} + \varepsilon^{i}_{1.t} \quad \textbf{(4.25)}$$

$$R^{e}_{t,i} = \alpha_{2,i} + \beta^{i}_{sdc}.u^{sdc}_{t} + \beta^{i}_{s}.SMB_{t} + \beta^{i}_{v}.HML_{t} + \beta^{i}_{m}.UMD_{t} + \varepsilon^{i}_{2,t} \quad \textbf{(4.26)}$$

$$R^{e}_{t,i} = \alpha_{3,i} + \beta^{i}_{ndc}.u^{ndc}_{t} + \beta^{i}_{s}.SMB_{t} + \beta^{i}_{v}.HML_{t} + \beta^{i}_{m}.UMD_{t} + \varepsilon^{i}_{3,t} \quad \textbf{(4.27)}$$

****insert table 4.9 about here****

Panels A, B and C of Table 4.9 respectively show the impact of durable, semi-durable and non-durable consumption shocks. Durable and semi-durable consumption shocks exert a negative impact on the ERPs of the various FTSE indices, whereas non-durable consumption shocks have a positive impact, even after controlling for the size premium, value premium and the momentum factor. In all the cases the momentum factor does not have a significant impact on the ERPs of the FTSE indices. In some cases, such as the ERPs of the FTSE 100 index and the ERP of Oil and Gases and Telecoms, the durable, semi-durable and non- durable consumption shocks overshadows the size premium, value premium and the momentum factor. The ERP of FTSE 250 index is marginally more sensitive to durable, semi-durable and non-durable consumption shocks as the beta coefficients are higher than the ones for FTSE 100 index.

****insert table 4.10 about here****

Next, I estimate the traditional Fama and MacBeth, (1973) model. Table 4.10 reports the estimations of second-stage cross-sectional regressions. Columns (1), (2) and (3) report the ERPs given the exposure to durable, semi-durable and non-durable consumption shocks respectively. Results show that ERPs of the various FTSE indices are positively related to the sensitivities (betas) of durable, semi-durable and non-durable consumption. The risk from the exposure to durable and semi-durable consumption shocks are positively priced suggesting that the ERPs of the various FTSE indices linearly increase with the exposure to shocks in durable and semi-durable. The risk from non-durable consumption shocks is negatively priced. This suggests that a one-unit increase in the exposure to non-durable consumption shocks leads to decrease ERP of the FTSE indices. The exposures to the durable, semi-durable and non-durable consumption shocks can explain 39.61%, 41.80% and 39.18% variation in the ERPs of the various FTSE indices respectively.

### 4.4.4 The impact of disaggregated consumption shocks on the ERP of 25 size and value portfolios.

****insert table 4.11 about here****

In this sub-section I examine the impact of dis-aggregated consumption shocks on ERP of 25 value-weighted Fama-French style portfolios. Subsequently, I investigate the cross-sectional pricing implications of these shocks in the cross-section of excess returns of these portfolios.

Panels A, B and C of Table 4.11 report the estimates of regressions of (4.19), (4.20) and (4.21) and shows impact of the shocks in the durable, semi-durable and non-Durable consumption on the ERPs of the 25 portfolios respectively. On average, the contemporaneous durable, semi-durable and non-durable consumption shocks are able to explain about 16.09%, 15.58% and 18.93% variation in the ERPs, respectively. As far as the exposure to durable and semi-durable consumption is concerned, the ERPs of small size portfolios have higher absolute betas (-1.65 and -1.59), on average, than of big size portfolios (-1.57 and -1.54). This may be because the returns on small stocks are more pro-cyclical.  On the basis of value dimension, however, I find that on average, the ERP of value stocks seems to be less sensitive to the shocks in durable, semi-durable and non-durable consumption shocks than the ERP of growth stocks. Moreover, the absolute sensitivity of the ERP of the value stocks to the shocks in durable and semi-durable consumption is more than the sensitivity to non-durable consumption shocks.

****insert table 4.12 about here****

Table 4.12 shows whether the shocks in durable, semi-durable and non-durable consumption are priced in the cross-section of the 25 portfolios or not. Columns (1), (2) and (3) reports the pricing ability of the risk exposure to durable, semi-durable and non-durable consumption shocks separately without controlling for the cross-sectional asset pricing factors. Column (4) reports the pricing of all three consumption shocks together, while columns (5), (6) and (7) reports the pricing ability of the dis-aggregated consumption shocks in presence of the cross-sectional asset pricing factors. It seems that only the risk exposure to non-durable consumption shocks are significantly priced in the cross-section of the ERPs of the 25 Fama-French portfolios.

## 4.5 Summary

The paper investigates the impact of aggregate and disaggregated personal consumption shocks on the ERP of various industry and 25 Fama-French value weighted portfolios in the UK. Relying on the existence of consumption-wealth channel of monetary policy, I derive aggregate and dis-aggregated consumption shocks. Assuming that consumers prefer smooth consumption path and maximise the expected discounted utility of future consumption I derive shocks to consumption as the deviation of actual consumption from a theoretically expected consumption path. I then investigate the impact of contemporaneous aggregate consumption shocks and find that they exert a statistically significant negative impact on the ERPs of various FTSE indices and the 25 Fama-French portfolios. The results are robust even after controlling for the size premium, value premium and the momentum factors. The findings are consistent with Parker, (2003) who shows that contemporaneous consumption risk is negatively related to the expected stock returns.

I also analyse the impact of shocks in disaggregated consumption i.e. the durable, semi-durable and non-durable. I find that contemporaneous durable and semi-durable consumption shocks have a negative impact on the ERPs of the FTSE indices and the 25 Fama-French portfolios which is consistent with our previous results when I use aggregate consumption shocks. On the contrary, the non-durable consumption shocks have a positive impact on the ERP. Further, the ERPs of small and value portfolios are more sensitive to durable and semi-durable consumption shocks than to non-durable consumption shocks, implying that big and growth portfolios may provide protection against the changes in durable and non-durable consumption. The results lend support to

CCAPM which suggests that asset prices are contemporaneously related to the consumption risk.

**Dissemination:** This paper was presented at '*PhD Conference in Monetary and Financial Economics'* (June 2016), Centre for Global Finance at University of West England, Bristol and sponsored by The Royal Economic Society, (along with Prof. Poshakwale).

## Appendix 4.1

The Office of National Statistic (ONS) measures consumer spending by the final consumption expenditure of households and Non-Profit Institutions Serving Households (NPISH). The quarterly data is chained-weighted 2011 British Pound Sterling.

Based on ONS definition Durable goods are consumer products that do not need to be purchased frequently because they are made to last for a long time (usually lasting for three years or more). Examples of such goods are washing machines, cars, fridges etc. There are approximately 22 components of durable goods in the ONS series of durable goods. Semi-durable goods are goods which are neither indestructible nor lasting but they can be used more than once before there is a need to replace them; they fall in-between Durable goods and Nondurable goods; examples include clothing and footwear or preserved foods. There are approximately 20 components of semi-durable goods in the ONS series. Nondurable goods are the opposite of durable goods. They are defined as goods that are immediately consumed in one use or ones that have a lifespan of less than 3 years. Examples include food, cleaning products, food, fuel, beer, cigarettes, medication, office supplies, packaging and containers, paper and paper products, personal products. There are approximately 20 components of non-durable goods and service in the ONS series.

The components of wealth are as follows; Physical Wealth is the total household physical wealth is calculated as the sum of the values recorded for each household for contents of the main residence, contents of other property, collectables and valuables, vehicles and personalised number plates. (Households may borrow money to buy things such as vehicles and contents. However, borrowing to finance such purchases will be covered when considering financial wealth. For these reasons, total physical wealth figures are only ever presented on a gross basis and do not consider liabilities).

Gross financial wealth is the sum of: formal financial assets (not including current accounts in overdraft), plus informal financial assets held by adults, plus financial assets held by children, plus endowments for the purpose of mortgage repayment (For the record, net financial wealth is the same minus financial liabilities which are the sum of arrears on consumer credit and household bills plus personal loans and other non-mortgage borrowing plus informal borrowing plus overdrafts on current accounts).

Private Pension Wealth is all pensions that are not provided by the state. They comprise occupational and personal pensions, and include pensions of public sector workers.

## Appendix 4.2

| Notation | Definition/Brief Explanation |
|---|---|
| $y_t$ | Aggregate personal income that is measured using income approach of secondary distribution of income accounts and uses the disposable income of households and Non-Profit Institutions Serving Households (NPISH) (in logs) |
| $\pi$ | Inflation. This is measured using annual log changes in Harmonised Consumer Price Index |
| $c_t$ | Aggregate final consumption expenditure of household and NPISH (in logs) |
| $w$ | Total Gross Wealth which is the total gross value of accumulated assets by households; the sum of four components: property wealth, physical wealth, financial wealth and private pension wealth |
| $r$ | Measure of monetary policy. This is Bank of England's Base Rate |
| $dc$ | Final consumption expenditure of household and NPISH on durable goods (in logs). See Appendix 4.1 for the details on durable goods. |
| $sdc$ | Final consumption expenditure of household and NPISH on semi-durable goods (in logs). See Appendix 4.1 for the details on of semi- durable goods |
| $ndc$ | Final consumption expenditure of household and NPISH on non-durable goods and services (in logs). See Appendix 4.1 for the details on of non- durable goods. |
| $SMB$ | This is size premium. It is calculated as the difference between the return on portfolio of small stocks and portfolio of large stocks |
| $HML$ | This is the value premium. It is calculated as the difference between the return on portfolios of stocks with high book-to-market ratio and stocks with low book-to-market ratio. |
| $UMD$ | This is the momentum premium. It is calculated as the difference between the return on portfolio of high momentum stocks and portfolio of low momentum stocks. |

**List of figures**

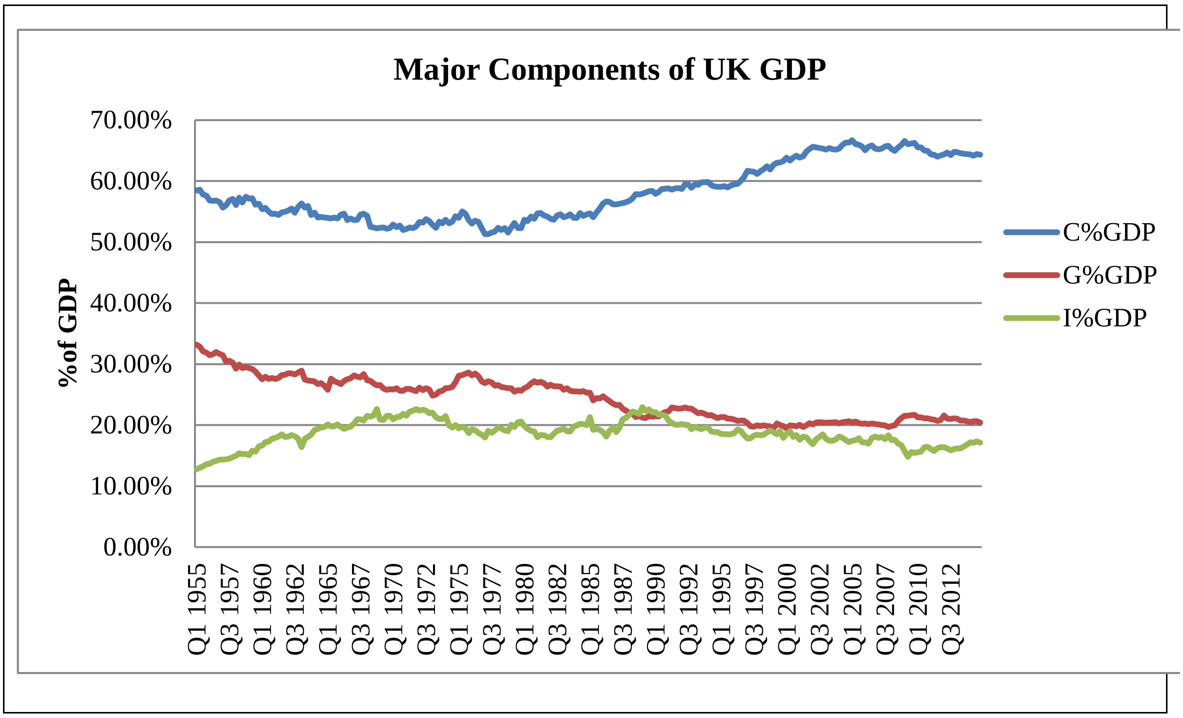



**Figure 4.1: Components of UK GDP (%)**

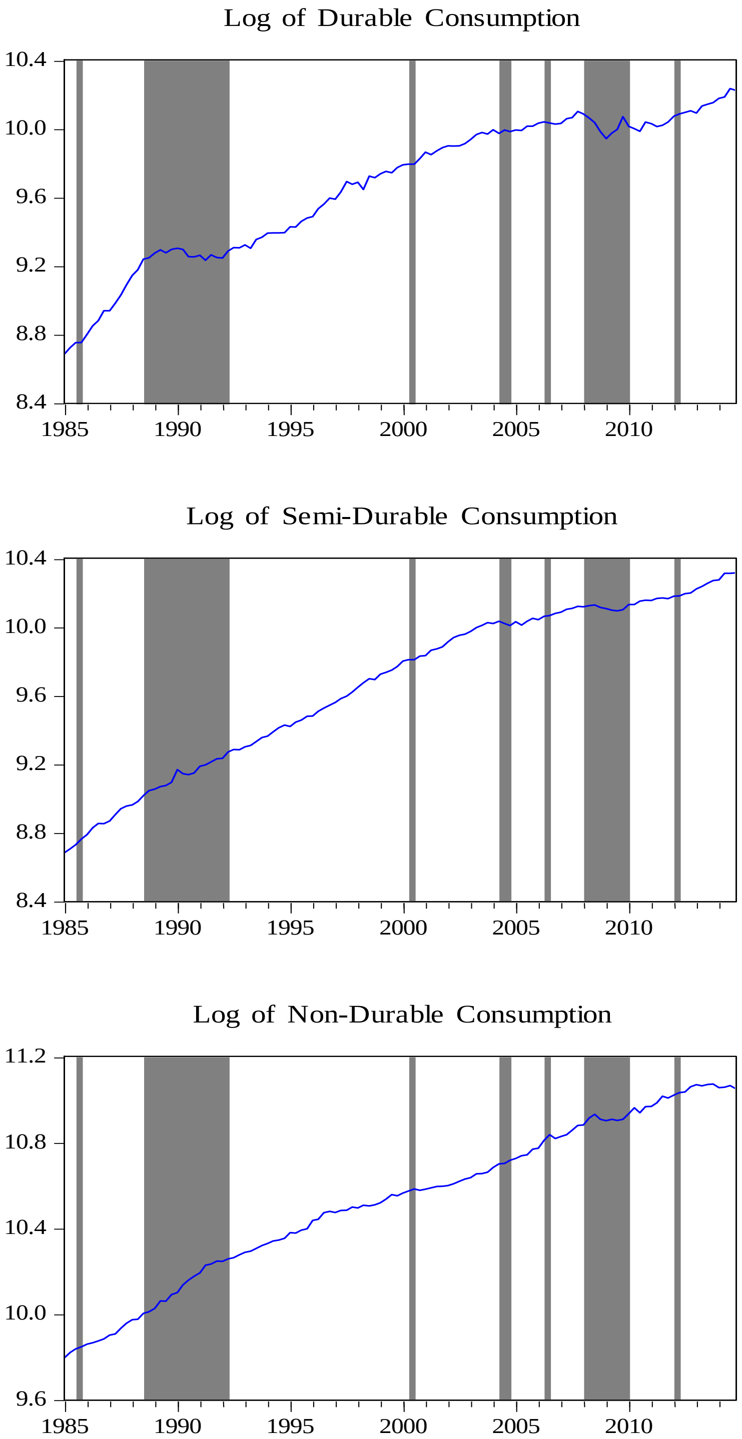



**Figure 4.2: Time series of durable, semi-durable and non-durable consumption (in logs)**

Sample period 1985Q1-2014Q4. Shaded areas are the recessions in the UK (measured as two consecutive quarters of decline in real GDP)

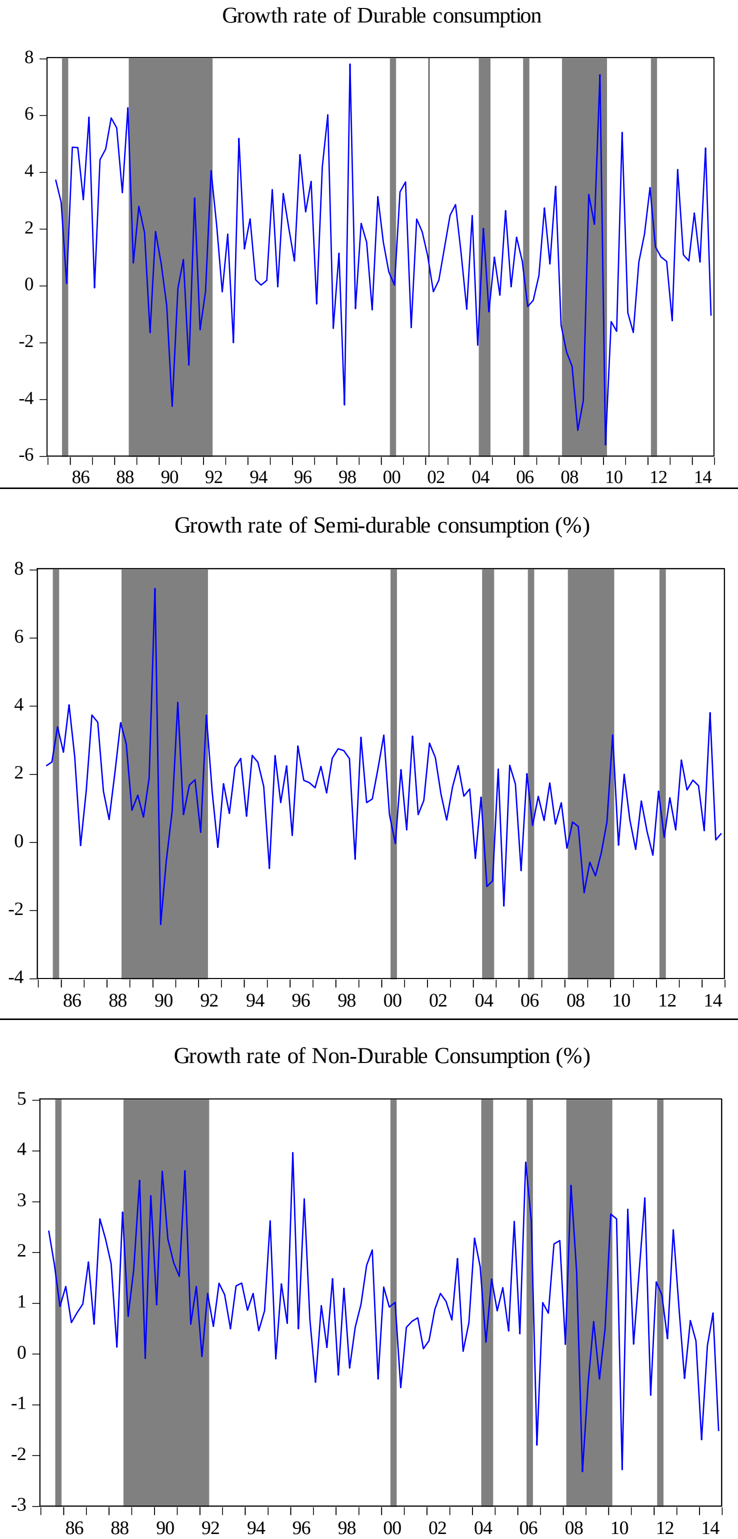



**Figure 4.3:Growth rates of durable, semi-durable and non-durable consumption**

Sample period 1985Q1-2014Q4. Shaded areas are the recessions in the UK (measured as two consecutive quarters of decline in real GDP)

## List of Tables

**Table 4.1: Descriptive Statistics of Annualised ERP of FTSE indices and 25 Value-weighted Portfolios**

| Panel A (Sample: 1988Q1- 2014Q4) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean (%) | Median (%) | Std. Dev.(%) | Skewness | Kurtosis | Jarque-Bera | Probability | Count |
| FTSE 100 | 3.58 | 7.19 | 30.07 | -0.61 | 3.60 | 8.26 | 0.02 | 108 |
| FTSE 250 | 5.88 | 8.59 | 36.80 | -0.70 | 4.02 | 13.66 | 0.00 | 108 |
| Basic Materials | 2.47 | 8.95 | 53.20 | -1.45 | 6.46 | 91.75 | 0.00 | 108 |
| Consumer Service | 2.29 | 7.18 | 34.82 | -0.75 | 3.93 | 14.03 | 0.00 | 108 |
| Consumer Goods | 4.54 | 8.81 | 41.14 | -0.57 | 4.69 | 18.75 | 0.00 | 108 |
| Financials | 3.64 | 10.08 | 43.32 | -0.76 | 4.40 | 19.15 | 0.00 | 108 |
| Healthcare | 5.43 | 9.27 | 27.88 | -0.43 | 3.19 | 3.44 | 0.18 | 108 |
| Industrials | 3.43 | 8.75 | 43.41 | -0.92 | 4.95 | 32.54 | 0.00 | 108 |
| Oil and Gas | 4.73 | 9.03 | 34.30 | -0.78 | 4.34 | 18.95 | 0.00 | 108 |
| Technology | 1.53 | 6.89 | 73.87 | -0.53 | 7.48 | 95.37 | 0.00 | 108 |
| Telecommunications | 4.07 | 5.13 | 41.73 | -0.37 | 3.65 | 4.34 | 0.11 | 108 |
| Utilities | 8.90 | 10.40 | 28.47 | -0.47 | 2.78 | 4.17 | 0.12 | 108 |

| Panel B (Sample: 1988Q1- 2014Q4) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Portfolios | Mean (%) | Median (%) | Std. Dev.(%) | Skewness | Kurtosis | Jarque-Bera | Probability | No. of Quarters |
| ESL | 1.68 | 9.40 | 54.50 | -0.45 | 5.27 | 26.83 | 0.00 | 108 |
| ES2 | 4.42 | 4.54 | 46.32 | -0.19 | 4.04 | 5.51 | 0.06 | 108 |
| ES3 | 4.92 | 5.46 | 42.11 | -0.52 | 4.36 | 13.23 | 0.00 | 108 |
| ES4 | 6.10 | 7.92 | 44.31 | -0.49 | 4.82 | 19.23 | 0.00 | 108 |
| ESH | 6.65 | 5.34 | 42.57 | -0.66 | 5.14 | 28.46 | 0.00 | 108 |
| ES2L | 0.12 | 3.83 | 55.85 | -0.85 | 6.14 | 57.33 | 0.00 | 108 |
| ES22 | 2.97 | 8.88 | 51.09 | -0.84 | 4.56 | 23.71 | 0.00 | 108 |
| ES23 | 4.41 | 8.69 | 40.36 | -0.61 | 4.06 | 11.68 | 0.00 | 108 |
| ES24 | 4.87 | 6.84 | 39.27 | -0.46 | 3.82 | 6.87 | 0.03 | 108 |
| ES2H | 5.36 | 11.02 | 51.47 | -0.61 | 6.31 | 55.88 | 0.00 | 108 |
| EM3L | 1.61 | 7.91 | 53.20 | -1.42 | 7.74 | 137.46 | 0.00 | 108 |
| EM32 | 1.34 | 6.69 | 43.75 | -0.59 | 4.27 | 13.55 | 0.00 | 108 |
| EM33 | 4.39 | 7.59 | 43.19 | -1.07 | 5.59 | 50.75 | 0.00 | 108 |
| EM34 | 3.36 | 9.90 | 44.95 | -0.97 | 5.29 | 40.48 | 0.00 | 108 |
| EM3H | 7.39 | 10.07 | 46.39 | -0.36 | 3.55 | 3.69 | 0.16 | 108 |
| EB4L | 6.03 | 13.08 | 44.68 | -0.33 | 6.37 | 53.16 | 0.00 | 108 |
| EB42 | 3.14 | 4.66 | 40.13 | -0.76 | 4.20 | 16.73 | 0.00 | 108 |
| EB43 | 7.06 | 10.64 | 39.48 | -0.80 | 4.38 | 20.06 | 0.00 | 108 |
| EB44 | 4.16 | 9.68 | 45.99 | -0.67 | 3.80 | 11.00 | 0.00 | 108 |
| EB4H | 4.99 | 9.74 | 51.07 | -0.60 | 4.32 | 14.31 | 0.00 | 108 |
| EBL | 3.42 | 9.18 | 31.64 | -0.68 | 4.11 | 14.03 | 0.00 | 108 |
| EB2 | 3.22 | 8.01 | 31.23 | -0.59 | 3.20 | 6.39 | 0.04 | 108 |
| EB3 | 3.90 | 8.08 | 36.98 | -0.67 | 4.38 | 16.62 | 0.00 | 108 |
| EB4 | 4.12 | 9.03 | 36.12 | -1.32 | 7.17 | 109.69 | 0.00 | 108 |
| EBH | 3.62 | 7.59 | 36.76 | -0.67 | 4.07 | 13.30 | 0.00 | 108 |

**Table 4.2: The impact of aggregate consumption shocks on the ERP of FTSE indices.**

Note: The dependent variable is ERPs of various FTSE indices (in percentage) calculated as the difference between total return and the 3 month Gilts rate. The independent variable is the consumption shocks. The model estimated is (4.12). The table reports quarterly estimates of the coefficients. Figures in the parentheses are t-statistics computed using Newey-West heteroskedastic-robust standard errors with 4 lags (initial pre-whitening using 2 lags). Adjusted sample period is 1990Q2 – 2014Q3.

| Portfolios | $\alpha$ | $\beta_c$ | F-Stat | DW-Stat | R2 |
|---|---|---|---|---|---|
| | (A) | (B) | (C) | (D) | (E) |
| FTSE 100 | 0.87 | -4.82*** | 28.67*** | 1.99 | 23.24% |
| | (1.35) | (-5.15) | | | |
| FTSE 250 | 1.55* | -5.40*** | 23.83*** | 1.78 | 19.69% |
| | (1.73) | (-4.14) | | | |
| Basic Materials | 0.84 | -3.76*** | 4.38** | 1.87 | 4.43% |
| | (0.77) | (-2.73) | | | |
| Consumer Services | 0.60 | -5.22*** | 24.32*** | 1.89 | 20.22% |
| | (0.69) | (-4.03) | | | |
| Financials | 0.86 | -7.45*** | 33.93*** | 1.74 | 25.90% |
| | (0.81) | (-5.32) | | | |
| Consumer Goods | 1.35 | -4.98*** | 14.91*** | 1.99 | 13.74% |
| | (1.52) | (-3.32) | | | |
| Healthcare | 1.30** | -4.01*** | 23.28*** | 1.94 | 19.52% |
| | (2.04) | (-4.17) | | | |
| Industrials | 0.79 | -6.36*** | 22.45*** | 1.89 | 18.96% |
| | (075) | (-3.96) | | | |
| Oil and Gas | 1.21* | -1.20 | 1.07 | 2.43 | 1.14% |
| | (1.75) | (-1.23) | | | |
| Utilities | 2.28*** | -3.07*** | 11.65*** | 2.07 | 10.79% |
| | (3.26) | (-4.22) | | | |
| Telecom | 1.01 | -5.11*** | 14.54*** | 1.81 | 13.10% |
| | (0.79) | (-4.61) | | | |
| Technology | 0.53 | -8.31* | 12.10*** | 1.51 | 11.27% |
| | (0.17) | (-1.93) | | | |

**Table 4.3: The impact of consumption shocks on the ERP of FTSE indices**

Note: The dependent variable is ERPs of various FTSE indices (in percentage) calculated as the difference between total return and the 3 month Gilts rate. The independent variable is the consumption shocks, SMB, HML and UMD. The model estimated is (4.14). The table reports quarterly estimates of the coefficients. Figures in the parentheses are t-statistics computed using Newey-West heteroskedastic-robust standard errors with 4 lags (initial pre-whitening using 2 lags). Adjusted sample period is 1990Q2 – 2014Q3**.**

| FTSE Indices | $\alpha_i$ | $\beta_c^i$ | $\beta_s^i$ | $\beta_v^i$ | $\beta_m^i$ | R2 | F-stat |
|---|---|---|---|---|---|---|---|
| | (A) | (B) | (C) | (D) | (E) | (F) | (G) |
| FTSE 100 | 0.89 | -4.73*** | 0.36 | -0.21 | -0.03 | 21.17% | 7.51*** |
| | (1.18) | (-5.07) | (1.03) | (-0.68) | (-0.10) | | |
| FTSE 250 | 1.32 | -4.78*** | 2.25*** | 0.05 | -0.10 | 43.60% | 19.75*** |
| | (1.67) | (-4.32) | (5.98) | (0.12) | (-0.26) | | |
| Basic Materials | 0.10 | -3.32* | 2.07** | 1.46** | 0.20 | 15.88% | 5.58*** |
| | (0.07) | (-1.84) | (2.70) | (1.98) | (0.27) | | |
| Consumer Services | 0.85 | -4.67*** | 1.26*** | -0.57 | -0.34 | 30.96% | 11.88*** |
| | (1.09) | (-4.12) | (3.41) | (-1.50) | (-0.85) | | |
| Financials | 0.62 | -6.85*** | 1.83*** | 0.60 | -0.11 | 37.95% | 15.83*** |
| | (0.56) | (-5.44) | (2.55) | (1.06) | (-0.25) | | |
| Consumer Goods | 1.36** | -4.47*** | 1.11* | 0.36 | -0.23 | 17.60% | 6.18*** |
| | (2.06) | (-4.19) | (1.69) | (1.16) | (-0.84) | | |
| Healthcare | 1.81*** | -3.97*** | -0.75*** | -0.73*** | -0.29 | 25.26% | 9.20*** |
| | (2.90) | (-4.42) | (-2.19) | (-2.44) | (-1.10) | | |
| Industrials | 0.80 | -5.75*** | 1.97*** | -0.43 | -0.23 | 32.20% | 12.52*** |
| | (0.89) | (-4.37) | (4.68) | (-0.83) | (-0.45) | | |
| Oil and Gas | 0.98 | -1.44 | -0.45 | 0.51 | 0.21 | 1.04% | 1.26 |
| | (1.17) | (-1.59) | (-1.02) | (0.96) | (0.46) | | |
| Utilities | 2.22*** | -3.07*** | -0.36 | 0.58 | 0.02 | 12.04% | 4.32*** |
| | (3.28) | (-3.29) | (-0.92) | (1.44) | (0.06) | | |
| Telecom | 1.31 | -5.17*** | -0.20 | -0.98 | -0.10 | 13.95% | 4.93*** |
| | (1.30) | (-5.67) | (-0.39) | (-0.98) | (-0.14) | | |
| Technology | 1.74 | -7.07*** | 3.17*** | -3.85*** | -1.04 | 44.82% | 20.70*** |
| | (1.32) | (-4.00) | (4.43) | (-3.04) | (-0.90) | | |

**Table 4.4: Pricing of aggregate consumption shocks in the Cross section of FTSE indices**

Note: The table reports the estimates of second-stage cross-sectional regressions of Fama and MacBeth (1973). The dependent variable is cross-sectional ERPs of the FTSE indices and the independent variables are the exposure to aggregate personal consumption shocks and other cross-sectional pricing factors obtained from the first-pass regression results in tables 4.2 and 4.3

| | 1 | 2 |
|---|---|---|
| $\gamma_0$ | 1.77*** | 1.56*** |
| t-statistics | (4.33) | (3.96) |
| Aggregate Consumption shocks | 0.14** | 0.087 |
| t-statistics | (2.11) | (1.24) |
| SMB | | -0.17 |
| t-statistics | | (-1.33) |
| HML | | 0.29 |
| t-statistics | | (1.58) |
| UMD | | -1.10 |
| t-statistics | | (-1.18) |
| R-squared | 28.12% | 6.00% |
| F-statistics | 3.91* | 1.17 |

**Table 4.5 The impact of aggregate consumption shocks on the ERP of 25 Fama-French style portfolios sorted on size and book-to-market characteristics.**

Note: This table reports the impact of aggregate consumption shocks on the ERP of 25 portfolios, sorted on size and book-to-market characteristics. The independent variable is the shocks in the aggregate consumption shocks. The reported t-statistics are corrected for heteroscedasticity and auto-correlation. Panel C- reports the R-squared and F-statistics of individual regressions.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Panel A: Constant | | | | | | | | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | T-statistics | | | | |
| Growth | 0.41 | 0.35 | 0.36 | 0.66 | 0.36 | 0.43 | 0.71 | 0.70 | 0.46 | 1.49 | 1.29 |
| BM2 | 0.63 | 0.49 | 0.47 | 0.60 | 0.46$^{**}$ | 0.53 | 1.56 | 1.08 | 1.33 | 1.65 | 2.06 |
| BM3 | 0.66 | 0.57$^{*}$ | 0.60$^{*}$ | 0.80$^{***}$ | 0.54$^{***}$ | 0.63 | 1.68 | 1.69 | 1.85 | 2.64 | 2.56 |
| BM4 | 0.75 | 0.68$^{**}$ | 0.38 | 0.50 | 0.32 | 0.53 | 1.98 | 2.18 | 0.92 | 1.58 | 1.25 |
| Value | 0.77 | 0.64$^{**}$ | 0.87$^{**}$ | 0.66 | 0.47$^{*}$ | 0.68 | 2.02 | 1.48 | 2.34 | 1.51 | 1.77 |
| Average | 0.64 | 0.54 | 0.53 | 0.64 | 0.43 | | | | | | |
| Panel B: Loadings on Consumption Shocks | | | | | | | | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | T-statistics | | | | |
| Growth | -1.87$^{***}$ | -1.73$^{***}$ | -1.72 | -1.55 | -1.66$^{***}$ | -1.71 | -3.22 | -2.89 | -1.63 | -2.91 | -4.47 |
| BM2 | -1.37$^{*}$ | -1.76$^{***}$ | -1.90$^{***}$ | -2.18$^{***}$ | -1.22$^{***}$ | -1.68 | -2.58 | -2.90 | -3.66 | -4.00 | -3.39 |
| BM3 | -1.61$^{***}$ | -1.44$^{***}$ | -1.52$^{***}$ | -1.32$^{***}$ | -1.48$^{***}$ | -1.47 | -3.48 | -3.11 | -3.61 | -2.62 | -3.99 |
| BM4 | -1.45$^{***}$ | -1.74$^{***}$ | -1.72$^{***}$ | -1.88$^{***}$ | -1.38$^{***}$ | -1.64 | -2.99 | -3.98 | -2.88 | -3.89 | -3.62 |
| Value | -1.57$^{***}$ | -2.16$^{***}$ | -2.20$^{***}$ | -2.18$^{***}$ | -1.50$^{***}$ | -1.92 | -3.71 | -3.95 | -4.39 | -3.84 | -5.31 |
| Average | -1.57 | -1.77 | -1.81 | -1.82 | -1.45 | | | | | | |
| Panel C | | | | | | | | | | | |
| R-squared | | | | | | | F-statistics | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | 9.52% | 7.90% | 8.99% | 9.70% | 22.89% | 11.80% | 10.10 | 8.23 | 9.48 | 10.32 | 28.50 |
| BM2 | 6.99% | 9.77% | 14.42% | 18.22% | 9.40% | 11.76% | 7.21 | 10.40 | 16.18 | 21.38 | 9.96 |
| BM3 | 12.03% | 10.50% | 10.76% | 9.31% | 13.74% | 11.27% | 13.13 | 11.26 | 11.57 | 9.85 | 15.29 |
| BM4 | 8.76% | 16.24% | 12.71% | 18.32% | 16.55% | 14.52% | 9.22 | 18.61 | 13.97 | 21.53 | 19.04 |
| Value | 11.05% | 14.15% | 17.81% | 14.97% | 13.66% | 14.33% | 11.93 | 15.82 | 20.80 | 16.90 | 15.19 |
| Average | 9.67% | 11.71% | 12.94% | 14.10% | 15.25% | | | | | | |

**Table 4.6 The impact of aggregate consumption shocks on the ERP of the 25 value-weighted Fama-French portfolios**

Note: Note: The dependent variable is the ERP of the 25 Fama-French portfolios. The independent variables are consumption shocks, SMB, HML and UMD. The model estimated is (4.15). The table reports quarterly estimates of the coefficients. The t-statistics computed using Newey-West heteroskedastic-robust standard errors with 4 lags (initial pre-whitening using 2 lags).

Panel A: Loadings on Consumption Shocks

| | Small | Size 2 | Size 3 | Size 4 | Large | Average | t-statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Growth | -1.66*** | -1.54*** | -1.44*** | -1.45*** | -1.64*** | -1.55 | -5.03 | -4.79 | -3.81 | -3.11 | -5.10 |
| BM2 | -1.05*** | -1.35*** | -1.58*** | -1.84*** | -1.19*** | -1.40 | -2.87 | -3.92 | -3.34 | -3.97 | -3.12 |
| BM3 | -1.32*** | -1.26*** | -1.35*** | -1.14*** | -1.59*** | -1.33 | -4.77 | -3.04 | -3.64 | -2.65 | -4.16 |
| BM4 | -1.13*** | -1.52*** | -1.41*** | -1.70*** | -1.35*** | -1.42 | -4.03 | -5.12 | -4.69 | -4.31 | -4.00 |
| Value | -1.22*** | -1.77*** | -1.91*** | -1.72*** | -1.29*** | -1.58 | -3.69 | -5.08 | -4.22 | -4.06 | -7.10 |
| Average | -1.28 | -1.49 | -1.54 | -1.57 | -1.41 | | | | | | |

Panel B: Loadings on SMB

| | Small | Size 2 | Size 3 | Size 4 | Large | Average | t-statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Growth | 1.31*** | 1.12*** | 0.93*** | 0.62*** | -0.01 | 0.80 | 5.13 | 6.60 | 7.68 | 3.63 | -0.05 |
| BM2 | 1.28*** | 1.30*** | 1.02*** | 0.76*** | 0.04 | 0.88 | 9.41 | 8.71 | 6.20 | 4.81 | 0.25 |
| BM3 | 1.14*** | 0.94*** | 0.98*** | 0.73*** | 0.17 | 0.79 | 9.61 | 6.56 | 5.91 | 5.03 | 1.54 |
| BM4 | 1.22*** | 0.97*** | 0.98*** | 0.66*** | 0.07 | 0.78 | 10.69 | 10.00 | 6.94 | 3.21 | 0.50 |
| Value | 1.14*** | 1.23*** | 1.03*** | 0.93*** | -0.28* | 0.81 | 8.40 | 8.55 | 8.40 | 5.34 | -1.83 |
| Average | 1.22 | 1.11 | 0.99 | 0.74 | -0.003 | | | | | | |

Panel C: Loadings on HML

| | Small | Size 2 | Size 3 | Size 4 | Large | Average | t-statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Growth | -0.57** | -1.02*** | -0.88** | -0.65*** | -0.53*** | -0.73 | -2.07 | -2.64 | -2.31 | -2.63 | -4.48 |
| BM2 | -0.29** | -0.22 | 0.42*** | 0.35** | 0.30* | 0.11 | -2.00 | -1.24 | 3.23 | 2.20 | 1.84 |
| BM3 | -0.02 | 0.19 | 0.27 | 0.21 | 0.04 | 0.14 | -0.13 | 1.30 | 1.64 | 1.61 | 0.19 |
| BM4 | 0.32*** | 0.30*** | -0.44** | -0.06 | -0.25* | -0.03 | 2.62 | 2.69 | -2.01 | -0.40 | -1.78 |
| Value | 0.47*** | 0.60*** | 0.57*** | 0.55*** | 0.17 | 0.47 | 4.18 | 2.70 | 4.56 | 3.62 | 0.47 |
| Average | -0.02 | -0.03 | -0.01 | 0.08 | -0.05 | | | | | | |

Panel D: Loadings on UMD

| | Small | Size 2 | Size 3 | Size 4 | Large | Average | t-statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Growth | 0.01 | -0.08 | -0.19 | -0.05 | -0.08 | -0.08 | 0.03 | -0.47 | -0.64 | -0.23 | -0.81 |
| BM2 | -0.07 | -0.15 | -0.04 | -0.12 | 0.02 | -0.07 | -0.45 | -1.06 | -0.39 | -0.85 | 0.14 |
| BM3 | -0.04 | 0.05 | 0.08 | 0.00 | 0.15 | 0.05 | -0.23 | 0.42 | 0.63 | 0.03 | 0.92 |
| BM4 | -0.02 | 0.03 | -0.16 | -0.05 | -0.06 | -0.05 | -0.14 | 0.36 | -0.98 | -0.31 | -0.43 |
| Value | -0.03 | -0.05 | 0.00 | -0.19 | -0.25 | -0.10 | -0.32 | -0.50 | 0.01 | -1.55 | -0.99 |
| Average | -0.03 | -0.04 | -0.06 | -0.08 | -0.04 | | | | | | |

| Adjusted R-squared | | | | | | | F-statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | 51.48% | 57.10% | 50.46% | 35.22% | 40.22% | 46.90% | 26.73 | 33.28 | 25.70 | 14.18 | 17.32 |
| BM2 | 57.04% | 54.20% | 52.89% | 42.09% | 10.89% | 43.42% | 33.20 | 29.69 | 28.22 | 18.63 | 3.96 |
| BM3 | 57.54% | 41.67% | 42.53% | 29.83% | 12.43% | 36.80% | 33.87 | 18.32 | 18.95 | 11.31 | 4.44 |
| BM4 | 59.06% | 56.23% | 53.04% | 33.89% | 18.27% | 44.10% | 35.98 | 32.15 | 28.39 | 13.43 | 6.42 |
| Value | 65.45% | 60.18% | 56.87% | 51.20% | 21.05% | 50.95% | 46.93 | 37.65 | 32.98 | 26.44 | 7.46 |
| Average | 58.11% | 53.88% | 51.16% | 38.45% | 20.57% | | | | | | |

**Table 4.7 Pricing of Consumption Shocks in the cross section of 25 Fama-French portfolios**

Note: The dependent variable is $R_{i,1} - R_{f,t}$ , quarterly cross-sectional ERPs of the 25 Fama-French style portfolios sorted on size and book-to-market characteristics. Column (1) shows price of risk of aggregate consumption. Columns (2), (3) and (4) shws the estimated prices of risks of aggregate consumption shocks after controlling for market risk premium and size, value and momentum risk premiums.

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $\gamma_0$ | 0.45** | 0.48 | 0.60*** | 0.55*** |
| t-statistics | (2.42) | (1.70) | (4.35) | (3.22) |
| Aggregate Consumption shocks | 0.06 | -0.07 | 0.08 | 0.09 |
| t-statistics | (0.61) | (-0.61) | (0.90) | (0.90) |
| Market premium | | 0.07 | | -0.06 |
| t-statistics | | (0.29) | | (-0.33) |
| Size premium | | | 0.11*** | 0.11** |
| t-statistics | | | (2.77) | (2.37) |
| Value Premium | | | 0.21*** | 0.21*** |
| t-statistics | | | (4.69) | (5.49) |
| Momentum Premium | | | 0.22*** | 0.27** |
| t-statistics | | | (2.90) | (2.49) |
| R-squared | | -0.7% | 48.92% | 46.97% |
| F-statistics | | 0.18 | 6.75*** | 5.17*** |

**Table 4.8: The impact of dis-aggregated consumption shocks on the ERP of FTSE sectoral indices.**

Note: The dependent variable is ERPs of various FTSE indices (in percentage) calculated as the difference between total return and the 3 month Gilts rate. Models estimated are (4.19), (4.20) and (4.21) in Panels A, B and C respectively. The table reports quarterly estimates of the coefficients. Figures in the parentheses are t-statistics computed using Newey-West heteroskedastic-robust standard errors with initial pre-whitening using 2 lags. Adjusted sample period is 1989Q2 – 2014Q4.

| | Durable Consumption Shocks | | | Semi-Durable Consumption Shocks | | | Non-Durable Consumption Shocks | | |
|---|---|---|---|---|---|---|---|---|---|
| | Panel A | | | Panel B | | | Panel C | | |
| | (A) | (B) | (C) | (D) | (E) | (F) | (G) | (H) | (I) |
| Portfolios | $\alpha_{1,i}$ | $\beta_{dc}$ | $R^2$ | $\alpha_{2,i}$ | $\beta_{sdc}$ | $R^2$ | $\alpha_{3,i}$ | $\beta_{ndc}$ | $R^2$ |
| FTSE 100 | 0.76 | -5.02$^{***}$ | 28.42% | 0.78 | -4.86$^{***}$ | 28.40% | 0.84 | 4.77$^{***}$ | 31.91% |
| | (1.17) | (-6.36) | | (0.89) | (-6.86) | | (1.40) | (6.56) | |
| FTSE 250 | 1.46$^{*}$ | -5.55$^{***}$ | 22.89% | 1.41 | -5.25$^{***}$ | 21.93% | 1.40$^{*}$ | 5.28$^{***}$ | 25.9% |
| | (1.69) | (-4.94) | | (1.55) | (-5.23) | | (1.73) | (5.55) | |
| Basic Materials | 0.65 | -5.14$^{***}$ | 9.34% | 0.60 | -4.79$^{***}$ | 8.69% | 054 | 5.17$^{***}$ | 11.92% |
| | (0.63) | (-3.65) | | (0.55) | (-4.08) | | (0.48) | (4.27) | |
| Consumer Services | 0.56 | -5.53$^{***}$ | 25.51% | 0.51 | -5.53$^{***}$ | 27.53% | 0.55 | 5.38$^{***}$ | 30.01% |
| | (0.66) | (-4.86) | | (0.58) | (-5.60) | | (0.68) | (5.62) | |
| Financials | 0.77 | -6.83$^{***}$ | 24.82% | 0.82 | -6.54$^{***}$ | 24.30% | 0.85 | 6.07$^{***}$ | 24.44% |
| | (0.78) | (-6.81) | | (0.78) | (-6.93) | | (0.87) | (5.85) | |
| Consumer Goods | 1.24 | -5.81$^{***}$ | 20.62% | 1.21 | -5.65$^{***}$ | 20.79% | 1.28 | 5.72$^{***}$ | 24.93% |
| | (1.52) | (-3.91) | | (1.45) | (-4.26) | | (1.59) | (5.46) | |
| Healthcare | 1.16$^{*}$ | -4.25$^{***}$ | 24.40% | 1.18$^{*}$ | -4.10$^{***}$ | 24.37% | 1.28$^{*}$ | 3.85$^{***}$ | 24.68% |
| | (1.74) | (-5.28) | | (1.71) | (-5.47) | | (1.98) | (5.35) | |
| Industrials | 0.70 | -6.48$^{***}$ | 22.78% | 0.65 | -5.96$^{***}$ | 20.28% | 0.65 | 6.12$^{***}$ | 25.07% |
| | (0.74) | (-4.32) | | (0.61) | (-4.50) | | (0.69) | (5.01) | |
| Oil and Gas | 0.98 | -2.45$^{***}$ | 5.16% | 1.07 | -1.95$^{**}$ | 3.50% | 1.08 | 2.12$^{**}$ | 4.82% |
| | (1.47) | (-2.62) | | (1.53) | (-2.48) | | (1.61) | (2.46) | |
| Utilities | 2.16$^{***}$ | -2.95$^{***}$ | 11.32% | 2.22$^{***}$ | -2.49$^{**}$ | 8.50% | 2.23$^{***}$ | 2.75$^{***}$ | 11.92% |
| | (3.23) | (-3.47) | | (3.25) | (-2.41) | | (3.60) | (3.29) | |
| Telecom | 0.97 | -5.23$^{***}$ | 15.65% | 0.98 | -5.42$^{***}$ | 17.77% | 1.03 | 5.24$^{***}$ | 19.57% |
| | (0.77) | (-6.87) | | (0.88) | (-5.91) | | (0.98) | (4.86) | |
| Technology | 0.66 | -9.34$^{***}$ | 16.23% | 0.37 | -9.37$^{**}$ | 17.11% | 0.24 | 9.27$^{***}$ | 19.51% |
| | (0.24) | (-3.08) | | (0.13) | (-2.40) | | (0.12) | (3.22) | |

**Table 4.9 The impact of dis-aggregated consumption shocks on ERP of FTSE Indices**.

Note: The dependent variable is the ERPs of the FTSE indices (in percentages). The independent variable is durable, semi durable and non-durable consumption shocks in Panels A, B and C respectively controlling for size premium (SMB), value premium (HML) and momentum factor (UMD). Table reports the estimated parameters of model (4.25), (4.26) and (4.27). Figures in parentheses are t-statistics computed using Newey-West HAC standard errors with 4 lags (initial pre-whitening with 2 lags). Adjusted sample size, 1990Q1 – 2014Q4.

| | Panel A Durable Consumption Shocks | | | | | | | Panel B Semi-Durable Consumption Shocks | | | | | | | Panel C Non-Durable Consumption Shocks | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FTSE Indices | $\alpha_i$ | $\beta^i_{dc}$ | $\beta^i_s$ | $\beta^i_v$ | $\beta^i_m$ | $R^2$ | F-stat | $\alpha_i$ | $\beta^i_{sdc}$ | $\beta^i_s$ | $\beta^i_v$ | $\beta^i_m$ | $R^2$ | F-stat | $\alpha_i$ | $\beta^i_{ndc}$ | $\beta^i_s$ | $\beta^i_v$ | $\beta^i_m$ | $R^2$ | F-stat |
| FTSE 100 | 0.84 | -4.91$^{***}$ | 0.33 | -0.08 | -0.11 | 26.68 | 10.01$^{***}$ | 0.88 | -4.75$^{***}$ | 0.31 | -0.07 | -0.11 | 26.46 | 10.00$^{***}$ | 0.80 | 4.76$^{***}$ | 0.31 | 0.10 | 0.01 | 30.01 | 11.93$^{***}$ |
| | (1.03) | (-7.11) | (0.96) | (-0.18) | (-0.26) | | | (1.05) | (-7.92) | (0.96) | (-0.15) | (-0.25) | | | (1.40) | (7.84) | (1.31) | (0.19) | (0.01) | | |
| FTSE 250 | 1.30$^{*}$ | -5.12$^{***}$ | 2.23$^{***}$ | 0.19 | -0.17 | 47.93 | 23.78$^{***}$ | 1.35$^{*}$ | -4.88$^{***}$ | 2.20$^{***}$ | 0.19 | -0.18 | 47.27 | 23.41$^{***}$ | 1.25$^{*}$ | 5.03$^{***}$ | 2.21$^{***}$ | 0.38 | -0.05 | 50.90 | 27.43$^{***}$ |
| | (1.69) | (-6.24) | (7.16) | (0.40) | (-0.42) | | | (1.71) | (-6.95) | (7.36) | (0.41) | (-0.43) | | | (1.73) | (7.66) | (7.44) | (0.85) | (-0.13) | | |
| Basic Materials | -0.10 | -5.17$^{***}$ | 2.05$^{***}$ | 1.64$^{**}$ | 0.22 | 22.28 | 8.10$^{***}$ | -0.06 | -4.88$^{***}$ | 2.03$^{***}$ | 1.65$^{**}$ | 0.21 | 21.89 | 8.01$^{***}$ | -0.28 | 5.69$^{***}$ | 2.06$^{***}$ | 1.90$^{***}$ | 0.40 | 26.84 | 10.35$^{***}$ |
| | (-0.07) | (-4.11) | (2.82) | (2.29) | (0.29) | | | (-0.05) | (-4.23) | (3.02) | (2.21) | (0.29) | | | (-0.22) | (5.78) | (3.18) | (2.74) | (0.56) | | |
| Consumer Services | 0.86 | -5.06$^{***}$ | 1.25$^{***}$ | -0.45 | -0.40 | 36.05 | 14.95$^{***}$ | 0.84 | -5.08$^{***}$ | 1.26$^{***}$ | -0.43 | -0.38 | 37.83 | 16.21$^{***}$ | 0.76 | 4.95$^{***}$ | 1.26$^{***}$ | -0.25 | -0.26 | 39.29 | 17.50$^{***}$ |
| | (1.09) | (-5.65) | (4.30) | (-1.15) | (-0.99) | | | (1.05) | (-7.00) | (4.30) | (-1.14) | (-0.97) | | | (0.99) | (6.68) | (4.32) | (-0.67) | (-0.68) | | |
| Financials | 0.67 | -6.52$^{***}$ | 1.80$^{***}$ | 0.76 | -0.25 | 39.28 | 17.01$^{***}$ | 0.81 | -6.29$^{***}$ | 1.71$^{***}$ | 0.76 | -0.27 | 38.09 | 16.38$^{***}$ | 0.74 | 6.02$^{***}$ | 1.71$^{***}$ | 0.96$^{*}$ | -0.14 | 38.58 | 17.02$^{***}$ |
| | (0.57) | (-7.00) | (2.91) | (1.43) | (-0.56) | | | (0.76) | (-7.28) | (2.68) | (1.34) | (-0.58) | | | (0.68) | (6.34) | (2.93) | (1.81) | (-0.34) | | |
| Consumer Goods | 1.27$^{*}$ | -5.58$^{***}$ | 1.09$^{*}$ | 0.53 | -0.26 | 26.22 | 9.80$^{***}$ | 1.27$^{*}$ | -5.45$^{***}$ | 1.10$^{**}$ | 0.54 | -0.25 | 26.65 | 10.08$^{***}$ | 1.20 | 5.73$^{***}$ | 1.09$^{**}$ | 0.76$^{*}$ | -0.10 | 31.19 | 12.56$^{***}$ |
| | (1.85) | (-5.30) | (1.93) | (1.69) | (-1.00) | | | (1.85) | (-4.63) | (2.15) | (1.67) | (-0.83) | | | (1.38) | (5.78) | (2.08) | (1.79) | (-0.36) | | |
| Healthcare | 1.73$^{***}$ | -4.09$^{***}$ | -0.78$^{***}$ | -0.61$^{**}$ | -0.36 | 29.01 | 11.11$^{***}$ | 1.71$^{***}$ | -3.94$^{***}$ | -0.76$^{***}$ | -0.60$^{**}$ | -0.36 | 28.85 | 11.14$^{***}$ | 1.71$^{***}$ | 3.63$^{***}$ | -0.77$^{***}$ | -0.49 | -0.29 | 28.22 | 11.03$^{***}$ |
| | (2.64) | (-5.39) | (-2.77) | (-2.12) | (-1.51) | | | (2.59) | (-5.57) | (-2.76) | (-1.96) | (-1.40) | | | (2.69) | (5.04) | (-2.68) | (-1.58) | (-1.21) | | |
| Industrials | 0.81 | -5.95$^{***}$ | 1.94$^{***}$ | -0.28 | -0.33 | 36.02 | 14.93$^{***}$ | 0.85 | -5.47$^{***}$ | 1.93$^{***}$ | -0.28 | -0.34 | 34.28 | 14.04$^{***}$ | 0.71 | 5.70$^{***}$ | 1.94$^{***}$ | -0.05 | -0.18 | 37.96 | 16.61$^{***}$ |
| | (0.90) | (-5.48) | (5.52) | (-0.53) | (-0.64) | | | (0.87) | (-6.52) | (5.97) | (-0.44) | (-0.54) | | | (0.89) | (7.35) | (5.67) | (-0.08) | (-0.28) | | |
| Oil and Gas | 0.73 | -2.74$^{***}$ | -0.47 | 0.63 | 0.22 | 5.71 | 2.50$^{**}$ | 0.83 | -2.23$^{***}$ | -0.53 | 0.61 | 0.19 | 4.17 | 2.09$^{*}$ | 0.74 | 2.59$^{***}$ | -0.52 | 0.73 | 0.28 | 6.69 | 2.83$^{**}$ |
| | (1.10) | (-3.17) | (-1.17) | (1.25) | (0.53) | | | (1.03) | (-3.22) | (-1.26) | (1.11) | (0.41) | | | (0.92) | (3.00) | (-1.28) | (1.41) | (0.63) | | |
| Utilities | 2.14$^{***}$ | -3.11$^{***}$ | -0.37 | 0.68 | -0.04 | 14.11 | 5.07$^{***}$ | 2.23$^{***}$ | -2.63$^{***}$ | -0.41 | 0.66 | -0.06 | 11.39 | 4.21$^{***}$ | 2.20$^{***}$ | 3.06$^{***}$ | -0.42 | 0.78$^{**}$ | 0.02 | 16.41 | 6.01$^{***}$ |
| | (3.20) | (-3.92) | (-0.99) | (1.69) | (-0.15) | | | (3.16) | (-2.81) | (-1.21) | (1.61) | (-0.27) | | | (3.64) | (4.02) | (-1.18) | (1.97) | (0.09) | | |
| Telecom | 1.34 | -5.05$^{***}$ | -0.22 | -0.88 | -0.20 | 15.43 | 5.52$^{***}$ | 1.31 | -5.22$^{***}$ | -0.20 | -0.85 | -0.18 | 17.47 | 6.29$^{***}$ | 1.21 | 5.02$^{***}$ | -0.19 | -0.67 | -0.06 | 18.37 | 6.74$^{***}$ |
| | (1.01) | (-5.52) | (-0.39) | (-0.93) | (-0.20) | | | (1.02) | (-6.30) | (-0.35) | (-0.95) | (-0.18) | | | (1.33) | (5.12) | (-0.42) | (-0.69) | (-0.10) | | |
| Technology | 1.94 | -7.68$^{***}$ | 3.12$^{***}$ | -3.69$^{***}$ | -1.15 | 48.18 | 24.01$^{***}$ | 1.70 | -7.76$^{***}$ | 3.29$^{***}$ | -3.64$^{***}$ | -1.09 | 49.60 | 25.61$^{***}$ | 1.40 | 7.15$^{***}$ | 3.37$^{***}$ | -3.36$^{***}$ | -0.91 | 49.11 | 25.61$^{***}$ |
| | (1.49) | (-4.95) | (5.03) | (-2.91) | (-0.94) | | | (1.34) | (-5.13) | (5.47) | (-2.84) | (-0.85) | | | (1.14) | (4.26) | (5.73) | (-2.67) | (-0.73) | | |

**Table 4.10: Pricing of dis-aggregated consumption shocks in the FTSE indices**

Note: The table reports the estimates of second stage Fama and MacBeth (1973) cross-sectional regressions. The dependent variable ERPs of the FTSE indices. The independent variable is the loading from equations table 4.8 for durable, semi-durable and non-durable consumption shocks. The reported t-statistics are corrected for heteroscedasticity and auto-correlation.

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $\gamma_0$ | 1.98*** | 1.99*** | 2.02*** | 2.04 |
| t-statistics | (4.67) | (4.37) | (4.22) | (1.00) |
| Durable Consumption Shocks | 0.16** | | | 0.28 |
| t-statistics | (2.41) | | | (0.44) |
| Semi-Durable Consumption Shocks | | 0.17** | | 0.35 |
| t-statistics | | (2.38) | | (0.94) |
| Non-Durable Consumption Shocks | | | -0.17** | -0.14 |
| t-statistics | | | (-2.32) | (-0.29) |
| Size Premium | | | | -0.09 |
| t-statistics | | | | (-0.27) |
| Value Premium | | | | 0.27 |
| t-statistics | | | | (1.57) |
| Momentum Premium | | | | -1.75 |
| t-statistics | | | | (-1.22) |
| R-Squared | 39.61% | 41.80% | 39.18% | 13.35% |
| F-statistics | 6.56** | 7.18** | 6.44** | 1.28 |

**Table 4.11 The Impact of dis-aggregate consumption shocks on the ERP of the 25 value-weighted Fama-French portfolios**.

Note: The dependent variable is the ERP of the 25 value weighted Fama-French Portfolios. The independent variables in Panels A, B and C are the durable, semi-durable and Non- durable personal consumption shocks. The table reports the estimated parameters of Models (4.19), (4.20) and (4.21). The t-statistics computed using Newey-West heteroskedastic-robust standard errors with 4 lags (initial pre-whitening using 2 lags).

| Panel A: Loadings on Durable Consumption Shocks | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | t-statistics | | | | |
| Growth | -2.08$^{***}$ | -2.07$^{***}$ | -1.91$^{***}$ | -2.00$^{***}$ | -1.85$^{***}$ | -1.98 | -4.91 | -3.66 | -3.03 | -4.38 | -5.63 |
| BM2 | -1.43$^{***}$ | -2.08$^{***}$ | -1.95$^{***}$ | -2.14$^{***}$ | -1.42$^{***}$ | -1.80 | -3.09 | -4.16 | -4.30 | -4.44 | -4.35 |
| BM3 | -1.57$^{***}$ | -1.51$^{***}$ | -1.69$^{***}$ | -1.58$^{***}$ | -1.55$^{***}$ | -1.58 | -4.31 | -3.72 | -4.60 | -3.49 | -4.67 |
| BM4 | -1.59$^{***}$ | -1.67$^{***}$ | -1.95$^{***}$ | -1.94$^{***}$ | -1.59$^{***}$ | -1.75 | -3.90 | -3.95 | -4.30 | -4.77 | -5.26 |
| Value | -1.58$^{***}$ | -2.00$^{***}$ | -1.85$^{***}$ | -2.08$^{***}$ | -1.43$^{***}$ | -1.79 | -4.74 | -4.76 | -3.77 | -4.45 | -7.78 |
| Average | -1.65 | -1.87 | -1.87 | -1.95 | -1.57 | | | | | | |
| R-Squared | | | | | | | F-statistics | | | | |
| Growth | 13.34% | 12.76% | 12.58% | 18.10% | 32.18% | 17.79% | 14.77 | 14.05 | 13.82 | 21.22 | 45.56 |
| BM2 | 8.65% | 15.50% | 18.30% | 19.94% | 14.55% | 15.39% | 9.09 | 17.61 | 21.50 | 23.92 | 16.34 |
| BM3 | 13.03% | 12.97% | 15.22% | 15.06% | 17.04% | 14.66% | 14.38 | 14.31 | 17.23 | 17.02 | 19.71 |
| BM4 | 11.89% | 16.93% | 17.36% | 22.06% | 24.74% | 18.59% | 12.95 | 19.57 | 20.16 | 27.18 | 31.55 |
| Value | 12.64% | 13.75% | 14.26% | 15.41% | 13.98% | 14.01% | 13.88 | 15.30 | 15.96 | 17.49 | 15.60 |
| Average | 11.91% | 14.38% | 15.54% | 18.11% | 20.50% | | | | | | |
| Panel B: Loadings on Semi-Durable Consumption Shocks | | | | | | | | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | t-statistics | | | | |
| Growth | -2.13$^{***}$ | -2.10$^{***}$ | -1.81$^{**}$ | -1.97$^{***}$ | -1.84$^{***}$ | -1.97 | -4.75 | -3.53 | -2.23 | -4.60 | -5.50 |
| BM2 | -1.40$^{***}$ | -1.85$^{***}$ | -1.82$^{***}$ | -1.96$^{***}$ | -1.41$^{***}$ | -1.69 | -3.26 | -3.86 | -4.45 | -3.91 | -4.70 |
| BM3 | -1.43$^{***}$ | -1.37$^{***}$ | -1.62$^{***}$ | -1.53$^{***}$ | -1.45$^{***}$ | -1.48 | -4.32 | -3.66 | -4.63 | -3.69 | -4.80 |
| BM4 | -1.47$^{***}$ | -1.55$^{***}$ | -1.74$^{***}$ | -1.89$^{***}$ | -1.56$^{***}$ | -1.64 | -3.71 | -3.66 | -3.71 | -5.17 | -5.83 |
| Value | -1.49$^{***}$ | -1.90$^{***}$ | -1.76$^{***}$ | -1.93$^{***}$ | -1.45$^{***}$ | -1.71 | -4.63 | -4.92 | -3.93 | -4.31 | -4.88 |
| Average | -1.59 | -1.76 | -1.75 | -1.86 | -1.54 | | | | | | |
| R-Squared | | | | | | | F-statistics | | | | |
| Growth | 14.80% | 14.00% | 11.91% | 18.76% | 33.92% | 18.68% | 16.67 | 15.62 | 12.97 | 22.17 | 49.28 |
| BM2 | 8.84% | 13.01% | 15.91% | 17.64% | 15.04% | 14.09% | 9.31 | 14.36 | 18.17 | 20.56 | 17.00 |
| BM3 | 11.45% | 11.40% | 14.78% | 14.86% | 15.76% | 13.65% | 12.41 | 12.35 | 16.65 | 16.76 | 17.96 |
| BM4 | 10.83% | 15.51% | 15.49% | 22.29% | 25.35% | 17.89% | 11.66 | 17.62 | 17.59 | 27.54 | 32.59 |
| Value | 11.99% | 13.05% | 13.57% | 14.15% | 15.29% | 13.61% | 13.08 | 14.40 | 15.07 | 15.82 | 17.33 |
| Average | 11.58% | 13.39% | 14.33% | 17.54% | 21.07% | | | | | | |
| Panel C: Loadings on Non-Durable Consumption Shocks | | | | | | | | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | t-statistics | | | | |
| Growth | 2.09$^{***}$ | 2.24$^{***}$ | 2.05$^{**}$ | 2.04$^{***}$ | 1.90$^{***}$ | 2.06 | 3.91 | 2.50 | 2.01 | 4.28 | 6.08 |
| BM2 | 1.52$^{***}$ | 1.97$^{***}$ | 1.87$^{***}$ | 2.06$^{***}$ | 1.36$^{***}$ | 1.75 | 3.49 | 4.29 | 5.97 | 5.53 | 5.37 |
| BM3 | 1.52$^{***}$ | 1.39$^{***}$ | 1.56$^{***}$ | 1.50$^{***}$ | 1.59$^{***}$ | 1.51 | 4.35 | 3.55 | 4.95 | 4.07 | 5.87 |
| BM4 | 1.37$^{***}$ | 1.55$^{***}$ | 1.94$^{***}$ | 1.90$^{***}$ | 1.68$^{***}$ | 1.69 | 3.80 | 3.87 | 4.62 | 5.69 | 6.76 |
| Value | 1.40$^{***}$ | 1.73$^{***}$ | 1.75$^{***}$ | 1.91$^{***}$ | 1.56$^{***}$ | 1.67 | 4.67 | 4.98 | 4.22 | 4.78 | 6.01 |
| Average | 1.58 | 1.77 | 1.83 | 1.88 | 1.62 | | | | | | |

**Table 4.11 continued…**

| | R-Squared | | | | | | F-statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Growth | 16.47% | 18.20% | 17.66% | 23.01% | 41.75% | 23.42% | 18.93 | 21.36 | 20.59 | 28.69 | 68.82 |
| BM2 | 11.92% | 16.91% | 19.31% | 22.52% | 16.16% | 17.36% | 12.99 | 19.53 | 22.97 | 27.90 | 18.51 |
| BM3 | 14.92% | 13.37% | 15.79% | 16.59% | 21.77% | 16.49% | 16.84 | 14.81 | 18.00 | 19.10 | 26.71 |
| BM4 | 10.78% | 17.90% | 22.32% | 25.78% | 33.60% | 22.07% | 11.59 | 20.93 | 27.59 | 33.34 | 48.58 |
| Value | 12.13% | 12.53% | 15.46% | 15.99% | 20.34% | 15.29% | 13.25 | 13.75 | 17.56 | 18.27 | 24.51 |
| Average | 13.24% | 15.78% | 18.11% | 20.78% | 26.72% | | | | | | |

**Table 4.12 The pricing of dis-aggregated consumption shocks in the 25 Fama-French portfolios sorted on size and book-to-market characteristics**

Note: The table reports the estimates of second stage Fama and MacBeth (1973) cross-sectional regressions. The dependent variable ERPs of the 25 Fama-French portfolios sorted on size and book-to-market characteristics. Columns (1), (2) and (3) presents the prices of risks of durable, semi-durable and non-durable consumption shocks alone respectively. Column (5) shows the prices of risk of dis-aggregate consumption shocks after controlling for the exposure to market risk premium. Column (6) presents the prices of risks of dis-aggregated consumption shocks after controlling for size, value and momentum premiums. Column (7) shows prices of risks of dis-aggregated consumption shocks after controlling for all the above asset pricing factors together.

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Constant | $0.80^{***}$ | $0.89^{***}$ | $1.05^{***}$ | $0.80^{***}$ | $0.68^{***}$ | $0.69^{***}$ | $0.60^{***}$ |
| | (3.31) | (3.93) | (5.44) | (5.11) | (4.00) | (4.00) | (3.32) |
| Durable Consumption Shocks | 0.14 | | | -0.02 | 0.11 | 0.13 | 0.16 |
| | (1.04) | | | (-0.25) | (1.39) | (1.11) | (1.57) |
| Semi-Durable Consumption shocks | | 0.19 | | -0.001 | 0.11 | 0.09 | 0.13 |
| | | (1.51) | | (-0.05) | (1.42) | (0.73) | (1.14) |
| Non-Durable Consumption shocks | | | $-0.28^{**}$ | $-0.18^{**}$ | $-0.29^{***}$ | -0.14 | $-0.18^{*}$ |
| | | | (-2.61) | (-2.17) | (-3.55) | (-1.43) | (-1.71) |
| Market Factor | | | | | -0.18 | | -0.11 |
| | | | | | (-1.06) | | (-0.55) |
| Size Premium | | | | | | $0.11^{**}$ | $0.10^{*}$ |
| | | | | | | (2.54) | (1.99) |
| Value Premium | | | | | | $0.22^{***}$ | $0.23^{***}$ |
| | | | | | | (4.49) | (4.44) |
| Momentum Premium | | | | | | 0.15 | 0.14 |
| | | | | | | (1.39) | (1.09) |
| Adjusted $R^2$ | 4.67% | 8.84%% | 23.36% | 44.85% | 33.24% | 45.75% | 44.30% |
| F-Statistics | 1.13 | 2.23 | $7.01^{**}$ | $5.88^{**}$ | | $4.37^{***}$ | $3.73^{**}$ |

# Paper 4

# 5 The impact of short and long term market implied risk on the UK ERP.

*"Markets love volatility" .... Christine Lagarde, MD, IMF.*

**Abstract**

I investigate the impact of short and long term implied market volatility on the equity risk premium (ERP) in the UK. I also investigate the pricing implications of short and long term implied market volatility in the cross-section of stocks returns. I find that both the short and the long term implied volatility have significant negative impact on the aggregate ERP, while at sectoral level the impact is heterogeneous. I find both short and long term volatility is priced negatively indicating that (i) investors are ready to pay for insurance against these risks (ii) investors care both short and long term implied market volatility.

**Keywords**: short term implied volatility, long term implied volatility, Equity Risk Premium, asset pricing.

***JEL Classification*: *G10; G12* and *C21***

## 5.1 Introduction

The recent rise in volatility of the financial markets has attracted the interests of both, market participants such as analysts, traders and investors and academics. On 8th September 2015, Bloomberg published an article which points to a renewed interest in market's most popular measure of volatility, the Chicago Board's option implied volatility index (VIX), which is a measure of "investor's fear" in the market (Whaley, 2000) following the devaluation of Yuan in August 2015[14]. Moreover, in the UK, the VFTSE index, which is similar to VIX has attracted attention following the UK's exit from the European Union. Figure 5.1 shows the daily VFTSE level for the period of October 2011- November 2016. The figure shows spikes in the VFTSE level around the three key events in past year, the Yuan devaluation in August 2015, the announcement of UK's EU referendum date in February 2016 and the "Brexit" in June 2016.

****insert figure 5.1 about here****

There is a long-standing academic interest in the relation between market volatility and stock market returns. The investigation of this relationship has often yielded mixed results. As Goyal and Santa-clara, (2003, p 975) puts it "*There is a long empirical literature that has tried to establish the existence of such a tradeoff between risk and return for stock market indices. Unfortunately, the results have been inconclusive. Often the relation between risk and return has been found insignificant and sometimes even negative"*. Most extant research investigates this relationship using realised or ex-post volatility rather than implied volatility [see for example, French, Schwert and Stambaugh (1987), Schwert (1989a), Bae, Kim and Nelson, (2007)]. Relatively fewer studies use implied or ex-ante volatility rather than realised volatility for explaining returns. Investors are mostly concerned about future uncertainties and hence implied volatility is a better measure of risk for determining stock returns. Ang, Hodrick, Xing and Zhang (2006) show that aggregate market volatility implied by the VIX index is a key factor in explaining the cross-section of expected returns. Bollerslev, Tauchen and Zhou, (2009) show that the difference between "model-free" implied variance (squared VIX index) and the realised variance significantly explains the variations in the expected stock returns. Further, Drechsler and Yaron (2011) show that the variance risk premium, the

---

[14] http://www.bloomberg.com/news/articles/2015-09-08/market-volatility-has-changed-immensely

difference between squared VIX index and the conditionally expected realised variance, is linked to the underlying economic volatility and can predict future stock market returns. Chang, Christoffersen and Jacobs (2013) show that within the equilibrium asset-pricing framework, innovations in market volatility are important pricing factors. Finally, Lubnau and Todorova (2015) analyse the predictive ability of short term market implied volatility in forecasting stock returns. Their findings suggest market inefficiency in some stock markets other than the USA as they find that periods of low volatility are followed by significant positive mean returns over 20, 40 and 60 trading days.

Although the extant literature has examined the empirical link between short-term implied volatility and returns, it overlooks the impact of long-term implied volatility. Adrian and Rosenberg, (2008) is one of the very few papers which considers the impact of long-term volatility. They decompose the conditional volatility of equity returns into short and long-term to capture the financial constraints and business cycle risks respectively. They find that both short and long-term volatility are negatively priced which suggests that investors pay for insuring against these risks.

Investors are not only concerned about short-term volatility but they are equally apprehensive about the likely impact of the longer-term volatility on stock returns. Consequently, it is critical to investigate the impact of both short and long-term implied market volatility on stock returns. Furthermore, such a study is virtually non-existent in the UK equity market. Against this backdrop, the objective of this paper is two folds; I first investigate to which extent both the risk associated with changes in both the short and long term implied volatility drive the UK ERP. The second objective is to investigate the cross-sectional asset pricing implications of these risks thus offering insights on the asset pricing implications of the risks arising from innovations in the short and the long-term implied volatility. It is critical to understand the differential impact of both the short and long term implied market volatility on stock returns. This is because investors not only care about factors that affect their investment opportunity set in the short term but also the factors that affect their portfolio performance in the long term.

I use the VFTSE volatility index and the FTSE 100 interpolated annualised Implied Volatility Index (IVI360) for the next 360 days, as proxies of short term and long-term market implied volatility respectively. Similar to the CBOE's VIX index, the VFTSE represents the risk-neutral expectation of market participants about the future market volatility of the FTSE 100 index over the next 30 calendar days. The interpolated FTSE IVI 360 represents market participants' risk-neutral expectations of expected market volatility over next one year. Both VFTSE and IVI360 are constructed using the collection of out-of-money put and call options on the FTSE 100 index using appropriate maturities and are considered as "model-free" measures of implied market volatility.[15] Similar to the VIX, the VFTSE is perceived by the market participants as the "investor's fear gauge" in the UK market with higher value reflecting turbulence in the UK markets and lower value reflecting tranquil periods. Additionally, since both the indices are constructed using collection of options on the FTSE 100 index, the implied volatilities reflected by these indices embody collective expectation of risk premia associated with factors such as jumps and/or stochastic volatility.

There is extensive support in the literature for using model-free measures of implied volatility. Jiang and Tian, (2005) show that such model-free implied volatility estimated from a portfolio of option prices is immune from model misspecification errors and is informationally superior to the implied volatility from Black-Scholes model. It also

---

[15] For more information regarding the construction methodology of the FTSE Implied Volatility Index please follow this link http://www.ftse.com/products/downloads/FTSE_Implied_Volatility_Index_Series.pdf

incorporates the information content of past realised volatility and is an efficient reflection of future realised volatility. Dennis, Mayhew and Stivers, (2006), show that systematic volatility, measured using implied volatility of Index returns, has substantial impact on stocks returns than idiosyncratic and firm level volatility. Banerjee, Doran and Peterson, (2007) also lend support to using model free implied volatility as they find that both current and future innovations in the implied volatility are useful in predicting future excess returns. Besides the rationale offered by academic research, the Bank of England (BoE) also considers implied volatility as one of the indicators of future economic uncertainty[16].

Furthermore, implied volatilities are directly observable as they are derived from the observed market prices of option on the underlying instrument. In contrast to this, the conditional or the realised volatility is not directly observable and depends on the type of time-series model employed for its estimation (See: Heynen, Kemna and Vorst, 1994, Dumas, Fleming and Whaley, 1998). Bekaert and Hoerova, (2014) decompose the squared VIX in two components, the conditional variance and Variance Premium to analyse which of the two components does better job in predicting stock returns and economic activity. They concede that the accuracy of their results depends on the different regression models they employ to estimate the conditional or the realised variance. This suggests that implied volatility, as reflected by the volatility indices such as VFTSE, is better contender to capture the volatility of the UK market as opposed to the historical volatility of the underlying instrument. Although, there is a debate in the academic literature regarding what is (should be) a better measure of market-wide volatility, implied or historical, yet there is some consensus that suggests that implied volatility is suitable measure of market volatility rather than historical. See Mayhew, (1995) for a review of literature on the implied volatility.

---

[16] http://www.bankofengland.co.uk/publications/Documents/inflationreport/2016/may.pdf

In the first objective, I study the impact of short term and long term implied volatilities on the ERP of aggregate and sectoral FTSE indices by calculating total excess returns on these indices over the returns on one-month UK treasury bills. For the aggregate FTSE indices, I use the ERP of the FTSE 100 and FTSE 250 indices. This is because these two indices serve as benchmark for majority of Exchange Traded Products in the UK. In wake of the UK's exit from the European Union, the performance of FTSE 100 was much better than that of FTSE 250 index suggesting that FTSE 250 index closely mirrors the UK domestic economic conditions. At sectoral level, I use the ERP of ten most widely followed sectors in the UK. These are, FTSE All Share Basic Materials, Consumer Services, Consumer Goods, Financials, Healthcare, Industrials, Oil and Gas, Telecom, Technology and Utilities. These indices are widely used for sector-focused Exchange Traded Products. Understanding the impact of changes in short and long term implied volatilities on the ERP of these sectoral indices helps us to get an insight about the response of ERPs of cyclical and defensive sectors. Following the literature on predicting the stock index returns [Pesaran and Timmermann (1995, 2000), Marquering and Verbeek (2004), Goyal and Welch (2003), Welch and Goyal (2007), Rapach, Strauss, and Zhou (2010), Della Corte, Sarno, and Valente (2010), Kellard, Nankervis, and Papadimitriou (2010)] I study the impact of changes in the short and long term implied volatilities on these FTSE indices after controlling for variety of control variables. First group of control variables include popular valuation ratios such dividend yield, price-to-earnings ratios and market liquidity. Second group of control variables contains eight macroeconomic indicators. These are overall market return, inflation, unemployment, changes in narrow and broad money supplies, changes in the Sterling Effective Exchange Rate Index, changes in the term spread (measured as the differences in the yields of 10 year UK Government Bond and three- month treasury bills) and the short-term transitory deviations between consumption, asset wealth and income (CAY), proposed by (Lettau and Ludvigson, 2001b). The third group of control variable contain leading economic indicators such as changes in retail sales, index of industrial production, consumer confidence and the Composite Leading Indicator.

In the second objective, I study the asset pricing implication of the risk associated with the changes in the short and long term implied volatilities using the ERP of value-weighted 25 Fama-French style portfolios constructed on size and book-to-market characteristics. I examine whether the innovations in the short and long term implied volatilities are cross-sectional pricing factors. This paper differs from Adrian and Rosenberg, (2008) who uses short and long-term conditional volatility of market returns rather than market-implied volatility.

Moreover, I study the price of risks of short and long term market implied volatilities in presence of popular cross-sectional pricing factors of Fama and French, (1992;1993) and Carhart, (1997). The primary reason why I study cross-sectional asset pricing implications of short and long market implied volatility using the size and book-to-market based portfolios is that these portfolios are critical for the investors who want to get exposure to size and value characteristics.

The result of the analysis can be summarised as follows; first, I find that the innovations in both the short and long term market implied volatility have significant negative impact on the ERP of aggregate FTSE indices, after controlling for the three groups of control variable viz. valuation ratios, macroeconomic indicators, and leading economic indicators.  In particular, the ERP of FTSE 250 index is more sensitive to the innovations in the short and long term market implied volatility than the ERP of FTSE 100 index. In general, the ERP of both the aggregate FTSE indices are more sensitive to the innovations in the long term market implied volatility than short term. This may suggest that, on aggregate, investors in the UK are more sensitive to the long term market volatility risk relative to short term.

Second, I find insignificant impact of the innovations in the short and long term implied volatility on the ERP of sectoral indices. However, the ERP of the stocks in the financial sector are more negatively sensitive to the innovations in the long term market implied volatility than short term, after controlling for the three groups of control variables. The stocks in the financial sector seem to be more sensitive to the innovations in the long term implied volatility in the UK. On the other hand, the impact of the innovations in the long term market implied volatility is strongly positive on the ERP of the stocks in Healthcare industry. On average, a 1% rise in the long term market implied volatility leads to 0.31% rise in the ERP of Healthcare industry, after controlling for the three groups of control variables. This suggests that the stocks in the Healthcare industry provide a reasonable hedge against the innovations in the long term implied market volatility.

Third, for the ERPs of the 25 Fama-French style portfolios constructed on the size and book-to-market characteristics, I find that, the impact of innovations in short (long) term market implied volatility has positive (negative) impact on the ERP of small size portfolios than the ERP of large portfolios after controlling for the market risk premium This suggests that the ERP of small size portfolios provide a hedge against the fluctuations in the short term market implied volatility than the ERP of large portfolios. However, large stocks provide hedge against innovations in the long term market implied volatility. Overall, I find that the ERP of these 25 portfolios are more sensitive to fluctuations in the long term market implied volatility than short term, after controlling for the market risk premium.

Fourth, I provide new evidence regarding the pricing implications of both short and long term market implied volatility. I show that both the short and the long term market implied volatility are a significant cross-sectional asset pricing factors with negative prices of risks in presence of the popular cross-sectional asset pricing factors of  Fama and French, (1992, 1993) and Carhart, (1997).  The cross sectional pricing ability of both the short and long term implied volatility is significant when I control for business cycle indicators. This result robust if we measure the innovations in the short and long term implied volatilities using the residuals of ARMA (1,1) model for the both the short and long term implied volatility. The major contribution of these empirical results to the extant literature is that it is critical to understand the differential impact and the pricing implications of both short and long term market implied volatility in stock returns.

The remainder of the paper is organised as follows; section 5.2 describes the theoretical motivation, in brief, along with the empirical methodology in section 5.2. Section 5.3 describes the data. In Section 5.4 I present the results of the empirical analysis. Section 5.5 concludes.

## 5.2 Theoretical Motivation and Empirical Framework

### 5.2.1 Theoretical Motivation

The Intertemporal Capital Asset Pricing Model of Merton, (1973) and the Arbitrage Pricing Theory (APT) of Ross, (1976) postulates that when the investor's future opportunity set is stochastic, asset risk premia are proportional to covariation of asset returns with systematic factors in addition to the market factor. The stochastic discount factor is a function of innovations in other systematic state variables that can drive investor's opportunity set. Campbell's, (1993) version of I-CAPM show that under the assumption of homoscedastic environment, investors care about future expected news of regarding market return. That is, excess stock returns or the ERP is proportional to the covariance of asset returns with future expected news regarding the market return. Chen, (2002) extends Campbell's, (1993) version of I-CAPM under the assumption of heteroscedasticity and time-varying conditional co-variances of asset returns with stochastic discount factor. He shows that investors care about future expected volatility and needs to be hedged against the possible innovations in the stochastic volatility along with the innovations in market return. Building on the theoretical implications of these studies, Ang et al., (2006), show that innovations in the VIX index, which is a risk-neutral and forward-looking measure of expected market volatility, is a systematic pricing factor along with the Fama and French, (1993) and Carhart, (1997) systematic risk factors. Adrian and Rosenberg, (2008) further show that investors not only care about short term conditional volatility but also about long term conditional volatility. The short and the long term conditional market volatility are separate systematic pricing factors.

Furthermore, from the behavioural finance perspective, Benartzi and Thaler, (1995) show that ERP puzzle can be rationalised if investors evaluate the performance their portfolios annually. That is, the parameters of loss aversion model of Benartzi and Thaler, (1995), which is based on the prospect theory of Kahneman and Tversky, (1979), are consistent with the observed level of ERP if the frequency of portfolio evaluation is annual. The intuition from their work is that investors are sensitive to the performance of their portfolios on an annual basis. Therefore, state variables that affect investor's opportunity set on an annual basis should help drive asset risk premia.

Motivated by the theoretical implications of the I-CAPM and its extended versions, along with the intuition of Benartzi and Thaler, (1995) I hypothesise that state variables such as short and long term implied volatility, that can affect investor's short and long term opportunity set (preferably over a year) should be driving factors of ERP and should be able to explain the time variation in the ERP. Moreover, these risk factors should be priced in the cross-section. In this article I operationalise this by using 30 days and 360 days implied volatility. Thus, the equation for the expected excess returns could take the following form

$$E_t\left(R^e_{i,t+1}\right) = \gamma_{1,t}.\,Cov_t\left(R^e_{i,t+1}, MKT_{t+1}\right) + \gamma_{2,t}.\,Cov_t\left(R^e_{i,t+1}, IV^S_{t+1}\right) + \gamma_{2,t}.\,Cov_t\left(R^e_{i,t+1}, IV^L_{t+1}\right) \quad \textbf{(5.1)}$$

where $R^e_{i,t+1}$ is the expected excess return on risky asset (expected ERP), $IV^S_{t+1}$ is the short term market implied volatility, $IV^L_{t+1}$ is the long term market implied volatility and $\gamma_s$ are the respective prices of risks

### 5.2.2 The Empirical framework

In this section I describe the empirical framework for our two objectives. I begin the analysis by studying the impact of risk associated with the innovations in the short term (VFTSE) and the long term market-implied volatility (IV360). For this, I estimate the following regression;

$$E^i_t = \alpha^i + \beta^i_{30}.\,\Delta IV_{30,t} + \beta^i_{360}.\,\Delta IV_{360,t} + \beta^i_x.\,x_t + \varepsilon^i_t \quad \textbf{(5.2)}$$

where, $E^i_t$ is the ex-post ERP of the FTSE index $i$, $\Delta IV_{30,t}$ is the changes in the short term market implied volatility (VFTSE index), $\Delta IV_{360,t}$ is the changes in the long term implied market volatility (IVI360), $x_t$ are the control variables and $\varepsilon^i_t$ is assumed to be a white noise process. $\beta^i_{30}$ and $\beta^i_{360}$ captures the sensitivity of ERP of the $i$ th FTSE index to short and long term implied volatility. As mentioned earlier, I use three groups of control variables; three valuation metrics, eight macroeconomic indicators and four leading economic indicators. With these sets of control variables, model (5.2) becomes,

$$E^i_t = \alpha^i + \beta^i_{30}\Delta IV_{30,t} + \beta^i_{360}\Delta IV_{360,t} + \beta^i_M.\,MKT_t + \beta^i_D DY^i_t + \beta^i_{pe}.\,P^i_t + \beta^i_{tr}.\,TR_{m,t} + \varepsilon^i_t \quad \textbf{(5.3)}$$

where, $MKT_t$ is the market risk premium, $DY^i_t$ is the dividend yield of the $i^{th}$ FTSE index, $P^i_t$ is the Price-Earnings ratio of $i^{th}$ FTSE index and the $TR_{m,t}$ is the trading volume or the market turnover by value. Gervais, Kaniel and Mingelgrin, (2001) show that trading volume contains important information about the future stock returns. Periods of excessive trading volume are followed by high excess stock returns and periods of low trading volume are followed by low excess stock returns. They refer to this phenomenon as *High Volume Return Premium.* Ang et al., (2006) also control for trading volume in their analysis. Furthermore, trading volume may also reflect market liquidity as it is useful in capturing the market's breadth ( see Chordia, Roll and Subrahmanyam, 2001 and Sarr and Lybek, 2002).

With the second group of control variables model (5.2) becomes,

$$E_t^i = \alpha^i + \beta_{30}^i \Delta IV_{30,t} + \beta_{360}^i \Delta IV_{360,t} + \beta_M^i . MKT_t + \beta_\pi^i . \pi_t + \beta_U^i . U_t + \beta_{M0}^i \Delta M0_t + \beta_{M4}^i \Delta M4_t + \beta_{ER}^i \Delta ER_t + \beta_{TS}^i \Delta TS_t + \beta_{cay}^i CAY_t + \varepsilon_t^i \quad \textbf{(5.4)}$$

where, $\pi_t$ is the inflation, $U_t$ is unemployment, $\Delta M0_t$ changes in the narrow money supply (M0), $\Delta M4_t$ is the changes in the broad money supply (M4), $\Delta ER_t$ is the changes in the Sterling Effective Exchange Rate Index, $\Delta TS_t$ is the changes in the term spread. Term spread is the difference between the yields on the 10 year and 3-month UK government bonds. Finally motivated by the Lettau and Ludvigson (2001b) I also control for the transitory deviations between the consumption, asset wealth and Income, (*CAY*). I construct the *CAY* variable as cointegrating residual of the following cointegrating regression;

$$c_t = \theta_0 + \theta_1 . a_t + \theta_2 y_t + \zeta_t \quad \textbf{(5.5)}$$

where, $c_t$ is the log of aggregate household consumption in the UK, $a_t$ is the log of aggregate household wealth and $y_t$ is the log of aggregate disposable household income. $\zeta_t$ = *CAY* is the transitory deviation between these three variables. I estimate this cointegrating by dynamic OLS.[17]

Finally, with the third set of control variables model (5.2) becomes

$$E_t^i = \alpha^i + \beta_{30}^i \Delta IV_{30,t} + \beta_{360}^i \Delta IV_{360,t} + \beta_M^i . MKT_t + \beta_{RS}^i RS_t^i + \beta_{IIP}^i . IIP_t^i + \beta_{CC}^i . CC_t + \beta_{LI}^i CLI_t + \varepsilon_t^i \quad \textbf{(5.6)}$$

where, $RS_t^i$ is the changes in the retail sales, $IIP_t^i$ is the changes in the Index of Industrial Production, $CC_t$ is the changes in the consumer confidence index and $CLI_t$ is the changes in the composite leading indicator. It is worth noting here that when the dependent variables in the models (5.3, 5.4, and 5.6) are the ERP of the aggregate FTSE indices i.e. FTSE 100 and FTSE 250, I do not include the market risk premium ($MKT$) as I measure this using the total return on the FTSE All Share index. On the other hand, when the dependent variables in these models are ERPs of the FTSE sectoral indices I include the market risk premium.

To investigate the cross-sectional asset pricing implications of the risk associated with changes in the short and long term market implied volatility I use the ERP of the 25 Fama-French style portfolios constructed on the basis size and book-to-market characteristics. For this we employ the two stage Fama and MacBeth, (1973) cross-sectional regression approach. In the first stage I run the following time-series regressions;

$$E_t^p = \alpha^i + \beta_{30}^p \Delta IV_{30,t} + \beta_{360}^p \Delta IV_{360,t} + \beta_{MKT}^p . MKT_t + \varepsilon_t^i \quad \textbf{(5.7)}$$

$$E_t^p = \alpha^i + \beta_{30}^p \Delta IV_{30,t} + \beta_{360}^p \Delta IV_{360,t} + \beta_{MKT}^p . MKT_t + \beta_S^p . SMB_t + \beta_H^p . HML_t + \beta_U^p . UMD_t + \varepsilon_t^i \quad \textbf{(5.8)}$$

[17] I do not present the results of this cointegrating regression in the Results section. These results are made available on request.

where, $E_t^p$ represents the ERP of the $p^{\text{th}}$ size and book-to-market portfolio, $SMB_t$ and $HML_t$ are the size and value premiums of Fama and French, (1992;1993) respectively and $UMD$ is the Carhart's, (1997) momentum factor, which is a portfolio of "winners minus losers". The respective $\beta^p$ coefficients represent the loadings of the ERP of the $p^{\text{th}}$ size and book-to-market portfolio on the respective factors. In the second stage, I estimate the following cross-sectional regressions to estimate the prices of risk arising due to changes in the short term and long term implied volatilities.

$$E_t^p = \gamma_0 + \gamma_{30}\,\widehat{\beta_{30}^p} + \gamma_{360}.\widehat{\beta_{360}^p} + \gamma_{MKT}.\widehat{\beta_{MKT}^p} + \eta^p \tag{5.9}$$

$$E_t^p = \gamma_0 + \gamma_{30}\,\widehat{\beta_{30}^p} + \gamma_{360}.\widehat{\beta_{360}^p} + \gamma_{MKT}.\widehat{\beta_{MKT}^p} + \gamma_S.\widehat{\beta_S^p} + \gamma_H.\widehat{\beta_H^p} + \gamma_U.\widehat{\beta_U^p} + \eta^p \tag{5.10}$$

where, $\gamma_{30}$ and $\gamma_{360}$ represent the unconditional prices of risk arising from the exposure to the risk of changes in the short term and long term implied volatilities. $\widehat{\beta_i^p}$ in models (5.9) and (5.10) are the exposure to the respective factors estimated from the time-series regressions (5.7) and (5.8) respectively. The corresponding $\gamma$ coefficients represent the prices of risks. Models (5.9) and (5.10) are estimated using Newey and West, (1987) (Heteroscedasticity and Autocorrelation Corrected) standard errors. In addition to controlling for the Fama and French, (1992;1993) and Carhart's, (1997) factors, I also estimate the prices of risk of short and long term implied volatilities by controlling for the seven economic indicators used previously in investigating the impact of changes of short and long term implied volatilities on the ERP of the FTSE indices. Thus I estimate following model:

$$E_t^p = \gamma_0 + \gamma_{30}\,\widehat{\beta_{30}^p} + \gamma_{360}.\widehat{\beta_{360}^p} + \gamma_\pi\widehat{\beta_\pi^p} + \gamma_U\widehat{\beta_U^p} + \gamma_{M0}.\widehat{\beta_{M0}^p} + \gamma_{M4}.\widehat{\beta_{ER}^p} + \gamma_{TS}.\widehat{\beta_{TS}^p} + \gamma_{CAY}.\widehat{\beta_{CAY}^p} + \eta^p \tag{5.11}$$

where, $\gamma_\pi, \gamma_U, \gamma_{M0}, \gamma_{M4}$, $\gamma_{TS}$ and $\gamma_{CAY}$ are the prices of risk associated with exposure to inflation, unemployment, changes in narrow money supply, changes in broad money supply, changes in the term spread and the *CAY*.

To check the robustness, I estimate the risk associated with short and long term market implied volatility using the residuals of the ARMA (1, 1) models for VFTSE and IVI360. I then use these residuals as a proxy of $\Delta IV_{30,t}$ and $\Delta IV_{360,t}$ re-estimate models (5.9), (5.10) and (5.11).

## 5.3 Data Description

I estimate the ERP of the FTSE indices as the difference between ex-post total return on these indices and the one month UK treasury bills rate. The ex-post total return is estimated using the Total Return Index which includes dividends. I obtain this data from DataStream. To estimate the ERP of the 25 value-weighted Fama-French style portfolios based on size and book-to-market characteristics, we use the returns on these portfolios from Gregory, Tharyan and Christidis, (2013). Similarly the data for the size premium, value premium and the momentum factor is also taken from the Gregory, Tharyan and Christidis, (2013). The market risk premium (*MKT*) is measured using the difference between the total return on the FTSE All Share Index and one-month treasury bills rate.

To measure the short and the long term market implied volatility we use the VFTSE and FTSE interpolated 360 days volatility indices. These volatility indices are estimated using portfolios out-of-the-money put and call options on the FTSE 100 indices. The risk associated with these implied volatilities is initially measured using first differences and then to check the robustness we employ the ARMA (1,1) model and use the residuals. We obtain this data from Bloomberg[18].

Panel A of figure 5.2 shows the VFTSE and FTSE IVI 360 days implied volatilities. The thick line (VFTSE) represents the implied volatility over the next 30 days (VFTSE index) and

---

[18] Bloomberg ticker for the 30 days and 360 days implied volatilities are VFTSE and IVUKX360 respectively.

the dotted line represents the implied volatility over the next 360 days (IV 360). Panel shows the changes in the VFTSE (D. VFTSE) and FTSE IVI 360 (D. IVI360) indices. For majority of the time the long term implied volatility is more than the short term. This suggests that, on average, the fear of long term is more than short term. However, during the turmoil periods such as during September and October 2008, we can see that the short term implied volatility is more than the long term implied volatility.

****insert figure 5.2 about here****

The control variables used in models (5.5, 5.6, and 5.8) are as follows; inflation is measured as annual changes in the Harmonised Consumer Price Index. Unemployment is measured as unemployed workforce as a percentage of economically active workforce claiming unemployment benefits i.e., Job Seekers Allowance and National Insurance Credits. The Sterling Effective Exchange Rate Index is measured using trade-weighted exchange rate of the British Sterling Pound. The narrow money supply is measured using M0 money supply, which included notes and coins in circulation outside the Bank of England. The broad money supply is measured using the M4 money supply which is composed of holdings of M0, sterling deposits at banks and building societies including certificate of deposits, other instruments with maturity no more than 5 years and liabilities of UK bank and building societies arising from the repo transactions. Term spread is the difference between the yields on 10 year UK government bond and 3-month treasury bills rate.

To calculate *CAY,* I use (i) Aggregate personal consumption, which is measured using seasonally adjusted data on consumer spending on durable, semi-durable and non-durable-goods and on services. (ii) Total Gross Wealth, which is the total gross value of accumulated assets by households; the sum of four components: property wealth, physical wealth, financial wealth and private pension wealth. (iii) Aggregate personal income, which is measured using income approach of secondary distribution of income accounts and uses the disposable income of households and NPISH.

The control group containing valuation metrics are as follows; dividend yields and PE ratio are the net dividend yields and Price-to-Earnings ratio of the respective FTSE indices. Market trading volume is measured using turnover by value which is the aggregation of number shares traded in the FTSE 100 index multiplied by the closing price of each share that constitutes the FTSE 100 index. The data is obtained from DataStream.

The control group containing the leading economic indicators are measured as follows; Retail sales is the seasonally adjusted index for total sales including automotive fuel at constant prices. The Index of Industrial Production is the seasonally adjusted index which measures the volume of production of the manufacturing, mining and quarrying and energy supply industries. Consumer Confidence is measured using European Commission consumer survey index which is seasonally adjusted. Finally, the changes in the composite leading indicator are the changes in the seasonally adjusted trend restored Composite Leading Indicator measured by the OECD. The data is obtained from DataStream.

The data is obtained at monthly frequency and the sample size is from February 2000 to July 2015. The sample size is decided on the basis of data availability for the FTSE IVI 360 index. Table 5.1 provides the descriptive statistics of the data. Panel A provides the descriptive statistics for the two implied volatility indices. The average monthly short and long term implied volatility of the FTSE 100 index is 20.19% and 21.68% respectively with standard deviation 8.00% and 5.66% respectively. Panel B provides the annualised descriptive statistics of the ex-post ERP of the FTSE indices. The average annual ERP of the FTSE 100 and the FTSE 250 indices are 0.89% and 6.75% respectively with standard deviation 14.23 and 17.70 respectively. Panel C provides the descriptive statistics of the annualised ERP of the 25 value weighted size and book-to-market portfolios. For simplicity we retain the same naming convention as in Gregory, Tharyan and Christidis, (2013). Panel D provides the annualised descriptive statistics of the four popular cross-sectional asset pricing factors. We can see that the momentum premium is the highest of all the pricing factors. This suggests that an investor would have earned an average of 9.54% by investing in a portfolio which is long “winners” and short “losers” based on past 12 months.

****insert table 5.1 about here****

Panel E presents the descriptive statistics of the control group containing macroeconomic indicators. The average annual growth rate of narrow money is 5.46% whereas the average term spread is about 0.99%. Interestingly, the average annual Sterling Effective Exchange Rate -0.69% which shows that on average the value of Sterling has fallen down against the basket of currencies of major trading partners of the UK. Panel F provides the descriptive statistics of the leading economic indicators. The average annual change in the Retail Sales is 2.24% while the average annual change in the Index of Industrial Production is -0.75% indicating that industrial production has decreased, on average, in the UK for the sample period. The average consumer confidence index is -8.16 while the average change in the composite leading indicator is 0.14. Finally, Panel G provides the descriptive statistics of the valuation ratios such as PE ratios and Dividend yield of each of the FTSE indices. The average dividend yield of the Healthcare sector is the highest (4.60). The average PE ratio of the Technology sector is the highest (30.21) more than the PE ratio of FTSE 100 index (15.05). See appendix 5.1 for a brief overview of the data.

## 5.4 Results

In this section I present the results of examination of the impact of risk associated with changes in the short and long term market implied volatility on the aggregate and sectoral

FTSE indices. I then move on to examine the cross-sectional asset pricing implications of the risks of short and long term implied volatilities using the 25 size and book-to-market portfolios.

### 5.4.1 The impact of short and long term implied volatility on ERP of FTSE indices.

In this sub-section I present the empirical results. I begin with examining the impact of innovations in short and long term implied volatility on the ERP of aggregate and sectoral FTSE indices and investigate whether the innovations can determine the ERP.

Tables 5.2, 5.3 and 5.4 present the results of the regressions 5.3, 5.4, and 5.6 respectively. In these three tables I assess the loadings on the short term and long term implied volatilities for ERPs of the aggregate and sectoral FTSE Indices. As far as the ERP of the aggregate FTSE indices (FTSE 100 and FTSE 250) I do not control for the market risk premium. This is because the proxy for market risk premium is computed using the total return index of FTSE All Share Index.

In table 5.2 I examine the impact of risk associated with $\Delta IV_{30}$ and $\Delta IV_{360}$ on the ERP of various FTSE indices after controlling for the first control group variables i.e. the dividend yields, PE ratios and trading activity. For the ERP of the aggregate FTSE indices we can see that both the short and the long term implied volatilities are significant drivers. On average, both short and long term implied volatilities exerts a negative impact on the ERP of the aggregate FTSE indices. This suggests that if both short and long term implied volatilities increases the ERP of the aggregate indices decreases. This is intuitive since the rise in volatility is associated with decreased overall returns and hence decreases the ERP. One of the reason why this happens is because the leverage effect argued by Black, (1976). Christie, (1982) and Schwert, (1989) show that volatility is an increasing function of financial leverage. Therefore, as the current implied volatility increases, the market participants expect that the future realised volatility will increase leading to an increase in the financial leverage. As such, current ERP decreases. Dennis, Mayhew and Stivers, (2006) also find a negative impact of innovations in the short term implied volatility on the stock index returns. However, they do not investigate the impact of innovations in the long term implied volatility,

Another possible explanation for this could be offered on the basis of the results of Mayfield, (2004). He finds that about half of the variation in the market risk premium is associated with future market risk. Since, we measure market risk using implied volatilities over next 30 and 360 days, innovations to market implied risk changes the future opportunity set of the investors which is reflected in the current ex-post ERP.

****insert table 5.2 about here****

****insert table 5.3 about here****

****insert table 5.4 about here****

The absolute impact of the short and the long term implied market risk is higher on the ERP of the FTSE 250 than on the ERP of FTSE 100 index. The ERP of the FTSE 250 is more sensitive to the risk associated long term implied volatility than short term. ($|\beta_{360}| > |\beta_{30}|$). On one hand this may be considered counterintuitive since (Benartzi and Thaler, 1995) show that investors are more sensitive to short term losses (myopic loss aversion) than long term. On the other hand, this could also be considered to be intuitive since (Benartzi and Thaler, 1995) show that the frequency of mental accounting is about one year. That is, investors on average evaluate the performance of their portfolio holdings on annual basis. If this is true, then the impact of expected volatility over next 360 days should be more than the impact of expected volatility over next 30 days. We can also see a similar pattern of the reaction of ERP of the FTSE 250 index in tables 5.3 and 5.4 where I control for macroeconomic factors and leading economic indicators respectively. In table 5.3 the impact of $\Delta IV_{360}$ is more than $\Delta IV_{30}$ ($|\beta_{360}|$=0.77 and $|\beta_{30}|$ = 0.49) on the ERP of FTSE 250 index while in table 5.4 it is $|\beta_{360}|$=0.72 which is greater than $|\beta_{30}|$ = 0.49. However, we do not see such differential impact of risk associated with $\Delta IV_{30}$ and $\Delta IV_{360}$ on the ERP FTSE 100 index. The ERP of FTSE 100 index is almost indifferent to the risk associated with changes in short and long term implied volatilities; although in tables 5.2, 5.3 and 5.4 we see a significant negative impact of short implied volatilities on the ERP of FTSE 100 index. In table 5.3, since we control for macroeconomic indicators, we see a relatively insignificant impact of long term implied volatility on the ERP of FTSE 100 index than short term.

As far as the ERP of the sectoral FTSE indices is concerned, we can see some variation the response of the ERP to short and long term implied volatility. Unlike for the aggregate FTSE indices, we now control for the market risk premium. This is predominantly why we do not see any significant impact of short and long term implied volatilities on the ERP. This can be seen from tables 5.2, 5.3 and 5.4. From table 5.2 we can see that after controlling for the valuation metrics, the ERP of Basic Materials is significantly sensitive to short term implied volatility ($\beta_{30} =$ -0.20). On the other hand, the ERP of stocks in the Healthcare sector is positively significant ($\beta_{30}$=0.27) to long term implied volatility. Similar reaction of the ERP of Healthcare sector can be seen from table 5.4 ($\beta_{30}$=0.23) where we control for leading economic indicator. The positive impact of the risk associated with changes in the long term implied volatility on the ERP of Healthcare industry can be interpreted as hedge against the increase in the long term implied volatility. This interpretation can be explained on the intuition of the results of Bakshi and Kapadia, (2003). Their results suggest that assets that have higher sensitivities to market volatility risk provide greater insurance against the market downside risk than those that have negative or lesser loadings on the market volatility risk. The rise in long term implied volatility is compensated more by the Healthcare than any other sector. However, from table 5.3 we see that the impact of ERP of the Healthcare sector is positive but insignificant in presence of other economic factors. From tables 5.3 and 5.4, a similar interpretation can be made about the ERP of the Telecom sector. The ERP of Financial sector is significantly sensitive to changes in the long term implied volatility. As the long term volatility rises the ERP of Financial sector decreases. On the other hand, the impact of short term implied volatility on the ERP of the Financial sector is positive in the all these tables, albeit insignificant.

****insert table 5.5 about here****

I also assess the impact of $\Delta IV_{30}$ and $\Delta IV_{360}$ on the ERP of aggregate FTSE indices in presence of all the control variables together ("kitchen-sink" regression). Panel A of table 5.5 reports the results for the changes in VFSTE and IVI360 as proxies of innovations in short term and long term implied volatility. After controlling for a variety of the leading economic variables and valuation ratios, the impact of risk associated with changes in both long and short term implied volatility is significantly negative. The ERP of FTSE 100 are slightly more sensitive to changes in short-term implied volatility than long term implied volatility ($|\beta_{30}|$ = 0.48 > $|\beta_{360}|$ = 0.37), whereas for the FTSE 250, the changes in long term implied volatility have a larger impact ($|\beta_{360}|$ = 0.61) than changes in the short term implied volatility ($|\beta_{30}|$ = 0.49). For robustness, we use ARMA (1, 1) model residuals as a proxy of innovations in the short and long-term market-implied volatility. Results in Panel B confirm that the changes in both short and long term implied volatility negatively impact the ERP of aggregate FTSE indices.

In general, the results, so far, indicate that the risks associated with changes in the short and long term implied volatility on sectoral basis are subsumed in the market risk premium. Yet at aggregate level these risks are significant.

### 5.4.2 Cross-Sectional ERP and prices of implied volatility risk.

In this section I analyse the impact of risk associated with changes in the short and long term market implied volatilities on the ERP of the value 25 Fama-French portfolios constructed on size and book-to-market characteristics. Initially I examine this impact in presence of the market risk premium. The results of this analysis are presented in table 5.6. In table 5.7, I examine the impact of $\Delta IV_{30}$ and $\Delta IV_{360}$ in presence of the size, value premiums of Fama and French, (1992;1993) respectively and momentum premium of Carhart, (1997). Subsequently, in the second stage we estimate the prices of risk associated exposure to $\Delta IV_{30}$ and $\Delta IV_{360}$. The estimated prices of risks in presence of the popular cross-sectional asset pricing factors are presented in table 5.8.

****insert table 5.6 about here****

Table 5.6 shows the loadings of $\Delta IV_{30}$ and $\Delta IV_{360}$ on the ERP in presence of the market risk premium only. On the basis of size dimension, the results indicate that the average impact of short term implied volatility on ERP of the size portfolios decreases as one moves from small size to large size. The average impact of $\Delta IV_{30}$ on the ERP of small size portfolios is 0.22 and decreases to -0.06 for the ERP of large portfolios. This suggests that small size portfolio provide higher risk adjusted compensation against the risk associated with short term implied volatilities than big size portfolios. Why do ERP of small stocks provide relatively more insurance against the risk of fluctuations in the short term market implied volatility than large stocks? This could be explained on the basis of intuition of the results of Pastor and Veronesi, (2003). They show that the uncertainty related to future profitability of small stocks is much higher than large stocks which explains why small stocks provide higher risk adjusted returns i.e. higher ERP than large stocks in the event of rise in the market's short term implied volatility. Furthermore, Adrian and Rosenberg, (2008) also show that average exposure of returns of small stocks to short term conditional market volatility is higher than large stocks.

Across the value dimension, the results indicate that the impact of risk associated with short term implied volatility on the ERP increases as one move from growth to value portfolios. On average, the impact of $\Delta IV_{30}$ on the ERP of growth stocks is 0.05 while that on the ERP of value stocks is 0.21. Growth stocks tend to provide lesser insurance against the risk of short term implied volatility than the value stocks. Although this may be the case, yet growth stocks still provide positive risk-adjusted insurance against fluctuations in the short term market implied volatility after controlling for market excess return and long –term market implied volatility.

As far as the impact of risk associated with long term implied volatility is concerned, the results indicate some striking features. On the basis of size dimension, average impact of $\Delta IV_{360}$ on the ERP of small is negative and significant (-0.66) and less than that of large stocks (0.16). Large stocks, on average, provide higher risk-adjusted compensation against the fluctuations in long term market implied volatility than small stocks. This results is qualitatively similar to Adrian and Rosenberg, (2008). Their results show that average loadings on long term conditional market volatility for the returns on large stocks are more than for the returns on small stocks. Thus, the changes in the "fear" of long term are compensated more by the ERP of large stocks than the ERP of small stocks after controlling for the market risk premium.

On the value dimension, we can see that the average response of ERP of growth stocks (-0.13) is more than the ERP of value stocks (-0.45). This is in line with the results of Adrian and Rosenberg, (2008). They show that the average loadings of returns of growth stocks on long term conditional market volatility is more (-0.08) than for the returns on value stocks (-0.15). However, similar to impact of short term implied volatility, the average magnitude of impact of long term implied volatility on the ERP of value stocks is larger than the ERP of growth stocks, i.e. $|-0.45| > |-0.13|$.

Overall, by comparing the top two panels of table 5.6 we can see that ERP of these portfolios are significantly sensitive to long term implied volatility than short term implied volatility. The average sensitivity of ERP of all the 25 portfolios to changes in short term market implied volatility is positive (0.02) and negative to the changes in the long term market implied volatility (-0.18). Thus it may be seen that ERPs of these 25 portfolios can provide a positive insurance against the fluctuations short term market implied volatility compared to long term implied volatility after controlling for the market factor.

However, from table 5.7, where I examine the impact of short and long term market implied volatility after controlling for market, size, value and momentum premiums, we can see that the significance of both short term and long term implied volatility reduces. Although this may be the case, by comparing the results in tables 5.6 and 5.7 we can observe a more striking feature. The ERP of growth stocks provides a positive hedge against fluctuations in the long term implied volatility in table 5.7 than in table 5.6 once we take into the value premium. An equivalent observation can be made regarding the ERP of value stocks. Comparing the tables 5.6 and 5.7 on the basis of the size dimension, we can see that the average sensitivity of the ERP of both the small and large stocks reduces to risk of both $\Delta IV_{30}$ and $\Delta IV_{360}$, once we take into account the size premium.

****insert table 5.7 about here****

In table 5.8, I examine the pricing of short and long term market implied volatility risk in the cross section of the 25 size and book-to-market portfolios. Column (1) shows the pricing of risks associated with $\Delta IV_{30}$ and $\Delta IV_{360}$ using second-stage Fama and MacBeth, (1973) cross sectional regressions (equation 5.9) after controlling for market risk premium. The first stage factor loadings are from table 5.6. The t-statistics are estimated using the Newey and West, (1987) (Heteroscedasticity and Autocorrelation Corrected) standard errors. In column (2) I present the estimated prices of risk associated with $\Delta IV_{30}$ and $\Delta IV_{360}$ after controlling for all the four popular cross-sectional pricing factors. It shows the results of the second stage Fama and MacBeth, (1973) cross sectional regression (5.10).

The results in column 1 of table 5.8 show that price of the risk associated with changes in short term implied market volatility is negative and significant (-1.95% monthly) after controlling for market risk premium. In addition to this, I also find that the price of risk of long term market implied volatility is negative and highly significant (-1.30 % monthly) at 1% significance level. The negative prices of risk of short and long term implied volatility can be interpreted as follows; when both short and long term market implied volatility are higher, then the assets that provide positive excess returns i.e. positive ERP, are more expensive compared to assets that have negative ERP and consequently have low expected returns. The price of risk of fluctuations in short term implied volatility of -1.95% means that assets which have unit exposure to short term market implied volatility will have 1.95% lower ERP than the asset with zero exposure to short term market implied volatility risk after controlling for the market risk premium. Similarly, the price of risk of long term implied volatility of -1.30% means that assets with unit exposure to long term market implied volatility risk will require 1.30% lower ERP than the assets with zero exposure to long term volatility risk after controlling for the market risk premium.

From column (2) of table 5.8 a similar interpretation can be deduced after controlling for the size, value and momentum premium in addition to the market risk premium. It can be seen that both short and long term market implied volatility risk has statistically significant negative prices of risks at 1% level.

****insert table 5.8 about here****

In columns (3) and (4) of table 5.8, I check the robustness of these pricing implications of risk of short and long term market implied volatility. Instead of measuring the risk associated short and long term market implied volatility as changes in the VFSTE and 360 days FTSE implied volatility indices, I estimate these risks as residuals of ARMA (1,1) models for the VFTSE and the 360 days FTSE indices. I do not present the first stage factor loadings (betas) on these residuals. Instead, I directly present the second stage Fama and MacBeth, (1973) cross sectional regressions (5.9) and (5.10) using the betas on these ARMA (1,1) residuals. Results from columns (3) and (4) show that the pricing of both short and long-term market-implied volatility remain negative and statistically significant confirming our earlier results reported in columns (1) and (2) respectively.

Table 5.9 shows the expected factor risk premiums of each of the 25 portfolios arising due to the exposure to risk associated with short and long term implied volatilities. These are calculated by multiplying the factor loadings from table 5.6 with prices of risks from column 1 of table 5.8. Panel A shows the factor risk premium attributable to the exposure to changes in the short term implied volatility. Panel B shows the factor risk premium attributable to the exposure to changes in long term implied volatility and Panel C shows the factor risk premium attributable to market exposure. From Panel A we can see that the average risk premium of the large stocks attributable to changes in short term implied volatility is more (0.11% monthly) than that of small stocks (-0.44% monthly). This is consistent with Adrian and Rosenberg, (2008) who find that the factor risk premia of large stocks attributable to conditional short-run volatility risk of are, on average, more than small stocks.

On the other hand, from Panel B we can see that average risk premium of large stocks attributable to long term implied volatility risk is less (-0.21% monthly), than that of small stocks (0.86% monthly). This is because the absolute value of loadings of ERP of small stocks is more than the loadings of large stocks on the long term implied volatility risk. Moreover, the factor risk premiums of these 25 portfolios on size dimension attributable to both the implied volatility components are more than the factor risk premium attributable to the market risk premium. For example, the factor risk premium of small stocks attributable to combined implied volatility components is 0.42% monthly (0.86% + (-0.44%)) which is greater than that attributable to market risk premium (0.15% monthly). Overall, the average monthly risk premium for all portfolios attributable to the risk of short and long-term market-implied volatility is -0.19% and 0.45% respectively implying that investors will expect to earn positive risk premium for the risks associated with changes in the long-term market implied volatility.

****insert table 5.9 about here****

### 5.4.3 Pricing implications of short and long term implied volatility in presence of business cycle indicators.

In the previous sub-section, I examine the pricing implications of the exposures to the short and long term market implied volatility in presence of popular cross-sectional asset pricing factors. In this section, I extend the analysis by checking whether the pricing ability of both short and long term market implied volatilities remain statistically significant after controlling for business cycle indicators. It is critical to understand this because as shown by Schwert (1989a, 1989b) business cycle is an important driver of market volatility. (Lettau and Ludvigson, 2001b) show that by incorporating macroeconomic risk such as transitory deviations in consumption, asset wealth, income (*CAY*), the importance of *SMB* and *HML* is reduced. Similarly, Vassalou, (2003) shows that a cross-sectional asset pricing model that includes a factor capturing the news regarding future evolution of GDP is vital along with the market risk premium. She also shows that when news regarding future evolution of GDP is incorporated in cross-sectional asset pricing model, the importance of *HML* and *SMB* pricing assets is reduced significantly. (Petkova, 2006) shows that by including innovations to business cycle indicators in the cross-sectional asset pricing models reduces the significance of *SMB* and *HML* factors

Therefore, I examine whether short and long term market implied volatility are cross-sectional asset pricing factors in the UK in presence of business cycle indicators. For this I use the second and third control group variables (macroeconomic indicators and leading economic indicators) from the previous sub-section 5.1 as pricing factors. I choose these indicators as control groups because these variables reflect the business cycle conditions.

****insert table 5.10 about here****

Table 5.10, presents the second stage Fama and MacBeth, (1973) cross-sectional regressions in presence of exposures to inflation, unemployment, changes in narrow money, changes in broad money, changes in Sterling effective exchange rate, changes in term spread and the CAY variable after controlling for the market factor. In columns (1) and (2) the prices of risk of short and long term market implied volatilities is estimated using exposures to $\Delta IV_{30}$ and $\Delta IV_{360}$ . For robustness, in columns (3) and (4) I estimate these prices of risk using the exposures to the residuals of ARMA (1,1) model for the IV 30 and IV360, similar to columns (3) and (4) of table 7.

The results from column (1) of table 5.10 indicate that after controlling for the exposure to the business cycle indicators using the macroeconomic variables, the long term market implied volatility is a significant pricing factor with negative price of risk. (-1.08%) at 1% level. The short term market implied volatility is also a significant pricing factor at 10% level with negative price of risk (-1.80%). In addition to this, the innovations to broad and narrow money supply are significant asset pricing factors after controlling for the market factor. The short term transitory deviations between consumption, asset wealth and income (*CAY*) are also a significant cross-sectional asset pricing factor at 10% level. From column (3) we can see that these results are fairly robust if we estimate the risk associated with short and long term implied volatilities using the residuals of ARMA (1,1) model. The pricing ability of short term implied volatility, however, loses its significance.

In column (2) of table 5.10, I assess the pricing ability of $\Delta IV_{30}$ and $\Delta IV_{360}$ after controlling for the leading economic indicators. These leading indicators are the leading indicators of business cycle. Especially the Composite Leading Indicator, which is designed by the OECD, gives early signs about turning points in business cycles[19]. We can see that both the short and the long term market implied volatilities are significant pricing factors at 5% level with negative prices of risks -2.39% and -2.37% respectively. From column (4) we can see that these results are fairly robust. The pricing ability of the exposure to short term and the long term implied volatilities is significant if we estimate these risks using the ARMA (1, 1) residuals. In addition to this we can see that shocks to consumer confidence and Composite Leading Indicators are significant cross-sectional asset pricing factors. This result is

[19] For details about construction methodology, see http://www.oecd.org/std/leading-indicators/

particularly significant in the UK context, given the negative shock to consumer sentiment in the wake of UK's exit from the European Union.

## 5.5 Summary

In this paper, I study the impact of innovations in short and long term implied market volatilities on the ERP of stock indices and 25 value-weighted Fama-French style portfolios sorted on the basis of size and book-to-market characteristics in the UK. Following the predictions of inter-temporal asset pricing theory, I also study the cross-sectional asset pricing implications of risk associated with short and long term implied market volatility in the cross section of 25 size and book-to market portfolios. Prior literature focuses only on the impact of short term implied volatility and stock returns. It is critical to understand the differential impact of both the short and long term implied market volatility on ERP. This is because investors not only care about factors that affect their opportunity set in the short term but also the factors that affect their portfolio performance in the long term. The underlying assumption of the analysis is that innovations in both 30 days and 360 days FTSE 100 implied volatility are the true reflection of expected market-wide systematic volatility in the short and long term in the UK equity market.

I have following five primary findings. First, I find that the ERP of aggregate FTSE indices has a strong negative relation with the innovations in both the short and the long term market implied volatility after controlling for valuation indicators, macroeconomic indicators and leading economic indicators. Notably, the impact of innovations in the long term market implied volatility has higher impact on the ERP of FTSE 250 index than the innovations in short term implied volatility. Additionally, the ERP of FTSE 250 index is more sensitive to innovations in long and short term implied volatilities than the ERP of FTSE 100 index.

Second, the innovations in short and long term market implied volatility has statistically insignificant impact on the ERPs of most of the sectoral indices except for the ERP of Financial and Healthcare sectors. The ERP of Healthcare sector is positively related to long term implied volatility implying that Healthcare sector provides positive hedge against long term market implied volatility.

Third, after controlling for the market risk premium, the ERP of small stocks provide higher compensation against the innovations in short term market implied volatility than the ERP of large size portfolios. On the value dimension, the ERP of both the growth and value stocks provide positive (negative) hedge against the innovations in short (long) term market implied volatility.

Fourth, the cross-sectional regression approach reveals new evidence that innovations in both short and long term market implied volatility are significant cross-sectional asset pricing factors with negative prices of risk, after controlling for the Fama and French, (1992;1993) and Carhart, (1997) factors. Notably, the long term market implied volatility is strong significant pricing factor than short term implied volatility.

Finally, the pricing ability of the short and long term implied volatility is significant after taking into account the innovations in business cycles indicators. The collective findings suggest that innovations in both short and long-term market-implied volatility are significant pricing factors in pricing assets in the UK

**Dissemination:** A shorter version of this paper is under review at *The European Journal of Finance.* (Along with Prof Poshakwale and Dr Agarwal).

## Appendix 5.1

| Control Group Variables | |
|---|---|
| Macroeconomic Variables | |
| Variable (Notation) | Definition/Brief Explanation |
| Inflation ($\pi$) | Measured as annual log changes in harmonised consumer price index |
| Unemployment (U) | Unemployment is measured as unemployed workforce as a percentage of economically active workforce claiming unemployment benefits i.e., Job Seekers Allowance and National Insurance Credits |
| Changes in Narrow Money Supply (ΔM0) | These are log changes in M0 money supply, which includes notes and coins in circulation outside Bank of England |
| Changes in Broad Money Supply (ΔM4) | These are log changes in M4 money supply which is composed of holdings of M0, sterling deposits at banks and building societies including certificate of deposits, other instruments with maturity no more than 5 years and liabilities of UK bank and building societies arising from the repo transactions |
| Effective Exchange Rate (ΔER) | These are log changes in the Sterling Effective Exchange Rate Index. The Effective Exchange Rate Index is measured using the trade-weighted exchange rate of the British Sterling Pound |
| Term Spread (TS) | Term spread is the difference between the yields on 10 year UK government bond and 3-month treasury bills rate. |
| CAY | These are transitory deviations (cointegrating residuals) between consumption, asset wealth and Income. To calculate CAY we use (i) Aggregate personal consumption, which is measured using seasonally adjusted data on consumer spending on durable, semi-durable and non-durable- goods and on services. (ii) Total Gross Wealth, which is the total gross value of accumulated assets by households; the sum of four components: property wealth, physical wealth, financial wealth and private pension wealth. (iii) Aggregate personal income, which is measured using the income approach of secondary distribution of income accounts and uses the disposable income of households and NPISH |
| Leading Economic Variables | |
| Retail Sales (ΔRS) | Log changes in retail sales, which are the seasonally adjusted index for total sales including automotive fuel at constant prices. |
| Index of Industrial Production (ΔIIP) | Log changes in the Index of Industrial Production. The index of industrial production is the seasonally adjusted index, which measures the volume of production of the manufacturing, mining and quarrying and energy supply industries |
| Consumer Confidence (CC) | Consumer Confidence is the seasonally adjusted European Commission consumer survey index. The index is calculated by taking the difference between the percentage of respondents giving favourable and unfavourable responses to qualitative multiple-choice questions. |
| Composite Leading Indicator (ΔCLI) | Log changes in the composite leading indicator. The composite leading indicator is the seasonally adjusted trend restored indicator measured by the OECD5. |
| Valuation Variables | |
| Dividend Yield (DY) | Dividend Yield of the FTSE indices |
| Price-Earnings ratio (PE) | Price-earnings ratio of the FTSE indices |
| Trading Volume (TR) | Market trading volume is measured using turnover by value, which is the aggregation of number shares traded in the FTSE 100 index multiplied by the closing price of each share that constitutes the FTSE 100 index |
| Implied Market Volatility Variables | |
| VFTSE | Annualised short term (next 30 days) implied volatility of FTSE 100 index. This is measured using the collection of out-of-money put and call options on the FTSE 100 index with 30 days to maturity |
| $\Delta IV_{30}$ | Changes in VFTSE index |
| IVI360 | Annualised interpolated long- term (next 360 days) implied volatility of FTSE 100 index. This is measured using the collection of out-of-money put and call options on the FTSE 100 index with 360 days to maturity |
| $\Delta IV_{360}$ | Changes in the IVI360 index |

## List of Figures

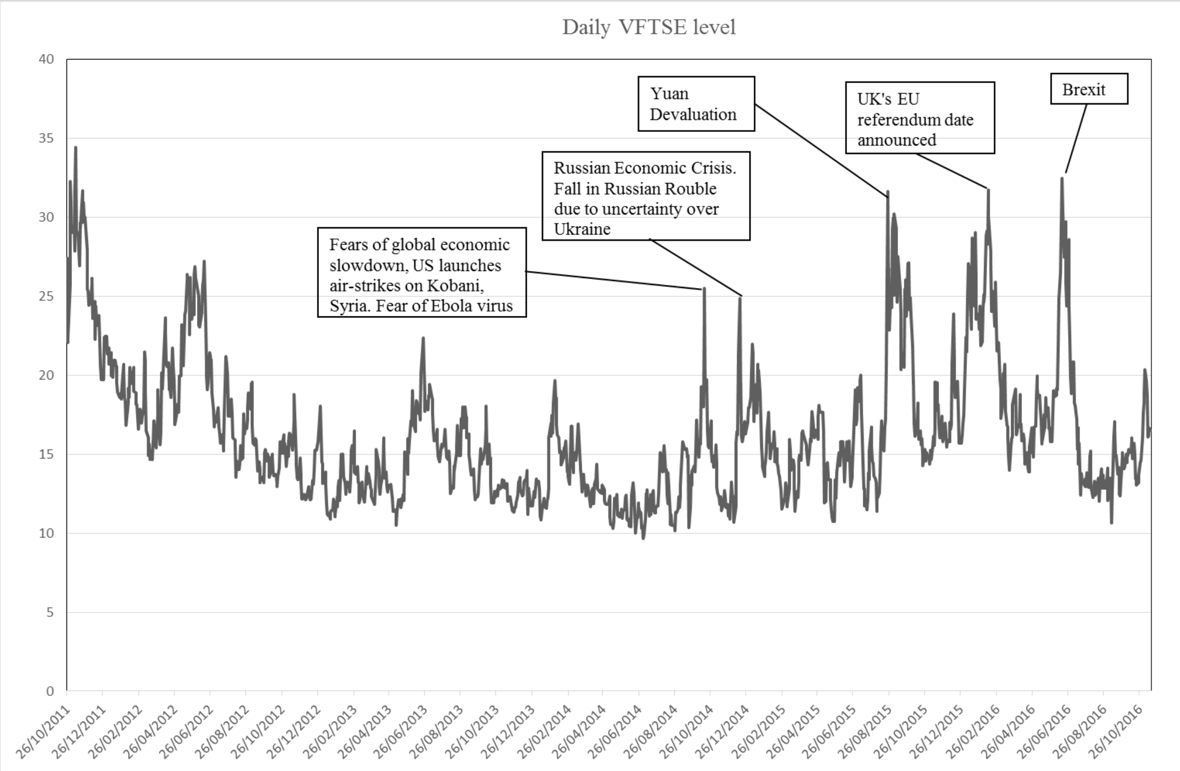
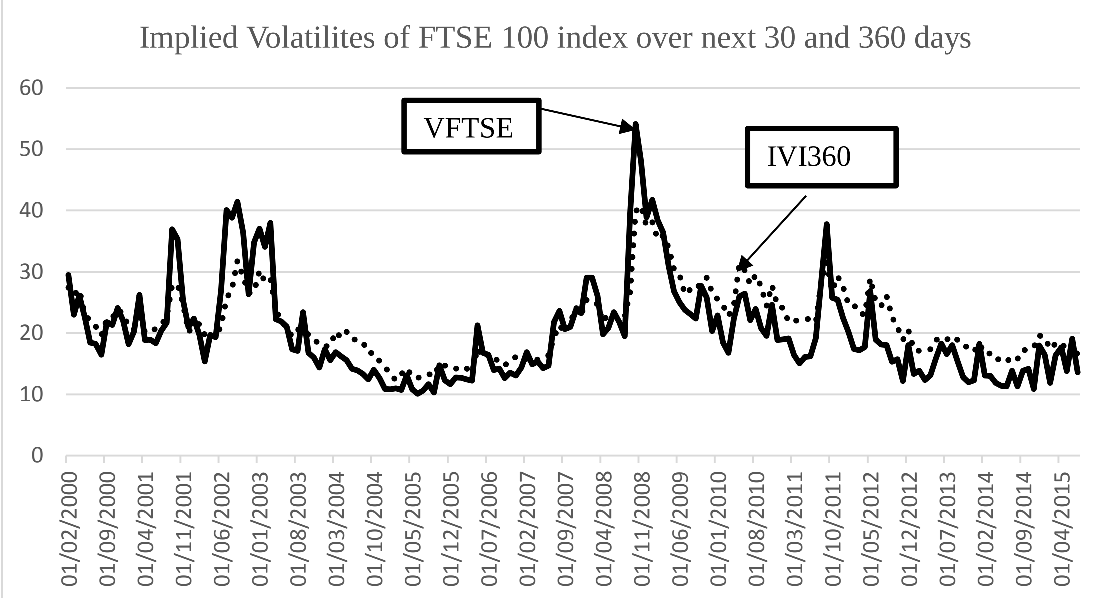


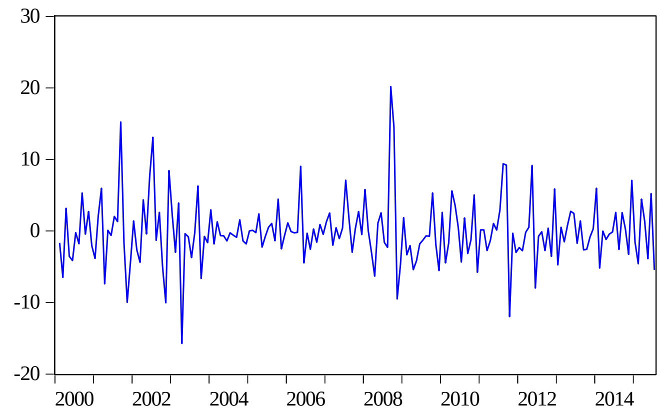

**Figure 5.1: Daily VFTSE Index**

Panel A




Panel B

D.VFTSE




D.IVI360

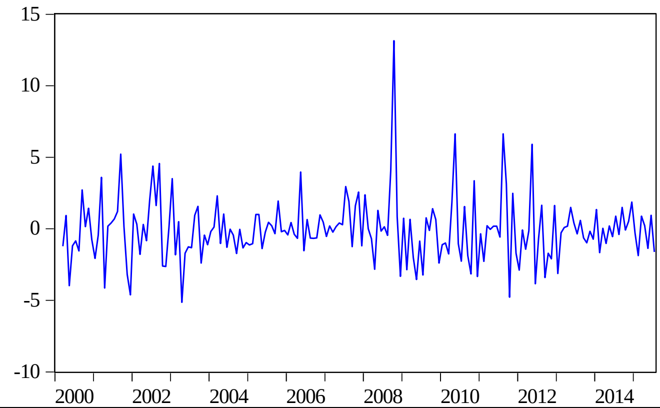



**Figure 5.2: The short and long term market implied volatilities**

## List of Tables

**Table 5.1: Descriptive Statistics: Sample Size: Feb 2000 – June 2015.**

| | Mean | Median | Std Dev. | Kurt | Skew | Count |
|---|---|---|---|---|---|---|
| Panel A | | | | | | |
| VFTSE | 20.19 | 18.30 | 8.00 | 2.29 | 1.44 | 185 |
| IVI360 | 21.68 | 21.06 | 5.66 | 0.65 | 0.79 | 185 |
| Panel B (Annualised) | | | | | | |
| FTSE 100 | 0.89 | 7.12 | 14.23 | 0.89 | -0.71 | 185 |
| FTSE 250 | 6.75 | 14.90 | 17.70 | 3.57 | -1.05 | 185 |
| Oil and Gas | 2.55 | 6.62 | 19.32 | 0.68 | -0.46 | 185 |
| Basic Materials | 4.70 | 13.04 | 26.67 | 4.67 | -1.11 | 185 |
| Industrials | 4.41 | 10.74 | 20.37 | 3.40 | -1.28 | 185 |
| Consumer Goods | 7.87 | 10.84 | 18.51 | 1.32 | -0.55 | 185 |
| Healthcare | 4.83 | 1.52 | 13.67 | 0.88 | 0.00 | 185 |
| Consumer Services | 1.51 | 8.49 | 16.71 | 2.03 | -0.92 | 185 |
| Telecom | -0.95 | 10.91 | 21.20 | 0.72 | -0.64 | 185 |
| Utilities | 8.08 | 12.24 | 12.55 | 0.46 | -0.69 | 185 |
| Financials | 0.61 | 5.04 | 20.64 | 3.69 | -0.67 | 185 |
| Technology | -8.60 | 7.33 | 32.50 | 2.10 | -1.09 | 185 |
| Panel C (Annualised) | | | | | | |
| SL | -0.83 | 8.26 | 23.51 | 1.33 | -0.61 | 185 |
| S2 | 7.10 | 10.12 | 19.38 | 0.73 | -0.13 | 185 |
| S3 | 7.82 | 13.01 | 19.26 | 2.51 | -0.03 | 185 |
| S4 | 11.13 | 12.79 | 18.84 | 3.60 | -0.33 | 185 |
| SH | 11.88 | 11.46 | 18.68 | 5.58 | 0.19 | 185 |
| S2L | -2.90 | 1.90 | 24.29 | 2.55 | -0.31 | 185 |
| S22 | 7.57 | 15.82 | 22.87 | 2.28 | -0.88 | 185 |
| S23 | 9.44 | 12.36 | 18.19 | 2.51 | -0.45 | 185 |
| S24 | 10.16 | 11.56 | 18.67 | 1.37 | -0.21 | 185 |
| S2H | 10.54 | 15.74 | 24.56 | 6.77 | 0.39 | 185 |
| M3L | 1.09 | 14.60 | 25.29 | 4.67 | -1.35 | 185 |
| M32 | 4.16 | 16.27 | 21.11 | 1.86 | -0.55 | 185 |
| M33 | 10.58 | 13.82 | 19.43 | 6.21 | -1.23 | 185 |
| M34 | 9.14 | 16.21 | 19.56 | 2.80 | -0.62 | 185 |
| M3H | 9.61 | 16.61 | 22.67 | 4.44 | 0.12 | 185 |
| B4L | 5.10 | 17.67 | 21.02 | 3.63 | -0.54 | 185 |
| B42 | 8.62 | 11.30 | 18.91 | 5.78 | -0.55 | 185 |
| B43 | 14.28 | 20.03 | 18.19 | 3.19 | -0.83 | 185 |
| B44 | 7.34 | 14.68 | 22.56 | 2.84 | -0.35 | 185 |
| B4H | 9.68 | 9.50 | 24.11 | 3.82 | -0.34 | 185 |
| BL | 0.49 | 2.48 | 12.92 | 0.70 | -0.47 | 185 |
| B2 | 3.48 | 10.25 | 14.05 | 1.36 | -0.85 | 185 |
| B3 | 5.99 | 8.37 | 18.14 | 1.47 | -0.62 | 185 |
| B4 | 5.53 | 12.13 | 18.53 | 1.47 | -0.49 | 185 |
| BH | 3.51 | 10.80 | 20.14 | 1.77 | -0.28 | 185 |

Table 5.1 continued

| Panel D (Annualised) | Mean | Median | Std Dev. | Kurt | Skew | Count |
|---|---|---|---|---|---|---|
| MKT | 1.71 | 10.00 | 14.40 | 1.19 | -0.80 | 185 |
| SMB | 3.10 | 1.29 | 11.84 | 2.81 | -0.08 | 185 |
| HML | 5.43 | 3.87 | 12.07 | 5.97 | -0.03 | 185 |
| UMD | 9.54 | 13.24 | 18.93 | 3.63 | -1.08 | 185 |

| Panel E (Annualised) | Mean (%) | Median (%) | SD (%) | Kurt | Skew | Count |
|---|---|---|---|---|---|---|
| Inflation | 2.39 | 2.31 | 0.95 | 0.89 | 0.30 | 185 |
| Unemployment | 3.44 | 3.10 | 0.84 | -1.26 | 0.57 | 185 |
| Narrow Money (M0) | 5.46 | 5.25 | 1.44 | 20.60 | -2.59 | 185 |
| Broad Money (M4) | 6.18 | 6.36 | 3.26 | 24.09 | 2.74 | 185 |
| Effective Exchange Rate | -0.69 | 0.01 | 5.02 | 3.92 | -0.95 | 185 |
| Term Spread* | 0.99 | 0.95 | 1.29 | -1.10 | 0.29 | 185 |
| CAY* | 0.004 | 0.00 | 0.02 | -0.79 | 0.08 | 185 |

| Panel F (Annualised) | Mean (%) | Median (%) | Std Dev (%). | Kurt | Skew | Count |
|---|---|---|---|---|---|---|
| $\Delta$RS | 2.24 | 2.59 | 1.05 | 2.01 | -0.38 | 185 |
| $\Delta$IIP | -0.75 | 0.00 | 0.95 | 4.19 | -0.99 | 185 |
| Consumer Confidence* | -8.16 | -5.10 | 8.96 | -0.24 | -0.73 | 185 |
| $\Delta$CLI | 0.14 | 0.16 | 0.25 | 2.53 | -0.30 | 185 |

Panel G

| | PE | | | | | DY | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Std Dev. | Kurt | Skew | Mean(%) | Median(%) | Std Dev.(%) | Kurt | Skew | Count |
| FTSE 100 | 15.05 | 14.06 | 4.51 | 1.43 | 1.17 | 3.32 | 3.32 | 0.60 | 2.06 | 0.45 | 185 |
| FTSE 250 | 18.86 | 18.76 | 3.27 | 1.43 | -0.22 | 2.76 | 2.63 | 0.55 | 4.90 | 1.92 | 185 |
| Oil and Gas | 13.48 | 13.03 | 4.70 | 5.02 | 1.52 | 3.36 | 3.21 | 0.72 | -0.20 | 0.68 | 185 |
| Basic Materials | 10.60 | 10.93 | 2.92 | -0.17 | -0.45 | 2.75 | 3.03 | 1.03 | -1.17 | -0.32 | 185 |
| Industrials | 17.63 | 17.03 | 3.92 | 1.91 | 1.05 | 3.07 | 2.84 | 0.82 | 1.71 | 1.25 | 185 |
| Consumer Goods | 15.57 | 15.33 | 3.54 | 1.42 | 0.49 | 3.37 | 3.20 | 0.91 | 3.64 | 1.45 | 185 |
| Healthcare | 17.37 | 16.25 | 5.15 | 0.91 | 1.10 | 3.48 | 3.32 | 0.86 | -1.31 | 0.05 | 185 |
| Consumer Services | 17.52 | 17.28 | 4.80 | -0.11 | 0.48 | 2.87 | 2.77 | 0.56 | 1.77 | 1.09 | 185 |
| Telecom | 20.96 | 13.16 | 18.10 | 1.59 | 1.60 | 3.72 | 4.09 | 1.73 | -1.21 | -0.13 | 185 |
| Utilities | 15.52 | 14.67 | 4.65 | 5.79 | 1.99 | 4.60 | 4.74 | 0.71 | -0.28 | -0.46 | 185 |
| Financials | 18.81 | 17.22 | 12.75 | 51.02 | 6.10 | 3.68 | 3.43 | 0.94 | 6.76 | 2.32 | 185 |
| Technology | 30.21 | 25.74 | 60.11 | 19.69 | 2.17 | 1.30 | 1.26 | 0.45 | 2.01 | 0.26 | 185 |

**Table 5.2: Impact of short and long term implied volatilities on the ERP of FTSE Indices**

Note: This table reports the results of regression (5.3). The dependent variables are the monthly ERPs of FTSE indices. Independent variables are the changes in the 30 days and 360 days market implied volatilities along with the first control group variables (valuation metrics). The figures in parentheses are Newey and West, (1987) heteroscedasticity and autocorrelation corrected t-statistics (pre-whitening with 5 lags) Adjusted sample size March 2000 to July 2015. *** represents significance at 1%, ** at 5% and * at 10%

| | $\alpha^i$ | $\Delta IV_{30}$ | $\Delta IV_{360}$ | $MKT$ | $DY^i$ | $PE^i$ | $TR_m$ | Adj.$R^2$ | F-stat |
|---|---|---|---|---|---|---|---|---|---|
| | | | | FTSE Aggregate Indices | | | | | |
| FTSE 100 | 6.23*** | -0.48*** | -0.48*** | | -1.13* | -0.16*** | -0.03*** | 60.06% | 56.33 |
| | (2.35) | (-11.03) | (-2.82) | | (-1.86) | (-2.37) | (-3.31) | | |
| FTSE 250 | 3.33 | -0.51*** | -0.69*** | | -1.85*** | 0.12 | -0.03* | 61.42% | 59.57 |
| | (1.22) | (-6.68) | (-4.32) | | (-3.29) | (1.30) | (-1.80) | | |
| | | | | FTSE All Share Sectoral Indices | | | | | |
| Basic Materials | -3.54** | -0.20** | -0.15 | 1.14*** | -0.80 | 0.56*** | 0.00 | 60.13% | 47.25 |
| | (-2.43) | (-2.16) | (-1.20) | (6.13) | (-1.42) | (2.96) | (-0.02) | | |
| Consumer Services | -0.71 | -0.07 | 0.05 | 0.97*** | 0.22 | 0.00 | -0.01 | 75.40% | 95.00 |
| | (-0.22) | (-0.59) | (0.29) | (11.86) | (0.32) | (0.02) | (-0.72) | | |
| Financials | 2.15* | 0.14 | -0.40*** | 1.20*** | -0.60** | 0.00 | 0.01 | 78.21% | 111.1 |
| | (1.78) | (1.30) | (-3.27) | (6.68) | (-2.05) | (-0.25) | (0.89) | | |
| Consumer Goods | 2.14 | -0.17 | 0.08 | 0.70*** | -0.38 | -0.02 | 0.00 | 40.08% | 21.51 |
| | (0.63) | (-1.45) | (0.41) | (11.12) | (-1.02) | (-0.13) | (-0.33) | | |
| Healthcare | -5.40*** | -0.11 | 0.27** | 0.45*** | 0.70** | 0.19*** | -0.03* | 26.55% | 12.08 |
| | (-2.89) | (-0.88) | (2.48) | (4.03) | (2.11) | (4.08) | (-1.78) | | |
| Industrials | 2.48 | -0.13 | 0.04 | 1.06*** | -0.70 | -0.01 | -0.01 | 70.09% | 72.87 |
| | (1.21) | (-1.43) | (0.39) | (14.86) | (-1.65) | (-0.13) | (-0.63) | | |
| Oil and Gas | 2.32* | -0.05 | 0.31 | 1.01*** | -1.25*** | 0.15*** | -0.02 | 57.48% | 42.46 |
| | (1.83) | (-0.31) | (0.77) | (8.63) | (-4.19) | (2.63) | (-0.99) | | |
| Utilities | 4.56*** | 0.15 | -0.16 | 0.49*** | -0.80** | -0.02 | -0.04*** | 31.37% | 15.02 |
| | (2.85) | (1.21) | (-0.56) | (8.16) | (-2.28) | (-0.59) | (-3.23) | | |
| Telecom | 2.87* | -0.14 | 0.26 | 0.89*** | -0.32 | -0.09*** | 0.01 | 41.81% | 23.04 |
| | (1.86) | (-0.97) | (1.44) | (3.85) | (-1.21) | (-3.59) | (0.32) | | |
| Technology | -7.13*** | 0.17 | -0.24 | 1.76*** | 4.75*** | 0.00 | 0.07** | 52.76% | 35.25 |
| | (-3.22) | (0.77) | (-0.77) | (6.98) | (3.33) | (-0.85) | (2.29) | | |

**Table 5.3: Impact of short and long term implied volatilities on ERP of FTSE indices**

Note: This table reports the results of regression (5.4). The dependent variables are the monthly ERPs of FTSE indices. Independent variables are the changes in the 30 days and 360 days' market implied volatilities along with the second control group variables (macroeconomic factors). The figures in parentheses are Newey and West, (1987) heteroscedasticity and autocorrelation corrected t-statistics (pre-whitening with 5 lags) Adjusted sample size March 2000 to July 2015. *** represents significance at 1%, ** at 5% and * at 10%.

| | $\alpha^i$ | $\Delta IV_{30}$ | $\Delta IV_{360}$ | $MKT$ | $\pi$ | $U$ | $\Delta M0$ | $\Delta M4$ | $\Delta ER$ | $TS$ | $CAY$ | Adj.$R^2$ | F-stat |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | FTSE Aggregate Indices | | | | | | | | |
| FTSE 100 | -1.72 | -0.50$^{***}$ | -0.41$^{*}$ | | -0.68$^{***}$ | 1.11$^{***}$ | -0.95 | -0.15 | -0.15 | -0.46 | 20.51 | 59.87 | 31.51 |
| | (-1.16) | (-7.81) | (-1.63) | | (-2.98) | (2.83) | (-1.24) | (-0.95) | (-0.81) | (-0.85) | (1.15) | | |
| FTSE 250 | -2.68$^{*}$ | -0.49$^{***}$ | -0.77$^{***}$ | | -0.99$^{***}$ | 1.63$^{***}$ | -0.18 | -0.25 | -0.14 | -1.60 | 34.76$^{***}$ | 58.74 | 30.11 |
| | (-1.79) | (-5.69) | (-4.30) | | (-3.00) | (3.33) | (-0.28) | (-1.00) | (-0.94) | (-1.56) | (2.24) | | |
| | | | | | FTSE All Share Sectoral Indices | | | | | | | | |
| Basic Materials | 0.69 | -0.20 | -0.14 | 1.12$^{***}$ | -1.06 | 0.63 | -0.57 | 0.06 | -0.04 | -0.63 | 24.01 | 55.14 | 23.61 |
| | (0.06) | (-1.08) | (-0.96) | (4.05) | (-0.80) | (0.26) | (-0.59) | (0.09) | (-0.10) | (-0.15) | (0.30) | | |
| Consumer Services | -1.17 | -0.07 | 0.05 | 0.97$^{***}$ | 0.03 | 0.19 | 0.85 | 0.07 | -0.02 | -1.17 | -1.85 | 75.52 | 57.78 |
| | (-0.93) | (-0.70) | (0.30) | (13.74) | (0.15) | (0.48) | (1.62) | (0.42) | (-0.17) | (-1.64) | (-0.150 | | |
| Financials | 1.42 | 0.17 | -0.43$^{***}$ | 1.23$^{***}$ | -0.20 | -0.31 | 0.49 | -0.29 | 0.24$^{*}$ | -1.03 | -17.24 | 78.29 | 67.34 |
| | (0.88) | (1.08) | (-2.57) | (6.96) | (-0.55) | (-0.55) | (0.95) | (-1.01) | (1.84) | (-1.34) | (-1.07) | | |
| Consumer Goods | 1.21 | -0.16 | 0.09 | 0.75$^{***}$ | 0.68 | -0.56 | -0.80 | 0.17 | 0.05 | -0.45 | -14.42 | 39.49 | 13.01 |
| | (0.65) | (-1.35) | (0.44) | (8.27) | (1.63) | (-0.82) | (-0.85) | (0.66) | (0.19) | (-0.40) | -0.79 | | |
| Healthcare | -0.06 | -0.16 | 0.27 | 0.43$^{***}$ | 0.33 | -0.02 | -0.59 | 0.19 | -0.17 | -3.52$^{***}$ | -10.44 | 24.64 | 7.02 |
| | (-0.03) | (-1.46) | (1.37) | (3.15) | (0.73) | (-0.04) | (-0.81) | (0.49) | (-0.87) | (-4.32) | (-0.52) | | |
| Industrials | -1.78 | -0.09 | 0.03 | 1.12$^{***}$ | 0.01 | 0.54 | 0.13 | -0.13 | 0.00 | 0.15 | 26.29$^{*}$ | 69.08 | 42.10 |
| | (-1.17) | (-0.72) | (0.20) | (12.60) | (0.03) | (1.08) | (0.15) | (-0.43) | (0.03) | (0.17) | (1.81) | | |
| Oil and Gas | 1.28 | 0.02 | 0.21 | 1.06$^{***}$ | 0.20 | -0.48 | -0.29 | 0.25 | -0.43$^{**}$ | 3.31$^{**}$ | -4.81 | 55.72 | 24.15 |
| | (0.73) | (0.14) | (0.69) | (8.07) | (0.52) | (-0.86) | (-0.33) | (1.24) | (-2.01) | (2.49) | (-0.32) | | |
| Utilities | 1.89 | 0.10 | -0.12 | 0.50$^{***}$ | 0.41 | -0.50 | -0.87 | -0.13 | -0.01 | -3.75$^{***}$ | -9.03 | 30.86 | 9.21 |
| | (1.35) | (0.80) | (-0.51) | (5.81) | (1.60) | (-1.110 | (-1.20) | (-0.77) | (-0.07) | (-3.31) | (-0.710 | | |
| Telecom | -1.61 | -0.07 | 0.32$^{*}$ | 1.00$^{***}$ | 0.22 | 0.20 | 0.36 | -0.05 | 0.24 | 0.83 | 10.39 | 37.12 | 11.86 |
| | (-0.56) | (-0.48) | (1.68) | (5.46) | (0.51) | (0.23) | (0.380 | (-0.17) | (0.66) | (0.50) | (0.35) | | |
| Technology | -10.68$^{**}$ | 0.05 | -0.18 | 1.59$^{***}$ | 0.79 | 1.82 | 2.13 | 0.40 | 0.91$^{***}$ | 1.75 | 78.70$^{*}$ | 50.30 | 19.62 |
| | (-2.23) | (0.20) | (-0.62) | (6.62) | (1.10) | (1.32) | (1.61) | (0.65) | (3.37) | (0.90) | (1.75) | | |

**Table 5.4: Impact of short and long term implied volatilities on the ER of FTSE indices**

Note: This table reports the results of regression (5.6). The dependent variables are the monthly ERPs of FTSE indices. Independent variables are the changes in the 30 days and 360 days market implied volatilities along with the third control group variables (leading economic indicators). The figures in parentheses are Newey and West, (1987) heteroscedasticity and autocorrelation corrected t-statistics (pre-whitening with 5 lags) Adjusted sample size March 2000 to July 2015. *** represents significance at 1%, ** at 5% and * at 10% .

| | $\alpha^i$ | $\Delta IV_{30}$ | $\Delta IV_{360}$ | $MKT$ | ΔRS | $\Delta IIP$ | $CC$ | $\Delta CLI$ | Adj.$R^2$ | F-stat |
|---|---|---|---|---|---|---|---|---|---|---|
| FTSE 100 | -0.44 | -0.49*** | -0.41** | | 0.22 | 0.49** | -0.01 | 2.53*** | 61.56% | 50.11 |
| | (-1.28) | (-8.29) | (-2.11) | | (1.39) | (2.220 | (-0.48) | (3.54) | | |
| FTSE 250 | -0.36 | -0.49*** | -0.72*** | | 0.24 | 0.72*** | -0.03 | 4.10*** | 61.69% | 50.38 |
| | (-0.92) | (-6.44) | (-4.32) | | (1.00) | (2.62) | (-1.47) | (7.07) | | |
| Basic Materials | 0.06 | -0.25 | -0.12 | 1.03*** | -0.06 | 0.48 | 0.05 | 4.10 | 57.30% | 36.28 |
| | (0.06) | (-1.54) | (-0.85) | (7.95) | (-0.15) | (0.96) | (0.790 | (1.54) | | |
| Consumer Services | -0.39 | -0.09 | 0.06 | 0.94*** | 0.05 | 0.23 | -0.03 | 0.65 | 75.61% | 82.48 |
| | (-1.22) | (-0.84) | (0.39) | (15.55) | (0.27) | (1.45) | (-1.43) | (0.74) | | |
| Financials | -0.23 | 0.14 | -0.42*** | 1.16*** | 0.26 | 0.14 | 0.02 | 1.98** | 78.46% | 96.77 |
| | (-1.12) | (1.43) | (-2.95) | (10.33) | (1.24) | (0.83) | (1.61) | (2.17) | | |
| Consumer Goods | 0.44 | -0.16 | 0.06 | 0.72*** | 0.08 | 0.19 | -0.02 | -0.25 | 39.54% | 18.19 |
| | (1.16) | (-1.26) | (0.31) | (7.97) | (0.33) | (0.63) | (-0.62) | (-0.19) | | |
| Healthcare | 0.34 | -0.09 | 0.23** | 0.48*** | 0.16 | -0.11 | -0.02 | -0.99 | 21.19% | 8.07 |
| | (0.91) | (-0.99) | (2.00) | (3.71) | (1.06) | (-0.47) | (-0.82) | (-0.73) | | |
| Industrials | 0.04 | -0.09 | 0.05 | 1.13*** | 0.01 | 0.16 | -0.02 | -0.12 | 69.17% | 59.98 |
| | (0.12) | (-0.88) | (0.30) | (12.76) | (0.06) | (0.79) | (-1.25) | (-0.16) | | |
| Oil and Gas | 0.51 | -0.01 | 0.19 | 1.08*** | -0.13 | -0.11 | 0.01 | -2.16** | 52.57% | 30.14 |
| | (1.17) | (-0.09) | (0.46) | (9.27) | (-0.56) | (-0.37) | (0.35) | (-2.09) | | |
| Utilities | 0.90*** | 0.16 | -0.13 | 0.56*** | -0.15 | -0.01 | 0.02 | -1.08 | 25.23% | 9.87 |
| | (3.03) | (1.19) | (-0.45) | (7.02) | (-0.73) | (-0.06) | (0.58) | (-1.56) | | |
| Telecom | 0.04 | -0.04 | 0.31* | 1.07*** | -0.17 | -0.21 | -0.01 | -2.12 | 38.68% | 17.58 |
| | (0.07) | (-0.23) | (1.66) | (5.51) | (-0.58) | (-0.53) | (-0.190 | (-1.25) | | |
| Technology | -1.87 | 0.12 | -0.14 | 1.67*** | -0.21 | -0.03 | -0.15 | -2.73 | 49.68% | 26.95 |
| | (-1.21) | (0.68) | (-0.41) | (2.88) | (-0.61) | (-0.07) | (-1.59) | (-0.95) | | |

**Table 5.5:Impact of short and long term implied volatility on the ERP of FTSE indices**

Note: This table reports the impact of $\Delta IV_{30}$ and $\Delta IV_{360}$ on the excess returns of aggregate FTSE indices after controlling for all the variables from the three control group variables together. Panel A uses changes in VFTSE and IVI360 implied volatility as proxies of innovations in short and long term implied volatility. Panel B uses the residuals of ARMA (1, 1) models for VFTSE and IVI360 as proxy of innovations in the short and long-term implied volatility. The reported t-statistics are corrected for heteroscedasticity and autocorrelation (Newey and West, 1987) pre-whitening with 5 lags. Adjusted sample size, March 2000 to July 2015. *** represents significance at 1%, ** at 5% and * at 10%

| | Panel A | | | | Panel B | | | |
|---|---|---|---|---|---|---|---|---|
| | FTSE 100 | t-stat | FTSE 250 | t-stat | FTSE 100 | t-stat | FTSE 250 | t-stat |
| $\alpha^i$ | 4.25*** | (2.09) | 4.72 | (1.26) | 0.04 | (0.02) | 2.61 | (0.78) |
| $\Delta IV_{30}$ | -0.48*** | (-9.08) | -0.49*** | (-6.71) | -0.56*** | (-9.55) | -0.59*** | (-7.65) |
| $\Delta IV_{360}$ | -0.37* | (-1.77) | -0.61*** | (-4.03) | -0.30 | (-1.45) | -0.49*** | (-3.10) |
| $DY^i$ | -1.02*** | (-2.77) | -2.23*** | (-4.20) | -0.20 | (-0.66) | -1.19** | (-2.53) |
| $PE^i$ | -0.21*** | (-4.11) | 0.01 | (0.11) | -0.09** | (-2.31) | -0.003 | (-0.03) |
| $TR_m$ | -0.03*** | (-3.89) | -0.02 | (-1.60) | -0.03*** | (-3.50) | -0.02 | (-1.38) |
| $\pi$ | 0.03 | (0.08) | -0.12 | (-0.21) | 0.14 | (0.57) | -0.05 | (-0.09) |
| $U$ | 0.68 | (1.57) | 0.02 | (0.03) | 0.45 | (1.35) | -0.07 | (-0.10) |
| $\Delta M0$ | -0.51 | (-0.77) | 0.43 | (0.72) | -0.52 | (-1.25) | -0.28 | (-0.41) |
| $\Delta M4$ | -0.01 | (-0.02) | -0.13 | (-0.55) | 0.04 | (0.15) | -0.07 | (-0.30) |
| $\Delta ER$ | -0.24 | (-1.15) | -0.32** | (-2.13) | -0.28 | (-1.28) | -0.40*** | (-2.69) |
| $TS$ | 0.03 | (0.05) | -1.04 | (-1.10) | 0.07 | (0.10) | -1.16 | (-1.19) |
| $CAY$ | 11.91 | (0.97) | 21.01 | (1.43) | 2.55 | (0.25) | 7.33 | (0.50) |
| $RS$ | 0.27* | (1.95) | 0.32 | (1.43) | 0.28** | (2.00) | 0.25 | (1.08) |
| $IIP$ | 0.29 | (1.29) | 0.49* | (1.86) | 0.27 | (1.08) | 0.53* | (1.93) |
| $CC$ | 0.05** | (2.22) | -0.11** | (-2.05) | 0.01 | (0.31) | -0.12** | (-2.09) |
| $CLI$ | 3.29*** | (2.84) | 4.86*** | (2.56) | 3.00** | 2.16 | 4.91*** | (2.62) |
| Adj.R2 | 34.53% | | 65.98% | | 66.73% | | 65.51% | |
| F-statistics | 7.10*** | | 23.31*** | | 24.19*** | | 22.96*** | |

**Table 5.6: Factor loadings on the ERP of the 25 Size and book-to-market sorted portfolios**

Note: This table reports the factor loadings from regression (5.7) of the ERP of each size-book-to-market portfolio on $\Delta IV30$ $\Delta IV360$ and the market factor. The associated t-statistics are Newey and West, (1987) heteroscedasticity and autocorrelation corrected (pre-whitening with 5 lags). Adjusted sample size March 2000 to July 2015. *** represents significance at 1%, ** at 5% and * at 10%.

| | Loadings on $\Delta IV30$ | | | | | | t-statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | $0.33^{**}$ | 0.08 | 0.06 | -0.11 | -0.09 | 0.05 | 1.98 | 0.55 | 0.35 | -0.93 | -1.20 |
| BM2 | 0.17 | 0.19 | 0.09 | 0.05 | $-0.14^{*}$ | 0.07 | 1.11 | 1.16 | 0.48 | 0.32 | -1.71 |
| BM3 | $0.20^{*}$ | 0.16 | 0.13 | -0.05 | -0.06 | 0.08 | 1.71 | 1.53 | 1.10 | -0.57 | -0.52 |
| BM4 | $0.25^{*}$ | $0.02^{*}$ | 0.08 | 0.02 | 0.01 | 0.07 | 1.70 | 0.09 | 0.52 | 0.25 | 0.10 |
| Value | 0.17 | $0.45^{**}$ | $0.23^{*}$ | 0.19 | -0.01 | 0.21 | 0.86 | 2.39 | 1.75 | 1.52 | -0.13 |
| Average | 0.22 | 0.18 | 0.12 | 0.02 | -0.06 | | | | | | |
| | Loadings on changes in IVI360 | | | | | | t-statistics | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | -0.57 | $-0.10^{**}$ | -0.09 | -0.11 | $0.22^{**}$ | -0.13 | -2.26 | -0.40 | -0.47 | -0.66 | 2.03 |
| BM2 | $-0.62^{***}$ | $-0.55^{***}$ | $-0.54^{**}$ | -0.34 | 0.18 | -0.37 | -4.10 | -2.72 | -2.08 | -1.24 | 1.17 |
| BM3 | $-0.78^{***}$ | $-0.55^{***}$ | $-0.76^{***}$ | $-0.38^{*}$ | 0.11 | -0.47 | -4.50 | -3.29 | -2.46 | -1.90 | 0.87 |
| BM4 | $-0.72^{***}$ | -0.12 | -0.27 | -0.40 | -0.02 | -0.31 | -3.23 | -0.37 | -1.26 | -1.30 | -0.19 |
| Value | $-0.62^{***}$ | $-0.79^{**}$ | -0.54 | $-0.60^{**}$ | 0.31 | -0.45 | -2.54 | -2.39 | -1.63 | -2.42 | 1.51 |
| Average | -0.66 | -0.42 | -0.44 | -0.36 | 0.16 | | | | | | |
| | Loadings on Market Factor | | | | | | t-statistics | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | $1.12^{***}$ | $1.06^{***}$ | $1.20^{***}$ | $0.98^{***}$ | $0.70^{***}$ | 1.01 | 7.41 | 6.74 | 7.52 | 8.84 | 10.40 |
| BM2 | $0.67^{***}$ | $1.06^{***}$ | $0.89^{***}$ | $1.21^{***}$ | $1.02^{***}$ | 0.97 | 5.96 | 7.39 | 5.47 | 10.50 | 8.16 |
| BM3 | $0.77^{***}$ | $0.81^{***}$ | $0.88^{***}$ | $0.87^{***}$ | $1.08^{***}$ | 0.88 | 8.89 | 6.59 | 9.16 | 7.82 | 12.85 |
| BM4 | $0.83^{***}$ | $0.85^{***}$ | $1.11^{***}$ | $0.91^{***}$ | $0.83^{***}$ | 0.91 | 6.04 | 6.06 | 9.06 | 7.84 | 11.60 |
| Value | $0.84^{***}$ | $1.28^{***}$ | $1.10^{***}$ | $1.26^{***}$ | $1.11^{***}$ | 1.12 | 3.40 | 4.32 | 5.12 | 6.40 | 7.62 |
| Average | 0.85 | 1.01 | 1.04 | 1.04 | 0.95 | | | | | | |
| | Adjusted R-squared | | | | | | F-statistics | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | | | | | | |
| Growth | 43.81% | 39.48% | 45.94% | 63.40% | 57.74% | | 48.56 | 40.79 | 52.84 | 106.67 | 84.34 |
| BM2 | 34.20% | 48.30% | 57.70% | 66.99% | 67.78% | | 32.70 | 57.98 | 84.19 | 124.78 | 129.35 |
| BM3 | 47.61% | 50.60% | 63.33% | 69.51% | 72.48% | | 56.44 | 63.49 | 106.33 | 140.09 | 161.68 |
| BM4 | 48.20% | 44.65% | 60.80% | 62.08% | 70.75% | | 57.77 | 50.20 | 95.63 | 100.85 | 148.52 |
| Value | 51.95% | 51.83% | 49.95% | 62.90% | 50.45% | | 66.94 | 66.62 | 61.88 | 104.42 | 63.12 |

**Table 5.7: Loading on the ERP of the 25 Size and book-to-market sorted portfolios**

Note: This table reports the factor loadings from regression (5.8) of the ERP of each size-book-to-market portfolio on $\Delta IV30$ $\Delta IV360$, the market factor, size, value and momentum premiums. The associated t-statistics are Newey and West, (1987) heteroscedasticity and autocorrelation corrected (pre-whitening with 5 lags). Adjusted sample size March 2000 to July 2015. *** represents significance at 1%, ** at 5% and * at 10%

| Loadings on changes in VFTSE | | | | | | | t-statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | 0.159 | -0.037 | -0.024 | -0.161$^{*}$ | 0.006 | -0.011 | 1.535 | -0.286 | -0.262 | -1.851 | 0.073 |
| BM2 | 0.023 | 0.031 | -0.074 | -0.102 | -0.153$^{*}$ | -0.055 | 0.302 | 0.307 | -0.783 | -0.811 | -1.806 |
| BM3 | 0.019 | 0.014 | -0.025 | -0.157$^{**}$ | -0.059 | -0.042 | 0.261 | 0.152 | -0.405 | -2.017 | -0.660 |
| BM4 | 0.049 | -0.196$^{**}$ | -0.028 | -0.084 | 0.068 | -0.038 | 0.595 | -1.966 | -0.295 | -0.865 | 1.182 |
| Value | -0.049 | 0.190$^{*}$ | -0.007 | 0.044 | 0.077 | 0.051 | -0.877 | 1.913 | -0.100 | 0.568 | 0.640 |
| Average | 0.040 | 0.000 | -0.031 | -0.092 | -0.012 | | | | | | |
| Loadings on changes in IVI360 | | | | | | | t-statistics | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | -0.095 | 0.227 | 0.178$^{*}$ | 0.035 | -0.028 | 0.063 | -0.728 | 0.976 | 1.697 | 0.235 | -0.236 |
| BM2 | -0.218 | -0.058 | -0.078 | 0.112 | 0.206 | -0.007 | -1.223 | -0.314 | -0.412 | 0.804 | 1.392 |
| BM3 | -0.262 | -0.147$^{**}$ | -0.347 | -0.100$^{*}$ | 0.084 | -0.154 | -2.177 | -1.077 | -1.783 | -0.784 | 0.791 |
| BM4 | -0.153 | 0.458$^{**}$ | 0.048 | -0.113 | -0.195$^{*}$ | 0.009 | -1.051 | 2.361 | 0.287 | -0.505 | -1.787 |
| Value | -0.002 | -0.055 | 0.128 | -0.144 | 0.099 | 0.005 | -0.014 | -0.257 | 1.102 | -0.701 | 0.632 |
| Average | -0.146 | 0.085 | -0.014 | -0.042 | 0.033 | | | | | | |
| Loadings on Market Factor | | | | | | | t-statistics | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | 1.09$^{***}$ | 1.08$^{***}$ | 1.22$^{***}$ | 1.01$^{***}$ | 0.76$^{***}$ | 1.03 | 7.74 | 9.82 | 8.79 | 10.58 | 9.97 |
| BM2 | 0.64$^{***}$ | 0.97$^{***}$ | 0.78$^{***}$ | 1.10$^{***}$ | 1.01$^{***}$ | 0.90 | 5.93 | 8.58 | 13.70 | 14.44 | 7.92 |
| BM3 | 0.69$^{***}$ | 0.74$^{***}$ | 0.81$^{***}$ | 0.83$^{***}$ | 1.11$^{***}$ | 0.84 | 9.48 | 6.93 | 12.23 | 9.10 | 14.40 |
| BM4 | 0.73$^{***}$ | 0.76$^{***}$ | 1.09$^{***}$ | 0.86$^{***}$ | 0.88$^{***}$ | 0.86 | 9.02 | 8.59 | 13.33 | 11.19 | 19.21 |
| Value | 0.70$^{***}$ | 1.11$^{***}$ | 0.94$^{***}$ | 1.11$^{***}$ | 1.06$^{***}$ | 0.98 | 11.55 | 11.58 | 8.87 | 10.65 | 7.06 |
| Average | 0.77 | 0.93 | 0.97 | 0.98 | 0.96 | | | | | | |
| Loadings on Size Premium (SMB) | | | | | | | t-statistics | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | 0.97$^{***}$ | 0.86$^{***}$ | 0.82$^{***}$ | 0.44$^{***}$ | -0.25$^{***}$ | 0.57 | 10.55 | 9.89 | 10.30 | 7.14 | -6.99 |
| BM2 | 0.86$^{***}$ | 0.93$^{***}$ | 0.66$^{***}$ | 0.66$^{***}$ | -0.04 | 0.62 | 12.24 | 13.71 | 7.30 | 10.61 | -0.47 |
| BM3 | 0.89$^{***}$ | 0.68$^{***}$ | 0.69$^{***}$ | 0.40$^{***}$ | -0.04 | 0.52 | 15.83 | 6.69 | 7.99 | 6.58 | -0.56 |
| BM4 | 0.92$^{***}$ | 0.91$^{***}$ | 0.73$^{***}$ | 0.48$^{***}$ | -0.21$^{***}$ | 0.56 | 15.62 | 15.50 | 14.85 | 4.35 | -5.67 |
| Value | 0.91$^{***}$ | 1.01$^{***}$ | 0.93$^{***}$ | 0.57$^{***}$ | -0.55$^{***}$ | 0.58 | 16.13 | 11.69 | 13.57 | 7.56 | -5.59 |
| Average | 0.91 | 0.88 | 0.77 | 0.51 | -0.22 | | | | | | |
| Loadings on Value Premium (HML) | | | | | | | t-statistics | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | -0.30$^{***}$ | -0.71$^{***}$ | -0.93$^{***}$ | -0.48$^{***}$ | -0.55$^{***}$ | -0.59 | -2.32 | -6.46 | -4.55 | -4.57 | -7.62 |
| BM2 | -0.37$^{***}$ | -0.20$^{***}$ | 0.36$^{***}$ | 0.32$^{***}$ | 0.23$^{***}$ | 0.07 | -4.27 | -2.59 | 4.13 | 3.97 | 2.67 |
| BM3 | 0.09 | 0.10 | 0.15$^{**}$ | 0.28$^{***}$ | 0.05 | 0.13 | 1.11 | 1.06 | 2.01 | 3.77 | 0.58 |
| BM4 | 0.23$^{***}$ | 0.34$^{***}$ | -0.47$^{***}$ | 0.07 | -0.23$^{***}$ | -0.01 | 2.62 | 3.25 | -7.29 | 1.06 | -4.56 |
| Value | 0.43$^{***}$ | 0.72$^{***}$ | 0.66$^{***}$ | 0.54$^{***}$ | 0.35$^{***}$ | 0.54 | 10.12 | 6.53 | 6.41 | 5.40 | 2.55 |
| Average | 0.02 | 0.05 | -0.05 | 0.15 | -0.03 | | | | | | |

**Table 5.7 continued**.

| | Loadings on Momentum Premium (UMD) | | | | | | t-statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Small | Size 2 | Size 3 | Size 4 | Large | Average | | | | | |
| Growth | 0.037 | -0.005 | -0.118 | 0.015 | -0.095*** | -0.033 | 0.516 | -0.089 | -1.128 | 0.350 | -2.307 |
| BM2 | -0.016 | -0.153*** | -0.036 | -0.056 | 0.070 | -0.038 | -0.282 | -4.675 | -0.841 | -1.447 | 1.286 |
| BM3 | -0.009 | -0.003 | 0.041 | 0.083* | 0.126 | 0.048 | -0.212 | -0.047 | 0.728 | 1.772 | 0.041 |
| BM4 | -0.007 | 0.065 | -0.085** | 0.005 | 0.011 | -0.002 | -0.150 | 1.478 | -2.033 | 0.149 | 0.289 |
| Value | -0.038 | -0.021 | 0.007 | -0.144 | -0.177 | -0.074 | -1.529 | -0.509 | 0.231 | -1.434 | -1.625 |
| Average | -0.007 | -0.023 | -0.038 | -0.019 | -0.013 | -0.020 | | | | | |
| | Adjusted R-squared | | | | | | F-statistics | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | | | | | | |
| Growth | 70.73% | 71.85% | 78.91% | 78.14% | 77.02% | | 71.29 | 78.86 | 115.13 | 110.01 | 103.25 |
| BM2 | 67.50% | 72.59% | 75.56% | 80.24% | 69.02% | | 64.35 | 81.78 | 95.28 | 124.86 | 68.96 |
| BM3 | 74.72% | 68.43% | 78.59% | 76.27% | 73.52% | | 91.14 | 67.10 | 112.99 | 99.01 | 85.69 |
| BM4 | 78.52% | 74.58% | 84.17% | 69.71% | 76.17% | | 112.49 | 90.49 | 163.21 | 71.20 | 98.49 |
| Value | 87.05% | 80.77% | 78.12% | 78.24% | 68.60% | | 205.93 | 129.12 | 109.93 | 110.66 | 67.62 |

**Table 5.8: Pricing of the innovations in short and long term market implied volatilities in the cross - section of 25 Size and Book-to-market sorted portfolios**

Note: This table reports the second stage Fama and Macbeth, (1973) cross-sectional regressions for the size and book-to-market sorted portfolios. Columns (1) and (2) present the estimates of cross-sectional regressions (5.9) and (5.10) respectively. Columns (3) and (4) are the re-estimates of cross-sectional regressions similar to (5.9) and (5.10), but by using ARMA (1,1) residuals for each of the VFTSE and IVI360 as proxies of innovations in short and long term market implied volatilities respectively. MKT, SMB, HML and UMD are market, size, value and momentum factors respectively. VFTSE and IVI360 are innovations in short and long term market implied volatilities respectively. The figures in parentheses are heteroscedasticity and autocorrelation corrected t-statistics. *** represents significance at 1%, ** at 5% and * at 10%

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $\gamma_0$ | 0.12 | 0.60*** | 0.13 | 0.48** |
| | (0.55) | (3.38) | (0.51) | (2.49) |
| VFTSE | -1.95* | -1.73*** | -0.97 | -1.75*** |
| | (-1.95) | (-3.81) | (-1.07) | (-4.78) |
| IVI360 | -1.30*** | -0.81*** | -1.00*** | -0.70*** |
| | (-3.79) | (-5.99) | (-3.65) | (-6.12) |
| MKT | 0.18 | -0.22 | 0.20 | -0.08 |
| | (0.90) | (-1.18) | (0.82) | (-0.40) |
| SMB | | 0.16** | | 0.13*** |
| | | (2.41) | | (2.61) |
| HML | | 0.71*** | | 0.69*** |
| | | (6.44) | | (8.57) |
| UMD | | -0.43 | | -0.55 |
| | | (-0.73) | | (-1.05) |

**Table 5.9: Factor risk premia of the 25 Fama-French portfolios sorted on size and book-to-market characteristics**

Note: This table reports the risk premia associated with changes in short and long term implied volatilities along with the market return. The risk premia are calculated by multiplying the factor loading from table 5.6 with prices of risk from table 5.8 column 1.

| | Small | Size 2 | Size 3 | Size 4 | Large | Avg |
|---|---|---|---|---|---|---|
| Panel A: Changes in VFTSE | | | | | | |
| Growth | -0.65 | -0.16 | -0.12 | 0.21 | 0.18 | -0.11 |
| BM2 | -0.33 | -0.38 | -0.17 | -0.11 | 0.27 | -0.14 |
| BM3 | -0.40 | -0.31 | -0.25 | 0.10 | 0.11 | -0.15 |
| BM4 | -0.49 | -0.03 | -0.15 | -0.04 | -0.01 | -0.14 |
| Value | -0.33 | -0.88 | -0.45 | -0.38 | 0.03 | -0.40 |
| Average | -0.44 | -0.35 | -0.23 | -0.04 | 0.11 | |
| Panel B: Changes in IVI360 | | | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | |
| Growth | 0.74 | 0.13 | 0.12 | 0.14 | -0.29 | 0.17 |
| BM2 | 0.81 | 0.72 | 0.70 | 0.44 | -0.24 | 0.49 |
| BM3 | 1.02 | 0.72 | 0.99 | 0.49 | -0.14 | 0.62 |
| BM4 | 0.94 | 0.16 | 0.35 | 0.52 | 0.03 | 0.40 |
| Value | 0.80 | 1.02 | 0.70 | 0.78 | -0.40 | 0.58 |
| Average | 0.86 | 0.55 | 0.57 | 0.47 | -0.21 | |
| Panel C: Market Risk Premium | | | | | | |
| | Small | Size 2 | Size 3 | Size 4 | Large | |
| Growth | 0.20 | 0.19 | 0.22 | 0.18 | 0.13 | 0.18 |
| BM2 | 0.12 | 0.19 | 0.16 | 0.22 | 0.18 | 0.18 |
| BM3 | 0.14 | 0.15 | 0.16 | 0.16 | 0.19 | 0.16 |
| BM4 | 0.15 | 0.15 | 0.20 | 0.16 | 0.15 | 0.16 |
| Value | 0.15 | 0.23 | 0.20 | 0.23 | 0.20 | 0.20 |
| Average | 0.15 | 0.18 | 0.19 | 0.19 | 0.17 | |

**Table 5.10: Pricing of the innovations in short and long term market implied volatilities in the cross-section of 25 size and book-to-market sorted portfolios**

Note: This table reports the second stage Fama and Macbeth, (1973) cross-sectional regressions for the size and book-to-market sorted portfolios. Columns (1) and (2) present the estimates of cross-sectional regressions after controlling for business cycle and leading economic indicators respectively. Columns (3) and (4) are the re-estimates of cross-sectional regressions, but by using ARMA (1,1) residuals for each of the VFTSE and IVI360 as proxies of innovations in short and long term market implied volatilities respectively. Market factor is the market risk premium. The various control factors are self-explanatory. *CAY* is the residuals of the contiegrating equation (3). The figures in parentheses are heteroscedasticity and autocorrelation corrected t-statistics. *** represents significance at 1%, ** at 5% and * at 10%

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $\gamma_0$ | 0.44* | 0.17 | 0.38* | 0.13 |
| | (1.92) | (0.92) | (1.68) | (0.59) |
| VFTSE | -1.80* | -2.39** | -1.01 | -1.76** |
| | (-1.78) | (-2.42) | (-1.60) | (-2.08) |
| IV360 | -1.08*** | -0.87** | -0.93*** | -0.78** |
| | (-3.35) | (-2.37) | (-3.27) | (-2.12) |
| Market Factor | -0.08 | 0.26 | 0.02 | 0.37 |
| | (-0.35) | (1.43) | (0.08) | (1.69) |
| Inflation | -0.21 | | -0.11 | |
| | (-0.93) | | (-0.50) | |
| Unemployment | 0.07 | | 0.16 | |
| | (0.28) | | (0.63) | |
| Changes in Narrow Money Supply (ΔM0) | 0.14* | | 0.15** | |
| | (1.81) | | (2.14) | |
| Changes in Broad Money Supply (ΔM4) | 0.54** | | 0.60** | |
| | (2.16) | | (2.39) | |
| Changes in Effective Exchange Rate | -0.52 | | -0.76*** | |
| | (-1.40) | | (-2.54) | |
| Changes in Term Spread (ΔTS) | 0.01 | | 0.01 | |
| | (0.16) | | (0.29) | |
| *CAY* | -0.01* | | -0.01** | |
| | (-1.95) | | (-2.18) | |
| Changes in Retail Sales (ΔRS) | | 0.11 | | 0.25 |
| | | (0.49) | | (0.82) |
| Changes in Index of Industrial Production(ΔIIP) | | -0.23 | | -0.22 |
| | | (-1.14) | | (-0.75) |
| Changes in Consumer Confidence (ΔCC) | | 4.04*** | | 5.59*** |
| | | (3.18) | | (4.75) |
| Changes in Composite Leading Indicator(ΔCLI) | | 0.09*** | | 0.08** |
| | | (2.72) | | (2.23) |

# 6 Conclusions, Contributions and implications

*"If all the economists were laid end to end, they'd never reach a conclusion"*

*George Bernard Shaw*

The topic of Equity Risk Premium has received and continues to receive a considerable attention from academics, practioners and policy makers. ERP is an essential element in estimating cost of capital which is required for evaluation of project investment. ERP plays a vital role in evaluating and assessing the performance of pooled investment products such ETFs, Unit Trusts, OEICs etc. For policy makers, it is critical to understand the response of ERP to macroeconomic shocks, which may arise due to unexpected policy actions, in order to assess the implications of policy actions on economy. This is because policy actions have a significant impact on economy through financial markets. Given the importance of ERP to the above three categories of professionals, it is reasonable to say that a research identifying determinants of ERP is warranted. Further, as evident from the review in paper 1, such a research is non-existent in the UK context.

This study empirically investigates the key determinants of the UK ERP by using three different theoretical foundations and provides valuable insights on the drivers of UK ERP. Below I present the key contributions of the study.

## 6.1 Contributions to the existing literature

### 6.1.1 Paper 1: Literature Review

In the first paper, I survey the literature on ERP. The strategy here was to classify the literature in three main categories. The first category deals with various estimation techniques of ERP. In the second category I survey the literature on various explanations and resolutions of the ERP puzzle. In the third category of the literature I survey the factors driving ERP in both domestic and international contexts. The major contributions of this paper is as follows; first, critically evaluating the literature on the various estimation techniques of ERP, I find that the literature does not seem to have a consensus in estimating the ERP. That is, in estimating ERP, different articles use different government securities as a proxy of risk-free assets. In some articles, the interest rate on 1-month treasury bills is used as a proxy of risk-free assets while in some other articles, the yields on 10 to 30-year government bonds are used as proxy of risk-free rate. Depending on the maturity of the government bond used, the expected ERP changes quite drastically. Further, as pointed out by Mehra, (2011) it is not unreasonable to say that 1-month or 3-month government bills cannot be used as proxy of risk free asset as most households do not hold these assets in their portfolio. Nevertheless, in the absence of true zero-beta asset, government securities may be considered as "proxies" of risk-free asset presumably because they are considered "default-free".

Second, after surveying the literature on resolution of the ERP puzzle, I find that the ERP puzzle is still one of the major asset pricing anomalies. That is, the observed ERP is not the same as the one implied by the canonical CCAPM model which is based on standard representative-agent framework with power utility. Nevertheless, the literature seems to have substantially developed the canonical CCAPM model by modifying the preference functions.

A critical examination of this survey reveals three research gaps that warrants further research. I discuss these in the following sub-sections.

### 6.1.2 Paper 2: The impact of monetary policy shocks on the ERP, before and after the QE in the UK.

In paper 2, I examine the response of ERP to monetary policy shocks, before and after QE in the UK. While the response of stock returns to monetary policy shocks are well understood in the literature, there is lack of evidence regarding the response of ERP to monetary policy shocks before and after QE. In particular, there is scarcity of such evidence in the UK. Thus, to address this research gap, this paper studies the impact of monetary policy shocks on the UK ERP before and after the QE. Such an investigation seems useful to both policy makers and practioners in present context, given that BoE provided additional monetary policy stimulus in the form of additional QE and reduction in the base interest rate.

Assuming that monetary policy shocks are the residuals of a modified Taylor, (1993) rule extracted from a SVAR and that these shocks are purely exogenous, I estimate their impact on ERP. The contribution of this paper is three-folds; First consistent with prior research, the paper finds that monetary policy shocks have statistically significant negative impact on the UK ERP over the sample period. That is, an unexpected rise in base interest rate would lead to downward pressure on the UK ERP. This suggests that the UK ERP significantly reacts to unexpected component of monetary policy. Second, I find new evidence regarding the asymmetric response of UK ERP to monetary policy shocks before and after the QE. That is, before the QE, monetary policy shocks have negative impact on the ERP while after the QE the monetary policy shocks have statistically significant positive impact on the ERP. This finding is robust for the ERPs of various sectoral FTSE indices and for the ERPs of 25 Fama-French style portfolios sorted on size and book-to-market characteristics. This finding provides a useful insight for policy makers as it directly sheds light on the asymmetric response of ERP before and after the QE. The implications of this finding is more relevant in the present context as the BoE has implemented further monetary stimulus in August 2016 in the form of interest rate reduction coupled with an increase in the purchase of the UK government bonds by £60 billion. Although the period of analysis for this paper does not include the August 2016 monetary stimulus, yet the findings of the paper sheds light on how the UK ERP will respond to this extra stimulus in the near future or if the current monetary stimulus is withdrawn gradually. Third, as suggested by Doh, Cao and Molling, (2015), the asymmetric response of ERP to monetary policy shocks may reveal vital piece of information regarding the future evolution of macroeconomic events which may not be conveyed by conventional macroeconomic factors such innovations to inflation or output gap. Thus, monetary policy makers may be able to avoid or reduce the future negative economic events by monitoring the impact of monetary policy shocks on ERP. And finally the fourth contribution is that, findings of this paper suggest a further development in theoretical linkages between monetary policy actions and stock market returns may be necessary within the general equilibrium framework that includes unconventional monetary policy regimes. Thus, this paper contributes not only to the existing academic literature, but it also provides a guide for the policy makers and the practioners regarding the behaviour of ERP to monetary policy shocks in future.

### 6.1.3 Paper 3: The impact of aggregate and disaggregate consumption shocks on the UK ERP.

Paper 3 examines the response of ERP to aggregate and dis-aggregate personal consumption shocks in the UK. In response to the empirical failure of canonical CCAPM, many new improvements have been suggested to the classical CCAPM. These new modifications to the consumption-based models linearize the stochastic discount factor in the form of consumption-based factor models. Although these models are successful in explaining the ERP using modified consumption based models, yet they are limited, in the sense, they do not take into account the effects of monetary policy changes on consumer choices. Relying on the well-known consumption-wealth channel of transmission of monetary policy, the paper empirically investigates the impact of both aggregate and dis-aggregate structural consumption shocks on the ERP. These consumption shocks represent the deviation of actual consumption path from a theoretically expected consumption path in response to shocks in agent's wealth and income and in presence of exogenous monetary and inflationary shocks. In addition to this, these structural consumption shocks can also be interpreted as idiosyncratic consumption risk or unexpected changes in the agent's consumption path.

The paper has following findings; first consistent with Parker, (2003), I find that the ERP is contemporaneously related to aggregate consumption risk estimated as structural aggregate consumption shocks. Aggregate consumption shocks exert negative impact on the UK ERP. The finding is robust after controlling for size, value and momentum premiums. The pricing ability of aggregate consumption shocks is weakly significant in the cross-section of ERPs of various FTSE indices but not in the ERPs of 25 Fama-French style portfolios. Although this may be the case, ERP seems to be linearly related to the exposure to the aggregate consumption shocks. That is, a unit increase in the exposure to consumption shocks raises the ERP. Secondly and most notably, I investigate the impact of dis-aggregated consumption shocks on ERP. In this respect, the paper contributes to the extant literature by providing a new finding. ERP responds asymmetrically to dis-aggregated consumption shocks. That is, the impact of durable and semi-durable consumption shocks is positive while the impact of non-durable consumption is negative on the ERP. This is an important contribution since it highlights the differential response of ERP to dis-aggregated consumption shocks. However, as far as cross-sectional asset pricing implication is concerned, only non-durable consumption shocks seems to be priced significantly with negative price of risk in the cross- section of 25 Fama-French style portfolios after controlling for Fama and French (1992, 1993) and Carhart (1997) asset pricing factors.

Collectively these findings lend support to the insights of the canonical CCAPM by providing evidence that ERP is linked to contemporaneous consumption risk. Furthermore, these findings may also suggest that it is crucial to incorporate disaggregated consumption, rather than aggregate consumption, within the DSGE framework. One of the short-comings of the current DSGE models employed in monetary policy analysis is that the representative-household is assumed to maximise its overall consumption, with little regards to utility from durable and semi durable consumption. The asymmetric response of ERP to disaggregated consumption shocks suggests that it may be important to decompose the inter-temporal optimisation problem, faced by the central planner, separately with durable and non-durable consumption as the argument of the total utility function.

### 6.1.4 Paper 4: The impact of short and long term market implied volatility on the UK ERP.

Paper 4 examines the impact of short and long term market implied volatility on the UK ERP. There two key arguments in this paper. First, it is critical to analyse the impact of implied market volatility rather than conditional or historical market volatility on the ERP. This is because implied market volatility is a forward-looking risk-neutral measure of systematic risk than historical or realised market volatility. Second, it is critical to differentiate the impact of short and long term implied volatility on the ERP since different investors have different investment horizon. The theoretical implication of Merton' (1973) ICAPM and Campbell's (1993) version of ICAPM motivates such an investigation. That is, the innovations in short and long term market implied volatility can have a significant impact on investor's future opportunity set and as such these innovations could be cross-sectional asset pricing factors.

The paper has following key findings; on aggregate level, the ERP of FTSE 250 index is more sensitive to the innovations in short and long term market risk than the ERP of FTSE 100 index. Moreover, the ERP of FTSE 250 is more sensitive to long term market implied volatility than short term market implied volatility. This finding is robust after controlling for various valuation ratios, macroeconomic indicators and leading economic indicators. This is presumably because the companies in the FTSE 250 index are more exposed to UK domestic economy than the companies in the FTSE 100 index. Second, the paper finds significant negative impact of innovations in the long term implied market volatility than short term on the ERP of 25 Fama-French style portfolios after controlling for the market risk premium. Third, the cross-sectional regressions reveal that, both the innovations in short and long term implied market volatility are significant pricing factors in the cross-section of 25 Fama-French style portfolios, with negative prices of risks, after controlling for popular cross-sectional asset pricing factors and business cycles indicators. These findings seem to be robust even if the innovations in the short and long term market implied volatility are proxied by the innovations from ARMA (1,1) models for respective implied volatilities.

Collectively, the findings of this paper contribute to the related literature by suggesting that innovations to both short term and long term implied volatility are important pricing factors and that these innovations can significantly drive the ERP in the UK. Furthermore, these findings imply that it is critical to differentiate the impact of innovations in short and long term market implied volatility on the ERP as investors not only care about the short term market implied risk but also long term market implied risk. These findings also suggest that when the implied market volatility is stochastic, expected asset risk premia are determined not only by the covariation of asset returns with systematic risk factors such as market risk premium, or with business cycle indicators, but also with the covariation with innovations in both short and the long term market implied volatility.

## 6.2 Limitations and future research

Finance and Economics, although belong to the conventional soft or social sciences, yet more often than not, are treated as though they are fields of hard sciences. Some of the great financial and economic theorists happen to be Physicists and/or Mathematician. Consequently, the research in these two fields of social sciences have been dominated by positivist ontology which rely on the assumption that there exist a single objective reality that can be achieved/perceived through controlled and structural approaches using statistics and mathematics. For example, within the representative agent framework, the life-time social utility/satisfaction is usually modelled with convex power functions. To put this in simple words, in finance and economics, peculiar traits of human beings such as "risk aversion", "Expectations", "satisfaction", "disappointment" and "fear" can not only be determined, but also, are usually modelled using mathematical functions.

On the basis of this argument, it may not be unreasonable to perceive that this study has limitations. In that, the study attempt to determine what affects Equity Risk Premium by assuming that human beings derive "utility" only from consumption (Paper 3) and by assuming that investor "fear" can be captured by implied volatility indices such as the VFTSE (Paper 4). Personally, I do not entirely believe that human beings can derive total lifetime utility from consumption alone and shocks to consumption can, therefore, be entirely seen as shocks to "well-being". Nor I entirely think, that fear about investing in stock market can be captured by implied volatility indices. However, that being said, there is mathematics in the nature. Certain natural phenomenon follows certain mathematical sequences. We were able to understand that gravity travels though space-time fabric as ripples, or for that matter, the Higgs particle exists, only after measurements. We tend to understand reality, clearer, when we assign a number to it or when we measure things. Although, understanding the human traits by measuring them and then assessing their impact on financial markets may not be an exact science, yet it is only after measuring these human traits, we are able to develop new financial instruments which can, to some extent, mitigate financial and economic risks.

To overcome some of these limitations, it might be perhaps useful, to take a social-constructionist approach to research in Finance, particularly in the area of Asset Risk Premia.

That is, it might be useful to develop new risk aversion proxies by conducting interviews/surveys with either small retail investors or with the institutional fund managers and understand how much premium equities can (should) offer to mitigate those new proxies of risk.

# Bibliography

Abel, A. (1990) 'Asset Prices Under Habit Formation and Catching Up with the Joneses', *American Economic Review1*, 80(2), pp. 38–42.

Adrian, T. and Rosenberg, J. (2008) 'Stock Returns and Volatility: Pricing the Long-Run and Short-Run Components of Market Risk', *The Journal of Finance*, 63(6), pp. 2997–3030.

Aiyagari, S.R. and Gertler, M. (1991) 'Asset Returns with Transactions Costs and Uninsured Individual Risk', *Journal of Monetary Economics*, 27(3), pp. 311–331.

Amisano, G. and Giannini, C. (1997) *Topics in Structural VAR Econometrics*.Second. Heidelberg and New York: Springer.

Ammer, J., Vega, C. and Wongswan, J. (2010) 'International Transmission of U.S. Monetary Policy Shocks: Evidence from Stock Prices', *Journal of Money, Credit and Banking*, 42(6), pp. 179–198.

Ando, A. and Modigliani, F. (1963) 'The "Life Cycle" Hypothesis of Saving: Aggregate Implications and Tests', *The American Economic Review*, 53(1), pp. 55–84.

Ang, A., Bekaert, G. and Liu, J. (2005) 'Why Stocks may Disappoint', *Journal of Financial Economics*, 76(3), pp. 471–508.

Ang, A., Hodrick, R. J., Xing, Y. and Zhang, X (2006)'The Cross-Section of Volatility and Expected Returns', *Journal of Finance*, 61(1), pp. 259–299.

Appelbaum, E. and Basu, P. (2008) 'A New Methodology for Studying the Equity Premium', *Annals of Operations Research*, 176(1), pp. 109–126.

Arrow, K. (1971) *Essays in the Theory of Risk-bearing*. Amsterdam: Markham Publication Company.

Auer, B.R. (2013) 'Can Habit Formation under Complete Market Integration Explain the Cross-section of International Equity Risk Premia?', *Review of Financial Economics,* 22(2), pp. 61–67.

Bach, C. and Møller, S. V. (2011) 'Habit-based Asset Pricing with Limited Participation Consumption', *Journal of Banking & Finance*, 35(11) Elsevier B.V., pp. 2891–2901.

Bae, J., Kim C. J. and Nelson, C. R. (2007) 'Why are Stock Returns and Volatility Negatively Correlated?', *Journal of Empirical Finance*, 14(1), pp. 41–58.

Baker, M. and Wurgler, J. (2006) 'Investor Sentiment and the Cross-Section of Stock Returns', *The Journal of Finance*, 61(4), pp. 1645–1680.

Baker, M. and Wurgler, J. (2007) 'Investor Sentiment in the Stock Market', *Journal of Economic Perspectives*, 21(2), pp. 129–151.

Bakshi, G. and Kapadia, N. (2003) 'Delta-Hedged Gains and the Negative Market Volatility Risk Premium', *Review of Financial Studies,* 16(2), pp. 527–566.

Ball, L.. M. (1999a) 'Policy Rules for Open Economies', in Taylor, J. B. (ed.) *Monetary Policy Rules*. Chicago: University of Chicago Press, pp. 127–156.

Ball, L.M. (1999b) 'Efficient Rules for Monetary Policy', *International Finance,* 2(1), pp. 66–83.

Banerjee, P.S., Doran, J. S. and Peterson, D. R. (2007) 'Implied volatility and future portfolio returns', *Journal of Banking and Finance,* 31(10), pp. 3183–3199.

Bansal, R. and Coleman II, W.J. (1996) 'A Monetary Explanation of Equity Premium, Term Premium and Risk-Free Rate Puzzles', *Journal of Political Economy,* 104(6), pp. 1135–1171.

Bansal, R., Robert, D., and Dana,K. (2009) 'Cointegration and Consumption Risks in Asset

Returns', *The Review of Financial Studies*, 22(3), pp. 1343–1375.

Bansal, R., Dittmar, R. and Lundbald, C. (2005) 'Consumption, Dividends, and the Cross Section of Equity Returns', *The Journal of Finance*, 60(4), pp. 1639–1672.

Bansal, R., Kiku, D., Shaliastovich, I. and Yaron, A. (2014) 'Volatility, the Macroeconomy, and Asset Prices', *Journal of Finance*, 69(6), pp. 2471–2511.

Bansal, R. and Yaron, A. (2004) 'Risks for the Long Run : A Potential Resolution of Asset Pricing Puzzles', *The Journal of Finance*, 59(4), pp. 1481–1510.

Banz, R. (1981) 'The Relationship between Return and Market Value of Common Stocks', *Journal of Financial Economics*, 9(1), pp. 3–18.

Barberis, N., Huang, M. and Santos, T. (2001) 'Prospect Theory and Asset Prices', *The Quarterly Journal of Economics*, 116(1), pp. 1–54.

Barro, R. (2006) 'Rare Disasters and Asset Markets in the Twentieth Century', *The Quarterly Journal of Economics*, 121(3), pp. 823–866.

Basu, S. (1977) 'Investment Performance of Common Stocks in Relation to their Price-Earnings Ratio: A Test of the Efficient Market Hypothesis', *The Journal of Finance*, 32(3), pp. 663–682.

Beirne, J. and De Bondt, G. (2008) 'The Equity Premium and Inflation', *Applied Financial Economics Letters*, 4(6), pp. 439–442.

Bekaert, G. and Hodrick, R. (1992) 'Characterizing Predictable Components in Excess Returns on Equity and Foreign Exchange Markets', *The Journal of Finance*, 47(2), pp. 467–509.

Bekaert, G. and Hoerova, M. (2014) 'The VIX, the Variance Premium and Stock Market

Volatility', *Journal of Econometrics*, 183(2), pp. 181–190.

Bekaert, G., Hoerova, M. and Lo Duca, M. (2013) 'Risk, uncertainty and monetary policy', *Journal of Monetary Economics*, 60(7), pp. 771–788.

Benartzi, S. and Thaler, R.H. (1995) 'Myopic Loss Aversion and the Equity Premiuim Puzzle', *Quarterly Journal of Economics*, 110, pp. 73–92.

Bernanke, B. (1986) 'Alternative Explanations of the Money-Income Correlation', *Carnegie-Rochester Conference Series on Public Policy*, pp. 49–99.

Bernanke, B.and Kuttner, K.N. (2005) 'What Explains the Stock Market ' s Reaction to Federal Reserve Policy ?', *The Journal of Finance*, 60(3), pp. 1221–1257.

Bernanke, B. and Blinder, A. (1992) 'The Federal Funds Rate and the Channels of Monetary Transmission', *American economic review*, 82(4), pp. 901–921.

Bjørnland, H.C. and Leitemo, K. (2009) 'Identifying the Interdependence between US Monetary Policy and the Stock Market', *Journal of Monetary Economics*, 56(2), pp. 275–282.

Black, F. (1976) 'Studies of Stock Price Volatility Changes', *Proceedings of the Meetings of the American Statistical Association Business and Economics Statistics Division*., pp. 177–181.

Black, F., Jensen, M. and Scholes, M. (1972) 'The Capital Asset Pricing Model: Some Empirical Tests', in Jensen, M. (ed.) *Studies in the Theories of Capital Market*. New York: Praeger.

Black, S. and Cusbert, T. (2010) 'Durable Goods and the Business Cycle', *Reserve Bank of Australia Bulletin*, , pp. 11–18.

Blume, M.E. and Friend, I. (1973) ‘A New Look at the Capital Asset Pricing Model’, *The Journal of Finance*, 28(1), pp. 19–33.

Boguth, O. and Kuehn, L.-A. (2013) ‘Consumption Volatility Risk’, *The Journal of Finance,* 68(6), pp. 2589–2615.

Bollerslev, T., Tauchen, G. and Zhou, H. (2009) ‘Expected Stock Returns and Variance Risk Premia’, *The Review of Financial Studies*, 22(11), pp. 4463–4492.

Bollerslev, T. and Woolridge, J. (1992) ‘Quasi-maximum Likelihood Estimation and Inference in Dynamic Models with Time-varying Covariances’, *Econometric Reviews*, 11(2), pp. 143–172.

Bollerslev, T. and Todorov, V. (2011) ‘Tails, Fears, and Risk Premia’, *The Journal of Finance*, 66(6), pp. 2165–2212.

Bomfim, A.N. (2003) ‘Pre-Announcement Effects, News Effects, and Volatility: Monetary Policy and the Stock Market’, *Journal of Banking & Finance*, 27(1), pp. 133–151.

Boudoukh, J., Richardson, M. and Whitelaw, R. (1997) ‘Nonlinearities in the Relation Between the Equity Risk Premium and the Term Structure’, *Management Science*, 43(3), pp. 371–385.

Bhar, R. and Malliaris, A.G. (2011) ‘Dividends, Momentum, and Macroeconomic Variables as Determinants of the US Equity Premium Across Economic Regimes’, *Review of Behavioral Finance,* 3(1), pp. 27–53.

Brav, A., Constantinides, G.M. and Geczy, C. C. (2002) ‘Asset Pricing with Heterogeneous Consumers and Limited Participation : Empirical Evidence’, *Journal of Political Economy,* 110(4), pp. 793–824.

Bredin, D., Hyde, S., Nitzsche, D. and O'reilly, G. (2007) 'UK Stock Returns and the Impact of Domestic Monetary Policy Shocks', *Journal of Business Finance & Accounting*, 34(5–6), pp. 872–888.

Breeden, D.T. (1979) 'An Intertemporal Asset Pricing Model with Stochastic Consumption and Investment Opportunities', *Journal of Financial Economics*, 7(3), pp. 265–296.

Brown, G.W. and Cliff, M.T. (2005) 'Investor Sentiment and Asset Valuation', *The Journal of Business*, 78(2), pp. 405–440.

Burmeister, E., Roll, R. and Ross, S. (1994) 'A Practitioner's Guide to Arbitrage Pricing Theory', in Peavy, J. W. (ed.) *A Practitioner's Guide to Factor Models*. Charlottesville, VA: The Research Foundation of the Institute of Chartered Financial Analysts., pp. 1–30.

Campbell, J.Y. (1987) 'Stock returns and the Term Structure', *Journal of Financial Economics*, 18(2), pp. 373–399.

Campbell, J.Y. (1993) 'Intertemporal Asset Pricing without Consumption Data', *The American Economic Review*, 83(3), pp. 487–512.

Campbell, J.Y. and Cochrane, J.H. (1999) 'By Force of Habit: A Consumption-Based Explanation of Aggregate Stock Market Behavior', *Journal of Political Economy*, 107(2), pp. 205–251.

Campbell, J.Y. and Chochrane, J. H., (2000) 'Explaning the Poor Performance of Conssumption-based Asset Pricing Models', *The Journal of Finance*, 55(6), pp. 2863-2878

Campbell, J.Y. (2008) 'Viewpoint: Estimating the Equity Premium', *Canadian Journal of Economics*, 41(1), pp. 1–21.

Campbell, J.Y. and Thompson, S.B. (2008) 'Predicting Excess Stock Returns Out of Sample:

Can Anything Beat the Historical Average?', *Review of Financial Studies*, 21(4), pp. 1509–1531.

Carhart, M.M. (1997) 'On Persistence in Mutual Fund Performance', *The Journal of Finance,* 52(1), pp. 57–82.

Castelnuovo, E. and Nisticò, S. (2010) 'Stock Market Conditions and Monetary Policy in a DSGE model for the U.S.', *Journal of Economic Dynamics and Control*, 34(9), pp. 1700–1731.

Chan, K.C. Karolyi, G. A., and Stulz, R. M. (1992) 'Global Financial Markets and the Risk Premium on U.S. Equity', *Journal of Financial Economics*, 32(2), pp. 137–167.

Chang, B.Y., Christoffersen, P. and Jacobs, K. (2013) 'Market Skewness Risk and the Cross Section of Stock Returns', *Journal of Financial Economics*, 107(1) Elsevier, pp. 46–68.

Chen, J.S. (2002) *Intertemporal CAPM and the Cross-Section of Stock Returns*.

Chen, S.S. (2007) 'Does Monetary Policy Have Asymmetric Effects on Stock Returns?', *Journal of Money, Credit and Banking*, 39(2–3), pp. 667–688.

Chordia, T., Roll, R. and Subrahmanyam, A. (2001) 'Market Liquidity and Trading Activity', *The Journal of Finance*, 56(2), pp. 501–530.

Christiano, L. J., Eichenbaum M. and Evans C. (1996) 'The Effects of Monetary Policy Shocks: Evidence from the Flow of Funds', *The Review of Economics and Statistics*, 78(1), pp. 16–34.

Christiano, L. J., Eichenbaum M. and Evans C. (1999) 'Monetary Policy Shocks: What have We Learned and to What End?', in Taylor, J. B. and Woodford, M. (eds.) *Handbook of Macroeconomics*. Volume 1,. Elsevier B.V., pp. 65–148.

Christie, A.A. (1982) ‘The Stochastic Behavior of Common Stock Variances: Value, Leverage and Interest Rate Effects’, *Journal of Financial Economics,* 10(4), pp. 407–432.

Claus, J. and Thomas, J. (2001) ‘Equity Premia as Low as Three Percent ? Evidence from Analysts ’ Earnings Forecasts for Domestic and International Stock Markets’, *The Journal of Finance*, 56(5), pp. 1629–1666.

Cochrane, J.H. (2001) *Asset Pricing*. Princeton: Princeton University Press.

Cochrane, J.H. (2008) ‘Financial Markets and Real Economy’, in Mehra, R. (ed.) *Handbook of the Equity Risk Premium*. 1st edn. Amsterdam: North-Holland, pp. 237–329.

Constantinides, G.M. (1990) ‘Habit Formation: A Resolution of the Equity Premium Puzzle’, *Journal of Political Economy,* 98(3), pp. 519–543.

Constantinides, G.M., Donaldson, J. and Mehra, R. (2002) ‘Junior Can’t Borrow: A New Perspective on the Equity Premium Puzzle’, *The Quarterly Journal of Economics,* 117(269–296)

Constantinides, G.M. and Duffie, D. (1996) ‘Asset Pricing with Heterogeneous Consumers’, *Journal of Political Economy*, 104(2), pp. 219–240.

Cook, T. and Hahn, T. (1989) ‘The Effect of Changes in the Federal Funds Rate Target on Market Interest Rates in the 1970s’, *Journal of Monetary Economics*, 24(3), pp. 331–351.

Della Corte, Pasquale, Sarno, L.., and Valente, G. (2010) ‘A Century of Equity Premium Predictability and the Consumption-Wealth Ratio: An International Perspective’, *Journal of Empirical Finance,* 17(3), pp. 313–331.

Dennis, P. Mayhew, S. and Stivers, C. (2006) ‘Stock Returns, Implied Volatility Innovations, and the Asymmetric Volatility Phenomenon’, *Journal of Financial and Quantitative*

*Analysis*, 41(2), p. 381.

Detemple, J.B. and Giannikos, C.I. (1996) ‘Asset and Commodity Prices with Multi-Attribute Durable Goods’, *Journal of Economic Dynamics and Control*, 20(8), pp. 1451–1504.

Devaney, M. (2008) ‘Will Future Equity Risk Premium Decline?’, *Journal of Financial Planning*, 21(4), pp. 46–53.

Doh, B.T., Cao, G. and Molling, D. (2015) ‘Should Monetary Policy Monitor Risk Premiums in Financial Markets?’, *Federal Reserve Bank of Kansas City: Economic Review*, 100(1), pp. 7–30.

Donaldson, R.G. Kamstra, M. J. and Kramer, L. (2010) ‘Estimating the Equity Premium’, *Journal of Financial and Quantitative Analysis*, 45(4), pp. 813–846.

Drechsler, I. and Yaron, A. (2011) ‘What’s Vol Got to Do with It’, *Review of Financial Studies*, 24(1), pp. 1–45.

Dropsy, V. (1996) ‘Do Macroeconomic Factors Help in Predicting International Equity Risk Premia?: Testing the Out-of-Sample Accuracy of the Linear and Nonlinear Forecasts’, *Journal of Applied Business Research*, 12(3), pp. 120–132.

Dumas, B. Fleming, J. and Whaley, R.E. (1998) ‘Implied Volatility Functions: Empirical Tests’, *Journal of Finance*, 53(6), pp. 2059–2106.

Eggertsson, G.B. and Woodford, M. (2003) ‘The Zero Bound on Interest Rates and Optimal Monetary Policy’, *Brookings Papers on Economic Activity*, 34(1), pp. 139–235.

Ehrmann, M. and Fratzscher, M. (2004) ‘Taking Stock: Monetary Policy Transmission to Equity Markets’, *Journal of Money, Credit, and Banking*, 36(4), pp. 719–737.

Ehrmann, M. and Fratzscher, M. (2003) ‘Monetary Policy Announcements and Money

Markets : A Transatlantic Perspective', *International Finance*, 6(3), pp. 309–328.

Ehrmann, M. and Fratzscher, M. (2005) 'Equal Size, Equal Role? Interest Rate Interdependence Between the Euro Area and the United States', *The Economic Journal*, 115(2001), pp. 928–948.

Eichenbaum, M. (1992) 'Interpreting Macroeconomic Time Series Facts: The Effects of Monetary Policy: Comments', *European Economic Review*, 36(5), pp. 1001–1011.

Epstein, L.G. and Zin, S.E. (1989) 'Substitution, Risk Aversion and the Temporal Behavior of Consumption and Asset Returns: A Theoretical Framework', *Econometrica*, 57(4), pp. 937–969.

Epstein, L.G. and Zin, S.E. (1991) 'Substitution, Risk Aversion and the Temporal Behavior of Consumption and Asset Returns: An Emprirical Analysis', *Journal of Political Economy*, 99(2), pp. 263–286.

Epstein Larry G and Zin Stanley E (1990) '"First-order" Risk Aversion and the Equity Premium Puzzle', *Journal of Monetary Economics*, 26, pp. 387–407.

Fama, E. and French, K. (1993) 'Common Risk Factors in the Returns on Stocks and Bonds', *Journal of Financial Economics*, 33(1), pp. 3–56.

Fama, E. and MacBeth, J. (1973) 'Risk, Return, and Equilibrium: Empirical Tests', *The Journal of Political Economy*, 81(3), pp. 607–636.

Fama, E.F. (1991) 'Efficient Capital Markets: II', *The Journal of Finance*, 46(5), pp. 1575–1617.

Fama, E.F. and French, K.R. (1992) 'The Cross-Section of Expected Stock Returns', *The Journal of Finance*, 47(2), pp. 427–465.

Fama, E.F. and French, K.R. (2015) 'A Five-factor Asset Pricing Model', *Journal of Financial Economics*, 116(1) Elsevier, pp. 1–22.

Fama, E. and French, K. (2002) 'The Equity Premium', *The Journal of Finance*, 57(2), pp. 637–659.

Ferson, W.E. and Harvey, C.R. (1994) 'Sources of Risk and Expected Returns in Global Equity Markets', *Journal of Banking & Finance*, 18(4), pp. 775–803.

Fielding, D. and Stracca, L. (2007) 'Myopic Loss Aversion, Disappointment Aversion, and the Equity Premium Puzzle', *Journal of Economic Behavior & Organization*, 64(2), pp. 250–268.

Fitzgerald, T. Gray, S., Hall, J. and Jeyaraj, R. (2013) 'Unconstrained Estimates of the Equity Risk Premium', *Review of Accounting Studies*, 18(2), pp. 560–639.

Freeman, M.C. and Davidson, I.R. (1999) 'Estimating the Equity Premium', *The European Journal of Finance*, 5(3), pp. 236–246.

French, K.R. Schwert, W.G. and Stambaugh, R. F. (1987) 'Expected Stock Returns and Volatility', *Journal of Financial Economics*, 19(1), pp. 3–29.

Friedman, M. (1961) 'The Lag in Effect of Monetary Policy', *Journal of Political Economy*, 69(5), pp. 447–466.

Friend, I. and Blume, M. (1975) 'The Demand for Risky Assets', *The American Economic Review*, 65(5), pp. 900–922.

Gabaix, X. (2012) 'Variable Rare Disasters: An Exactly Solved Framework for Ten Puzzles in Macro-Finance', *The Quarterly Journal of Economics*, 127(2), pp. 645–700.

Gagnon, J. Raskin M., Remache J., and Sack B. (2010) 'Large-scale Asset Purchases by the

Federal Reserve: Did They Work?', *Federal Reserve Bank of New York Economic Policy Review*, 17(1), pp. 41–59.

Gagnon, J. Raskin M., Remache J., and Sack B. (2011) 'The Financial Market Effects of the Federal Reserve ' s Large-Scale Asset Purchases', *International Journal of Central Banking*, 7(1), pp. 3–43.

Gali, J. (1992) 'How Well does the IS-LM Model Fit Postwar U.S. Data', *The Quarterly Journal of Economics*, 107(2), pp. 709–738.

Gervais, S. Kaniel, R. and Mingelgrin, D.H. (2001) 'The High-Volume Return Premium', *The Journal of Finance*, 56(3), pp. 877–919.

Gibbons, M.R., Ross, S. and Shanken, J. (1989) 'A Test of the Efficiency of a Given Portfolio.', *Econometrica*, 57(5), pp. 1121–1152.

Gilchrist, S. and Leahy, J. V. (2002) 'Monetary policy and Asset Prices', *Journal of Monetary Economics*, 49(1), pp. 75–97.

Glick, R. and Leduc, S. (2012) 'Central Bank Announcements of Asset Purchases and the Impact on Global Financial and Commodity Markets', *Journal of International Money and Finance*, 31(8), pp. 2078–2101.

Goyal, A. and Santa-Clara, P. (2003) 'Idiosyncratic Risk Matters !', *The Journal of Finance*, 58(3), pp. 975–1007.

Goyal, A. and Welch, I. (2003) 'Predicting the Equity Premium with Dividend Ratios', *Management Science*, 49(5), pp. 639–654.

Graham, J.R. and Harvey, C.R. (2005) 'The Long-run Equity Risk Premium', *Finance Research Letters*, 2(4), pp. 185–194.

Graham, J.R. and Harvey, C.R. (2012) ‘The Equity Risk Premium in 2012’, *SSRN Electronic Journal*

Gregory, A., Tharyan, R. and Christidis, A. (2013) ‘Constructing and Testing Alternative Versions of Fama-French and Carhart Models in the UK’, *Journal of Business Finance and Accounting*, 40(1 and 2), pp. 172–214.

Gul, F. (1991) ‘A Theory of Disappointment Aversion’, *Econometrica*, 59(3), pp. 667–686.

Guo, H. (2004) ‘Stock Prices, Firm Size, and Changes in the Federal Funds Rate Target’, *The Quarterly Review of Economics and Finance*, 44(4), pp. 487–507.

Hall, R.E. (1988) ‘Intertemporal Substitution in Consumption’, *The Journal of Political Economy*, 96(2), pp. 339–357.

Hansen, L. and Jagannathan, R. (1991) ‘Implications of Security Market Data for Models of Dynamic Economies’, *Journal of Political Economy*, 99(2), pp. 225–262.

Hansen, L.P. Heaton, J. C. and Li, N. (2008) ‘Consumption Strikes Back? Measuring Long- Run Risk’, *Journal of Political Economy*, 116(2), pp. 260–302.

Heaton, J. and Lucas, D.J. (1996) ‘Evaluating the Effects of Incomplete Markets on Risk Sharing and Asset Pricing’, *Journal of Political Economy*, 104(3), p. 443.

Heynen, R. Kemna, A. and Vorst, T. (1994) ‘Analysis of the Term Structure of Implied Volatilities’, *The Journal of Financial and Quantitative Analysis*, 29(1), pp. 31–56.

Ioannidis, C. and Kontonikas, A. (2008) ‘The Impact of Monetary Policy on Stock Prices’, *Journal of Policy Modeling*, 30(1), pp. 33–53.

Jacobs, K. and Wang, K. (2004) ‘Idiosyncratic Consumption Risk and the Cross Section of Asset Returns’, *The Journal of Finance*, 59(5), pp. 2211–2252.

Jansen, D.W. and Tsai, C.-L. (2010) ‘Monetary Policy and Stock Returns: Financing Constraints and Asymmetries in Bull and Bear Markets’, *Journal of Empirical Finance*, 17(5) , pp. 981–990.

Jermann, U.J. (2010) ‘The Equity Premium Implied by Production’, *Journal of Financial Economics*, 98(2), pp. 279–296.

Jiang, G.J. and Tian, Y.S. (2005) ‘The Model-Free Implied Volatility and its Information Content’, *Review of Financial Studies*, 18(4), pp. 1305–1342.

Joyce, M.A. Lasaosa A., Stevens I. and Tong M, (2011) ‘The Financial Market Impact of UK Quantitative Easing The Financial Market Impact of UK Quantitative Easing’, *International Journal of Central Banking*, 7(3), pp. 113–161.

Julliard, C. and Ghosh,  a. (2012) ‘Can Rare Events Explain the Equity Premium Puzzle?’, *Review of Financial Studies,* 25(10), pp. 3037–3076.

Kahneman, D. and Tversky, A. (1979) ‘Prospect Theory: An Analysis of Decision Under Risk’, *Econometrica,* 47(2), pp. 263–291.

Kanas, A. (2008) ‘A Note on the Relation between the Equity Risk Premium and the Term Structure’, *Journal of Economics and Finance,* 34(1), pp. 89–95.

Kanas, A. (2009) ‘The Relation between the Equity Risk Premium and the Bond Maturity Premium in the UK: 1900–2006’, *Journal of Economics and Finance,* 33(2), pp. 111–127.

Keim, D. and Stambaugh, R. (1986) ‘Predicting Returns in the Stock and Bond Markets’, *Journal of Financial Economics,* 17(2), pp. 357–390.

Kellard, N.M. Nankervis, J.C. and Papadimitriou, F. I. (2010) ‘Predicting the Equity Premium with Dividend Ratios: Reconciling the Evidence’, *Journal of Empirical Finance,* 17(4) Elsevier B.V., pp. 539–551.

Kilian, L. (2012) ‘Structural Vector Autoregressions’, in Hashimzade, N. and Thornton, M. (eds.) *Handbook of Research Methods and Applications in Empirical Macroeconomics*. Cheltenham: Edward Elgar, pp. 515–554.

Kim, S. (1999) ‘Do Monetary Policy Shocks Matter in the G-7 Countries? Using Common Identifying Assumptions about Monetary Policy Across Countries’, *Journal of International Economics*, 48(2), pp. 387–412.

Kim, S. (2001) ‘Effects of Monetary Policy Shocks on the Trade Balance in Small Open European Countries’, *Economics Letters*, 71(2), pp. 197–203.

Kim, S.W., Krausz, J. and Nam, K. (2013) ‘Revisiting Asset Pricing under Habit Formation in an Overlapping-Generations Economy’, *Journal of Banking & Finance*, 37(1) , pp. 132–138..

Kizys, R. and Spencer, P. (2008) ‘Assessing the Relation between Equity Risk Premium and Macroeconomic Volatilities in the UK’, *Quantitative and Qualitative Analysis in Social Sciences*, 2(1), pp. 50–77.

Kocherlakota, N. (1996) ‘The Equity Premium : It ’ s Still a Puzzle’, *Journal of Economic Literature*, 34(1), pp. 42–71.

Korajczyk, R. A. and Viallet, C.J. (1992) ‘Equity risk premia and the pricing of foreign exchange risk’, *Journal of International Economics*, 33(3–4), pp. 199–219.

Krishnamurthy, A. and Vissing-Jorgensen, A. (2011) ‘The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy’, *Brookings Papers on Economic Activity*, 2011(2), pp. 215–287.

Kumar, A. and Lee, C. (2006) 'Retail Investor Sentiment and Return Comovements', *The Journal of Finance*, 61(5), pp. 2451–2486.

Kurov, A. (2012) 'What Determines the Stock Market's Reaction to Monetary Policy Statements?', *Review of Financial Economics*, 21(4) Elsevier Inc., pp. 175–187.

Kurov, A. (2010) 'Investor Sentiment and the Stock Market's Reaction to Monetary Policy', *Journal of Banking & Finance*, 34(1) Elsevier B.V., pp. 139–149.

Kuttner, K.N. (2001) 'Monetary Policy Surprises and Interest Rates: Evidence from the Fed Funds Futures Market', *Journal of Monetary Economics*, 47(3), pp. 523–544.

Kydland, F. and Prescott, E. (1982) 'Time to Build and Aggregate Fluctuations', *Econometrica: Journal of the Econometric Society*, 50(6), pp. 1345–1370.

Labadie, P. (1989) 'Stochastic inflation and the equity premium', *Journal of Monetary Economics*, 24(2), pp. 277–298.

Lastrapes, W.D. (1998) 'International Evidence on Equity Prices, Interest Rates and Money', *Journal of International Money and Finance*, 17(3), pp. 377–406.

Leibowitz, M.L. (2003) 'The Higher Equity Risk Premium Created by Taxation', *Financial Analysts Journal*, 59(5), pp. 28–31.

Lettau, M. and Ludvigson, S. (2001a) 'Resurrecting the (C) CAPM: A Cross-Sectional Test When Risk Premia are Time-Varying', *Journal of Political Economy*, 109(6), pp. 1238–1287.

Lettau, M. and Ludvigson, S. (2001b) 'Consumption, Aggregate Wealth, and Expected Stock Returns', *The Journal of Finance*, 56(3), pp. 815–849.

Lettau, M., Ludvigson, S. C.and Wachter, J. A. (2008) 'The Declining Equity Premium: What Role Does Macroeconomic Risk Play?', *Review of Financial Studies*, 21(4), pp. 1653–

1687.

Lintner, J. (1965) ‘Security Prices, Risk, and Maximal Gains from Diversification’, *Journal of Finance*, 20, pp. 587–615.

Longin, F. and Solnik, B. (1995) ‘Is the Correlation in International Equity Returns Constant: 1960–1990?’, *Journal of International Money and Finance*, 14(1), pp. 3–26..

Longstaff, F.A. and Piazzesi, M. (2004) ‘Corporate Earnings and the Equity Premium’, *Journal of Financial Economics*, 74, pp. 401–421.

Lubnau, T.M. and Todorova, N. (2015) ‘The Calm After the Storm: Implied Volatility and Future Stock Index Returns’, *The European Journal of Finance*, 21(15), pp. 1282–1296.

Lucas, R.E. (1978) ‘Asset Prices in an Exchange Economy’, *Econometrica*, 46(6), pp. 1429–1445.

Ludvigson, S.. (2013) ‘Advances in Consumption-Based Asset Pricing: Empirical Tests’, in Constantinides, G. M. et al. (eds.) *Handbook of Economics and Finance*. 2nd edn. Amsterdam: Elsevier B.V., pp. 799–906.

Ludvigson, S., Steindel, C. and Lettau, M. (2002) ‘Monetary Policy Transmission through the Consumption-Wealth Channel’, *Economic Policy Review, Federal Reserve Bank of New York*, pp 117-133.

Lutkepohl, H. (2005) *New Introduction to Multiple Time Series Analysis*. 2nd edn. New York: Springer.

MacDonald, G. Mullineux, A. and Sensarma. R. (2011) ‘Asymmetric Effects of Interest Rate Changes: The Role of the Consumption-Wealth Channel’, *Applied Economics*, 43(16), pp. 1991–2001.

Mankiw, N.G. and Zeldes, S.P. (1991) ‘The Consumption of Stockholders and Non-stockholders’, *Journal of Financial Economics*, 29(1), pp. 97–112.

Markowitz, H. (1952) ‘Portfolio Selection’, *The Journal of Finance,* 7(1), pp. 77–91.

Marquering, W. and Verbeek, M. (2004) ‘The Economic Value of Predicting Stock Index Returns and Volatility’, *Journal of Financial and Quantitative Analysis*, 39(2), p. 407.

Mayfield, S.. (2004) ‘Estimating the Market Risk Premium’, *Journal of Financial Economics*, 73(3), pp. 465–496.

Mayhew, S. (1995) ‘Implied Volatility’, *Financial Analysts Journal*, 51(4), pp. 8–20.

McGrattan, E. and Prescott, E. (2003) ‘Average Debt and Equity returns: Puzzling?’, *The American Economic Review*, 93(2), pp. 392–397..

Mehra, R. (2003) ‘The Equity Premium : Why Is It a Puzzle ?’, *Financial Analysts Journal,* 59(1), pp. 54–69.

Mehra, R. (2011) ‘The Equity Premium Puzzle Revisited’, in Hammond, P. et al. (eds.) *Rethinking the Equity Risk Premium*. Charlottesville, VA: Research Foundation Publications, CFA Institute, pp. 148–154.

Mehra, R. and Prescott, E. (1985) ‘The Equity Premium: A Puzzle’, *Journal of Monetary Economics*, 15(2), pp. 145–161.

Mehra, R. and Prescott, E.C. (1988) ‘The Equity Premium: A Solution?’, *Journal of Monetary Economics*, 22(1), pp. 133–136

Meier, A. (2009) ‘Panacea, Curse, or Nonevent? Unconventional Monetary Policy in the United Kingdom’ *IMF Working Paper No. 09/163*.

Merton, R. (1973) ‘An Intertemporal Capital Asset Pricing Model’, *Econometrica*, 41(5), pp. 867–887.

Merton, R. (1976) ‘Option Pricing When Underlying Stock Returns Are Discontinuous’, *Journal of Financial Economics,* 3, pp. 125–144.

Miles, D. (2011) *Monetary Policy and Financial Dislocation* Royal Economic Society, London

Miles, D. (2012) ‘*Asset Prices, Saving and the Wider Effects of Monetary Policy*’, Manchester: Manchester Business Conference.

Mishkin, F. (1996) *The Channels of Monetry Transmission: Lessons for Monetary Policy*. Cambridge MA.

Modigliani, F. (1963) ‘The Monetary Mechanism and Its Interaction with Real Phenomena’, *Review of Economics & Statistics,* 45(1), pp. 79–107.

Modigliani, F. (1971) ‘Monetary Policy and Consumption: Linkages via Interest Rate and Wealth Effects in the FMP Model’, *Consumer Spending and Monetary Policy: The Linkages*. Nantucket Island: The Federal Reserve Bank of Boston. Series 5, pp. 9–84.

Møller, S.V. (2009) ‘Habit Persistence: Explaining Cross-sectional Variation in Returns and Time-varying Expected Returns’, *Journal of Empirical Finance*, 16(4) , pp. 525–536.

Mumtaz, H. and Zanetti, F. (2013) ‘The Impact of the Volatility of Monetary Policy Shocks’, *Journal of Money, Credit and Banking,* 45(4), pp. 535–558.

Neri, S. (2004) *Monetary Policy and Stock Prices: Theory and Evidence*., Economic Working Papers.

Von Neumann, J. and Morgenstern, O. (1944) *Theory of Games and Economic Behaviour*.

New Jersey: Princeton University Press.

Newey, W.K. and West, K.D. (1987) 'A Simple Positive Semi Definite Hetroskedasticity and Autocorrelation Consistent Covariance Matrix', *Econometrica*, 55(3), pp. 703–708.

O'Hanlon, J. and Steele, A. (2000) 'Estimating the Equity Risk Premium Using Accounting Fundamentals', *Journal of Business Finance and Accounting*, 27(9 &10)

Okun, A.M. (1962) 'Potential GNP - Its Measurment and Significance', *American Statistical Association , Proceedings of Business and Economics Statistics*., pp. 98–104.

Otrok C., Ravikumar, B. and Whiteman, C.H. (2002) 'Habit Formation: A Resolution of the Equity Premium Puzzle?', *Journal of Monetary Economics*, 49, pp. 1267–1288.

Pagan, A. (1995) 'Three Econometric Methodologies: An Update', in Oxley, L. et al. (eds.) *Surveys in Econometrics*. Oxford: Blackwell Publishing Inc.

Parker, J.A. (2003) 'Consumption Risk and Expected Stock Returns', *The American Economic Review*, 93(2), pp. 376–382.

Parker, J. and Julliard, C. (2005) 'Consumption Risk and the Cross Section of Expected Returns', *Journal of Political Economy*, 113(1), pp. 185–222.

Pastor, L. and Stambaugh, R.F. (2001) 'The Equity Premium and Structural Breaks', *The Journal of Finance*, 56(4), pp. 1207–1239.

Pastor, L. and Veronesi, P. (2003) 'Stock Valuation and Learning about Profitability.', *Journal of Finance*, 58(5), pp. 1749–1790.

Patelis, A.D. (1997) 'Stock Return Predictability and The Role of Monetary Policy', *The Journal of Finance*, 52(5), pp. 1951–1972.

Pesaran, M.H. and Timmermann, A. (2000) 'A Recursive Modelling Approach To Predicting UK Stock Returns', *The Economic Journal*, 110(110), pp. 159–191.

Pesaran, M.H. and Timmermann, A. (1995) 'Predictability of Stock Returns: Robustness and Economic Significance', *The Journal of Finance*, 50(4), pp. 1201–1228.

Petkova, R. (2006) 'Do the Fama-and-French Factors Proxy for Innovations in State Variables?', *The Journal of Finance*, 61(2), pp. 581–512.

Piazzesi, M., Schneider, M., and Tuzel, S. (2007) 'Housing, Consumption and Asset Pricing', *Journal of Financial Economics,* 83(3), pp. 531–569.

Power, J. (2004) 'Durable Spending, Relative Prices and Consumption', *Bank of England Quarterly Bulletin*, 44(1), pp. 21–31.

Pratt, J. (1964) 'Risk Aversion in the Small and in the Large', *Econometrica*, 32(1–2), pp. 122–136.

Rapach, D. E., Strauss, J. K., and Zhou, G. (2010) 'Out-of-Sample Equity Premium Prediction: Combination Forecasts and Links to the Real Economy', *Review of Financial Studies*, 23(2), pp. 821–862.

Rietz, T. (1988) 'The Equity Risk Premium: A solution', *Journal of Monetary Economics,* 22(1), pp. 117–137.

Rigobon, R. and Sack, B. (2003) 'Measuring The Reaction of Monetary Policy to the Stock Market', *The Quarterly Journal of Economics*, 118(2), pp. 639–669.

Rigobon, R. and Sack, B. (2004) 'The Impact of Monetary Policy on Asset Prices', *Journal of Monetary Economics*, 51(8), pp. 1553–1575.

Roll, R. (1977) 'A Critique of the Asset Pricing Theory's Tests Part I: On Past and Potential

Testability of the Theory', *Journal of Financial Economics*, 4(2), pp. 129–176.

Ross, S. (1976) 'The Arbitrage Theory of Capital Asset Pricing', *Journal of Economic Theory*, 13(3), pp. 341–360.

Routledge, B.R. and Zin, S.E. (2010) 'Generalized Disappointment Aversion and Asset Prices', *The Journal of Finance*, 65(4), pp. 1303–1332.

Rozeff, M.S. (1974) 'Money and Stock Prices', *Journal of Financial Economics*, 1(3), pp. 245–302.

Rubinstein, M. (1976) 'The Valuation of Uncertain Income Streams and the Pricing of Options', *Bell Journal of Economics*, 7(2), pp. 407–425.

Salyer, K.D. (1998) 'Crash states and the equity premium: Solving one puzzle raises another', *Journal of Economic Dynamics and Control*, 22(6), pp. 955–965.

Samuelson, P. and Merton, R. (1974) 'Generalised Mean-Variance Trade-offs for Best Perturbation Corrections to Approximate Portfolio Decisions', *The Journal of Finance*, 29(1), pp. 27–40.

Santa-Clara, P. and Yan, S. (2010) 'Crashes, Volatility and the Equity Premium: Lessons from S&P 500 Options', *The Review of Economics and Statistics*, 92(2), pp. 435–451.

Santos, T. and Veronesi, P. (2006) 'Labor Income and Predictable Stock Returns', *The Review of Financial Studies*, 19(1), pp. 1–44.

Sarkar, A. and Zhang, L. (2009) 'Time Varying Consumption Covariance and the Dynamics of the Equity Premium: Evidence from the G7 Countries', *Journal of Empirical Finance*, 16(4), pp. 613–631.

Sarr, A. and Lybek, T. (2002) *Measuring liquidity in financial markets*.

Savage, L.J. (1954) *The Foundations of Statistics*.Enlarged E. New York: John Wiley and Sons.

Schwert, G.W. (1989a) 'Why Does Stock Market Volatility Change Over Time?', *The Journal of Finance*, 44(5), pp. 1115–1153.

Schwert, G.W. (1989b) 'Business Cycles, Financial Crises, and Stock Volatility.', *Carnegie-Rochester Conference Series on Public Policy*. Vol.31, pp. 83–125.

Sharpe, W. (1964) 'Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk.', *Journal of Finance*, 19(3), pp. 425–442.

Shiller, R.J. (1982) *Consumption, Asset Markets and Macroeconomic Fluctuations*., Carnegie Rochester Conference Series on Public Policy.

Siegel, J.J. (2005) 'Perspectives on the Equity Risk Premium', *Financial Analysts Journal*, 61(6), pp. 61–73.

Sims, C.A., (1980) 'Macroeconomics and Reality', *Econometrica*, 48(1), pp.1-48

Sims, C.A. (1992) 'Interpreting the Macroeconomic Time Series Facts: The Effects of Monetary Policy', *European Economic Review*, 36(5), pp. 1001–1011.

Söderlind, P. (2006) 'C-CAPM Refinements and the Cross-Section of Returns', *Financial Markets and Portfolio Management*, 20(1), pp. 49–73.

Sousa, R.M. (2010) 'Consumption, (Dis)aggregate Wealth, and Asset Returns', *Journal of Empirical Finance*, 17(4) Elsevier B.V., pp. 606–622.

Svensson, L.. (2000) 'Open-economy Inflation Targeting', *Journal of International Economics*, 52(1), pp. 155–183.

Taylor, J.B. (1993) ‘Discretion Versus Policy Rules in Practice’, *Carnegie-Rochester Conference Series on Public Policy*, 39(1), pp. 195–214.

Tednogap, R. (2007) *Consumption Volatility and the Cross-Section of*. Stockholm.

Thorbecke, W. (1997) ‘On Stock Market Returns and Monetary Policy’, *The Journal of Finance*, 52(2), pp. 635–655.

Tobin, J. (1969) ‘A General Equilibrium Approach To Monetary Theory’, *Journal of Money, Credit and Banking*, 1(1), pp. 15–29.

Tristani, O. (2009) ‘Model Misspecification, the Equilibrium Natural Interest Rate, and the Equity Premium’, *Journal of Money, Credit and Banking*, 41(7), pp. 1453–1479.

Tversky, A. and Kahneman, D. (1992) ‘Advances in prospect theory: Cumulative representation of uncertainty’, *Journal of Risk and Uncertainty*, 5(4), pp. 297–323.

Vassalou, M. (2003) ‘News Related to Future GDP Growth as a Risk Factor in Equity Returns’, *Journal of Financial Economics*, 68(1), pp. 47–73.

Wachter, J. A. (2013) ‘Can Time-Varying Risk of Rare Disasters Explain Aggregate Stock Market Volatility?’, *The Journal of Finance*, 68(3), pp. 987–1035.

Weil P. (1989) ‘The Equity Premium Puzzle and the Risk-Free Rate Puzzle’, *Journal of Monetary Economics*, 24(3), pp. 401–421.

Welch, I. (2000) ‘Views of Financial Economists on the Equity Premium and on Professional Controversies’, *The Journal of Business*, 73(4), pp. 501–537.

Welch, I. (2008) ‘The consensus estimate for the equity premium by academic financial economists in December 2007’, *Available at SSRN 1084918*, pp. 1–14.

Welch, I. and Goyal, A. (2008) 'A Comprehensive Look at The Empirical Performance of Equity Premium Prediction', *Review of Financial Studies*, 21(4), pp. 1455–1508.

Whaley, R.E. (2000) 'The Investor Fear Gauge', *The Journal of Portfolio Management,* 26(3), pp. 12–17.

Yogo, M. (2008) 'Asset Prices Under Habit Formation and Reference-Dependent Preferences', *Journal of Business & Economic Statistics*, 26(2), pp. 131–143..

Yogo, M. (2006) 'A Consumption-Based Explanation of Expected Stock Returns', *The Journal of Finance*, 61(2), pp. 539–580.