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A State-Space Version of Fama and French's Three-Factor Model: Evidence from the Tunisian Stock Exchange

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Abstract

We develop a state-space version of the three-factor model of Fama and French (1993) for exploring the macroeconomic determinants of risk underlying size (SMB) and value (HML) factors. To the best of our knowledge, this is the first study that examines how loadings on HML and SMB factors are affected by unanticipated changes in macroeconomic factors and whether they exhibit an asymmetric behavior over the business cycle. We test the hypothesis that the betas associated with HML and SMB factors of firms with different size or a different BE/ME ratio react differently to changes in macroeconomic conditions. In addition to the hypothesis that some type of stocks (value and small ones) become more responsive to such a change during period of economic contraction than during an expansion. Our focus is the Tunisian stock Exchange. The evidence we found supports the time variation of portfolios returns' sensitivities to market, HML and SMB factors with unanticipated changes in monetary and economic conditions. Hence, the assumption of constant coefficients in the traditional three-factor model seems to be unreasonable. Betas associated with HML and SMB factors showed countercyclical behavior through the phases of the business cycle. In a recession, value (small) firm's risk associated with the HML (SMB) factor is more strongly affected by worsening credit market conditions than during an economic expansion. Further results show that value (small) firm's risk associated with the HML (SMB) factor is more strongly affected by tighter credit market conditions than growth (large) firm's risk. Thus, our results most closely support a risk-based explanation for SMB and HML.

Keywords: size and value premiums, Fama and French three-factor model, state-space framework, unexpected changes in macroeconomic conditions, asymmetric response over business cycle, Tunisian Stock Exchange

1. Introduction

A large body of empirical research gives evidence that the market beta is imperfect and insufficient to explain the higher returns of certain assets relative to others. In the United States, Rosenberg and Lanstein (1985), Fama and French (1992, 1993, 1995, 1996) and Lakonoshok, Sleifer, and Vishny (1994) provide evidence that stocks with a high Book-to-Market equity (BE/ME) ratio (value stocks) tend to have higher average returns than stocks with a low BE/ME ratio (growth stocks). These higher average returns are not consistent with the Capital Asset Pricing Model (CAPM) because value stocks seem to have abnormal higher returns even after accounting for market beta. Conversely, growth stocks seem to do systematically worse than their CAPM betas suggest. The pioneering work of Banz (1981) provide evidence that average returns on small American stocks (low ME) are too higher given their beta estimates and average returns on large stocks are too low. Because CAPM does not explain these patterns in average returns, they are called anomalies. To explain these facts, multifactor extensions of the CAPM are needed. Accordingly, Fama and French (1993) developed a three-factor asset pricing model which relates the expected returns of a portfolio to excess returns on a market portfolio, a book-to-market equity factor (value premium) which is the difference between excess returns on a portfolio of high BE/ME stocks and excess returns on a portfolio of low BE/ME stocks (HML: High minus Low) and size factor (size premium), which is the difference between excess returns on a portfolio of small stocks and excess returns on a portfolio of large stocks (SMB: Small minus Big). Fama and French (1993) show that variation in average returns of 25 size-BE/ME sorted portfolios of stocks listed in NYSE, AMEX and NASDAQ over the period of July 1963-december 1987, can be explained by varying loadings on the latter two factors. Fama and French (1996) argue that anomalies relating to CAPM widely disappear by using the three-factor model.

Many studies have been conducted to test the ability of Fama and French's three-factor model to explain and predict the variation in stocks' returns rate. Other studies investigate if the three-factor model perform better than the traditional CAPM. The consensus is that the three-factor model of Fama and French (1993) does a good job in explaining cross-sectional average returns and has more explanatory power than the CAPM in the French stock exchange (Lajili, 2002), in the Istanbul Stock Exchange (Asku & Onder, 2003), in the Asian emerging markets of Hong Kong, Korea, Malaysia and Philippines (Drew and Veeraraghavan (2003), in the Australian stock exchange (Guant, 2004), in Amman stock market (Al-mwalla & Karasneh, 2011), in the Tunisian stocks market (Bergaoui, 2013), in Pakistan equity market (Abbas, Khan, Aziz, & Sumrani, 2015) and in China's stock market (Xie & Qui, 2016). In line with Fama and French (1993), all of the above studies show that higher returns on small stocks are explained by a difference in the slopes of small and big stocks on the SMB factor. Moreover, higher returns of value stocks are explained by a difference in the slopes of value and growth stocks on the HML factor.

Although the framework of Fama and French is simple, yet there is an empirical controversy about the exact economic interpretation of value (HML) and size (SMB) premiums. Some have argued that value and size premiums arise because of investor overreaction (Lakonishok et al., 1994). They argue that value (growth) stocks tend to be firms, which are weak (strong) on fundamentals. They suggest that investors overreact to performance and assign irrationally low values to weak firms and irrationally high values to strong firms. When overreaction is corrected, weak firms have high stock returns and strong firms have low returns. Others have argued that value and size premiums arise from data snooping or data biases (Kothari, Shanken, & Sloan, 1995; Mackinlay, 1995), Black (1993)). However, this set of explanations has been challenged by studies that have proved the robustness of the three-factor model of Fama and French (1993) in explaining cross-sectional average returns on a holdout sample of financial firms (Barber & Lyon, 1997; Al-mwalla & Karasneh, 2011) and outside the US markets. A third possible explanation is that value and size premiums relate to risk. In line with rational asset pricing, Fama and French (1993, 1995, 1996) consider HML and SMB as risk premiums that compensate for additional non-diversifiable risk associated with the size and book-to-market equity ratio. The biggest problem is that Fama and French (1993) are silent about why the size of a company or its book-to-market ratio is a proper indicator of risk.

Cochrane (1999) asks: "what are the macroeconomic risks for which the Fama-French factors are proxies?" and suggests that "there are hints of some sort of a distress or recession factor at work". Some studies invoked the concept of financial distress to explain these anomalous in the cross-section of stock returns. Chan and Chen (1991) provided evidence indicating that there is a large proportion of marginal firms (with lower production efficiency and higher financial leverage) in the small cap portfolio. Since marginal (distressed) firms have lost market value because of poor performance, while having higher financial leverage and cash flow problems, their prices tend to be more sensitive to adverse economic conditions. According to Fama and French (1995), the book to market equity ratio and slopes on HML represents relative distress. Firms which are weak and have low earnings tend to have a high book to market ratio and positive slopes on HML, whereas firms which have persistent high earnings have low BE/ME and negative slopes on HML. Chen and Zhang (1998) found that small-value stocks are riskier because they are usually firms under distress; they have high financial leverage and face substantial uncertainty in future earnings. In an earlier paper (Bergaoui, 2015) we evaluated the relationship of some market- and accounting-based measures of financial distress risk and profitability with BE/ME and size (ME) for stocks listed in the Tunisian stock Exchange (TSE), over the period July 1998 to December 2010. Our results provide evidence that the Tunisian value stocks and small stocks are riskier because they usually belong to firms under distress. They have persistent poor performance, higher financial leverage and face substantially uncertainty about future earnings. Hence, investors would ask for a substantial premium to hold value or small stocks and would hold growth or large stocks despite a low premium. If small stocks and value stocks are subject to higher risk of distress, would they be more sensitive to downturns in the economy? Would they be more affected by adverse economic and monetary conditions?

Several authors examine directly whether stock performance during bad macroeconomic times determines average returns of size or BE/ME-sorted portfolios. Jagannathan and Wang (1996) use the return on human capital, Chan, Chen, and Hsieh (1985) look at industrial production and inflation among other variables, Thorbecke and Coppok (1995), Thorbecke (1997), Jensen, Johnson, and Mercer (1997) and Black and McMillan (2005) look at the monetary environment. All these authors find that average returns line up with betas calculated using macroeconomic indicators. However, according to Cochrane (1999), macroeconomic factors are theoretically easier to motivate but none explains the value and size portfolios as well as the (theoretically less solid) size and value factors of Fama and French (1993).

The main purpose of our paper is to present additional evidence regarding the source of value and size premiums by linking the more fundamentally (macroeconomic) determined factors with the empirically more successful value and small-firm factor portfolios. We propose a flexible framework for exploring the macroeconomic determinants of risk underlying the SMB and HML factors. We develop a state-space version of the three-factor model of Fama and French (1993) that takes into account two main criticisms addressed to the static version of the model. Namely, economic interpretation of the HML and SMB factors and the implicit assumption of constant model coefficients (betas). This last hypothesis was largely rejected by an abundant literature confirming the variation over time and across the business cycle of the stocks expected returns and risk (Fama & French, 1989; Harvey, 1991; Evans, 1994; Jogannathan & Wang, 1996; Jensen & Mercer, 2002; Perz-Quiros & Timmermann, 2000; Petkova & Zhang, 2005; Gulen, Xing, & Zhang, 2008). Jagannathan and Wang (1996) point out that the constant beta assumption is not reasonable, since the relative risk of firm's cash flow is likely to vary over the business cycle. During a recession, for example, financial leverage of firms in relatively poor shape may increase sharply relative to other firms causing their stock betas to rise. Hence, betas and expected returns will in general depend on the nature of the information available at any given point in time and vary over time. Jensen et al. (1997) argue that investors assess risk change based on the economic and monetary environment. The change in an investor's risk perception affects the influence of risk factors on stock returns. They suggested that investor's risk concerns are different during restrictive and expansive monetary policy. This shift in risk perception manifests itself in terms of different sensitivity to risk factors. Hence, time-varying properties of beta coefficients seem more realistic than the non-stochastic beta assumption. If HML and SMB serve to mimic the risk factors related to size (ME) and to the BE/ME ratio, sensitivity of stocks with different size and different BE/ME to these two factors (betas) should vary. More specifically, we consider whether the betas associated with HML and SMB factors of firms with different size or different BE/ME ratio react differently to changes in macroeconomic conditions. Does some type of stocks become more responsive to such a change during period of economic contraction than during a period of economic expansion?

Several studies point to an asymmetric response to changes in macroeconomic variables over different stages of the business cycle (Perez-Quiros & Timmermann, 2000; Black & McMillan, 2005; Gulen et al., 2008). If value (small) stocks are, inherently, more risky than growth (large) stocks, one would expect betas of value (small) stocks to be more responsive to changes in economic conditions than betas of growth (large) stocks and that this responsiveness increases during economic contractions. In this case, one could interpret the cross-sectional differences in expected returns by differences in risk. To the best of our knowledge, this is the first study that examines how loadings on HML and SMB factors are affected by macroeconomic factors, especially in the Tunisian Stock Exchange. In the state-space version of the three-factor model that we propose, we would allow the betas (loadings on the three factors of Fama and French (1993) to vary with the state of the economy and with the underlying macroeconomic fundamentals that measure changes in credit market conditions.

By studying the time-variation of small (versus big) and value (versus growth) firms' risk, with macroeconomic fundamentals, in the context of a model that accounts for cyclical asymmetries, we are able to shed new light on the sources of SMB and HML premiums. Our paper has implications for professional investment managers. Indeed, a greater understanding of the underlying mechanism governing the dynamics of value and size premiums would enable managers to improve their investment performance. It is important to know whether these premiums arise from inherent risk in value and small stocks and thus whether such patterns may be affected by changes in macroeconomic conditions.

The remainder of the paper is organized as follows. Section 2 is a review of the literature. Section 3 describes the data and documents the size and BE/ME ratio effects on the Tunisian stocks market. Section 4 describes the state-space version of the three-factor model and the associated theoretical hypotheses for examining differences in the sensitivity of betas of ranked portfolios to changes in macroeconomic conditions. The fifth section presents the estimated results, while the final section concludes with the main findings.

2. Size Premium, Value Premium, Macroeconomic Risk and Cyclical Variations: Literature Review

Fama and French (1993, 1995, 1996) are strong supporters of the efficient market hypothesis. They believe that one only gets excess returns when taking on extra risk. Thus, if small size or value stocks have higher than average returns, then they must be riskier. To test this hypothesis, several authors examine the effect of changing economic conditions on size-BE/ME sorted portfolios or on HML and SMB premiums. These studies regress excess returns of these portfolios on the first lag of macroeconomic variables such as interest rates, money supply growth, inflation and industrial production.

Jensen et al. (1997) consider the influence of Federal Reserve's policy on stock returns. They find that, over the period 1964-1994, size and price-to-book effects depend largely on the monetary environment. Specifically, small-firm and low price-to-book premiums are economically and statistically significant only in expansive monetary policy periods and are small and in some instance negative in a restrictive policy period. Jensen & Mercer (2002) reexamine a three-factor model that includes the beta, ME and BE/ME ratio. They allow monetary conditions to influence the relationship between the risk factors and average returns of 125 portfolios sorted on beta, ME and BE/ME ratios, by introducing a dummy variable that represents the stringency of monetary policy. The latter is estimated using changes in the US Federal Reserve's discount rate. Over the period 1965-1997, Jensen & Mercer (2002) find that ex-ante proxy for monetary stringency significantly influences the relationship between stock returns and all three risk factors. All three variables are found to contribute significantly to explaining cross-sectional returns variation in expansive policy periods. Additionally, risk premiums associated to these three variables are small in restrictive policy periods.

This evidence indicates that investors should consider the fed's policy stance when using strategies that rely on size or price-to-book ratios.

The study of Perez-Quiros and Timmermann (2000) aims to test the hypothesis that small-cap stocks are more adversely affected by tighter credit market conditions (lower liquidity and higher short-term interest rates) than large stocks, especially during periods of economic downturns. They model excess returns of 10 size-sorted decile portfolios as a function of an intercept term and lagged values of the one-month T-bill rate, a default premium, changes in money stock and dividend yield. They use the Markov Switching model introduced by Hamilton (1989) that accounts for state dependence in risk and expected returns. Perez-Quiros and Timmermann (2000) find that, over the period 1954 to 1997, small firms' excess returns most strongly negatively correlate with the short interest rate in the recession state. However, the estimated coefficients on the T-bill rate are much smaller in the expansion state (only two are significant at conventional levels). Higher monetary growth is associated with higher expected excess returns only for the smallest firms in the recession state. The default premium is mainly important in the excess return equation during an economic recession and particularly so for small firms. They also find that volatility (risk) of small firms is most strongly affected by a recession state and more sensitive to interest rate changes in recession periods. They provide evidence that small firms display the highest degree of asymmetry in their risk across recession and expansion states, which translates into a higher sensitivity of their expected stock returns with respect to variables that measure credit market conditions.

Black and McMillan (2005) examine whether sensitivity of value stocks to changes in macroeconomic conditions differs from that of growth stocks and whether book-to-market sorted portfolios exhibit an asymmetric response to changes in economic conditions over the business cycle. They relate excess returns of each of the 10 Book-to-market decile sorted portfolios to lagged values of the one-month Treasury bill and annualized changes in money supply over the period January 1975 to December 2000. They use annualized changes in industrial production to define the state of the economy. Coefficients of their model vary with a Dummy variable that takes 1 if changes in industrial production are positive (the economy is in an expansionary state) and zero otherwise (the economy is in a contractionary state). They find that portfolios returns respond more to changes in interest rates and money supply in a recessionary period than in an expansionary period. Furthermore, returns on value stocks are more responsive to changes in macroeconomic conditions than growth stocks and that this responsiveness does increase during an economic contraction. Furthermore, average volatility also increases with book-to-market ratio and changes in output growth rates only affect volatility of the highest book-to-market portfolios, whereby volatility in such portfolios increases during a recessionary period.

Andersen, Bollerslev, Diebold, and Wu (2005) relate market betas of each of the 25 size-BE/ME sorted portfolios with a macroeconomic indicator using a state-space framework. They provide evidence that, over the period February 1993 to May 2003, American equity market's betas do indeed vary with a macroeconomic indicator such as industrial production growth and that macroeconomic effects on expected returns are large enough to be economically important. Moreover, their results strongly indicate that the counter-cyclicality of betas is primarily a value stock phenomenon, suggesting that the well-documented value premium may, at least in part, be explained by an increase in expected returns of value stocks during bad economic periods.

Gulen et al. (2008) are also interested in the macroeconomic determinants of value premiums. They apply the two-state Markov Switching framework of Perez-Quiros and Timmermann (2000) on monthly excess returns of the decile portfolios formed on book-to-market equity. The data for the decile returns and Treasury bill rates are from Kenneth French's Web site. The sample period is from January 1954 to December 2007. They find that during recessions, the expected excess returns of value stocks are most strongly affected and the expected excess returns of growth stocks are least affected by worsening aggregate economic conditions as measured by higher short-term interest rate and higher default spread (measure of bankruptcy risks). During expansions, the expected excess returns of both value and growth stocks have insignificant loadings on the short-term interest rate and the default spread. Because of these asymmetries in response across the states of the economy, the expected value-minus growth returns displays strong cyclical variation. It tends to skip upwards rapidly during recessions and to decline more gradually during expansions.

Sarwar, Mateus and Todorovic (2016) examine asymmetries in size, value and momentum premiums during economic cycles in the UK and their macroeconomic determinants. They use monthly UK market data from July 1982 to June 2014. The UK SMB, HML and UMD factor data is comparable with the Fama-French's US equivalents. Using the Markov switching framework (closely related to Perez-Quiros and Timmermann (2000) and Gulen et al. (2008)), they related size (SMB), value (HML) and momentum (UMD) premiums to lagged values of UK macroeconomic variables, such as GDP growth, interest rates, money supply, credit spreads and inflation. They find that magnitude of most of the coefficients of macroeconomic variables is higher during economic downturns than economic upturns, suggesting that investors require greater compensation for higher macroeconomic risk. They find clear evidence of cyclical variations in the three premiums, most notable being that in the size premium, which changes from positive in expansions to negative in recessions. Macroeconomic indicators inducing such cyclicality the most are variables that proxy credit market conditions, namely the interest rates, term structure and credit spread.

All the above studies argue that the observed value and size premiums result from greater risk associated with holding value and small stocks, respectively, and hence higher returns as compensation. Their results thus provide general support for the rational market risk explanation of the value and size premiums.

In empirical finance, much attention was given to the time variation of the expected returns of size-BE/ME sorted portfolios or HML and SMB. In contrast, there has been little direct evidence to date (if any) on the time variation of loadings on the HML and SMB factors of Fama and French (1993). These different studies ask whether there exists a differential response in expected returns to negative monetary policy shocks between small (value) and large (growth) firms. In contrast, in our paper, we ask whether there exists a differential response in betas associated with value and size premiums (measures of risk) to negative aggregate shocks between value (size) and growth (large) firms. We also notice that the literature on the panoply of macroeconomic sources that can cause asymmetry in expected returns of value and small cap portfolios over different phases of business cycle focuses predominantly on the US market. Our study extends the previous literature by considering (if any) the cyclical variation of loadings on the HML and SMB factors and their macroeconomic determinants in the Tunisian stock market. It is a small market that accounts for slightly less than 100 listed securities.

3. Size and BE/ME Effects on the Tunisian Stock Market: Data Description and Methodology

We have examined the existence of size and BE/ME effect in the Tunisian stock market in an earlier paper (Bergaoui, 2015), over the period from July 1998 to December 2010. Our results confirm the presence of significant and strong BE/ME and size effects in the Tunisian stocks returns.

3.1 Portfolios Returns

Consistent with prior research, the sample includes only non-financial firms that trade in the Tunisian Stock Exchange (TSE), over the period from July 1998 to December 2010. Monthly stock prices, ME, and accounting data are obtained from the TSE's electronic database.

We have formed size-BE/ME portfolios using the methodology of Fama and French (1993). To be included in a portfolio, a firm must be trading in TSE both in December (t-1) and in June (t). Stocks with negative BE/ME are eliminated, as they do not have meaningful explanations. The number of firms that fulfill the data requirements range from 15 in 1998 to 28 in 2010. At the end of June of each year (t), stocks are assigned to two portfolios of (Small: S and Big: B) size based on whether their June market Equity (ME) is above (B) or below (S) the median ME. The same stocks are allocated in an independent sorting to three BE/ME portfolios, denoted as Low (L) Medium (M) and High (H). The BE/ME partitioning is based on the breakpoints for the bottom 30%, middle 40% and the top 30% of the BE/ME value in December (t-1), for TSE stocks. Six Size-BE/ME sorted portfolios are formed at the intersection of the two firm sizes and three BE/ME portfolios. The six formed portfolios are SH, SM, SL, BH, BM and BL. The ranking is redone each year and the portfolio composition changes because of the change in size and BE/ME values of firms listed in TSE. Monthly value-weighted returns of the six portfolios are calculated from July of year (t) to June of year (t+1). Average returns, from July 1998 to December 2010, of the six size-BE/ME sorted portfolios are calculated.

The results provide evidence of the presence of a BE/ME effect on the Tunisian Stocks Exchange (TSE). We find that excess returns of the six Size-BE/ME sorted portfolios are positive. We note a consistent negative relationship between size and average returns. The difference between the average returns of small and big stocks is positive (in all BE/ME category). This confirms the presence of a size effect on the TSE. We also notice (holding size constant) a monotonic positive relation between the BE/ME ratio and average returns, as in Fama and French (1993). We find that two stock portfolios with the high BE/ME ratio produces returns in excess of the two stock portfolios with the low BE/ME ratio. Consistent with the findings of Fama and French (1993), Kothari et al. (1995), Loughran (1997) and Daniel, Titman & Wei (2001), we notice that the BE/ME effect decreases with size and that the SH portfolio has the highest returns. For more details, see Bergaoui (2015).

3.2 Market, HML and SMB Factors

We replicate the Fama and French (1993) design in the construction of the SMB and HML portfolios that mimic the additional risk factors related to size and BE/ME. The SMB factor (size premium) is the monthly difference between the average of the returns of the three small stocks portfolios (SH, SM and SL) and the average of the returns of the three big portfolios (BH, BM and BL): SMB = {(SH+SM+SL)/3-(BH+BM+BL)/3}. The HML factor (value premium) is the monthly difference between the average of the returns of the two high BE/ME portfolios (SH and BH) and the average of the returns of the two low BE/ME portfolios (SL and BL): HML = {(SH+BH)/2-(SL+BL)/2. MKT= Rm_t-r_f: market factor (market risk premium) where Rm_t is monthly return of the Tunisian stock market index (TUNINDEX) and r_f is risk free rate; it is the monthly equivalent rate to monetary market rate. Average returns, from July 1998 to December 2010, of the HML and SMB factors are reported in Table 2.

Table 2. Monthly average returns (in percent) from July 1998 to December 2010

	MKT	SMB	HML
Average returns	0.76	0.954	2.316
Standard deviation	3.99	9.39	10.7
t-student	2.33	1.244	2.65

We notice that for the TSE, the three premiums are positive which is consistent with the risk-based explanation of size and BE/ME effects of Fama and French (1995, 1996). The average value of market risk premium is 0.76% per month (σ= 3.99), or 9.12% per year. The average size premium (SMB) is 0.954% per month (σ= 9.39) or 11.448% per year. Both premiums are higher than those found by Fama and French (1993) in the US market (the US market premium is 0.43% per month and the size premium is 0.27% per month). The average value premium (HML) is 2.316% per month (σ= 10.7) or 27,792% per year suggesting a higher return on value stocks compared to growth stocks. We note that the value premium observed on the Tunisian Stock market is remarkably more important but also more volatile than that observed in Fama and French (1993) (it is 0.44 per month with a σ =2.56 on the American Stock Exchange). We also notice that the value premium and the risk-market premium are significantly different from zero, with a t-value of 2.65 and 2.33, respectively. However, the size premium is not significantly different from zero (t-value= 1.244) but is economically significant, as it is positive and could be interpreted as a risk premium. The results reported in Table 2 have implications for investors in the TSE. Indeed, as the investment strategy based on the BE/ME ratio seems to outperform the market, investors in the TSE can also perform well above market returns. They just have to take a long position in value stocks and a short position in growth stocks (HML). Are these superior returns associated with superior risk? It is important to know whether these premiums arise from inherent risk in value and small stocks and thus whether such patterns may be affected by changes in macroeconomic conditions. Indeed, a greater understanding of the underlying mechanism governing the dynamics of value and size premiums would encourage investors to take advantage of such an investment strategy and enable them to improve their investment performance. It is important to identify the economic conditions in which the investment strategy is favorable or unfavorable.

3.3 Macroeconomic Factors

The relevant macroeconomic variables that we propose in this study are Money supply, interest rate, inflation and industrial production. They are commonly used in the literature on forecasting stock returns.

The Money Market Rate (MMR): Serves as a benchmark to determine debtor and creditor interest rates and to which is indexed the greatest part of interest rates. Consequently, the variation of MMR bears mechanically on the other banking interest rates. Therefore, MMR provides an indicator of market wide interest rates. The central bank of Tunisia (CBT) acts on the liquidity of the interbank market to influence the formation of interest rates and bring them to the required level. The evolution of MMR then reflects the monetary growth objectives of the central bank and thus the fate of monetary policy. It provides an indicator of the degree of tightness of credit market conditions. Referring to the literature on predicting economic cycles, Jagannathan and Wang (1996) suggest that, in general, interest rates are probably the most useful in predicting future economic conditions. This variable is widely used in the literature for modeling the expected returns and volatility of stocks (Chan, Chen & Hseih, 1985; Harvey, 1989; Fama and French, 1989; Perez-Quiros & Timmermann, 2000; Andersen et al., 2005; Black & McMillan, 2005; Gulen et al., 2008; Sarwar et al., 2015).

Monthly changes in the monetary aggregate M2 (dM2) (Note 4) measure the degree of liquidity in the economy. Our choice is motivated by the fact that the monetary aggregate M2 appears to be the CBT's leading indicator of monetary policy, while it monitors a number of other indicators, such as the level of net international reserves and the monthly inflation rate to assess the appropriateness of its monetary policy. Change in money supply proxies liquidity changes and monetary policy shocks (Perez-Quiros & Timmermann, 2000; Black & McMillan, 2005; Gulen et al., 2008; Sarwar et al., 2015). Intuitively, changes in money supply affects economic conditions and investment premium as they indicate credit market conditions.

Unexpected inflation: It is measured by the unanticipated monthly percentage changes in the Consumer Price Index (CPI). We took into account the effect of inflation as economic growth always brings with it the threat of inflation. The latter always carries the risk of an increase in interest rates (the goal of monetary policy is to ensure growth without inflation). Intuitively, any change in interest rates will affect the stock market. Many empirical studies have shown the effect of unexpected inflation on stock returns (Chan et al., 1985; Chen, Roll & Ross, 1986; Ferson & Harvey, 1998; Sarwar et al., 2015).

Data on real economic activity are monthly changes in industrial production index (IPI). It provides a metric on the state of the economy, i.e. whether the economy is in an expansionary or contractionary state (Mcqueen & Roley, 1993; Black & McMillan, 2005; Petkova & Zhang, 2005; Andersen et al., 2005).

4. A State-Space Version of the Three-Factor Model of Fama and French (1993)

The basic idea of Fama and French (1993) is the size and BE/ME ratio are considered as risk factors that are remunerated. Therefore, they developed a three-factor model in which the expected returns of a portfolio in excess of the risk-free rate is explained by sensitivity to three factors: (i) excess returns on a broad market portfolio MKT (Rm-Rf); (ii) The book-to-market equity factor HML (value premium) and the size factor SMB (size premium). The three-factor model provides a highly useful tool for selecting portfolios, evaluating their performance (Puttengill, Chang, & Hueng, 2013), measuring abnormal returns in event studies (Oberndorfer, Wagner & Ziegler, 2011) and estimating equity cost (Mishra & O'Brien, 2016). Despite the fact that the three-factor model is a benchmark in the asset pricing theory, it is still the object of empirical tests, aimed to identify the risk underlying the SMB and HML factors. Hence, we propose a State-Space version of the three-factor model. It is a flexible framework that allows the betas of the model (loadings on the three factors of Fama & French, 1993) to vary with the state of the economy and with the underlying macroeconomic fundamentals that measure changes in credit market conditions. This allows us to examine how loadings on the HML and SMB factors are affected by macroeconomic factors. The state-space version of the three-factor model is defined by the following two equations:

The measurement equation:

$$(R_{pt}-r_f) = \alpha_p + \beta_{MKT}\ (Rm_t-r_f) + \beta_{HMLt}\ HML_t + \beta_{SMBt}\ SMB_t + e_t \tag{1}$$

The transition equations:

$$B_{MKT} = \beta_{MKT(t-1)}+S_1*(1-D_{t-1})*dM_{2(t-1)}+S'_1*D_{t-1}*dM_{2(t-1)}+\delta_1*(1-D_{t-1})*dMMR_{t-1}+\delta_1'*D_{t-1}*dMMR_{t-1}+\gamma_1*(1-D_{t-1})*dCPI_{t-1}+\gamma_1'*D_{t-1}*dCPI_{t-1}+u_{1t} \tag{2}$$

$$\beta_{HMLt}=\beta_{HML(t-1)}+S_2*(1-D_{t-1})*dM_{2(t-1)}+S'_2*D_{t-1}*dM_{2(t-1)}+\delta_2*(1-D_{t-1})*dMMR_{t-1}+\delta_2'*D_{t-1}*dMMR_{t-1}+\gamma_2*(1-D_{t-1})*dCPI_{t-1}+\gamma_2'*D_{t-1}*dCPI_{t-1}+u_{2t} \tag{3}$$

$$\beta_{SMBt}=\beta_{SMB(t-1)}+S_3*(1-D_{t-1})*dM_{2(t-1)}+S'_3*D_{t-1}*dM_{2(t-1)}+\delta_3*(1-D_{t-1})*dMMR_{t-1}+\delta_3'*D_{t-1}*dMMR_{t-1}+\gamma_3*(1-D_{t-1})*dCPI_{t-1}+\gamma_3'*D_{t-1}*dCPI_{t-1}+u_{3t} \tag{4}$$

Where R_{pt}: Monthly return of portfolio p.

MKT= Rm_t-r_f : Market risk premium;

Rm_t: Monthly return in the TSM index (TUNINDEX);

r_f: Risk free rate, it is the monthly equivalent rate to monetary market rate;

SMB_t: *The* monthly difference between the return on a portfolio of small stocks and on a portfolio of big stocks (neutral with respect to the BE/ME ratio);

HML_t: *The* monthly difference between the return on a portfolio of high BE/ME stocks and the return on a portfolio of low BE/ME stocks (neutral with respect to size);

B_{MKT}, β_{HMLt}, β_{SMBt}: *Factor* loadings;

$dM_{2(t-1)}$: Unanticipated monthly percentage changes in the monetary aggregate M2;

$dMMR_{t-1}$: Unanticipated monthly percentage changes in the Money Market Rate;

$dCPI_{t-1}$: Unexpected inflation as measured by monthly percentage changes in the consumer price index (CPI);

α_p *is* an intercept.

$e_t \sim$ iid $N(0, \sigma^2)$ and $u_{it} \sim$ iid $N(0,\sigma^2)$.

The stats-space version of the three-factor model that we developed in this paper separates periods of economic recession and periods of economic expansion through the introduction of a dummy variable D_{t-1} that takes 1 if $dIPI_{t-1}>0$ and zero otherwise, where $dIPI_{t-1}$ is the monthly percentage changes in Industrial Production Index. This measure of real activity is often used in the literature to distinguish between periods of economic recession and periods of economic expansion (Mcqueen & Roley, 1993; Black & McMillan, 2005; Petkova & Zhang, 2005). Indeed, several studies in the literature have shown the dependence of the impact of macroeconomic variables on returns and risk of stock portfolios of the state of the economy. The same type of economic information could be "good" or "bad" news for the stock market depending on its timing (in a period of expansion or recession) (Perez-Quiros & Timmermann, 2000; Black & McMillan, 2005; Gulen et al., 2008; Cenesizoglu, 2011; Sarwar et al., 2015).

The S_i, δ_i and γ_i coefficients refer to the response of factor loadings (βi) to changes in money supply, interest rates and inflation, respectively, during contractionary periods.

The S_i', δ_i' and γ_i' coefficients refer to the response of factor loadings (βi) to changes in money supply, interest rates and inflation, respectively, during expansionary periods.

Variation over time and across states of the economy, in the risk of Size-BE/ME sorted portfolios is determined by the parameters of the conditional betas equations (2), (3) and (4).

If value (small) stocks are, inherently, more risky than growth (large) stocks, one would expect betas of value (small) stocks to be more responsive to changes in economic conditions than betas of growth (large) stocks and that this responsiveness increases during economic contractions. Then, one would expect to find S_i, δ_i, γ_i and S_i', δ_i', γ_i' of value and small stocks to be greater than S_i, δ_i, γ_i and S_i', δ_i', γ_i' of growth and big stocks, respectively. We would also expect to find S_i>S_i', δ_i> δ_i' and γ_i > γ_i' (in absolute value). Accordingly, the response of betas to money supply, interest rate and inflation changes would be greater in a recessionary than in an expansionary regime. In this case, one could interpret the cross-sectional differences in expected returns by differences in risk.

To estimate the impact of changing economic conditions on factor loadings, the efficient markets hypothesis implies that only the unanticipated components of economic news should be used. Indeed, security prices should only respond to the unexpected part of the news since the expected part should already be embedded in stock prices. In the American and other developed markets, researchers use survey data as a measure of market expectation because they are efficient and unbiased (Cenesizoglu, 2011; Bergbrant & Kelly, 2016). Nevertheless, no surveys are conducted in the Tunisian money market to measure expectations of its participants for different macroeconomic indicators. Hence, we use time- series models, instead of survey data to measure the expected changes in economic indicators. We use ARMA (p, q) models. Unanticipated components of macroeconomic variables changes is measured as the difference between the observed values of economic variables and the expected component as predicted by the ARMA (p, q) models.

To the best of our knowledge, this is the first study that examines how loadings on the HML and SMB factors are affected by unexpected changes in macroeconomic factors (that measure credit market conditions), especially during contractionary and expansionary periods.

5. The Results of the State-Space Version of Fama and French's Three-Factor Model

Estimation of the state-space version of the three-factor model is performed by applying the Kalman Filter and using the maximum likelihood method. We report the results for each of the four size-BE/ME sorted portfolios: SH, SL, BH and BL (Note 5), over the July 1998-December 2010 period, in Table 3.

Table 3. Estimation of the state-space version of three-factor model of Fama and French (1993) over the period from July 1998 to December 2010

		S_1	S_1'	δ_1	δ_1'	γ_1	γ_1'
	SH	-2.2515	1.7836	4.775	3.4937	0.3160	4.4026 *
	SL	-3.3679	8.7840 *	5.9966	4.9906	8.033 *	7.8209 *
β_{MKT}	BH	-7.4178 **	2.5964	6.0461 *	3.426	1.9240	4.4010
	BL	-3.4470	2.6267	5.8917	-1.1688	9.8468 **	1.8352
		S_2	S_2'	δ_2	δ'_2	γ_2	γ'_2
	SH	-3.2090 **	3.4405 ***	7.2460 ***	0.8928	0.7587	2.6660 ***
	SL	-2.5575 *	2.9339	5.8954 ***	0.4646	4.1507 **	1.5298
β_{HML}	BH	-4.4945 ***	5.0921 ***	5.2435 ***	2.0164 **	2.9858 **	5.2675 ***
	BL	0.07528	1.4955	3.7776 *	1.6777	2.9908	3.7779 ***
		S_3	S_3'	δ_3	δ'_3	γ_3	γ'_3
	SH	-7.1913 ***	7.9960 ***	13.1151 ***	3.500 **	1.9442	5.6789 ***
	SL	-7.5448 ***	7.3062 ***	5.5164 **	0.1626	9.5916 ***	8.1678 ***
β_{SMB}	BH	-4.6298 *	6.8280 ***	3.7871 *	0.4772	1.8442	5.5719 ***
	BL	-4.4623	5.7745 ***	4.2896 ***	2.4275	3.8207	5.8714 ***

* P-value< 10%, ** p-value< 5%, ***p-value<1%. The S_1, S2, S_3, (S_1', S_2', S_3') coefficients refer to the response of β_{MKT}, β_{HML} and $\beta_{SMB,}$ respectively, to unanticipated changes in money supply, as measured by dM2, during contractionary (expansionary) periods. The δ_1, δ_2, δ_3 (δ_1', δ_2', δ_3') coefficients refer to the response of β_{MKT}, β_{HML} and $\beta_{SMB,}$ respectively, to unanticipated changes in interest rates, as measured by dMMR, during contractionary (expansionary) periods. The γ_1, γ_2, γ_3 (γ_1', γ_2', γ_3') coefficients refer to the response of β_{MKT}, β_{HML} and $\beta_{SMB,}$ respectively, to unexpected inflation, as measured by dCPI, during contractionary (expansionary) periods (Note 6).

5.1 Variation Over Time and Across Economic States in the Risk (Betas) Associated to Market, HML and SMB Factors

Table 3 shows that for each of the Size-BE/ME sorted portfolios and in each loading factor equation (β_{MKT}, β_{HML}, β_{SMB}), there is at least one coefficient that is statistically significantly different from zero. This implies that Market, HML and SMB factor loadings vary over time with changes in monetary and economic conditions. To ensure statistical significance of the time-variation of exposures to Market, HML and SMB factors, we tested the null hypothesis that all coefficients associated with macroeconomic variables in the betas equations are jointly zero, against the alternative hypothesis that all coefficients are different from zero.

H0: Sij =S_{ij}' =δ_{ij} = δ_{ij}'= γ_{ij} = γ_{ij}' =0 (Note 7) where i = 1,2, 3 and j= portfolio SH, SL, BH, BL

H1: all coefficients ≠ o.

Using the Wald test, the results reject the null hypothesis at levels of statistical significance of less than 1%. Therefore, it seems that, in the TSE, the sensitivities of Size-BE/ME sorted portfolios returns to market, HML and SMB factors are time varying. Unanticipated changes in monetary and economic conditions seem to affect the influence of Fama and French's risk factors on stock returns. Hence, the assumption of constant betas coefficients in the traditional three-factor model of Fama and French (1993) seems unreasonable. This result provides empirical support for the rational market risk explanation of value and size premiums. Indeed, investor's risk concerns are different in times of restrictive and expansionary monetary policy (Jenson et al., 1997; Jensen & Mercer, 2002) or during contractionary and expansionary periods (Jogannathan & Wang, 1996). This shift in risk perception manifests itself in terms of different sensitivity to the risk factors, proxied by MKT, HML and SMB.

Table 3 shows that, in a recession period, the unanticipated changes in the aggregate money supply (dM2) generates negative coefficients (S_i) for all size-BE/ME sorted portfolios, in each beta equation. It seems that unanticipated higher monetary growth has the effect of reducing risk associated with market, HML and SMB factors during contractionary periods. One possible explanation is that the CBT conducts monetary expansion when the economy is in deep recession. This can have the effect of increasing investor expectations concerning future cash flows of companies. Therefore, the risk associated with stocks decreases. By way of contrast, in an expansion period, all coefficients on the unanticipated changes in money supply (S_i') are positive. This implies that the same information is perceived as bad news for the the TSE, in periods of economic expansion. It has the effect of increasing the amounts of risk associated with Market, HML and SMB factors. This result is consistent with Mcqueen & Roley (1993) who show that macroeconomic news has different effects at different points in the business cycle. One possible explanation is that, in periods of economic expansion, unanticipated expansion of the money supply leads market participants to expect the central bank to tighten conditions in order to offset an increase, which will result in higher interest rates in the future. Investors generally perceive a higher interest rate as an indicator of a higher macroeconomic risk. Based in the statistical significance of coefficients associated with dM_2, we note that unanticipated changes in the money supply have a greater effect on β_{SMB} and β_{HML} relative to $\beta_{Mkt.}$

Table 3 shows that an unanticipated increase in the Money Market Rate (dMMR) (reflecting tightening credit market conditions) appears to be bad news for investors in the TSE, in all states of the economy (expansion or recession). It seems that an unanticipated increase in MMR increases the sensitivity of SH, SL, BH and BL portfolios to market, HML and SMB factors. However, the statistical significance of coefficients associated with dMMR (δ2 and δ3) is mainly observed in recession's periods. Investors holding Size-BE/ME sorted portfolios seem to give more importance to unanticipated changes in MMR in periods of economic recession. One possible explanation is that, during economic recessions, the firm's net worth will be lower than usual. Bearing on the idea that a decline in a borrower's net worth raises the agency cost of the external finance, tighter credit markets will be associated with stronger adverse effects than during an economic expansion, when the firm's net worth is higher (Perez-Quiros & Timmermann, 2000).

The results in Table 3 also show that unexpected inflation has the effect of increasing the Size-BE/ME sorted portfolios sensitivities to MKT, HML and SMB factors during contractionary and expansionary periods. In fact, unexpected inflation can lead to the expectation of a more restrictive monetary policy by the CBT, which in turn would lead to a reduction in the present value of future cash flows of firms through an increase in interest rates. Therefore, the risk associated with equity increases.

Overall, results show that there is an economic evidence of asymmetries in the factor loadings (β_{SMB}, β_{HML}) of Fama and French (1993). However, they do not prove that asymmetries are statistically significant.

In what follows, we will test the statistical significance of asymmetry in betas variations over the economic cycle.

5.2 Tests of Statistical Significance of Cyclical Asymmetries in Fama and French's (1993) Factor Loadings (Betas)

To the best of our knowledge, this is the first study that examines whether there are asymmetric responses in betas associated with value and size premium to negative aggregate shocks across contractionary and expansionary periods. We test the null hypothesis of symmetry:

H_0: $|S_{ij}| = |S'_{ij}|$ against H_1: $|S_{ij}| > |S'_{ij}|$ where i=1, 2, 3 and j: portfolios SH, SL, BH, BL

H_0: $|\delta_{ij}| = |\delta'_{ij}|$ against H1: $|\delta_{ij}| > |\delta'_{ij}|$

H_0: $|\gamma_{ij}| = |\gamma'_{ij}|$ against H_1: $|\gamma_{ij}| > |\gamma'_{ij}|$

Therefore, to support the rational market risk view of value and size premiums, one would expect (the alternative hypothesis) that the response of Size-BE/ME sorted portfolios' betas (β_{HML},β_{SMB}) to unanticipated changes in monetary and economic conditions to be greater in a recessionary than in an expansionary regime. The results are reported in the following table:

Tableau 4. Tests of statistical significance of cyclical asymmetries in β_{MKT}, β_{HML} and β_{SMB} over the period July 1998-December 2010

		$H_0 : \|S_i\| = \|S_i'\|$		$H_0 : \|\delta_i\|=\|\delta_i'\|$		$H_0 : \|\gamma_i\|=\|\gamma_i'\|$	
		$\mathfrak{M}$	p-val	$\mathfrak{M}$	p-val	$\mathfrak{M}$	p-val
β_{MKT}	SH	0.0111	0.9162	0.0006	0.9804	0.4860	0.4857
	SL	0.3729	0.5414	0.0028	0.9574	0.0159	0.8995
	BH	0.1527	0.6959	0.6767	0.4107	0.2465	0.6195
	BL	0.0308	0.8606	0.2533	0.6147	1.4766	0.2243
β_{HML}	SH	0.0169	0.8964	9.4967	0.0021***	0.8356	0.3607
	SL	0.0197	0.8882	8.9664	0.0027***	14.8024	0.0001***
	BH	0.1029	0.7484	4.1356	0.0420**	0.7565	0.5175
	BL	0.5562	0.4558	1.2983	0.2545	0.2262	0.6343
β_{SMB}	SH	0.0054	0.9414	10.4141	0.0013***	0.8383	0.3599
	SL	2.1645	0.1412	4.4900	0.0341**	2.7807	0.0954*
	BH	1.4755	0.2343	1.3174	0.2511	2.60711	0.1064
	BL	0.3288	0.5075	0.3187	0.5724	0.3573	0.5500

P-value refers to the degree of significance of the null hypothesis H0. * P-value: reject H0 at the significance level of 10%: **p-value: reject H0 at the significance level of 5% ***p-value: reject H0 at the significance level of 1%. $\mathfrak{M}$: The Wald statistic follows a standard chi-square.

Table 4 shows that, contrary to the results of several previous empirical studies of the US and other developed markets, the assumption of counter-cyclicality of market beta facing macroeconomic information is not confirmed in the Tunisian context. Indeed, the null hypothesis of symmetry of market beta's response to changes in macroeconomic indicators through the economic cycle phases cannot be rejected under the considered statistical significance levels. This result is confirmed for all the size-BE/ME sorted portfolios. Therefore, in the TSE, market beta seems to vary depending on unanticipated changes in macroeconomic indicators. However, this variation is of the same magnitude whether in periods of recessions or economic expansion.

In line with expectations, the recessionary coefficients associated with unanticipated changes in Money Market Rate (dMMR) are of greater magnitude (in absolute value) and of greater statistical significance than the expansionary coefficients, both in the β_{HML} and β_{SMB} equations.

In the β_{HML} equation, we have $\delta_2>\delta_2$ for the portfolios SH, SL and BH. Therefore, during periods of increased macroeconomic risk, the β_{HML} of value stocks (regardless of size) becomes much more sensitive (in terms of magnitude) to an unexpected restrictive monetary policy (unexpected increase of MMR) than during periods of economic expansion. On the other hand, for growth stocks, this asymmetry variation is observed only for the category of small-cap stocks (SL).

The null hypothesis on the coefficients associated with changes in MMR (δ_3=δ_3') in the β_{SMB} equation is strongly rejected for the SH and SL portfolios. The sensitivity of small stocks (whatever the category of the BE/ME ratio) to the SMB factor, seems to increase more significantly during economic recessions with respect to a more restrictive monetary policy compared to periods of economic expansion. The risk associated with large cap stocks seems to react homogeneously to an unanticipated increase of MMR in all states of the economy. These results are consistent with the assumptions of Gertler & Gilcrist (1994). It seems that firms with a relatively strong financial position, like large firms, would show less asymmetric response to monetary shocks during the economic cycle.

Hence, we notice that, during periods of increased macroeconomic risk, the factor loadings of Fama and French (1993) become more sensitive to changes in interest rates and hence investors are willing to require higher rates of returns compared to periods of economic booms.

According to Table 4, the null hypothesis of a symmetric response to unanticipated changes in M2 does not seem to be rejected at conventional levels. The asymmetric effects of shocks in the M2 aggregate on β_{HML} and β_{SMB} is perceived in terms of signs rather than in terms of amplitude (see Table 3).

Table 4 also shows that the null hypothesis on the coefficients associated with unexpected inflation is rejected for the SL portfolio, in the β_{HML} and β_{SMB} equations. It seems that the risk associated with small firms with a low BE/ME ratio are more sensitive to an unexpected increase in inflation during periods of economic recession, compared to periods of economic expansion.

5.3 Relationship of the Effect of Macroeconomic Information on Betas with the Size and BE/ME Ratio

Our aim is to see whether value and small stocks are more (negatively) affected by unanticipated changes in macroeconomic indicators, especially during economic downturns, compared to growth and large stocks, respectively. We referred to Table 3 to see if the coefficients associated with the different macroeconomic indicators relate to the ME and BE/ME ratio.

Referring to the results reported in Table (3), we notice that in the equation of conditional market beta (β_{MKT}) there is no monotonic relationship between the coefficients associated with macroeconomic indicators and the BE/ME ratio or ME. This means that, even under the conditional version of the three-factor model, market beta does not explain the difference between value and growth stock returns, or between small and large firms' returns.

In the β_{HML} equation, we note a systematic relationship between all the coefficients associated with changes in macroeconomic indicators and the BE/ME ratio. Coefficients of the value stocks portfolios are higher than those of the growth stocks portfolios, whatever the category of market capitalization (one exception is the coefficient on inflation in recession periods). Thus, the risk of value stocks, associated with HML factor, increased more significantly than that of growth stocks with respect to adverse changes in monetary and economic conditions. As investors seek additional compensation for accepting higher risk, expected returns of value stocks would be higher than those of growth stocks.

In the β_{SMB} equation, the amplitude of the coefficients associated with changes in money supply (M2), changes in MMR, and with inflation, increases from large cap stocks to small cap stocks (whatever the category of the BE/ME ratio). Therefore, it seems that sensitivity of small stocks to the SMB factor is more strongly negatively affected by a restrictive monetary policy compared to that of large firms. This result is confirmed, both in periods of economic downturns and in periods of economic expansions, regardless of the category of the BE/ME ratio. (With a single exception for growth stocks during periods of economic expansion when the coefficient of the SL portfolio is lower than that of the BL portfolio, but both coefficients are statistically not significantly different from zero)

Consistently with recent imperfect capital market theories (Gertler & Gilchrist (1994)), the results of our study imply that small firms' risk (associated with SMB factor) is strongly more affected by tighter credit market conditions than large firms 'risk, in all economic states. Thus, investors would require higher returns to take on this additional risk.

5.5 Estimation of Conditional Betas and Specification Tests

We have estimated conditional betas: β_{MKT}, β_{HML}, β_{SMB} and the intercept of the conditional version of Fama and French's (1993) three-factor model. Our goal is to see if, even under the conditional version of the model, HML and SMB continue to have an incremental power over the market factor to explain the difference between value and growth stocks returns, or between small cap and large cap stocks returns. The results of conditional betas: β_{MKT}, β_{HML}, β_{SMB}, and the intercept are reported in the following table

Tableau 5. Results of conditional β_{RM}, β_{HML} and β_{SMB} and intercept over the period July 1998-December 2010

	α	β_{MKT}	β_{HML}	β_{SMB}
SH	0.00915	0.6161 ***	0.41196 ***	0.8538 ***
SL	-0.00073	1.1800 ***	-0.3943 ***	0.6742 ***
BH	0.00064	0.6574 ***	1.2927 ***	-1.8617 ***
BL	0.01216	0.2239 *	-1.3125 ***	-1.9219 ***

* P-value < 10%, *** p-value < 1%. α: Intercept of the model.

Even in the conditional version of the three-factor model of Fama and French (1993), the coefficients associated with the HML and SMB factors are statistically significantly different from zero. This confirms the additional explanatory power of the HML and SMB factors, in addition to the market risk premium for the cross-sectional variation of stock returns in the TSE. Consistent with the results of Fama and French (1993) under the static version of the three-factor model, we notice that the coefficients associated with HML (β_{HML}) are positive and statistically significant, at the 1% significance level, for the two portfolios with the high BE/ME ratio (SH and BH). They are negative for stocks with a low BE/ME ratio (SL and BL). Therefore, the positive sensitivity of the value stocks to the HML factor explains their relatively higher returns compared to those of growth stocks. Similarly, the coefficient associated with the size factor SMB (β_{SMB}), is positive for the two portfolios of small cap stocks and negative for the two portfolios of large cap stocks. A positive coefficient combined with a positive SMB premium, results in higher returns for small cap stocks.

According to Fama and French (1993) and Ferson and Harvey (1998), if a model is parsimonious and describes well the cross-section of average returns, the intercepts of the model should be indistinguishable from zero. Indeed, the intercept is often used in finance as a measure of abnormal returns (the component of returns unexplained by the model). Hence, we are especially interested in whether the mimicking returns of SMB and HML absorb the size and book-to-market effects on average returns. We then examine intercepts of four measurement equations. Table (5) shows that all intercepts are close to zero at the considered statistical significance level. This implies that, even under the conditional version of the three-factor model, Market, HML and SMB still explain well the cross-section of average returns. Fama and French (1993) argue that, if a model captures the cross section of expected returns, the predictability of stock returns should be embodied in the explanatory returns (risk premiums) of the model. Model residuals should be unpredictable. To test this hypothesis, we run regressions of residuals (obtained from the four measurement equations) on all instrumental variables of the model. Thus, we estimated regressions of the residuals on macroeconomic indicators (dM2, dMMR, dCPI) and the three Market, SMB and HML factors. The results show that all the coefficients associated with the macroeconomic variables as well as those associated with the Market, HML and SMB factors are not statistically significantly different from zero. This implies that the residuals do not contain additional information on the returns of the SH, SL, BH and BL portfolios, in addition to that taken up by the three factors MKT, HML and SMB (Note 8).

6. Conclusions

Despite the fact that the three-factor model of Fama and French (1993) is a benchmark in the asset pricing theory, it is still the object of empirical tests, aimed to identify the risk underlying the SMB and HML factors. The main purpose of our paper is to explore the macroeconomic determinants of risk underlying the SMB and HML factors. Hence, we propose a State-Space version of the three-factor model. It is a flexible framework that allows the betas of the model (loadings on the three factors of Fama and French, 1993) to vary with the state of the economy and with the underlying macroeconomic fundamentals that measure changes in credit market conditions. In empirical finance, there has been little direct evidence to date (if any) on the time variation of loadings on the HML and SMB factors of Fama and French (1993) with changes in macroeconomic conditions. Our study extends the previous literature, by examining how loadings on the HML and SMB factors are affected by unanticipated changes in macroeconomic factors and whether they exhibit an asymmetric behavior during the business cycle. In particular, we ask whether the betas associated with the HML and SMB factors of firms with different size or different BE/ME ratio react differently to negative aggregate shocks and whether such response exhibits asymmetry across the different stages of the business cycle, i.e, between expansionary and contractionary regimes. Unlike most previous studies which focused on the American and other developed markets, we are interested in the Tunisian Stock Exchange. It's a small market that capitalizes less than 100 listed securities.

The main empirical results of the State-Space version of Fama and French's three-factor model and of the associated tests do indeed support the time variation of sensitivities of size-BE/ME sorted portfolios' returns to the market, HML and SMB factors with unanticipated changes in monetary and economic conditions. Hence, the assumption of constant (betas) coefficients under the traditional three-factor model of Fama and French (1993) seems not reasonable. Contrary to the results of several previous studies of the US and other developed markets, the assumption of counter-cyclicality of market beta facing macroeconomic information is not confirmed in the Tunisian context. It seems that variations of market beta with unanticipated changes in macroeconomic indicators is of the same magnitude in all states of the economy. However, the results support the asymmetric behavior of betas, associated to the HML and SMB factors, to changes in monetary conditions between stages of the business cyclical. Loadings on the HML and SMB factors respond more to unexpected changes in monetary market interest rate in a recessionary period than in an expansionary period. therefore, during periods of increased macroeconomic risk, loadings of Fama and French' factors (1993) become more sensitive to changes in interest rates and consequently investors are willing to demand higher return rates than during periods of economic booms. The asymmetric response of betas associated with the HML and SMB factors to unexpected changes in money supply is perceived in terms of signs rather than in terms of amplitude. Unexpected higher monetary growth has the effect of reducing the risk (betas) associated with the market, HML and SMB factors during a deep recession. The same information has the effect of increasing these betas during economic expansion.

Furthermore, the loadings of value stocks (whatever the category of market capitalization) on the HML factor are more responsive to changes in macroeconomic conditions than those of growth stocks. Therefore, the risk of value stocks increased more significantly than that of growth stocks with respect to adverse changes in monetary and economic conditions. As investors seek additional compensation for accepting higher risk, expected returns of value stocks would be higher than those of growth stocks. Similarly, the loadings of small cap stocks on the SMB factor are strongly more affected by tighter credit market conditions than those of large cap stocks, in all states of the economy. As small cap stocks are more risky than large cap stocks, investors would demand a higher compensation (higher expected returns) for a greater risk. We notice that, even under the conditional version of the three-factor model, market beta does not explain the difference between value and growth stock returns or between small and large stocks. There is no monotonic relationship between the coefficients associated with macroeconomic indicators, in the beta market equation, and BE/ME ratio or ME.

Even under the conditional version of the three-factor model, we found a monotonic relationship between the coefficient associate with HML (conditional beta) and the BE/ME ratio. It is positive and statistically significant for the two portfolios with a high BE/ME ratio. It is negative for portfolios with a low BE/ME ratio. then, the higher sensitivity of value stocks to the HML factor explains their relatively higher returns compared to those of growth stocks. Likewise, the coefficient associated with the SMB (conditional beta) factor relates to size. Thus, it is positive for the portfolios of small firms and negative for the portfolios of large ones. A positive coefficient combined with a positive SMB premium translates into higher returns for small firms. The results of the state-space version of the three-factor model are consistent with those of Fama and French's static version of the model.

These results thus provide general support for the rational market risk explanation of the value and size premiums in the Tunisian context. It seems that HML and SMB serve to mimic the risk factors associated with unexpected changes in monetary and economic conditions. Our paper has implications for professional investment managers. Indeed, a greater understanding of the underlying mechanism governing the dynamics of value and size premiums would enable managers to improve their investment performance.

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Notes

Note 1. Financial firms are excluded in the study of Fama and French (1993).

Note 2. Because of measurement difficulties and selection biases, fundamentally determined macroeconomic factors will never approach the empirical performance of portfolio-based factors. However, they may help to explain which portfolio-based factors really work and why (Cochrane, 1999).

Note 3. They argue that a stabilization policy requires that the fed follows a restrictive policy when the economy is strong and interest rates are rising and an expansionary policy when the economy is weak and rates are falling.

Therefore, risk premiums must be relatively high for firms that have market views indicating high risk in expansionary policy periods.

Note 4. M1 (millions of Tunisian Dinars) is the sum of currency and demand deposits. M2 is the sum of M1 and quasi-money.

Note 5. We have ignored median BE/ME portfolios (SM, BM) because of the weakness of their results which can be explained by a greater heterogeneousness of their stocks.

Note 6. We use ARMA(p,q) models to measure expected changes in macroeconomic variables. The unanticipated component of each macroeconomic indicator is measured as the difference beteween the announcement value of the economic variable and the expected component as predicted by ARMA models. The results of ARMA models for the different macroeconomic variables are reported in the Appendix (table A1).

Note 7. The test is conducted using the Wald statistic which is distributed χ^2 (q) with a degree of freedom equal to the number of restrictions under the test. The wald test results are reported in the Appendix (table A2).

Note 8. The results of these regressions are available on request.

Appendix

Table (A1). The results of ARMA (p, q) models over the period July 1998-December 2010:

	C	AR(1)	AR(2)	MA(1)	MA(2)
dCPI	0.0027	0.2954			
dM2	0.0097	1.17	-0.857	-1.343	0.989
dMMR	-----	0.385	-0.811	-0.363	0.964

The values in the table denote the coefficients associated with AR (1), AR (2), MA (1), MA (2), terms. C: is a constant. The unanticipated component of each economic indicator is calculated as the difference between the observed value and the value predicted by ARMA (p, q). All coefficients are statistically significant at the conventional level of 1%

Table (A2). Tests of statistical significance of cyclical asymmetries in $\beta_{MKT,}$ β_{HML} and β_{SMB} over the period July 1998-December 2010

		β_{MKT}	β_{HML}	β_{SMB}
SH	$\mathfrak{M}$	22.3473***	72.9433***	171.955***
	p-val	0.001	0.000	0.000
SL	$\mathfrak{M}$	12.4550*	56.9859***	35.9731***
	p-val	0.0526	0.000	0.000
BH	$\mathfrak{M}$	19.526***	48.247***	145.419***
	p-val	0.0034	0.000	0.000
BL	$\mathfrak{M}$	22.268***	23.502***	68.082***
	p-val	0.0011	0.0006	0.000

P-value refers to the degree of significance of the null hypothesis of symmetry H0, that all coefficients in each beta equation are indistinguishable from zero. * P-value: reject H0 at the significance level of 10%. ***p-value: reject H0 at the significance level of 1%. χ^2 : The Wald statistic follows a standard chi-square.