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Some Econometric Issues on the Evaluation of Hedge Fund Risk-taking Cycles

CAHIER DE RECHERCHE

UNIVERSITÉ DE SHERBROOKE

Préambule

La gestion financière responsable vise la maximisation de la richesse relative au risque dans le respect du bien commun des diverses parties prenantes, actuelles et futures, tant de l'entreprise que de l'économie en général. Bien que ce concept ne soit pas en contradiction avec la définition de la théorie financière moderne, les applications qui en découlent exigent un comportement à la fois financièrement et socialement responsable. La gestion responsable des risques financiers, le cadre réglementaire et les mécanismes de saine gouvernance doivent pallier aux lacunes d'un système parfois trop permissif et naïf à l'égard des actions des intervenants de la libre entreprise.

Or, certaines pratiques de l'industrie de la finance et de dirigeants d'entreprises ont été sévèrement critiquées depuis le début des années 2000. De la bulle technologique (2000) jusqu'à la mise en lumière de crimes financiers [Enron (2001) et Worldcom (2002)], en passant par la mauvaise évaluation des titres toxiques lors de la crise des subprimes (2007), la fragilité du secteur financier américain (2008) et le lourd endettement de certains pays souverains, la dernière décennie a été marquée par plusieurs événements qui font ressortir plusieurs éléments inadéquats de la gestion financière. Une gestion de risque plus responsable, une meilleure compréhension des comportements des gestionnaires, des modèles d'évaluation plus performants et complets intégrant des critères extra-financiers, l'établissement d'un cadre réglementaire axé sur la pérennité du bien commun d'une société constituent autant de pistes de solution auxquels doivent s'intéresser tant les académiciens que les professionnels de l'industrie. C'est en mettant à contribution tant le savoir scientifique et pratique que nous pourrons faire passer la finance responsable d'un positionnement en périphérie de la finance fondamentale à une place plus centrale. Le développement des connaissances en finance responsable est au cœur de la mission et des intérêts de recherche des membres tant du Groupe de Recherche en Finance Appliquée (GReFA) de l'Université de Sherbrooke que de la Chaire Desjardins en finance responsable.

La finance responsable (ou durable) vise donc notamment à développer des modèles, des produits et des services ainsi qu'à orienter les marchés financiers et les décisions en matière de fiscalité dans une perspective durable et responsable. À cet effet, les Professeur(e)s Frank Coggins, Claudia Champagne et Lyne Latulippe ont publié en 2018 aux Éditions *Thompson Reuters* un recueil de textes s'intitulant « Éléments de la finance responsable : une approche multidimensionnelle ». Ce collectif contribue à mieux définir et délimiter la finance responsable en la décloisonnant dans une perspective multidimensionnelle. Il regroupe des textes d'universitaires de différentes disciplines ainsi que de spécialistes de l'industrie financière, propose des pistes pour tendre vers une meilleure finance, vers une finance plus responsable. Le présent cahier de recherche constitue l'un des textes (chapitres) tirés de ce collectif.

Some Econometric Issues on the Evaluation of Hedge Fund Risk-taking Cycles

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1. INTRODUCTION

The US financial system has been hit by a wave of financial innovations since the start of the 1980s which has led to the spread of new kinds of financial instruments such as options and structured products like CLO (collateralized loan obligations) and CDO (collateralized debt obligations). Securitization[1] is also a new kind of financial activity which has registered a very quick growth since the 1990s.[2] These developments have led to the rise of new forms of banking which, in contrast to the traditional business lines of banks, are market-based like shadow banking.[3] Moreover, the growth of hedge funds has been very important since the start of the 1990s and especially during the period stretching from 2000 to 2007—i.e., just before the occurrence of the subprime crisis. Indeed, confronted by a structural decrease in interest rates, investors were in "search of yield"[4] and the products engineered by hedge funds provided an attractive return compared to other securities available on financial markets. However, investors often forget that yield and risk are two sides of the same coin. Indeed, these funds are involved in option-like strategies which embed substantial higher moment risk—especially risk related to negative return skewness and high return excess kurtosis.

1. Note that there is a distinction between structured products and securitization. Structured products are engineered derivatives like credit default swaps (CDS) and lookback straddles. But they may also include securitized assets like mortgage-backed securities (MBS) or CLO. Securitization is the process of transforming illiquid assets into liquid ones, like transforming a pool of mortgages into MBS sold to investors.
2. For instance, in 2006—i.e., just before the subprime crisis—securitization was equal to 16% of GDP in the US and to 8% in the United Kingdom. Source: "The role of banks in the monetary policy transmission mechanism", *ECB Monthly Bulletin*, August 2008, p. 85-98.
3. I.e., these institutions finance their activities by relying on financial market securities and not on deposits like traditional banks.
4. On the "search of yield" problematic, see: "The role of banks in the monetary policy transmission mechanism", *ECB Monthly Bulletin*, August 2008, p. 85-98.

In this respect, this chapter provides an overview of our results on the cyclicality of hedge fund risk-taking and provides a summary of the difficulties in estimating risk in the hedge fund industry. Overall, the returns of hedge funds are procyclical. These issues may have important consequences from the point of view of responsible finance. Indeed, an understatement of risk may lead to an overstatement of the performance of hedge funds and thus attract uninformed investors in search of yield. Turning to procyclicality, this means that most securities engineered by hedge funds do not differ intrinsically from the other assets available on financial markets. In contrast with common beliefs, hedge fund business lines thus embed a substantial amount of market (systematic) risk in spite of their hedging transactions. Once again, uninformed investors may invest wrongfully in this industry to hedge their portfolios. However, procyclicality in the hedge fund industry seems to have receded through time. Moreover, some strategies like market neutral and futures are much less procyclical than others. These strategies may thus offer good investment opportunities during bad times.

2. MEASUREMENT ERRORS IN ASSET PRICING MODELS

When analyzing the returns of hedge funds, we obviously cannot rely on ordinary least squares (OLS) regressions because one of the basic assumptions of OLS is that the innovation or error term is normally distributed. Indeed, hedge fund returns are not normally distributed. Strategies' returns tend to be negatively skewed while normal returns are symmetric (zero skewness). For the investor, this means that negative outliers—i.e., negative returns—are more frequent with hedge fund return distributions than with a normal distribution. Moreover, hedge fund returns display excess kurtosis with respect to the normal distribution for which kurtosis is equal to 3. This means that extreme events, like crises, are more frequent with hedge fund returns than with normal returns. In Racicot and Théoret (2014a), we propose new instruments to tackle the non-normality of hedge fund returns and the measurement errors embedded in empirical asset pricing models.[5] These instruments embed the

5. Indeed, theoretical asset pricing models rely on *expected* excess returns while empirical asset pricing models resort to observed excess returns. The endogeneity issue related to the use of observed excess returns at the empirical level must be tackled with robust instruments. Moreover, specific biases in the hedge fund industry—like the survivorship bias and the biases associated with return smoothing and asset illiquidity—magnify the measurement errors problem.

higher moments of our models' explanatory variables and are used to smooth or filter our endogenous variables.[6] The simple higher moment instruments (*hm*) are the higher moments of the explanatory variables proposed by Fuller (1987), Cragg (1997) and Lewbel (1997). These instruments are particularly well-suited to model hedge fund returns which are usually negatively skewed and which display a high level of excess kurtosis. Using these instruments to deal with the endogeneity issues embedded in hedge fund asset pricing models, we rely on the GMM (Generalized Method of Moments) to run our regressions.[7]

In Racicot and Théoret (2014a), we also innovate by proposing an econometric procedure which is based on the artificial Hausman (1978) regression and which embeds a measurement errors test. To implement this kind of regression, we define a vector of artificial variables which are the differences between the explanatory and instrumented variables. We then perform a Hausman artificial regression using ordinary least squares (OLS) which includes the vector of artificial variables. This vector allows us to gauge measurement errors. We also developed a test on the magnitude of measurement errors. Our experiments suggest that these dimensions may have important repercussions on the evaluation of the performance of the various strategies available to investors. Performance may be quite overstated but also quite understated, which suggests that the investor must be very prudent when he puts his money in the hedge fund industry.

3. HEDGE FUNDS AND SYSTEMIC RISK

We can also go a step further and investigate how hedge funds as a group react to macroeconomic uncertainty (see Racicot and Théoret, 2016a). This question is important because if hedge funds react homogeneously across the strategies they follow, systemic risk is increased in the hedge fund industry and the possibilities of portfolio diversification are then quite restricted. Indeed, hedge fund systemic risk has been conceptualized as a situation in which a

6. The cumulant instruments are a combination of the Durbin (1954) and Pal's (1980) estimators which were used previously to tackle the endogeneity issue associated with the econometric problem of errors-in-variables (RACICOT, 1993; DAGENAIS and DAGENAIS, 1994, 1997).
7. Heuristically, the GMM estimator can be viewed as a least-squares using optimal weights for moments.

large number of financial institutions (e.g. hedge funds) fail due to a common contagion process. In this respect, a great number of hedge funds have failed in the recent subprime crisis and the average rate of survival of a representative hedge fund does not exceed five years (Dan McCrum, *Financial Times*, July 2014). Previous studies find that agents tend to take less risk as a group when macroeconomic and financial uncertainty increases (Beaudry *et al.*, 2001; Baum *et al.*, 2002, 2004, 2009; Calmès and Théoret, 2014). These authors base their analysis on the following equation:

$$\forall i, \quad \forall t, \quad \frac{\partial Var\left(w_{it}^{ra}\right)}{\partial \sigma_{v,t}^{2}} = f(\varphi, \sigma_{v,t}^{2}) < 0 \qquad (1)$$

where w_{it}^{ra} the cross-sectional dispersion[8] of the shares of risky assets in the investors' portfolios, each investor or category of investors being denoted by i; $\sigma_{v,t}^{2}$ is the conditional variance[9] of a macroeconomic time series which stands as uncertainty in the model and φ is the degree of risk aversion of the representative investor. Equation (1)—which is based on an optimization model—shows that the variance of the cross-sectional dispersion of the weights of risky assets in investors' portfolios is reduced when macroeconomic uncertainty increases. The risk-taking behavior of investors thus becomes more homogeneous when macroeconomic uncertainty increases, which increases systemic risk in the economy. For instance, they deleverage their balance sheet together, which leads to fire sales which compounds the leverage problem by generating spillover effects (Shleifer and Vishny, 2010; Gennaioli *et al.*, 2013). This increases procyclicality in the sense that the behavior of investors amplifies the business cycle.

In the framework of their study, Beaudry *et al.* (2001) find that firms search for less risky investment projects when macroeconomic uncertainty increases. As regards Baum *et al.* (2002, 2004, 2009), they find that banks reduce, as a group, their loans-to-assets ratio when uncertainty increases, preferring to load liquid assets. Finally, Calmès and Théoret (2014) show that banks reduce their fee-based activities—i.e., activities which are positioned off-balance-sheet like securitization and investment banking—when uncertainty increases.

8. The cross-sectional dispersion is the contemporaneous standard deviation of the investors' shares (see RACICOT and THÉORET, 2014b).
9. The conditional variance is a time-varying variance based on an information set. For more details, see RACICOT and THÉORET (2001), chap. 10.

This model has been transposed to hedge fund strategies, more specifically the strategies followed by the funds included in the *Greenwich Alternative Investment* database (see Racicot and Théoret, 2016a). The behavior of the cross-sectional dispersion of hedge fund strategies' betas is modelled using a return equation which includes the traditional factors of the Fama and French model (1993) and the returns of lookback straddles which help depict the hedge fund option-like strategies (Fung and Hsieh, 1997, 2001, 2004). This is the observation or signal equation in their Kalman filter setting. The state equations are the time-varying alphas and betas of the strategies used to compute their cross-sectional dispersions. Consistent with Beaudry *et al.* (2001), the cross-sectional dispersion of strategies' betas shrinks when macroeconomic and financial uncertainty increases. Hedge funds thus reduce as a group their systematic risk—as measured by their beta—when uncertainty is higher by deleveraging their balance sheets. As explained earlier, this common willingness to reduce systematic risk is a source of systemic risk since it leads to frictions in the economic and financial systems.

This empirical model is also applied to the cross-sectional dispersions of strategies' alphas and strategies' returns. However, their cyclical behavior is not in line with Beaudry *et al.*'s conjecture. These dispersions tend to increase during episodes of rising macroeconomic uncertainty, which suggests that hedge fund strategies become less homogenous on the return and alpha dimensions in times of turmoil. This result may be explained by the presence of Black's (1976) leverage effect which is at play during financial crises. According to this effect, the volatility of stock markets—as measured by the variance of returns—increases when stock prices move downward. Another explanation lies in the fact that the exposure of hedge fund strategies to risk factors is quite different from each other. Procyclicality thus seems to have receded through time in the hedge fund industry, which suggests that a learning process is at play.

4. IN SEARCH OF OTHER SOURCES OF MARKET ANOMALIES IN THE HEDGE FUND INDUSTRY[10]

Fama and French (2015) recently proposed an augmented version of their former asset pricing model (Fama and French, 1993) which, in addition to their three classical factors, includes two new

10. For an introduction to regression analysis with applications to finance, see RACICOT and THÉORET (2001).

factors associated with the q-factor model (Abel, 1983; Cochrane, 2005). This augmented empirical asset pricing model may be written as follows:

$$\forall i, \forall t \quad R_{it} - r_{ft} = \alpha_i + \beta_{i1}\left(R_{mt} - r_{ft}\right) + \beta_{i2} SMB_t + \beta_{i3} HML_t + \beta_{i4} CMA_t + \beta_{i5} RMW_t + \varepsilon_{it} \qquad (2)$$

where R_{it} is the return on investor *i*'s portfolio;[11] r_{ft} is the risk-free interest rate; R_{mt} is the return on the market portfolio; SMB_t and HML_t are the factors related to the well-known small size and value anomalies, respectively; CMA_t is the return on a portfolio which is long in firms displaying a low investments-to-assets ratio and short in firms having a high corresponding ratio; RMW_t is the return on a portfolio which is long in firms having a high profitability and short in firms displaying a low profitability. In the q-factor model, a higher exposure to *CMA* and *RMW* factors commands a higher expected excess return.

Abel (1983) has provided one of the first versions of the q-factor model.[12] According to this model, firms' investment is a positive function of Tobin's *q* and a negative function of the cost of funding investment. Tobin's *q* is a well-known statistics which is the ratio of the market value of firms' assets to their book value.[13] When q >1, firms invest. In the long-run, the steady state Tobin's *q* converges to 1.

According to the classical q-factor model a stock expected return is related essentially to three factors. First, it co-moves positively with its risk premium (see Racicot and Théoret, 2016b). Second, it co-moves positively with the profitability factor as measured by Tobin's *q*. Finally, it co-moves negatively with the investment factor. This is the essence of the investment-based asset pricing model.

Equation (2) is estimated using the Greenwich Alternative Investment monthly database over the period 1995-2012. More precisely, in addition to the general index, the returns of nine hedge fund strategies are investigated. Specific dimensions of hedge funds are accounted for by adding, in Equation (2), the seven factors proposed by Fung and Hsieh (1997, 2001, 2004) to estimate models of hedge fund returns. An autoregressive term is also added to account

11. A hedge fund strategy in our case.
12. For more details on this approach, see RACICOT and THÉORET (2016c).
13. In economic theoretical models, Tobin's *q* is the expected marginal revenue product of capital.

for the practice of return-smoothing observed in the hedge fund industry and for the relative illiquidity of many hedge fund strategies' portfolios (Pástor and Stambaugh, 2003; Bali *et al.*, 2014). In addition to the returns on lookback straddles,[14] these factors include the change in the ten-year interest rate and the change in the credit spread. The Fung and Hsieh factors comprise five categories of lookback straddles, the change in the ten-year interest rate, and the change in the credit spread. The lookback straddles—which are especially useful to study the trend followers—are: the bond lookback (bond_look), the stock lookback (stock_look), the short-interest lookback (shortint_look), the currency lookback (currency_look) and the commodity lookback (commod_look). Finally, d(CredSpr) stands for the change in the credit spread—i.e., the spread between the BBB and AAA U.S. corporate bond yields—, and d(10Yt) is the change in the rate of the 10-year U.S. federal government bond. Note that the augmented equation also includes the Carhart's (1997) momentum factor (UMD).[15]

In contrast to Fama and French (2015) results, these experiments suggest that HML is not made redundant in the hedge fund industry when adding CMA and RMW to the asset pricing model. When studying the interactions between SMB and HML, on the one hand, and CMA and RMW, on the other hand, SMB co-moves (negatively) more with RMW and HML co-moves more (positively) with CMA, results which are consistent with Fama and French (2015). Indeed, small firms are usually less profitable than big ones and firms with a high book-to-market value generally invest less—i.e., they are more conservative. Moreover, hedge fund strategies tend to have a higher exposure to firms with a high investment-to-assets ratio (low CMA), on the one hand, and weak firms' stocks (low RMW), on the other hand. The preference of hedge fund strategies for weak firms is consistent with their usual positive exposure to small firms.

14. A lookback call option gives the right to buy the underlying asset at its lowest price observed over the life of the option. Similarly, a lookback put option allows the owner to sell the underlying asset at the highest price observed over the life of the option. The combination of these two options is the lookback straddle (Fung and Hsieh, 2004). The time series of the straddles appear on the Hsieh's website. For more details, see RACICOT and THÉORET (2016a).

15. UMD—the abbreviation of up minus down—is a diversified portfolio which is long in returns of selected stocks having a persistent upward trend and short in stocks displaying a persistent downward trend. A momentum investment strategy is the tendency of an investor to buy and sell stocks based on past returns of the stocks, that is, to buy recent winners and sell recent losers (Bikhchandani and Sharma, 2000).

The dynamic properties of the augmented equation are also quite interesting (see Racicot and Théoret, 2016c). Indeed, there are reasons to suspect that hedge fund strategies are asymmetric depending on the state of the business cycle. This introduces non-linearities in the asset pricing model. Financial institutions are more constrained in periods of recession or crises which lead to more abrupt reactions to financial risk and economic uncertainty during these periods than in normal times. To study this kind of non-linearities, a Markov regime switching setting is selected (Goldfeld and Quandt, 1973; Hamilton, 1989, 1994, 2005). Funds evolve in two regimes: state 1 and state 2—i.e., expansion and recession, or normal times and crisis. The parameters of our asset pricing model might differ in state 1 and state 2.

Regressions are run using the Greenwich Alternative Investment monthly database over the period 1995-2015. This period is particularly interesting since it includes many crises: the Asian-Russian-LTCM crisis (1997-1998), the tech-bubble crisis (2000-2002), and the subprime crisis (2007-2009). In this dynamic setting, the q-factors span risk dimensions which are not captured by SMB and HML. Some factors are more at play during a regime. CMA and RMW factors are more at play in the low regime[16]—i.e., in recession or crisis—in the strategies' return equations, in the sense that exposures to these factors are usually higher (in absolute value) in the low regime. In other respects, some hedge fund strategies succeed quite well in timing risk factors over both regimes while others, which are more cyclical, have more difficulty in controlling the rise in risk in the low regime. These strategies—i.e., equity market neutral, futures, macro, short-sellers, and value index—monitor quite well the phases of the business cycle and may represent good opportunities for investors in times of recession or crisis—i.e., when the marginal utility of consumption is high (Cochrane, 2005). The cyclical strategies which are more hit by crises are: convertibles, diversified event-driven, fixed income, growth, long-short credit, mergers, multistrategy and opportunistic index. Note that, for the cyclical strategies, the unconditional probability to be in the low regime is close to one during crises while it is less the case for the "dynamic" strategies.

16. In a Markov regime-switching setting, the regimes are identified by analysing the plots of the unconditional probabilities associated with the Markov switching regressions.

A robustness check may be performed to test this Markov regime switching model on the aggregate of U.S. banks and shadow banks (see Racicot and Théoret, 2016c). Not surprisingly, the behavior of U.S. banks is very cyclical, the unconditional probabilities of the low regime being close to 1 during each US recession or crisis. More interestingly, banks are negatively exposed to SMB in the low regime, which suggests that they practice credit rationing in times of crisis (e.g., Kashyap and Stein, 1993). Moreover, according to our findings, the exposures of banks and shadow banks to risk factors are quite different during the high regime. However, they are much closer during the low regime. This suggests that the behavior of banks and shadow banks becomes more homogenous in times of crisis, an obvious source of systemic risk for the US financial system (Wagner, 2008, 2010; Calmès and Théoret, 2014).

5. CONCLUSION

The estimation of asset pricing models is often performed using static devices, in the sense that the time-varying or dynamic behavior of investors is overlooked. Moreover, the non-linearities or asymmetries in the exposures of investors to risk and uncertainty factors are not accounted for. This framework of analysis is obviously not well-suited for the study of hedge fund strategies. Our recent articles which are revisited in the present paper try to fill these gaps in the econometric estimation of the risk-taking behavior of hedge funds. In this respect, we rely on the Kalman Filter, the truncated regressions and the Markov regime switching setting to decrypt the cyclical aspects of hedge fund strategies. In the future, we will go a step forward by investigating the cyclicality of hedge fund return higher moments like return asymmetry and kurtosis.

In other respect, socially responsible investment (SRI) and hedge funds may not seem a priori compatible (Filbeck *et al.*, 2016). Hedge fund investors, like pension funds or university endowments, are in search of substantial long-term absolute returns. Therefore, the question lies in the capacity of SRI strategies to deliver higher absolute returns than corresponding hedge fund strategies and much less in the ethical dimensions of SRI by themselves. Actually, a hedge fund investor may think, rightly or wrongly, that SRI may penalize returns. However, according to Filbeck *et al.* (2016), there is some evidence that hedge funds following SRI strategies can outperform hedge funds which are not involved in such strategies.

Further research is warranted to shed more light on this issue. In this respect, the methodologies which are discussed in this article are very relevant to estimate alternative specifications of the model proposed by Filbeck *et al.* (2016) to analyze the impact of the SRI factor on hedge fund performance. Indeed, this model could be enlarged to include risk factors specific to the hedge fund industry and could be estimated by more robust methods than ordinary least squares.

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