

Information Asymmetry in the French Market around Crises

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ABSTRACT

This paper posits itself in the stream of literature related to event studies and in particular the September 11th event. It is the first study to our knowledge that investigates the impact on the French financial market of September 11th, 2001 and September 21st, 2001. Was there any information asymmetry around these two dates? How did French investors react to these tragic events?

We implement an information cost model and a jump diffusion model to capture the magnitude of shocks in stock price processes. We found that the information linked with the domestic event has been straight away absorbed while the information related to the international event has been spread out between the 12th and 17th September.

JEL Classification: C13, G13

Keywords: Information costs; Implied volatility; Jump diffusion model

I. INTRODUCTION

One of the strong assumptions underlying the standard financial theory is that investors are perfectly informed about security returns. This is not a reasonable assumption since investors pay to obtain information. Information is regarded today as a valuable commodity. In practice, information is costly. In fact, investors do not invest in all the available assets in the market place. They choose a subset from the available assets. They selected only the assets about which they are informed. Tesar and Werner (1995) found strong evidence of a home bias concerning domestic investment portfolios. This home bias can be partly explained by the transaction costs, but also by the information costs that are defined as the cost of collecting, gathering and treating the flow of information required for asset allocation. Falkenstein (1996) explained that the preference for some assets is explained by low costs of transactions but also by the fact that investors tend to trade on assets for which they hold information. Forester and Karolyi (1999) showed that the abnormal returns of a given portfolio can be explained by the asymmetric information. Coval and Moskowitz (1999) showed that assets whose information is available to a restricted set of investors offer greater expected returns than assets with widely dispersed information. Kadlec and MC Connell (1994) explain that the variation in share value is attributed to investor recognition factor as highlighted by Merton (1987). He introduced a modified capital asset pricing model, CAPM, relaxing the hypothesis of equal amount of information for each investor. This model of capital market equilibrium with incomplete information may provide some insights into the behavior of security prices.

Bellalah and Jacquillat (1995) have extended this version of CAPM with incomplete information to option valuation deriving an option formula taking into account an information cost for the option itself and another information cost for its underlying. This model is shown to correct some of the bias of the standard Black-Scholes (1973) model. As a consequence, it can also help explain certain stylized facts of the volatility smile. Bellalah, Aboura, Villa and Prigent (2000) explained that the inclusion of information costs impact on the smile asymmetry and that this model can produce asymmetric smiles even if the physical distribution is symmetrical. Recently, Bellalah and Mahfoudh (2004) used a model with stochastic volatility and jumps in the presence of incomplete information to explain the smile effect.

In this article, we compare the out-of-the sample performance of the information cost model (denoted ICM) with as benchmark, the jump diffusion model (denoted JDM) of Ball and Torous (1983, 1985) and Maltz (1996). The objective is twofold. First, we check the behavior of the models around the September 11, 2001 attack and the explosion of the AZF factory in Toulouse, the September 21st. At this moment, many people in France made a connection between both events. The idea is to understand how the French market reacted to these shocks. This is an important question in empirical finance since it sheds light on the behavior of the markets around these events. This can provide some new insights and explanations of the reaction of the markets to these events.

This paper is organized as follows. Section II presents the theoretical models to be tested and discusses the impact of the information costs on the volatility smile. Section III presents the sampling methodology. Section IV presents the empirical results. Section V summarizes and concludes.

II. THE THEORETICAL MODELS

Information plays a central role in financial markets. Using models which account for the effects of incomplete information can help to explain some deviations between market prices and model prices.

A. The Information Cost Model

We propose to display the theoretical model of Bellalah and Jacquillat (1995). This model is an extension of the Merton's (1987) CAPM with incomplete information. The central hypothesis in the Merton's (1987) model is that an investor includes a security S in his portfolio only if he has some information concerning the first and the second moment of the return distribution. The model is:

$$E(R_S) - R = \beta_S [E(R_m) - R] + \lambda_S - \beta_S \lambda_m \quad (1)$$

Where $E(R_S)$ is the equilibrium expected return on security S , $E(R_m)$ is the equilibrium expected return on the market portfolio. R is one plus the riskless rate r , β_S is the beta of security S , λ_S is the equilibrium aggregate "shadow cost" for the security S , λ_m is the weighted average shadow cost of incomplete information over all securities in the market place. This model is an extension of the CAPM to an environment of incomplete information. Indeed, when $\lambda_m = \lambda_S = 0$, the model collapses to the CAPM. The value of a European call is derived in Bellalah and Jacquillat (1995) as being equal to:

$$C_{ICM} = S e^{-(\lambda_C - \lambda_S)\tau} N(d_1) - K e^{-(r + \lambda_S)\tau} N(d_2) \quad (2)$$

where:

$$d_1 = \frac{\ln \frac{S}{K e^{-(r + \lambda_S)\tau}} + \frac{1}{2} \sigma^2 \tau}{\sigma \sqrt{\tau}}$$

$$d_2 = d_1 - \sigma \sqrt{\tau}$$

with $N(\cdot)$ being the cumulative normal density function. The terms λ_C and λ_S correspond respectively to the information costs on the option and the underlying asset. When $\lambda_C = \lambda_S = 0$, this formula collapses to the Black-Scholes (1973) formula.

Figure 1a shows that the more the access to the information is costly, the more the option call price grows with a magnitude higher for in-the-money (ITM) options than for out-of-the money (OTM) options. This stylized fact is at the origin of the asymmetry in the smile due to the inclusion of information costs.

Figure 1b displays the difference between the Black-Scholes (1973) prices and the ICM prices. We note that the spread between both prices increases along with the information costs moreover when options are in-the-money or at-the money (ATM). In

Figure 1c, we note that the more the volatility level is weak, the more the difference between ITM and OTM options is high. Figure 1d reveals that the more the maturity is long, the more the price difference between ITM and OTM options increases.

Figure 1

The effect of information asymmetry on the volatility smile and the option prices

Figure 1a shows three skews corresponding to three levels (1%, 5% and 10%) of information costs (IC). Figure 1b displays price differences between call options of the ICM and the Black-Scholes (1973) model, for information costs going from 0 to 10% and strikes from 70 to 130. The underlying value is equal 100, interest rates are set to zero, time to expiration is equal to 6 months and volatility to 20%. Figure 1.c displays also this difference but with information costs set to 1%, maturity to 1 month and a volatility level rising from 10% to 50% with strikes ranging between 70 and 130. Figure 1d shows this difference between prices but with information costs set to 1%, a volatility set to 20%, strikes going from 70 to 130 for a maturity covering several periods from 1 month to 1 year.

Figure 1.a

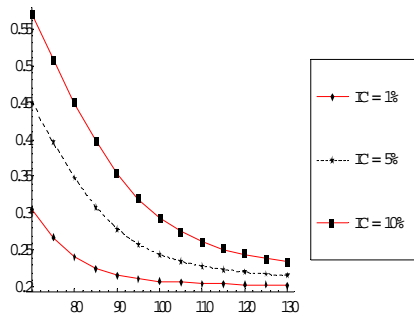


Figure 1.b

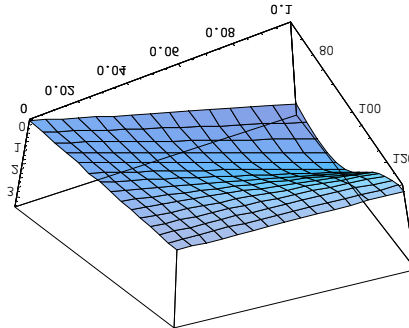


Figure 1.c

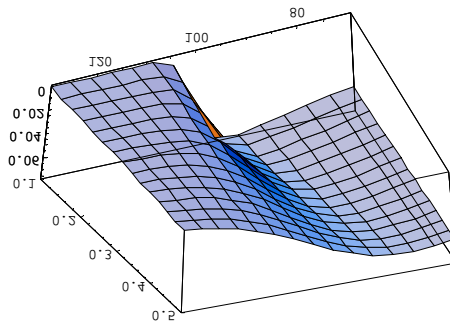
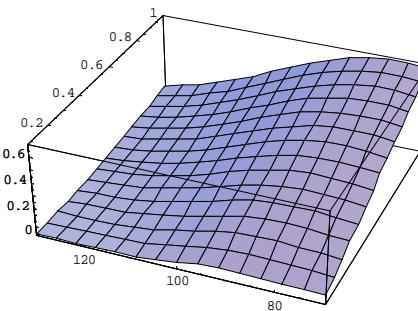


Figure 1.d



B. The Jump Diffusion Model

After the introduction of geometric Brownian motions, much attention was devoted to Poisson distributions as an alternative specification of stock returns. This was supported by various empirical evidence concerning “abnormal” variations in the stock price process. Large values of returns occur too frequently to be consistent with normality assumption. Both skewness and kurtosis are captured by the Poisson distribution. However, the expansion of these models are limited to the fact that there are few cases where closed-form solutions are given, specifically when there is a non zero probability of early exercise, or when the distribution of jumps is neither lognormal nor discrete. In this section we assume that S_t follows a log-normal jump diffusion, i.e., the addition of a geometric Brownian motion and a Poisson jump process. This price process under the risk-neutral probability can be shown to be:

$$\frac{dS}{S} = (r - \lambda E(k))dt + \sigma d\tilde{Z}_S + kdq_\tau \quad (3)$$

With q_τ a Poisson counter with average rate of jump occurrence λ ($\text{prob}(dq = 1) = \lambda dt$) and k the jump size. Ball and Torous (1983, 1985) and Maltz (1996) supposed as a realistic simplification that during the life of the option (overall for short-term options), there will occur at most one jump of constant size. If no events occur in the option life, the associated probability is $(1 - \lambda \tau)$ and will be $\lambda \tau$ if one event occurs during this time interval. When such event occurs, there is an instantaneous jump in the stock price. Ball and Torous (1983, 1985) call this simplified version as the Bernoulli distribution version of the jump-diffusion model.

$$C_{\text{JUMP}} = (1 - \lambda \tau) \left[\frac{S_t}{1 + \lambda k \tau} N(d_1 + \sigma \sqrt{\tau}) - K \exp(-r\tau) N(d_1) \right] + \lambda \tau \left[\frac{S_t}{1 + \lambda k \tau} (1 + k) N(d_2 + \sigma \sqrt{\tau}) - K \exp(-r\tau) N(d_2) \right] \quad (4)$$

where:

$$d_1 = \frac{\ln(S_t / K) - \ln(1 + \lambda k \tau) + (r - \sigma^2 / 2)\tau}{\sigma \sqrt{\tau}}$$

$$d_2 = \frac{\ln(S_t / K) - \ln(1 + \lambda k \tau) + \ln(1 + k) + (r - \sigma^2 / 2)\tau}{\sigma \sqrt{\tau}}$$

This formula corresponds to the Black-Scholes (1973) call option value weighted by the probability of a jump and by the probability of no jump with the stock price divided by the expected value of a jump, $(1 - \lambda k \tau)$.

III. DATA DESCRIPTIONS

The call options database covers every day of September 2001. This database can be given, upon request, by Euronext S.A. The twenty days considered in September are the 3rd, 4th, 5, 6, 7, 10, 11, 12, 13, 14, 17, 18, 19, 20, 21, 24, 25, 26, 27 and 28th.

These options are short-term European style PXL options written on the CAC 40 Index. We have in total 7015 intra-daily call options divided in 6327 out-of-the-money and 688 in-the-money options. The database contains: the strike price, the future price, the premium, the maturity and the risk-free interest rate. The maturities that are included go from 27 days to 6 days. The EURIBOR 1 month interest rate is used as a daily proxy of risk-free rate and was downloaded from DATASTREAM. The stream of dividends is also extracted from DATASTREAM.

IV. THE OUT-OF-SAMPLE VALUATION ANALYSIS

This section conducts some empirical tests and shows how to estimate some of the model's parameters. This allows measuring the empirical effects suggested in this study.

A. The Information Cost Estimation Procedure

We estimate the implied volatility σ_{ICM} , the option information cost λ_C and the underlying information cost λ_S minimizing the following loss function:

$$\min_{\sigma_{ICM}, \lambda_C, \lambda_S} \sum_{j=1}^N [C_{OBS,j} - C_{ICM,j}(\sigma_{ICM}, \lambda_C, \lambda_S)]^2 \quad (5)$$

where $C_{ICM}(\sigma_{ICM}, \lambda_C, \lambda_S)$ is the theoretical call option price of the model, which is calculated for any option in a given current day's sample.

B. The Jump Diffusion Model Estimation Procedure

We estimate implicitly the parameters of the jump diffusion model. We estimate the jump occurrence parameter λ , the jump size parameter k and the implied volatility σ_{JDM} by minimizing the following loss function :

$$\min_{\lambda, k, \sigma_{JDM}} \sum_{j=1}^N [C_{OBS,j} - C_{JDM,j}(\lambda, k, \sigma_{JDM})]^2 \quad (6)$$

where $C_{JDM}(\lambda, k, \sigma_{JDM})$ is the theoretical call option price given by the jump diffusion model that is calculated for any option in a given current day's sample.

C. Implied Parameters

Table 1 displays the parameters estimated from three models. σ_{BS} , σ_{ICM} and σ_{JDM} are respectively the implied volatilities of the Black-Scholes (1973) model, ICM and JDM. λ_S and λ_C represent respectively the information cost of the underlying index and of the option. λ is the jump intensity and k is the size of the jump.

Table 1
Implied parameters

Date	BS	ICM			JDM		
	σ_{BS}	σ_{ICM}	λ_S	λ_C	σ_{JDM}	λ	k
03/09/01	0.2443	0.2194	0.0910	0.0046	0.2139	0.7776	-0.1843
04/05/01	0.2382	0.2125	0.0931	0.0044	0.2069	0.7773	-0.1864
05/09/01	0.2415	0.2171	0.0963	0.0044	0.2121	0.7779	-0.1877
06/09/01	0.2627	0.2294	0.1330	0.0016	0.2243	0.7723	-0.2385
07/09/01	0.2787	0.2458	0.1371	0.0013	0.2409	0.7721	-0.2450
10/09/01	0.3115	0.3588	0.0503	0.0086	0.2638	0.7665	-0.2978
11/09/01	0.2943	0.3601	0.0454	0.0088	0.2815	0.7740	-0.1275
12/09/01	0.4523	0.3763	0.0565	0.0083	0.4063	0.7659	-0.3220
13/09/01	0.3547	0.3061	0.0325	0.0093	0.2765	0.7438	-0.5136
14/09/01	0.3621	0.3023	0.0323	0.0093	0.3306	0.7742	-0.2399
17/09/01	0.4829	0.4685	0.0801	0.0041	0.3914	0.7265	-0.7042
18/09/01	0.4102	0.3376	0.0395	0.0091	0.3329	0.7504	-0.5441
19/09/01	0.3708	0.2945	0.0273	0.0095	0.2927	0.7416	-0.6134
20/09/01	0.4433	0.3865	0.0379	0.0094	0.3661	0.7401	-0.6324
21/09/01	0.5041	0.4764	0.1671	0.0151	0.4085	0.7123	-0.9203
24/09/01	0.4811	0.4422	0.0686	0.0082	0.3932	0.7588	-0.6720
25/09/01	0.4158	0.3441	0.0404	0.0090	0.3861	0.7777	-0.2660
26/09/01	0.3491	0.3322	0.1370	0.0015	0.3020	0.7659	-0.4817
27/09/01	0.2834	0.2687	0.1219	0.0100	0.2665	0.7853	-0.2019
28/09/01	0.1562	0.1767	0.0071	0.0101	0.1553	0.7232	-0.0317
Average	0.3468	0.3178	0.0747	0.0073	0.2975	0.7744	-0.3808

The three volatility measures seem to have the same behavior even if they differ by their values. It is not surprising to see that the Black-Scholes (1973) (denoted BS) volatility is the highest in average since the effect of the attack is absorbed by the jump parameter in the JDM and by the two information costs in the ICM. The effect of the attack is overall reflected the September 12th, since it occurred less than three hours before the closing of the French market. The BS implied volatility has increased by more than a half (53.68%) from September 11th to 12th while the JDM volatility has risen by 44.33%. The ICM volatility remained stable by a neglectible increase of 0.5%. At the same moment, in September 11th, the CAC 40 index has decreased by 4.69% while the VX1 volatility index has increased by a huge amount of 105% according to the MONEP.

The information costs remained relatively stable through time. The same stability is observed for the average annualized jump occurrence, which is equal to 0.77 times per year. This means that the probability that a jump is observed in average before the expiration date is equal to 6.45%. The average annualized size of the jump as been multiplied by two and three, respectively the September 12th and 13th. The highest values for the size parameter are reached on September 17th (-0.7042) and September 21st (-0.9203).

The highest values for the volatilities were on September, 21st where the AZF factory in Toulouse has blown up. From September 21st to 22, the BS volatility has grown by an amount of 13.7% while the security information cost has risen by 340% showing that the investors paid theoretically more for increasing their information to re-allocate their assets. From September 20th to 21st, the jump size has grown to 45.52%. 92% of the variation was explained by a jump in the stock price process and not by a volatility phenomenon.

The impact of the September 11th was reflected through the volatility and jump parameters the day after, but the impact had a second magnitude on September 17th. The reason is that the NYSE was closed from September, 11th until September, 17th. Therefore, the French market couldn't import the necessary amount of volatility from the domestic market. This means that there was not transmission of information concerning the magnitude to give for this event, which justifies the stability of the information cost parameters around this period.

V. CONCLUSION

This paper posits itself in the stream of literature related to empirical anomalies and event studies. It uses models accounting for the effects of incomplete information in explaining some market reactions. We discuss the impact of the tragic events occurred in September 2001, namely, the September 11, 2001 attack and the blow up of the AZF factory in Toulouse.

The principle is to quantify the reaction of French investors relative to these events. We implemented an information cost model to check if the price of information has varied around these two dates. As a benchmark, we choose a jump diffusion model to capture the magnitude of the shock in the stock price process.

We found that the impact of September 11th was strongly reflected in terms of volatility and jump only from September 17th. The principal reason is that the French market did not import abroad volatility since the main US markets were closed from September 11th to 17th. The impact of the September 21st was strongly reflected through a rise of volatility and overall through a rise of the jump parameter in the stock price process that explains around 92% of the price variation. In contrast with the previous event, the information is here domestic and was rapidly absorbed by the French market.

The extension of this study will quantify the impact of these shocks through a stochastic volatility model allowing for jumps to observe the behavior of the correlation coefficient and volatility of volatility parameters that drive the smile dynamic. A possible framework for this future work, can be the model of Bellalah and Mahfoud (2004) accounting for the effects of stochastic volatility, jumps and incomplete information.

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