The Overreaction Smile

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Abstract

Using daily data on S&P 500 index options, this paper examines the elasticity of options implied volatility. While finance theory predicts a smoothing effect on a time series of implied volatilities with the same underlying asset but different maturities, empirical studies have shown that longer-maturity options tend to overreact to changes in implied volatility of shorter-maturity options. By increasing the time-window of previous studies (i.e. looking at long-maturity options up to 18 months), we find that the overreaction phenomena disappears in the medium-run (for long-term options with a 6-month-maturity) and even turns into underreaction for maturities starting from eight months onwards, before displaying normal-reaction and overreaction patterns again in the very long-run (14 months and beyond). Graphically, we obverse a U-shaped projection of the reaction coefficient over time, which was predicted, by the existing literature, to be a (more-or-less) straight line. We hence call this observed phenomenon “the overreaction smile”.

Keywords: Options Prices, Options Smile, Overreaction, Underrecation, Implied Volatility, Investor Behavior, Cognitive Biases

JEL-Classification: G08, G12

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Introduction

As long as investors will be human beings, they will be subject to irrationality. Prompted by feelings, their judgments get in the way of sheer rationality and make their decisions drift away from what common sense usually calls for (see Tversky and Kahneman, 1974).

The idea that investors are able to correctly incorporate new information into options prices had first been challenged by Stein (1989). The options market, often regarded as a market of specialists[2], with its pricing process closely tied down by the Black-Scholes' (1973) formula might have yet appeared rather unlikely to display investors' misreactions. But Potheshman (2001) and more recently Christoffersen et al. (2010) have also reported overreaction[3] patterns in this market. However, even though it is now widely acknowledged that options traders behavior does affect options prices (see Potesham, 2001), the pattern that this irrationality follows has not been clearly defined yet.

The volatility component being the only unknown parameter to price an option according to the famous Black-Sholes' (BS) formula, options implied volatility (IV)[4] remains a "humanly"-estimated parameter which can capture any beliefs, noises, sentiments; in other words, any behavioral biases. Since IV follows a mean-reverting process (Ielpo and Simon, 2010), any given option IV is supposed to tend toward its long-run mean (the average IV over the life of that option). To illustrate that property, Stein (1989) gives the following example: "Suppose that volatility averages fifteen percent, but that it fluctuates up and down quite rapidly, governed by a strong mean-reverting process. If a one-month option currently has an IV of twenty-five percent, a two-month option should have an IV that is somewhat lower, with the exact level determined by the coefficient of mean-reversion. Conversely, when a one-month option has an IV of five percent, the two month-option should have a higher one". That mean-reversion characteristic allows us to determine the theoretical level of "correct" reaction as well as levels of underreaction and overreaction of the market. But whereas all the existing literature focuses on a relatively small time-window for options maturities[5] (namely one to two months), our study examine maturities between one and 18 months and hence redefines the notions of short- and long-term options in the literature. Moreover, daily data allow us to have roughly ten times more observations[6] than what appears in the existing research works, which have - so far - used only weekly data.

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[2] Due to the minor representation of retail investors.

[3] And also underreaction for the former.

[4] The variable which when entered into the BS formula gives the current theoretical price of the option.

[5] Most of the research works were conducted at a time where a time-to-maturity of two months was considered a long-term maturity.

[6] 1,248 observations for every maturity period, except 17 months and 18 months (1,247).

Using daily data on S&P 500 European options from January 2000 to December 2004 - and in line with the findings of Stein and Christoffersen et al., we find that index options investors tend to significantly overreact when pricing short-term options (one-month to six-month). However the evidences presented here shows that the overreaction phenomenon disappears in the medium-run and turns into underreaction for maturities between eight and 12 months before displaying normal-reaction and overreaction patterns again from 14 months onwards. Graphically, we then obverse a U-shaped projection of the reaction coefficient over time, which was predicted, by the existing literature, to be a (more-or-less) straight line. We hence called that observed phenomenon “the overreaction smile”.

The remainder of the paper is organized as follows. In Section 2, we review the literature. Section 3 presents the data. In Section 4, we introduce the first model tested here and discuss the empirical analysis as well as the results. Section 5 gives an overview of the set-up of our second test and provides a comparison between the results of the two tests. Section 6 concludes.

Existing Literature

While there is a large literature reporting overreaction and/or underreaction patterns from investors in the stock market (see DeBondt and Thaler, 1985, and Barberis et al., 1998), a few only tackles the domain of options. Among them, the vast majority of the research works conducted find evidence that long-term options tend to react more to change in IV than short-term options.

Stein (1989) is the first to derive and empirically test a model that describes the relationship between IV on options of different maturities between 1983 and 1987. Assuming that volatility evolves according to a given continuous-time mean-reverting AR1 process, with a constant long-run mean and a constant coefficient of mean-reversion, he finds that, theoretically, the IV of a longer maturity (two-month) option should move in a responsive and smoothing[7] way to a move in the IV of a shorter maturity (one-month), which he called “implied volatility elasticity”. However, his empirical tests being inconsistent with the predictions of his model, Stein concludes that long-term IV overreact to changes in short-term IV; the empirical values of this elasticity exceeded the theoretical upper bound of normal-reaction.

In line with these findings, Christoffersen et al. (2010), replicate Stein’s analysies with more recent data (1996 - 2004). Considering the same maturity time-frame[8], they demonstrate the robustness of Stein’s results but differ in interpreting them. While Stein considers the

[7] Stein expects this smoothing effect to lead the IV towards its long-run mean.

[8] One-month maturity for short-term options and two-month maturity for long-term options.

overreaction observed in his sample as an anomaly vis-à-vis rational expectations, Christoffersen et al. explain it by a pricing kernel that depends on volatility[9].

Focusing on the difference between options on value and growth stocks, He et al. (2010), also confirm the overreaction hypothesis for their sample period (2004 - 2005). Their empirical results indicate a greater degree of overreaction in options on growth indices compared to options on value indices with long-term maturity being set at one month and short-term maturity set at two months, following the methodology of the papers cited before. The only author to have ever increased the maturity time-window is Poteshman (2001). Although his empirical tests consider options maturities up to seven months, his paper investigates options market reactions with respect to changes in the instantaneous volatility of the underlying asset and thus cannot serve as a benchmark for our study.

As in Stein and Christoffersen et al., our study focuses on the term structure of IV, with volatility measured per levels. In other words, the model developed by Diz and Finucane (1993), using changes in IV, does not apply here. Having said that, Diz and Finucane's comments on the mean reverting volatility model used by Stein raise a serial correlation issue, which, though debatable, could lead, on some levels, to a misrepresentation of the data generated through the model. Their study concludes indeed that a simple mean reverting model of implied volatility may not adequately characterize the time series properties of implied volatility. They argue that information about expected future volatility are not only to be found in short-term implied volatilities. Taking their remark into account, we conduct in section five a second test which is not based on the assumption that instantaneous volatility evolves according to a continuous-time mean reverting AR1 process.

Data

We use daily European option data on the S&P 500 index (symbol: SPX) from OptionMetrics over the period January 2000 to December 2004 and follow common practice in the empirical option pricing literature. The market for S&P index options and futures is the most active index options and futures market in the world, with an average daily volume over our sample period of 129,226 trades[10]. Moreover, daily data allow us to have roughly ten times more observations[11] than what appears in the existing research works, which, so far, have only used weekly data.

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[9] In their model, the pricing kernel specification is monotonic in returns and also monotonic in volatility.

[10] Source: Chicago Board Options Exchange, 2011. Average daily volume between January 2000 and December 2004.

[11] 1,248 observations for every maturity period, except 17 months and 18 months (1,247)

We follow Barone-Adesi et al. (2008) in filtering the original options data. For liquidity reasons, we only consider closing prices of out-of-the money put and call SPX options for each trading day and take the bid-ask midpoint prices.

Implied volatilities are calculated by setting the theoretical option price equal to the midpoint of the best closing bid price and the best closing offer price for the option. The Black-Scholes formula is then inverted using a numerical search technique to find out the option IV:

$$C = Se^{-qT} N(d_1) - Ke^{-rT} N(d_2)$$
$$P = Ke^{-rT} N(-d_2) - Se^{-qT} N(-d_1)$$

where,

$$d_1 = [\ \ln(S/K) + (r - q + ½IV^2)\ T\ ] / IV\sqrt{T}\ ,$$
$$d_2 = d_1 - IV\sqrt{T} / 2\ ,$$

With C being the price of a call option and P, the price of a put option. S is the underlying asset current price, K is the option strike price, T is the time to maturity, r is the continuously-compounded interest rate, q is the continuously-compounded dividend yield, and IV is the option implied volatility.

First Test

Model

Following Stein (1989), we assume in this section that the "instantaneous volatility" at time t, denoted hereafter iV_t, evolves according to a continuous-time mean reverting AR1 process:

$$diV_t = -a\ (iV_t - iV)d_t + biV_t\ dz. \tag{1}$$

Where a is the reversion coefficient, b is the variance of iV_t, and dz is the Wiener increment[12].

At times t+n, volatility is hence expected to decay away towards its long-run mean level, which means that the level of implied volatility of an option at time t with expiration at time t+n, denoted by $IV_t(t+n)$, should be the same as the average expected iV over the life-time of the option, i.e. [t , t+n]. In other words, whenever iV is below its long-run mean level, IV is expected to increase over the option remaining time to maturity. Conversely, whenever iV is above its long-run mean level, IV is expected to decrease over the option remaining time to maturity[13].

[12] dz = edt$^{1/2}$, where e is the standard normal distribution.

[13] See Stein (1989) for details and full derivations.

Since instantaneous volatility (iV) is not a directly observable parameter, Stein derives an elasticity relationship (see equation (2)) using two options on the same underlying asset but with different time-to-maturity: a short-term maturity option, with time-to-maturity T^{st} and implied volatility IV^{st}_t, and a long-term maturity option, with time-to-maturity $T^{lt} > T^{st}$, and implied volatility IV^{lt}_t. As in Stein (1989), T^{st} is set at one month but while he sets T^{lt} at two months, we use a rolling time-window and let T^{lt} take values between two and 16 months, i.e. T^{st} [1] and T^{lt} [2 , 16]. The elasticity relationship may be expressed as:

$$(IV^{lt}_t - \overline{iV}) = \frac{T^{st}(p^{Tlt} - 1)}{T^{lt}(p^{Tst} - 1)} (IV^{st}_t - \overline{iV}), \qquad (2)$$

Where p is the first order autocorrelation coefficient of implied volatility.

This elasticity equation (2) depends on p, which can also be referred to as the mean reversion parameter or as the decay parameter, and on the time-to-maturity of the two options. That is, equation (2) can be rewritten as:

$$(IV^{lt}_t - \overline{iV}) = \beta\,(p, T^{st})\,(IV^{st}_t - \overline{iV}), \qquad (3)$$

Where β is the elasticity parameter that encompasses both the mean reversion parameter p and the time to maturity of the so-called short-term option.
We empirically test equation (3).

Empirical Results

It has been shown in previous studies (see French et al., 1987) that the implied volatility on a short-term option has theoretically the same serial correlation characteristics than the instantaneous volatility. Calculating the autocorrelation for IV^{st}_t allows us to capture serial correlation characteristics of the instantaneous volatility. We do this for up to eight lags[14] and for each subsample year, as well as for the full sample. Then, for the ease of use and comparison, we convert the autocorrelations into “implied” p’s by raising them to the one-over-lag power (see Table I).

[14] In weeks. Adding more lags is not necessary as we normalize the results to calculate p.

Based on those results, β's has been computed using Stein (1989)'s linear endpoint approximation[15]:

$$\beta = \frac{(1+p^4)}{2}, \tag{4}$$

Table II shows a *p-average* coefficients of 0.73 on the lower-bound and of 0.80 on the upper-bound[16]. In other words, results of testing equations (4) set the theoretical value of β for our sample period to be somewhere between 0.64 and 0.70[17], which gives us the theoretical "normal" range of IV elasticity. Under the lower-bound (0.64), we will speak of underrecation and above the upper-bound (0.70), overreaction signals will be displayed.
Table III presents the results of the regression of the first test, where $IV^{lt}{}_t$ is regressed onto $IV^{st}{}_t$. All the regressions are standard OLS.
The first four coefficients of regressions - corresponding at long-term maturities between two and five months - show overreaction, while nearly all the others have values below the theoretical "normal" range of reaction (0.70), which implies a tendency for long-term maturity options to underreact to changes in the IV of short-term maturity options. The longest maturity tested here (18 months), however, falls in the "normal" reaction category, namely with a coefficient slighlty above 0.64.

But what is more striking than the coefficient values in themselves is the trend that those values follow overtime. Indeed, we observe that the regression coefficients decrease in value until long-term maturity is set at 12 months and increase again from that point onwards (at least until the end-point of our study: 18 months), which results in a U-shaped line[18] once the coefficients are plotted over the different long-term maturity values[19] (see Figure II). In other words, those results clearly indicates the existence of a changing reaction that seems to depend on the time-horizon investors have to make their forecasts on. For, even though most of the time in the domain of underreaction, their reaction (within this domain) is more or less pronounced, and we

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[15] Though only an approximation method, it makes the testing procedure even more conservative. If the approximation were to be inexcat, it would result in a too slow mean reversion parameter, and hence, it would make it more difficult to find overreaction patterns.

[16] The simple average of all *p's min* in Table II for the 2000 - 2004 period is 0.73 and 0.80 for all *p's max*.

[17] Corresponding respectively to an average *p-min* = 0.73 and an avearge *p-max* = 0.80.

[18] With a clear lower point that goes out of the general trend for long-term maturity = 12 months.

[19] Every month between two and 18 months.

could speak of low-underrecation between months 8-10 and 15-17 and of strong-underrecation for months between 11 and 13.

These observations do not refute the results of Stein (1989) neither those of Christoffersen et al. (2010), nor any of the existing literature as those studies have only considered long-term maturities as being of two months. Now, if one only looks at long-term maturity = 2 months in our study[20], she or he will come to the same conclusion as the previously-cited studies, that long-term maturity options tend to overreact to change in IV of short-term maturity ones. But what we do, then, differently is that we extend the time-window of what we consider as long-term maturities and apply the same regression method; an approach that has not been conducted before - Stein only assumes in a footnote that overreaction evidences would be even slightly stronger if the time-to-maturity of the long-term option were to be longer, expecting hence a more or less straight line of coefficients over time.
Our results, however, prove this expectation wrong. And this interesting pattern that the regression coefficients display could actually allow us to define more clearly the notion of "time" in the options market.

For our results to be accurate and precise we conduct, in the following section, a second test of overreaction on the same data, following precisely the methodology of Christoffersen et al. (2010).

Second Test

Model

Diz and Finucane (1993) argue that a simple mean reverting model of implied volatility may not adequately characterize the time series properties of implied volatility. The question is still debatable. But while our first test is based on the assumption that instantaneous volatility evolves according to a continuous-time mean reverting AR1 process, our second test, below, does not rely on such requirement.
Following Christoffersen et al. (2010), equation (3) and (4) are rewritten, so that:

$$(IV^{lt}_t - \overline{iV}) = ½ \, (IV^{st}_t - \overline{iV}) \, E_t \, (IV^{st}_{t+(lt-st)} - \overline{iV}). \tag{5}$$

Equation (5), once turned, yields:

$$E_t \, [(IV^{st}_{t+(lt-st)} - IV^{st}_t) - 2(IV^{lt}_t - IV^{st}_t)] = 0, \tag{6}$$

[20] Which corresponds to the first line in Table III or the first dot in Figure II.

Under “normal” reaction, the prediction error in equation (6) should remain a white noise. In case of overreaction, the sign of the prediction error will be negative, as the time series in brackets will be negatively correlated with $IV^{st}{}_{t}$. For the same reason, a prediction error with a positive sign will demonstrate an underreaction phenomenon[21].

Empirical Results

In this second set-up, we regress the left-hand term of equation (6) on the current information, namely $IV^{st}{}_{t}$. The results are displayed in Table IV. Stein as well as Christoffersen et al. use the same type of regressions and both find a significant, negative sign for each of them - whether for their sub-sample or for their full-sample, which strongly favors the overreaction hypothesis. Yet, both studies only focus on long-term maturity set at two months, which corresponds to the first line of Table IV. Our result for $lt = 2$ months is then in line with their common findings.

Our rolling windows of lt up to 18 months, allows us, however, to capture the evolution of the reaction over time. And confirming the outcomes of our first test, we find an evolving investors reaction that goes from overreaction over the first five months to “normal” reaction when long-term maturity reaches six months[22]. From that point on, until long-term maturity = 14 months, all coefficients are strongly positive, investors reactions remain, hence, in the domain of underreaction[23].

The results of the two different set-ups (first test and second test) only clearly diverge after 14 months. Whereas in this second test, the consistent negative coefficient signs after 14 months seems to indicate a return to overreaction in the very long-run, the first test describes - from that point onwards - an upward trend towards overreaction but stops at normal reaction at the end of the rolling time-window (18 months).

Table V summarizes the points of convergence and divergence of the two sets of test. The latter only appearing in the very-long run[24], we can say with confidence that our results are robust up to slightly over a year (13 months), which provides us with a solid ground of reactions pattern for

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[21] Unlike in the first set-up of our study, there is no “normal reaction” range. “Normal reaction” is supposed, here, to yield a prediction error of 0. It is fairly assumable, however, that one can still speak of “normal reaction” when the prediction error is, if not stricly 0, at least around that value.

[22] The coefficient of regression for $lt = 6$ months being close to 0 (0.052), it can be considered as a sign of “normal” reaction.

[23] For $lt = 12$ and 13 months, their coefficients of regression can also be interpreted as a sign of “normal” reaction.

[24] Though a difference appears for lt = seven months, the margin for the coefficient of our first test to qualify as underreation is only of 0.655 - 0.640 = 0.015 - a hundredth of coefficient - which can prevent us to place this point in the divergence category.

this time-period. With the same confidence, we can say as well that the reaction pattern over our entire time-window (18 months) follows a U-shaped trend that goes from overreaction in the short-run to underreaction in the middle-run and tends to go back to overreaction in the longest-term.

What is less clear, however, is the exact nature of the reaction when dealing with long-term options whose maturity is over 13 months vis-à-vis short-term options with a one-month maturity. The second test indicates a faster-changing pattern of reaction with only five maturities falling in the domain of underreaction[25] when the underreaction phase lasts for twice as much longer in the first test.

As our second test does not rely on a simple mean-reverting model of implied volatility, one can easily go back to Diz and Finucane (1993)'s comments, mentioned earlier, to consider our second test as being more robust. Moreover, the most recent study on investors' reaction in the options markets - Christoffersen et al. (2010) - also uses the same set-up of test as the one we use for our second test.

Conclusion

In the economic world, the perfect efficiency of markets has long been considered a truism. Yet, the idea that the creation - and further developments - of prices be of predictable nature still remains appealing to everyone having a stake in any exchange market.

The options market, where prices are tied down by a given formula (Black-Scholes), appears to be the ideal candidate to find predictable prices and volatility levels. But even in that very peculiar place, arbitrageurs have difficulties in detecting opportunities and, in fine, in driving prices back to their intrinsic values. This is clearly demonstrated in the studies of Stein (1989) and Christoffersen et al. (2010). Both works come to the conclusion that investors tend to overreact to the arrival of new information. In other words, long-term options have a tendency to react more to change in implied volatility than short-term options.

We built on those two studies and find significant results that favor their overreaction hypotheses. What we question, however, is their definition of short-term maturity and long-term maturity in the context of options trading. By focusing on a relatively small time-window for options maturities (namely one to two months), they - and all the existing literature - ignore the possibility that traders behavior could evolve over time, once they need to make forecasts on longer-term volatility.

Not only we find, here, that traders reaction changes depending on the time-horizon they had to establish their forecasts but we also observe a clear systematic pattern in the development of their reactions over time. Through an examination of maturities between one and 18 months, we

[25] Namely 7, 8, 9, 10, 11

show that the overreaction phenomena disappear in the medium-run (for long-term options with a 6-month-maturity) and even turns into underreaction for maturities starting from eight months onwards before displaying normal-reaction and overreaction patterns again in the very long-run (14 months and beyond). Graphically, we then obverse a U-shaped projection of the reaction coefficient over time, which was predicted, by the existing literature, to be a (more-or-less) straight line. We hence called this observed phenomenon “the overreaction smile”.

Our paper also makes reasonable, and empirically supportable, assumptions in redefining the notions of short- and long-term options in the literature. By simply looking at the specific maturity period at which the reaction pattern starts to shift, we can divide our data sample in short-, medium, and long-term options. Short-terms options would be options whose maturity lies between one and six months (a period corresponding to overreaction), medium-term options would consist of options displaying a time-to-maturity between six and 12 months (underreaction phenomena), and long-term options would represent those options which expire in one year or later (back to overreaction behavior).

Further research, in the field of behavioral finance, needs to identify the reasons why such a reaction pattern is observed. Griffin and Tversky (1992) come up with some explanations for overreaction and underreaction in making forecasts but their findings are neither related to the passing of time nor to the idea of having to make forecasts, at a given point in time, about different time horizons.

Another possible extension would be to find out wether such an “overreaction smile” is also displayed with different underlying assets, such as currencies or commodities.

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Appendix

Table I
Autocorrelograms and Implied *p*'s for Short-term Implied Volatility (IV^{st}_t), Full Sample
Below are the of lag lengts (in weeks), the autocorrelation levels, and the implied *p*'s, which are the autocorrelation s raised to the one-over-lag power.

Lag (Weeks)	Autocorrelation	Implied *p*'s
1	0.899	0.899
2	0.851	0.922
3	0.803	0.930
4	0.746	0.930
5	0.695	0.930
6	0.660	0.933
7	0.618	0.934
8	0.617	0.935

Table II
Implied *p*'s Min and Max for Short-term Implied Volatility (IV^{st}_t) and Corresponding *β*'s, Yearly Subsamples
For each subsample, as well as for the full sample, the lowest and the highest levels of *p*'s are taken out, which allows ud to calcultae the corresponding minimum and maximum level of *β*'s, where β is approxiamted by taking the half of $(1+p^4)$.

Subsample	*p*'s min	*p*'s max	Corresponding *β*'s (min - max)
2000	0.662	0.817	0.60 - 0.72
2001	0.677	0.719	0.61 - 0.63
2002	0.870	0.910	0.79 - 0.84
2003	0.944	0.945	0.90 - 0.90
2004	0.494	0.570	0.53 - 0.55
Full Sample	0.899	0.930	0.83 - 0.87

Table III

Regressions of IV^{lt}_t onto IV^{st}_t , with different long term values (lt), Full sample

IV^{lt}_t is the implied volatility of the options serie with long-term maturities (rolling from 2 to 18 months), and IV^{st}_t is the implied volatility of the options serie with short-term maturity (fixed at 1 month). N=1,248 except for lt=17 and 18 (1,247)

lt value (months)	Regression Coefficient	Standard Error	R^2
2	0.926	0.002	0.99
3	0.859	0.004	0.97
4	0.798	0.006	0.94
5	0.743	0.007	0.91
6	0.696	0.007	0.88
7	0.655	0.008	0.86
8	0.620	0.008	0.84
9	0.592	0.007	0.84
10	0.570	0.007	0.83
11	0.555	0.008	0.81
12	0.524	0.009	0.72
13	0.545	0.011	0.68
14	0.550	0.013	0.58
15	0.561	0.017	0.47
16	0.579	0.021	0.38
17	0.609	0.025	0.32
18	0.641	0.031	0.26

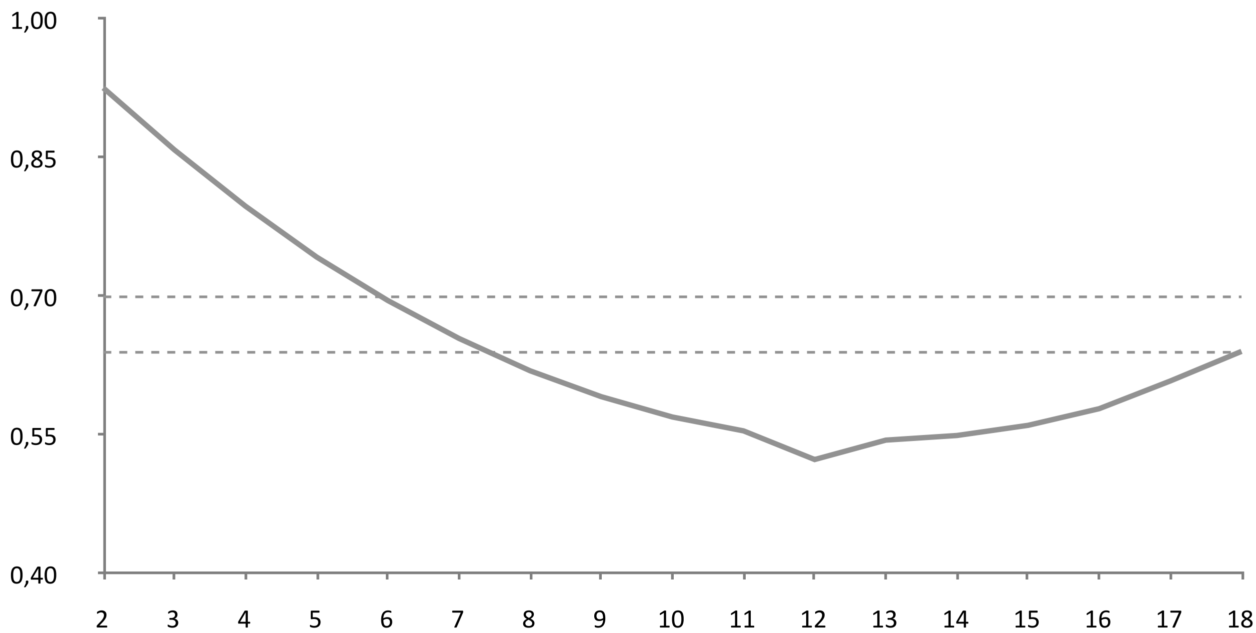

Figure I

Coefficient of Regressions of IV^{lt}_t onto IV^{st}_t over different long term values (lt), Full sample

IV^{lt}_t is the implied volatility of the options serie with long-term maturities (rolling from 2 to 18 months), and IV^{st}_t is the implied volatility of the options serie with short-term maturity (fixed at 1 month). On the Y-axis are thecoefficient of regression values and an the X-axis are the different long-term maturity value. The lower-bound dotted line is set at 0.64, and the upper-bound dotted line is set at 0.70, that is the theoretical range of "normal" investors reaction.

Table IV

Regressions of $[(IV^{st}_{t+(lt - st)} - IV^{st}_t) - 2(IV^{lt}_t - IV^{st}_t)$ onto IV^{st}_t over long term values (lt), Full sample

IV^{lt}_t is the implied volatility of the options serie with long-term maturities (rolling from 2 to 18 months), and IV^{st}_t is the implied volatility of the options serie with short-term maturity (fixed at 1 month). Due to the rolling time-window nature of "t+(lt - st), the number of observations "N" declines over time.

lt value (months)	Regression Coefficient	Standard Error	t-Statistic	N
2	-0.098	0.019	-5.13	1227
3	-0.106	0.025	-4.22	1206
4	-0.078	0.030	-2.63	1185
5	-0.040	0.032	-1.24	1164
6	0.052	0.034	1.52	1143
7	0.090	0.036	2.51	1122
8	0.085	0.037	2.28	1101
9	0.091	0.037	2.46	1080
10	0.097	0.037	2.62	1059
11	0.137	0.038	3.61	1038
12	0.053	0.048	1.12	1017
13	0.044	0.045	0.99	996
14	-0.156	0.051	-3.04	975
15	-0.313	0.058	-5.39	954
16	-0.325	0.069	-4.72	933
17	-0.285	0.078	-3.64	911
18	-0.331	0.092	-3.58	890

Table V
Results comparison of the two tests (Table III and IV)
Fitted below are the results of both Table III and Table IV, ranked according to their respective "reaction category".

	First Test (*Table III*)			Second Test (*Table IV*)		
lt value (months)	Overreaction	Normal	Underreaction	Overreaction	Normal	Underreaction
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						