Implied volatility and warrant issuing strategies: some evidence from the Johannesburg Stock Exchange

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Financial institutions have extended their competitive realm through issuing warrants as retail products. By comparing products from different financial institutions which are similar in all respects, but are differently priced through different implied volatilities, market inefficiencies are demonstrated. Competition between issuers lead to clearly identifiable market strategies. It is further argued that issuers, by providing less than complete market information, have developed a position of relative strength, compared to the buyers of warrants.

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Introduction and problem statement

Warrants are instruments tracking an underlying asset in a way similar to an option and can be priced by means of the Black-Scholes model. In South Africa, warrants are issued on the Johannesburg Securities Exchange by independent financial institutions. Investors can simply buy these as they would a share and gain a leveraged exposure in the market. It does not require significant capital to take a position and even small investors can include an entire basket of warrants in their portfolio.

Currently, seven institutions actively issue independent spreads of warrants on the JSE. Not all warrants trade with great depth and liquidity, and issuers compete for the popularity of their warrants. For the investor who has opted to take a position through warrants, selecting which issuer's instrument to participate in, is an important decision. Issuers have different issuing strategies offering dissimilar benefits and returns. The most crucial parameter to consider is the implied volatility, which is an indication of future movements in the price of the underlying assert.

This article investigates the mechanics of warrants, implied volatility and how this parameter is incorporated into issuing strategies. Although implied volatilities are often published, the values were frequently found to be inaccurate. As a small difference in implied volatility could result in a significant difference in contract price, a method is presented to calculate more accurate implied volatilities. This is then applied to warrants issued by different writers to analyse the types of strategies followed by issuers.

A second section introduces the warrants trading on the JSE while Section 3 deals with volatility and the various measurements thereof. The empirical analysis follows in Section 4 and in Section 5 issuer strategies are analysed. Section 6 contains the conclusion.

Warrants trading on the JSE

In American and most European financial markets, a warrant is a security issued by a company which provides the holder with the right to buy a share in the company at a fixed price during the life of the warrant. It is thus a call option issued by a firm on its own stock in order to raise funds. Such warrants have to be valued in a different way than other call options, since exercising the warrant affects the value of the underlying asset. It increases the shares outstanding and brings fresh cash into the company, both of which will affect the share price. The expected negative impact (dilution) of an exercise makes the warrants less valuable than otherwise similar call options.

In German, Australian and South African financial markets, warrants are independent derivative instruments issued by financial institutions which trade on the stock exchange where the underlying asset is listed. On exercise of an in-the-money warrant, it is sold back to the issuer with no affect on the underlying asset. The Black-Scholes equation therefore should hold for these warrants.

Warrants are commercial retail products. Warrant writers enter long positions either in assets or their derivatives on SAFEX (which requires significant capital) and then short these positions in small contract sizes as retail products on

the JSE. Private and small investors can then afford to take long option positions in the form of put and call warrants. This of course comes at a cost as any retail product would. The warrants trade more expensively than their counterparts on SAFEX, all parameters being equal.

A separate market emerges that trade these instruments in which the investor can buy and sell options tracking the underlying asset at a premium price. The market, however, loses efficiency due to the fact that the warrant has to be bought from the writer and therefore eliminates the opportunity of arbitrage through shorting overly expensive warrants. This contributes to the escalated price of the warrant. If the warrant were to trade at a price lower than its counterpart on SAFEX, an arbitrageur could enter the market by going long in the warrant and shorting a similar option on SAFEX. This is, however, only a distant possibility, as the writers maintain an elevated price.[1]

Turning attention to the Black-Scholes equation for options, the price difference presents itself in the volatility, which is the only uncertain parameter. If volatility is calculated using the known parameters of time, asset and option spot price, interest rate and strike price, it gives an indication of what the entire market expects volatility to be. However, in the case of warrants the writers manage to control this value through their asking or bidding price as the only short player in the market.

The JSE allows the ruling price of an asset to move when no trade occurs in an attempt to reflect the market's opinion more accurately. In the case of warrants, the issuer utilises this status quo to influence the price of the warrant so that it continues to track the underlying asset at a specific volatility when no volume changes hands. For instance, had the underlying share price moved considerably bullish on a particular day, and no trade occurred on the warrant, the writer can simply enter a bid price higher than the previous traded price before markets close, and the JSE will record this as the closing price. This becomes a continuous exercise and is part of 'market-making'. If the writer's market-making ability is disciplined and unbiased, however, traders can expect the warrant to trade as a fairly valued derivative instrument.

When trading occurs, the ruling price of the warrant becomes the price at which trade occurs. When no volume is trading, the JSE rules state that the closing price becomes either the bid price if this is higher than the last traded price or the asking price if this is lower than the last traded price, creating a range of non-traded price fluctuations. When both bid and ask prices exist within the range, yet no trade occurs, the ruling price remains the last traded price. If no trade has occurred on a particular day, the previous day's close substitutes for the last traded price.

Issuing a warrant is a composite undertaking and requires depth in the financial institution. The trading dynamics have to be managed throughout the life of a warrant in order to create a sensible instrument. The different independent issuers on the JSE are as follows:

Table 1: Institutions issuing warrants on the JSE

Issuer	Issuer Key
BNP PARIBAS	BP
DEUTSCHE BANK	DB
GENSEC BANK	GB
INVESTEC BANK	IB
SOCIETY GENERAL	SG
STANDARD BANK	SB
UBS WARBURG	UB

In addition to these, the mining house Harmony has entered the market in issuing independent warrants specifically on their own shares. This initiative was sparked after numerous complaints were made to the company about biased market-making by independent issuers. The three largest volume issuers, Standard Bank, Investec Bank and Deutsche Bank dominate the market and the smallest volume issuers, UBS Warburg and Gensec Bank often have no trades in their instruments.

In order to track the underlying share price, market makers use various trading parameters and not necessarily the actual traded price. A popular method is to use the average of the bid and offer prices for the underlying asset in the market and to incorporate a desired volatility parameter to calculate the warrant price. Market-making then consists of maintaining bid and offer prices for the warrant below and above their calculated price. This method allows the market maker to track movements in the underlying more closely, because the next trading price of the underlying is likely to be in between the current bid and offer prices. It does not, however, weigh supply and demand and cannot anticipate movements due to large orders entering the market.

Volatility

The volatility of an asset price is a measure of uncertainty about the returns provided from an investment in the asset and is measured by the variability in its price over time (usually over one year). For a share it is usually the standard deviation of the continuously compounded returns provided by an investment in the share.

One estimate of future volatility of the asset underlying an option is by using historical prices and assuming that the realised level of volatility will continue into the future. Estimating volatility from historical data depends on the time frame of volatility interested in. Usually a standard deviation of the daily percentage changes in the share price is calculated for a period equal to that which the investor intends to hold the option. The asset price is observed at fixed intervals (i.e. daily at close) and the natural logarithms of daily price ratios are calculated:

[1]The writers maintain an influence on the price by shorting more warrants to supplement the open interest in the market or neutralising existing open interest. (See Section 3.)

$$u_i = \ln\left(\frac{S_i}{S_{i-1}}\right)$$

where S_i is the spot price in period i.

The standard deviations of these values:

$$s = \sqrt{\frac{\sum u_i^2 - \left(\sum u_i\right)^2}{(n-1)}} \quad \text{for n days,}$$

divided by the square root of the number of trading days per year (τ), produces the estimate of yearly volatility $\hat{\sigma}$:

$\hat{\sigma} = \frac{s}{\sqrt{\tau}}$ where τ usually is 250 days.

Of course, it remains questionable whether historical volatility can be used to forecast future volatility.

When dealing with options, implied volatility is widely believed to be informationally superior to historical volatility, because it is the market's forecast of future volatility (Jarrow, 1998:211). This holds if it is assumed that the Black-Scholes volatility computed from the market price of an option is a good estimate of the market's expectation of the underlying asset's volatility, if the market's expectation is informationally efficient and if perfect liquidity exists in the option market.

In options markets, the implied Black-Scholes volatilities vary with both strike and expiration. This variation, known as the implied volatility smile, is a significant and persistent feature of most index options (Jarrow, 1998:367). Graphically it manifests if the implied volatility of an option is plotted as a function of its strike. Out-of and in-the money options have higher implied volatilities than at the money options and from there, the 'smile'.

For most warrants, however, implied volatility is found to be a poor forecast of subsequent realised volatility. Partly the problem arises from the methodology used to calculate the estimated volatility.

The Black-Scholes formulas for both calls and puts cannot be arranged in such a way that volatility (σ) is expressed in terms of the other parameters (spot and strike price, interest rate, time to expiry and option price). Thus, an iterative search process is used to determine an implied volatility, which is accurate within an acceptable tolerance. Using known historical information and guessing an implied volatility, a value for the call (put) is determined and compared to the actual call (put) value. A positive exponential relationship exists between volatility and the call (put) price, so that if the calculated value is higher than the actual value, the next iteration incorporates a lower volatility and *visa versa*. A good estimate for the next iteration is:

$$\sigma_n = \frac{(1 - \text{calculated price})}{x(\text{actual price})} + \sigma_{n-1}$$

where:

σ_{n-1} is the estimate in the previous iteration;
actual price is the warrant spot; and
x is a sensitivity parameter (1 to 7).

Through the iteration process, the values calculated for the implied volatility approach a value corresponding to the actual option price. The lower the value for the sensitivity parameter, the faster a value within an acceptable tolerance is reached. Certain combinations of spot and strike prices force the calculated values to oscillate divergently around the corresponding value. By increasing the sensitivity parameter, the oscillations reduce so that the calculated volatilities converge towards the corresponding option value. Nine iterations are usually sufficient to achieve this value for any combination of parameters, given that the sensitivity parameter allows for convergence. The acceptable tolerance is set such that the error is negligible over the entire spectrum of parameters. This error (ε) is measured as the difference between the actual option price and the calculated option price from the previous volatility, as follows:

$$\varepsilon = \frac{(\text{calculated price} - \text{actual price})}{\text{actual price}}$$

A feasible error tolerated between the actual and calculated option price for the purpose of the empirical investigation is $\pm$ 0,3% for all data excluding the last two months to expiry. An error of 0,3% leaves sufficient room to identify discrepancies between different implied volatilities. Time to expiry is a dominant factor in relating volatility and option price and it is found that, due to time decay within the last two months, price becomes less sensitive to changes in volatility so that this prescribed error cannot guarantee a realistic representative implied volatility. Therefore data within the last two months to expiry is omitted from investigation.

The standard deviation estimate of volatility was developed for liquid and efficient options markets. When examining the implied volatility of a warrant, there seems to be little correlation with subsequently realised volatility, nor does it reflect the information contained in recent observed volatility. For example, Figure 1 illustrates the implied volatility of a BNP Paribas call warrant on Anglo-Platinum for the period up to 23 August 2001 being ~ approximately 55% at close on that day. Observing the share price from this day onwards and calculating the standard deviation in the change of the subsequent share price from this day on (and increasing the days to moving average), it approaches a value which is about 20% lower than the original implied volatility.

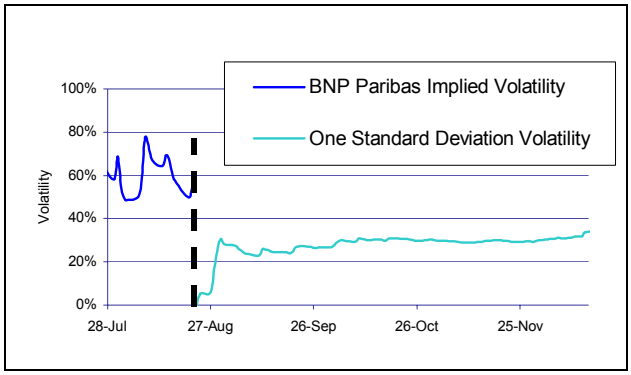

Figure 1: AngloPlat: Implied vs Historical Volatility

Empirical analysis

The empirical study compares historical warrant pricing dynamics. Because the actual price at which trade occur gives the best indication of the market's sentiment, all implied volatilities are calculated using market closing prices for both warrants and their underlying assets as published by the JSE rules of trading.

As the price of an underlying asset changes, only a portion of the fluctuation in the corresponding warrant price can be attributed to implied volatility changes. When warrants with identical strike and underlying asset parameters, issued by different writers are compared, discrepancies in the market's implied volatility can be seen, because writers manage to maintain different implied volatilities. To illustrate this, Figure 2 shows the differences in warrant prices and the resulting implied volatilities between identical Anglo call warrants issued by BP and IB between August and December 2001. The warrant prices have been multiplied by their cover ratio to represent the option on one share. Other warrant parameters are:

Underlying Asset	Anglo
Strike price	1300c
Expiry Date	20 March 2002
Type	American Call

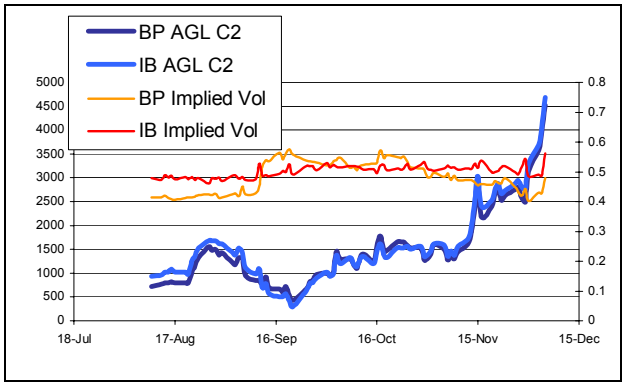

Figure 2: Anglo: BP vs IB Warrants

Clear discrepancies can be seen in the price of otherwise similar warrants with differences in the resulting implied volatilities at times reaching almost 10%. No consistent pattern seems to be shared and the levels cross in magnitude sporadically. Naturally, when the price is higher, the implied volatility is higher. For an investor who would have liked to take a leveraged long position on Anglo during this time, the price difference induced by volatility differences could have meant a substantial difference in return on investment.

The return on investment is calculated using the average warrant price over the remainder of the time period. Graph 3 plots the percentage difference between the return on investment of the two warrants versus the difference between the corresponding implied volatilities over the time frame investigated.

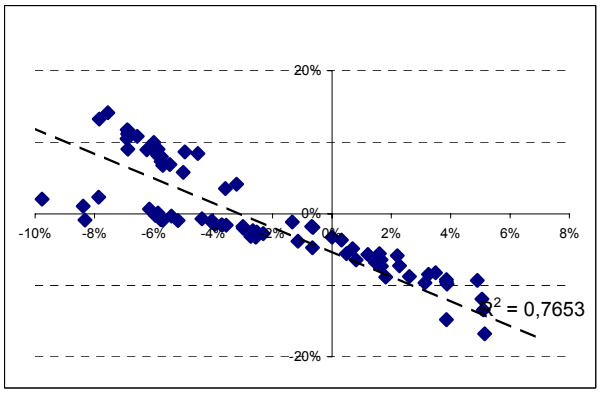

Figure 3: Anglo: ROI(BP-IB) vs Implied Vol (BP-IB)

A clear linear relationship can be identified. The greater the difference in implied volatility when purchased, the higher the return on investment for a specific warrant if compared to its counterpart. A regression line drawn for the points delivers a R-square of 0,7653. Thus 76,5% of the discrepancies in return on investment can be described by the difference in implied volatility.

To confirm this observation, a sample of similar pairs of warrants traded on the JSE were subjected to the same analysis. Unfortunately few identical warrants exist on the JSE and the sample included pairs of warrants with an expiry difference of not more than one day, and all other parameters equal. The maximum error occurring due to the day expiry difference is less than the $\pm$0,3% acceptable tolerance for all data excluding two months to expiry. A total of nine pairs of warrants were identified and included in the sample. All warrant prices are multiplied by their cover ratio's to express an option on one share. The relationships all confirm the same pattern (details are available on request from the outlets).

A summary table of the results is as follows:

Table 2: Correlation between discrepancies in return on investment and differences in implied volatility for nine similar warrant pairs

Code	Strike Price	Expiry Date	Issuer	Type	Average Volume	Sample Dates	R square
2AGLBP	13000	20/03/2002	BP	USA Call	30147659	08/10/01-	0,765
2AGLIB	13000	20/03/2002	IB	USA Call	53107395	12/05/01	
1AMSBP	40000	20/03/2002	BP	USA Call	24635872	06/29/01-	0,734
5AMSDB	40000	21/03/2002	DB	USA Call	726192	01/21/02	
4BILIB	7000	18/09/2002	IB	USA Call	31304978	01/17/01-	0,881
5BILDB	7000	17/09/2002	DB	USA Call	0	02/11/01	
1DTCSB	2000	21/03/2002	SB	USA Call	3834916	08/22/01-	0,793
4DTCBP	2000	20/03/2002	BP	USA Call	736565	01/21/02	
2FSRBP	1000	20/03/2002	BP	USA Call	508989	06/28/01-	0,826
3FSRDB	1000	21/03/2002	DB	USA Call	19663	11/01/01	
4INTBP	18000	20/03/2002	BP	EURO Put	2586696	08/23/01-	0,842
4INTSB	18000	21/03/2002	SB	EURO Put	5318223	01/18/02	
1KMBDB	3800	17/09/2002	DB	USA Call	1641666,67	01/17/02-	0,720
2KMBIB	3800	18/09/2002	IB	USA Call	6260255,56	02/11/02	
3OMLSB	2200	21/03/2002	SB	USA Call	1135760	06/28/01-	0,782
4OMLDB	2200	21/03/2002	DB	USA Call	55479	10/10/01	
2SAPBP	7000	20/03/2002	BP	USA Call	21985201	06/28/01-	0,882
4SAPDB	7000	21/03/2002	DB	USA Call	2950710,5	10/19/01	

The R-squares for the sample vary from 0,72 upwards, which shows excellent correlation. This means the observations are not mere random noise and confirms that there are indeed substantial differences in implied volatilities with explanatory power.

As noted earlier, a fair price for the warrant, which includes the premium, is calculated by the issuer throughout the life of the warrant using a desired volatility parameter. The issuer maintains an influence on the actual trading price in the market by:

- shorting more warrants at a asking price to supplement the open interest held by private investors, or
- by reducing the open interest by neutralising some of the open interest with a bid price.

The bulk of the open interest trades are among the investors themselves. Some market efficiency emerges in that an investor retains the choice in which issuer's warrant to participate in. The volatility parameter used by the issuer to calculate a bid price for new warrants issued has a direct influence on the popularity of the warrant. Issuers compete to have the most attractive warrants in the market, which results in higher volume traded on these warrant. Issuers do not publish the total number of warrants issued (i.e. open interest in the market).[2] It is therefore difficult to learn the success of various strategies. No trading volume on a warrant is evidence of an unsuccessful strategy, although high volume is not necessarily evidence of success.

Issuer strategies

Issuing warrants is a potentially lucrative business. The issuers hedge their short position on the JSE, so not to have a naked position in the market and thus, do not profit from a move in the underlying price either way. The hedge usually takes one of the following forms:

- by increasing (for calls) or reducing (for puts) their long position in the underlying asset[3], or
- buying similar derivatives on the derivative exchange or
- purchasing customised over-the-counter (OTC) options wholesale.

It was stated that a warrant always trades at premium volatility over observed volatility of the asset, which often decreases towards expiry. This phenomenon is explained by

[2] It would only be possible to calculate the open interest in the market if all transactions since the birth of the warrant are monitored, although the trading system from 9th May 2002 permits only anonymous trading, which would render this impossible.

[3] Warrants provide an additional benefit to investors: Issuers hedge their positions in warrants shorted by buying the underlying after the warrant is bought. If a significant volume of warrants with a high gearing are purchased from the issuer, the amount of more expensive shares bought to hedge the position could move the price in favour of the investor in the short term.

one of the ways in which some issuers secure profit. Initial proceeds are earned from the premium added through issuing at retail volatility higher than the wholesale volatility. Investors are willing to pay a premium, because a demand for such instruments exist and the investors do not have the capital to participate in the derivative exchange itself. If the warrant expires out-of-the-money, the issuer retains the premium difference. The implied volatility premium is also winded down gradually over the life of the warrant so that it can be effectively neutralised at a cheaper price. The profitability is thus a function of the open interest in the market and the difference in issuing- vs. neutralising-volatility.

Warrants trading on the JSE are usually American, so that the issuer can neutralise open interest at any time, i.e. when there are no buyers in the market for investors wanting to sell. This also means liquidity is guaranteed for an in-the-money warrant. When the demand of an issuer's warrant is down, neutralising some of the open interest creates artificial demand and escalates the price by law of supply and demand. When the market demand is up, the issuer would short more warrants creating supply, which deflates the price and increases the open interest towards greater proceeds. The strategy is thus to increase the open interest in the long term and to influence the supply and demand to maintain the implied volatility at the issuers discression. When the open interest is expanding, the issuer would benefit from maintaining a higher implied volatility so that the new warrants are issued dearly. When the open interest is contracting, the issuer would benefit from maintaining a lower implied volatility so that the warrants are neutralised cheaply.

By studying the sample of similar warrants' volatility, a fairly consistent hierarchy in the discrepancies emerges. Some issuers constantly maintain a higher level of implied volatility. Deutsche Bank warrants most frequently have the lowest implied volatility and Investec Bank warrants frequently have the highest. Issuer strategies are thus similar as other retail products. A low cost leadership would aim at maintaining a low implied volatility and thus resulting in lower cost warrants. Differentiation strategies maintain higher implied volatilities and resulting prices, and market the warrant more aggressively or offer special attributes to the warrant.

Such attributes include consistency in the implied volatility. While low cost strategy issuers' instruments might fluctuate speciously, a differentiated issuer aims at maintaining an implied volatility, which corresponds to the actual impulsiveness of the share price. Some issuers vow to maintain the implied volatility consistently, regardless of changes in the impulsiveness of the underlying share. Investors increasingly prefer this consistency to provide predictability in their investment.

Some differentiated issuers offer more unique instruments, such as index warrants and compound warrants, which are warrants on warrants that naturally provide higher gearing. Deep-in-the-money warrants are issued as a new special instrument that the investor holds for exposure to a long-term leveraged position. Differentiated issuers would also pay commission to traders for pushing their product. The success of commission structures is questionable because it attracts quick-traders who do not contribute to the long-term open interest. Differentiation of distribution in the case of warrants means the issuer have efficient electronic systems enhancing communication with the traders and often providing information regarding their warrants, making it more appealing for the trader to recommend.

Identifying exactly which strategy an issuer pursues is complex. In order for an issuer to maintain a strategic level of implied volatility on a warrant, a critical mass of open interest must be achieved. An issuer cannot control the supply and demand if the open interest is too small or liquidity is insufficient. The issuer then needs to drop the volatility and price to attract investors and thus might be confused with having a low cost strategy, because the open interest is not made public.

Some issuers recently altered their strategies. Bank Paribas and Gensec Bank both have repositioned themselves through lowering their general implied volatilities. The implied volatilities of warrants listed on the JSE for each share were compared to estimate the average overall issuing strategies. The following table describes the hierarchy of implied volatilities and other strategies:

Table 3: Issuing strategies

	Implied Volatility Strategy				
Issuer	Low	Medium	Premium	Commission Paid?	Attributes
BNP PARIBAS	x			no	
DEUTSCHE BANK	x			no	
GENSEC BANK		x		no	Specialised products, High Doubles
INVESTEC BANK			x	yes	Consistent Vols, Efficient Distribution
SOCIETY GENERAL		x		no	
STANDARD BANK		x		yes	Consistent Vols
UBS WARBURG			x	no	Distinguished House Image

Conclusion

Choosing in which issuer's warrant to participate can lead to significant differences in the outcome of an investment. The fact that issuers exert influence on the supply and demand on their instruments (thus controlling the level of implied volatility) and pay commission to traders, prove that the warrant market is less than efficient. It is recommended that issuers publish the open interest of their warrants along with the price and volatility. This would allow investors to monitor the influence exerted by the issuer and determine the depth of the actual market, which would result in a more efficient market.

From observing the evidence of return on investment vs. implied volatility, it seems that low implied volatility warrants hold more benefit for investors than differentiation strategy issuer's warrants. Because issuers earn profits mainly from the difference between wholesale and retail prices of instruments, the implied volatility of a warrant has a floor level below which the market-makers would not drop their volatility. Warrants with the lower implied volatility leave less room for the market-makers to wind down the

value of the open interest. Consistent regression results, confirm that a relationship exists between higher returns and purchasing at low implied volatilities.

Warrants which incorporate commission paid to brokers and high marketing costs holds no additional benefit to investors. Consistency in implied volatility though, provides certainty and a more impartial price, both beneficial to the investor. Investors have recently started to take note of these issues and are 'voting with their feet'. They are increasingly supporting institutions that maintain consistent levels of implied volatility. Traders avoid issuers that move their volatilities to match the underlying impulsiveness, because it often becomes an issue of how this level is measured and what depth of historical data is used.

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