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The Hard Truth About Market Volatility

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Volatility is seizing financial markets. Investors who pay attention to one of the best-known financial models of all time could see it coming. What does this moment teach us about future market volatility?

The years since the Global Financial Crisis (GFC) have been good ones for investors. Low rates persisted and easy money flowed through the financial system, fueling steadily climbing market returns while globalization, technology advances, and business-process improvements generated massive productivity gains, keeping inflation in check.

There were occasional signs that this apparent Goldilocks scenario might be fragile — for example, an uptick in prices as the labor- and production-cost advantages of globalization started to fade provided a hint that very low inflation might not coexist comfortably with loose monetary policy indefinitely. The limitations of globalization crystalized further in the eruption of the US/China trade war. Covid-19 disruptions exposed the underlying vulnerability of the finely calibrated global trade system. The Russia-Ukraine war compounded that vulnerability. Today's investors are gripped with uncertainty as markets tumble and market volatility rears its head.

For investors, this is a moment that calls for a renewed understanding of volatility, one that goes beyond conventional hedges and traditional measures. Why? Because the post-GFC global growth story has been built on practices and policies that have suppressed volatility and — as we're beginning to see — permanent suppression of volatility may be untenable. In fact, there is reason to believe that the volatility these practices and policies have squeezed out of the system will come roaring back. Knowing how, when, and in what form will be crucial for investors to understand.

To make a start, in this paper, we'll explore the nature of volatility using one of the foundational models of financial theory and look beyond standard, market-focused volatility measures to see where meaningful risk currently resides.

Black-Scholes and the Indestructibility of Volatility

A helpful way of thinking about volatility emerges from the Black-Scholes model. Introduced in 1973, Black-Scholes is indispensable for pricing options contracts. Because pricing options depends on assessing volatility, Black-Scholes provides a useful framework for understanding risk.

The Black-Scholes equation describes how option prices change with time along with a few other variables. The equation requires five inputs: the option's strike price, the current stock price, time to expiration, the risk-free rate, and volatility (see Appendix). Volatility — defined as the tendency to change rapidly and unpredictably, especially for the worse — is a key variable in the Black-Scholes equation. The model certainly has some oversimplifications for those infrequent moments of high turbulence, but it still serves as a useful tool.

Familiar as Black-Scholes has become, it may be easy to forget that the model's origins are in physics. In particular, the model refers to the physical phenomenon of heat flowing through a uniform metal rod. In fact, simple algebra transforms the Black-Scholes equation into one that is analogous to the heat equation in physics. The financial equivalent of heat is volatility.

The deep connection between one of the most used frameworks for understanding financial-market risk and this observable physical phenomenon is meaningful to investors for a simple reason. The law of conservation of energy in physics states that heat cannot be created or destroyed. To the extent that Black-Scholes provides a meaningful description of financial markets by analogy, this suggests that volatility cannot be created or destroyed. If volatility appears low, that's because it's been suppressed in the present and will reappear in the future — or else volatility is appearing in areas of the larger system that conventional financial-market measures can't capture.

Very low volatility was the hallmark of financial markets in the years following the GFC. But volatility has been erupting on multiple fronts for some time — in politics and society, and now in financial markets. Against this backdrop, the idea that volatility is indestructible may give us a helpful way of understanding what's happening now and what may come next. If volatility appeared to vanish from markets for a time, but it cannot be destroyed, then how was it suppressed? Where did it go? Where might it appear next? And what does this mean for long-term investors? In this piece, we'll open a discussion of these critical questions and propose some initial answers, by focusing on pockets of the market where volatility has been or is currently suppressed.

Easy Money, Part 1: Loose Monetary Policy and the Relentless Search for Return

Interest rates have been falling for more than forty years. Rates fell even faster in the aftermath of the GFC and hit new lows in the Covid crisis. Institutional investors, strapped for return in a low-yield environment, have taken on more and more risk to meet return targets. And they've succeeded. Over the past few decades, financial returns have been exceptionally strong — even as bond yields collapsed to near zero.

In order to meet their requirements, pension funds, other institutional investors, as well as individual retirees took increasingly aggressive positions in risk assets, including equities. These hardly seemed risky, as perpetual buy orders drove prices up — and the mechanics of this relentless buying trend had the parallel effect of reducing volatility.

Investors also turned to illiquid and longer-dated investments for return, including private equity and real estate. In this case, the perception that these instruments exhibit lower volatility attracts investors, which allows the pattern to persist longer, until the eventual reverse takes place.

Why is such a reverse likely? The surplus of cheap money became so vast that it flowed toward private ventures indiscriminately, leading to a tighter dispersion of returns. On the ground, this means that poorly managed firms have been able to continue operating on the back of cheap capital and credit, in some cases using leverage to engineer financial outcomes that have little connection to fundamentals. In the absence of cheap money, companies are more likely to fail (including the ultimate failure — bankruptcy), revealing flaws in business models and in management that investors — who are themselves under pressure to find the best uses for relatively scarce capital — can then act on. As we've observed in recent years, volatility can be suppressed for some time in this scenario. But as we saw in 2022, long-term investors can't ignore fundamental flaws indefinitely, nor can the supply of easy money continue indefinitely. When the suppressive effect of that cheap cash is withdrawn through rate hikes and other central-bank actions, volatility returns to markets with a vengeance, as the consequences of poor management become more visible and the value of future cash flows becomes less certain.

The potential downside of this backdrop became evident in the first quarter of 2020, when US credit markets seized up and the Fed, along with the US Treasury, had to deploy staggering firepower to keep markets functioning. If you are a pension fund, relying on massive rescue interventions of this kind is probably not how you would choose to meet your obligations.

In 2022, as central banks reduced the money supply to combat inflation, volatility was unleashed among those high-growth companies that had the most uncertain cash flow, as well as those with a high beta propensity. The top performers from the time when volatility was suppressed — growth and high beta stocks — were decimated. Despite much speculation to the contrary in the post-GFC period, volatility never really disappeared from markets; volatility can neither be created nor destroyed.

Volatility can be suppressed in the present, only to reappear in the future. The steady rise in equity-market returns that investors enjoyed during the post-GFC period were, in a way, stolen from the future. Has that future now arrived? If so, investors will need to work much harder to achieve their objectives in an era of more expensive money, higher dispersion of returns, and greater volatility.

Easy Money, Part 2: Loose Monetary Policy, Leverage, and Share Buybacks

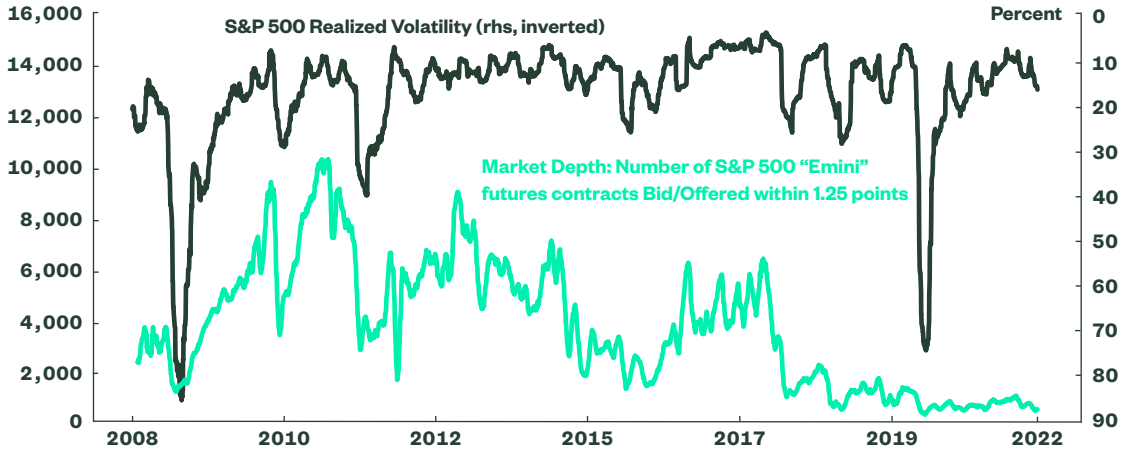
Just as the river of cheap money flowing from central banks has nudged investors to take on risk while masking volatility, free-flowing cash has created incentives for companies to load up on risk by engaging in share buybacks. This behavior has artificially boosted both earnings per share and total shareholder returns, keeping volatility subdued despite the additional risk.

Over the past 12 years, companies have capitalized on low rates to issue more and more debt, refinancing higher-cost obligations and using the funds to buy back shares at an unprecedented rate.

As a result of these cumulative buybacks, equities market depth has suffered, as fewer shares circulate among fewer market participants (see Figure 1). In fact, overall equity-market liquidity has decreased, particularly in the United States.

In the short term, buybacks can contribute to lower volatility for a time, through the mechanics of continuous buying action. But this again represents an exchange of lower volatility today for elevated volatility at some point in the future — because impaired market liquidity can lead to explosive volatility when market panics and stress events strike. We saw an example of this in March 2020, in the Covid drawdown, when demand for liquidity far outstripped markets' ability to supply it.

Figure 1
Market Depth as Measured by Number of Contracts Trading in a Liquid Manner, and S&P 500 Realized Volatility (Inverted)



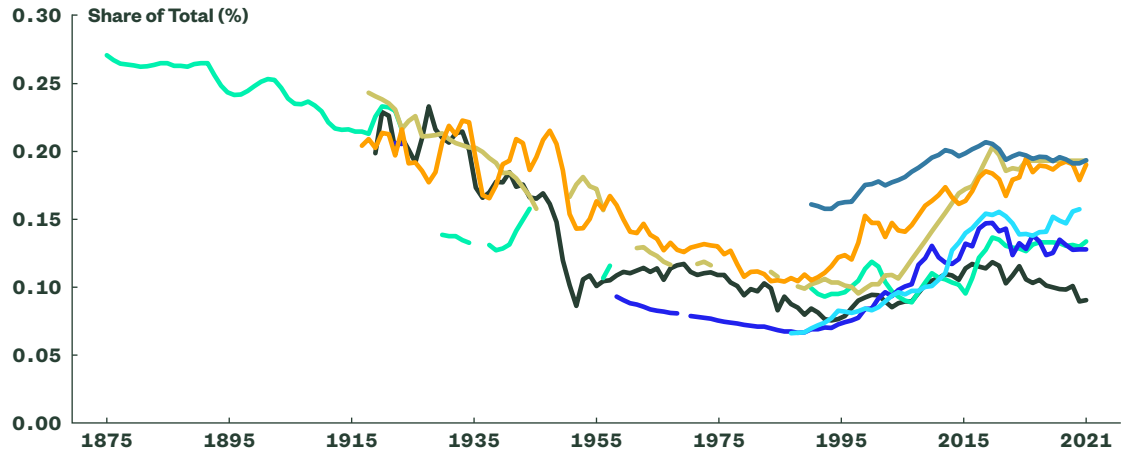
Source: JP Morgan.

Easy Money, Part 3: The Ballooning Wealth Gap and Social Unrest

Quantitative Easing has contributed to a ballooning wealth gap, which has led to social and economic movements around the world. These movements pose risks to overall social, economic, and market stability.

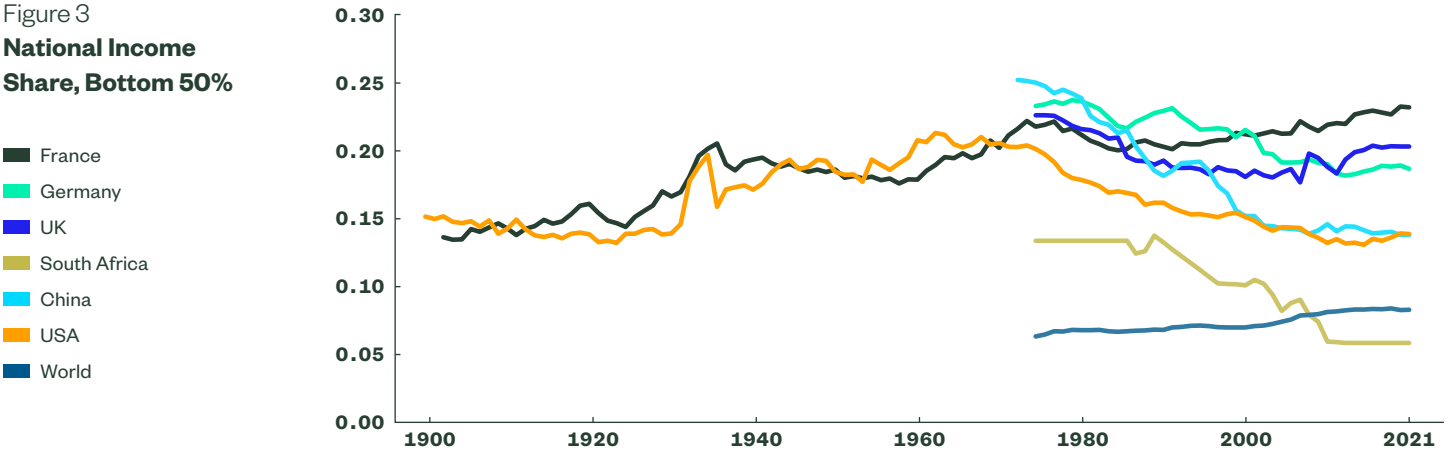
The United States is the most extreme example of this trend. The national income share of the top 1% of primary income has increased dramatically from just over 10% in 1980 to almost 20% in 2019 (see Figure 2). The bottom 50% has not fared well; over the same time frame, its share has collectively declined substantially (see Figure 3).

Figure 2
National Income Share, Top 1%



Source: World Inequality Database.

Figure 3
National Income Share, Bottom 50%



Source: World Inequality Database.

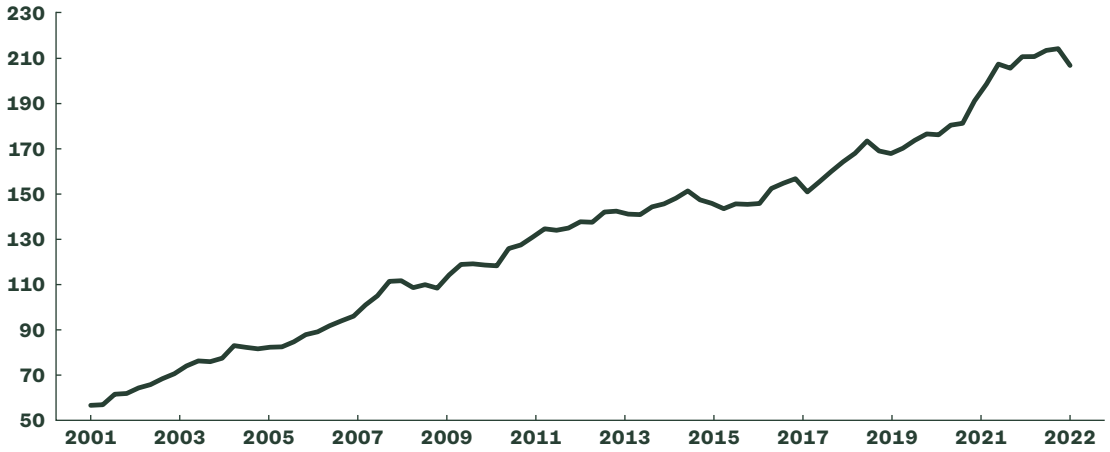
Owners of capital have benefited greatly compared to the average worker since interest rates began their downward trajectory in the early 1980s. Because lower interest rates penalize savers and reward capital owners, easy money fueled a massive transfer of wealth from workers — i.e., sellers of labor — and retirees to owners of capital. Demographics played a role in intensifying the effect; governments and monetary authorities, backed into a corner by a widespread banking crisis, moved to support asset prices by lowering rates at the same time that large numbers of retirees — the quintessential savers — started exiting the labor market and entering retirement.

Low rates can subdue market volatility for a time, but increasing concentration of wealth has historically led to social and geopolitical unrest. In a sense, easy money pushes volatility and risk from markets into society at large — moving from one part of the overall social and economic system (i.e., markets) to another one (i.e., politics and society). Social tension then builds toward a day of reckoning when workers revolt, creating an explosion of volatility and, eventually, a system-wide reset of society, politics, markets, and the economy as a whole. Today, increasing concentration of wealth is clearly contributing to polarized political conflict and unrest.

Debt

Another disturbing development over the past years has been the fourfold increase in total debt for the G20 nations. As an economy is saddled with debt, it becomes difficult for that economy to sustain prior levels of productivity and growth over time. Debt by itself is not a bad thing; it is when an economy borrows well beyond its means (e.g., exhibiting a debt-to-GDP ratio in excess of 100%) that it becomes difficult to deliver the same level of productivity for the usage of that debt. Excess debt has adversely affected countries many times in the history of the world, going back to Greek and Roman times. Typically, it results in a painful ending and a restructuring that ultimately impacts the volatility of the country's risk assets.

Figure 4
G20 Total Debt
USD Trillions



Source: Bank of International Settlements — Q2 2022.

Supply-Chain Reengineering and Just-In-Time Inventory Practices

Over the past 30 years, firms have taken aggressive action to create lean and highly efficient supply chains, using just-in-time inventory practices, aggressive supplier streamlining, and other techniques. Costs dropped and working-capital metrics improved greatly due to these efforts, steadily benefiting stock prices.

These highly efficient practices contribute to a perception of low volatility, because they create positive financial results that do not fully account for the risks a firm has undertaken to achieve them. Just-in-time inventory practices, for example, can reduce a company's inventory days and improve working capital performance — but even a slight interruption in the supply chain can bring manufacturing operations to a standstill. Streamlining the supplier base can help a company to consolidate purchasing power, reducing the cost of administration and providing leverage to negotiate discounts and terms, but reduced redundancy in the supply chain can make it more difficult to mitigate any problems that might come up with a supplier. Ultimately, supply-chain reengineering gives investors a false sense of the stability of the business model and the durability of financial returns.

A combination of globalization and the ubiquity of supply-chain "optimization" practices is now placing not just individual companies in jeopardy, but entire economies. As suppliers concentrate in low-cost geographies, a few countries have become effectively the global factory floor for all developed economies. In recent years, we have witnessed the turmoil in global supply chains caused by the pandemic and the effects of the Zero Covid Policy on Chinese manufacturing. As we saw during the onset of the pandemic, the global supply chain has become highly concentrated in some key areas, with many dependencies that were not visible to investors and other observers. Even a rudimentary production process, such as making basic personal protective equipment (PPE), could not be ramped up quickly enough to serve citizens in most developed markets.

And there are other potential disruptors that could severely damage highly concentrated, and therefore highly exposed, supply chains — e.g., changes in international alliances, political upheaval, and natural disasters fueled by climate change, just for a start.

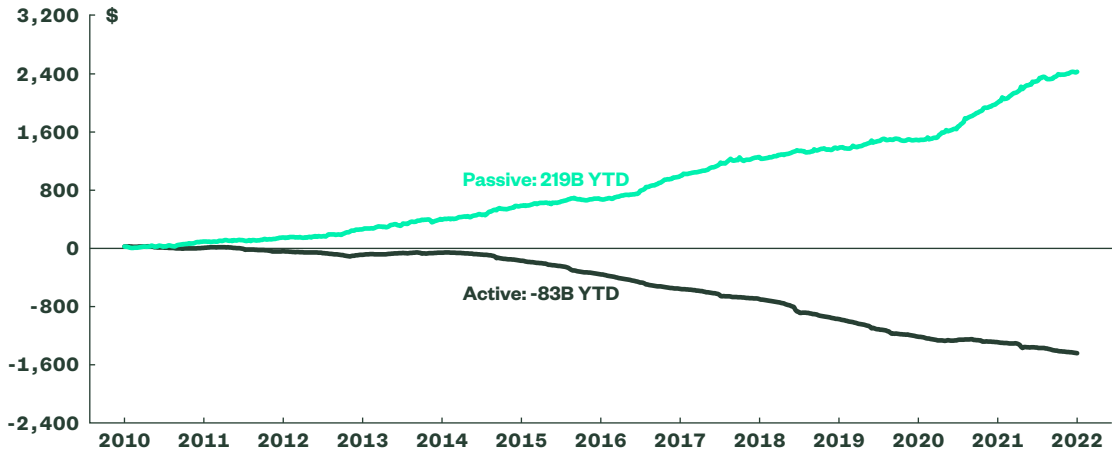
Supply-chain reengineering smoothed over variability and natural perturbations in stock-price performance for three decades. The supply-chain fragility that resulted was exposed by the pandemic. There are now other supply-chain risks brewing, which are likely to translate into future disruptive events, triggering further waves of volatility. When (or if) supply chains once again stabilize, investors would be well-advised to remember that the apparent safety and durability of cash flows and returns may well be based on an illusion.

The Rise of Index Funds

For markets to function, they need active participants who seek true valuation; this is the heart of price discovery. When index investors far outnumber active ones, price discovery can become impaired. Rather than being driven by investors who are studying fundamentals and assessing risk, prices in an index-dominated market are simply driven by index flows. In an environment in which volatility is already suppressed by a range of other forces, index investors — tempted by handsome returns and an apparent lack of risk — can pile into markets, further suppressing volatility. Again, these index investors are borrowing returns from the future, because explosive volatility can result when crucial information suddenly becomes widely known. The exposure of systemic weakness in the supply chain during the Covid crisis is an example of such information. Once the exit-door stampede is triggered, index funds contribute to even more pronounced volatility, as index managers sell off holdings to maintain their respective mandates.

Equities markets are currently dominated by index investors. Figure 5 shows how markets once dominated by active investors have evolved, with index funds now representing over 40% of the overall equities market and almost a quarter of the fixed income market. With the trend toward index investing showing little sign of shifting, investors can expect further volatility to emerge from this phenomenon in future.

Figure 5
Active vs. Passive Equity Fund Flows
USD Billions



Source: JP Morgan.

Investors who are exposed to excessive leverage add to the risk. This group doesn't always have a clear grasp of how volatility can present itself because, in their investing experience, securities can only go up in an environment of suppressed volatility. Their buying action keeps suppressing volatility right up until some precipitating event. And only when the margin calls come does their exposure materialize. And, of course, this adds to volatility in a negative direction as they're forced to sell.

Conclusion

A range of forces, including overly lax monetary policy, globalization, and widespread business practices like supply-chain reengineering and aggressive buybacks have suppressed volatility in recent decades. Low market volatility, in turn, has attracted investors and given rise to additional phenomena (e.g., the rise of index investing and excessive use of leverage) that have, over time, detached securities prices from fundamentals while driving up prices irrespective of risk — and thus helping to suppress volatility even further.

The Black-Scholes model suggests that — because volatility cannot be created or destroyed — the idea of a permanent low-volatility, upward-trending market is an illusion. Volatility is either expressing itself in the present — in areas of the overall socio-economic system that are not captured by conventional market measures of volatility — or it has merely been delayed and will make its presence felt in the future (or both). We're already seeing ample evidence of volatility appearing through social unrest, political polarization, and the mainstreaming of previously extreme views.

The suppression of volatility has both known and unknown consequences and risks. The unknown risks are of greater concern — as who knows how suppressed volatility will explode in future? Some of these risks are routinely acknowledged by institutional investors; others may seem counterintuitive at first blush. Each represents a potential for change in the financial ecosystem and should be assessed and managed as part of a thoughtful investment process.

The overarching lesson here is that markets can either experience volatility as we go — with periodic ups and downs — or markets can suppress volatility to support a steady upward trajectory. The latter ultimately leads to painful losses, unless governments intervene to suppress volatility and prop markets back up.

And we have seen evidence of explosive volatility materializing in markets — only to be suppressed again by government intervention. As inflation takes hold, institutional investors are asking themselves how durable and how reliable that government intervention is likely to be. Especially now that we're seeing a few cracks in this approach. Will the longstanding, steady upward climb in markets prior to the most recent drawdown give way to episodic downward slides or a more prolonged slide?

Appendix

The Black Scholes Formula and Heat Equation — *Pricing the Future* — George G. Szpiro

M is the number of shares S is the share price
N is the number of options
C is the call price
V is the portfolio value

$$V = M \times S + N \times C \quad (1)$$

For every move in either the share price or options price, there is a commensurate move in the portfolio value

$$dV = M.dS + N.dC \quad (2)$$

Using Ito's Calculus, dC can be converted into a Taylor series

$$dC = \frac{\partial C}{\partial S}.dS + \frac{\partial C}{\partial t}.dt + \frac{1}{2}.\frac{\partial^2 C}{\partial S^2}.\sigma^2 S^2 dt \quad (3)$$

Now substitute 3 for dC in equation 2

$$dV = M.dS + N.\left[\frac{\partial C}{\partial S}.dS + \frac{\partial C}{\partial t}.dt + \frac{1}{2}.\frac{\partial^2 C}{\partial S^2}.\sigma^2 S^2 dt\right] \quad (4)$$

If one were to adjust the ratio of shares to options such that the portfolio is hedged at all times then by this logic, the ratio must be the inverse of the way in which the option varies in response to a change in the price of the share.

$$\frac{M}{N} = -\frac{\partial C}{\partial S} \quad (5)$$

If the price of the option increases by, 50 cents in response to a $1 increase in the share price, i.e $\frac{\partial C}{\partial S} = 0.5$, then the dealer must hold short two options in order to keep the portfolio hedged

Let us examine a portfolio that has just one share, i.e. set M=1. Therefore by equation 5, the number of options needed to hedge the portfolio is

$$N = -\frac{1}{\partial C/\partial S} \quad (6)$$

Rearranging terms in 4, we get

$$dV = \left(M + N\frac{\partial C}{\partial S}\right)dS + N\left[\frac{\partial C}{\partial t} + \frac{1}{2}.\frac{\partial^2 C}{\partial S^2}.\sigma^2 S^2\right]dt$$

Substituting equation 6 for N in equation 4, the change in value of the hedge portfolio is:

$$dV = -\left(\frac{1}{\partial C/\partial S}\right)\left[\frac{\partial C}{\partial t} + \frac{1}{2}.\frac{\partial^2 C}{\partial S^2}.\sigma^2 S^2\right]dt \quad (7)$$

Since this portfolio is hedged, the return of the portfolio dV/V must be equal to the risk free rate, r, multiplied by the time period elapsed, dt

$$\frac{dV}{V} = -r.dt \qquad 8$$

Rearranging terms and substituting (1) for V and equation (6) for N (M=1), we get:

$$\frac{dV}{V} = -\ r.dt.V = r.dt\left(S - \frac{C}{\partial C/\partial S}\right) \qquad 9$$

Setting 7 and 9 equal and rearranging terms, we obtain the differential equation that Black and Scholes had to tackle

$$\frac{\partial C}{\partial S} = rC - rS\ \frac{\partial C}{\partial S} + \frac{1}{2}.\frac{\partial^2 C}{\partial S^2}.\sigma^2 S^2 \qquad 10$$

There is a boundary condition that states on the exercise date, the price of the option, C, must be equal to the larger of zero or the difference between the stock price and the exercise price. Equation 10 is a classical differential equation and these are notoriously difficult to solve. With some sophisticated change of variables, the differential equation 10 can be transformed into a well-known equation in physics, the heat equation.

Let us say the heat at position x at time t is denoted by U(x,t) then the heat equation says:

$$\frac{\partial U}{\partial t} = \frac{\partial^2 U}{\partial x^2} \qquad 11$$

The solution to this equation was developed by Fourier in 1822 in his book Theorie Analytique de la Chaleur (Theory of Heat)

$$U(x,t) + e^{\frac{xt}{Y}}.\left[A.\cos\left(\frac{x}{y}\right) + B.\sin\left(\frac{x}{y}\right)\right] \qquad 12$$

Where ^{Y} stands for a unit of length. Sorting out the change of variables, solution 12 can be transformed to the solution of the differential equation (10) given by Black, Scholes and Merton

$$C = S.N(d_1) - X.e^{-rt}N(d_2)$$

$$\text{Where}\quad d_1 = \frac{Ln\left(\frac{s}{x}\right) + \left(r + \frac{1}{2}\sigma^2\right)T}{\sigma\sqrt{T}}$$

$$\text{And } d_2 = d_1 - \sigma\sqrt{T}$$

Where C is the price of the option, S is the share price, X is the exercise price. T is the number of periods remaining until the exercise date; r is the risk free date per period (same units as T)

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* Pensions & Investments Research Center, as of December 31, 2021.
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