Is Quantum Computing Investable As The Next AI?

By Vineer Bhansali | January 23rd, 2025

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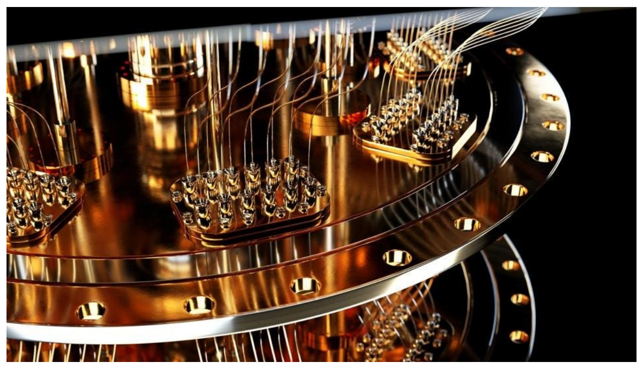
The boom and bust and re-boom in quantum computing stocks over the last few weeks (look for example at the price gain and collapse and re-gain of RGTI, QBTS, QUBT, IONQ and others) has drawn comments from analysts that, on the one hand, equate quantum computing with a "bubble," and on the other hand compare it with the early days of AI.



Questions include: How far can quantum computing go? Can it challenge classical computing in the near future? Are quantum computing stocks worth investing in? Is one of these companies, or maybe one that is not even a company yet, but just in the heads of physicists somewhere in one of the tech universities around the world, the next big thing? Is this a lot of hocus pocus or a computational paradigm that might blow current capabilities out of the water and make NVDA look like, well, Intel of prior years?

Investing in quantum computing is additionally scary today because the price of quantum computing stocks is being driven by both speculative instinct and the opinions of some of the rock stars of the AI revolution, who, if I may say so, probably do not know much more than the rest of us when it comes to forecasting the potential power and timing of when the strategy may become practical. One might be forgiven for thinking that comments regarding the near-term viability of quantum computing by Jensen Huang and Mark Zuckerberg from a few weeks ago are somewhat self-serving, looking to protect their turf from a potential new game-changing technology, though in fairness they are also quite involved in pushing the frontiers of quantum computing technology. For sure, if Nvidia has ushered in exponential growth in computational power behind AI, then the potential of quantum computing, which can provide a "double exponential" speedup in computation (this is known as Neven's law), will make classical computing based on even the fastest NVDA GPUs look linear.

And there are good reasons why NVDA cannot just come out and say quantum is *the* next big thing, because doing so would likely decimate the market for their current chips and the profitability that has propelled it to be the most valuable company in the world (as of the date of this writing). In the world of computing, linear speedup, even relatively speaking, is considered an insult, because quantum computing theoretically has the potential of not just exponential, but a "double exponential" speedup.

So, the simple answer to whether practical quantum computing is on the horizon in the near future is that no one really knows. It is similar to the task of predicting the probability that a meteor will hit the earth over the next decade. We simply don't know. But that should not prevent us from being somewhat prepared. To me, the real question is not whether practical quantum computing will happen in the next few years, but what are the consequences if it does, and how, as an investor can I rationally position myself for the rare but impactful consequences. The physical laws behind quantum computing are on solid ground, unlike many other fads like negative interest rates that were implemented in Germany, or perpetual motion machines of eras past.

First, let us put some confusion to rest. There is already a "practical" quantum computer in operation today. As a matter of fact, it has been in operation for as long as our physical world has existed. Yes, current physics says that nature is a massive quantum computer. I did my Ph.D. in Theoretical Physics, in the area of Quantum Field Theory, which strangely enough, works amazingly well in explaining the real world. The fact that nature seems to obey the rules of quantum mechanics all the way down to elementary particles and beyond is now beyond doubt. I also had the distinct pleasure of being at Caltech around the time that Nobel laureate

Richard Feynman started to seriously think about quantum computers and around when he uttered the famous quote that "Nature isn't classical, dammit, and if you want to make a simulation of nature, you'd better make it quantum mechanical".

In other words, even the fastest NVDA chips only get you a classical approximation to the real thing when it comes to simulation. It is akin to trying to simulate the nature of sub-atomic particles by applying Newton's laws to smaller and faster bouncing balls.

At some point the classical simulation will just fail because bouncing balls will never be able to replicate the peculiar quantum mechanical laws obeyed by sub-atomic particles. There are indeed problems today, though somewhat academic, that are practically impossible for classical computers to solve. As far as practicality goes, let's not forget that the period between when proclamations were made that humans could not fly to when airplanes showed it could be done was quite short. What it took was a change of mindset and the development of a parallel framework - humans fly in planes by understanding the basic principles of aerodynamics, not by flapping their wings like birds. The quantum approach to computing will also develop parallel ways of solving the problems of computation, and they cannot be extrapolated from classical ways of computing. Its a new paradigm, and new paradigms can quickly shatter the constraints of old paradigms.

After close to three decades of research, quantum computers have been built that can theoretically solve problems that cannot be solved on a classical computer (see the discussion of "quantum supremacy," and a more sober look in light of recent claims by the Google team here by one of my other professors from Caltech, the theoretical physicist John Preskill), and the question now is not whether quantum computers that can exceed current classical computing is possible, but how hard really the current problems like error correction are. Impossible is bad, hard is good! The history of human innovation is that when the possibility of a game-changing technology exists, the speed at which hard problems become easier to solve is much faster than linear thinking allows us to imagine. When the rate at which the innovation — i.e. quantum computing's rate of growth — is doubly exponential, not just exponential, the possibility of missing the inflection point is very real. And much of the acceleration in such situations also comes from incumbents who are competing amongst themselves for the next big thing. No wonder that after tanking quantum computing stocks, NVDA announced a" Quantum Day" at its GTC conference on March 20 (here).

"To me, it seems that the commercial race is already on, though it might be beneficial to do the development in stealth mode for most so they don't get crushed out of their path to progress."

This brings me to investability. Stock market investing is always risky, and speculative stock-market investing, as in quantum computing stocks (or AI, turn-of-the-century dot-coms or Bitcoin not too long ago), is doubly risky.

But the upside compensation for taking the risk can also be large, which might justify a thoughtful, carefully considered, small allocation, to moonshot investments. The precise modeling of potential gains and losses for such speculative investments is basically impossible. At the simplest level, one can simply think of investing in such stocks as a biased coin flip experiment, where the odds of the coin flip coming up heads — i.e. a “win” is some number you make up — and the odds of the stock going belly up (i.e. price falling to zero), is one minus that number. An unbiased coin would have a probability of coming up heads or coming up tails to be equal or 50%. What makes things even more tricky is that these odds are dynamic and ever-changing, and can be subject to the opinions of experts who also know very little about the future but still have influence on pricing.

> “Which means that proper sizing, or allocation of capital, is one of the only ways to ensure that one can stay the course, “HODL,” and not be shaken out.”

The mathematics of biased coin-flip betting is well known. As a matter of fact, it forms the foundation of all option pricing. For our purposes here let us imagine that the coin we are tossing has a very low probability of coming up heads. If this probability is labelled p, then the expected value, or average return over many such bets, assuming equal payoffs in the win and the loss states, is simply equal to p. So if the probability of success is 10% on one trial, then over many independent trials, the expected payoff can be estimated by multiplying 10% by the payoff if there is success. The lower the probability of success, the lower the expected value. Just like lottery tickets which have a very low probability of success, the expected value of speculative stock investing is very low. But that’s not the end of the story. As one would expect, both lottery tickets and speculative stocks have massive “skewness” and “kurtosis” when the probability of success is low, despite having very low expected value. Skewness is a measure of the asymmetry of payoffs, and kurtosis is a measure of how “fat” the tail is. For a coin toss with probability of success p, the skewness and kurtosis both go to infinity when the probability of success is very low. This should not be a shocking result — we all know how low probability investments, e.g. bitcoin, can deliver massive returns (just recall bitcoin’s experience over the last few years).

While it is easy to pooh pooh those dumb souls who bet on fat right tails, or lottery ticket-like investments, the fact of the matter is that such investments can make life-changing impact for investors, if they are made at a time when the price is not already discounting the massive positive returns. For a stock bought cheaply enough, this upside potential can counter the low expected return. Also note that both the skewness and kurtosis for a coin toss is minimum when the risks are balanced; i.e. the probability of success and failure are equal to 50% each.

The danger of investing in such speculative investments arises from taking on too much exposure. This is because a low probability of success effectively guarantees that on average, returns will be low or negative. So, the bet one is making really is that by investing at the right price, the potential of outsized gains on the winners makes up for the almost certain losses on the losers.

Again, as most readers undoubtedly know or have read, the optimal exposure that maximizes the long term growth rate of simple binary investments is given by the almost too simple (and magical) Kelly criterion (see here) which says that the optimal fraction to invest is simply $p-(1-p)/b$, where b are the odds upon success. For example, if one bets a dollar and upon a win is returned three dollars, and upon a loss loses the one dollar he bet, then $b=2$. So, we can see that if the probability of success is very low, then the payoff has to be very high for a profitable bet to be possible. If the payoff is not high enough then the optimal allocation must be very small.

Let us calibrate this to investing in quantum computing. If we believe that quantum computing has the potential to revolutionize computation, then it is not hard to imagine a 100 to 1 payoff though it could take years for this to happen. So, if the probability of success is 5% , then the "optimal" fraction to bet at this enormous potential payout is about 4% of the portfolio. In this example, the investor should bet nothing if the potential payoff is less than about 19 times (obtained by dividing the probability of failure which is 95% by the probability of success which is 5%). In its current state, no one knows which type of quantum computing technology and which company will succeed. So, it also behooves the investor to divvy up the total allocation amongst many different technologies.

Clearly, I take the view that quantum computing is very risky but investable, regardless of what the talking heads say, as long as there is potential for massive upside, the entry price is right, and as long as the exposure is kept small enough to not create a situation where the investor is forced out at the wrong time.

The gut wrenching 50% decline in one day on an off-the-cuff comment by Jensen Huang last week illustrates that those who had positions too large or leveraged probably got forced out at the wrong price, creating the buying opportunity for those who were able to step in at the right size.

> "At the end of the day, sizing exposures is probably as important, if not more important than getting the direction of investments right for any investment. In the case of highly speculative moonshots like quantum computing stocks, sizing things right — i.e. big enough but not too big —and owning the upside, skewness and the kurtosis, is probably the approach that balances out the risks with the potential of outsized returns."

Just as there are catastrophic "left tails" which can destroy value, there are also "right tails", which, if not managed for, can create massive missed opportunities. Like they say — you have to be "in it to win it." Just be careful how much you risk.

Important Disclosures

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