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Emerging Technologies, Innovation, and Volatility: A Mini-Review

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Abstract

It is widely asserted that emerging technologies, innovation, and technological disruption lead to increased volatility among stock markets. At first glance, this might appear contradictory since, by definition, novel developments, information technology for example, should surely help to make firm-specific information available on a timelier basis.

Starting from the economic theory that defines innovation as long-term, in the light of financial markets shortening investment time horizons to optimize returns and empirical evidence, this article reviews current research on the interplay between emerging technologies, innovation, and volatility. Since risk is commonly used as a proxy for uncertainty, and innovation is an example of true uncertainty, we explore emerging technologies and innovation in the context of return and volatility.

We observe that idiosyncratic risk and, indeed, overall risk have increased as a result of emerging technologies. The main drivers of risk in the aforesaid inter play are the use of more complex methods to calculate the fundamental value of assets, over-enthusiasm with regard to innovation fuelling over-expectations that are nourished by herding behavior, asymmetric information and the world economy shifting towards one that is driven by intangible assets.

Additionally, some properties of emerging technology and innovation can be defined as diffusive, persistent, heterogeneous, and momentum-oriented, which brings us back to the historical implications of technology bubbles.

Keywords

Emerging technologies • Innovation • Volatility • Idiosyncratic volatility

Introduction

The financial sector is undergoing transformation, driven mainly by emerging technologies as a source of technological innovation. From chatbots to Artificial Intelligence (AI) and Blockchain, among many others, financial organizations are constantly trying to keep up with the latest tech trends, and stock markets are quick to react to this.

Information technology has helped to make firm-specific information available on a timelier basis, which should improve information about future discounted cash flows and lead to a decrease in volatility. However, though it might appear contradictory, the uncertainty about new technologies tends to affect stock price levels and make them more volatile. Explains that although better information about future cash flows increases the volatility of the stock-price level, it reduces the volatility of the stock return because news arrives earlier, at a time when the cash flows in question are more heavily discounted [1-3].

Some literature has recently proposed that the New Economy is impacting the stability of the market valuation process and that this is leading to stock price volatility [4-6]. Since prices are expected to reflect expectations about future profit, it makes sense for expectations about the outcome of a technological innovation to also be reflected in stock prices and their returns [7, 8].

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From a Knightian uncertainty point of view, the outcomes of an investment in an emerging technology can be considered uncertain. And since volatility is commonly used as a proxy for uncertainty and innovation as an example of true uncertainty, it makes sense to explore emerging technologies and innovation in the context of return and volatility [9].

Emerging technology, innovation, and volatility involve a certain level of complexity, and should therefore be explored by bridging long-term economic growth with the short termism of a financial landscape that continuously seeks to optimize investment opportunities. In other words, two different timescales in two different domains [10].

The objective of this review is to establish the state of the art of the interplay between emerging technologies, innovation, and volatility, an understanding of which is especially interesting due to the increasing relevance of technologies, and particularly emerging technologies, and the general increase in volatility as observed by several studies [4,6].

Regarding the terminology, place the term “emerging technology” in the context of contemporary innovation theory [11]. The term may take the form of “discontinuous innovations derived from radical innovations” and might be consolidated within what the socio-economist and historian Carlota Perez introduced as “techno-economic paradigm” [12,13]. In this review, we use the definition proposed by and which is associated to the attributes of radical novelty, relatively fast growth, coherence, prominent impact, and uncertainty and ambiguity [14].

Emerging Technologies, Innovation, and Volatility

The firm

High-tech sectors are a unique setting that is systematically different to that of traditional firms. High-tech firms are defined as knowledge-based organizations since they are non-vertically integrated and human capital intense which entails a higher level of unreported assets compared to traditional firm [15-21].

Predictable earnings and returns in high-tech firms are generated by intangible assets that are associated with a higher degree of uncertainty

[22,23]. As reported by earnings volatility related to R&D expenditure is three times larger than earnings volatility associated to tangible assets [23].

The positive relationship between the share of intangible assets (as a proxy for IT-related changes) and the increase in idiosyncratic risk in the 1990s is consistent with the view that IT increases uncertainty with respect to firm valuation [24]. Since intangible assets are highly transferable, high-tech firms are more exposed to underinvestment encounter higher risk levels and find it harder to obtain external funding for their R&D activities [25-27]. State that the R&D intensity in firms adds another important dimension to the size and value effects in describing stock returns, especially for small high-tech firms [28]. At stock level, high-tech stocks are growth stocks but are also considered riskier because they do not typically offer dividends. For instance, show that insiders in high-tech firms make more generous profits [29].

Additionally, the momentum of growth stocks may be higher [30]. A large body of research elaborates on the effects of IT on the values of old and new companies [31-34]. Found that firms operating with old capital are riskier and hence offer higher expected returns, given that old capital firms are more likely to upgrade earlier and are therefore more exposed to shocks driven by the technology frontier [35]. Found the effect of firm innovativeness on market position and financial position is stronger for firms in high-tech industries, for innovativeness outputs and for radical innovations [36].

Recently, under the light of "disruption" the surge in new technology has been attributed to startups that develop products for a niche market, and subsequently take that technology to the core market, where it disrupts the leading positions of incumbent firms [37].

Volatility

Technological change was first identified in the light of economic growth theory as a key factor of economic growth [38,39]. The importance of innovation was first highlighted by Schumpeter as part of his Theory of Economic Development which he described as the disruption caused by the introduction of novelties to the regular circular flow [40]. Historically, it is important to recognize the role of technological revolutions, since the market economy progresses in the form of a succession of major surges in development driven by these, as asserted by Carlota Perez in her classic work on technological change.

In this context, the stock market plays a significant role in facilitating such novelties, since funds flow into them as investors seek to make extraordinary gains from innovation. Also agree that a developed stock market is especially relevant for making innovation-intensive, high-tech industries uniquely suited for financing technology-led growth [16].

Uncertainty about new technologies affects not only the level but also the volatility of stock prices [41-43]. Logically, since volatility is used as a proxy for uncertainty and innovation as an example of true uncertainty it makes sense to explore emerging technologies and innovation in the context of return and volatility [9].

Price fluctuations play a role in directing economic activities since they reflect expectations with regard to future economic activity [44-47]. Historically associate fluctuations in the stock market with three technological revolutions: Electricity, World War II, and IT [48]. These authors document long lags in the operation and diffusion of new technologies. From the firm perspective, economic growth affects firm profitability and activity, resulting in modified profitability prospects, expected earnings and dividends of shares [46,49-51]. The rational expectation hypothesis asserts that individuals base their decisions on their human rationality, the available information, and their past experiences. Hence, the current price of a given stock equals the expected optimal forecast based on that information and since stock prices are expected to reflect expectations about future profits, they also reflect expectations about technological innovation [7, 8,52].

A century ago, defined volatility as the coefficient of nervousness or coefficient of instability, which makes sense in this context where expectations about the future course of an innovation will be especially influenced by investors' beliefs [53]. The ultimate value of an innovation is so dynamic and uncertain that managerial expectations about its future course are likely to be especially influential in the minds of its adopters [54].

Excess volatility peaks precisely during periods associated to uncertainty such as radical technological changes and therefore the fundamental information is less useful for making predictions about future values [55,56]. The former dot.com bubble and its subsequent crash re-opened the debate about the reliability of financial valuation models such as the well-known textbook DCF method [57].

From the technological revolution perspective, the most turbulent and creative destruction takes place when old technologies are replaced by new ones. Over-excited agents flood the market with excess funds, based on unrealistic expectations about future cash flows, and indeed decouple finance from the real economy or even decouple the temporary price from its fundamental valuation, initiating a major bubble [58]. State that such circumstances are caused by investors being overly influenced by the speculation of other investors, leading to the "herd effect" and the overreactions highlighted by [59,60]. From a different perspective, show that emerging technologies may lead to an increase in integration, channeled by increased volatility spill-over across stock markets [61].

The risk and uncertainty profiles of emerging technologies are not constant. During technological revolutions, the nature of this uncertainty shifts from being mostly idiosyncratic, due to the small scale of production and a low probability of large-scale adoption, to becoming more systematic as a result of an increased likelihood of adoption [7].

Idiosyncratic volatility

The volatility of asset returns can be classified into market and firm-specific volatility, the latter otherwise known as idiosyncratic volatility, the overall increase of which is attributed by some literature to the IT revolution and to the fact that the economy is increasingly driven by intangible assets [4,6,22,30,62,63,].

A large body of the literature provides evidence that innovative sectors are riskier and involves more idiosyncratic or firm-specific risk than traditional markets do [22,24,43]. Found that the consensus in analysts' forecasts is negatively associated with a firm's level of intangible assets and that lower levels of analyst consensus are associated with high-technology manufacturing companies [64]. These findings can be explained by the relatively high R&D expenditure of high-tech firms.

Found that Exchange Traded Funds (ETFs), as proxies for the emerging technology environment, its price returns and idiosyncratic risk, are negatively related in high volatility regimes and positively related in low volatility regimes, suggesting that idiosyncratic risk will penalize/reward investors' returns on investment in emerging technologies under certain circumstances [65].

Described the risk and return profile for knowledge-intense firms, suggesting that price jumps may be explained by knowledge capital intensity since firms with two standard deviations more knowledge capital are valued 10-50% more [66].

Ultimately, idiosyncratic volatility can be used as an alternate measure of information asymmetry since it is a measure of the amount of price variability due to firm-specific information [67].

Asymmetric information

Projects, and certainly projects related to emerging technologies, can generate a greater degree of asymmetric information, since managers have more knowledge about the state of the outcome than the outside world and as a result, stock return volatility increases [68]. High-tech firms particularly suffer from the asymmetric information problem [42,64,69,70].

R&D investment intensity is another approach to explaining stock volatility behavior in the high-tech sphere. Provide evidence of this

through the way it generates information asymmetry with regard to a firm's prospects [42]. State that mispricing can arise if investors are unable to correctly estimate the long-term benefits of R&D investment or whether R&D firms are riskier than others and, as expected, the study confirms that more innovative firms are able to earn excess returns in the future [71]. Stocks listed on markets in continental Europe and operating in high-tech sectors are more prone to undervaluation due to information asymmetries that are more severe in bank-based countries.

To offset the lack of information, high-tech firms hold conference calls and provide the public with additional information about financial conditions [72]. Found that the use of conference calls is greater in the high-tech sector than in other industries and that this can lead to lower idiosyncratic volatility [73]. This could be viewed as a strategy that high-tech firms use to overcome the burden of the initially high levels of idiosyncratic risk.

Properties of emerging technologies and innovation

Financial time series present several characteristics that are also known as stylized factors, namely volatility clustering, heteroscedastic variance, non-normal leptokurtic distribution, and leverage effect. The underlying reason for this is related to the rate of information arriving in the market errors in the learning processes of economic agents and the artificial nature of a calendar timescale in lieu of a perceived operational timescale [74-76]. Stylized factors can be linked with technological change behavior and are also often associated to bubble-like patterns during technological revolutions that are attributed to market irrationality [55,77]. The statistical structure of industrial evolution is revealed in stochastic processes, whose rates of change have all the familiar signs of complex system dynamics. Heavy tails are increasingly related to innovation dynamics and are viewed as evidence of lumpy growth, suggesting the absence of a single rational expectation and instead indicating the occurrence of extreme events due to greater market opportunities for dynamic innovation [78,79]. When a technology is subject to increasing returns, this sets the stage for a distinctive pattern of diffusion, driven by positive feedback loops in terms of adoption and the associated "bandwagon" effects [80-83]. The "bandwagon" phenomenon can also be seen in bull markets and the growth of bubbles. This sequence proves the existence of an underlying correlation mechanism, which can be interpreted as the innovation self-organizing its growth process.

The persistence over time of innovation dynamics is also recognized by the literature as a distinct feature [84-86,78]. Technologies mature with time and firms that have invested in innovation in the past are more likely to innovate in the future [87,88]. This endogenous and procyclical process of adoption is consistent with the cyclical patterns of dissusion. Since new technologies take time to catch on, the cyclical response to news shocks is highly persistent [89]. Attributed such heterogeneous behavior to differences in the ability to innovate and/or adopt innovation developed elsewhere due to product characteristics and production processes, and particularly (ii) different organizational arrangements and (iii) different production efficiencies [78].

Momentum, considered a market anomaly, is often associated to investor irrationality since investors under react to new information by failing to incorporate it in their transaction prices [90,91]. Nevertheless, much as in the case of price bubbles, momentum can even be observed among perfectly rational investors [92]. Show that the stocks of high-tech firms generate greater momentum returns, though this response is asymmetric for low-tech stocks [15]. Came to the similar conclusion that momentum variables are important while fundamental variables have at best weak explanatory power based on the medium-term aftermarket in high-tech US IPOs [93,94].

Conclusion

The study presents a review of current research on emerging technology, innovation, and volatility. After a general overview, key areas are addressed including the firm, idiosyncratic risk, asymmetric information, and some specific properties of emerging technologies and innovation. The study is based on secondary information.

The structure of the study is based on the rationale that since risk is commonly used as a proxy for uncertainty, and innovation is an example of true uncertainty emerging technologies and innovation should be examined in the context of return and volatility.

The interplay between these aspects entails a certain level of complexity, since it requires the bridging of two different timescales: long-term economic growth and the short termism of the financial landscape seeking to optimize investment opportunities.

One important implication is that several and/or similar terms are used in the literature to refer to emerging technology, especially in the contemporary innovation literature, and there is an ex-ante need for the terminology standardized.

One conclusion is that emerging technologies and innovation are associated to an increase in stock market volatility. After reviewing the theoretical arguments on economic growth, and the way they relate to stock market fluctuations and irrational and rational expectations, it is common sense to observe that there is a connection within the framework of the New Economy. Since emerging technologies can be interpreted as being derived from radical innovation and may be consolidated within what Carlota Perez introduced as "techno-economic paradigm" the stock market will reflect the economic conditions, which are ultimately related to technological change.

Risk in the described scenario is mainly driven by uncertain individual events concerning emerging technology and innovation, whose overall aggregated impact generates stock market volatility. The main drivers of risk in the presented scenario are increasingly more complex methods to identify the fundamental value of assets, over-enthusiasm about innovation fuelling over-expectations that are nourished by herding behavior, asymmetric information and the world economy shifting towards an intangible asset driven one, with this latter factor also being considered a source of the increasing idiosyncratic volatility.

Certain properties of emerging technologies and innovation can be defined as diffusive, persistent, heterogeneous and momentum-oriented, which brings us back to the historical implications of technology bubbles, idiosyncratic risk and indeed the fact that the overall risk resulting from the emerging technology environment is not constant being initially mostly idiosyncratic and becoming more systematic following large-scale adoption.

Future research will merge empirical evidence with social science theory, update the evidence in fast-changing circumstances, broaden our understanding of time series behavior and seek to close the wide gap between risk and uncertainty.

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