A Framework For The Assessment Of Future Information Technology Risk

Hein Kristiansen
Chief Software Architect, Capra Consulting AS

Magnus Bjelkerud
Partner, Risikotavler AS

Executive Summary

In this whitepaper, we address how ongoing changes in the environment continuously affect future information technology risk. Our aim is to help the reader identify and understand exposure as well as establish a framework to better assess and manage this type of Risk going forward.

We look at why real options give us a framework for valuing flexibility as defined by the ability to add cumulative functionality and/or capability. Investment activities should be constructed using either call options providing upside risk or put options removing technical debt and/or underperforming functionality yielding less downside risk. We look at the implicit, transactional and volatile nature of exposure, and address the difference between functionality and capability in order to better explain how risk can be managed in the future.

Our goal is to provide the reader with a better understanding of exposure and the corresponding risk, by establishing a framework for greater accuracy.

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Definitions

When used in this whitepaper, the following terms have the meanings specified below:

"Capability" means an abstract feature of Functionality shared across multiple Domains.

"Catastrophic Failure" means a complete breakdown of the ability to do business due to the inability to maintain Software and/or Information in Production.

"Competitive Advantage" is the result of sustainable growth generated by Flexibility.

"Domain" means a distinct business area.

"Environment" means external markets, vendors and other forces affecting the future of information technology.

"Expiry Date" is the point in time when an investment activity is released into Production and the value of the built in optionality is being realised.

"Flexibility" is the adaptiveness to future events caused by Uncertainty through persistent increased ability to add cumulative Functionality and/or Capability.

"Functionality" means concrete business-level functions found within Software and/or Information constrained to a single Domain.

"Information" means observations, transactions and/or other data of critical importance to the business.

"Premium" means either costs incurred or costs avoided by entering into or foregoing an investment activity with exposure to Uncertainty in the Environment.

"Production" means the internal technological environment containing business critical Software and/or Information.

"Risk" means beneficial or adverse economic consequence from exposure to Uncertainty.

"Software" means source code managed either directly by internal developers and/or indirectly through the acquisition of third party systems.

"Technical Debt" is the result of persistent inertia caused by complexity found within Software and/or Information resulting in reduced ability to add cumulative Functionality.

"Uncertainty" is the randomness of the Environment.

"Volatility" means the rate of change of Uncertainty.

"Wind extinguishes a candle and energizes fire. Likewise with randomness, uncertainty, chaos: you want to use them, not hide from them. You want to be the fire and wish for the wind."

~

Nassim Nicholas Taleb

Introduction

The information technology landscape has changed significantly over the previous two decades, as we are entering the third of this millenium. Choice, and hence Uncertainty, is both abundant and all around us. Costs of non-human input factors have been deflationary for over a decade, with no likely change in sight going forward. Still, investment activities within information technology are underperforming at an alarming rate. Why is this the case when we are faced with such opportunities?

The two most likely factors are the increasing rate of change in the Environment and our inability to absorb the future optionality given by the abundance of choice available. The first is due to economies of scale built up over decades within the biggest global vendors and is here to stay whether we like it or not. However, with the help of time, we can address the second and optimize our understanding of the inherent Risk found within both of these factors. To do so, we first need to look at a few of the underlying trends that have greatly influenced the Environment since the turn of the century.

The biggest effect has perhaps come from virtualisation, which has caused a shift from a hardware driven to a Software based information technology economy. As Marc Andreessen pointed out in his 2011 seminal article Why Software Is Eating The World[1] in the Wall Street Journal: "More and more major businesses and industries are being run on Software and delivered as online services."

This has become particularly evident over the last five years where vendors like Amazon Web Services (AWS) not only deliver traditional infrastructure as online services, but also aggregate services such as industrial IoT, 5G connectivity, satellite base stations and quantum computing all accessible through Software development kits. In fact, as the result of virtualisation providing the fundamental building block of the public cloud, virtually everything, from a consumer perspective, can now be consumed as an online service. Software is everywhere.

From an economical perspective, this has fundamentally changed the business model, removed barriers to entry and laid the foundation for a new paradigm based on Flexibility. Creating a new world order where the ability to respond to change is the ultimate Capability needed to provide sustainable growth. In his 2007 article Design Stamina Hypothesis[2] Martin Fowler argued for the inherent value of good design as the increased ability to add cumulative Functionality over time. This still holds true for each individual piece of Software. However, given that Software now permeates everything, he gave us a near perfect definition of Flexibility going forward.

Fowler beautifully hypothesised that paying an upfront Premium on good design would yield positive future optionality in the form of increased ability to add cumulative functionality at an increasingly faster rate. This effectively implies that sustainable growth can be achieved in the future given that we invest in Flexibility today, with the optimal investment strategy eventually leading to Competitive Advantage. Consequently, he also stated that not investing

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[1] Andreessen, Marc - Why Software Is Eating The World
[2] Fowler, Martin - Design Stamina Hypothesis

in design would implicitly yield the corresponding negative effect through decreased ability to do the same. At the same time proposing that the implication of no design would yield persistent inertia in the form of Technical Debt over time. With the worst case scenario resulting in Catastrophic Failure due to the inability to maintain Software and/or Information in Production. Hence, Fowler, inadvertently or not, defined a basis for managing future information technology Risk by giving us a workable definition of Flexibility identifying both the implicit and the transactional nature of exposure to Uncertainty over time.
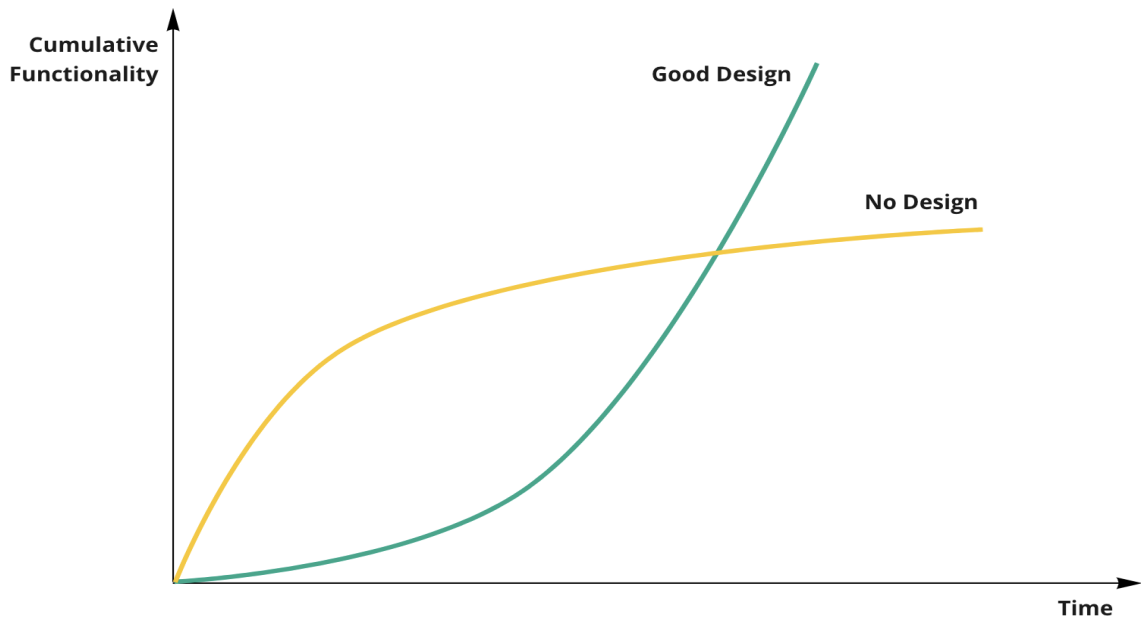
Diagram 1 - Design Stamina Hypothesis

When transitioning consumption from hardware purchases to online services, as Andreessen postulated, we also implicitly get exposed to the benefits of automation. When Software is consumed as an online service, it can be automatically updated behind the scene provided that the interface remains the same. AWS has famously kept its original interface to their first cloud offering, S3, functioning since its release in 2006. In fact, it is the company's policy to do so with every service offering allowing for automation to benefit both new and existing customers. Consider that against the previous paradigm, which often required the purchase of new hardware in order to run the next version of Software. The effect on our understanding of time is profound. Software delivered as an online service is never finished, effectively meaning it should no longer have a predetermined shelf life as in the previous paradigm. This should inspire us to change our tactics significantly allowing us to increase Flexibility over time.

Perhaps no one has outlined the consequences of this more eloquently than Simon Sinek in his book The Infinite Game: How Great Businesses Achieve Long-Lasting Success[3] published in 2019. Where he argues that we increasingly find ourselves in infinite games as opposed to finite ones. Games where there are both known and unknown players, rules are

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[3] Sinek, Simon - The Infinite Game: How Great Businesses Achieve Long-Lasting Success

changeable and our sole objective is to perpetuate the game. In other words, to keep playing indefinitely. For companies that have transitioned to delivering and/or consuming Software through online services, this should sound eerily familiar. Sinek advocates for the benefits of existential Flexibility as one of his key factors for success in this paradigm. If we take into account Fowler's definition of Flexibility and apply it not just to Software or even information technology as a business area, but to the firm as a whole, we start to understand the true value of this Capability.

But first, let us examine the effect Uncertainty has on how we perceive Risk.

Understanding Uncertainty

Uncertainty is simply the randomness of the Environment, where the Environment is an aggregate of external markets, vendors and other forces affecting the future of information technology. As opposed to Risk, which is the economic consequences of being exposed to Uncertainty. Risk and Uncertainty are not interchangeable concepts, even though they might appear to be correlated over time.

Traditionally, within information technology, we as humans have attempted to design routines and methodologies that would make the randomness of the Environment appear more linear. Therefore, in doing so, we assumed we were both prudent and, hence, Risk averse. However, this approach has two fatal flaws. First, it fails to recognize that Uncertainty equals opportunity as there would be none without randomness. In our opinion, increased ability to adapt to a fluctuating Environment over time will yield a significant Competitive Advantage. Second, it wastes resources attempting to avoid failures at any costs, instead of seeking to release the beneficial economic consequences to be gained through a healthy exposure to Uncertainty.

As humans we also have a bias towards precision over accuracy. Often assuming that if things can not be measured, they can not be correspondingly managed. However, as within similar less rigid disciplines, like economics, we can use our power to define hypotheses as a means to establish clarity. It is our belief that having an improved sense of accuracy provides a better understanding of our interactions with the Environment. By gaining a clear definition of Flexibility, as proposed by Fowler[4], we now have the ability to seek a better way to assess and manage the associated Risk going forward.

In their 2013 paper Information Technology And Business-Level Strategy[5] Drnevich and Croson stated that "Flexibility can improve efficiency (price minus cost) through enabling the firm to minimize the costs of adapting to a new situation" and "Flexibility can improve effectiveness (value minus price) through enabling the firm to seize an opportunity for extraordinary profit." They concluded that the concept of real options is perhaps the most applicable in the valuation of information technology investment activities under Uncertainty. This was reiterated by Mark Schwartz in his book War And Peace And IT[6] published in 2019.

Next, let us look at how understanding exposure helps us assess Risk as a factor of future optionality using real options as suggested by Drnevich and Croson.

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[4] Fowler, Martin - Design Stamina Hypothesis
[5] Drnevich, Paul L. & Croson, David C. - Information Technology And Business-Level Strategy: Toward An Integrated Theoretical Perspective
[6] Schwartz, Mark - War And Peace And IT

Assessing Risk

When looking at the economic consequences of Uncertainty in the Environment, we have to understand the characteristics of exposure. In a world favoring Flexibility this is best done by examining the future optionality effect on our profit and loss statement caused by existing and planned investment activities using real options.

Exposure Is Implicit

The first thing we need to understand about exposure is that it is implicit. This occurs immediately when we deploy Software and/or Information into Production as it exposes us to Uncertainty in the Environment following the Expiry Date represented by this milestone. Both when investment activities are in development and/or released into Production, this future optionality is best represented by the implied payoff from buying a call option. This strategy carries a Premium (costs incurred) before the Expiry Date as well as the opportunity for upside Risk following the milestone.
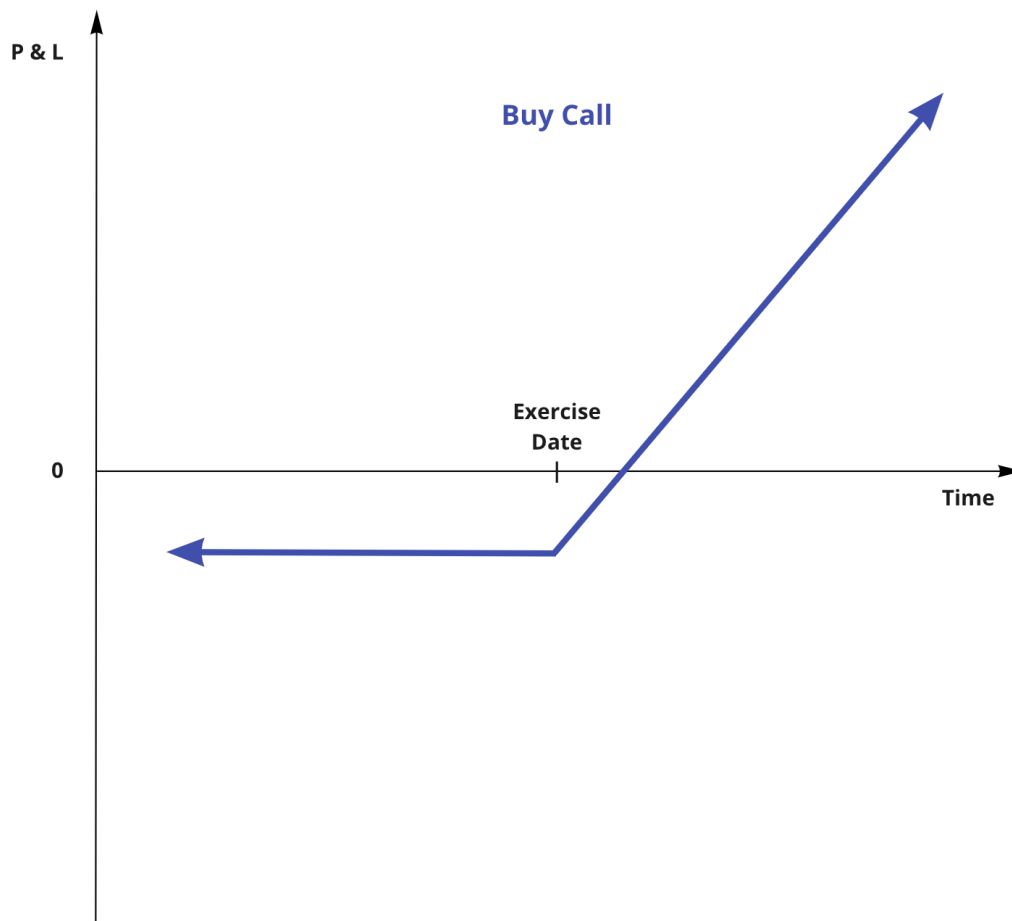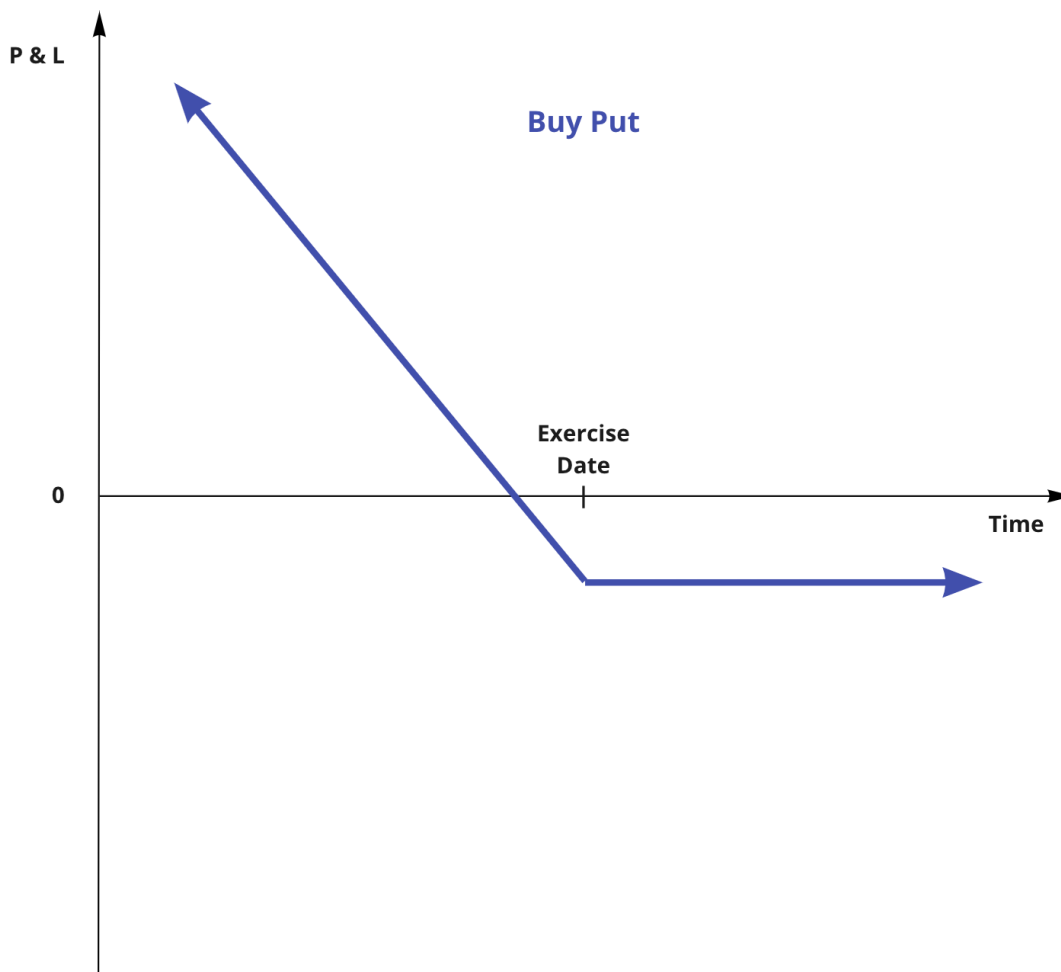
Diagram 2 - Buy call option

Likewise, terminating a previous investment activity is best represented by buying a put option. This strategy removes previously anticipated upside Risk at a Premium (costs incurred) following the Expiry Date.

Diagram 3 - Buy put option

Although we will mostly focus on call options strategies in this whitepaper, it is important to assess the implicit optionality of existing investment activities put into Production. If their optionality has not paid off and instead resulted in Technical Debt, we are exposed to an even greater downside Risk due to the transactional nature of exposure.

Exposure Is Transactional

The key characteristic of exposure is that it is transactional. Trading in financial options markets this is self-evident due to the fact that for every buyer of an option there must also be a seller. But when valuing real options, the transactional nature of our exposure and the associated downside Risk is much less visible. However, by deploying Software and/or Information into Production we are implicitly assuming a downside Risk due to the Volatility in the Environment. This strategy is best exemplified by assuming that we are selling one or more call options to the Environment as soon as we actively engage with it.
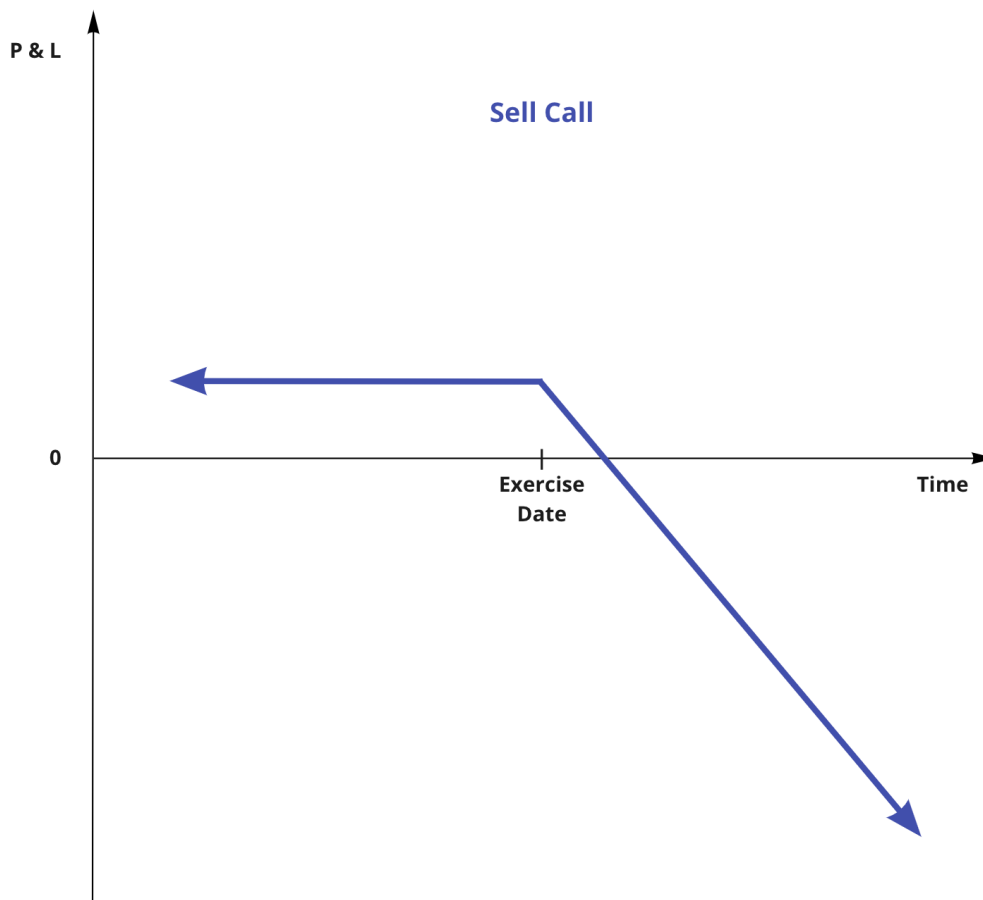
Diagram 4 - Sell call option

Similarly, we must assume that not removing Technical Debt will expose us to significant downside Risk also due to the Volatility in the Environment. This strategy is best exemplified by assuming we are selling one or more put options to the Environment as soon as we ignore our responsibility to stay on top of current improvements available and removing obsolete Functionality and/or Capability. Without establishing sufficient accuracy and understanding of the Environment, we are, in effect, giving these options away while simultaneously exposing ourselves.
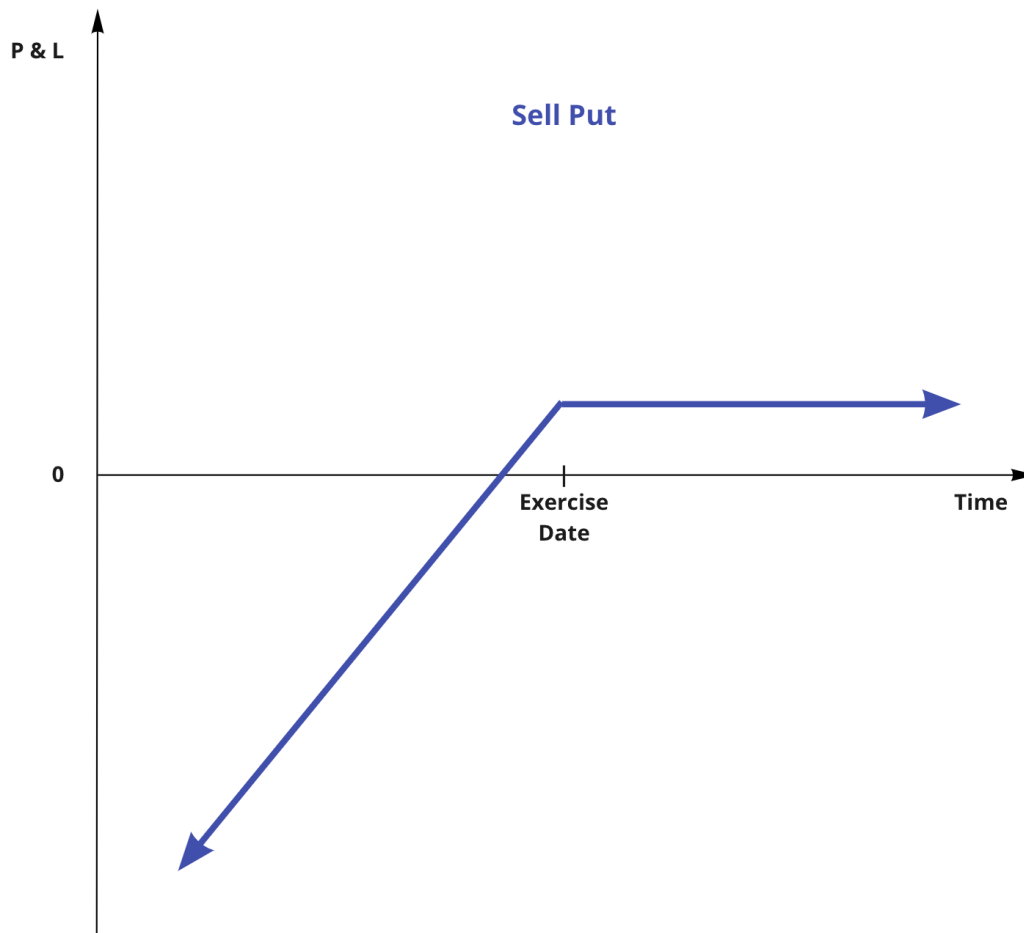
Diagram 5 - Sell put option

Hence, we must address this naturally occurring imbalance in our portfolio of investment activities by buying a sufficient amount of call and/or put options. This is necessary in order to alleviate the implicit downside Risk enforced on us by the Uncertainty in the Environment.

Exposure Is Volatile

Lastly, we need to understand that exposure is volatile as we can not predict the distribution and value of future optionality at the Expiry Date. However, randomness can be viewed as a binary path ending in either success or failure at some point in the future. Hence, the distribution of outcomes is dependent on the Volatility of this randomness. Higher Volatility increases Risk and widens the distribution of outcomes, creating more outcomes with a positive payoff as suggested by Amram and Kulatilaka in their 1999 book Real Options: Managing Strategic Investments In An Uncertain World[7].

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[7] Amram, Martha & Kulatilaka, Nalin - Real Options: Managing Strategic Investments In An Uncertain World
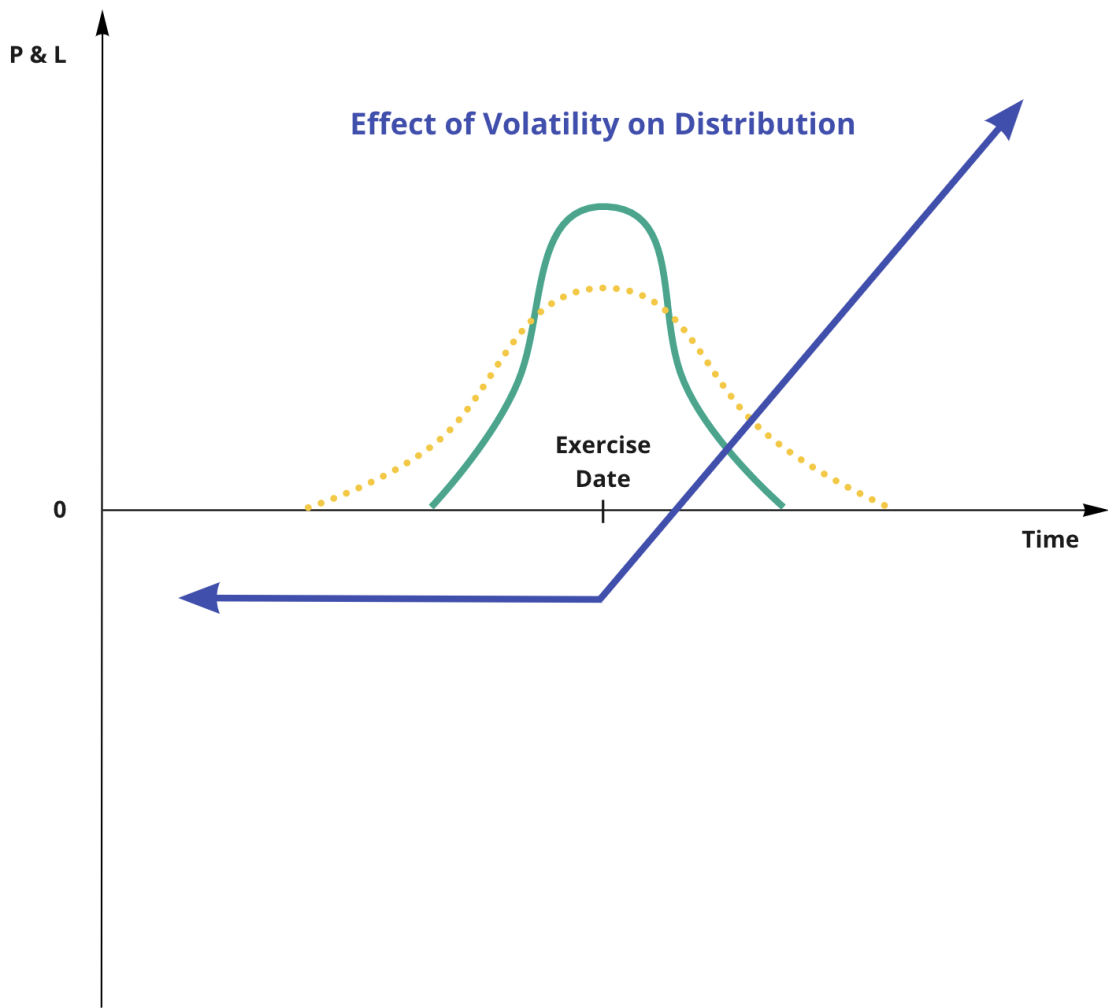
Diagram 6 - Effect of Volatility on distribution

Similarly, higher Volatility yields a bigger payoff and/or Premium as the option becomes more valuable.
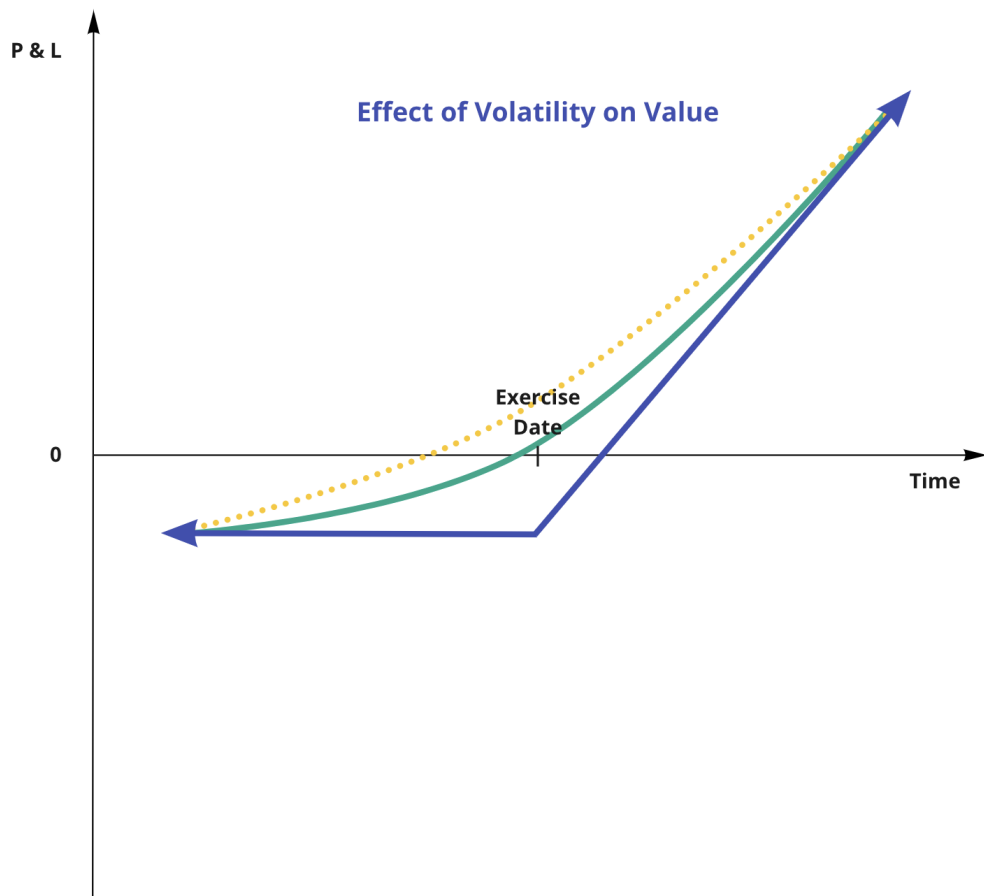
Diagram 7 - Effect of Volatility on value

In order to efficiently manage Risk, we will first have to look at where we have exposure and secondly why we have exposure.

Identifying Exposure

Now that we have a framework for assessing risk, we can examine high-level Capabilities, in the form of abstract features of Functionality shared across multiple Domains, which implicitly expose us to downside Risk due to Uncertainty. The following is a non-exclusive list of information technology areas to consider, when seeking to manage Risk:

Security

Following the recent ongoing wave of ransomware attacks leading to temporary inertia, if not Catastrophic Failure, security Risk is perhaps the most identifiable exposure to Uncertainty. Failure to adhere to the triad of confidentiality, integrity and availability has, in some cases, proven to yield significant fragility with virtually unlimited downside Risk. Similarly, the leaking of sensitive Information and the existence of bad, or at best naive, internal actors can lead to significant damage to a rigid non-flexible firm through failure to implement segmentation and principle of least privilege.

Automation

Observing the trend to move consumption of information technology from a hardware based paradigm to one based on online services, has provided us with the opportunity for automation. We see this in the form of continuous integration and continuous deployment of both Software and infrastructure, allowing firms to repeatedly deploy small rapid updates into Production yielding increased Flexibility. Automation is the fundamental building block of antifragility and exposes non-flexible firms to Uncertainty through competition. Flexible firms will be more nimble as a result of automation and leave the laggards of their industries behind, rendering them unable to keep up with the speed of innovation.

Infrastructure

Automation has become most prevalent when looking at infrastructure. With the introduction of public cloud offerings, flexible firms can now consume infrastructure as online services and automate them using infrastructure as code. This was initially observed through the introduction of the DevOps paradigm, which, more recently, has turned into NoOps and further reducing previous barriers to entry by removing a significant amount of manual labour required. Non-flexible firms observe increasing exposure to Uncertainty if not properly exposed to public cloud offerings. This is evident through lack of participation in the economies of scale available in the Environment as well as exposure to scarcity of knowledge. Flexible firms have through strategic investment activities gained the ability to deploy small rapid changes to their infrastructure into Production, while simultaneously taking advantage of the economic benefits of not having to invest in hardware, which conversely can not be upgraded incrementally.

Software

When we consume infrastructure as online services as through public cloud offerings, nowhere is exposure to speed of innovation and knowledge scarcity more apparent than

when it comes to Software. Flexible firms have the ability to develop, manage and automate the code necessary to respond to changes in the Environment and, hence, benefit from both speed of innovation and economies of scale. Non-flexible firms are solely dependent on third party systems, which often requires suitable hardware to be maintained and upgraded over time yielding significant downside Risk when compared to their competition. They are also implicitly exposed to their suppliers ability to react to the Environment potentially increasing their exposure to further persistent inertia. Non-flexible firms are also exposed to scarcity of knowledge if they do not maintain a sufficient capacity to perform adequate due diligence during their purchasing process.

Information

Information, as defined by observations, transactions and/or other data of critical importance to the business, is perhaps the area where Capability is both the most difficult to identify and acquire. The introduction of different database technologies in the form of online services has radically changed how we manage data. Flexible firms are no longer building data models to suit available technology, but rather switching to technologies that better support their ideal data structures. They will likely create horizontal value chains across their firms highlighting the inherent Capability of their data structures and facilitate sharing by standardizing how models are exposed using hypermedia and international standards. Non-flexible firms are often locked into normalising their models in order to fully take advantage of traditional relational databases, exposing them to an increasing amount of complexity and lack of innovation speed as compared to their competition.

Knowledge

When we increasingly start to consume information technology as online services through Software, we require a very different skill set than that which served us best in the previous hardware based paradigm. A software driven economy requires new knowledge to ensure adequate security, automation and understanding of infrastructure when consumed through onlines services, potentially leading to scarcity both internally and externally. Flexible firms understand this and are willing to invest in and/or pay a Premium for the knowledge required to ensure the release of sufficient upside Risk through Flexibility going forward.

Understanding Exposure

After identifying where we have exposure, it is necessary to examine why it exists. This will give us a better understanding of how it arises and how we can prepare to mitigate Risk as early as possible going forward. The following is a non-exclusive list of factors that can explain why there is Uncertainty in the Environment as well as give us an indication of the amount of Volatility that is prevalent:

Criminality, Legislation & Government

Perhaps the most obvious reason for exposure comes from external actors in the Environment. Certain governments pose a threat to firms in the form of surveillance, which could result in unwanted Information leakage. Legislation aimed at protecting the right of the individual could similarly result in fines and irreparable damage to a firm's brand. Non-flexible firms with an undue lax security position are also subject to criminal hacker and/or ransomware attacks often leading to persistent inertia and the potential for Catastrophic Failure.

Competition

Non-flexible firms are exposed to downside Risk in the form of disruption stemming from both known and unknown players in their respective industries. Often making the faulty assumption that the competition must be suffering from the same limitations as oneself. As discussed in the previous section, there are numerous areas where upside risk can be released as a result of Uncertainty. Some have less visibility than others and Flexibility is terribly hard to gauge from afar. Add scarcity to the mix, in the form of limited availability of knowledge, and the downside Risk from competition becomes even more apparent.

Economies Of Scale

As we have moved to consume information technology as online services through the public cloud offerings of the biggest vendors in the world, flexible firms are implicitly exposed to the economies of scale generated by these services. Allowing them to allocate capital to other investment activities releasing more upside Risk. As opposed to non-flexible firms, which are forced to write off inert hardware investment over time hampering innovation, reducing Flexibility and potentially leading to scarcity due to inability to attract the necessary knowledge to implement change.

Speed Of Innovation

Speed of innovation is a direct result of exposure to economies of scale as the size of the biggest vendors in the world is now allowing them to outpace their consumers' ability to consume their online services. Flexible firms understand this and build their own development teams that are able to capture this upside Risk. Combined with automation and a realisation that everything is Software, their benefit from increased Flexibility going forward quickly becomes apparent. Non-flexible firms are dependent on one or more third parties'

ability to react to the Environment, putting them at significant downside Risk as opposed to their more nimble counterparts.

Complexity

Perhaps the most damage is imposed on non-flexible firms in the form of unnecessary complexity resulting from existing Technical Debt and/or lack of knowledge. As discussed in the previous section, complexity stemming from attempts to conform Information to technology as opposed to the other way around is one example. Non-flexible firms also suffer downside risk from complexity in Software when buying third party systems, without performing the necessary due diligence to identify the implications such a purchase might have on Risk in the form of reduced Flexibility.

Scarcity

Scarcity of knowledge is perhaps the most significant Risk factor resulting from the move to consume information technology as online services. Our ability to educate and train Software developers are improving, but the paradigm shift has been less kind to upper and middle management. These resources often cling to tactics gained in the previous paradigm, effectively failing to release available upside Risk due to Uncertainty as a result. Inability to attract sufficient knowledge to counter this trend will likely lead to scarcity, which could prove to pose the biggest downside Risk of all to non-flexible firms.

Managing Risk

Now that we have a better understanding of where and why we have exposure, we can look at strategies for how to manage this Risk. This will lay the foundation necessary to establish harmony between exposure to risk and your ability to manage it over time. While we will not address specific technical strategies in this whitepaper, we have opted to include a few high-level tactics that have proven successful in the past.

Embrace Volatility

One of the key benefits of gaining an understanding of your exposure to Uncertainty is that you will be able to use Volatility to release upside Risk. By embracing Volatility you can increase your Risk tolerance when you are further away from the Expiry Date. This will allow you the opportunity to release more upside Risk, while at the same time giving you enough time to correct for adverse outcomes. This is of critical importance when it comes to Functionality. The same works for Capability, however, when starting out, you should address Capabilities with lower Volatility and closer Expiry Dates first. The reason being that these will highly likely reduce Risk associated with Functionality and speed up overall delivery of your investment activities.

When using put option strategies to remove low yielding Functionality and/or Technical Debt, start with low Volatility investment activities with shorter Expiry Dates. This will likely help to identify and isolate high Volatility Functionality, so that it can be removed at a lower Premium with less Risk in the future.

Isolate Capabilities

In order to reduce fragility of Production, it is necessary to identify, prioritize and isolate Capability. This will naturally increase the level of security and automation as well as result in greater Flexibility over time yielding antifragility. As Nassim Nicholas Taleb stated in his book Antifragile: Things That Gain From Disorder[8] published in 2012: "Antifragility is beyond resilience and robustness. The resilient resists shocks and stays the same, the antifragile gets better. We can almost always detect antifragility (and fragility) using a simple test of asymmetry: anything that has more upside than downside from random events (or certain shocks) is antifragile; the reverse is fragile."

Our advice is to always separate Capability out into their own investment activities and, if possible, use dedicated experienced resources to deliver this type of generic Functionality into Production. Allowing Capability to be produced and maintained in parallel with traditional Functionality, will likely be the most potent strategy to both reduce overall downside Risk and provide maximum Flexibility going forward.

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[8] Taleb, Nassim Nicholas - Antifragile: Things That Gain From Disorder

Establish Transparency

Lastly, in order to make better investment strategies we need to establish transparency so that we can receive feedback from our portfolio of investment activities. As Mark Schwartz suggests in his 2019 book War And Peace And IT[9] there are three models for doing so: the product model, budget model and objective model.

In the product model, teams of technologists have the freedom to develop and prioritize ideas for their product roadmap prioritizing product objectives. Using the budget model, there is simply a rolling set of tasks that must be completed by delivery teams with their own budgets prioritizing whatever needs to be produced at any moment in time. While in the objective model, the team owns the business objective rather than a set of requirements and does whatever it deems necessary to accomplish the objective. Which approach works best, is highly dependent on the quality of available resources, existing Capability and business model of the firm.

We tend to favour the product model whenever Software is delivered as an online service and the economic profit mechanism is Schumpeterian Flexibility rents as suggested by Drnevich and Croson[10]. Where a flexible firm can take advantage of opportunities that arise during disequilibrium and exploit those for superior profitability, or, conversely, during difficult conditions can reconfigure itself by reversing investment activities and salvaging value from obsolete Functionality and/or Capability. A slow and more rigid firm, usually a sign of persistent inertia created by poor management, might be better off trying the budget model to incentivise new ideas to spring from the bottom up. The objective model is similar to that of the product model, but requires significantly more knowledge, insight and reflection by management in order to be successful. However, it can be used with great effect when attempting to identify which Functionality and/or Capability offers further potential upside Risk after having been in Production for a while.

[9] Schwartz, Mark - War And Peace And IT
[10] Drnevich, Paul L. & Croson, David C. - Information Technology And Business-Level Strategy: Toward An Integrated Theoretical Perspective

Understanding Time

What separates a flexible firm from their competition is perhaps that they have understood that they are playing an infinite game, as suggested by Sinek. They have established a just cause, trusting teams and understands the need for existential Flexibility in order to perpetuate the game indefinitely[11]. Consequently, they seek to maximise Flexibility through sustainable growth creating opportunity for Competitive Advantage over time. They acknowledge that occasional small failures are not only inevitable but necessary in order to make them antifragile[12]. Flexible firms understand that emphasizing improved quality over time gives them the characteristics needed for existential Flexibility and, hence, the ability to pivot their business model if required by randomness in the Environment.

In other words, flexible firms have understood how to bend the trilemma of cost, quality and time, by using time to their advantage. They routinely invest in Capability over time with the sole goal of improving the quality of Software and/or Information in Production. This in term leads to greater Flexibility through the ability to add cumulative Functionality at an increasingly faster rate. Hence, reducing time-to-delivery and over time providing them with sustainable growth and Competitive Advantage over their peers.

Similarly, they efficiently balance Risk by embracing Volatility and spreading investment activities out over time accordingly. Seeking to maximize the release of upside Risk while simultaneously reducing downside Risk. Using time to their advantage, they know that they are constructively working towards perpetuating their own future existence.

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[11] Sinek, Simon - The Infinite Game: How Great Businesses Achieve Long-Lasting Success
[12] Taleb, Nassim Nicholas - Antifragile: Things That Gain From Disorder

Conclusion

Without uncertainty, there is no opportunity to realise the beneficial economic consequences caused by the increasing availability of upside Risk. To paraphrase Gordon Gekko: "Uncertainty, for the lack of a better word, is good." Consequently, the failure to identify and mitigate exposure to downside Risk caused by Uncertainty, poses an imminent danger of suffering dehabiliting losses as a result of ever increasing amounts of Volatility in the Environment. As long as there is exposure, which, at a future date, will implicitly subject us to Risk, we must efficiently address this future optionality and adjust our investment activities in information technology accordingly going forward.

Our belief is that this whitepaper will give the reader a better understanding of where exposure can be found and why it is consequential. Understanding is the fundamental stepping stone for establishing a framework from which you can derive better strategies for identifying and implementing investment activities with greater accuracy.

Be the fire and wish for the wind.

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