Review of Economic Bubbles

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Abstract

This paper investigates the history of economic bubbles and attempts to identify whether there are direct correlations between different bubbles. To support this research, literature has been consulted on historical and recent bubbles, theories surrounding speculation, the market for venture capital, and bubbles in the technology sector. By analysing a range of bubbles, rather than just those in the technology sector, general bubble-principles are also identified. All the economic bubbles are classified under "uncontrolled risk" and a recommended method that can detect and analyse full impacts by uncontrolled risk will be presented, together with future directions to be discussed.

1 Definition

Eatwell et al (1987) define speculative investors as those that are *"interested in profits from trading in the asset rather than its use or earnings capacity"*. As such, non-speculative investors are interested in gaining from the development of a product, or gaining from the earnings of such a venture. Further to Eatwell's definition, Siegel (2003) adds that this implies the involvement of "momentum" investors, whose aim is to sell to other investors at a higher price, as quickly as possible. Under this definition, almost any investment targeting a capital appreciation may be classed as a speculative one. Many of the investment activities examined in this paper are speculative, taking place due to publicity, popularity or the "momentum" of a scheme. These factors generally lead to increased risk in such investments.

In this context, an economic "bubble" is defined as a period in which speculative investment leads to an overvaluation of securities within a particular sector (Siegel, 2003). Economic bubbles may "burst" when investors realise that the industry within the bubble is not as profitable or sustainable as they first thought. At this point, valuations of the companies and securities involved descend rapidly to pre-bubble levels. Many bubbles are only categorised as such after they have "burst". Scientifically defining the term "bubble" is a subject of some debate, particularly bubbles which have yet to collapse (O'Hara, 2008).

The financial crisis in 2008 and 2009 period has resulted in economic downturns in many countries with high unemployment rates and economic bubbles at national and international levels. Causes included a lack of governance, easy and uncontrolled mortgage lending, speculation of the financial market and finally inappropriate use of irrelevant models for speculation resulting in evaporation of "hot-money" (Hamnett, 2009; MacKenzie and Spears, 2012; Chang 2014). This motivates us to investigate all economic bubbles to understand the causes, ways to minimise their impacts and any correlation between bubbles. This paper starts with a review of historic bubbles in Section 2 and technology bubbles in Section 3. While taking lessons learned, Section 4 explains whether past bubbles can be relevant to technology bubbles including Web 2.0. Section 5 discusses a suitable model to analyse "uncontrolled risk", the overall factor that causes economic bubbles and the future of Web 2.0. Section 6 give a conclusion and describes future work.

2 Historic Bubbles

A number of economic bubbles occurred during the last 400 years. Several have been studied for this review: the dot-com bubble, the Winchester Disk industry, the "Railway Mania", the South Sea Company and the "Tulip Mania".

2.1 The "Tulip Mania" (1634 - 1637)

The Tulip Mania involved the establishment of a futures market in the Netherlands, in which contracts of sale were traded for tulip bulbs before the end of the growing season. Tulips had to be traded as bulbs, as it was not feasible to transport the live plants. Tulips had been introduced to Western Europe in the middle of the 16th century and were becoming a status symbol of successful merchants (Garber, 1989). Until 1634, bulbs were grown and sold solely by professional growers.

After 1634, a broad group of amateurs also began growing bulbs. This led to the emergence of new and vivid tulip variants, which were particularly sought-after. Prices for bulbs of these novel variants rose with their popularity. Each tulip plant may, over three to seven years, produce a number of additional bulbs and seeds. These maybe removed from the plant and traded. The simple mathematics of purchasing one bulb, and being able to sell several spawned bulbs a few years later caused some to acknowledge that plantation is a type of investment (Garber, 1989).

The seasonal nature of the tulip commodity meant that traders exchanged contracts on tulip bulb futures. That is, contracts were made to buy and sell (at a specified price) quantities of tulip bulbs that were not yet ready. Traders had to forecast demand, and purchase futures accordingly.

A formal futures market was established in 1636, making it easier to trade the contracts. The price of tulip bulbs subsequently rose steadily as traders assumed that wealthy foreign individuals would always purchase bulbs of the novel vivid varieties, regardless of the price. This assumption seemingly arose due to the popularity of bulbs amongst wealthy Dutch families. Growers often created new variants, fostering a perception of fashion in tulip varieties and subsequent price rises. Traders believed they could always make a profit due to the perceived desirability of their constantly evolving product.

However, by February 1637(three years after the introduction of novel varieties), traders realised that no-one would actually pay such great prices for tulip bulbs. The price quickly declined to its pre-bubble state (Garber, 1990). Many had purchased expensive tulip bulb futures, speculating that they could re-sell the spawned bulbs three to seven years later.

Based on the literature review, this bubble appears to have formed for the following reasons:
- Excitement and hype surrounding the commercial viability of a new product, recently introduced to the continent. This was fuelled by continual product development, fostering the creation of new varieties, perceived as desirable.

- Over-estimation of demand for the product. Traders failed to anticipate the factors that limited demand, assuming growth would come from overseas as easily as it had domestically.

- The notion that the product represented a viable growth investment. In reality, the mechanics of supply and demand ended the bubble before any purchased tulips would have spawned new bulbs.

2.2 The South Sea Company (1720)

The South Sea Company was formed in London as an intricate method of providing funding to the

government following the War of the Spanish Succession (Garber, 1990). The scheme was similar to one that was run in France by John Law. In 1705, Law published an economic theory that ultimately led to the establishment of national banks and paper currency, as opposed to physical gold and silver, described as "unemployed resources" by Law (1705).

Law also suggested that to raise finance for a venture, an entrepreneur need only make bold claims about their undertaking, and sell shares in the scheme at increasing prices. The revenue-generation of the venture was purported to eventually raise public confidence in the shares, stabilising the price (Garber, 1990).

The South Sea Company is an example of one such venture. Individuals holding £9.47m (approximately equivalent to £1.89tn in 2014) of short-term government bonds were convinced to exchange them for shares in the South Sea Company, effectively writing off the government debt (Temin & Voth, 2004). In exchange, the government granted the Company a monopoly on trade via the "South Sea" (i.e., to South America) and paid the Company an annuity of 6% revenue. The annuity was intended to provide the company with ample revenue to fund its ventures.

Until 1720, the Company issued shares so it could fund further government debt acquisitions, fulfilling its purpose to write-off government debt. At this point, the company began promoting the potential of its South American trade monopoly. This, and the government's decision to allow the company to autonomously set share prices autonomously on stock issues, inflated share prices from £130 (per hundred shares) in January 1720 to £950 in July of the same year. This is shown in Figure 1, which is adapted from Temin & Voth (2004).

Many politicians were persuaded to invest in the venture, and were offered generous exclusive share schemes (Garber, 1990). This served to secure high-profile political support for the venture, further increasing publicity and the share price.

Figure 1 – Share price of the South Sea Company during 1720

Many shares in the company were sold as *subscription shares* to make the scheme feasible for a wider audience. Under the South Sea Company's subscription scheme, investors provided a down-payment and scheduled instalments in exchange for a specified number of shares. Investors received a fraction of a real share per instalment.

If the value of the company rose during the subscription, then the investor would gain shares worth more than he paid for them, and have the convenience of spreading the payments. The company

gained the down-payment and the later subscriptions, making this scheme instrumental in raising capital quickly and providing reliable, regular income in the medium-term.

However, Shea (2004, 2007) hypothesised that owners of subscription shares perceived them as a type of call option; they were obliged to pay the subscription, but could choose to default in the future if the subscription did not appear worth paying. This would be a cost-effective strategy when the share price of the company was sufficiently below the price of the subscription, making the subscription a more expensive means of purchase.

Furthermore, the Company introduced a programme offering investors cash loans, taking Company shares (regular and subscription) as collateral. The cash was sourced from subscription share instalments. This type of arrangement would become particularly expensive for the Company if the value of the shares held as collateral fell so much that the recipient of the loan was unable to afford or repay it (Shea, 2007).

Prices of shares in the South Sea Company began to fall during the third quarter of Year 1720, when instalments were due for subscription shares. Many shareholders found themselves unable to afford the subscription, unless they sold their shares. Many defaulted, reducing cash flow from the subscription shares scheme. Insufficient records are available to attribute the decline to the loans programme definitively, although it is likely.

Coupled with similar events occurring internationally, this caused the share price to fall rapidly (Smant, 2012). As the price fell below that of subscription share purchase prices, many investments were rendered worthless. The subscription share scheme effectively allowed the South Sea Company to set its own share price but the price of a share is representative only if someone is willing to buy at that price. Thus, the share price of the South Sea Company had to fall, due to the collapse in demand.

The actions of the company directors may be regarded as irresponsible, in particular the methods by which shares were structured and marketed, but no illegal activities took place. In contrast to the "Tulip Mania", this bubble appears to have formed due to speculation surrounding the potential of a new venture about which the potential investors knew very little, rather than a new product. The speculation was catalysed by people in the company acting to increase the share price artificially.

The Bubble Act 1720 was introduced as an instrument to control inflating share schemes. It prohibited companies from trading shares without permission from the government.

2.3 The "Railway Mania" (1840-1846)

This bubble occurred in the UK during the 1840s, shortly after the Industrial Revolution. The first railways were demonstrated as an effective method of transporting passengers and goods, and appeared to be a key industry in a time when the country was increasing output of manufactured goods (McCartney & Arnold, 2003).

The Industrial Revolution had also created wealth for many middle-class families. The Bubble Act 1720, enacted following the South Sea Bubble, had recently been repealed. This enabled railway companies to sell shares without Government oversight, and many middle-class families were financially capable of making the investment (McCartney & Arnold, 2003). Many companies were provisionally registered with the prospect of building various railways. Figure 2 shows how few of these provisional registrations were actually completed.

Some of these companies sold shares in their projects in exchange for a 10% deposit, whilst retaining the right to demand the remaining 90% at any time. The strong success of early railway projects, combined with the strong marketing for further rail projects, led many middle-class people to invest in these schemes, and sometimes more than they could afford.
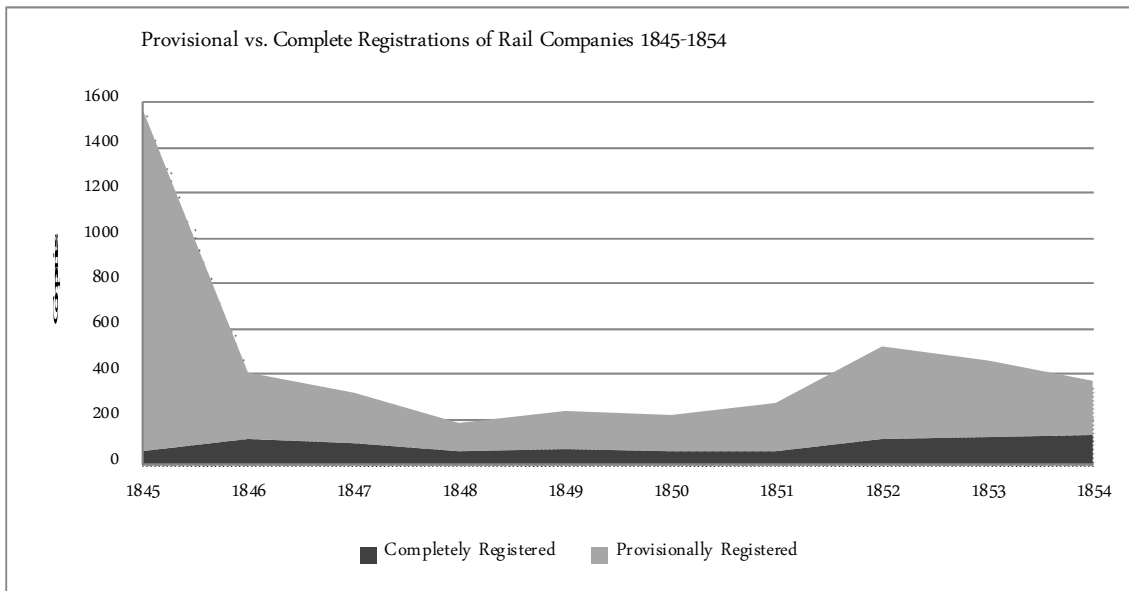
Figure 2 – Provisional vs. Complete Registrations of Rail Companies 1845-1854 (Taylor, 2006)

Whilst liberated from the Bubble Act1720, Railway construction projects still had to petition the government to approve their route and permit land purchases (Odlyzko, 2010). The proposals of many companies were passed with minimal intervention because various MPs had invested in the projects themselves.
However, the difficulty in constructing railways was realised only when several rail construction projects actually started. This rendered many of the rail projects demonstrably unviable, so the speculation ended and many projects collapsed.

This bubble appears to have occurred due to investor speculation surrounding the unexplored potential for railways. The speculation was driven by rail companies and other investors, who believed that rail technology could transform transport whilst being profitable. However, in its infancy, the limits and returns of rail technology were unknown, so all the investors would have been operating in an unfamiliar environment, reducing their ability to evaluate the rail projects adequately prior to making an investment.

2.4 Financial crisis in 2007-2009

The largest financial crisis after the second world war started in 2007 in the US, whereby a large scale of housing bubbles triggered the crash of the US market, known as the 'credit crunch'. As the term has implied, it was extremely easy to borrow credits for mortgages without performing serious credit checks on mortgage applicants (Mian and Sufi, 2008). When more people could not pay up mortgages on time and houses had more difficulties to be resold, banks had less cash available while the rate of mortgages had not changed. The problem could become worse when the same situation persisted for some time. As a result, many banks were unable to provide sufficient credit and borrowed money between each other. Eventually when money ran out, closure of banks and loss of credit due to toxic debts happened. It then escalated into international problems, particularly for western countries due to the similarity in the banking structures and lack of cash return lending to the banks based in the US (Brunnermeier, 2008; Mian and Sufi, 2008).

In the UK, financial crisis started its toll since 2008 where the first wave of hit happened in the finance industry, whereby there was a mass job lost in 2008 when several investment banks closed in London and the Royal Bank of Scotland's (RBS) toxic debts came to light in 2008. The UK Government rescued the RBS by putting a nearly £50 billion credit in. Then this resulted in problems with borrowing more money, making the UK more vulnerable to higher unemployment rate and cuts in public services to keep the bill (Foster and Magdoff, 2009; Legrain, 2010). While taking its toll in 2009, there was numerous public protests in 2009. Financial crisis between 2007 and 2009 have promoted the UK Government to think of the national strategies to cut the bill,

including raising taxes for the rich, cutting public services, reducing annual spending on military, research and conservation and tightening on governance on financial services. The UK has performed slightly better than the majority of the western developed economies up-to-date but still has not entirely been free from the damaging impacts from the financial crisis in 2007 and 2009 (UK Government, 2015).

2.5 Discussion

The bubble situations described above occurred in different centuries and very different industries. However, they all developed due to investors having higher expectations of a new technology or product than was actually deliverable. The primary driver for their growth was speculation surrounding the companies or industries involved. In some cases, this led investors and those involved in the ventures to perform insufficient *due diligence* – taking time to *critically* analyse an investment or investment opportunity to find whether it is aligned with the investor's objectives and attitudes to risk (Pack, 2002). This concept is discussed further in section 3.4.

In some cases, the "inflation" of bubbles appears to have been due to corrupt and/or unethical activities by stakeholders. During the Railway Mania and South Sea bubbles, for example, companies ensured that certain government officials had a personal interest in their venture (Garber, 1990; Odlyzko, 2010), making it easier to gain government acceptance and support for their ventures. While this may be the case, they were legitimate operations according to the legislation of their time. In the cases of many historic bubbles, legislation was implemented to prevent similar events from occurring again (Garber, 1990; Taylor, 2006).

However, this is not the only factor affecting the growth of early bubbles. These ventures depended upon the showmanship of their promoters their ability to energise potential investors about novel ideas, and their ability to inflate share prices. It may be argued that an appropriate process of critical evaluation through due diligence should be the panacea to showmanship or speculation surrounding a venture. However, showmanship and marketing tactics may lead a potential investor to think less critically, and neglect some due diligence.

Nevertheless, in *all* the cases described above, showmanship and/or speculation surrounding the novel product contributed to the growth of a bubble. This indicates that investors have difficulty performing due diligence upon ventures that operate in areas outside of the investor's expertise. Table 1 provides an overview of the bubbles and themes that have been discussed in this section. Technology sector bubbles are covered in the next section.

Table 1: Overview of Economic Bubbles

Bubble	Date	Location	New Product or Venture	Product or Venture	Investor Classes	Government Corruption
"Railway Mania"	1840s	UK	Yes	Trade	Middle and Aristocracy	Yes
South Sea	1720	UK	Yes	Government Debt and Trade	All	Yes
"Tulip Mania"	1630s	Holland	Yes	Trade	Middle and Aristocracy	Yes
Financial crisis	2007-2009	UK and developed western economies	No	Government Debt	All	Yes

The economic bubbles detailed in this section appear to have exhibited positive feedback loops as a mechanism of their growth. Many investments were made in these schemes without due

diligence because the share or product price was rising, and investors speculated that they could make a capital gain. However, the act of purchasing products or shares increased the unit price, which fuelled speculation amongst those who had invested. This in turn led to further investment, and represents a positive feedback loop.

Financial crises and "bubbles" which can occur on an international scale arise as a result of complex international issues and have triggered economic crashes in most western economies. Australia and New Zealand are notable exceptions; they seem to rely much less on US and European lending businesses as a result of their isolated locations. As discussed in Section 2.4, bubbles often arise from a lack of governance and credit control on mortgages and investments made by banks. This means that better transparency, governance, risk management and international co-operation for tackling problems in finance sector is increasingly important, since the scale of the losses can be beyond control by many governments. One of the most well-known examples is the bankruptcy of the Icelandic Government at the end of Year 2008 which can be attributed to poor control of government borrowing (Foster and Magdoff, 2009).

Investment in these schemes represents an abstraction of involvement in the underlying businesses and products. Had investors considered the effects of supply and demand in the Tulip or Railway Manias, then the bubbles may have been less severe. Promotion, hype, and abstraction from the underlying product may have inhibited investors' rational consideration in these situations. For the purposes of summarising the key drivers behind each bubble, the following stages of bubble development are defined.

- Initial Development. Covering very early development of the bubble, before it exhibits significant growth.

- Growth and Performance. The stage at which valuations of securities within the bubble rise beyond rational levels. A "rational" valuation being, perhaps, defined as one obtained through a calculative process of valuing the assets underlying security, ignoring the influence of factors that may provoke speculation.

- Collapse. When the bubble "bursts", causing valuations to return to rational levels.

Table 2 shows a summary of the key drivers behind the three bubbles described in this section, according to the stages above.

	Tulip Mania	South Sea Co.	Railway Mania
Initial Development	Speculation surrounding a novel product.	Speculation surrounding the prospect of lucrative trade.	Speculation surrounding the prospect of novel rail trade/transport.
Growth and Performance	Speculation surrounding prices for the product.	Schemes that permitted anyone to invest in the venture, and marketing.	Schemes that permitted anyone to invest in the venture, and marketing.
Collapse	Realisation that speculated prices were irrational.	Lack of actual trade; unsustainable financial situation.	Realisation of technological limitations, costs, and actual requirements.

3 Technology Bubbles

Many technology companies are (or have been) supported by venture capital companies (Hellman & Puri, 2002). Technology companies (particularly those producing software products) have a short development cycle. As such, technology start-ups may find themselves in competition with other start-ups before they have shipped a product, making investment in the sector risky (Sahlman,

1997). Venture capitalists supporting these companies typically expect a percentage of their portfolio companies to fail completely and a relatively small percentage to achieve significant success (Cochrane, 2005). The remainder are expected to achieve "success" (i.e., some return on investment) but not *significant* success.

Agility has been mentioned as a beneficial trait to be possessed by a technology start-up. Companies that fail to adapt within the fast-paced technology sector can find their products quickly become unpopular. This necessitates shorter release cycles, which are potentially more expensive. Musser & O'Reilly (2006) note this as a best practise for Web 2.0 companies, referring to the "perpetual beta" as evidence. A Web 2.0 service running a perpetual beta release cycle offers their users services that are not fully tested, on the understanding that some components may not work as expected. This enables new features to reach the market sooner, rather than undergoing a lengthy period of internal testing (Musser & O'Reilly, 2006).

The tendency to release new features as early as possible may be reflective of the "get big fast" strategy observed in the original dot-com bubble companies. Under this strategy, companies aimed to get their offerings to market as quickly as possible, with the assumption that being first-to-market improves uptake by users (Oliva, Sterman, & Giese, 2003).

Competition and rapid development within the technology sector may have repercussions for investors: Sahlman and Stevenson (1985) suggest that the collective behaviours of investors, particularly venture capitalists, may be destructive for an industry. This is exemplified by the Winchester Disk industry between 1977 and 1984.

3.1 The Winchester Disk Bubble (1977-1984)

A "Winchester Disk" is a hard disk that follows the design and operating principles of the first Winchester Disk designed at IBM in the early 1970s. This was a spinning-platter hard disk, and is the principal design for contemporary spinning drives. Through research and development, the Winchester Disk industry rapidly improved the speed, capacity and reliability of their proprietary offerings. The later production of industrial standards for these drives led to the de-facto design for magnetic hard disks, which are still used today.

Many companies in the Winchester Disk industry were start-ups and typically required large amounts of capital to run their R&D operations, without which they would quickly loose competitive advantage. Despite being costly start-ups, one Winchester Disk company was reported as a *significantly successful* investment, when the value of the company rose 31.75 times following its Initial Public Offering (IPO).

Enthused by these results, other venture capital companies were keen to see their own portfolio companies pioneer technological breakthroughs and produce similar performance at IPO. This potential for exceptional returns ensured that high levels of R&D investment continued in the sector until 1984 (Sahlman & Stevenson, 1985).

However, the rapid innovations in drive design and performance made it very difficult for any company to maintain market leadership for long enough to exploit their position. Venture capital companies eventually realised this and lost confidence in the industry, causing the collapse of many disk manufacturers. Of the 100 companies that existed during the bubble, only five remain today.

Sahlman and Stevenson attribute the collapse of this industry to *Capital Market Myopia*; a phenomenon where investors become so engaged with the *companies* they support, they fail to realise the wider-reaching implications of their collective activities upon the *industry* (Sahlman & Stevenson, 1985). This was catalysed by the initial success story, and the perception that the product was destined to (a) become a popular necessity and (b) remain a high-price item. Under this theory, the industry collapsed because competition between *investors* resulted in mutually destructive competition between their portfolio companies. Once again, the effects of supply and

demand upon the entire market appear to have been overlooked.

3.2 Dot-Com Bubble (1995-2000)

The dot-com bubble began in 1995, shortly after developed countries gained access to the World Wide Web, and ended in 2000. It comprised many young publically traded internet companies, funded by venture capital at a time when online trading was a novel concept. Many of these companies operated at a loss deliberately, providing services for little or no money to increase their market share. Once they had a suitable market share, they planned to exercise techniques to monetise it.

Hawkins observed that growth of the bubble prompted the publication of "many articles and books" about business models, a subject that had rarely been discussed or studied as extensively before in either the mainstream or academic press (Hawkins, 2004). This observation coincides with the desire to grow market share, exhibited by many dot-com start-ups at the time. Ovila (2003) describes the attitude of the time as a 'get big fast' strategy, in which retailers would attempt to be the first to the online market, and discount heavily in order to gain customers.

Further observation of academic discussion shows a tendency towards the notion that the technological capability of a company should be balanced with organisational capabilities (Wheale & Amin, 2003). This discounts the then-popular notion that new markets could be created online, given sufficient capital investment and the technological capability. The flawed notion that new markets could be created in this way arguably contributed to the speculation surrounding dot-com companies, and therefore the inflation of their share prices.

Ultimately, investors lost confidence in internet companies because share prices had risen without an accompanying growth in profit, signalling poor long-term investment prospects. The projected monetisation opportunities failed to materialise for these ventures, many of which were making great losses due to their expensive market share growth strategies (Wheale & Amin, 2003).

3.4 Due Diligence and Speculation

The previous sections found that bubble investors are often willing to leave their area of experience or expertise. This section introduces due diligence; a conceptual process that may be used to evaluate an investment opportunity to assist in making a rational, informed decision.

The financial sector safeguards itself from potentially unsafe investments through an evaluative process of analysis and due diligence, performed upon any new investment opportunity (Sudek, 2006) or potential acquisition. Factors such as the investors' appetite for risk and objectives are taken into account, and the potential investment evaluated against them. Due diligence is not limited to one particular technique; the techniques employed depend upon the nature of the investment or acquisition (Pack, 2002). An example technique for performing due diligence in technology operations is shown as an illustrative example.

The Gartner Hype Cycle is a high-level model used to describe and analyse technologies as they enter a market and become mainstream (Smith, 2003). When used in Gartner reports, it shows the *maturity* of various technologies graphically. "Maturity", here, is defined as the progression of a technology through the distinct stages of industry adoption, as defined by Gartner and discussed further below. Note that the cycle describes *technologies*, such as the concept of cloud computing, rather than *products* of the technology, such as Amazon's EC2 cloud computing platform. According to Gartner, it is a tool that may be used by management and IT decision makers to perform due diligence upon IT investments which they do not fully understand (Linden & Fenn, 2003).

Gartner reports plot contemporary technology product offerings on this chart, to aid decision makers in deciding whether a particular technology is sufficiently mature or reliable for their business. The cycle proceeds through several distinct stages, as shown in Figure 3:
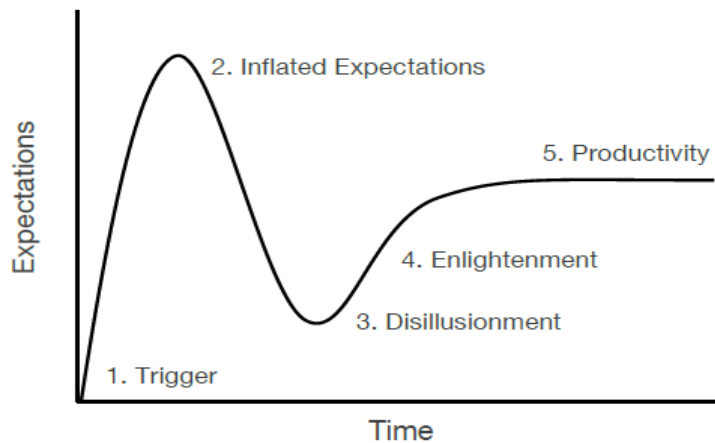
Figure 3 - Gartner Hype Cycle (Linden and Fenn, 2003)

1. In the "Technology Trigger" phase, a new *technology* is discussed in the media, and it gains publicity.

2. The "Peak of Inflated Expectations" occurs when the technology is most visible in the media due to success stories and other coverage. At this phase, some early adopters may begin using the technology.

3. The "Trough of Disillusionment" follows, where the inflated expectations are not realised in practical applications of the technology. At this stage, the technology may be updated or repaired to resolve issues found by early adopters.

4. The "Slope of Enlightenment" arises as people begin to understand and accept the limitations of the technology. At this phase, many interested parties consider using the technology, create implementation plans, and integrate it into their business.

5. The "Plateau of Productivity" phase begins when the technology and the resultant products gain broad commercial acceptance.

Despite its widespread use in Gartner reports, discussion surrounding the Hype Cycle discounts its use as a valid metric or instrument (Smith, 2003). Critics in the scientific community find particular fault with its naming as a "cycle"; Gartner does not describe the model as being cyclic, so these critics describe it as the Hype Curve. Furthermore, the placement of a technology on the curve does not appear to be backed by quantitative data (Fenn, 2010), and is instead an arbitrary and often unexplained placement made by a Gartner analyst.

During a discussion at the AYE Conference for Human Systems, Jerry Weinberg voiced criticism of the model, noting that the circumstances or actions required for the initial "Technology Trigger" are not defined by Gartner, so it is impossible to know when the model should be applied to a technology (Smith, 2003). He notes that by analysing several of Gartner's own annual report publications, technologies vanish and appear at various stages on the model over a period of years. Thus, Gartner presents the Hype Cycle as an instrument that can be beneficial to decision makers, but simultaneously disproves its efficacy by arbitrarily moving technologies on the curve year-by-year.

A further argument is that Gartner consistently place technologies directly *on* the curve; if the model was backed by quantitative data, a more representative placement would be possible, off the curve (Smith, 2003). The curve could then be plotted according to the data, and proven thereby. This deficiency suggests that technologies are forced into a position on the nominally-defined Hype Cycle curve, rather than the curve actually being a trend line that is the product of on-going quantitative analysis of various technologies.

In its current form, the cycle implies that a technology always reaches the "Plateau of Productivity" stage. In reality, many technologies never emerge from the disillusionment stage. Nevertheless, the cycle does contribute value to Gartner reports, providing an executive overview of technologies for people who do not have time or resource to investigate the technologies themselves.

The hype cycle illustrates the nature of a bubble, albeit a bubble of inflated expectations rather than actual valuations. At the early states, while early adopters are using the product, expectations exceed the product's capabilities. Expectations "crash" when users realise that the products does not deliver on them all. Finally, a correction occurs, which brings the expectations of the product in line with its capability. In all these stages, the difference between expectations and actual deliverable capability is analogous to the market valuation of a security, versus the actual underlying value.

This section has aimed to demonstrate that tools and techniques for due diligence are available, but may require expert interpretation of the results. In the Hype Cycle example, a company's attitudes to risk and adoption of premature technologies may require a more specialised interpretation of the data. Furthermore, a specialist would be capable of analysing other technologies (analogous with other investments or opportunities) that lie in a similar place in the results, and draw further insights and conclusions from those associations.

Social Networks and Cloud Computing have featured on Gartner Emerging Technology reports and on hype cycle charts therein. The following section focuses on how these technologies have enabled innovation in Web 2.0 services, and how they are enabling new business models.

3.6 Discussion

In section 2.2, it was suggested that economic bubbles might form when investors leave their area of expertise to participate in potentially speculative investment activities in unfamiliar sectors. The review of technology sector bubbles confirms this; venture capitalists were willing to leave their area of expertise to become involved in the popular dot-com and Winchester drive industries.

The collapse of the Winchester Disk industry has already been attributed to the concept of Capital Market Myopia, in which the collective competitive actions of investors is detrimental to an entire industry ecosystem. This concept could also be applied to the 2001 dot-com bubble. Valliere and Peterson (2004) show that venture capital was obtained by many web start-ups, and that there was competition between venture capital firms to invest in web start-ups.

Given the outcome of the dot-com bubble, many companies in the sector would have failed due diligence tests. Competition between investors to gain exposure to such a sector is indicative of speculative behaviour.

In discussion

The author frequently works with clients seeking investment for their new companies, and some who seek investment for their ongoing, established activities. While discussing the nature of VCs and their own investors with business, they have described various potential investors as follows:

- "Expensive".
- "Specialised in a sector".
- "Wanting to break into a sector".

These comments provide anecdotal evidence that there exists a range of VC, in terms of price and sector specialisation. It also supports the notion that some VCs attempt to gain exposure in sectors they have never worked in. As such, VCs may pay more than a company is worth in these situations. Therefore, the concept of Capital Market Myopia and eventuality of investors leaving

their sector of expertise should be taken forward as potential indicators of bubble scenarios. Table 3 shows a summary of the two bubbles discussed here, and uses the same format as the Historic Bubbles Discussion in 2.4.

Table 3: Summary of bubbles described in this section

	Winchester Disk	Dot-Com
Initial Development	Enterprise demand for products for this industry. Over-estimation of demand growth. Over-estimation of attainable prices.	Potential of trade opportunities over the Internet
Growth and Performance	Competition between companies, by products and product development.	Development and discovery of Internet business models. Competition between inexperienced investors, trying to produce successful portfolio companies.
Collapse	Cost of product development. Short product lifecyle.	Poor profit due to failure of lack of business models.

4. Investors Understanding of Novel Technologies

Within the reviews of historic and more recent technology sector bubbles, a recurring theme appears to be the *lack of understanding by investors of the limits or costs associated with novel technologies*. This section explores that notion further, through analysis of literature and the case studies already detailed above.

The widespread use of new and un-tested technology in bubbles has made it difficult for investors to distinguish between companies likely to succeed and likely to fail. This has been seen in the following bubbles thus far:

- Dot-com
- Winchester Disk
- Railway Mania

The lack of familiarity or understanding of these technologies inhibited investors from effectively evaluating their investment opportunities, leading to poorly researched speculative investment in the bubbles analysed. This is because the investors were unfamiliar with the technology, and the limits of novel technologies can rarely be known until they are met.

For instance, in the Winchester Disk bubble, the rapid pace of technological evolution meant that the position of market leadership was often held by a different company each week, in terms of cost, performance, quality and orders (Sahlman & Stevenson, 1985). Such rapid changes in a brand new sector will have limited the experience investors could draw upon.

A set of objectives, and plan for "exiting" the investment should form the basis of evaluation for even minor investment opportunities. In the situations described above, again due to a lack of domain familiarity, few investors understood when to exit from their investments. Valuations may have risen to, and beyond, investors' "success" criteria but investors chose to pursue further gains, instead of exiting their investments when "success" was achieved. Furthermore, investors had no benchmark or objective by which to measure when an investment had succeeded. By the same logic, the opposite should also be true; investors would have lacked the experience and knowledge to identify when an investment had failed, and should no longer be pursued. If processes of due diligence had been correctly enforced, the lack of experience and domain knowledge would have reduced such investments.

4.1 Investor Attitudes to Technology during the Dot-Com Bubble

In section 2.3, the concept of *Capital Market Myopia* was linked to the Winchester Disk bubble. It may also be feasible to apply this concept to the dot-com bubble of 2001. To test the applicability of this concept, Valliere and Peterson (2004) interviewed 57 venture capital investors who were active in the Internet sector during 2001, to understand cognitive processes that might have led to the inflation of the dot-com bubble.

The investors were asked about their strategy when investing in unfamiliar sectors prior to the bubble. In these situations, the nature of investment success criteria was understood, but the investor may have had limited or no experience in the sector. The resulting cognitive model, shown in Figure 4, involves "fundamental venture capital operations" of sourcing, screening, structuring, monitoring and exiting.
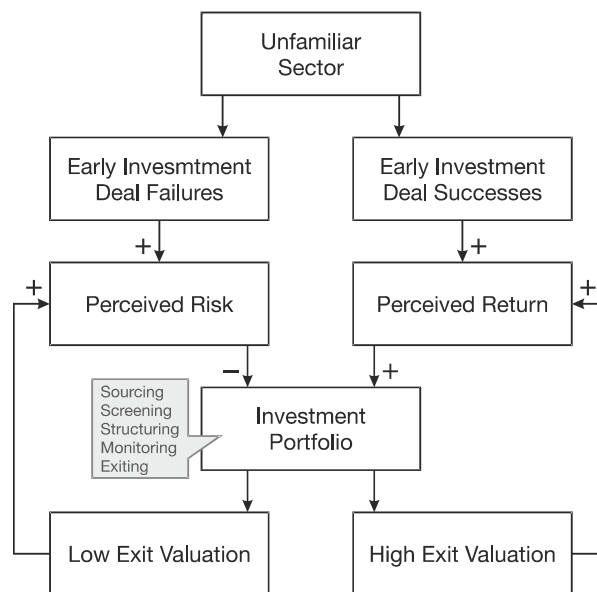

Figure 4 – Cognitive Model of Investors operating in unfamiliar sectors Derived from Valliere & Peterson (2004)

While described as a "Cognitive Model", no formal modelling technique appears to be applied. Nevertheless, the underlying meaning is clear; links between cells represent influences that either positively or negatively affect their target. For instance, a low exit valuation for an investment contributes positively to investors' perception of risk.

The same investors were asked about their strategy during the bubble, in relation to the unfamiliar internet sector. It was found that:

- Investors had no way of knowing when an internet company was successful, because few (if any) had achieved resounding success at the time.

- Discussions between investors about the seemingly magnificent prospects of internet companies encouraged individual investors to invest speculatively, with little or no due diligence.

Following these findings, Valliere and Peterson (2004) acknowledged that, in relation to investors in the Internet bubble, "forces were operating that were not represented in the simple cognitive model of Figure 4".

Figure 5 shows Valliere and Peterson's subsequent development of the cognitive model, which incorporates changes to address these behaviours. The original model is shown in white boxes, and additions are shown in shaded boxes.
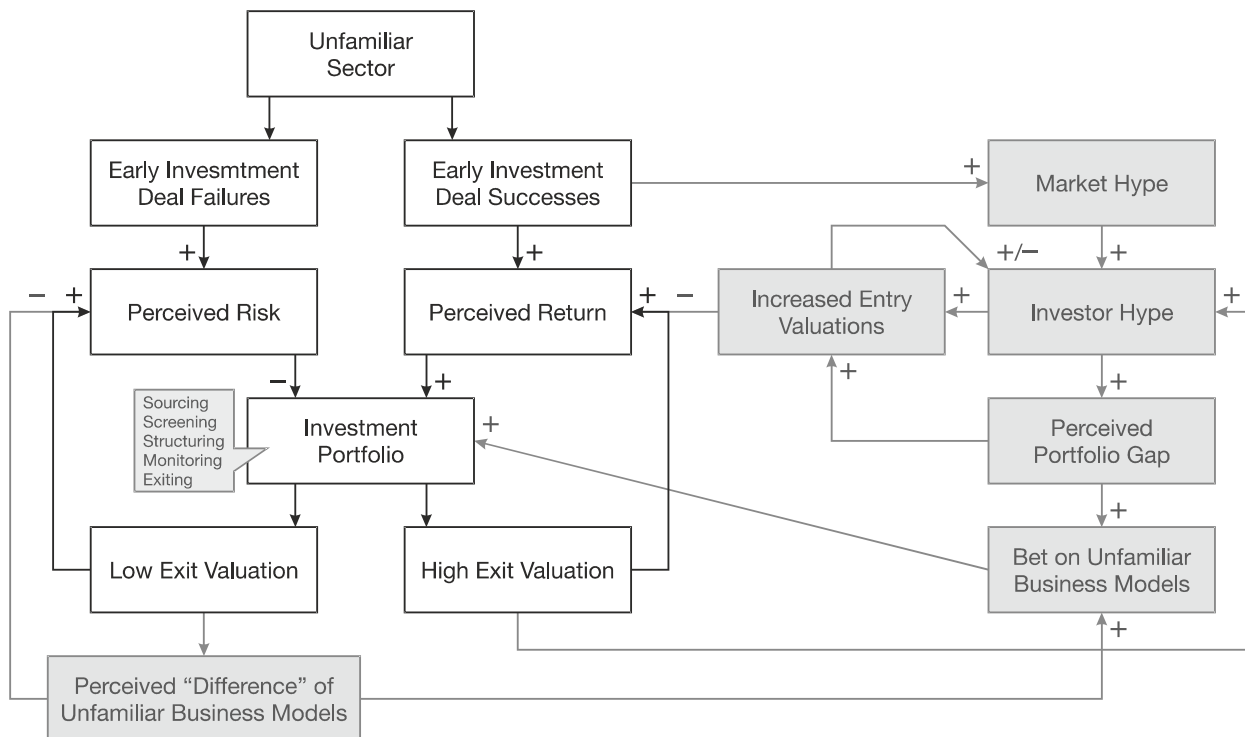
Figure 5: Cognitive Model of Investors during the dot-com bubble (Valliere and Peterson, 2005)

A closed positive reinforcement loop exists within the shaded cells on the right side of the model. Under bubble conditions, this causes a rise in entry valuations for companies and speculative investment through the "hype" components. Under normal circumstances, the links in the unshaded model components result in a balanced process. That is, there is no perpetual positive or negative reinforcement.

The "Perceived Difference of Unfamiliar Business Models" cell is noted as decreasing "Perceived Risk" during bubble situations, which may appear contrary to expectations–unfamiliarity should surely *contribute* to a sense of risk. Valliere and Peterson attribute their model to a key finding in their interviews; that investors in a bubble situation assume the content of due diligence must change because they are unfamiliar with the business model or technology employed. Another factor behind this model decision was the assumption by bubble investors that the failure of one business model increased the likelihood of a working one being found in the remaining companies. In a later paper, Valliere and Peterson develop their 2004 work and respond to questions raised by the community. Their work was constructed using prospect theory: an economic theory for analysing decision-making by individuals in situations that involve risk and reward (Kahneman & Tversky, 1979). The community asked whether alternative behavioural analysis methods might reveal alternative models, suggesting that it could not be applied to *all* investors during the bubble period.

Valliere and Peterson had focused only on venture capitalists in their first work, and agreed that another analytical framework may be more suited to the "*less experienced, but rational, internet investors*" (Valliere & Peterson, 2005). This means that the formation of the dot-com bubble may be attributed to more than just venture capitalists, which may be true when companies grew and some began to file for IPOs.

5 Future Directions

On the study of various economic bubbles, some have correlations on each other. For example, the bankruptcy and the rapid fall of certain industries and companies are due to the unexpected factors that make the businesses to decline sharply. All these factors can be summed as follows. Over competition in the market; rapid falls in demand and popularity; government and/or company policies that have made irreversible and adverse impacts; slow response to problem and lack of

effective contingency plans. All the unexpected events happen at short notice so that the risk can rise out of control and cannot be managed. This is similar to William Sharpe's CAPM model presented in his Nobel speech in which risks are classified as either under control (unsystematic) and or uncontrolled (systematic) risks (Sharpe, 1992). Thus, careful, thorough and effective risk management, guideline, tolerance and analysis are required to reduce impacts from economic bubbles, and to understand the extent of damage and prevent or postpone the future economic bubbles. The following is proposed to address this challenging task:

Firstly, important metrics that can cause the economic bubbles need to be identified. Each metric has to be quantified and measured over a period of time. They will be used for data analysis to understand any implications and any correlation between different events, periods and case studies. Secondly, suitable datasets from similar studies will be investigated. These datasets will be used to study the cause, recommended resolution and analysis of economic bubbles. Thirdly, a suitable model should be used to analyse the full impacts caused by economic bubbles. The selected model needs to be able to identify key metrics and process all the datasets. The types of risks may include the controlled and uncontrolled, the internal and external. All the values for risks need to be monitored and analysed. Outputs can be in the form of visualisation so that unexplored areas can be identified and checked more thoroughly.

Organisational Sustainability Modelling (OSM) is one such model. It can keep track of risk and inform the stakeholders with the implications and interpretation of risk analysis (Chang et al., 2016). This includes how to identify and measure key metrics. OSM also uses its own linear regression method to analyse beta, the uncontrolled risk value. Beta should be kept below 1. If the beta value in any month exceeds 1, then the warnings will be provided to the stakeholders for them to take more cautious steps to minimise the risks involved. OSM can also compute the values of internal and external risks, so that businesses can identify what goes wrong with their strategies and operations, so that operational and strategic risks can be reduced. The data analysis of OSM includes easy to understand statistics and also visualisation, the latter of which includes analytics, graphs and charts to allow business leaders to understand the impacts of the risks to their businesses. The status of "return" can be analysed together with risk. The definition of return depends on each organisation's focus, out of technical, financial and user focus approaches. The stakeholders, project leaders and investors can find that understanding the status of risk and return in real-time can be useful for the projects involved. Different case studies have been used to support the validity and usefulness of OSM. For example, Vodafone has been studied for the mobile cloud services and strategies in 2010 including analysing the risk and return of their investment (Chang et al., 2011). Future directions may include the use of suitable models such as OSM to understand the implications of economic bubbles, so that results from quantitative analysis and visualisation can support hypotheses causing economic bubbles and correlation between different economic bubbles.

Another topic of discussion is whether Web 2.0 may fail due to a shortage of support and esteem. Web 2.0 is the second generation of the internet development and service. The main difference between Web 1.0 and 2.0 is, Web 2.0 allows users to broadcast their news, share with peers and exchange ideas. The rise of Web 2.0 has created profitable business models for technological giants such as Facebook, Google and mobile service providers.

Before discussing whether Web 2.0 maybe another bubble, other technological related topics should be considered. One of such an example is the Internet of Things (IoT). The rise of the IoT means that all the users are not only connected to the internet but also between each other's mobile devices. This allows everyone to stay connected and collaborate with each other. IoT can also blend with Cloud Computing to allow users to get the services available in Cloud Computing and then establish community-like interactions with other users in IoT (Gubbi et al., 2013). IoT is also closely related to smart cities, whereby all the data on all the vehicles and mobile devices can be captured and sent for analysis. This allows the government and businesses to understand the behavioural patterns of their people, so that they can make more accurate predictions based on the data they have analysed (Gubbi et al., 2013; Hwang et al., 2013). Apart from IoT, another area

for growing needs is social network analysis. The focus is to study the relationship between people by the use of innovative techniques, whereby the understanding about the strength of friendship can be useful for businesses (Chang, 2016). When the businesses know the relationship between themselves, customers and suppliers periodically, they can revise their strategies according to the suggestions from social network analysis.

6 Conclusion and Future Work

This literature review has examined previous economic bubbles together with some of their causes and identified characteristics in each one. Over time, investors have learnt the procedure and importance of performing due diligence upon investment opportunities. Nevertheless, when hype and speculative investment surrounds a company or market sector, the findings in this chapter suggest that investors may be willing to reduce due diligence and take unmeasured risks in sectors with which they lack experience.

The untested nature of business models employed by modern web companies means that many investors are fundamentally unfamiliar with the sector. These companies have the potential to generate revenue in novel ways through their user databases and other data, but few current business models have proven this successful. The corporate venture capital investors appear to view larger web companies with optimism, due to the size of their user-bases. The web sector is developing rapidly due to technological progress supporting the phenomenon of Web 2.0, which has two effects. Firstly, unfamiliar business models are emerging, which are difficult for investors to evaluate. Secondly, there are fewer barriers to entry and overheads in the Web 2.0 sector, which would otherwise reduce possible financial gains. All the economic bubbles have reflected that risk management, guidelines and analysis are essential to any form of business or government. Several recommendations have been suggested for future directions.

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