M@n@gement

ISSN: 1286-4892

Unplugged

Pierpaolo ANDRIANI
Bill MCKELVEY 2011

Managing in a Pareto world calls for new thinking

M@n@gement, 14(2), 89-118.

M@n@gement vol. 14 no. 2, 2011, 89-118
Unplugged

Managing in a Pareto world calls for new thinking

Pierpaolo ANDRIANI
Euromed Management
pier2paolo@gmail.com

Bill MCKELVEY
UCLA Anderson School of Management
mckelvey@anderson.ucla.edu

Abstract:
Research findings showing the ubiquity of Pareto and 'power-law' distributions in the social and organisational worlds underlie increasing calls for complexity-driven ideas to be applied more frequently to organisational and management research. Power laws indicate well-formed Pareto distributions. Given that the world of business is, then, quite likely Paretian rather than Gaussian, phenomena in the long tails are often more important than worrying about the average. Consequently, how to modify strategic attention and what to tell managers? Basic ideas highlighting key differences between Gaussian and Paretian approaches are first reviewed. Then, five specific cases highlighting the managerial tails of Pareto distributions are discussed. These illustrate how overall managerial effectiveness is improved by managing the Pareto tails rather than relying on conventional wisdom to manage 'average' behaviour. Insights and effective strategies better tuned to Pareto-distributed managerial practice follow.

Key words:
Extremes, complexity, long tails, Pareto, power laws, scale-free dynamics, Hollywood economics, illycaffé, Union Pacific railroad.

INTRODUCTION

> *Much of the real world is controlled as much by the 'tails' of distributions as means or averages: by the exceptional, not the commonplace; by the catastrophe, not the steady drip…. We need to free ourselves from 'average' thinking*. (Nobel Laureate P. W. Anderson, 1997: 566)

The material and points of view presented in this unplugged paper have grown, partly by accretion and partly by modification of our previously held views, over several years. Pierpaolo's discovery of power laws was accidental. Biologist Brian Goodwin gave a seminar at the London School of Economics in 1999. Since he was in London anyway and had read Goodwin's previous book, *How the Leopard Changed its Spots* (1994), Pierpaolo went to the seminar expecting to hear about evolutionary problems and complexity. Instead, most of the seminar was on the asymmetric distributions of events. Pierpaolo was not impressed. The argument seemed to boil down to the fact that common events are, as might well be assumed, more common than rare events and that their relative frequencies seem to be connected by a number of relationships.

A couple of years later Pierpaolo heard Barabási give a talk in Boston and suddenly it all became clear. He realised that a power law (PL)[1] is the indication of diversity's tendency to catalyse itself. Diversity in social and natural systems leads to further diversity, or in Kauffman's words: 'Diversity probably begets diversity; hence diversity may help beget growth' (Kauffman, 1995: 292).

The history of the universe, societies and technologies show it. Requiem to Equilibrium, limited variance frameworks, and the self-correcting Invisible Hand! We started looking at the tail of extreme events and quickly became convinced of the inadequacies of gradualist and equilibrium-based frameworks (McKelvey & Andriani, 2005). Some of the material and reflection from our initial research has seeped into the Hollywood case presented in this article. When Anderson published his book in 2006, it became clear that there are two long tails and that any unconstrained market is fully Paretian.[2] The first tail is about extreme events, that is, high-impact, low-frequency events, like the Lehman Brothers bankruptcy or a major earthquake. Taleb (2007) calls these events 'black swans'. The complexity literature has focused mostly on the extreme-event tail. The second tail is about high-frequency, low-impact events. The homeless case shows the relevance of the first tail, while the long-tail case and the illycaffè case show the implications of the second Pareto tail for managers.

Despite mounting evidence against the Gaussian-based view, however, we struggled to publish our first paper. The objections we received ranged from minor details to a request for an entirely new statistical toolkit in place of what we teach in a traditional statistics class. We indirectly answered these objections by pointing out that the main problem is not methodological (i.e., lack of a toolkit for database analysis), but ontological: what type of reality do we assume we are dealing with? Hence, shifting paradigms make it possible to adopt a different take on problems. The first journal to which we submitted the full paper rejected all but some 200 words and dismissed the one reviewer who said 'publish it'. Four revisions preceded publication. The good side to this, however, is that we will end up with five papers published from the first version rather than just one!

Working for a while in the Baroque city of Lecce in Southern Italy, we discovered Gladwell's case on the homeless. This reveals in a very practical way the potential dormant in the paradigm switch to which we alluded above. Around the same time (2006) I had the chance of interviewing Ernesto Illy, the Chairman of illycaffè (Andriani & Detoni, 2008). Illy was a scientist, an entrepreneur and a man of immense culture and curiosity. He was also very knowledgeable on the subject of complexity and was close to both Prigogine's group in Brussels and the Santa Fe Institute's group in New Mexico. Ernesto Illy was unaware of PLs but

1. Vilfredo Pareto was born in 1848, in Paris, of a French mother and Italian father. They moved to back to Italy in 1858, where Pareto received a degree in engineering. In 1893 the French economic marginalist Léon Walras appointed Pareto as Lecturer in Economics at the Université de Lausanne, Switzerland, where he remained for the rest of his life. His most famous book, which we cite, was published in 1897.

2. PL relationships link two variables [such as rank (e.g., city size) and frequency (e.g., size measured by number of residents)] in the form $F \sim N^{-\beta}$, where F is frequency, N is rank (the variable) and β, the exponent, is constant. This differs from an exponential equation where the exponent is the variable and N is constant. In Gaussian distributions data points are assumed to be independent-additive. Independent events generate normal distributions, which sit at the heart of modern statistics. When events are interactive, Pareto distributions dominate because of positive feedback processes (or other scale-free dynamics), which cause extreme events to occur more frequently than 'normal' bell-shaped distributions and Gaussian-based statistics lead us to expect. In other words Paretian distributions show unlimited variability, unstable means and nearly infinite variance. At this stage we use the term Pareto and PL interchangeably. The signature of a PL is a straight line when plotted on double logarithm axes. It becomes impossible to predict single events because the range of dynamical behaviour of the phenomenon is fundamentally unbounded. This is frightening for managers looking for certainty but empowering for managers looking for radical transformations.

knew a lot about scalability[3] and extreme events induced by so-called tiny initiating events (TIEs). He told us how illycaffè changed the Brazilian coffee market by amplifying small, existing instabilities into scalable macro-effects. We succinctly tell this story in our fourth case.
Bill (second author) has been a railroad and train enthusiast since the age of two. He is an expert on designing and building operating model steam engines and has built bridges, tunnels, switches and tracks for the Los Angeles Live Steamers Railroad Museum (which operates live-steam model engines and trains in the Griffith Park of Los Angeles). Unlikely as it may seem, if he had not been admitted to the PhD program at MIT after his MBA, his other choice was to become a steam-locomotive engineer on the Union Pacific Railroad. The Union Pacific was still running the full-size version of its newest and best steam engine—the one he was dreaming of operating. Needless to say, this historical and rather personal attachment to the Union Pacific made him especially sensitive to the operational and management disaster we discuss in our Union Pacific-Southern Pacific-merger example.
Meanwhile, Bill lives in California, a land where 16,000 level-1 to level-4 earthquakes occur every year. He has also suffered the two level=6+ quakes to have occurred in the past 30 years and has studied why some buildings fail while others do not, how builders violate the building codes and where people are most likely to be killed (in the most recent 6+ quake, 60 out of the 63 people killed lived on the first floor of apartment buildings). In short, California is the only US state that focuses on the long Pareto-tail of the earthquake distribution. For people living in quake-land, Pareto distributions are what we worry about every day: when will the next level-8+ quake happen? With Pareto distributions burned into our brains, it doesn't take much to get one wondering about where else Pareto distributions—and then PLs—thrive. Predictably, they thrive in living systems that have Pareto rank/frequency-distributed predator/prey environments and consequently require internal requisite fractality[4] to survive (McKelvey, Lichtenstein, & Andriani, 2011). Requisite fractality ranges from biological species and niches to companies in competitive environments.
In the past few years the complexity-theory literature has paid increasing attention to PLs, long tails, extreme outcomes, fractals and other Pareto-related effects (Schroeder, 1991; West & Deering, 1995; Iannaccone & Khokha, 1996; Barabási, 2002; Newman, 2005). Entirely new fields such as econophysics and sociophysics have arisen (Mantegna & Stanley, 2000; Chatterjee, Sudhakar, & Chakrabarti, 2005; Chatterjee & Chakrabarti, 2006, 2007) based on recognition of the fact that the nonlinear interdependences among people give rise to a more complex world in which PLs are the signature of scale-free dynamics.
Aside from a few exceptions (De Vany, 2003; Anderson, 2006; Taleb, 2007), the management, organisation-theory and economics and business literatures are trailing behind, but at the same time they offer a very rich field of inquiry to researchers who want to explain the origin and dynamics of the extreme diversity of business structures. On the one hand, we see extreme outliers at one end of a Pareto long-tailed distribution: positive extremes such as GE, Microsoft, Walmart and

3. This means, as Anderson shows, that the entire market, from the smallest to the largest segment, is described by a PL relationship. It also means that markets are nested within markets; in other words, markets are fractal. As we explore later, fractals are similar-looking patterns in physical or living systems that appear at different scales, such as how trees go from large branches to small twigs or airports have the same essential features from giant hubs like Heathrow or O'Hare down to the thousands of tiny airports around the world.
'Parietian' ideas, distributions and PLs date back to Pareto's first books written at the Université de Lausanne: Cours d'économie politique, Vol. I, 1896; Vol. II, 1897.

4. Scalability refers to the ability of a system to achieve a fractal structure across multiple (if not all) levels, which requires scale-free causal dynamics at multiple levels. These are explained by various scale-free theories. These dynamical patterns (also called 'scaling laws') can appear similar at many orders of magnitude (Zipf, 1949) and drive order creation at multiple nested levels (West, Brown, & Enquist, 1997).

Google, and negative extremes such as the Challenger and Pioneer disasters, LTCM, Parmalat, Enron, CountryWide, IndiMac, Bear Sterns, Fanny Mae/Freddie Mac and Lehman. At the opposite end, we see the (other) Pareto long tail Chris Anderson writes about: a tail consisting, for example, of Amazon's book sales or 17 million small, family-owned stores, many of which thrive in idiosyncratic micro-niches.

Previous papers (Andriani & McKelvey, 2007, 2009) have reviewed the literature on PLs, demonstrated the ubiquity of PLs in the social sciences and more particularly in the organisational world, applied Pareto-driven ideas to methodology and research in organisation science and developed a framework to explain the emergence of PLs in the social sciences (which we call scale-free theory). In this article we focus on a different aspect: given that the world in which organisations live is frequently Paretian, what types of changes in thinking and practices are required in the fields of management and strategy to help managers to prosper in a Paretian world? How to transform the new understanding of scalability and scale-free theories into tools that may help us to anticipate and govern the transformation of TIEs into extreme outcomes, either to shape the emergence of new business market and/or organisational structures favourably or to avoid the potentially lethal consequences of such a development? (Royer, 2003) Can scale-free theories help identify TIEs, which Holland calls 'small "inexpensive" inputs' or 'lever point phenomena' (2002: 29)?

These are major questions that require a reorientation of management and organisation theory. In this paper we show how the practice of management can drastically change if a practising manager adopts a Paretian course of action. We show in five short cases that the shift from Gaussian to Paretian involves more than a change in the tools used for statistical analysis. We base four of our illustrative examples on cases developed by other authors, while the illycaffè case was developed by Andriani. It signifies a shift in perspective that enables the manager to look at old things with new eyes. This change of perspective reveals novel strategic possibilities and operational approaches that were hidden from view under Gaussian management. In practice, rather than conceptualising a phenomenon by squeezing its diversity into a Gaussian distribution and working out the properties of the representative agent by calculating its mean and variance, managers should look at the entire unbounded distribution and pay particular attention to its tails. We show that by focusing on the tails, managers can find novel strategies and solutions. We believe that this unplugged article represents a first attempt to apply Paretian ideas to strategic management; we hope that it will stimulate other researchers to extend it. We begin with a review of basic ideas that differ between the Gaussian and Paretian approaches. We then discuss five specific cases in which the Paretian standpoint offers new insights and effective strategies. A discussion and conclusion follow.

M@n@gement vol. 14 no. 2, 2011, 89-118
Unplugged

PARETO VS GAUSS: WHY POWER LAWS MATTER

Abbott (2001: 7) discusses how the 'general linear model' from Newtonian mechanics came to shape social scientists' thinking:

> *The phrase 'general linear reality' denotes a way of thinking about how society works. This mentality arises through treating linear models as representations of the actual social world.… The social world consists of fixed entities (the units of analysis) that have attributes (the variables). These attributes interact… to create outcomes, themselves measurable as attributes of the fixed entities.*

The 'general linear reality' (GLR) model has influenced not only the way researchers build models and the philosophical assumptions they use, but more broadly the way we conceptualise the world. GLR, Abbott claims, has transformed normal distributions from a tool relevant under a set of specific circumstances into a representation of the world as it is. By stressing the centrality of fixed, independent entities as objects, GLR fails to account for the emergent properties of systems that derive from connectivity within or among systems. The consequent interdependence among agents[5] generates Paretian dynamics and PLs as its hallmark.

PLs seem ubiquitous: they appear in leaves, coastlines and music (Casti, 1994), and they characterise earthquakes and hurricanes. American, Japanese, Chinese and Indian cities, among many others (but clearly not all), follow a PL when ranked by population (Auerbach, 1913; Zipf, 1949; McKelvey, Lichtenstein, & Andriani, 2011). The structure of the Internet follows a PL (Albert, Jeong, & Barabási, 1999), as does the size of firms (Stanley et al., 1996; Axtell, 2001). We have collected over 100 examples of PLs in the social and organisational world (Andriani & McKelvey, 2009). Brock (2000) suggests that PLs are the fundamental feature of the Santa Fe Institute's complexity science.

A Pareto distribution plotted as a double-log scale appears as an inverse PL, a negatively sloping straight line. PLs are 'indicative of correlated, cooperative phenomena between groups of interacting agents' (Cook, Ormerod, & Cooper, 2004: 3). As noted earlier, PLs often take the form of rank/frequency (R/F) (or size) expressions such as $F \sim N^{-\beta}$, where F is frequency, N is rank and β, the exponent, is constant.[6] Most firms are R/F-distributed, with one CEO at the top and many workers at the bottom of a multi-level hierarchy. Most industries are R/Fs, with the largest (often giant) firms at the top (e.g., Microsoft or Walmart) and thousands or millions of small businesses at the bottom with many size levels in between. The mean represents neither the top nor the bottom. In 'exponential' functions the exponent is the variable and N is constant. Theories explaining PLs are also scale-free, i.e., the same explanation (theory) applies to several adjacent levels of analysis.

We argue that PLs and scale-free theories apply to management and organisations. Furthermore, there is good reason to believe that PL effects are ubiquitous in organisations and industries showing adaptive change, and have far greater consequences than current management

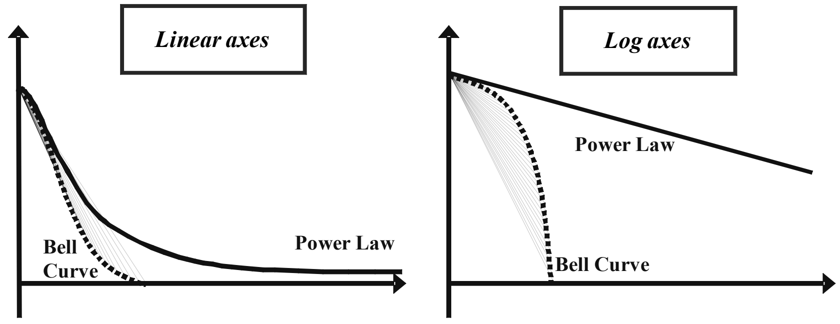
5. Requisite fractality follows from Ashby's (1956) classic Law of Requisite Variety, which McKelvey and Boisot (2009) modernize into 'requisite complexity'. But since industry ecosystems and firms are both rank/frequency-distributed, this means that the fractal complexity inside a firm has to keep changing to stay competitive with respect to the changing fractal complexity in its external competitive environment (McKelvey, Lichtenstein, & Andriani, 2011).

6. Note that though a PL exponent is constant, the exponent is in general different depending on the setting, industry, time, etc. For example, Stanley et al. (1996) find slightly different scaling coefficients across a large sample of firms for sales, assets, number of employees, etc.

theories presume. We argue that whenever tension and connectivity dynamics exist, the probability that PL-distributed phenomena will occur increases substantially. PL distribution is a natural attractor for interdependent phenomena characterised by potentially unlimited variability. From a mathematical standpoint, distributions fall between the extremes of the normal and the PL distribution. These are the only two stable distributions. The former constitutes the natural attractor for limited-variance phenomena (where the central-limit theorem applies), while the latter is the natural attractor for interdependent phenomena, characterised by potentially unlimited dynamic variability and scale invariance (fractal). To the extent that real social and economic phenomena fall either in the Gaussian, Paretian or the intermediate space, managers ignoring PL effects risk missing important aspects of the dynamics of business phenomena. Specifically, the extreme outcome at one end of the Pareto tail is typically $N = 1$, i.e., it is characterised by low frequency but has a disproportionate impact on adjacent systems. Extreme outcomes and radical innovations fall into this group. At the opposite end the N can run into the millions. The mode, mean and median do not overlap as they do in a normal distribution. Moreover, in many PL distributions the mean does not really exist. There is no typical scale and therefore the use of averages and standard deviations to represent the phenomenon is misleading. Methods of good management at one extreme do not apply to the opposite extreme: managing one of the millions of small, family-owned stores (officially defined as having no paid employees) is not the same as managing Walmart. Managing the median firm is not the same as managing at either extreme. As Axtell (2008) points out, 'the typical firm does not exist'.

PL phenomena exhibit Paretian rather than Gaussian distributions; see **Figure 1.** The fundamental difference lies in assumptions about the correlations among events. In a Gaussian distribution the data points are assumed to be *independent-additive*. Independent events generate normal distributions, which sit at the heart of modern statistics. When events are *independent-multiplicative* (Limpert, Stahel, & Abbt, 2001) they generate a lognormal distribution. When events are *interdependent-multiplicative*, Paretian distributions dominate because positive-feedback processes leading to extreme outcomes occur more frequently than 'normal', bell-shaped, Gaussian-based statistics lead us to expect; normality in social, organisational, and industry distributions is *not* the norm.

Figure 1. Gaussian vs Power-law distributions



Several theories explain PLs. They typically hinge on *interdependence* among data points and a possible ensuing positive feedback or other scale-free process. Herein lies the problem for 'normal' science: most quantitative research involves the use of statistical methods presuming *independence* among data points and Gaussian 'normal' distributions. The many findings of natural and social PL phenomena, however, indicate that *interdependence* is far more prevalent than 'normal' statistics assume and the consequent extremes have far greater consequences than the 'averages' in between.
In reality, what are most important to managers are the extremes they face, not the averages. Yet, most academics' research produces results based on averages in normal distributions and associated statistical significances (Andriani & McKelvey, 2007). We believe that research results stemming from Pareto-based science (what we now term 'power-law science'; Andriani & McKelvey, 2011) could be of more value to managers. But how? How does the study of PL science contribute practitioner-relevant academic research and the practice of management?

MANAGING IN A PARETO WORLD CALLS FOR NEW THINKING

Below, we apply the Paretian framework to five specific areas to show how the change in paradigm from Gaussian to Paretian allows a better understanding of reality and helps formulate original and effective management strategies. In particular, a shift of managerial attention from the centre of the distribution (the average) to the tails (the outliers) reveals unsuspected solutions to existing problems and promising opportunities for growth. We start by examining the emergence of *Pareto tails in Internet sales* and the consequent change of strategy; we then focus on the business of an 'experience good' such as the *movie industry* and show how risk and prediction are redefined; next we show how concentrating on the tail suggests an alternative strategy to deal with the *homeless problem*. Then, we turn to the emergence of a new business ecosystem triggered by the butterfly effect of the entry of an Italian company in the *Brazilian coffee market*; finally, we examine the collapse of *Union Pacific Railroad* to illustrate how a Paretian approach can help explain and potentially avoid major catastrophes.
Our case illustrations of Pareto and PL management can be divided into two groups. In the first group we discuss three examples of advantages that can be enjoyed when managers focus on managing the Pareto tails rather than expecting to make improvements by managing at the Gaussian mean. The second group illustrates the positive and negative consequences of scalability, i.e., when TIEs spiral up into extreme positive or negative outcomes. The Brazilian coffee case is the positive example. The resulting gridlock on the Union Pacific Railroad shows what can happen if negative TIEs scale up to cause an extreme event.

FOCUSING ON PARETO TAILS RATHER THAN GAUSSIAN MEANS: PARETO-BASED MANAGEMENT

Managing Chris Anderson's High-frequency, Low-Cost 'Long Tail' for Profit

The Information and Communication Technology (ICT) revolution over the past 20 years has created conditions for the emergence of a profitable complement to the traditional economy of high-volume sales, that is, Anderson's (2006) (other) long tail of business micro-niches. The traditional economy based on high-volume 'hits' is a consequence of the limited carrying capacity of conventional markets: products and services have to compete for scarce distribution channels, shelf space and advertising dollars, etc. The tyranny of 'shelf space' associated with the cost of production creates a minimum-cost barrier below which it is unproductive to store or display products. The allocation of scarce resources, therefore, becomes one of the main tasks of managers. Since the ICT revolution allows managers to escape these effects, traditional market assumptions and behaviours are being transformed.

First, for most retailers shelf-space for products is limited and only the 20% of products that 80% of the customers want to buy are selected; this is the so-called 80/20 rule. This product-selection base is built by taking the minimum common denominator across heterogeneous classes of customers, in effect treating a population as a sum of homogeneous entities (i.e., presuming limited variance). In a world of scarce resources, exploiting what the average consumer wants works. Second, the 80/20 rule leads intuitively to concentrating management efforts on the profitable 20% of products and essentially discarding the remaining 80%. Third, the profitability threshold leads to the definition of failure and success. Products exceeding the profitability threshold by the largest possible amount define success. Conversely, lack of high sales signals failure. The mentality of high-volume hits then begins to dominate marketing.

When distribution, marketing and search become cheap and readily available, markets develop Anderson's (other) long tail of proliferating niches containing fewer and fewer customers. This alters the balance between hits and micro-niches, thereby causing the emergence of 'unconstrained' markets which show both tails of a Pareto distribution: the long tail of the 'hit' product niches and the long tail of diversified micro-niches that appeal only to a few consumers. The meaning of the 80/20 rule is also transformed. In the traditional economy, a minority of products (the 20%) generates the majority of revenues (~80%) and virtually all of the profits. In an economy of many micro-niches, every product generates a profit even if sold only once. Assuming, for example, that the new Internet-based markets with physical plus virtual distribution channels carry 10 times as many products as the physical distribution chain (so the traditional 100% (80% + 20%) becomes just 10% of the new markets), the hits (now just 2% of the products) still account for a disproportionate amount of revenues and profits, but now the previous unprofitable 80% and the new tail both generate approximately equal profits. The result is the transformation of the 80/20 rule. The basis of competition shifts from 'average-based' minimum-common-denominator management searching for 'hits' to business that caters for the long tail of niche products. This world is typified by the PL distribution.

Eric Schmidt, CEO of Google, makes the following observation about the long tail (from Anderson, 2006: 214):

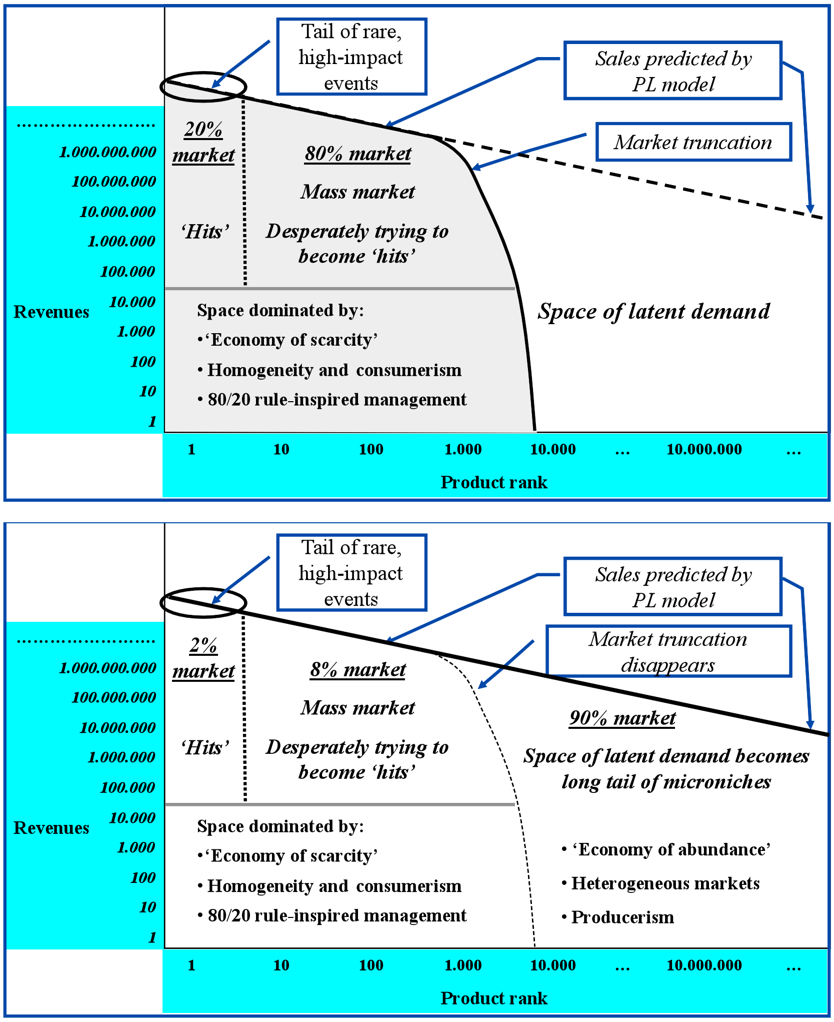
> *The recognition that businesses such as ours show a Pareto distribution appears to be a much deeper insight than anyone realized*…. *When we looked at our business, we concluded that we built a model that works particularly well in the middle of the curve. After reading the article* [Anderson, 2004]*, we looked at the Tail and asked ourselves: 'How are we doing against this opportunity*?
>
> *Take a Pareto curve of the world's businesses, ranked by revenue. Number one is Walmart. So what is the last entry? It turns out it's a person in India with a basket selling something they made. The area under that curve, which includes about a billion people, is essentially the world's GDP. So start at the bottom and move up the curve until you've got people with an Internet connection. They're reasonably educated, they're a small business, and they want to market their goods. And we ask ourselves, 'what benefit can our model bring them to increase their revenues?' And the answer is that if we let them do business outside their own villages, they're reaching a larger market, have got more suppliers, better price competition, and so on.*

What do we conclude from the analysis above? The natural shape of unconstrained markets is Paretian with two fat tails: (a) high-volume hits comprising one extreme; and (b) a long tail of idiosyncratic micro-niches at the other extreme. The fact that distributions of commodities are PL-shaped is not particularly new. What is new in Anderson's analysis is the argument that the emergence of virtual, Internet-based markets makes the distribution of markets fully Paretian.[7] In other words, a PL distribution is a natural attractor for markets not constrained by bottlenecks in production, distribution and search, as shown in **Figure 2**. Business models appropriate for the opposite ends are very different. The most successful cases of the past 10 years – the Googles, eBays, and Amazons of the decade in question – are extreme outcomes that have also developed business models appropriate for the other 80% of the Paretian world (Anderson's 'other' long tail). Paretian markets look very different from traditional markets. The emergence of the long tails determines the emergence of new business models and it correspondingly determines the relative obsolescence of business models typical of the centre of the distribution.

7. Brynjolfsson, Hu and Smith (2006) show that the micro-niche long tail is explicitly due to Internet marketing.

Figures 2a and 2b. From constrained to Paretian markets: the tail of hits and the long tail of micro-niches.*

*Traditional markets (fig. 2a) show a truncated distribution of goods. Long-tailed markets develop in the region of latent demand space beyond the cut-off point that constrains mass markets.



Managing Extreme Uncertainty to Increase the Blockbuster Tail

The movie industry in the U.S. (i.e., Hollywood) is exposed to radical uncertainty and extreme outcomes, unlike most industries. Most movies are money-losers. A few blockbusters make huge profits and support the industry (De Vany, 2003). The Hollywood saying 'nobody knows anything' (Goldman, 1983) indicates that predictability of the success (or failure) of movies has systematically escaped the efforts of analysts, academics and practitioners. Extreme outcomes such as 'The Blair Witch Project', which cost $60,000 and brought $140 million, or the failure of 'Waterworld', which cost $175 million but grossed only $88 million in North American box-office receipts, are typical examples. The usual predictors of movies' success, such as budget, release date, variables related to actors, Academy Awards, critics' reviews, etc., do

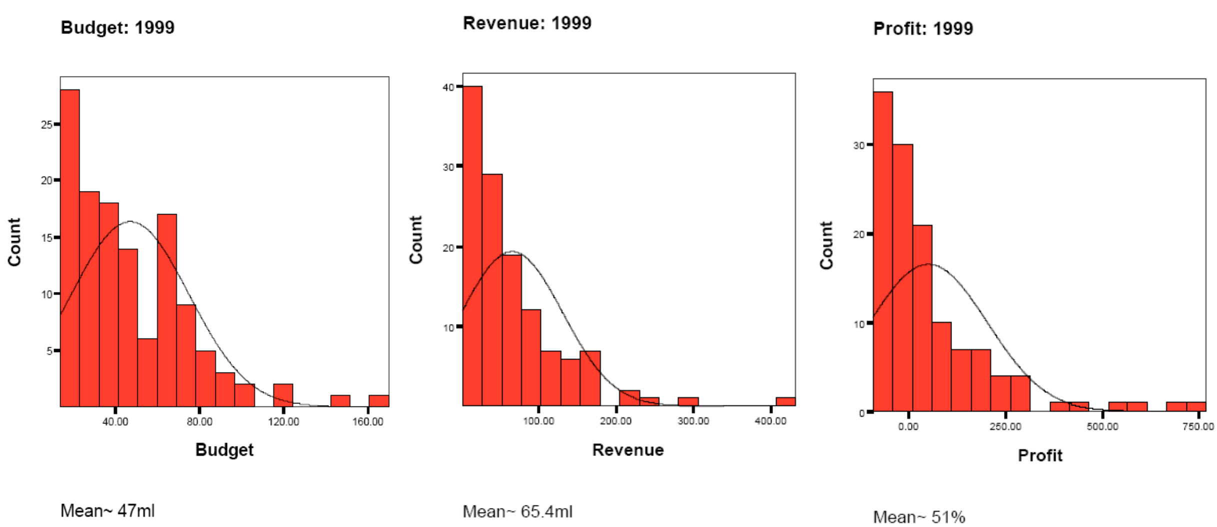
M@n@gement vol. 14 no. 2, 2011, 89-118
Unplugged

not seem to give any reliable predictions about the box-office success of a movie. Escoffier and McKelvey (2011) show that crowd-wisdom[8] is the best predictor of opening-weekend box-office receipts.

Assuming that the movie world is Gaussian rather than Paretian is problematic on several counts. First, it gives an unrealistic picture of risk. Assuming that the movie industry is Gaussian, the probability of success of a movie such as 'Home Alone' (which made a profit of $93 million) is 2.97×10^{-16}, a virtual impossibility. A stable Pareto gives the much more reasonable value of 0.83%. The 'Waterworld' failure would never have been predicted by using Gaussian statistics (-3.41×10^{-12}), against a Pareto probability of 0.45% (De Vany 2003: 219, 284). Second, it masks the importance of the rare events determining the success of the industry. Third, if success is unpredictable, certain practices such as flat-fee distribution rights and contracts based on expected results are counter-productive and damaging to the industry. Fourth, in attempting to stabilise revenues and improve predictability, studios invest in sequels and make the plots of most movies follow a list of pre-determined and distilled ingredients. This is based on the 'minimum-common-denominator' strategy described in our first example about Anderson's (other) long tail. Again, there is little evidence that these rules deliver any consistent results.Is the movie world Paretian? The typical distribution of budget, revenue and profit (movies released in 1999) is shown in **Figure 3** (Longstaff, Velu, & Obar, 2004); the histograms show the typical signs of Pareto distributions. De Vany's (2003) research confirms the dominance of Pareto distributions in the industry.

8. Other examples of crowd-wisdom (or crowd-sourcing) are given in Surowiecki's The Wisdom of Crowds (2004).

Figure 3. Budget, revenue and profit in the US movie industry in 1999*



** Reproduced from Longstaff, Velu, & Obar (2004).*

How does management change if we assume that the long tails rather than the average lie behind an effective Hollywood business model? First, reliance on star power and following the star system do not produce consistent results. As De Vany (2003) points out, star and, in general, movie contracting should shift from expected results to outcome-based results. For instance, reward and contracting should be based on a Paretian view of risk, by nature unpredictable, and hence linked to actual and not predicted results. Second, given radical uncertainty, it is unlikely that success will come from the application of some formulaic recipes (sequels are the perfect example of this approach since the profitless ones greatly outnumber the profitable ones; see Sood and Drèze (2006)) that appeal to the minimum common denominator of the potential audience, as opposed to the search for truly original plots. The Gaussian approach leads to homogeneity, the Paretian approach to heterogeneity. Third, if movie success or failure is based on the 'epidemics' of scalable communications (i.e., large audiences result from the multiplicative spreading of opinions – 'word-of-mouth' communications – in heterogeneous networks, not from the additive aggregation of homogenous individuals), then promotion and marketing campaigns should target the mechanism of information-spreading in scale-free networks.[9] In his book, *The Wisdom of Crowds*, Surowiecki (2004) suggests that viral marketing, prediction markets, blogs, and word-of-mouth communities may be more effective in advertising 'trailer' and movie design (Escoffier & McKelvey, 2011) than traditional marketing methods.

Fourth, if prediction is impossible, what type of assessment of future outcomes is possible? De Vany's (2003) description of the Pareto distribution as the universal attractor of the movie industry calls for a different approach. The nonlinear, R/F and sometimes chaotic nature phenomena underlying PL distributions and the unlimited variability from one tail to the other undermine the prediction of single events. However, the exponent of a PL distribution gives relevant information about the nature of potential outcomes. For instance, De Vany and Walls (2002) show that the categories according to which movies are classified (G, PG, PG13 and R) exhibit Pareto distributions with different exponents. Ranking the distributions according to their exponent, α (for revenues the values are: G=1.591; PG=1.814; PG13=1.661; R=2.274), shows that Hollywood invests disproportionately in R-rated films (about 52%), which is the group with the shortest revenue tail (highest α). Ironically, this is the only group with stable mean and finite variance ($2<\alpha<3$). As De Vany and Walls (2002: 450) write: 'a studio seeking to trim 'down-side' risk and increase 'upside' possibilities can do so by shifting production dollars out of R-rated movies into G-, PG- and PG13-rated movies'. In other words, an analysis of the Pareto exponent indicates the maximum risk and returns that a type of movie can deliver and hence enables a better portfolio approach to risk/return in the movie business.

Fifth, the double-log graph of Hollywood box-office revenues (in Figure 2) shows a heavily truncated Pareto distribution (De Vany, 2003). Just past rank 100, the distribution shows a sharp drop-off, with profit quickly approaching zero around rank 500. The distribution, however, does not reflect the inherent quality of the movies as perceived by the crowd. According to Anderson (2006), the truncation is simply a sign of bottlenecks in distribution. The carrying capacity of the theatre system is

9. In the past decade or so, 'word-of-mouth' has turned into 'word-of-mouse' since movie-goers can communicate by email to all their friends simultaneously, and over the past few years they have been able to communicate their opinions via text message even before the movie ends.

about 100 films. Lower-ranked movies simply fail to be shown in theatres; from the perspective of box-office revenues, they simply do not exist. A Pareto approach introduces an interesting twist to this story. If the natural form of diverse markets without bottlenecks is Pareto (as the music, book and most other industries show), then a focus on theatre distribution blocks the emergence of the second tail of the Pareto distribution, the niche-proliferation tail with lots of small events. This 'missing' part is the space of potential demand that Hollywood leaves unexploited: we now know that the movie industry makes only around 14% of its gross revenue from theatres (Epstein, 2005). How could Hollywood move into this 'second-tail' space? As Anderson shows in his book *The Long Tail* (2006), this requires moving from an economy of consumerism to an economy of 'producerism', which corresponds to a shift from an economy of hits to an economy of some big hits and many micro-niches.

Managing to Lower the Cost of the 10% Chronic Homeless Tail

Nowhere are management priorities better illustrated than in Gladwell's article for *The New Yorker* (2006). We start with his data and stories about the cost of trying to solve the 'homeless drug addict or alcoholic problem', where 'what is important' is so obviously different for the relatively few 'chronic' homeless as compared to the vast majority at the opposite end of the R/F distribution, who stay in a shelter for only one or two nights per year. Gladwell gives various homeless numbers for Philadelphia, New York, Boston, Denver and San Diego, as well as one in Nevada ('Million Dollar Murray'). In **Table 1** we use the Pareto distribution of homeless costs that Culhane discovered in Philadelphia,[10] but we then bring it to life using New York's actual cost of housing and health-related treatments for the homeless.

10. Gladwell (2006) reports on Dennis Culhane's database on Philadelphia's distribution of homeless people.

Table 1. Distribution and cost of homeless‡

	New York City≠				Boston	Denver	S. D.	Nevada	S.D.
Distribution by persons using the services	147k 1 night	98k 2 nights	2500 Periodic*	2500 Chronic†	119 people	1000 people	15 people	1 person§	1 person
Cost/group/year	50% for $9,702	30% for $12,936	10% for $13.86 million	10% for $62 million	$18.834 million	$45 million	$1.5 million		
Cost/person/year	$66	$132	$4,158	$24,800	$31,650	$45,000	$66,700	$100,000	$312,950

‡ Constructed from data supplied by Gladwell (2006).
≠ We apply the Pareto distribution of homeless costs in Philadelphia to NYC and its costs.
** Periodic = a three-week stay every once and a while, with more in winter; we estimate a total of four.*
† Chronic = staying in a homeless shelter most of the time and running up significant medical costs.
§ Million Dollar Murray is the name given to a drug and alcohol addict who cost Nevada $100,000 during each of the 10 years before he died.

The left half of the table focuses on the Pareto distribution of the costs of the homeless people just in New York City (NYC). The high-frequency end of the distribution shows that 147,000 homeless people stayed in a city-owned shelter just one night per year at a cost of $64/night; the total cost of the 147,000 stays adds up to just $9,702/year (total). At the high-expense end of the Pareto distribution we see that the 2,500 'chronic' homeless cost $24,800 each per year, for an astonishing total yearly cost of $62,000,000 On the right-hand side of **Table 1** we show some costs suffered by some cities smaller than NYC which are actually much higher on a 'per person' basis than in NYC. As can be seen in the table, these costs start at $31,650/person and end up with so-called 'Million Dollar Murray' in Nevada, costing $10,000,000 over ten years. Gladwell mentions that one person in San Diego cost nearly $313,000 for just one year.

Gladwell notes that the cost of housing and treating the homeless in several cities, which is Pareto-distributed, shows a PL distribution if graphed on double-log scales. After his discussion from which we generate the numbers in **Table 1**, Gladwell shifts his focus to how the city of Denver decided to deal with the very expensive 'tail' of its Pareto distribution of homeless costs. The city has 1000 'chronic' homeless. The cost 'on the street' of their current method of housing and treating the tail of the distribution – the 1000 – averages $45,000 per person per year.

The basic idea is simple: it is cheaper to give a person like 'Million Dollar Murray' his own room and nurse than treat him in the prevailing fashion. Denver now 'recruits' its chronically homeless to take up residence in rooms it provides for free. The cost of a city-paid room plus a staff of ten people to manage the programme and make sure the homeless actually spend their nights in their city-paid rooms adds up to $15,000 per person and is expected to reduce to some $6,000 in the near future,compared to $45,000/person using the traditional approach. It is therefore clear that it is cheaper to take a radically different approach to manage the extreme cost tail of the distribution as opposed to the traditional method of doing what seems reasonable for the 80% who stay in shelters for a day or two and do not run up incredible medical costs.

FOCUSING ON POSITIVE & NEGATIVE SCALABILITY DYNAMICS

Here we focus, first, on an example of positive scalability dynamics, where TIEs scale up to a positive outcome: our illycaffè case. In the subsequent Union Pacific Railroad example, we describe an example showing how negative TIEs scaled up to shut down the railroad.

Managing the Missing Tail: the Decommoditisation of the Coffee Market in Brazil

If a truncated Pareto distribution indicates a constrained market where one of the tails is missing, what are the strategic implications of this?

A typical example of a truncated market is a commodity market (CM). CMs are based on product standardisation, that is, on making uniform specifications of product quality across all buyers and sellers, and in all regions (Thomsen, 1951). By constraining diversity, standardisation generates markets centred around *average* quality with a strong truncation that effectively prevents the boundless diversity of higher-quality products from emerging and occupying the latent market space of the truncated tail, the generally ignored 'long tail' on which Anderson focuses (as we discussed earlier). Standardisation generates Gaussian markets and creates a uniform homogenous product, thereby reducing geographic and quality variety in the commodity business. Missing tails indicate hidden opportunities for strategists who search for new markets with Paretian eyes. Below, we describe a case of market development based on a decommoditisation strategy.

At the end of the 1980s, Brazilian coffee was a highly regulated commodity product (Daviron & Ponte, 2005). Prices were set at the New York Coffee Exchange (NYCE), where transactions were structured around quality standards that paid no attention to coffee aroma or geographical origin (Daviron & Ponte, 2005: 70). The commodity business model pushed Brazilian producers, cooperatives and exporters to mix different lots of coffee in order to achieve economies of scale.

Following the liberalisation of the coffee market in 1990 (Pendergrast, 1999), the Italian company illycaffè, the leader in high-quality espresso-style quality coffee, entered the Brazilian coffee market in 1991 and launched a new sourcing strategy based on (a) direct relationships with farmers, (b) price differentials to reward quality and (c) an award for the best coffee beans that worked as a pull attractor (Hagel, Seely Brown, & Davison, 2010) for producers who wanted to escape the tyranny of CMs. The award and disintermediation strategy that illycaffè implemented created a bypass to the financial bottleneck set by the NYCE prices and for the first time in Brazilian history established an incentive to switch to quality.

Relative to the multi-billion-dollar Brazilian coffee business and compared with the multinational coffee producers (e.g., Nestle, Sara Lee, Tchibo, etc.; see Daviron & Ponte, 2005) illycaffè is a small competitor, with 550 employees and €280 million in turnover in 2009. Even though the $30,000 first prize in the illy award contest is a tiny sum for a medium- or large-scale coffee producer, illycaffè triggered an historical transformation of the multi-billion-dollar coffee industry in Brazil. First, illycaffè's actions caused the bifurcation of the coffee market into quality and commodity (Andriani & Detoni, 2008). Entire regions that were unknown or known for bad quality adopted quality and were literally pulled out of obscurity and poor prices (Saes, Nakazone, & Da Silva, 2003). Illycaffè's strategy of transferring technical knowledge to farmers through the launch of the Illy University and the Suppliers' Club created a knowledge network where knowledge transfer and innovation practices spread in an epidemic way (Andriani, Biotto, & Ghezzi, 2011).

The award triggered a long series of unintended effects:

1. The need to promote quality generated the emergence of local associations, which in turn created forums that facilitated the diffusion of innovations (Rauscher & Andriani, 2009).
2. A commodity product is location-independent. Quality food or drink are, rather,

associated with specific locations (the 'geography of food' generated Geographic Indication of Origins); this sparked investment in geography-based brands (regional, local, farm-based).

3. 'Geography of food' requires traceability; this pushed a transformation of the cooperative and warehousing system to enable traceability in order to keep track of the geographic origins of beans.
4. The emergence of brands and traceability led to the emergence of geographic trademarks and quality certifications.
5. Illycaffè's direct-sourcing strategy was imitated by several multinationals and has become the norm in the quality business.
6. In order to replicate the bifurcation dynamics that lead to the emergence of quality, the award mechanism itself was imitated by local and national institutions in Brazil (Saes, Nakazone, & Da Silva, 2003).

There are two aspects of illycaffè's strategy that are of relevance to this paper. First, illycaffè intentionally ignored the average part of the Brazilian coffee market (which at the time was all that was known) and targeted a niche that they presumed to exist. Instead of following traditional and well-tested strategies, they launched a pull strategy (Hagel, Seely Brown, & Davison, 2010)—based on the Award—that addressed the extreme high-frequency tail of that market. Second, when the initial intuition was proven correct, they built on the TIEs (i.e., Award plus direct sourcing) by crafting an emergent strategy that accompanied and modulated the decommoditisation process that led to the emergence of the quality sector in Brazil. Given that in 1991 the Brazilian coffee market was in a state of adaptive tension (McKelvey, 2001, 2008) created by the collapse of the previous regulatory order, the illycaffè TIEs triggered a process of decommoditisation that turned a niche strategy into a macro-transformation, an extreme event. The case shows that organisations can indeed govern the transformation process by identifying CMs and using an emergent strategy to start a process of decommoditisation. The identification of a CM is easily done by means of a Pareto analysis: a truncation in the range of diversity of the (for instance) rank-size distribution is the hallmark of a commodity. Particularly when the CM has undergone some kind of shock, the conditions and timing may be ripe for organisations to create TIEs and manage the unfolding transformation process, that is, set off what we call 'scalability' events. It is to such events that we now turn.

Managing Scalability: Seeing Butterfly Events in Time to Do Something

In their book, *Managing the Unexpected*, Weick and Sutcliffe (2001: 3–4) say that '…people often take too long to recognise that their expectations are being violated and that a problem is growing more severe.... Managing the unexpected often occurs in the earliest stages, when the unexpected may give off only weak signals'. Their book is about how 'high-reliability firms' such as aircraft carriers and nuclear power plants have learned to pay more attention to TIEs – we often refer to TIEs as 'butterfly events' in honour of Lorenz's classic paper of 1972. The management problem is how to transform butterfly events into 'butterfly levers' (see Holland, 2002: 29) that may be used to stop

M@n@gement vol. 14 no. 2, 2011, 89-118
Unplugged

bad butterfly events from spiralling into negative extreme outcomes like Chernobyl, the Challenger disaster or Enron, or enable good butterfly events to spiral up into positive extremes like Microsoft, Walmart, Google, Intel's processor chip and the Internet (for which the initiating butterfly event was a computer-to-computer communication between UCLA and University of Illinois). We now focus on the failure to see butterfly events and levers in the Union Pacific's acquisition of the Southern Pacific railroad, beginning with a short description.

The almost complete deregulation of American railroads in 1980 reduced their number from 40 to ten. The Union Pacific's acquisition of the Southern Pacific left the American West serviced by only two giant railroads, the Union Pacific being the largest in the nation with over 30,000 miles of track (Union Pacific, 2008). Even before the merger, the risk of future operational problems was readily apparent. For example, most of the Southern Pacific track (which was the primary route between the Los Angeles shipping port and Houston), was single-track, which meant trains could not pass each other and made it the primary source of congestion, delay, and increased customer shipping costs, all of which started the gridlock on the Union Pacific after the merger. In addition, the Union Pacific cut many Southern Pacific jobs outright. When the remaining Southern Pacific employees, who knew about the history of gridlock on the Southern Pacific, told their new Union Pacific bosses about the Southern Pacific problems and solutions that worked, they were ignored. In their book, Weick and Sutcliffe make special mention of the arrogance of Union Pacific managers toward 'expendable' former Southern Pacific employees. The acquisition occurred in July 1996. Union Pacific claimed it would save $627 million. In fact, 'by March 1998 delays in shipments had cost rail customers approximately $1 billion in curtailed production, reduced sales, and higher shipping costs' (Union Pacific, 2008).

To begin, we highlight some of the butterfly events on the Union Pacific railroad that Weick and Sutcliffe describe (2001: 4–10). Seemingly random clues that were not seen as TIEs concerned, for instance, drop in the average speed of trains from 19 to 12 mph, crews falling asleep while running trains, scarcity of locomotives, increase in accidents, etc. Here we try to mention only random incidents that might have turned into actual TIEs. These seemingly random events were seen as trivial and/or normal and therefore no one had obvious reasons to worry about scalability. We show a longer list in **Table 2**; these occurrences are examples of TIEs, the butterfly events. In **Table 3** we paraphrase a number of higher-impact outcomes that were set off by the butterfly events. These are indications of scalability. The small events mentioned in **Table 2** spiralled up into scalable outcomes (**Table 3**) that eventually led to system-wide gridlock: the ultimate extreme outcome. None of these outcomes could result from a single isolated butterfly event. The latter have to scale up – spiral up – via some causal process such that they have a broader impact.

Table 2. Early clues in the form of butterfly events

1. Large cuts in personnel	2. Crews on duty longer than the law allowed
3. Fatigued crews	4. Equipment not maintained
5. Dispatchers unfamiliar with assigned territory	6. Shipments lost and could not be traced
7. Speed of trains dropped from 19 to 12 mph	8. Crews falling asleep while running trains
9. Not enough locomotives	10. Trains backing up in Englewood yard

Table 3. Evidence of scalability

1. Shippers upset by delays becoming ever worse	2. Trains stuck in sidings without locomotives
3. October 8th; 550 freights standing still	4. Stalled trains meant crews' duty time expired
5. Trains going in opposite directions could not pass each other on a single mainline because sidings were filled with backed-up trains	6. Since most stalled trains were pointed toward the Englewood yard in Huston, no trains could leave Englewood because of the blocked mainlines
9. 1800 locomotives unavailable because they were stuck in the wrong place	10. Sorting of cars into trains by destination was centralised, thereby exacerbating the delays
11. More engines sent to Englewood to unblock system; but they just added to the blockage	12. Denial of failures repeated at all levels of the hierarchy
13. 'The system was gridlocked as far away as Chicago'. (Weick & Sutcliffe, 2001, p. 6)	

Having described what we have reduced to brief descriptions in the foregoing tables, Weick and Sutcliffe then describe some of Union Pacific's managerial responses. We paraphrase these in **Table 4**.

Table 4. Evidence of management failures

1. Old-line operations staff were running the railroad; CEO started as a brakeman	2. Blamed blizzards, track work, flash floods, derailments, Hurricane Danny, poor maintenance
3. Ignored early warning signs	4 Failure to articulate important mistakes
5. Did not organise a means of detecting them	6. Allowed events to spin out of control
7. Mentality: UP is the victim not the culprit	8. 'Crisis times treated just like normal times' (p. 17)
10. 'Preoccupation with success and its denial of failures…repeated at all levels of the hierarchy' (p. 11)	11. 'UP executives neither looked for failures nor believed that they would find many if they did' (p. 11)
12. 'Slowdowns were underreported and allowed to incubate until they were undeniable and…irreversible' (p. 11)	
13. 'People keep mentioning intimidation, a militaristic culture, hollow promises to customers, abandonment of workarounds, production pressure on train crews….' (p. 14)	
14. 'The UP…favoured centralisation and formalisation and treated improvisation as insubordination' (p. 15)	

Weick and Sutcliffe's identifications of Union Pacific management's failures are very accurate and, in fact, could be broadly applied to almost any kind of organisational failures, especially those seemingly due to apparent management failures. In particular, Weick and Sutcliffe mention that:

- 'Early and ample signs that the Union Pacific did not understand….' (2001: 8), and failures to detect that allow '…unexpected events to spin out of control'. (2001: 9)
- Managers need to '…treat any lapse as a symptom that something is wrong…that could have severe consequences if separate small errors happen to coincide at one awful moment….' (2001: 10)
- 'Resilience is a combination of keeping errors small….' (2001: 14)

Management scholars worry about case writers who are 'theory-laden': they see what their theories tell them to look for (Kuhn, 1970; Franklin et al., 1989; Guba and Lincoln, 1994). But the opposite may be true as well: one cannot see what one is not looking for. For us, scalability dynamics and their causes may not be seen unless one is better trained to see them. Elsewhere (Andriani & McKelvey, 2009), we describe 15 theories about why scalability dynamics occur. But it is not just about 'seeing' butterfly events. As Holland (2002: 29) observes, it is about managers learning to think about TIEs as 'levers' by which either negative scalability dynamics can be shut down or positive scalability dynamics can be enabled and sped up. In **Table 2** we list a few 'butterfly levers' that most obviously apply to the Union Pacific circumstances, to high-reliability firms more broadly and to organisations in general. Their applicability to smouldering crises and risk management is described in more detail in Andriani and McKelvey (2010).

DISCUSSION

We started our article by stressing Abbott's claim that many disciplines in the social sciences are subtly influenced by the General Reality Model, which has reified the Gaussian view and given Gaussian methods a certification of nearly universal validity and applicability. In contrast, we observe that complex systems and their statistical hallmark, PLs, result from the establishment of a collective system of interdependencies among agents that give rise to a self-organising adaptive system. The system self-organises around some dynamical patterns that are amplified until they become a new form of collective order, a system efficaciously adapted to a competitive context. This is something that science can study, model and try to anticipate; needless to say that managers need to learn how best to exploit this process. In general, the precise prediction of single events remains outside the capability of current science, but the anticipation of major reversals in trends or the development of a cascade from TIEs via the study of the build-up of interdependencies in the system becomes possible. We claim that the Paretian view gives a more realistic representation of social dynamics. The emergent collective order of complex systems allows some limited forms of prediction. In particular, the tail and slope of PL distribution give important information about the nature of the phenomenon in question and provide important information to the decision maker.

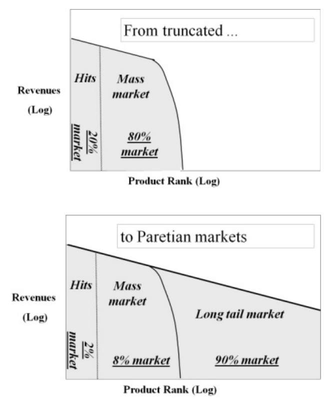
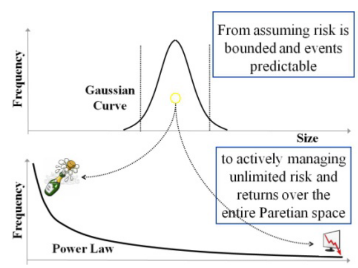
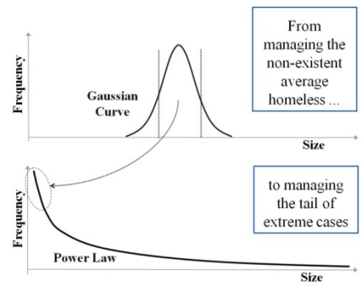
The Paretian view, or what we call 'power-law science', (Andriani & McKelvey, 2011) affects the way we look at and conceptualise the following general question: how does this change in perspective impact strategy and the practice of management? We offer a comparative view of Gaussian vs. Paretian views in **Table 5**. This is a major problem that involves a paradigm change in the Kunhian sense.

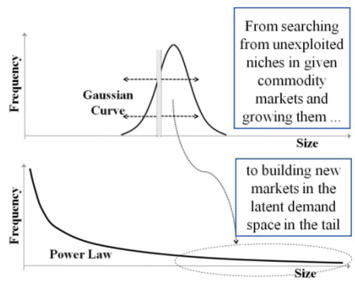
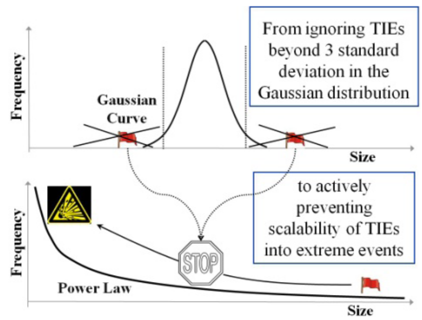
Table 5. Gaussian vs. Paretian responses to key questions

What is the probability of occurrence of extreme events and how important are they in shaping the basic features of social systems?	*Extreme events a few standard deviations away from the average are so rare that it is safe to ignore them. Also, social systems evolve by the slow accumulation of small changes (gradualism).*	*Extreme events are much more likely to occur and with bigger magnitude than linear science wants to think. Also, the basic features of social systems emerge quickly during so-called punctuation periods (times of radical change).*
What is the role of TIEs in the development of extreme events?	*Big changes must be caused by big causes,and big disasters by big shocks. Causality matters. TIEs are irrelevant!*	*Life is inherently nonlinear. Google did not exist 10 years ago. It started with better search software. From there it invented a brave new world. Spotting TIEs early can facilitate new Googles and/or prevent new Enrons.*
Is the diversity of social systems and business phenomena bounded or unbounded?	*The diversity of social business phenomena is captured by normal statistics. It is usually possible to represent the diversity by means of a mean and the variance around the mean.*	*Diversity is unbounded. Most often means are unstable and variance is practically infinite. This results in long tails. The centre of a Pareto distribution can at best capture the past. The tails of the distribution are where innovations occur.*
Can we predict business and social transformations?	*Yes! The number of outcomes of a business initiative is finite. The tails of a Gaussian distribution are fundamentally finite. Therefore, given enough knowledge and the availability of relevant frameworks, prediction is possible. Statistics and probability theory are the tools to use.*	*Given the nonlinearities and emergent properties prediction of single events is impossible. Quantitative methods, such as agent-based computational modelling, are to be complemented by qualitative/intuitive approaches.*

In this essay, the impact of the Gauss-to-Pareto transition is shown by means of five paradigmatic examples that serve to illustrate the aspects of: (1) a change in strategy and business practices resulting from the emergence of a constellation of profit-making micro-niches in industries based on intangible products and internet distribution channels; (2) the perception and management of risk in the movie business; (3) the management of an apparently intractable social problem such as the chronic homeless in a modern city; (4) opportunities hidden in Anderson's (2006) missing (other) 'long tail' of a Pareto market and the strategy for turning TIEs into extreme events; and (5) lessons from 'smouldering' crises such as the Union Pacific example (Andriani & McKelvey, 2010) and what we can learn about the early perception and scalability of TIEs in the prevention of such disruptive crises. A synthesis of the cases is presented in **Table 6**

Table 6. Synthesis of the case studies

Cases	Gaussian-inspired manager	Paretian-inspired manager	Gaussian methods	Paretian methods	Graphical representation
Long tail	Search for hits assuming economy of scarcity. Develop products that appeal to a base as large and homogenous as possible.	Complement hits strategy in the truncated market with niche aggregation strategy in the long-tail market (economy of abundance).	Minimum-common-denominator approach: one size fits all. Use mean and variance to define segments.	Develop products based on customers' diversity. Let niches emerge.	
Hollywood blockbuster tail	Assume risk is bounded and events are predictable within the statistical boundaries of the normal distribution.	Assume risk and returns are unbounded as given by the Pareto distribution.	Gaussian statistics and statistical significance tests.	PL methods, extreme events statistics and fractal methods.	
Chronic homeless tail	Define properties of average homeless people and then design strategy.	Focus on extreme cases in the low-frequency / high-impact tail.	Gaussian statistics and statistical significance tests.	PL methods, extreme event statistics and fractal methods.	

Cases	Gaussian-inspired manager	Paretian-inspired manager	Gaussian methods	Paretian methods	Graphical representation
illycaffè	Market is given. Look for unexploited, hidden niches.	CMs hide latent markets. Induce decommodi-tisation cascade that transforms homogenous markets into heterogeneous ones.	Traditional market research based on segmentation around average consumer.	Amplify small instabilities by using scalability and play keystone role to govern emergent ecosystem.	
Union Pacific's acquisition of Southern Pacific railroad	Assume gradualism and linearity. Ignore outliers and TIEs.	Assume scalability. Outliers and TIEs require active management.	Manage centre of distribution. Discard outliers.	Manage tails of distribution. Actively watch out for scalability signs. Design and implement policies to stop (or favour) amplification of TIEs.	

Our first three cases are examples of managers learning or needing to learn about the advantages of Pareto-based management. Managers who adopt the Paretian view can easily observe that the world in which they live is not dominated by well-behaved Gaussian means and variances but is instead dominated by the uncertainties characterising both of the long tails of the Pareto distribution, as well as the horizontal scalability dynamics buried in the R/F lying in between. Once one switches perspective, the unbounded nature of risk is immediately recognised. In the movie industry, the lack of correlation between primary production variables and box-office results becomes evident and management practices based on predictions of single events become questionable.

The emergence of the long tail of micro-niches is difficult to explain solely by means of traditional statistical tools. The problem with Linear Science (defined more fully as Abbot's (2001) 'general linear reality' (GLR)) and normal statistics rests on the assumption of limited variance (Mandelbrot, 1963). This translates into the assumption that the world is complicated but not complex. Complex systems result from emergent properties, which are often comprised of multiplicative interactions rather than just additive ones. In a complicated world, the properties of systems may be derived from the properties of their constituent elements. For instance, in the neoclassical view of economics, the properties of the macro level are derived by aggregating the properties at the micro level (firms, institutions, individual actors, transactions, etc.). Similarly, in the neo-Darwinian account of evolution, the properties of an organism are set by the information in its genes (Dawkins, 1976). The causal chain runs bottom-up, from firms to economies and from genes to organisms. Ignoring emergent properties allows reality to be simplified.

The GLR assumption and the consequent methodology and methods have permeated entire disciplines within management and business studies, from decision-making to marketing and from logistics and supply-chain management to strategy. If reductionism is a valid strategy, the possible states of a system are finite and consequently both the heterogeneity of the agents of a social-economic system and its pattern of variability are finite both in principle and in practice. The purpose of the analyst is to identify the 'atoms' of the system. These can be a gene (Dawkins, 1976), a meme (Dawkins, 1976), a rational optimiser (Nash, 1950), a technique (Mokyr, 2002), a way of making a living (Vermeij, 2006), a routine (Nelson & Winter, 1982), or any fundamental units that may be aggregated to reconstruct a seemingly non-dynamical system. The result is that they show linear dynamics. In fact, if the evolution of a system follows a set of scale-independent universal laws, then the task of predicting the evolution of a system may be transformed into a modelling exercise of decomposing complicated systems down into individual parts, followed by the analysis of the behaviour of the system's parts, and finally by the re-aggregation of the findings and predictions about the behaviour of the whole.

The GLR approach fails on two accounts: First, it ignores the reality that emergent properties increase the irreducible diversity and heterogeneity of agents at the specific level on which they operate. The emergence of company culture, or routines in social groups, is a result of the connections within networks (connectionist property) and cannot be 'reduced' to the properties of the agents. Second, the focus of GLR-based sciences is on discrete entities (objects) rather than on connections among entities.[11] Independent or weakly interdependent entities may be treated by means of Gaussian statistics, which reduces complexity in aggregating micro-level diversity through population parameters and thereby gives rise to the concept of the representative agent and related variability. The representative agent acts as a bridge between the diversity of the micro-level and macro-level aggregates. Assuming that diversity is finite and mostly contained within two standard deviations from the mean, attention focuses on the centre of the distribution, where most of the data are expected to fall. The rare outcomes that lurk in the tail of the distribution are treated as outliers and usually discarded. Reliance on central tendencies is particularly problematic in strategic and entrepreneurship studies. The normalisation of samples (i.e., winsorising) for statistical analyses aims to eliminate outliers, which in a gradualistic view of societal change are attributed to measurement errors or other spurious effects.

Management by averaging can be misleadingly simple and dramatically ineffective, as the chronic homeless case illustrates. Reliance on the idea of the mean-plus-limited variance as a correct representation of reality leads researchers to develop minimum-common-denominator strategies to maximise value around average agents; this is the one-size-fits-all approach. Size is determined by the average of the phenomenon.

11. Connections, and, in general, the context within which the entities operate, are seen as forces that affect the variable attributes of the entities.

For instance, in dealing with an epidemic, Gaussian managers assume constant contagion probabilities and adopt blanket vaccination policies. Dealing with the homeless, they reduce the diversity of homeless to a non-existent average homeless and provide a homogenous solution designed for a non-existent entity. Managers wanting to shift perspective have discovered that addressing the extreme cases out in the long tail may be cheaper and more effective. Ironically, the US Internal Revenue Service (tax-collection agency) has finally discovered that it can find vastly more 'missed' tax payments by the top 20% of corporations and wealthy individuals than by spending their audit costs on the average (or smaller) firms and less wealthy people (Bloomquist & Emblom, 2008). Unconstrained by the diversity-limiting paradigm, Pareto strategists realise, instead, that change happens in the tails and that the non-existence of a representative scale (or agent) creates opportunities for the emergence of innovative business models that rely on unbounded diversity.

The final two cases illustrate another typical aspect of Paretian systems, i.e. scalability. This refers to the fact that the same (or similar) dynamical processes apply on different scales and hence can trigger major runaway phenomena. In the illycaffè case we deal with the opposite issue, namely that of how TIEs can trigger the emergence of new business ecosystems, whereas in the Union Pacific case we deal with how to prevent TIEs from escalating into destructive extreme outcomes.

Toyota has long been known for wanting its assembly line workers to shut down the entire line if they see something that is not right. Rochlin (1989: 167) notes that on the aircraft carrier *Carl Vinson*, 'any critical element that is out of place will be discovered or noticed by someone before it causes problems'. Of course, not every random error or event scales up into an extreme outcome. But as Andriani and McKelvey (2009) show, scalability is much more prevalent than most people are willing to realise. In spite of this, we see no evidence that scalability has seeped into management or organisation theory textbooks. The Union Pacific Railroad example shows that the adoption of a Paretian approach, and learning how to look for negative TIEs, will help managers negate scalable TIEs before they spiral into extreme negative outcomes.

In what follows, we briefly show how scale-free theories[12] can be used to make sense of the scaling-up of TIEs into extreme outcomes over which managers could/should gain leverage.

12. For a more exhaustive treatment of scale-free theories, see Andriani and McKelvey (2009).

Combination Theory

normal distributions of different variables remain normally distributed if they are combined (even becoming more normally distributed, in fact, because of the central-limit theorem). But if several organisational processes producing somewhat skewed distributions happen to combine multiplicatively, their combined outcome distribution will become PL-distributed (Newman, 2005). The PL distribution acts as an attractor for the combination of non-normal distributions. Let us suppose that before the merger Union Pacific activities were normally distributed: things mostly worked as expected, with some random deviations because of events like the flu, storms, or random equipment failures. Thus, normally, train crews are on time; trains are on time; locomotives are at the right location on time; repair and dispatch crews are on time; locomotives and crews and other railroaders function effectively most of the time, etc. Then comes the merger. Now suppose each of the foregoing normal distributions becomes skewed. Since there are several of these, and since they interact with multiplicative effects, we see the emergence of dramatic scalability. The possible states of the entire system expand from the limited variability of a well-behaved normal distribution into the unbounded variability of a PL. Extreme events, such as a gridlock of the entire system, become highly likely and evolve rather quickly. Because of the high likelihood of cumulative multiplicative-interaction effects, spiralling out of control on a railroad having long sections of single-track mainline, one could easily predict the likelihood of extreme outcomes and then try to manage against them.

Preferential Attachment Theory

Given newly arriving agents in a system, larger nodes with an enhanced propensity to attract agents will become disproportionately even larger, resulting in the PL hallmark (Yule, 1925; Barabási, 2002). In the illycaffè case, we see the switch to quality occurring in an epidemic fashion. The success of the early farmers, who invested in quality, encouraged nearby farmers also to adopt quality. The epidemics spread along existing social networks. The more nodes switched to quality, the more they were collectively able to exploit scale and scope advantages, with the consequence that additional farmers also chose to adopt quality. When enough farmers adopted quality it became convenient to form Associations of quality producers. In the regions we studied (Andriani, Biotto, & Ghezzi, 2011) we observed preferential-attachment dynamics not only at the level of individual farmers but also at the farmers' Association level. When farmers formed the first coffee Association, they were quickly imitated. The first Association started a cascade by showing the advantages for quality producers to form Associations and caused nearby areas to form their own Associations. Confirming the preferential attachment scheme, we find a significant concentration of Associations in specific regions and a virtual absence in others. Cascades of preferential attachments were also observed for other related aspects. The illycaffè Award, the TIE that unleashed the quality-transformation dynamics, became the early node that triggered an imitative cascade of other Awards. In the hope of enabling the same transition from commodity to quality that the 'illy' Award had caused, several local and national institutions in Brazil set up new Awards. Interestingly, if one maps the regulations of the various Awards, the illy Award clearly emerges as the 'rich-get-richer' node.

Preferential attachment theory suggests that as the Union Pacific and Southern Pacific social and work-related networks merged, some individuals would emerge as more 'connectively' important in getting the new system and new ways of getting things up and running. Prior dominant nodes could reasonably be expected to be replaced by new 'social stars' who rose to connectivity prominence because they offered relevant information, skills and solutions benefiting other employees scattered around the new railroad context. Instead of this, however, the old-guard railroaders kept themselves dominant and inadvertently kept the old pre-merger railroad networks dominant also: the old Union Pacific network trying

M@n@gement vol. 14 no. 2, 2011, 89-118
Unplugged

for dominance over both railroads; the old Southern Pacific network in rebellion, passive resistance and slow-downs. Alternatively, both could have joined in with a collective reframing of a new combined network with new social stars emerging. Managers aware of this theory would expect network dynamics to change dramatically with the merger and would 'manage' to facilitate this outcome, which would be extreme in the sense that a few key social stars would come to dominate.

CONCLUSION

Extreme outcomes toward the end of Paretian long tails and the micro-niches in Anderson's (other) long tail (2006) challenge the dominance of existing theories, most of which are rooted in the concept of GLR (Abbott, 2001). By definition and convention, then, extreme outcomes are rare and difficult to describe via traditional statistics, making a significant portion (but not all) of GLR-based research misleading to managers.

Most costs and profits originate in the Pareto long tail of extreme events. These are the parts of the distribution on which we concentrate in this paper. They originate in the tail of distributions and grow around dynamical trajectories that are often unexpected and unprecedented. These outcomes start up as TIEs at the Anderson end of a Pareto distribution and then, via scalability dynamics (two of which we describe at the end of our discussion section above), may spiral up into positive or negative extreme outcomes. Extreme outcomes tend to redraw the basic features of systems and therefore give rise to new systems. If the knowledge of the ordinary is of no help, it becomes necessary to pay attention to the tails of the distribution, to the outliers, and identify early on the expansionary self-organising dynamics that trigger the emergence of a new system. Admittedly, managers whose firms are well below average may make good money by bringing their firms up to 'average' quality. It must be acknowledged, however, that most managers are under pressure to beat the average and get their firms out toward what is called the 'stochastic frontier'.[13] It is the tails that count the most!

13. A firm that lies below the stochastic frontier suffers from inappropriate, or out-of-date performance objectives and/or technical inefficiencies of some kind. Best practices are missing. Managers at BMW have their firm at the frontier; Rick Wagner, at GM when it filed for bankruptcy, obviously had no ability to get his firm up to the average before it filed for bankruptcy, let alone move it toward the stochastic frontier.

Pierpaolo Andriani is Associate Professor of Innovation and Complexity at Euromed Management, Marseille, France. He received his Ph.D. from Durham University, UK. His research interests are focused on the impact of complexity theory on innovation, organisational theory and entrepreneurship. His research has been published in *Organization Science*, *Journal of International Business Studies*, *Long Range Planning* and other journals.

Bill McKelvey (Ph.D., MIT, 1967) is Professor Emeritus at the UCLA Anderson School of Management. His book *Organizational Systematics* (1982) remains the definitive treatment of organisational taxonomy and evolution. He co-edited the *SAGE Handbook of Complexity and Management* (2011) and is currently editing five books on complexity science for Routledge's Great Works. He has published around 70 papers on the complexity science of organisations and management since 1997.

REFERENCES

- Abbott, A. (2001).
Time Matters: On Theory and Method. Chicago, IL: University of Chicago Press.

- Albert, R., Jeong, H. & Barabási, A.-L. (1999).
Diameter of the world wide web, *Nature*, *401*(6749), 130-131.

- Anderson, C. (2004).
The long tail. *Wired*, *10*, 169-177.

- Anderson, C. (2006).
The Long Tail. London: Random House Business Books.

- Anderson, P. W. (1997).
Some thoughts about distribution in economics. In Arthur W. B., Durlauf, S. N., & Lane, D. A. (Eds.), *The Economy as an Evolving Complex System II* (pp. 565-567). Reading, MA: Addison-Wesley.

- Andriani, P., Biotto, G., & Ghezzi, D. (2011).
The emergence of trust-based knowledge ecosystems: the case of illycaffè in Brazil. In F. Belussi & U. Staber (Eds), *Networks of Creativity and Innovation*. London: Routledge.

- Andriani, P., & McKelvey, B. (2007).
Beyond Gaussian averages: Redirecting organization science toward extreme events and power laws. *Journal of International Business Studies, 38*, 1212-1230.

- Andriani, P., & Detoni, A. F. (2008).
An interview with Ernesto Illy on complexity, coffee and management. *Emergence: Complexity and Organization*, *10*, 84-88.

- Andriani, P., & McKelvey, B. (2009).
From Gaussian to Paretian thinking: Causes and implications of power laws in organizations. *Organization Science*, *20*, 1053-1071.

- Andriani, P., & McKelvey, B. (2010).
Using scale-free theory from complexity science to better management risk. *Risk Management, An International Journal*, *12*(1), 54-82.

- Andriani, P., & McKelvey, B. (2011).
From skew distributions to power-law science. In Allen, P., Maguire, S., & McKelvey, B. (Eds), *Sage Handbook of Complexity and Management* (pp. 254-273). London: Sage.

- Ashby, R. W. (1956).
An Introduction to Cybernetics. London: Methuen.

- Auerbach, F. (1913).
Das Gesetz der Bevolkerungskoncentration. *Petermanns Geographische Mitteilungen*, *59*, 74-76.

- Axtell, R. L. (2001).
Zipf distribution of U.S. firm sizes. *Science*, *293,* 1818-1820.

- Axtell, R. L. (2008).
Nonexistence of a typical firm in the U.S. economy: Extremely heavy tails in firm size and growth. Presented at Organization Science Winter Conference. The Resort at Squaw Creek, CA, Feb. 8.

- Barabási, A.-L. (2002).
Linked: The New Science of Networks. Cambridge, MA: Perseus.

- Bloomquist, K., & Emblom, E. (2008).
Estimation of corporate tax underreporting using extreme values from operational audit data. Presented at the Organization Science Winter Conference, February 7-9th, Steamboat Springs, Colorado.

- Brock, W. A. (2000).
Some Santa Fe scenery, in Colander, D. (Ed), *The Complexity Vision and the Teaching of Economics* (pp. 29-49). Cheltenham, UK: Edward Elgar.

- Brynjolfsson, E., Hu, Y., & Smith, M. D. (2006).
From niches to riches: Anatomy of the long tail. *Sloan Management Review*, *47*(4), 67-71.

- Casti, J. L. (1994).
Complexification. London: Abacus.

- Chatterjee, A., Sudhakar, Y., & Chakrabarti, B. K. (2005).
Econophysics of Wealth Distributions, New Economic Windows Series. Milano: Springer-Verlag Italia.

■ Chatterjee, A., & Chakrabarti, B. K. (2006).
Econophysics of Stock and other Markets, New Economic Windows Series. Milano: Springer-Verlag Italia.

■ Chatterjee, A., & Chakrabarti, B. K. (2007).
Econophysics of Markets and Business Networks, New Economic Windows Series. Milano: Springer-Verlag Italia.

■ Cook, W., Ormerod, P., & Cooper. E. (2004).
Scaling behaviour in the number of criminal acts committed by individuals. *Journal of Statistical Mechanics: Theory & Experiment* P07003.

■ Daviron, B. & Ponte, S. (2005).
The Coffee Paradox: Global Markets, Commodity Trade and the Elusive Promise of Development. London: Zed Books.

■ Dawkins, R. (1976).
The Selfish Gene. Oxford: Oxford University Press.

■ De Vany, A. (2003).
Hollywood Economics. New York: Routledge.

■ De Vany, A., & Walls, W. D. (2002).
Does Hollywood make too many R-rated movies? *Journal of Business, 75*, 425-451.

■ Epstein, J. (2005).
Downloading for dollars: The future of Hollywood has arrived. *Slate Magazine*, November 28, 2005

■ Escoffier, N., & McKelvey, B. (2011).
Using 'crowd-wisdom' strategies to reduce market failure: Proof-of-concept from the movie industry. Working paper, UCLAAnderson School of Management, Los Angeles, CA.

■ Franklin, A., Anderson, M., Brock, D., Coleman, S., Downing, J., Gruvander, A., Lilly, J., Neal, J., Peterson, D., Price, M., Rice, R., Smith, L., Speirer, S., & Toering, D. (1989).
Can a theory-laden observation test the theory? *The British Journal for the Philosophy of Science*, *40*, 229-231.

■ Gladwell, M. (2006).
Million-dollar Murray: The power-law distribution. *The New Yorker*, (February 13 & 20), 96-98; 101-107.

■ Goldman, W. (1983).
Adventures in the Film Trade. New York: Warner.

■ Goodwin, B. (1994).
How the Leopard Changed its Spots: The Evolution of Complexity. London: Orion Books.

■ Guba, E. G., & Lincoln Y. S. (1994).
Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds), *Handbook of Qualitative Research* (pp. 105-117). Thousand Oaks, CA: Sage.

■ Hagel, J., III, Seely Brown, J., & Davison, L. (2010).
The Power of Pull: How Small Moves, Smartly Made, Can Set Big things in Motion. New York: Basic Books.

■ Holland, J. H., (2002).
Complex adaptive systems and spontaneous emergence. In A. Q. Curzio & M. Fortis (Eds), *Complexity and Industrial Clusters* (pp. 24-34). Heidelberg, Germany: Physica-Verlag.

■ Iannaccone, P. M., & Khokha, M. (1996).
Fractal Geometry in Biological Systems. Boca Raton, FL: CRC Press.

■ Kauffman, S. A. (1995).
At Home in the Universe: The Search for Laws of Self-Organization and Complexity. Oxford, UK: Oxford University Press.

■ Kuhn, T. S. (1970).
The Structure of Scientific Revolutions. Chicago: University of Chicago Press.

■ Limpert, E., Stahel, W. A., & Abbt, M. (2001).
Log-normal distributions across the sciences: Keys and clues. *BioScience*, 51, 341-352.

■ Longstaff, P. H., Velu, R., & Obar. J. (2004).
Resilience for industries in unpredictable environments: You ought to be like movies. http://www.pirp.harvard.edu/pubs_pdf/longsta/longsta-p04-1.pdf

■ Mandelbrot, B. B. (1963). New methods in statistical economics. *Journal of Political Economy*, *71*, 421-440.

■ Mantegna, R. N., & Stanley, H. E. (2000).
An Introduction to Econophysics. Cambridge, UK: Cambridge University Press.

■ McKelvey, B. (2001).
Energizing order-creating networks of distributed intelligence. *International Journal of Innovation Management, 5*, 181-212.

■ McKelvey, B. (2008).
Emergent strategy via complexity leadership: Using complexity science & adaptive tension to build distributed intelligence. In M. Uhl-Bien & R. Marion (Eds.), *Complexity and Leadership: Part I: Conceptual Foundations*. Charlotte, NC: Information Age Publishing, pp. 225-268.

■ McKelvey, B., & Andriani, P (2005).
Why Gaussian statistics are mostly wrong for strategic organization. *Strategic Organization*, *3*, 219-228.

■ McKelvey, B., & Boisot, M. (2009).
Redefining strategic foresight: 'fast' and 'far' sight via complexity science. In L. A. Costanzo & R. B. MacKay (Eds), *Handbook of Research on Strategy and Foresight*. Cheltenham, UK: Edward Elgar, pp. 15-47.

■ McKelvey, B., Lichtenstein, B. B., & Andriani, P. (2011).
When organizations and ecosystems interact: Toward a law of requisite fractality in firms. In Moreno, M. J. L. (Ed), *Chaos and Complexity in Organizations and Society.* Madrid, Spain: UNESA. pages 153-191

■ Mokyr, J. (2002).
The Gifts of Athena: Historical Origins of the Knowledge Economy. Princeton, NJ: Princeton University Press.

■ Nash, J. F. (1950).
The bargaining problem. *Econometrica*, *18*, 155-162.

■ Nelson, R. R., & Winter, S. G. (1982).
An Evolutionary Theory of Economic Change. Cambridge, MA, Harvard University Press.

■ Newman, M. E. J. (2005).
Power laws, Pareto distributions and Zipf's law. *Contemporary Physics*, *46*, 323-351.

■ Pendergrast, M. (1999).
Uncommon Grounds: The History of Coffee and How it Transformed Our World. New York: Basic Books.

■ Rauscher, I., & Andriani, P. (2009).
illycaffè and the Brazilian coffee knowledge networks. In A. Romano & G. Secundo (Eds.), *Dynamic Learning Networks: Models and Cases in Action* (pp. 57-75). New York: Springer.

■ Rochlin, G. I. (1989).
Informal organizational networking as a crisis-avoidance strategy: U.S. naval flight operations as a case study. *Industrial Crisis Quarterly*, *3*, 159-176.

■ Royer, I. (2003).
Why bad projects are so hard to kill. *Harvard Business Review*, *81*(2), 48-56.

■ Pareto, V. (1896).
Cours d'Economie Politique, Vol I, Rouge: Paris.

■ Pareto, V. (1897).
Cours d'Economie Politique, Vol II, Rouge: Paris.

■ Saes, M. S. M., Escudeiro, F. H., & Da Silva, C. L. (2006).
Estratégia de diferenciação no Mercado Brasileiro de café. *Revista Brasileira de Gestão de Négocios*, *8*(21), 24-32.

■ Schroeder, M. (1991).
Fractals, Chaos, Power Laws. New York: Freeman.

■ Sood, S. & Drèze, X. (2006).
Brand extensions of experiential goods: Movie sequel evaluations. *Journal of Consumer Research,* Inc., *33*, 352-60.

■ Stanley, M. H. R., Amaral, L. A. N., Buldyrev, S. V., Havlin, S., Leschhorn, H., Maass, P., Salinger, M. A., & Stanley. H. E. (1996).
Scaling behaviour in the growth of companies. *Nature*, *379*, 804-806.

■ Surowiecki, J. (2004).
The Wisdom of Crowds. New York: Random House.

■ Taleb, N. N. (2007).
The Black Swan. New York: Random House.

■ Thomsen F. L. (1951).
Agricultural marketing. New York: McGrow Hill.

■ Vermeij, G. J. (2006)
Nature: An Economic History. Princeton, NJ: Princeton University Press.

■ Weick, K. E., & Sutcliffe, K. M. (2001).
Managing the Unexpected: Assuring High Performance in an Age of Complexity. San Francisco, CA: Jossey-Bass.

■ West, B. J., & Deering, B. (1995).
The Lure of Modern Science: Fractal Thinking. Singapore: World Scientific.

■ West, G. B., Brown, J. H. B., & Enquist, J. (1997).
A general model for the origin of allometric scaling laws in biology. *Science*, *276*(4), 122-126.

■ Yule, G. U. (1925).
A mathematical theory of evolution based on the conclusions of Dr. J. C. Willis. *Philosophical Transactions of the Royal Society of London*, *213*, 21-87.