

THE TIPPING POINT OF THE ‘TIPPING POINT’ METAPHOR: AGENCY AND PROCESS FOR WAVES OF CHANGE

Pojanath Bhatanacharoen¹, David Greatbatch and Timothy Clark

Durham Business School, Durham University

pojanath.bhatanacharoen@dur.ac.uk; david.greatbatch@dur.ac.uk; timothy.clark@dur.ac.uk

ABSTRACT

This paper asks how certain ideas become fashionable and what conditions underpin the innovation and diffusion of knowledge. It investigates the emergence of the ‘tipping point’ metaphor, which has been widely used in academia and the media to describe, account for and/or predict a process or potential process of change or even cataclysmic occurrences in a range of contexts, including urban studies and climate change. Adopting an approach which combines citation, network and discursive analysis, we explore the usage of this term which has varied and contested meanings over time and argue that there are multiple access points to which innovation and knowledge diffuse in academic communities. We use the notion of wave-like phenomena to enhance our understanding of the emergence of this concept within and across academic disciplines.

Key words: Innovation and Knowledge Diffusion, Tipping Points, Combined Methods, Discursive Approach

I. INTRODUCTION

The term ‘tipping point’ in its most basic meaning refers to a critical point when unprecedented changes occur rapidly with irreversible effect. It entered the academic lexicon when it was used by the political scientist Morton Grodzins in 1957 in his sociological studies on racial segregation to describe the critical threshold at which point the white population would leave an area where more and more black people were present. The use of the tipping point metaphor has subsequently evolved and spread across many disciplines ranging from sociology (Wolf, 1963; Stinchcombe et al, 1969; Pryor, 1971; Schwab and Marsh, 1980), and health sciences (Davis, 2000; Anderson, Qingsi, Hua et al., 2003) to environmental sciences, in particular on the study of climate change (Lindsay and Zhang, 2005; Walker, 2006; Winton, 2006; Lenton 2008). Malcolm Gladwell, an American journalist, further popularized the term tipping point, first in his New Yorker article (June 3, 1996), and later in his book ‘The Tipping Point: How little things can make a big difference’ (2000). Despite the wide-reaching usage of the term tipping point across time and subject areas, surprisingly little can be found in the literature on how the metaphor has entered the lexicon and been used to generate knowledge about events. Is the term imbued with the different meaning for different users? If yes, how do the different tipping point discourses affect the way scientists research their subjects and the decision-making of policy-makers? If such phenomena as tipping points exist, how do they occur? What are the agency and impetus for change?

¹ Pojanath Bhatanacharoen, Durham Business School, Durham Business School, Mill Hill Lane, Durham City DH1 3L, pojanath.bhatanacharoen@durham.ac.uk

We address these issues in two ways. First, drawing on the work of Abrahamson (1996), Kieser (1997), and Bentley and Ormerod (2009), this paper explores the process of a tipping point, that is to say, the peak and decline of a certain phenomenon. We begin by reviewing citation analysis and looking at its development in the context of management fashion and how citation analysis has been used to explain diffusion. In their studies on metaknowledge, that would say a new corpus of academic studies concerned with the process in which knowledge is produced, spread and consumed, James and Evans (2011) suggest that more thorough investigations are needed to compliment the previous quantitative studies. While these studies were able to establish the networks of academic communities using citation analysis, they were unable to offer a fine grain explanation to the research dynamics in their context. Similarly to management fashion studies, citation analysis in metaknowledge smoothes out or ignore discontinuities which means that they both fail to capture the life cycle of an idea. Thus, while citation analysis forms foundation for our empirical analysis, this approach is complimented by discourse analysis.

Second, drawing on discourse analysis (Gilbert and Mulkay 1984; Potter and Wetherell 1987; Woofitt 2005), we then move on to the discursive analysis of the term tipping point to unpack the meaning of the term for different users. Drawing on the work of Giroux (2006) and Benders and van Veen (2001), this paper maps out the discursive evolution of the term tipping point on two case studies 1) the racial segregation in urban areas, and 2) climate change to unpick the questions of how we currently understand the metaphor in the context of idea diffusion and spread of fashion. To identify and explore those features of the rapid irreversible changes we refer to as tipping point, we investigate academic articles containing the term tipping point from 1957 when the term 'tip point' first appeared until present day. To assess the rise in popularity of the term tipping point, we begin with organizing the articles by year and subject areas. Then, a network analysis of these citations is conducted to see who cited whom to build up a picture of how the use of the term tipping point has cascaded in the academic literature and to what extent the term has been transmitted across different disciplines.

This paper contributes with an alternative way of looking at innovation and knowledge diffusion. The concept of tipping point is a set of contested ideas both within and outside of the academia. Below, our preliminary studies show that there is a multitude of access points for ideas and knowledge to enter into academic communities. We demonstrate how concepts may spread through instrumental usage which created different meanings of the tipping point concept depending on the users' strategic action. The preliminary findings suggest that the spread of the term tipping point in the academic communities manifest itself as two waves of diffusion. The first wave started around 1957 and the second around 2003. In relation to the tipping point discourses, the first impressions suggest that the metaphor possesses embedded interpretative viability or pragmatic ambiguity which allows the metaphor to transcend its original meaning and gain a widespread usage in a wave-like manner.

II. INNOVATION AND DIFFUSION OF KNOWLEDGE

A prominent approach to understanding how ideas diffuse is the management fashion approach developed by Abrahamson (1996). Adopting citation analysis, the number of references to a particular idea during a number of years are counted and coded in order to identify the life cycle of a fashionable management idea. He argued that there exist a community of fashion setters which consist of management consultants, management gurus,

business schools, and mass media organizations. These actors are in a competition to sense managers' emergent collective preferences for new management techniques. To succeed, they must invent rhetorics which convince the managers that their proposed techniques are rational and progressive. Thus, in this view, the management fashion setting community is the main agent for generating and selling new management techniques, reducing the role of managers to passive recipients. Abrahamson's findings suggest that the life cycles of management fashions begin with the increase in citations which then peak before they eventually decline. The different ideas do not rise and fall at the same rate and there are variations in the curves which signify the peak of an idea.

Citation analysis is a useful first step to help us identify and narrow the terms of interest and indicate when and for how long an idea is popular. Nevertheless, this approach alone cannot explain the emergence of the observed phenomenon mainly because it does not take into account the context, i.e. the discourse that surrounds a language unit and helps to determine its interpretation, in which ideas are articulated. As H el ene Giroux pointed out '...a text is never isolated from the context of its production. Rather, it is suffused by the context – from the choice of tone, vocabulary or rhetorical figures to the ideational and ideological content' (2006: 1237). Clark indicated that '[u]nless each article is read it cannot indicate whether the idea was central or peripheral to the main topic or whether it was referred to positively or negatively' (2004: 299).

Clark has questioned the assumption that citation analysis actually captures the complete life cycle of an idea. He indicated that 'whilst management fashion researchers claim that the main focus of their research is on the diffusion process and the degree to which ideas become institutionalized within organizations, and profess that one outcome of their research is the development of criteria to assist managers in detecting those ideas / techniques which are potentially transient and toxic, they rarely provide direct empirical evidence of organizational implementation (2004: 299).' Clark argued that since citation analysis is limited to the counts of references to an idea in selected sections of the print media (mainly leading academic journals, semi-academic journals and the popular management press) this approach is ill-equipped to measure the degree to which ideas are "adopted" by organisations (Clark, 2004).

As Benders and Van Veen point out, the popularity of a topic in the press, however, is not necessarily closely linked to its "adoption" in a particular management population (2001: 42).' A high count of how many times a management fashion appears in the press does not equal the rate of its adoption. Thus, Heusinkveld and Benders (2001) argued that a bell-shaped curve only demonstrates a subject's popularity in the press. Citation analysis needs to be complemented by other approaches which assess the process and the extent to which a topic's popularity in the press affects the institutional design changes within an organization.

An alternative approach which overcomes some of limitations of citation analysis is discourse analysis which allows us to generate a deeper and wider understanding of the various possible interpretations of the term 'tipping point'. By viewing language as a continuous and ever evolving social interaction and to assess the social contexts in which discourse is embedded, we categorize the different definitions of 'tipping point' across time and subject disciplines. Derrida has argued that Western metaphysics tends to create the impossibility of demarcating the essence of things and fix the identity of words and projects. He suggested that the project of trying to determine the meaning of things is doomed to fail because there will always be ambiguities that cloud absolute distinctions (Howarth, 118). However, as Potter and

Wetherell indicated, ‘the constructive and flexible ways in which language is used should themselves become a central topic of study (1987:35).’

In fact, interpretative space is important to the potential success of an idea. Of a particular relevance to our investigation on the discursive evolution of the term tipping point, a strand in management fashion scholarship have moved from merely assessing the how and why some management fashion gain popularity and begin to look at what the different management discourses mean and the definitions of popular terms at different times. Kieser (1997) in his discussion of rhetoric and myth in management fashion offered a critique of Abrahamson in terms of the sociology of fashion. Kieser pointed out that an idea becomes broad principles in which ambiguity and vagueness is embedded. This results in an interpretative openness which renders an idea adaptable to different situations and needs and thus increases its universal applicability and popular appeal. Benders and van Veen (2001) too offer similar observations. A discourse typically has a highly variable meaning. This implies that, Total Quality Management for instance, could mean many things to different people and as a result there is no homogenous view of what the term means. They argued that popular management ideas have ‘interpretative viability’ which allows the users to cherry pick the components and attributes that suit them. Management fashions are thus viewed as ‘the production and consumption of temporarily intensive management discourse, and the organizational changes induced by and associated with this discourse (2001; 40)’.

Giroux extended this idea of interpretative viability further and argued that, to increase the chances that an idea becomes popularized, a pragmatic ambiguity must be embedded in that idea. Pragmatic ambiguity is defined as ‘the condition of admitting more than course of action...’ (2006: 1229) Drawing from Eisenberg’s argument, Giroux suggested that ‘communicative effectiveness should not be equated with clarity, and that there are many situations in which ambiguity should be preserved and even sought.’ (2006: 1229). To reduce conflicts in an organization setting where the multitude of actors are bound to represent different viewpoints, providing an organization with a normative texts which can be open to interpretations to suit different interests is a solution. Thus, as Giroux indicated, ‘...the many conceptual turns and twists that are associated with these translations are merely instrumental: the goal is not conceptual development, but collective action.’ (2006: 1232) In a multilateral setting, the differing viewpoints render the aggregation of interests difficult. By committing the organization to broad principles based on shared values, but leaving the interpretation of how to implement the principles to the individuals, the organization may avoid conflicts. In other words, by keeping ideas ambiguous and therefore open to interpretations, the normative text would create a *modus vivendi* and enable or strengthen collectivity within an organization. This ambiguity determines the usability of a management idea and perhaps their popularity. We argue that the term tipping point possesses such embedded interpretative viability or pragmatic ambiguity which allows the metaphor to transcend its original meaning and gain a widespread usage.

Gilbert and Mulkay’s (1984) main concern was to question the way we studied the scientific discourses. Dissatisfied with the lack of a systematic understanding of the social production of scientists’ discourse, in particular the way that the established scholarship tended to seek single and coherent ‘definitive versions’ of the scientists’ story, Gilbert and Mulkay suggest that

Instead of assuming that there is only one truly accurate version of participants’ action and belief which can, sooner or later, be pieced together, analysts need to become more

sensitive to interpretative variability among participants and to seek to understand why so many different versions of events can be produced. (1984; 2)

This is particularly relevant to the study of tipping points because there are disputes within the scientific community as regards the use of the term tipping point in climate change discussions and studies. However, Gilbert and Mulkay suggested that their conclusions about the importance of discourse analysis should apply to any realm of sociological studies, making this approach a flexible and heuristic foundation for future analytical possibilities. It is important that the approach adopted here does not adhere to the study of discourses in a particular discipline, i.e. scientific knowledge, as the term tipping point has spread across such a diverse range of disciplines.

Gilbert and Mulkay proposed in a more systematic way four steps to conduct qualitative studies:

1. Obtain statements by interview or by observation in a natural setting.
2. Look for broad similarities between the statements.
3. If there are similarities which occur frequently, take these statements at face value, that is, as accurate accounts of what is really going on.
4. Construct a generalized version of participants accounts of what is going on, and present this as one's own analytic conclusions. (Gilbert and Mulkay, 1984:5).

This provides us with a simple interpretative framework for the study of complex macro systems but also the micro-interactions between individuals. While we have yet to obtain statements by interview or by observation in a natural setting, we analyze the texts themselves and look at each author's statement as regards to their use of the term tipping point to deduce patterns of innovation and diffusion. We will begin our investigations with a citation analysis of academic articles. To assess the rise in popularity of the term tipping point, we begin with organizing the articles by year and subject areas. Then, a network analysis of these citations is conducted to see who cited who to build up a picture of how the use of the term tipping point has cascaded in the academia and how the term has been transmitted across the disciplines. We then move on to the discursive analysis of the term tipping point to unpack the meaning of the term for different academic users and address some of the deficiencies of these other methods.

III. ESTABLISHING THE NETWORK: CITATION ANALYSIS

Bentley and Ormerod² (2009) adopted another approach developed from evolutionary analysis which moves further away from the previous citation analysis to look at the mechanisms underpinning decision-making. Evolutionary analysis draws on models of evolution used in biological studies to map out the probability of reproductive selection amongst the population in evolutionary games. Lieberman, Hauert and Novak (2005) introduced the evolutionary graph theory which studies the continual change through the concepts of variation, interaction, selection and drift. These models are useful for distinguishing the different types of network in selection or decision-making process. The proposition is that certain network structures 'amplify' selection, that is, to enable the selection of small differences in fitness. Furthermore, the star-like 'Influentials' network (see Figure 3a, Lieberman, Hauert and Novak, 2005) favours selection, and so does the hierarchical 'funnel network' (such as funnelling ideas into a scientific paper, though all the citations). By contrast, other networks favour drift, as when 'small upstream populations

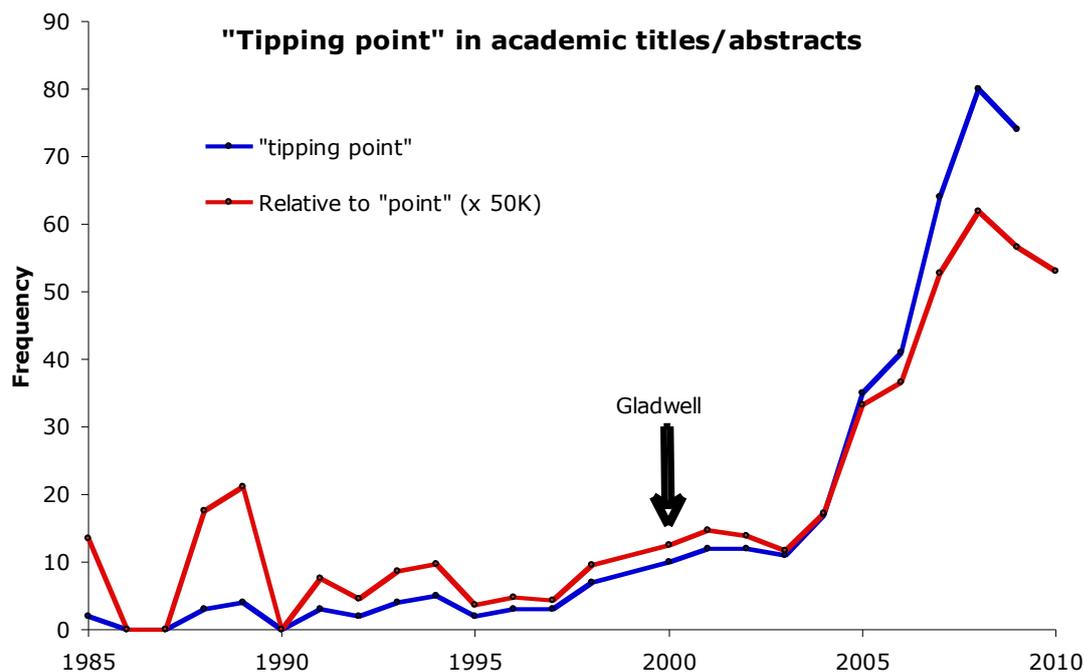
² Bentley, Ormerod and the authors of this paper are collaborating on an interdisciplinary project on tipping points at the Durham University.

feed into large downstream populations' (Figure 2h) which is similar to the classic marketing mole of 'Inventor' who is the early adopter of a new idea before it spreads and become popularized.

For Bentley and Ormerod, the culture evolution is seen as the transfer of a multitude of ideas through a population. They elaborated on the concept that there are social versus independent interests in the process of information transmission. The social transmission is defined as the way people adopt an idea simply because others have adopted it regardless of what it is. Independent decision, on the other hand, is when an idea is adopted because of a conscious decision made independently by the individual. This spectrum of decision-making modes provides conceptualization to evaluate the forms of cultural transmissions in the social world. Using case studies on public interest in 'bird flu' in 2005 and 'swine flu' in 2009, Bentley and Ormerod found that in both cases, social transmission was more important than independent decision and that fear is 'contagious'. Nevertheless, they suggested that a minority of independent behaviour can lead an entire group in a cohesive direction. This distinction between independent and social decision-making allows us to hypothesize the conditions under which predictable directions through informed independent decisions are made, as opposed to the drifting upon the tides of fashion which characterizes social decision-making. It is also useful because this allows us to explore the linkages and connections – or the lack of them – between the individual and the social world and between the agency and the structure.

Using citation analysis in academic journal titles and abstracts, Bentley suggests that the term 'tipping point' is hardly a huge trend, as it has only appeared approximately 400 times and other terms such as Social Capital will yield a much higher number of citation.³ Nonetheless, Figure 1 shows the classic pattern of a diffusion curve. Two measures from the ISI Web of Science were used. One is merely the raw number of appearances of 'tipping point' in academic journal article titles, abstracts or keywords (blue line). However, this statistic can be highly misleading since the amount of journal article verbiage has increased dramatically in the last 15 years through the creation of many hundreds of new journals and the increase of keywords and abstract text in each article. For this reason, the relative frequency of 'tipping point' is shown as a proportion of a mundane term – in this case 'point' – which could be expected to crudely represent the increase in overall verbiage (by roughly a factor of 3 from 1990 to 2010). The proportion of 'tipping point' relative to the commonplace word 'point' is small. Hence, for comparison, the proportions have been scaled up by a factor of 50,000 (red line).

³ Unpublished work.

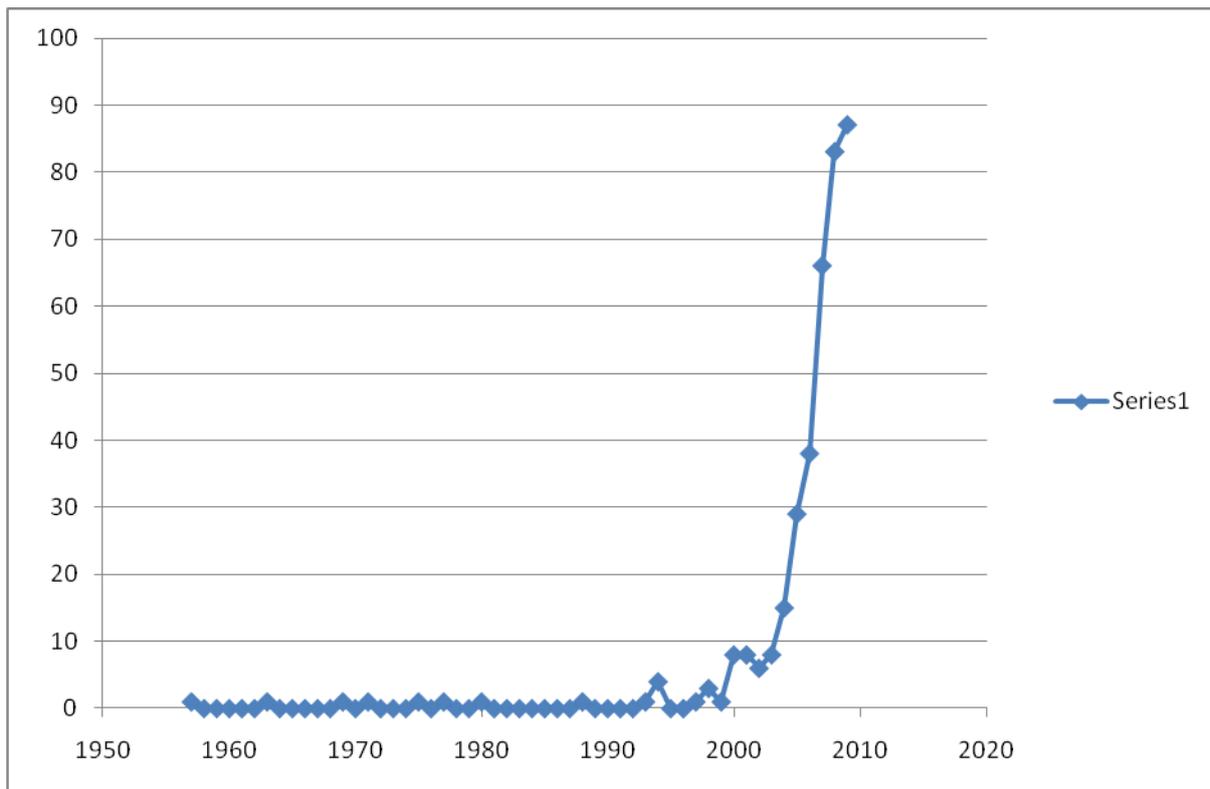


The figure shows that Malcolm Gladwell's (2000) *Tipping Point* bestseller had an effect, although the term did not begin to accelerate in academic journal literature until 2003. This three year time lag is reasonable considering the academic publishing process which - can often take two years from first draft to actual publication. Interestingly, a Google Trends analysis shows the term 'tipping point' with fairly consistent search volume since 2004 (with the exception of a brief burst of interest the a hip-hop album 'The Tipping Point' released by the Roots on 13 July 2004). According to this citation analysis, although it is too early to say, it appears 'tipping point' may have reached its peak academic popularity in 2008 (which, if you consider the time lag, might be a year of writing of about 2005 or 2006). Thus, it might be possible to fit a diffusion model to predict the decline of a tipping point.

Bentley suggests that if evolutionary analysis is applied to these citations studies, we can specify our hypotheses even further. The hypothesis is that the hierarchical systems favoured selection of ideas, whereas the newer de-centralized networks favour random drift. The more centralized form of dissemination is exemplified by rigid management hierarchies, Top 40 radio and a small number of key academic journals. The more de-centralized dissemination categories are online blogs, music sharing, and a vast amount of academic journals.

In tracking the development of the tipping point concept within and across disciplines, we searched the ISI Web of Knowledge index between 1957 and 2009 for academic articles which contain the words 'tipping point' in titles and/or abstract. This search returned 368 articles. Figure 2 below shows the total number of tipping point articles. Approximately only 5 % of the articles using the term tipping point were before 2000 and the use of the term has increased exponentially in the last decade.

Figure 2. The Total Number of Tipping Point Articles 1957 - 2009



In terms of network analysis, only 29 articles cited others within these 368 articles. The most frequently cited item was however not an academic article – it was Malcolm Gladwell’s book ‘The Tipping Point: How little things can make a big difference’ (2000) with 69 citing articles. Most of the articles therefore use the tipping point concept without attributing it to other articles, that is to say, they use the concept without indicating from where it originated.

The period 1957 – 1999 (before Gladwell’s book was published in 2000) is characterized by a very small network. This academic community studied racial segregation in urban areas. The most cited article was Wolf (1963) ‘The Tipping-Point in Racially Changing Neighborhoods’ *Journal of the American Institute of Planners* who cited Grodzins. Stinchcombe, McMill and Walker (1969) in turn cited Wolf (1963). Therefore, it was clear how the term cascaded. The period 2000 onwards, however, showed no clear connectedness between users. Nevertheless, the most cited are Lenton (2008) article *Tipping elements in the Earth’s climate system*; Walker (2006) *The tipping point of the iceberg*, and Winton (2006) *Does the Arctic sea ice have a tipping point?* Overall, these articles cite other authors within their own disciplines, and there does not seem to be a cascading effect across disciplines.

Figure 3. By Discipline 1957 – 2009.

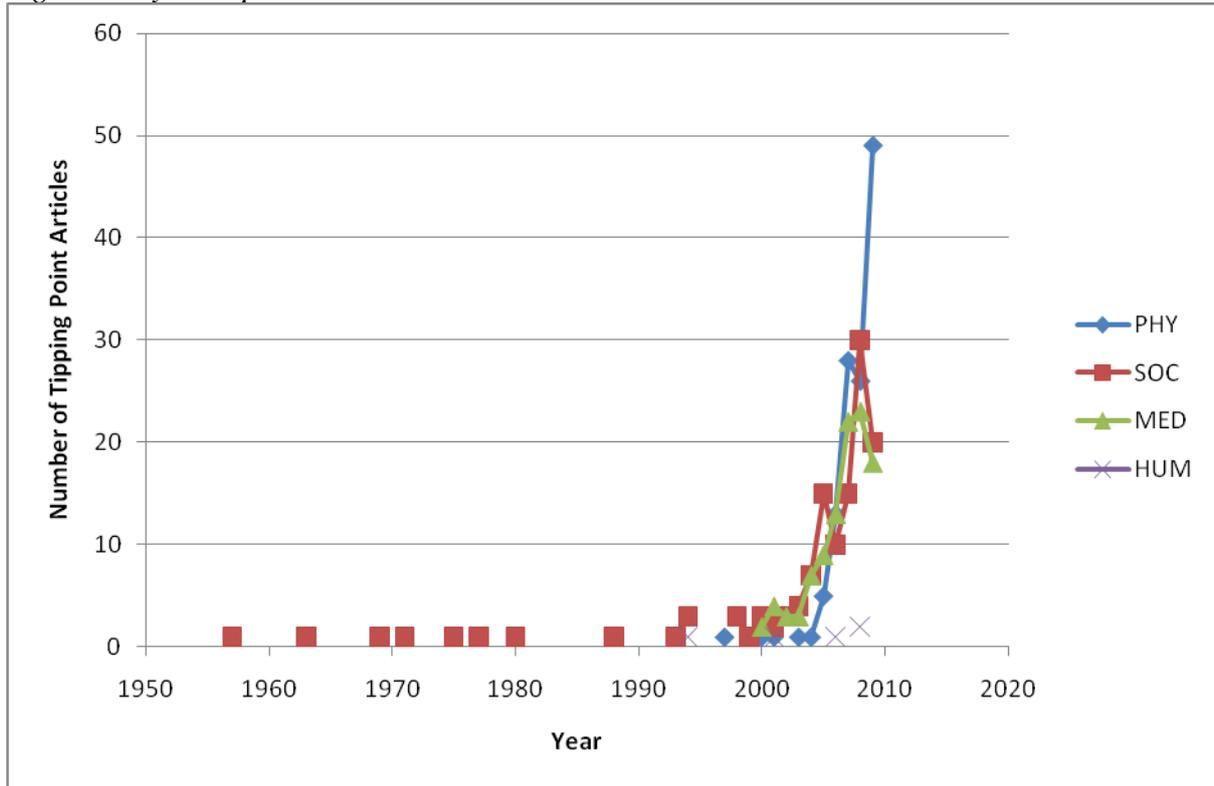
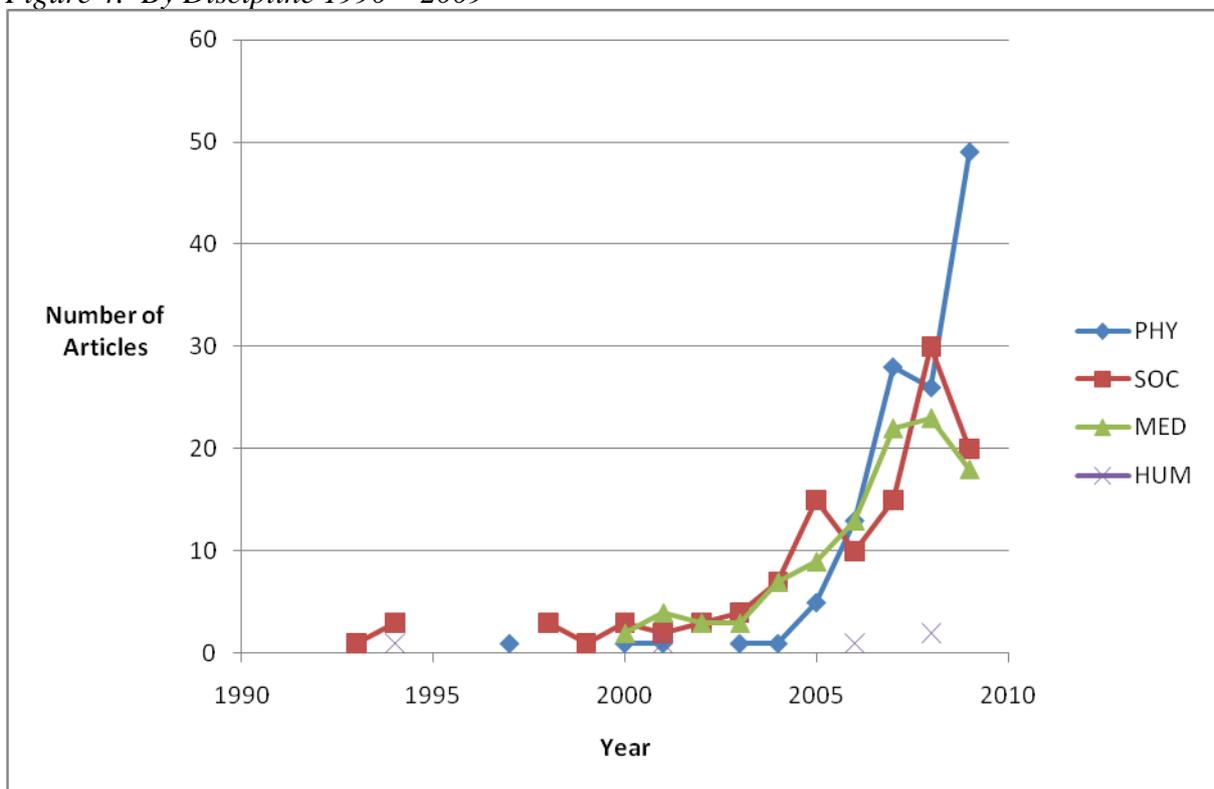


Figure 4. By Discipline 1990 – 2009



We then categorized the articles into four broad disciplines: 1) Physical Sciences; 2) Social Sciences; 3) Medical Sciences, and 4) Humanities and Arts. Figure 3 and 4 show that Social Sciences adopted the tipping point term first. Although barely used in the Humanities, they followed suit. Then Medical Sciences started to use the term followed by Physical Sciences. The trend really took off around 2003. Overall, they adopted the tipping point term around the same time. In evolutionary analytical terms, this implies that the period from 1957-2000 with a strict hierarchy system favoured selection of ideas. By contrast, the post-Gladwell usage of tipping point concept illustrates the more centralized form of dissemination, i.e. through books, internet and media, and therefore typifies the random drift.

Although this type of network analysis allows us to examine relations between individuals and social world, and shows how structures in population leads to different diffusion, this approach typically adopts quantitative scales that are presumed to be simply given. As a result, it is unclear why certain types of linkages are considered as being stronger than others, or why some characteristics are typified in the way they are. Moreover, citation analysis shows the broader movements of a trend, but it does not reveal the nuances on the different interpretations of the use of the term 'tipping point'. This approach overlooks the importance of context in explaining the emergence of popular ideas. In order to truly assess the diffusion of new ideas and concepts, we need an approach which reflects the complexity of the social processes which underpin the formulation of ideas prior to their dissemination. Provided the citation studies are not over-interpreted, this paper proposes that qualitative assessments of context, namely discourse analysis, complement the preceding citation analysis.

IV. DISCURSIVE ANALYSIS

We use two case studies for the discursive analysis of the tipping point concept, namely the studies of racial segregation in urban studies and the climate change debates. Since the tipping point concept first appeared in the academic literature in this area, and there was a quantitatively clear connection between the users of tipping point metaphor in the studies of racial segregation in urban studies, we began our discursive analysis with this subject area. The term 'tipping point' was first coined by the political scientist Morton Grodzins in 1957 in his sociological studies on racial segregation to describe the critical threshold when the white population would leave an area where more and more black people were present. In the article published in *Scientific American*, the term that he actually used was 'tip point'. Grodzins (1957: 34) wrote:

This process of "tipping" proceeds more rapidly in some neighborhoods than in others. White residents who will tolerate a few Negroes as neighbors, either willingly or unwillingly, begin to move out when the proportion of Negroes in the neighborhood or apartment building passes a certain critical point. This "tip point" varies from city to city and from neighborhood to neighborhood. But for the vast majority of white Americans a tip point exists. Once it is exceeded, they will no longer stay among Negro neighbors.

In other words, the 'tip point' is understood as a point where the increase in small and incremental changes have exceeded a certain threshold and 'tipped' the system out of balance leading to radical changes. In the academic literature the concept of tipping was introduced by Grodzins but the literature suggests that the phenomenon to which it refers was brought into the academic literature by Banfield and Meyerson (1955) *Politics, Planning and Public Interest*. Glencoe, III: The Free Press. Banfield was a political scientist and Meyerson was an academic and urban planner, so the 'tipping'/'tip point' concept was being used in the

academic literature two years before the publication of Grodzin's "Metropolitan Segregation" article in 1957. However, Grodzin was clearly collaborating with Edward Banfield, as he co-authored a book with him in 1958 (Grodzins, M and Banfield, E (1958) *Government and Housing in Metropolitan Areas*).

It appears that the term and phenomenon initially derived from outside academia from the parlance of real estate agents/urban planners in relation to racial segregation. The concept of "tipping" appears to have been used in the first instance by urban planners/ housing professionals. Meyerson and Banfield quote the Chairman of the Chicago Housing Association:

I knew what had happened in those projects that were supposed to be 50-50; the whites had never moved in and so they had become all-Negro projects. I saw that Cabrini was successful with 30 per cent Negroes. I figured that more than 30 per cent wouldn't work but between 10 and 30 would work all right. More than 30 would tip it over.

(reproduced in Wolf, E.P (1963) "The Tipping Point in racially Changing Neighbourhoods", *Journal of American Planning Association* V.29 (3):217-222)

Grodzins states: 'Real estate operators, seeking higher revenues that come from Negro overcrowding, talk freely among themselves about "tipping a building" or "tipping a neighbourhood."' With regards to the provenance of the tipping point concept, Pryor (1971: 417), 'An Empirical Note on the Tipping Point' states:

In real estate parlance the "tipping point" is the critical proportion of Negroes in a neighbourhood that may trigger off a rapid White exodus. The conventional wisdom generally places this point at roughly 20 to 30 per cent. In recent years the concept has also appeared not only in the popular press but in scholarly analyses of urban housing problems as well. Although the idea of the tipping point has a certain intuitive appeal, it has been subjected to relatively little critical analysis. The purpose of this article is to clarify certain issues surrounding the tipping point concept, to show how it can be measured from data at discrete time intervals, and to propose an alternative approach.

This period was characterized by a high consistency in the use of the term, that is to say, the users within this academic community meant the same thing when they applied the term tip point or tipping point. Wolf (1963: 218) confirmed that her contemporaries meant the same thing when they used the tip point/tipping point concepts. Also, here, Wolf used the 'tip point' and 'tipping point' concepts interchangeably to refer to the same phenomenon. The term 'tip point' thus evolved into 'tipping point' very early on.

The use of tipping point metaphor after Gladwell's book has been published is characterized by inconsistent and sometimes unreferenced use of the term. However, in the context of climate change, the term usually refers to 'the moment at which internal dynamics start to propel a change previously driven by external forces.' (Walker 2006; 802). Russill (2008) has suggested that climate change debates are characterized by an alarmist approach which typically is filled with urgency and the threat of irreversibility. This alarmist approach, Russill argues, is consistent with how the epidemiological imaginary has been used in the past to increase public awareness and motivate activism in public health care. However, while it is true that Gladwell's definition of tipping point is likened to the process of how

virus spread (Gladwell, 2000), climate change scientists do not tend to use epidemiological imaginary when discussing tipping points. As discussed below, there were variations in the use of the tipping point concept which suggests that the term has embedded interpretative viability or pragmatic ambiguity, or what we would like to term ‘plasticity’ which allows the tipping point metaphor to be moulded into different meanings to suit different purposes.

According to our ISI Web of Knowledge search, the first academic article on climate change which uses the term tipping point in its title and abstract is that written by Lindsay and Zhang (2005). While they did not outline an explicit definition of tipping point, they indirectly described the tipping point as a point where the accumulation of small changes leads to a big topical change in a system. They wrote in the abstract (2005; 4879): ‘The late 1980s and early 1990s could be considered a tipping point during which the ice-ocean system began to enter a new era of thinning ice and increasing summer open water because of positive feedbacks. It remains to be seen if this era will persist or if a sustained cooling period can reverse the process.’ First of all, the Lindsay and Zhang article’s use of tipping point concept was not filled with epidemiological imaginary. Secondly, they carefully pointed out that it remained to be seen whether the process can be reversed, and did not paint an apocalyptic picture. Compared to the definition of tipping point given by Walker above which referred to ‘irreversible effect’, Lindsay and Zhang’s treatment is more neutral. Winton (2006) too did not use epidemiological imaginary. He wrote: ‘If a glass is slowly tipped with a finger, it eventually reaches a point where its upright equilibrium becomes unstable and it proceeds rapidly to a new stable equilibrium on its side (2006; 1).’ This interpretation refers to the law of physics rather than an epidemiological imaginary.

Lenton et al (2008; 1786) indicated that ‘Many of the systems we consider do not yet have convincingly established tipping points. Nevertheless, increasing political demand to define and justify binding temperature targets, as well as wider societal interest in non-linear climate changes, makes it timely to review potential tipping elements in the climate system under anthropogenic forcing.’ In other words, scientists have not been able to conclusively demonstrate whether many aspects of climate change are in fact reaching a tipping point. Yet, there is an urge to influence policy-making, and, therefore, scientists should define parameters under which climate change problems can be framed through a policy lens.

This is consistent with Russill’s (2008) suggestions that scientists such as James Hansen or politicians like Tony Blair have used the tipping point metaphor on its more apocalyptic end of its meaning spectrum to attract public attention, raise debates and motivate public action. Hansen, a NASA climate scientist first applied the tipping point metaphor at an address to the American Geophysical Union. He said: ‘I present multiple lines of evidence indicating that the Earth’s climate is nearing, but not passed, a tipping point, beyond which it will be impossible to avoid climate change with far ranging undesirable consequences.’ Although Hansen’s discourse did not use the epidemiological imaginary such as proposed by Russill, Hansen did indeed use the tipping point metaphor not merely as a means to describe the climate problem to a public audience, but as an agent of change to raise public and grassroots awareness and action. This is further demonstrated in his following statement:

There is little merit in casting blame of inaction, unless it helps point toward a solution. It seems to me that special interests have been a roadblock wielding undue influence over policy-makers. The special interests seek to maintain short-term profits with little regard to either the long-term impact on the planet that will be inherited by our children and grandchildren or the long-term economic well-being of our country.

The public, if well-informed, has the ability to override the influence of special interests, and the public has shown that they feel a stewardship toward the earth and all of its inhabitants. Scientists can play a useful role if they help communicate the climate change story to the public in a credible understandable fashion.

This is a rhetorical and direct plea to the public audience to act against special interests for the greater good. This usage is a public discourse rather than a scientific discourse to describe policy. The noteworthy point here is that Hansen is a scientist. Nevertheless, his usage of the tipping point discourse did not first appear in academic writing, but in wider public sphere to specifically form public opinion and therefore shape policy.

In fact, the first usage of tipping point concept in climate change discussions seems to have originated from non-academic media. As Walker (2006; 802) commented: ‘In 2004, 45 newspaper articles mentioned a ‘tipping point’ in the connection with climate change; in the first five months of this year [2006], 234 such articles were published. “Warning hits tipping point”, one UK newspaper recently warned on its front page; “Climate nears point of no return,” asserted another. The idea is spreading like a contagion.’ Interestingly, Walker made a point as regards to how the concept of tipping point spread like a virus. However, scientists do not use epidemiological imaginary to problematize climate change.

There are common threads with both of our two case studies. At both waves of diffusion, the tip point and tipping point metaphors originated from outside of the academia. They were both used to frame and reframe an issue, describe a problem and facilitate our understanding of the world. Moreover, although their historical contexts were different, both issues were hot topics in their time: racial segregation was a hot topic in 1950’s America, and, as our environmental awareness increased, climate change has become a big item on the policy agenda of our generation. Nevertheless, there are two main differences. First, the use in urban planning tended to be more descriptive. In climate change, by contrast, there is a much higher degree of sense of urgency and catastrophic threats. The second difference is the scale of the subject which is being communicated through applying the tipping point metaphor. The studies of racial segregation in urban areas, although it was a widespread problem in 1950s America, could be classified as a local problem with consequences restricted to the neighbourhood. While it is irreversible, the problem was still smaller and affected fewer people and not unprecedented. The tipping point analogy was thus used as lessons to inform urban planning for other neighbourhood projects. Climate change, by contrast, is a global issue, and therefore is imbued with a much wider and more far-reaching consequences.

V. CONCLUSION

We have reviewed the literature then reported on empirical work on how the tipping point concept diffused within academic communities and become popular. The citation analysis allowed us to identify the sudden rise in the use of the tipping point concept. We then searched academic papers at that point in time and, in so doing, examine discursively how the term is being used and defined in different contexts and by different stakeholders. Looking at the historical contexts allows us to question why it is relevant at this point in time.

This preliminary study has shed some lights on the natural history of the tipping point metaphor. ‘Tip point’ originated in the parlance of practitioners in estate building and entered the academic lexicon through Grodzins. The use in the studies of racial segregation on urban areas was consistent with very little variation in meanings. With Gladwell, the term

re-entered the academia. This is an interesting diffusion pattern because the term re-entered the academic through popular culture via non-academic sources such as newspaper. The use and meaning changed and became much more varied. This was possible because the term has plasticity which can be bent to suit the user's motivation and strategy. In other words, once the tipping point was in popular culture domain, its use became more and more instrumental the meaning changes with different purposes of different users. During both waves of diffusion, the tipping point concept found its way into the academia independently of other corpus of academic communities and the different disciplines' use of tipping point metaphor developed independently from each other. There were interactions between academic and non-academic sources, feeding each other back and forth. This gave us an indication that there were multiple access points into academic literature.

However, these findings also give us more hints and raise further questions for future investigations. For instance, we now know that the 'tip point' concept evolved into 'tipping point' very early on. This leads to the question of why and how this has happened. Additionally, we have no indication yet of how the 'tip point' concept entered the parlances of practitioners in estate building. This is something that we will be examining in the future. Furthermore, it was clear that Gladwell had a crucial role to play in popularizing tipping point term. It would therefore be useful to map out a more detail account of how the re-entry of tipping point concept in the academic domain relates to Gladwell if they relate at all. Finally, we also established that the climate change debates started in non-academic domain. This means that there is a scope to analyze newspapers, audiovisual materials and internet sources such as blogs to further develop our understanding of the public communication's role in the innovation and knowledge diffusion.

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