Paper to be presented at the 24th IMP Conference

Network Connectivity and Business Netquakes – Ways to Understand the Spread of Change

by

Peter Dahlin
Jönköping International Business School
Sweden
peter.dahlin@jibs.hj.se

Virpi Havila
Uppsala University
Department of Business Studies
Sweden
virpi.havila@fek.uu.se

Abstract

Business network dynamics are generally discussed from the perspective of a focal business relationship and of relationships (e.g. with customers and/or suppliers) connected to it. Such studies examine how direct relationships influence each other, while indirect business relationships (e.g. with customers' customers) are generally ignored. Thus, we still know little of how change spreads in business networks.

We propose a framework inspired by seismology, using the term 'netquake' to describe spread of change in business networks. In a business network, the effects of a netquake can basically take two forms: 1) change in the interaction between actors in the existing structure of connected ongoing business relationships, and 2) change in the overall network structure of connected relationships, by ending existing business relationships or initiating new ones. We propose that the intensity of a netquake can be identified using these basic forms of change in the network. The more changes in the network structure of connected relationships in relation to the amount of adaptation in the ongoing connected relationships, the higher the intensity of the netquake.

Earlier business network studies have shown that business relationships affect each other, which has been described as connectedness. In this paper we discuss connectedness at network level, i.e. network connectivity, as an important factor for understanding variations in netquake intensity. High level of connectivity means that changes spread easily in the network, whereas a low level of connectivity moderates the spreading, and thus the business netquake intensity.

The analysis is based on structural linkages of bankruptcies among Swedish IT-companies. The bankruptcies are both seen as the epicentre of business netquakes, and as effects of other netquakes. The spread of change can consequently be addressed through the occurrence of bankruptcies, and other types of effects are thus disregarded in this study. A higher level of network connectivity can be assumed in situations where many bankruptcies can be linked through connected business relationships, indicating high netquake intensity, whereas isolated bankruptcies, indicating low netquake intensity, are expected in structures with lower connectivity. The analysis indicates a large variability of the observable structural linkages of bankruptcies, and supports network connectivity as an important concept to understand spread of change in business networks.

1 INTRODUCTION[1]

[1] We would like to thank Peter Thilenius for the contribution to the ideas behind this paper.

This paper takes its starting point in the business network approach, which is based on the notion that companies have exchange relationships with other companies; relationships that, in turn, are the building blocks of business networks (for a review of the business network literature, see, e.g., Easton, 1992; Ford, 2002). Through these business relationships the companies are connected to other parts of the business network, for example, customers' customers and suppliers' suppliers. This connectedness means that change happening in one part of the network may spread in the business network.

Here we discuss connectedness at a business network level, i.e. business network connectivity, as an important factor for understanding variations in how changes spread in business networks. Our purpose in this paper is to elaborate further on the meaning of network connectivity and its impact on the spread of change. The underlying assumption is that changes spread more easily in the business network in situations of high level of connectivity, whereas low level of connectivity moderates the spreading. When discussing spread of change in business networks we use the concept 'business netquake intensity', which is a framework inspired by seismology. In a business network, the effects of a 'business netquake' can basically take two forms: 1) change in the characteristics of the interaction between actors in the existing structure of connected ongoing business relationships, and 2) change in the overall network structure of connected relationships, by ending existing business relationships or initiating new ones. In this paper we concentrate on structure affecting changes when discussing business network connectivity.

The analysis will be based on structural linkages of bankruptcies among Swedish IT-companies. A higher level of network connectivity can be assumed in situations where many bankruptcies can be linked through connected business relationships, indicating high business netquake intensity, whereas isolated bankruptcies, indicating low business netquake intensity, are expected in structures with lower network connectivity. The analysis indicates a variability of the characteristics of business network structures, based on the observable structural linkages of bankruptcies, and supports network connectivity as an important concept to understand spread of change in business networks.

The structure of the paper is as follows. First, we discuss the concept of netquakes, the inspiration from earthquakes, and especially how business netquakes can be used in describing types of effects on business networks from events taking placing the business network. Then we briefly discuss business relationships and connectedness of business relationships. Thereafter, we focus on how to study connectivity in business networks, and illustrate the discussion with examples of structural linkage of bankruptcies among Swedish IT-companies during 1994-2003. We end our paper with a discussion of the importance of network connectivity as an factor for understanding variations in how change spreads in business networks.

2 BUSINESS NETQUAKES

In an earthquake the ground starts to shake. You hear a rumbling from the ground, things around you start to sway back and forth, and some of them may fall to the ground or collapse. After a while it is over, leaving behind more or less severe effects. The more or less devastating effects extends out from the quake, the so called epicentre of the earthquake. The ending of a long-term business relationship, for instance due to a bankruptcy, can be compared to an earthquake, as it can 'shake up' the involved parties, and perhaps also involve a lot of 'rumbling'. Such change could also affect the business network of which the terminated business relationship was part. Although earthquakes

occur frequently, some are severe while others go unnoticed. If we compare this to business relationships that end, the situation is similar: the ending of one business relationship can 'shake the ground', causing collapses far away, whereas another business relationship can end with no effect on the surrounding network.

Before discussing 'business network earthquakes', we need to understand what an earthquake is. The aim here is to use 'earthquake' as a metaphor and a starting-point for discussing the spread of change in a business network.

2.1 Measuring earthquakes[2]

The earth consists of layers. The topmost layer is the lithosphere, which comprises the crust and solid portion of the upper mantle. The crust ranges from approximately 5 to 70 km in thickness worldwide, and the mantle (both upper and lower) is approximately 2900 kilometres thick. The crust of the lithosphere is divided into many tectonic plates that are constantly moving in relation to each other. (http://scign.jpl.nasa.gov/learn/plate1.htm, 2004-07-28). Earthquakes occur when these plates, for example, dive under, press against, or pull away from each other.

An earthquake is 'the vibration, sometimes violent, of the Earth's surface that follows a release of energy in the Earth's crust' (http://pubs.usgs.gov/gip/earthq1/how.html, 2004-07-27). One way to describe earthquake is as follows:

> "When the Earth's plates move against each other, stress is put on the lithosphere. When this stress is great enough, the lithosphere breaks or shifts. Imagine holding a pencil horizontally. If you were to apply a force to both ends of the pencil by pushing down on them, you would see the pencil bend. After enough force was applied, the pencil would break in the middle, releasing the stress you have put on it. The Earth's crust acts in the same way. As the plates move they put forces on themselves and each other. When the force is large enough, the crust is forced to break. When the break occurs, the stress is released as energy which moves through the Earth in the form of waves, which we feel and call an earthquake." (http://scign.jpl.nasa.gov/learn/eq1.htm, 2004-07-27)

There are three different types of waves: P waves, S waves, and surface waves. The P waves are the fastest of the three types, whereas the S waves are more dangerous as they are larger and produce both vertical and horizontal motion in the earth's surface. The surface waves are the slowest and move close to or on the earth's surface (http://scign.jpl.nasa.gov/learn/eq6.htm, 2004-07-27). The epicentre is the point on the earth's surface vertically above the point of origin of an earthquake (http://scign.jpl.nasa.gov/learn/glossary.htm, 2004-07-28).

The size of an earthquake can be measured in several ways. One way is to describe the effect of an earthquake on the earth's surface in terms of *intensity*. One example of an intensity scale is the Modified Mercalli Intensity Scale, which is based on observed effects. The lower numbers on the intensity scale indicate how the earthquake is *felt* by people, while the higher numbers indicate the *observed* damage. (http://earthquake.usgs.gov/learning/topics/mercalli.php, 2006-08-26) For example, the intensity indicated by numbers I and II implies that only a few people may have noticed the earthquake. Levels III and IV, in turn, indicate that more people, especially those indoors, may have felt the earthquake, while levels V or higher indicate observable damage, ranging from, for example, broken windows (V) to total destruction (XII).

[2] We would like to thank Björn Lund, Geophysics Department, Uppsala University for his constructive comments on an earlier draft of this paper.

The various levels of the Modified Mercalli Intensity Scale can be described as follows (http://earthquake.usgs.gov/learning/topics/mercalli.php, 2006-08-26):

Level I. Not felt except by a very few under especially favourable conditions.
Level II. Felt only by a few persons at rest, especially on upper floors of buildings.
Level III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
Level IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
Level V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
Level VI. Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
Level VII. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
Level VIII. Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
Level IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundation.
Level X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
Level XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
Level XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Another type of measurement is the *magnitude* of the earthquake. Magnitude is determined using mathematical formulae and information from seismograms. One way to express magnitude is using the Richter scale. The scale is logarithmic; for example, number 7 on the scale indicates that the ground motion is 10 times larger than that indicated by number 6 (http://pubs.usgs.gov/gip/earthq1/measure.html, 2004-07-27).

Earthquakes of great magnitude do not necessarily cause the most intense surface effects. The surface effects also depend on local surface and subsurface geological conditions. For example, if two areas are equally distant from an earthquake's epicentre, severe effects are more likely where the ground is unstable and consists of sand or clay, than if the ground consists of granite. Besides its magnitude and the geological conditions, an earthquake's destructiveness also depends on the distance from the epicentre and the design and construction of the buildings in the affected area (http://pubs.usgs.gov/gip/earthq1/measure.html, 2004-07-27).

2.2 Describing Business Netquakes[3]

The plates can be regarded as companies, and the relationships between the plates as business relationships between companies. When two plates move against each other they exert forces on themselves and on each other, and when these forces are great enough, the crust breaks. This is also the case with two business parties: when enough 'stress' is involved in a relationship, it needs to be released. In some situations, this 'stress' leads to the termination of the business relationship. This, in turn, could cause a 'netquake' in the surrounding business network. In an earthquake seismic waves

[3] En earlier version of this discussion can be found in Dahlin, Havila & Thilenius, 2004.

spread, while in a netquake the 'waves' convey negative information, leading to the spread of increased uncertainty through the network of connected relationships.

The strength of an earthquake can range from a slight tremble, only detectable by a seismologist's instruments, to a devastating catastrophe causing mayhem and complete destruction. A netquake can similarly range from just another ending relationship between two parties, unnoticed by the rest of the network, to the complete dismantling of the network surrounding the terminated relationship.

The effects of an earthquake can be described using the Modified Mercalli Intensity Scale, a scale mirroring the effects of the earthquake on the earth's surface. The effects of a netquake, its intensity, are similarly observable in the effects of the ending business relationship on the relationships connected with it. These effects appear in the connected relationships, as the waves of uncertainty spread from the ended business relationship that forms the epicentre of the netquake. The greater the effects on the business network, the greater the intensity of the netquake.

In an earthquake, the effects on the surface of the seismic waves are not always the same. This variation has to do with the varying geological configuration of the earth's outermost layer and also the design and construction of buildings. With some types of ground the effects become more serious, and with others, less so. Similarly, in the case of a netquake, various types of 'ground' and 'building construction' lead to more or less serious effects. The particular effects the netquake causes depend on the type and strength of the connected business relationships, but also on the structural ability to spread the change. In some business relationships, the waves of uncertainty lead to increased commitment as the parties try to adapt to the new situation; in others, 'de-commitment' is made, indicating the beginning of the end of the relationships.

The fundamental idea of a business network is the connectedness of the relationships comprising it. In reality, it is generally difficult to study the spread of change in business networks, as several events may cause change concurrently, or nearly concurrently, throughout the network. However, when a relationship is terminated it is often possible to trace the effects or non-effects of the termination on other connected relationships.

Inspired by the effects of earthquakes, we propose a 'business netquake intensity' framework to describe the effects of ending an individual business relationship on the overall business network (see Table I) (Dahlin, Havila & Thilenius, 2004). The effect on the network varies in extent and type. From a non-spreading *tremble*, the effects increase to *swaying* as some surrounding relationships are affected and must adapt to the new conditions. As the severity increases, more and more relationships are forced to change; some might even end as a result of the *shaking* in the network. The most extreme condition is when the ending of a relationship causes the *breaking* of the network, in the sense that the network is completely restructured. The complete framework helps us better understand how change can spread in business networks, and represents a step further towards understanding how change in one business relationship influences other business relationships connected to it.

Table I. Business netquake intensity

Type of Effects	**Effect on the Business Network**	**Observable effects**
0 – Trembling	The ending of a business relationship in the network is observed by others in the network but does not lead to any change.	- Increased information flows
1 – Swaying	The ending of a business relationship in the network leads to some changes, mostly in the	- No connected relationships break. - Some connected relationships

	form of adaptations in ongoing business relationships.	are affected. - All connected relationships can adapt to the new situation within the existing network structure.
2 – Shaking	The ending of a business relationship in the network leads to changes in the network through both adaptation in ongoing business relationships and changes in the network structure.	- Most connected relationships are affected. - Some of the connected relationships break. - Some of the connected relationships adapt to the new situation within the existing network structure.
3 – Breaking	The ending of a business relationship in the network leads to severe changes, to a large extent through changes in the network structure.	- All connected relationships are affected. - Many of the connected relationships break. - Few of the connected relationships adapt to the new situation within the existing network structure.

To sum up, in order for changes to be able to spread, the connectedness of business relationships is a prerequisite – if two business relationships are not connected to each other, change will not spread from one to the other. Therefore, understanding of connectedness in the business network is a key issue for understanding spread of change in business networks.

3 CONNECTEDNESS OF BUSINESS RELATIONSHIPS

Although many business relationships, and consequently also business networks, are long-term oriented and thus rather stable over time, they constantly change both through mutual adaptation and more radical events. Earlier research has shown that such business relationships change continuously in content, strength, and nature through ongoing interaction between the involved parties (e.g. Anderson et al., 1994; Håkansson and Snehota, 1995). For example, two business actors (Actor A and Actor B) may agree to make changes to their ordering procedures, and measures taken in such a direction can be regarded as adaptation within the business relationship. This, in turn, may have consequences for the business relationship between Actor B and Actor C, which means that the two business relationships (between Actor A and Actor B, and between Actor B and Actor C) are connected to each other as the change in the first one spreads to the second.

However, if a situation arises that cannot be handled by the flexibility and adaptability of the business relationship, there is a risk that the relationship might end. Radical change and the ending of business relationships have attracted increased attention from researchers over the past decade (Harrison, 2004; Tähtinen and Halinen, 2002), and are regarded as important factors in understanding business relationships and networks. The main focus of research into business relationship ending has been on the dissolution process itself (e.g. Alajoutsijärvi et al., 2000; Giller and Matear, 2001; Halinen and Tähtinen, 2002; Tähtinen, 2002) and on the factors influencing the ending of a business relationship (e.g. Gassenheimer et al., 1998; Haugland, 1999), while less attention has been devoted to the network effects of business relationship ending, i.e. how the

surrounding business network is affected by the ending of a business relationship. Based on the definition of business networks as connected business relationships, it is likely that the ending of a business relationship affects the connected relationships or even the overall business network structure.

Although the theme of dissolving business relationships has received increased attention over the past ten years, we still lack research into the effects on the surrounding business networks. Business networks are usually regarded as changing incrementally, meaning that the overall pattern of business relationships seems to remain more or less stable over time, even though changes take place within individual business relationships. It has, however, been shown that business networks evolve in response to specific events (Madhavan et al., 1998); for example, changes caused by a merger or acquisition can spread and affect the surrounding business network (Havila and Salmi, 2000). Halinen et al. (1999) regard such critical events as 'the impulse that allows tensions to be released and the network to reconfigure' (p. 786), meaning that some business relationships may end or new business relationships may be established. Whether this happens depends on how the business relationships handle the event, i.e. the specific character of the relationship, as well as the context in which it is embedded (Gidhagen, 2002).

It is possible that some changes can occur in isolation within a business relationship without affecting or being affected by other relationships in the surrounding business network. Such change can be characterised as 'confined change' (Halinen et al., 1999). However, business relationships are not isolated islands, so what happens in one relationship often influences what happens in other connected ones (Håkansson and Snehota, 1989). Thus, there can be a kind of 'connected change' (Halinen et al., 1999) that causes a type of 'domino effect' among inter-linked business relationships (Hertz, 1998).

A connected change means that changes in one particular relationship may both directly and indirectly influence connected relationships. Thus, due to various network interdependencies, indirect relationships relatively distant from that particular business relationship can be affected. The effects on connected relationships of a connected change may, however, vary. Less serious change may be handled through adaptation of the relationship, while more severe changes might ultimately lead to the dissolution of existing relationships or the establishment of new ones. So the ending of a business relationship can, in some situations, lead to incremental network change, and in others, to radical network change (Halinen et al., 1999; Havila and Salmi, 2000). This means that while change in one business relationship, in some situations, might be handled by adaptation in the connected business relationships, it could lead to the dissolution of existing relationships or the establishment of new ones in others, thus leading to changes in the overall network structure (Halinen et al., 1999). Consequently, a low level of business network connectivity may hinder the spread of change, whereas a high level of business network connectivity enables changes to spread more easily.

4 STUDYING CONNECTIVITY IN BUSINESS NETWORKS

Studying spread of change in business networks is a challenging issue. One challenge is the difficulty in knowing from the beginning, which business relationships are connected and should therefore be included in the study. This is usually solved by asking managers about their perceptions of effects from one business relationship on another. For instance, if one business relationship ends, the focus can be on the effects from that ending on other relationships. Or less dramatic, if the level of trust increases in one business relationship does it also increase in other business relationships connected to the first one? Thus, not only the existence, but also the character of connections can be addressed (cf. Dahlin & Thilenius, forthcoming). In this way it is possible to trace a business network of connected business relationships by asking managers either at one of the companies or one (or

several) of the companies that are influenced. The researcher usually ends up with a rather confined case study, since managers often have little knowledge about effects on indirectly connected business relationships, i.e. two or more steps away from their own company. This means that the researcher needs to use a "snow ball method" to be able to follow the spread of change in the business relationships.

Another challenge when studying spread of change in business relationships is to decide when in time to collect information. The spread of change does not necessarily take place immediately after an event, but can be delayed.

4.1 Method

This paper is based on a study (see further Dahlin, 2007) where change of business networks is studied using mergers, acquisitions, and bankruptcies among Swedish IT-companies as the event ("quake") that may start a "business netquake". Data on Swedish IT companies that were involved in mergers, acquisitions or went bankrupt was collected and coded from news items in three Swedish newspapers, Computer Sweden, Svenska Dagbladet and Upsala Nya Tidning, during 1994-2003. Different kinds of relations between companies were also recorded; buyer-seller relationships, ownership relations, and partnership relations. Although the focus of the data collection was on IT-companies, many different kinds of companies were included in the data as an IT-company can merge with or be related to companies in other lines of businesses. Thus, the setting is made up of IT-related companies in Sweden during the turbulent era, which is often referred to as the "IT boom", "IT crash" or "IT bubble", which was a time with many start-ups, but also with many mergers, acquisitions and bankruptcies.

A total number of 125 546 published articles in 1994-2003 were reduced to 3 625 through computerized searches, which identified those articles containing information about a merger, acquisition or bankruptcy. The searches were followed by manual read through and assessment of the content of each of the 3 625 news items before structuring the relevant data by using a custom designed coding scheme and computer software. From the news items data about the events (i.e. mergers, acquisitions, and bankruptcies), companies and relations were recorded. Although the study originates from Swedish IT-companies, it extends over national borders through business relationships and co-involvements in mergers, acquisitions and bankruptcies, and also includes companies in various other lines of business, as long as they are related to any of the IT-companies.

The result of this data structuration technique is a rather large amount of interrelated coded meta-data describing 1 402 mergers, acquisitions, or bankruptcies, 3 211 companies, and 3 383 relations, which provides an opportunity to study connectivity among the companies included in the study. The longitudinal aspect is also covered by the data; through the dating of the sources. The obtained data set is limited to the information given by media in the included news items. This means that we only know about those companies and relations that are mentioned in the news items. However, we assume that the journalists that wrote the articles chose to write about the most important mergers, acquisitions, and bankruptcies that took place. We also assume that when other companies and relations than those that were directly involved in the mergers, acquisitions or bankruptcies are mentioned in the articles, the journalists chose to write about the important ones. Especially, in case of bankruptcies it can be assumed that when other companies are mentioned they are probably important to consider. In this paper, bankruptcies are the only type of event that may start a "business netquake" that is considered. This delimitation is chosen as bankruptcies are a kind of situation in which other relations connected to the bankrupt company always are influenced, and it is thus a rather radical event.

In the data set we can find totally 120 companies that have gone bankrupt sometime between 1994-2003. Figure 1 shows the entire data set (including the 120 companies and 3091 other companies

linked to each other through the 3383 registered relations). The bankrupt companies are highlighted as larger and darker nodes whereas the smaller and brighter nodes are the companies that are not known to be involved in a bankruptcy during the studied period. These nodes are shown as different shapes, which indicate whether they are IT-companies or not. Important to note is that the picture is an aggregate of the 10 years, and does thus not take the temporal aspect into consideration. However, we know from earlier research (see, e.g., Håkansson & Snehota, 1995) that business relationships tend to be long lasting and we therefore can assume that if a relationship between two companies existed in 2002 it probably also existed already 2001.

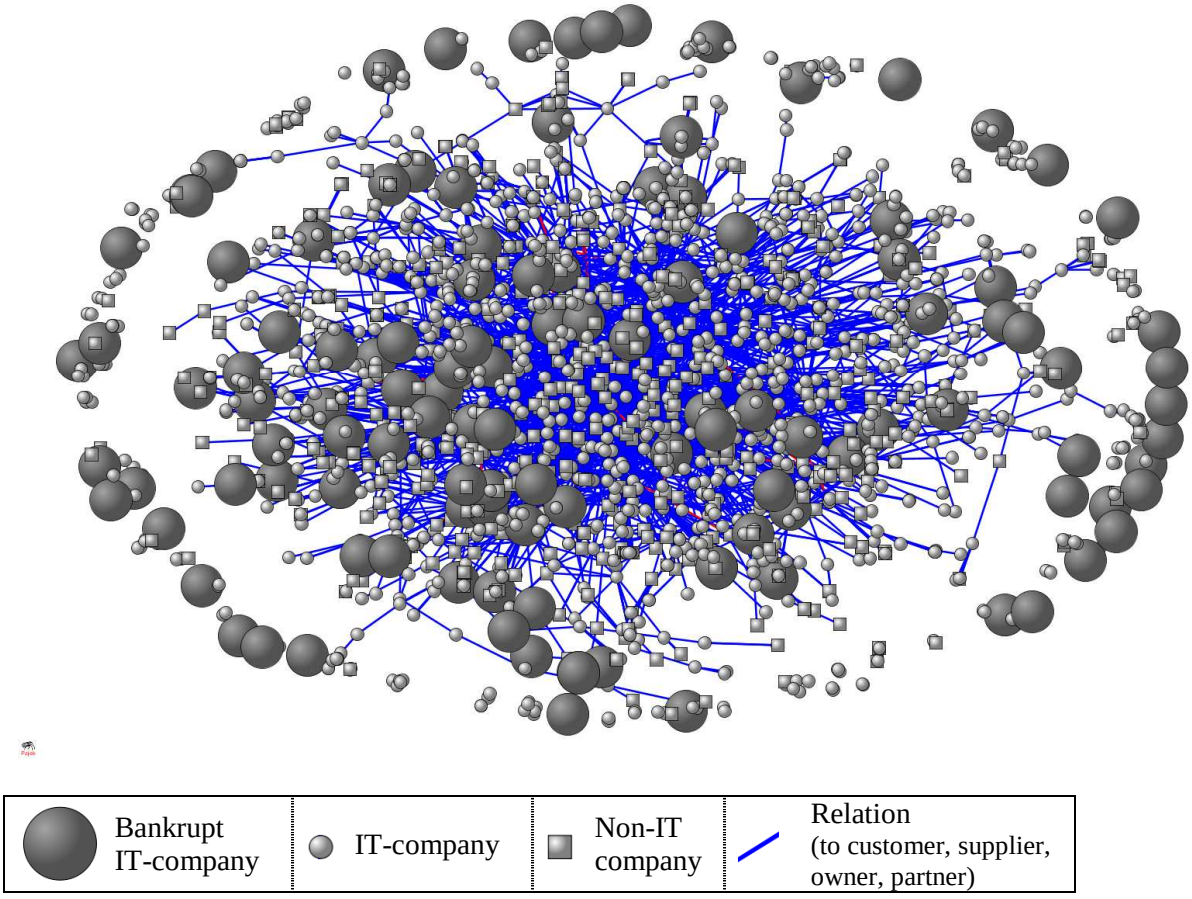

Figure 1 Connectedness among the bankrupt IT-companies during 1994-2003

5 DIFFERENT TYPES OF NETWORK CONNECTIVITY

If a bankruptcy occurs in a generally weakly connected setting, i.e. in a business network characterised by a low level of connectivity, the effects of the change are not likely to spread far. The interesting question is what can be seen as a weakly connected setting and what a is strongly connected setting?

The most extreme example of a weakly connected setting is when a company has few relations that, in turn, are weakly connected only to few other relations. In this study there were 21 of the 120 companies that went bankrupt for which no information of relations to other companies could be found in the news articles. This does not of course mean that they were totally isolated, but it indicates that the bankruptcy of these 21 companies was not expected to have wider direct consequences on other companies, at least what was known to the journalists. Thus, this could be

seen to indicate low connectivity in a business network due to low importance of the company to other connected companies.

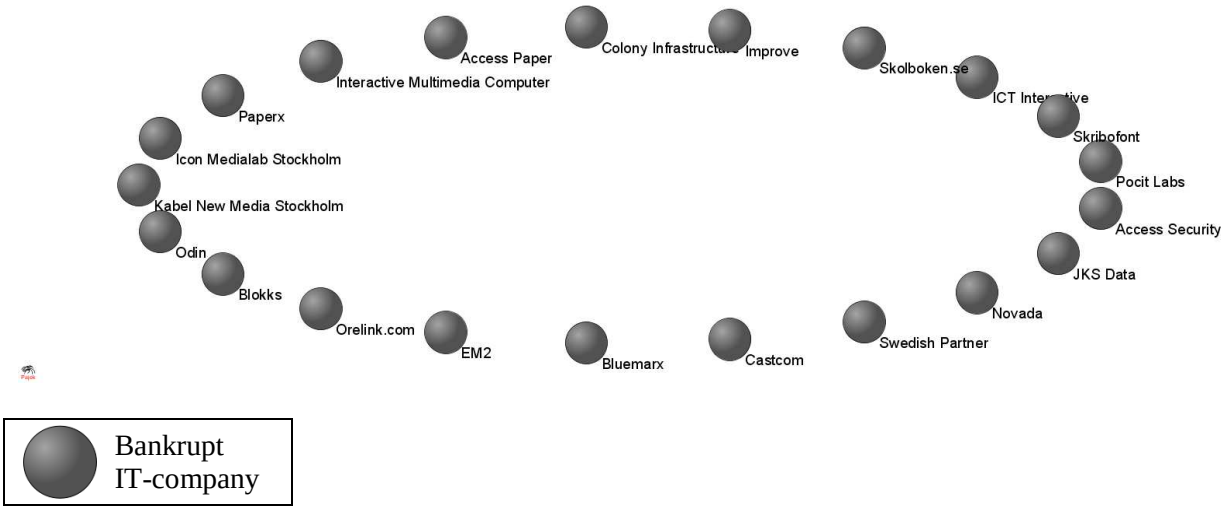

Figure 2 Isolated bankrupt companies during 1994-2003

Another example of connectivity is shown in Figure 3. What is depicted is the setting around the Swedish subsidiary, Razorfish Sweden, of the large American IT-service company Razorfish. Razorfish Sweden went bankrupt in the beginning of 2001 and Figure 3 shows the the companies that are connected to Razorfish Sweden 2 steps out (left) and 3 steps out (right) from it. What cannot be seen in the figure is the timing as the figure is a combined representation of the 10 years of data.

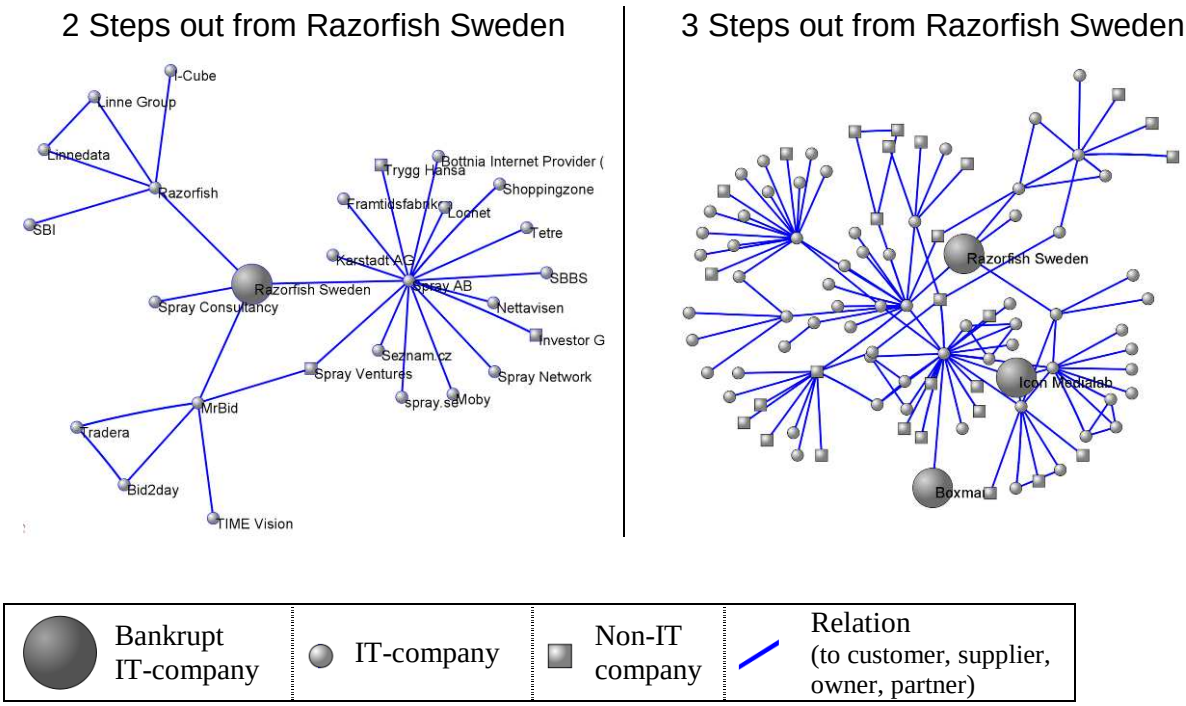

Figure 3 Razorfish Sweden and related companies during 1994-2003

As can be seen in the left part of the figure, the bankruptcy of Razorfish Sweden is not linked to any other bankruptcy (large dark nodes) when going two steps out from the company, i.e. including

actors such as the customer's customer. However, as is shown to the right, when an additional step is added, and thus including actors such as the customer's customer's customer, the bankruptcy of Razorfish Sweden can be linked to two other bankruptcies. Boxman (IT-company) went bankrupt in 2000 and Icon Medialab (IT-company) faced insolvency in 2002. This illustrates a higher level of connectivity than what could be seen in Figure 2, as connections among the companies (both to other companies and other bankruptcies) could be found during the studied time period. As the data is based on news items, it means that the journalists have considered it to be relevant to include other companies in the articles. In this way it is possible through the analysis trace the linkages between the companies.

A third example of a setting is that of Textile Solutions, which went bankrupt in 2001 (see Figure 4). Textile Solutions was a Swedish Internet-trade company with about 15 employees. Starting in the immediate context of Textile Solutions, and only extending one step away from it, five companies are known (from the news articles) to be related to the company. Some of these are owners of Textile Solutions, and some are suppliers. One of the suppliers, the IT-company Mind, did also experience financial difficulties and was set in bankruptcy in 2002.

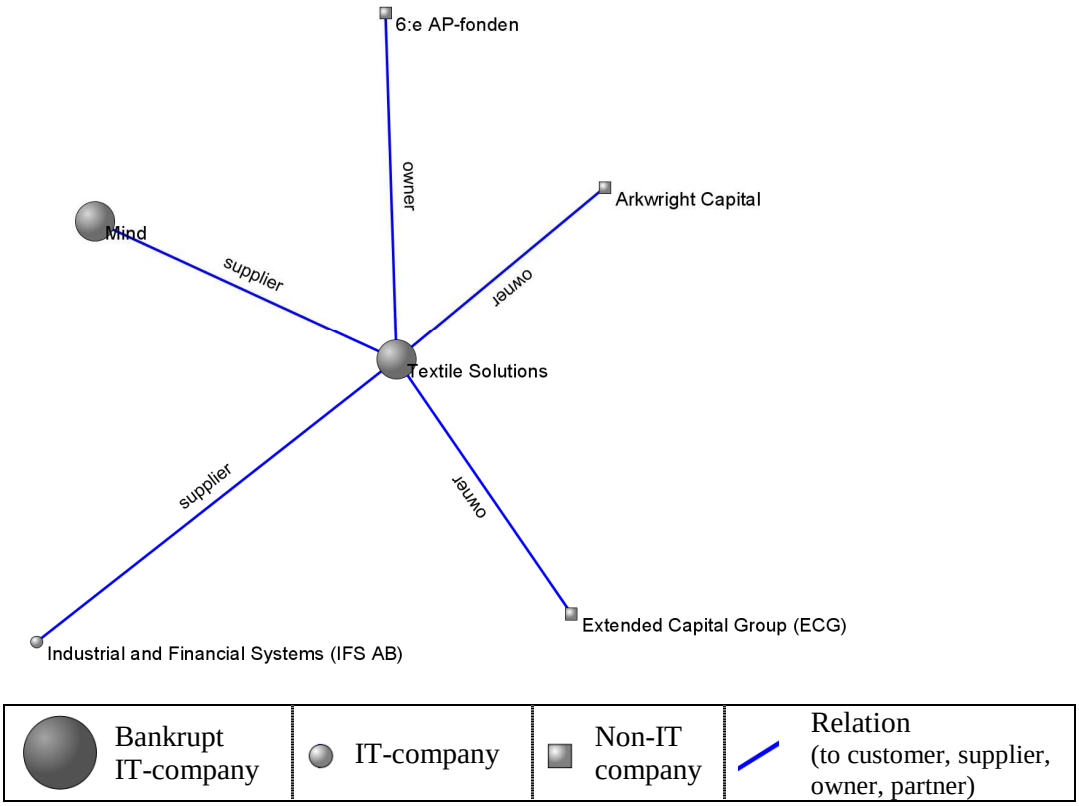

Figure 4 The bankrupt company Textile Solutions and directly connected companies during 1994-2003

The bankrupt IT-company Textile Solutions can thus be linked directly to another bankruptcy. It is not argued that the bankruptcy of Textile Solutions was a direct cause to the bankruptcy of Mind, which was a substantially larger company focused on IT-consultancy. It can, however, be possible that both these bankruptcies were influenced by a general uncertainty and instability. If the inclusion is widened, and a distance of two relations out from Textile Solutions is allowed, two more bankrupt companies can be linked to Textile Solutions, shown in the left part of figure 5. Continuing the widened distance to three steps out, a total of 18 bankrupt actors can be linked to the bankrupt

Textile Solutions. This illustrates a situation where connectivity can be considered high in comparison to the earlier examples.

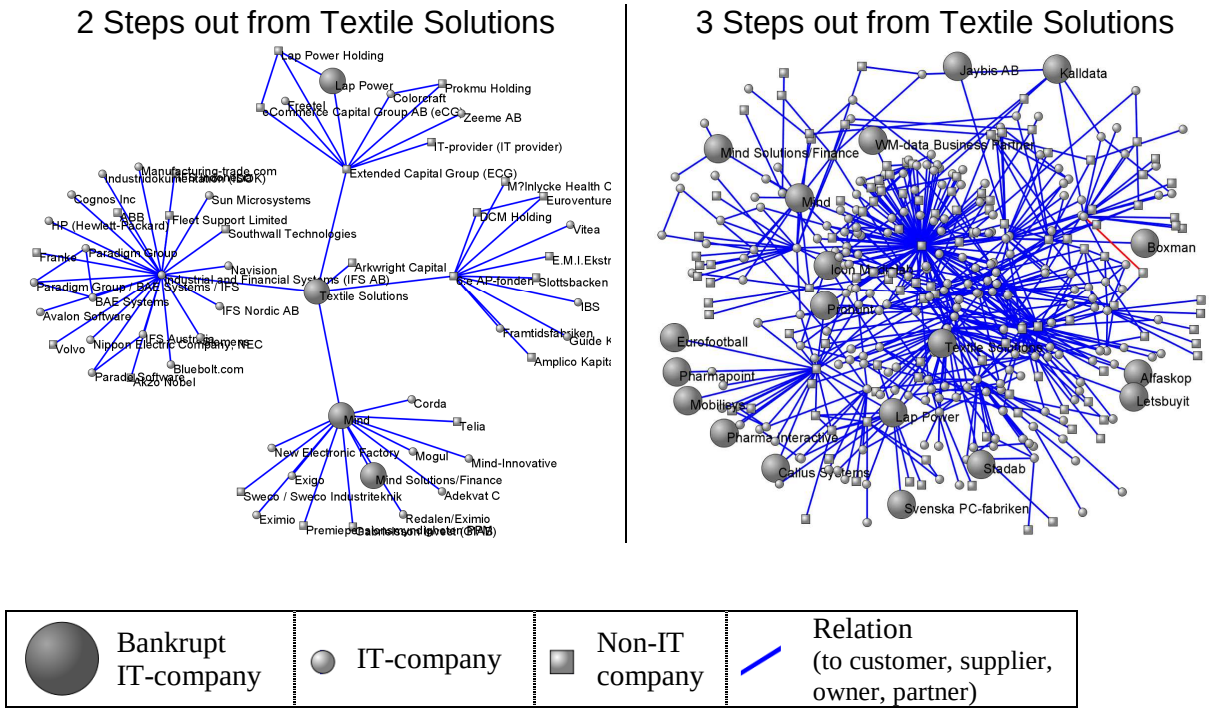

Figure 5 The bankrupt company Textile Solutions and directly and indirectly connected companies during 1994-2003

To sum up, if a bankruptcy cannot be linked to another event, in this paper another bankruptcy, through a short "walk" (de Nooy, Mrvar & Batagelj, 2005) of two or three relations away from the bankrupt actor, the business network setting in which the bankruptcy occurred is considered to be characterized by a relatively low level of connectivity indicating that changes probably will not spread very far. If, on the other hand, a bankruptcy is directly or indirectly linked to many other bankruptcies, a high level of connectivity can be argued, indicating that changes can spread more easily in the business network.

6 CONCLUDING REMARKS

Business network dynamics is generally discussed from the perspective of a focal business relationship and of relationships (e.g. with customers and/or suppliers) directly connected to it. Such studies examine how direct relationships influence each other, while indirect business relationships (e.g. with customers' customers) are generally ignored. This means that we still know very little of how change spreads further in business networks, and how the structure of business networks changes. One reason for this is that it is difficult to study wider structures of connected business relationships. Each company has its own 'network picture' (Ford et al., 2003), which means that the business network looks different depending on from where it is studied, and each specific actor is not likely to know about actors beyond its close context (Thilenius, 1997).

In this paper we use bankruptcies among Swedish IT-companies during 1994-2003 as a starting point for the analysis. A bankruptcy is an event that always influences other, at least the directly,

connected companies, as a company disappears as an actor from the business network when it goes bankrupt. Thus, accordingly, the business network structure is changed, and that change may spread through the connected business relationships. The identification of the spread of change is based on the structurally close occurrence of bankruptcies, i.e. several bankruptcies can be linked to each other through a few business relationships, and the used data collection method has a built in tendency to include the stronger connected business relationships. In this paper, we are not discussing how and when it changes, but rather the fact that in some situations the change is more likely to spread than in others. The underlying assumptions are that

(1) if the bankruptcy occurs in a part of a business network, which is characterised by a low level of connectivity, the spread of change is dampened, and
(2) if the bankruptcy occurs in a part of business network, which is characterised by a high level of connectivity, change spreads more easily.

As the examples in this paper illustrate, a low level of network connectivity is suggested when the network structure shows that few companies and no other bankruptcies are directly or in-directly connected to the bankrupt company, extending a couple of steps out from the bankrupt company. Similarly, a high level of network connectivity is suggested in the example where many relations, as well as other bankruptcies, are directly connected to the bankrupt company, or indirectly linked through a 2 or 3 step walk. Thus, the network connectivity is here based on the inter-linkage of bankruptcies through a business network structure.

In section 2.2, we discussed four levels of intensity of ‘business netquakes’: (1) tremling, (2) swaying, (3) shaking, and (4) breaking. Depending on the type of ‘ground’, a business netquake can lead to more or less serious effects. Network connectivity can be seen to be one dimension of the ‘ground’, that influences how far the change spreads. A generally higher level of connectivity in business networks enables a wider and more severe spread of change. This means that when an event occurs in one place of the business network, changes in connected parts of the business network structure are more likely to follow if the connectivity is high in the part of the business network where the first event took place.

References

Alajoutsijärvi, K., Möller, K. and Tähtinen, J. (2000). 'Beautiful exit: how to leave your business partner'. *European Journal of Marketing*, **34**(11), 1270–90.

Anderson, J., Håkansson, H. and Johanson, J. (1994). 'Dyadic business relationships within a business network context'. *Journal of Marketing*, **58**, 1–15.

Dahlin, P., 2007, Turbulence in Business Networks. A Longitudinal Study of Mergers, Acquisitions and Bankruptcies Involving Swedish IT-companies, Doctoral Dissertation No. 53, Mälardalen University, Sweden.

Dahlin, P., Havila, V. and Thilenius, P. (2004). 'Netquakes – effects of ending business relationships'. Paper presented at the 3rd Nordic Workshop on Relationship Dissolution, September 17–19, Kukkolaforsen, Sweden.

Dahlin, P. & Thilenius, P. (eds.) (forthcoming) *Exploring Business Networks - The Character of Connections*

de Nooy, W., Mrvar, A. & Batagelj, V. (2005). *Exploratory network analysis with Pajek*. New York: Cambridge University Press

Easton, G. (1992). 'Industrial networks: a review'. In Axelsson, B. and Easton, G. (Eds.), *Industrial Networks – A New View of Reality*. London: Routledge, 3–27.

Ford, D. (Ed.) (2002). *Understanding Business Marketing and Purchasing*. London: Thomson Learning.

Ford, D., L.-E. Gadde, H. Håkansson and I. Snehota (2003), *Managing Business Relationships*, 2nd edition, Chichester, John Wiley.

Gadde, L.-E. and Mattsson, L.-G. (1987). 'Stability and change in network relationships'. *International Journal of Research in Marketing*, **12**, 29–41.

Gassenheimer, J. B., Houston, F. S. and Davis, J. C. (1998). 'The role of economic value, social value, and perceptions of fairness in interorganizational relationship retention decisions'. *Journal of the Academy of Marketing Science*, **26**(4), 322–37.

Gidhagen, M. (2002). Critical Business Episodes: The Criticality of Damage Adjustment Processes in Insurance Relationships. Doctoral thesis, Uppsala University, Department of Business Studies.

Giller, C. and Matear, S. (2001). 'The termination of inter-firm relationships'. *The Journal of Business & Industrial Marketing*, **16**(2), 94–112.

Halinen, A., Salmi, A. and Havila, V. (1999). 'From dyadic change to changing business networks: an analytical framework'. *Journal of Management Studies*, **36**, 779–94.

Halinen, A. and Tähtinen, J. (2002). 'A process theory of relationship ending'. *International Journal of Service Industry Management*, **13**(2), 163–80.

Harrison, D. (2004). 'Is a long-term business relationship an implied contract? Two views of relationship disengagement'. *Journal of Management Studies*, **41**(1), 107–25.

Haugland, S. A. (1999). ‘Factors influencing the duration of international buyer–seller relationships – the analysis of discrete structural alternatives. *Journal of Business Research*, **46**(3), 273–80.

Havila, V. and Salmi, A. (2000). ‘Spread of change in business networks: an empirical study of mergers and acquisitions in the graphic industry’. *Journal of Strategic Marketing*, **8**, 105–19.

Hertz, S. (1998). ‘Domino effects in international networks’. *Journal of Business to Business Marketing*, **5**, 3–31.

Håkansson, H. and Snehota, I. (1989). ‘No business is an island: the network concept of business strategy’. *Scandinavian Journal of Management*, **5**, 187–200.

Håkansson, H. and Snehota, I. (Eds.) (1995). *Developing Relationships in Business Networks.* London: Routledge.

Johanson, J. (1989). ‘Business Relationships and Industrial Networks’. In Malm, A. T. (Ed.), *Perspectives on the Economics of Organisation*: *Crafoord Lectures 1*. Lund, Sweden: Institute of Economic Research, Lund University Press.

Madhavan, R., Koka, B. R. and Prescott, J. E. (1998). ‘Networks in transition: how industry events (re)shape interfirm relationships’. *Strategic Management Journal*, **19**, 439–59.

Thilenius, P. (1997). *Subsidiary network context in international firms.* Doctoral Thesis No. 68, Department of Business Studies, Uppsala University, Uppsala.

Tähtinen, J. and Halinen, A. (2002). ‘Research on ending exchange relationships: a categorization, assessment and outlook’. *Marketing Theory*, **2**, 165–88.

Tähtinen, J. (2002). ‘The process of business relationship ending – its stages and actors’. *Journal of Market-Focused Management*, **5**, 331–53.

Tähtinen, J. and Halinen, A. (2002). ‘Research on ending exchange relationships: a categorization, assessment and outlook’. *Marketing Theory*, **2**(2), 165–88.