10 The Global Web

On our sixth trip into Netland, we will go a level higher in complexity. In Chap. 8, we examined social networks where the elements were usually individual people. In Chap. 9, we saw some of the networks these communities produced. In this chapter, we investigate 'supersocial' nets, in which the elements are the social networks of the previous chapter, in the form of firms, investor groups or whole nations. Chapters 8 and 10 together show another nice example of nestedness.

10.1 The World Trade Web

Markets behave like networks. During the last century, our world became really small, not only in the sense that a former adventurous expedition by Marco Polo is now the daily routine of many business executives specialized in Eastern markets, but also from the network point of view. The world market has small-worldness (Serrano and Boguna, 2003). The first scale-free market behavior was noted by Benoit Mandelbrot (1963) when looking for regularities in price fluctuations. His observations were confirmed later on a larger scale (Mantegna and Stanley, 1995). The market of our global village is also scale-free in the distribution of both trade degrees and trade link strengths (Li et al., 2003). Influence links also show a scale-free strength distribution, which means that a small proportion of actors have an exceptionally high influence on the behavior of others (Janssen and Jager, 2003). Markets are disassortative, showing an avoidance of linkages between hubs (Serrano and Boguna, 2003).

Markets are not in equilibrium. Devastating market crashes, like the tulip speculation in the Netherlands in 1637, the South Sea Company scandal in England in 1720, or the more recent world trade crashes of 1929, 1987, 1997, 1998 or 2000 (Sornette, 2003) may lead to a quasi-instantaneous evaporation of trillions of dollars. Market crashes may swallow years of pensions and savings in a minute. It is our common

interest to learn about their development and to recognize the factors what might stabilize the markets.

Market dynamics shows the properties of self-organized criticality. Self-organized criticality may evolve from reorders triggered when a final product is completely sold out. This chain of reorders behaves very similarly to the avalanches typical of the self-organized critical state (Scheinkman and Woodford, 1994). In another form of the same phenomenon, the continuous inflow of energy is the never-ending penetration of new and reintroduced products. Tension may develop from various sources. Accumulating trade surpluses and deficits as well as chronic under- or over-evaluation of prices or stocks may all cause increasing tension in the market. A 'rational bubble' may develop if the actual market price depends positively on its own expected rate of change and the positive feedback leads to an increasing discrepancy. A similar scenario is the 'speculative bubble', where the hope of a large profit and the generated buying spree enforce each other for a while. Relaxation may occur smoothly or abruptly. The latter may lead to a market crash, a market quake. Price fluctuations and the extent of market quakes both display scale-free distribution. This scale-free distribution is not due to fluctuations in the incoming information, but is in fact caused by the collective behavior of the actors on the market. Here I have to recall what we learned about panic quakes in Sect. 3.2. When we panic, herding behavior occurs. A tension is given and relaxation is delayed. A typical self-organized criticality develops (Bak et al., 1997; Helbing et al., 2000; Saloma et al., 2003). *"I am preoccupied by my saving efforts to cover the costs of my canoe tour with Pity, and I am getting more and more anxious as I listen to you. Please, do not try to tell me that people are in a continuous state of panic on the world markets."* Do not panic, Spite! In most cases, there is indeed no panic on the markets. However, herding does occur – and in fact this may lead to a well-justified panic.

How does this work? If we do have 'business as usual', actors on the market behave in the 'usual' way. Most actors follow a fundamentalist strategy, i.e., they analyze the fundamental value of the market item, and buy (sell) if the market value is below (above) this value. Fundamentalists know what they want and they have a wide variety of incoming information, all of which influences their final bullish or bearish behavior. On the other hand, 'noise traders' attempt to identify price trends and patterns and consider the expectations and behavior of other investors as an important source of information. Uninformed investors also rely heavily on general market opinion, exemplified by

the opinion of a few key players or by rumors. The less information they have, the more they follow the crowd. If changes become abrupt, even the fundamentalists, the key players, will not have enough time for analysis, since they have to act promptly. The action space becomes rather limited.

We may analyze the situation within the framework of weak and strong links. Spite, if you still have your aversions for weak links, feel free to go with Pity to raise some cash for your tour. In the 'business as usual' situation, a fundamentalist actor on the market has a number of weak links. She or he is weakly linked to several sources of information which all modulate her or his final decision (to sell or buy). Other actors are linked to different information sources and will act differently. There is a diversity of opinions and actions which leads to another set of weak links. All these links help market stability. If collective behavior (herding) develops, the market actor will rely on a rather limited amount of information which already makes a strong link. Moreover, this information tends to become just one piece of information, namely, what the majority does. As herding develops, each of the actors will rely increasingly on the same information. If the link strength distribution departs from the usual scale-free pattern where weak links dominate and becomes an almost all-strong network, the market will be significantly destabilized and its behavior will become critical. If (1) the market is overvalued, (2) actors start to believe that the bullish trend is not sustainable, and (3) they also believe that the others believe the same, then a market quake may develop (Bak et al., 1997; Buchanan, 2000; Krugman, 1989; Lux and Marchesi, 1999; Ponzi and Aizawa, 2000; Sornette, 2003).

Shakespeare on Wall Street. The last few sentences concerning the expectations of market actors call for a comparison with the great masters of Sect. 9.2. Great masters are people who have the exceptional cognitive abilities required to think to the 6th order: "The master supposes that the audience will believe that A supposes that B intends to guess how C understands what D thinks ..." (Dunbar, 2005; Dunbar et al., 1994; Stiller et al., 2003). What are market gurus supposed to do? It has already been noted by Keynes (1936) in his famous beauty contest parable that the optimal strategy is not to pick those faces that you find beautiful, but those the other players find beautiful. However, the other players also know this rule and will not think about their own choice, but about the choice of the others, and so on. *"I honor Keynes' genius but I will never change my strong belief that Pity is the*

prettiest girl in the whole world." You deserved the kiss, Spite. This was nice of you. But let me give you some advice: when you invest your fortune to raise cash for your canoe tour, please avoid the stock markets. Returning to the market gurus, we may state that "the guru supposes that the market agents will believe that A supposes that B intends to guess how C understands what D thinks ...". The iterative loop developed here is rather similar to that of the great masters. *"Do you really believe that Shakespeare would go to Wall Street if he were alive today?"* I believe Shakespeare's and the market guru's motivations are different. Shakespeare was mobilizing his 6th order thinking to discover and show our world to us. A market guru mobilizes her or his nth order thinking to discover and show the market to us. I have to say that my world is not really restricted to the market and I do not think Shakespeare would have wanted to restrict his to it either. However, there is another possible answer here. Do we have a Shakespeare today? If you cannot see him, could it not be because he is already on Wall Street?

How much can you earn with 1 dollar in 70 years if you are a market guru? If in 1926 you had invested your dollar in one-month U.S. Treasury Bills which is one of the safest securities in the world, by 1996 your original investment would have grown to 14 dollars. If you had taken a greater risk and invested your dollar in the S&P 500, you would now have 1 370 dollars. What would have happened if you had known which of these two investments would give you a higher return in the coming month, and you had changed your investment accordingly for 70 consecutive years? Your single dollar would have made you a startling 2 296 183 456 dollars by 1996 (Farmer and Lo, 1999).

It is time to return to market quakes. Big market crashes show distinct characteristics. A crash is preceded by a slow buildup of long-range correlations leading to the global cooperative behavior of the market actors described above. This is marked by a series of unusual oscillations superimposed on scale-free behavior. When a market quake approaches, the oscillations become faster, showing the increasing aggregation of a multitude of agents into a kind of superagent. After the crash, oscillations start again and the superagent becomes fragmented as business gets back to usual. Our losses are not due to the markets. They are due to our own collective behavior (Buchanan, 2000; Krugman, 1989; Lux and Marchesi, 1999; Sornette, 2003).

Embargos as destabilizers of the global market. A diversity of actors in the market helps to avoid crashes. Diversity is beneficial to global markets as well, due to the development of weak links. Consequently, extensive embargo policies are detrimental to the main actors themselves, since they decrease market diversity and, therefore, stability.

Collective behavior is not restricted to people on the market. Most countries (with the notable exception of Germany, Austria and Japan) on the world trade web showed a rather significant synchronization of their economic cycles with those of the USA between 1974 and 2000 (Li et al., 2003). In our global village, whether we want it or not, both joy and sorrow are joint experiences. We have to care about each other ... *"and develop weak links to preserve our stability."* Yes, Spite, but the help here is more complex than weak links. The main lesson of this chapter is that we should avoid herding and try to behave like human beings in times of danger.

Behaving like humans is not always as easy as it seems. There are also ways to prepare for damage. Wealth distribution and bet-hedging are commonly used tactics to make our future safer in uncertain conditions (Bernoulli, 1738). As examples of this, both ownership diversification (Stark and Vedres, 2002) and portfolio diversification (Stark 1996) are widely used measures in uncertain market conditions. From the network approach, this bet-hedging strategy improves the stability of the economy by introducing a larger number of weak links instead of a few strong ones.

In summary, the maintenance of weak links between market actors and with their various sources of information seems to be highly beneficial for market stability. As an important form of this, market diversity has to be promoted if we hope to avoid the devastating crashes of the past. Moreover, we should gather together all our wisdom and strength and behave as human beings and not as part of a herd when danger threatens.

10.2 Turning Points in History

Not only markets, but also human history is full of crashes. Actually, we have almost nothing else in our written history but crashes. These were the events considered to be worth recording. In this section, I will use our knowledge of networks to show that many properties of the turning points in our history can actually be quite well explained with

network dynamics. I will start with self-organized criticality, the herding behavior similar to what happens in market crashes, then continue with topological phase transitions, and conclude with an analysis of link strengths in these processes.

On 30 September 1920, King Alexander I of Greece wanted to save his gardener's monkey from a quarrel with his dog. The monkey accidentally bit the king on his calf. The wound got infected and the handsome king died in painful agony three weeks later. Alexander I was succeeded by his father Constantine, who returned to the throne after his abdication in 1917. King Constantine started and lost a war with Turkey where thousands of civilians were massacred and 1.5 million Greeks and Armenians had to be evacuated. *"This is a very sad story. I will make a note never to buy even a toy monkey for Pity at Christmas to save us from accidentally starting the Third World War. Can you tell me how monkey bites affect your networks? Do you wish to imply that networks get blood-poisoning?"* The key word is not the monkey here, Spite, but self-organized criticality. Wars follow scale-free statistics, meaning that we have had many small-scale wars in human history and, fortunately, only a few megawars, like World Wars I and II (Levy 1983; Richardson, 1948). Since the situation leading to a war is extremely complex, we still do not have a full explanation for this law, known as Richardson's law.[1] However, self-organized criticality may be a key point here, too. A continuous and uneven technological change plays the role of inflowing energy, allowing conquering desires to develop as tensions. A geopolitical avalanche is started, where more and more metastable countries join the bandwagon. The war (a society quake) propagates like a forest fire, another self-organized critical phenomena (Buchanan, 2000; Kennedy, 1987; Roberts and Turcotte, 1998). If the tension is big enough to be critical, the initial trigger may be a very tiny event, like the shot by Gavrilo Princip in Sarajevo or the bite of the gardener's monkey in Athens.

Self-organized criticality also invokes collective wartime behavior (Brunk, 2003), like the herding effects leading to the highly overestimated stock prices and the subsequent market crashes of the previous section. Collective behavior helps tiny events (shots, bites and the like) to explode into a widespread vox populis, forcing politicians to follow the 'nation's will'.

[1] Lewis Fry Richardson is also known for the famous paradox of the British coastline: if he measured it with smaller and smaller scales, the length of the coastline became longer and longer. This is a typical fractal property which helped Benoit Mandelbrot (1967; 1977) to formulate his famous concept of fractals.

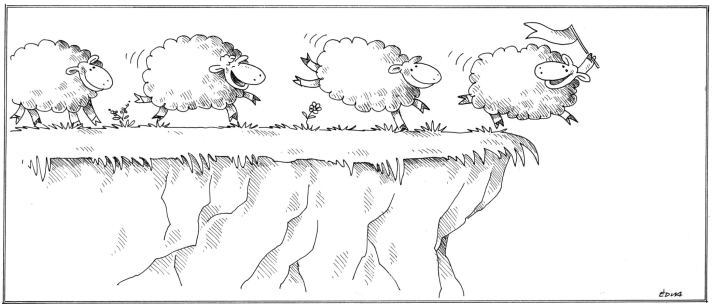

Fig. 10.1. Collective behavior causes tiny events to explode into a widespread vox populis

Collective behavior and the good consumer. A rather significant amount of high-profit production builds on the collective behavior of consumers. If consumers avoided collective behavior, TV advertisements could win only a tiny fraction of people over to the idea that they should change their recently bought mobiles to the latest model. These would be those five people who dropped, lost, or otherwise incapacitated their mobile over the last few weeks. In reality, millions will buy the new model, feeling sure that the other million will do it and becoming afraid that by abstaining they will not be keeping up with the Jones's. Manufacturing just five new mobiles would not make a profit, but manufacturing a million certainly will. A great many interests tend to push average members of society into a state suitable for collective behavior. We should bear in mind that whoever becomes accustomed to engaging in mindless collective behavior in one aspect of life will be highly susceptible to herding in all other aspects of life, including market crashes, wars, and all other events which would certainly ruin the large profits of any business on Earth (Kopp, 2000).

"If wars are scale-free, should we fear for an even bigger event than World War II?" Unfortunately, this cannot be excluded, Spite. Statistics may pacify us into believing that a gigawar is even less likely than World War II was, but the scale-free distribution says nothing about actual incidence. Indeed, it may happen tomorrow. The take-home message is that, when you start a war, you never know how big it will be in the end. What is the solution? We should build up trust and weak links between nations, as I will explain in Sect. 10.3. Another piece of advice also comes from our previous notes. When you see herding behavior start to propagate in your country, watch out and try to remain human – or otherwise, be prepared for a war.

Now take a deep breath, drink a glass of crystal clear water, relax, and most importantly: think. We have already had three examples of herding: panic, market crashes, and war. *Is it always useful to become immersed in synchronization with the crowd?* Should we not develop a better ability to discriminate between the synchronized relaxation of joyful laughter and the 'over-synchronized' relaxation of devastating crashes and wars? Should we not learn from networks and *confine* relaxation by allowing only information to go for a global ride? The advice at the end of the book might help us to accomplish these complex and demanding tasks.

Fortunately, human history is not only a history of wars. We have had many other turning points, too. The generalization of network properties is a very powerful tool for understanding the rugged landscape of the punctuated history equilibrium. In Sect. 3.4, I gave two examples of topological phase transitions[2] developed by Tamas Vicsek and coworkers (Derenyi et al., 2004; Palla et al., 2004), applying the idea to cells and animal communities. Here I extend this analogy to societies and show the possible involvement of weak links in stabilization.

- **Random graph phase.** A random graph develops if resources are plentiful. Surprisingly, the hunter–gatherer societies of prehistoric times were rather rich. Sixteen thousand years ago the average height of our Paleolithic male ancestors was 170 to 177 cm (Cohen and Armelagos, 1984), and this significantly declined later, only to be surpassed again in the last century. Association was rather loose, there were no classes, and no continuous discrimination occurred. This society was in the random graph, primitive community phase. But the population grew and, consequently, resources became scarce, whereupon a random to scale-free transition occurred, which may have grown into a scale-free to star transition. This may have corresponded to the development of the first classes in the society.[3,4]

[2]For the definition, see the glossary in Appendix B.

[3]In fact, a similar, but reversed change can be noted in modern, Western societies, giving a partial scale-free to random transition as a result of ample resources. This is continuously challenged, however, by population growth and by the large increase in population density.

[4]Successful empires may have lost their strength in part due to this scale-free to random transition, which disorganized and softened the original, strong links.

- **Scale-free phase.** The scale-free system is a 'borderline' case between the random graph and the star phase. It is very fragile and transient, but in spite of this, it is very robust. We call it democracy. This democracy net always keeps a delicate balance between anarchy (random net) and dictatorship (star net). Fortunately, in democratic systems, the society is not segmented and weak links flourish. Consequently, the fragile system becomes robust. Democratic systems show the greatest complexity of all. However, weak links and their buffering may grow too great. A democratic society remains flexible for smaller challenges, but occasionally may become overcomplicated and unable to make a fast response to a life-threatening danger.[5]
- **Star phase.** If the situation gets really bad and resources become exhausted or unavailable, the scale-free phase changes into a star phase. Democracy collapses and a dictatorship develops. In dictatorships, theocracies and meritocracies, the society is segmented, secondary contacts and weak links are sparse and buffering is small. The system is centralized and efficiently fights against big, well-known challenges. However, the system is unstable and cannot respond to complex challenges. In the background new social formations arise. They are neither buffered nor channeled, but oppressed. Tension often develops and self-organized criticality may arise, leading to a society quake. Depending on its size and form, the society quake may be a reform, a system change, a revolution, a civil war, and so on, and the list is long. The society quake may facilitate a disintegration of the society net into fully connected subgraphs.
- **Disintegration to fully connected subgraphs.** When the situation becomes tragic, resources become grossly unavailable, the star phase breaks and the network disintegrates into a number of small, but fully connected subgraphs. This is the end of the network, since its integrity (its netsistance) is lost. Dictatorships often end with a sudden, disintegrating event. In wars, revolutions and similar social cataclysms, weak links are all broken, and only fully connected subgraphs like core families, small military units, etc., try to survive or escape together. However, the situation here is vastly different from that in our body or a cell. Disintegration is called

[5] You may recall here the analogy with muscle unit synchronization in Sect. 7.3. There I mentioned that weak links are necessary for changing, unknown tasks of high complexity, e.g., playing music, while strong links are required for the fast execution of well-defined tasks, e.g., weight lifting. A life-threatening danger is a rather well-defined task where survival often depends on the speed of the response.

death in that case. Disintegration here inevitably leads to terrible suffering. However, it is also a new opportunity. Here the network elements (people) remain functional, even if they are temporarily alone. Unlike our cells or proteins, they still have their ability to survive, even under these conditions. They can regress to a more primitive life form. In social cataclysms, buffering and order cease. Members of isolated subgraphs have a new opportunity to reform a big net, their society. Hidden social formations come to light, competing violently with one another, and a new strategy is selected. After this the system may return to a dictatorship, or become a democratic formation, if the anticipated challenges are drastic but simple, or small but complex, respectively.[6]

French absolutism and revolution: An example of a star → subgraph → scale-free transition. Degenne and Forse[TS a] (1989) gave an interesting network analysis of the French monarchy, where the initial segmentation of the society became increasingly dysfunctional as noble titles were sold and resold in massive quantities during the 17th and 18th centuries. Although only strong links were allowed, weak links developed as well. Institutional gridlock made the French Revolution a credible option. This example illustrates the benefits of the subgraph phase. As Montesquieu (1734) noted: "[in war] each person places himself in a suitable situation, whereas in times of peace, he is positioned by others, and generally very injudiciously." Indeed, social cataclysms reduce the links of the atomized society and facilitate upcoming change. Is the situation really so 'suitable' in the middle of a cataclysm? For Montesquieu, who lived 66 years of peace in an outgrown society anticipating a big change (the French Revolution), a cataclysm was obviously more desirable than it would be to us, for we regularly witness the past and present horrors of the world on the small screen in our living room.

Social classes and Karl Marx revisited. A social class can be regarded as a network module. When a large number of network members find themselves in the same situation, with strong links to each other and rather weak links, if any, to the other modules of society, social classes will develop. Social classes presuppose uniformity within segments of the society. This is only temporary, since technological development requires

[6] A subgraph to star phase transition might have occurred when the Greek towns became more dependent on a mother-town, called a metropolis, when threatened by an outside danger. As an additional example, challenged empires may have partially disintegrated due to the star to subgraph transition.

[TS a] Please check this author's name, do you mean Forsé (Michel)? Also in Bibliography.

greater specialization. Diversity and weak links then develop. Consequently, uniformity, exclusive strong links and social classes slowly dissolve. The diversification of internal links may also be triggered by the diversification of external links. In the long run, globalization certainly helps democratic change from the network point of view. In addition to these ideas, Karl Marx might have been right in stating that all classes will be erased and communism will appear if resources become plentiful again. Indeed, in this case the scale-free or star network might shift to a random graph pattern and its structures might dissolve. Thinking about the increase in human population and the situation in Africa, this will not be achieved on a global level in the near future. Moreover, we have grown quite used to the state of 'organized criticality', the scale-free, democratic and highly complex social net. The low complexity of a random graph might seem extremely dull to us. From the network point of view, communism is not an exciting alternative.

The end of history. On the basis of the above interpretation, democracy is certainly not the ultimate equilibrium constituting "the end of history . . ." (Fukuyama, 1992). Democracy is a highly robust, but at the same time very fragile, complex system, which requires constant change to maintain its self-organized state. Democracy is by definition not in equilibrium. The random graph pattern may pose a system of boring and very low-complexity equilibrium. If all of us ever find ourselves with plenty of resources, that will be THE END of our history.[7]

The extremely hypothetical picture of the topological phase transitions exemplified above is based on the important work by Tamás Vicsek and colleagues (Derenyi et al., 2004; Palla et al., 2004). Many of the examples lack sufficient detail to be fully convincing. Nevertheless, I hope they demonstrate that topological phase transitions of networks provide a useful tool for analyzing and understanding the key trends and events in our past.

Before I shift to another useful tool, link strength analysis, let me analyze the effects of globalization on the interactions of social nets in a few examples. My first example is the exportation of democracy. Weak links are important in society, but they are not useful all the time. Weak links will not be much help for societies which are not in their scale-free phase. Weak links and democracy may not fit a resource-poor society which requires a star phase to survive and develop. Moreover,

[7] The almost certain boost in human population under these conditions makes this highly unlikely.

the complexity of the scale-free system needs a certain level of practice to maintain, and development of this practice requires time and self-organization.

The development of democracy is a slow process requiring several generations of resource expansion. We may have two rather widely separated phenotypes of BIGS and SMALLS adapted to low and high resources, respectively (Bateson et al., 2004). The reversal of these phenotypes is fairly slow, requiring a change in resources for several generations.[8] In Sect. 7.5, I put forward the idea that BIGS tend to build weak links, while SMALLS keep mainly strong contacts. Following this thought further, I may conclude that the growth of resources in the Western part of the world will inevitably lead to a gradual shift towards the BIG phenotype and the development of multiple weak links. This leads to an increased speed of innovation and to a better stabilization of society. It thus serves as an important reason for making democracy viable. If we accept this view, in countries where resources are not abundant, or were not abundant up until two generations before, democracy is not viable in its well-developed, pure form. Let me add an important remark here. Obviously, we have a multitude of reasons which lead to one social formation or another. Link strength is just one of them. However, I am quite sure it is worth thinking about this in the context of exporting democracy. We may have voluntaristic demands to build up stable democracies in countries where poverty was or is prevalent. In a society where the majority still belong to the STRONGLINKER personality trait, this will not be stable. Now take a deep breath, drink a glass of crystal clear water, relax, and most importantly: think. *Has the time not come to slow down a bit?* If certain changes require three generations, why do we want to accomplish them in just one year?

Are civilization diseases our penalty for achieving democracy? In Sect. 7.5, where I introduced the concept of SMALL and BIG phenotypes (Bateson et al., 2004), I noted that a similar concept, the concept of thrifty genotypes and phenotypes (Hales and Barker, 1992; Neel, 1962), found a correlation between our change of lifestyle and many of the civilization diseases such as diabetes, obesity, high blood pressure, atherosclerosis, etc. The question arises as to whether civilization diseases might be unavoidable consequences of our change of lifestyle, leading to a modern society with weak links, better stability and an improved potential

[8] You may live in luxurious conditions but, if your grandparents lived in poverty, you may still harbor the SMALL phenotype.

for achieving innovations.[9] Our 21st century Hamlet in the third world countries may have a rather difficult dilemma:

> To eat, or not to eat: that is the question:
> Whether it is nobler in the mind to eat less,
> Stay healthy and preserve the old society,
> Or to take arms against a sea of troubles,
> Start to eat, get diabetes and build democracy?

Fortunately, it is not yet clear whether these two changes are related in any way. A rather intensive study would be required to see whether there is a range of slow increases in welfare and nutrition for which civilization diseases can be avoided, and the SMALL phenotype (and STRONGLINKER personality trait) can still be changed. *"This is an excellent and very important research program! Shall we start it tomorrow?"* Spite, I am happy to see your enthusiasm, but I have to discourage you. Obviously, we can start animal experiments of this sort even today. However, animal experiments have a very low predictive value (if any) for the human situation when it comes to questions of nutrition. Carefully planned nutritional experiments with fully informed and consenting participants can be envisaged with human beings. However, by the very essence of the problem, the outcome will be revealed only after two to three generations. Think about the situation if the results show that the original setup was badly designed and the experiment has to be repeated in a modified form! No third world countries will be left (I am always super-optimistic as you know) by the time our great-grandchildren eventually finish this project.

Globalization brings freedom of travel, and this in turn brings foreigners. If we integrate them, they will increase our stability. If we try to assimilate them, we do not gain very much. If we segregate them, our future is in danger. Integration of foreigners brings the development of several stabilizing weak links into the society. Assimilation consumes diversity and destroys the chances of making weak links between society members. Segregation is even worse, since it does not give the smallest chance for any links to develop and gives rise to relaxation barriers. Tensions develop and the danger of unpredictable society quakes increases. I quoted the Admonitions of the Hungarian King, St. Stephen in Sect. 8.3: "A country with one language and one custom is weak and perishable. Therefore, I order you, my son, to show goodwill to our visitors, and protect and cherish them, so that they

[9] I am thankful to Gabor Szegvari for this question.

will prefer to stay with you rather than to live elsewhere." What was a major source of modernity a thousand years ago has become a major source of stability today.

Pagel and Mace (2004) gave an interesting analysis of human cultural diversity. They note that group homogeneity, group cohesion and the development of common norms help altruistic, cooperative behavior and effectively filter and deter cheats. However, this requires the minimization of intergroup migration. Foreigners break cohesiveness by introducing the danger of escaping cheats. A period of experience (i.e., that cheating is not highly prevalent among foreigners) as well as greater resources (occasional cheats do not pose a great threat) are both required to ease our historical wariness of strangers. You may take your glass of crystal clear water and note once again the need for patience. If we wish to achieve stability, we should slow down, not only in our deeds, but also in our judgements.

But diversity is a double-edged sword. Cultural diversity also means customs like slavery, female genital mutilation, child exploitation, etc., which cannot be tolerated in our globalized, modern world. General norms should be observed by all of us. However, with these limitations, diversity requires enhanced protection today. Both experimental model systems (Kerr et al., 2002) and game theory models (Axelrod, 1997) suggest that the majority culture 'naturally' endangers minority cultures, even without any bias in social influence. This danger is further increased if the population becomes well-mixed, as humankind tends to do today. Due to our increased freedom to make links only with those we wish to, the extinction of the minority cultures is growing even closer. Moreover, the free choice of links greatly increases the chances of segregating the remaining cultural groups. Same-interest groups and same-opinion islands are increasingly formed, and intersegmental communication may easily deteriorate. There is an urgent need to make special and directed efforts to educate ourselves and our societies to build intercultural, bridging, weak links.

Analyzing social formations from the standpoint of link strength, the stabilizing force of weak links can be found mainly in the scale-free (democratic) periods of our history. Dictatorships (star phase) traditionally hate weak links and try to destroy them. Weak links cannot be monitored, cannot be controlled, and pose a continuous threat to any dictator (Arendt, 1973). Disintegrated or random graph societies neither need nor display weak links. Thus in both pure star-phase and random graph formations the strengths of all links are more or less alike. Links are close to 'all-strong' in the star phase, and 'all-weak' in

random graphs, if 'strong' and 'weak' make any sense in the absence of another link as a reference strength. Fully connected subgraphs do not form a society, so the strength of their long-range links is zero.

Weak links and modernity. Medieval society was very hierarchical and had very few weak links. The spread of weak links started with the widespread use of money, developed through the economic necessities of the 16th century, and was generalized by the growing social life and the Enlightment of the 17th and 18th centuries. The first step in these changes was the widespread use of money at the end of the Middle Ages, which allowed greater flexibility in society and, bringing with it a wide variety of roles and interactions, turned many formerly strong links into weak links (Simmel, 1990).[10] The development of overseas commerce in 16th century England depended on the creation of joint stock companies. Joint investment allowed investors to raise the high costs and spread the risks of pirate attacks or bad weather. As an additional effect, the joint stock company developed weak links between its investors. By the 18th century, life flourished in English and French society. In London, 20 000 inhabitants met every night in public places, while in France the multiplication of social roles became extremely well developed. As soon as a person could not be reduced to a single role, the idea of personality was born. Determined, normative and publicly sanctioned expectations gave rise to the ambiguity of the individual. Weak links were both signs and instigators of modernity (Degenne and Forse[TS a], 1999; Fukuyama, 1995; Seligman, 1997).

Weak links and transcendency. Spite, here you may turn your critical attention elsewhere for a while! A rather provocative idea will follow. If I put together the idea of Dunbar (1998; 2005) that the registry of our social contacts requires a tremendously high brain capacity and the notion that extensive emotions as well as meditation require a high level of neural synchrony (Aftanas and Golocheikine, 2001; Damasio, 1994; Orme-Johnson and Waynes, 1981; Rolls, 1999), I may provoke your mind with the statement that these may balance one another. The increase of weak links and the decrease of religious belief in the 16th, 17th and 18th centuries was not just a mere coincidence, and was not only a struggle between the rising bourgeois class and the power of the church. It also reflected a decrease in the synchronization intensity as our brain became occupied by the increasing registry of social links and developed the 5th order thinking of

[10] I am grateful to Eszter Babarczy for this idea.

Shakespearean theater. Our great-grandparents might sacrifice the wholeness of their transcendent link for the incoming flood of social links. This may be an important reason behind the benefits of hermitage. *"In spite of your warning, I stayed and listened patiently to your idea. You describe this transition as a tragedy. Let me play with the idea that you are right. In this case, our great-grandparents lost their superstitious nightmares in parallel with the decrease in their transcendent experiences. The same emotional super-synchrony you mentioned may be needed for both. Do you really want witch-burning back?"* Witch-burning is not my favorite Sunday brunch special. However, the wholeness of transcendence is a great loss for many around us. A great loss. The loss of social links would also be a great loss (as an important example of this, I could not write this book!) and would ruin the whole society. What can we do? You know, Spite, I am forever an optimist. I hope we will develop a good enough brain to have them both.

10.3 Weak Links: A Part of Social Capital

In the last section we saw that our society net may undergo quite profound changes from a random graph to the scale-free, star and disintegrated phase as resources become sparse or stress develops. In this section, I will make a few remarks on the competitiveness of societies using their network structure as a guide.

The formation of a top network demands the stability of its elements, the participating bottom networks. We are currently witnessing the globalization of the world. The world economy as a top network requires the stability of the bottom networks, the participating countries. Our globalizing world is highly competitive. Evolvability of societies, and their readiness to discover and implement technological developments is a key element in their competitiveness. Here I will continue with the examination of both requirements.

Social stability demands the stability of the participants. Our psychological stability is a sensitive balance influenced by a large number of effects, such as hormonal status, social links, etc. Studies by Kunovich and Hodson (1999) demonstrated that weak links in the form of informal social nets, such as sports clubs and social activities, improve mental health after a traumatic event, such as the civil war in Croatia. However, participation in formal groups, providing strong links, such as church, party organizations, and unions was shown to be detrimental to mental health. Similarly, stress due to evacuation of an Israeli community was efficiently counteracted with the *perception* of social embeddedness (weak links), and did not require actual reassuring contacts (strong links) with the stressed people (Steinglass et

al., 1988). While our common sense agrees with the help of social links to cope with stress, the detrimental effect of strong links may seem paradoxical. As an explanation, strongly linked communities may revive and relive stressful events, thereby hindering the healing process (Kunovich and Hodson, 1999). Moreover, a strong link expects a future reciprocation and this obligation may pose an unbearable burden on the stressed individual (Kawachi and Berkman, 2001).

In contrast to the stabilizing role of weak links, social segregation and tensions are detrimental to our well-being. Negative social experiences destroy our well-being more than an equal amount of positive experiences can help us (Rook, 1984). Segregation invokes loneliness, helplessness and the feeling that the individual has lost control over her own life. Stress provokes an attitude of rivalry in men which is destabilizing for their health (Kopp and Réthelyi, 2004). A self-perpetuating vicious circle may develop. Male participation in civic organizations may break this vicious circle by decreasing both rivalry itself and the fear of insufficient rivalry. Fortunately, women respond to stress differently. They do not compete – they socialize (Skrabski et al., 2004).

The above examples may be generalized. Not only psychological stability, but health and longevity are also improved in a society which is not segregated, where the backbone of strong links is helped by a large number of changing, informal weak links. Social links decrease both hypertension and the probability of heart attacks. Building a social net roughly equals the health benefits of non-smoking (Kopp and Réthelyi, 2004; Marmot and Smith, 1989; Putnam, 2000; Skrabski et al., 2003). Self-efficacy is an important element of health, allowing us to cope with the difficult situations in our life (Bandura, 1997). This is extended by resourcefulness, which is our hope that we will be able to get help when it is needed (Antonovsky, 1985).

Innovativeness is a key element of competitiveness. The fast spread of innovation depends on long-range society contacts, which are usually weak links. Fukuyama (1995) described the difference between traditional French and German companies. Due to the long history of French absolutism, governmental control and title-based hierarchy (Degenne and Forse[TS a], 1999), in a traditional French company the links between the workers and supervisors were mostly formal and strong. Detailed regulations often made sudden, ad hoc changes impossible, thereby hindering competitiveness. As an example of this, the regulations governing the dyeing of cloth run to 317 articles. In contrast, in a traditional German company the manager knew the workers and their contacts were less formal. The same parallelism can be

drawn between the traditional Chinese family business and traditional Japanese collective behavior (Fukuyama, 1995). *"Are you sure about these judgments? Germany is also well-known for tight regulations, and the love of French people for style and art is common knowledge."* Many thanks to you Spite, for this warning. It is not the actual nation that is important here, since generalizations never catch the complexity of real life. You should only pay attention to the two extremes of possible behavior. The take-home message is quite clear: in all cases, weak links help flexibility and the development of innovation.

Competition and innovation both increase and continuously reshape specialization and division of labor (Durkheim 1933; Fukuyama, 1995). Concomitantly, social roles become more complex and differentiated. Proliferation and transience of roles erode their stable definitions. Role expectations become ambiguous and negotiable (Seligman, 1997). All these challenge social stability and require a constant rebuilding of the social net. To achieve this, we need weak links as a sign of modernity, since strong links can tie only stable and established roles.

Innovation needs good communication between the segments of society. To respond to complex challenges, novel and unusual links have to be built. At first these links are by definition weak. However, the transfer of complex, tacit knowledge requires more than a weak link. It also needs benevolence- and competence-based trust (Hansen, 1999; Levin and Cross, 2004).

In summary, both social stability and competitiveness are helped by a complex halo of links in society. Importantly, it is not only the links, but also their perception, our trust, which stabilizes our mental and physical health and makes complex information accessible. "Trust enters into social interaction in the interstices of the system or at system limits, when for one reason or another systemically defined role expectations are no longer viable." Trust starts, where confidence ends (Seligman, 1997). Trust makes it easier for us to invest energy in building up long-range, weak links. Trust is the probability of weak links, the probability of the development of the modern social net.

Trust is a part of social capital. Social capital refers to the institutions, relationships, and norms that shape the quality of a society. It is important to note that social capital is not just the sum of the institutions which underpin a society – it is the glue that holds them together. Social capital has several key ingredients (Fukuyama, 1995; Putnam, 2000; Seligman, 1997):

- a well-developed social net,
- participation in civil organizations,
- cohesion of local communities,
- solidarity,
- trust, reciprocity and community support.

I hope that the present book convinces the reader that weak links are also a part of our social capital. Weak links are the same "lubricants of the social system" (Arrow, 1974), just as the weak-linker water was for proteins (Sect. 5.3).

Modern times have multiple effects on social capital. Our increased opportunities for building weak links certainly help the development of the social net, trust, support, solidarity and cohesion. In contrast, market behavior and relativization (Sect. 8.6) cause the erosion of social capital. We are increasingly shareholders and not stakeholders in our societies. Our commitments and responsibilities are short-term, market-oriented and private, rather than long-term, generalized and public (Dahrendorf, 1968). The erosion of social capital paves the way to the development of collective behavior and vice versa, herding helps to destroy social capital.

Robert Putnam's powerful analysis *Bowling Alone* described the erosion of social capital in the United States (Putnam, 1995; 2000). Television, suburban sprawl and all the changes of modernity curtailed the once so common and rich American social life with its picnics, bridge clubs, churches and the like. September 11 and the subsequent response made another attack against social capital: it eroded trust. Trust is a treasure of a modern society. Trust is actually more than a treasure. Trust is a necessity for stability and competitiveness. *Whoever destroys a single bit of social trust after three beers, whether a terrorist, a politician, or any one of us, harms the stability and competitiveness of the whole nation.* Trust is like our well-being, discussed at the beginning of this section. It has to be built up over generations, but it can be destroyed in a second. Trust-killers push their modern society back into the Middle Ages. Now take a deep breath, drink a glass of crystal clear water, relax, and most importantly: think. Think about your responsibility to save social trust, and especially before the next time you start to speak.

This is the end of our sixth trip into Netland. Spite, it is your turn to make the summary now. *"OK, Peter, I will try. I was fascinated how the sync between people which you called herding determined market crashes, peace and war. It was also interesting that big events at the stock exchange or in history followed the same self-organized criticality as sand piles or our favorite pastime with Pity: sex*

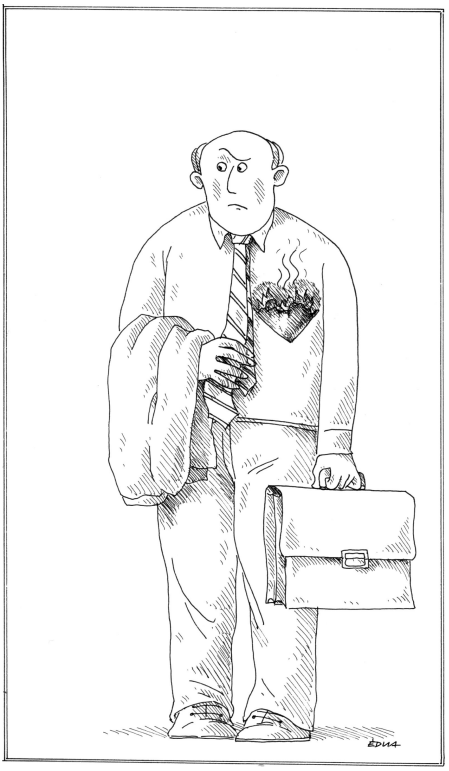

Fig. 10.2. September 11 and the subsequent response made another attack against social capital: it eroded trust

quakes. Your analogy of topological phase transitions with major changes in history was rather striking. Pity and I have agreed to read a few more books to see whether we believe it or not. I liked your thoughts on the role of patience in the exportation of democracy, and on the network backgrounds of conservatives and liberals. Finally, I was truly touched by the idea of trust as a part of social capital and as a basis for our mental and physical health. Pity and I have promised each other that we will trust each other forever." Spite, I am happy to hear the decisions you have made regarding your own life as a result of this chapter. However, do you not think you have forgotten something? *"Like what?"* Weak links! We had quite a lot of evidence to suggest that diversity and weak links stabilize both markets and societies. I also discussed the development of weak links and argued that they are part of our social capital. The trust that you and Pity feel for one another is called confidence, because your link is strong (at least I hope so). Trust is our opportunity to make stabilizing weak links.