Report
DYNAMO 63
3.2009

Net work(th)s

In our last Report, we argued that the struggle for hegemony of the best mental model in economics has been largely fought about the assumptions over the capabilities and talents of individuals. The traditional view of economic agents as rational and logic individuals competes against alternative proposals, which assume more 'human' like patterns of behavior.

In this contest for the podium of ideas, where these two streams – rationality & behavior – fight over the best explanation for the economic and financial events, the focus of the discussion has fallen exclusively on 'elements'. If agents are rational, markets, businesses and economies will typically be rational, ie, efficient. If actors follow patterns of emotional decisions, markets in aggregate will behave in a more erratic and unpredictable way. In practice, markets present periods of apparent 'normality' punctuated by sharp fluctuations in asset prices, allowing both schools to experiment alternate moments of ephemeral triumph. This unsettling inconsistency suggests that something is missing from the discussion. The purpose of this letter is to revisit some forgotten arguments and bring them to the debate through a different perspective.

Network Interactions

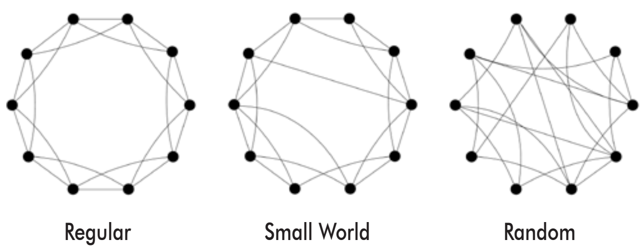
Research progress in the field of complexity has brought important contributions to the way we see the world. One of the main lessons of this approach is to emphasize the importance of understanding how different phenomena are organized, rather than focusing only on their components. And this proposition is valid not only for natural phenomena, but also for social occurrences. Many complexities inherent to human sociology have little to do with sophisticated attributes of our psychology, presenting patterns of behavior also found in several other places where a conscious activity plays no role.

Complexity research can be approached by several different branches of study. One of them encompasses complex adaptive systems (CAS). In Dynamo Reports no. 55 and 56, we highlighted that financial markets have characteristics that are typical of CAS: a large number of heterogeneous agents with local information, interacting in a continuous innovation and learning environment. This connectivity and interdependence brings something new, an emergent property, that is derived from the parties, but cannot be reduced to them. Often, the resultant does not bear the same traits of the original parties. Accordingly, we concluded that: i) sharp fluctuations in financial asset prices do not predominate, but are expected. They are derived from the system's internal mechanics, the progressive, cooperative and non-linear nature of repetitive interaction between many individuals; ii) in a densely connected structure, the mere sum of certain individuals' attributes – such as 'rationality' (irrationality) – does not necessarily make the system behave in a rational (irrational) way. These findings offer a new hue to the discussion initiated in our last Report.

Network theories represent another line of research in complexity science. Insights from the topology of network systems in several other disciplines – physics, biology, engineering, and epidemiology – have helped in the understanding of social phenomena, where the connectivity of individuals is dense, such as the economy and financial markets. These systems present properties that are typical of network systems.

One result from the topology of a highly connected network is an attribute known as 'small world'. The term was coined in 1967 from the experiment of Stanley Milgram, who distributed random letters and found that any two people in the world would be separated by no more than six 'connections'. Milgram's original insight was virtually forgotten for thirty years. In 1998, Duncan Watts and Steve Strogatz published a three-page article in the journal *Nature* containing the mathematical explanation for the mystery of the small world phenomenon. The results can be summarized by the graphs below:

Types of Network Graphs:



The first graph represents ordered or regular network models. The vertices, or edges, are strongly connected one to the next, forming local clusters. The withdrawal of some of these links does not promote disruptions on the network, since there is path duplication. However, to go from one side of the network to another one needs to move a long way, node by node.

The third graph is arranged randomly. In this case, long distance paths appear, shortening the distances inside the network. However, adjacent edges are not directly connected, presenting a low level of clustering.

The second chart, on the other hand, contains distant vertices linked by long paths, while local connections remain strong. According to the authors, this is a typical representation of a small world scheme. Interestingly, this pattern of interconnections is present in various phenomena, such as the structure of our neurons. In this case, the biological sense is clear: rather than travel a long distance between various regions of the brain, synapses take shortcuts along the way, producing quick responses such as "this is fire, move your hand away quickly". At the same time, if part of the brain is damaged, the functionality of the entire system is not at risk. In fact, studies show that patients suffering from local brain damages preserve functions and skills derived from other regions of this organ.

This means that a *small world* network layout not only presents clusters of directly linked nodes, but also holds an ability to quickly shorten distances, spreading local effects to the entire network. Local disturbances may soon gain global proportions. International financial markets highly connected have successively shown evidence of *small world* effect.

Albert-László Barabási (2002) took the results of Watts and Strogatz' research a step further, seeking to understand the evolutionary aspects of *small world* models. His work shows that as this kind of network grows, the number of links to each vertex is not constant. Instead, a few vertices attract or concentrate many connections, whereas many nodes are left with very few ties. Barabási found that the frequency of these links follows a fat tail distribution, following a power law 'curve'. This means that there is a greater number of edges with much more or much less connections than one might expect if the links followed a Gaussian, or random distribution. Evidences from other areas such as the study of infectious diseases in humans, forest fires spreading patterns, or the biochemistry of our cell metabolism, show that a fat tail frequency distribution of links brings large implications for the robustness of the network. This type of distribution appears more resistant to random disturbances, but more susceptible to targeted attacks. This is because, attacks aimed at strongly connected points (hubs), produce great damage, while random attacks are more likely to fall on the network's periphery. When the latter happens, the system survives well as local links have redundant connections (clustering).

Here we see another clear implication for financial markets. Most of the time, the system co-exists with localized, low impact disorders, which do not undermine the stability of the entire structure. If suddenly a financial institution of great importance (hub) finds itself in trouble, stress spreads across the network. Thus, periods of apparent 'normality' should not be seen as a triumph of the virtues of the agents, because there are no guarantees of the definitive safety of the system. Another lesson is that large institutions should be monitored with close scrutiny, as they have the potential to cause chain reactions, compromising the stability of the entire network.

Another feature of network schemes is the presence of critical points. Initially, increased connectivity produces robustness and stability. But at a certain point, the system switches side, and interconnections start to act as shock amplifiers. Cascade impacts appear, spreading risk and fragility to the environment. The final effects are usually disproportionate to the initial changes, a typical feature of nonlinear phenomena. Precisely as financial markets behavior: long periods of apparent 'normality' (robustness) abruptly interrupted by crises (weaknesses), interpreted as 'atypical' movements. Stimuli initially perceived as modest and localized, such as rupture of the sub-prime market, produce extravagant effects when they reach a critical point.

Thus, typical properties of networks – small world behavior, high interdependence, extreme events, presence of critical points – help us understand market fluctuations without appealing to arbitrary classifications (normal x atypical) or ambiguous assumptions of individual behavior (rational x emotional).

Interactions on Transit

Network attributes also help to explain individual decisions in critical moments, when triggered by external disturbances. Insights from epidemiological processes show that individuals tend to adopt two different strategies when faced with risks of contagious diseases: people typically 'hide', avoiding contact with the outside world; or 'flee', moving away from risky areas. The decision to hide facilitates local disease containment, as was the case with SARS, preserving the system as a whole. On the other hand, the decision to flee risks the population in general. The parallel with financial crisis is immediate. During moments of financial stress, some investors hide, quickly reducing market liquidity. Others run away at any price, starting disordered sales. In the first case, the crisis is limited to the market that lost liquidity; in the second one, the crisis spreads to different asset types and markets, becoming a global problem. Interestingly, a rational response on an individual level triggered a systemic problem. Connectivity produced collective externalities, unintended results from individual decisions. And in this case we cannot say that the impertinence of the limbic system is to blame.

Another example. We saw in Report n. 56 that the robustness of complex adaptive systems depends on the presence of some key attributes. One of them is diversity, a quality that brings to the system a variety of individuals, strategies and prospects. Evidence from biology shows that diversity is a key factor for the stability and resilience of ecosystems. Usually, the loss of diversity leads to imbalances and species extinction.

The same is true for financial markets. At an individual level, portfolio diversification strategies reduce risk. This willingness to diversify found abundant supply of products from financial institutions in an environment highly prone to innovation. Securitizations, debt obligations and collaterals, properly packaged, – became more prominent in the balance sheets of financial agents. At the same time, we have recently observed an evident homogeneity of strategies and performance among financial players. Asset pricing and risk management models are for the most part equally available to all market participants. As abundant liquidity brought down the threshold to access capital, excessive returns were rapidly arbitrated by imitative competition. Haldane (2009) shows that in the 2004-2007 period, the correlation of returns of large financial groups, insurance companies and hedge funds was close to one. "Finance became a monoculture. In consequence, the financial system became, like plants, animals and oceans before it, less disease-resistant. When environmental factors change for the worse, the homogeneity of the financial eco-system increased materially its probability of collapse" (Haldade, 2009). So, once more, individuals' rational motivations (sound risk management) when carried through the network of relationships that make up financial markets, eventually generated homogeneous strategies among agents, putting the stability of the system at risk. In this case, the intricate network of connections produced an emerging property, distant from individuals' original intentions.

A better understanding of the network phenomena also suggests insights for regulatory design. Before the latest crisis, regulatory scrutiny has focused on institutions' risk control instruments, viewing them as independent entities. In a broader view, taking into account the connectivity between agents, systemic risk cannot be mitigated by sophisticated individual risk management models only. Regulators should consider factors such as the contagion of key institutions (hubs), the degree of connection between financial products and the role and attributions of financial agents. Lessons from network dynamics applied to financial systems suggest a regulatory agenda that would closely monitor large institutions, favoring products that are less horizontally interlaced and a narrower definition of financial institutions' competences. Regulatory measures should promote greater task division between financial players, thereby increasing the robustness of the network. That seems to be the motivation behind the recent discussion about a return of the Glass-Steagall Act and the intention of the U.S. government to limit the activities of investment banks' proprietary desks.

Interactions in Crisis

Complex systems such as the economy and financial markets cannot be explained only by assumptions of agents' behavior, as traditional theory adepts and their leading critics insist. The structure of relationships, the nature of interconnections, should be taken into account. The problem is that, whatever the approach, the conclusion is the same: crises seem inevitable in financial markets. This uncomfortable result lands through several orbits.

Numerous experiments in behavioral finance over the past three decades, endorsed by the most recent advances in neuroscience, confirm that individuals are influenced by certain psychological characteristics when making choices involving risk. Studies show that hope and fear are two of the most prominent elements (Shefrin 2000). At the individual level, they jeopardize probability assessment, producing poor financial decisions. In aggregate, when piled up in the same direction, they produce waves of euphoria or collective panic.

In capitalist societies, the golden rule is the competitive innovation. It is what produces the creative spark of technological progress, increasing social well-being. But in the logic of development through creative destruction, competition is synonymous with anxiety and stress. The system advances by a constant battle at the frontiers of knowledge, technology and management. In an open society, stability is unknown. Opportunities and risks arise every moment. The present is fluid, the future is uncertain. If fear and hope are in *homo sapiens'* DNA, a capitalist environment is a constant call for these emotional components. Individuals pursue financial independence early in their careers (fear) or attempt to take advantage of ever-present opportunities to improve their financial situation (hope). Genetics and environment combined conspire against equilibrium and order. Financial instability is endogenous to capitalism1.

If one prefers the complexity approach, the conclusion does not change. Because of their intense interactivity, the economy and financial markets behave as complex systems. Features such as critical points, positive feedbacks, and high impact events will make any system with an abundant number of connections produce unexpected results. Furthermore, financial markets exhibit other properties, such as *tight coupling*. The term, borrowed from engineering, points out that the components of complex systems are critically interdependent, in other words, they are connected in such a way that there is little room for errors, adjustments or recalibrations (Bookstaber, 2007). In this case, the lack of margin for error is a consequence of rapid changes in prices of financial assets combined with the immediate need for liquidity. Each time, new information arrives and is incorporated by the agents, generating buy and sell orders, given the urgent need for liquidity. Prices change, leading to further updates on investment strategies, some of them even occur automatically. Mechanisms of positive feedback, such as leverage and margin calls, complicate the situation, producing nonlinear effects. The result is a system whose structure is prone to disaster, where small initial variations may encourage undesired chain reactions, producing high-impact effects.

Financial theory is in crisis. As in the real world, the debate in the field of ideas has lost direction. Seduced by reason, captured by behavior, lives a false ambiguity. Oscillates between states of sanity and pathology. The diagnosis arrives late, after symptoms become apparent.

In the legacy of the Enlightenment, crisis confronts the order of reason and questions the pretence of knowledge. In a logical world of cause and effect, those responsible disruptions must be found and punished. As we saw in the previous Report, this time the former Fed Chairman was the chosen one. And his biography has suffered the consequences. The curious thing is that attempts to make logical sense of an uncertain world are accompanied by psychological biases, as behavioral theorists point out[2]. On the other hand, behavioral and adaptive theory followers fall into a trap of reason: the crisis causes discomfort and anxious to quickly find a solution, the normative suggestion (government) runs over the good method.

The debate around agents' bipolar decision making assumptions (rational or emotional) is poor. Hence, the surprises and concerns brought by each financial crisis, where the pendulum of empiricism creates a situation in which one side seems to be winning the battle, and the other claims to be winning the war. At this point, it would be interesting to leave the anthropomorphism of economic theory and incorporate the contributions of other relevant mental models. A better understanding of interactive phenomena – complex systems and network infrastructure – provides interesting insights to comprehend the latest financial crisis. In a subject of relationships, connectivity has much to say. It produces something new, different, that is not captured by the lens of those trained to focus only on assumptions about individual behavior.

Our efforts here at Dynamo to broaden the scope of our mental models and the capabilities of our analytical toolbox have not been in vain. Some ideas are beginning to appear in light of our study of network structures.

The first takeaway is that instability is a natural part of the system. Intrinsic properties of network structures place these schemes on the edge of instability. Interactions follow unpredictable paths, often detached from participants' original intentions. Periods of apparent calmness will likely be interrupted by inexplicable fluctuations that could ultimately reshape the financial, economic, social or political landscape. That is an important lesson for equity managers, especially in a bull market. But it is probably an even more useful insight for value investors, who see their discipline particularly tested during periods of significant market appreciation.

In addition, various businesses are based on networks, for example: internet and e-commerce, software and IT platforms, telephony, payment systems, loyalty programs, and retail distribution as well. Competition dynamics in these industries can only be understood in a network context. Often, these businesses present an artificial weakness, an apparent lack of barriers to entry. However, the robustness of the network lies on the lattice of connections, on the broadness of relationships, and on the stock of accumulated knowledge – often derived

1 Any memory of Hyman Minsky's work here is not just coincidence. The sentence is inspired by the 'financial instability hypothesis' developed by the American economist in the 60s and revisited by a few good analyses of this last financial crisis.

2 In this case, the attribution bias (that overvalues the intentions and underestimates the circumstances) and the illusion of control (when someone think to have power to control or influence results that are out of her/his circle of competence).

from a long process of trial and error and not so much relied in the size of investment in physical capital, which is an attribute more evident. The privileged position of incumbents is a decentralized, counter-intuitive power. Economies of scale and positive externalities are network attributes which outsiders have more difficulty to perceive. The challenge faced by competitors who try to replicate a network-based business model is an evidence of this argument.

We intend to address this issue with a more pragmatic approach in another Report. But we still have room here for a couple of examples, as an aperitif and illustration.

A well-known result of complex network theories is the rule "*the rich get richer.*" Basically, these models attempt to explain the behavior of networks that grow through 'preferred attachments'. The conclusion is that new nodes prefer to connect to older vertices, which already have many connections. Over time, these 'single connections' end up becoming hubs themselves. Not every business with positive network externalities follows such growth pattern, typical of digital or web-based businesses (software, search engines, e-commerce, relationship websites, etc.). Companies that can move first into this type of business build obvious competitive advantages over potential newcomers. Hence the resilience of already established networks. However, in certain sectors, this attraction-effect collides with obstacles. This applies to segments where growth finds diseconomies of scale, such as airports. International hub airports grow up to a point where delays and congestion eventually transfer passenger flow to other nearby airports. Hence the expansion of regional airlines in America, which have focused on providing alternative routes to major hubs. So the lesson here is to try to identify among network business those that present *the rich get richer* effect without any physical limitations to growth. The business model of Multiple, TAM´s loyalty program spin off, appears to meet these requirements.

There is a widespread perception in the market today that companies that make capture of transactions on credit cards and debit cards, so-called 'acquirers', in this case Cielo and Redecard, should present significant falls in their profitability in future years. One reason for such concern is the possibility of entry of new players, something allowed by regulatory initiative that imposed the end of the exclusivity of the relationship between acquirers and flags, and consequently the requirement of interoperability of the POS (point of sales) machines. Analysts predict that the newcomers will go after big retailers first, as a way to gain volume (scale) and thus pay for the initial capex to establish their networks. Moreover, by taking these important customers (hubs) from the incumbents the new comers would deal a harsh blow to their competitors. It turns out that in this space, the economic contribution of large costumers is not proportional to the volume of transactions they generate. In the incumbent networks, Cielo and Redecard, the profitability seems to be generated by the small costumers, the retail one. The commercial hub is not an economic hub. Of course, it makes sense for incumbents to retain their big customers as a way to generate volume and keep their transaction costs competitive. But it is not fundamental to the profitability of the business at the end of the day. Moreover, as prices to large customers are already low, the entrant will find it difficult to monetize its initial capex following a strategy to attack the commercial hubs. Our analysis in this segment is still at the beginning and deserves more investigation, but the lesson suggests that acquirers' network in Brazil seem to present business models more robust, where attacks targeting commercial hubs, theoretically most exposed to competition, do not produce substantial damages to the business' sustainability. Moreover, much of the profitability of these companies comes from small clients, 'hidden' inside the network and representing a higher threshold for a new entrant to achieve sufficient scale.

Here at Dynamo, we follow the theoretical discussions with practical curiosity. The idea is to borrow insights from the frontier of academic knowledge that can help us in the interior of our research process. As we saw above, even in at a very early stage, our efforts to understand the dynamics of interactive processes promises rewards.

Rio de Janeiro, March, 8th, 2010.

DYNAMO COUGAR x IBX x IBOVESPA
Performance up to December/2009 (in R$)

Period	Dynamo Cougar	IBX average	Ibovespa average
60 months	185,3%	176,8%	160,4%
36 months	67,5%	48,4%	53,3%
24 months	26,6%	0,0%	6,7%
12 months	81,5%	72,1%	81,8%
3 months	17,9%	10,3%	10,8%

NAV/Share on December 31st = R$ 246,224428156

DYNAMO COUGAR x FGV-100 x IBOVESPA
(Performance – Percentage Change in US$ dollars)

Period	DYNAMO COUGAR* Quarter	DYNAMO COUGAR* Year to Date	DYNAMO COUGAR* Since 01/09/93	FGV-100** Quarter	FGV-100** Year to Date	FGV-100** Since 01/09/93	IBOVESPA*** Quarter	IBOVESPA*** Year to Date	IBOVESPA*** Since 01/09/93
1993	-	38,8%	38,8%	-	9,1%	9,1%	-	11,1%	11,1%
1994	-	245,6%	379,5%	-	165,3%	189,3%	-	58,6%	76,2%
1995	-	-3,6%	362,2%	-	-35,1%	87,9%	-	-13,5%	52,5%
1996	-	53,6%	609,8%	-	6,6%	100,3%	-	53,2%	133,6%
1997	-	-6,2%	565,5%	-	-4,1%	92,0%	-	34,4%	213,8%
1998	-	-19,1%	438,1%	-	-31,5%	31,5%	-	-38,4%	93,3%
1999	-	104,6%	1.001,2%	-	116,5%	184,7%	-	69,5%	227,6%
2000	-	3,0%	1.034,5%	-	-2,6%	177,2%	-	-18,1%	168,3%
2001	-	-6,4%	962,4%	-	-8,8%	152,7%	-	-24,0%	104,0%
2002	-	-7,9%	878,9%	-	-24,2%	91,7%	-	-46,0%	10,1%
2003	-	93,9%	1.798,5%	-	145,2%	369,9%	-	141,0%	165,4%
2004	-	64,4%	3.020,2%	-	45,0%	581,2%	-	28,2%	240,2%
1stQuar/05	-1,7%	-1,7%	2.967,4%	-1,7%	-1,7%	569,9%	1,1%	1,1%	243,8%
2ndQuar/05	5,4%	3,6%	3.133,2%	3,0%	1,3%	589,8%	7,5%	8,7%	269,6%
3rdQuar/05	32,3%	37,1%	4.178,3%	25,2%	26,8%	763,7%	31,6%	43,0%	386,5%
4thQuar/05	3,0%	41,2%	4.305,5%	3,1%	30,8%	790,7%	0,8%	44,1%	390,2%
1stQuar/06	23,3%	23,3%	5.332,9%	18,9%	18,9%	959,0%	22,5%	22,5%	500,5%
2ndQuar/06	-3,9%	18,5%	5.122,2%	-4,6%	13,4%	910,5%	-2,7%	19,2%	484,4%
3rdQuar/06	5,7%	25,3%	5.418,6%	2,6%	16,4%	937,2%	-1,0%	18,0%	478,4%
4thQuar/06	19,6%	49,8%	6.498,3%	23,0%	43,2%	1.175,8%	24,1%	46,4%	617,7%
1stQuar/07	9,7%	9,7%	7.136,3%	10,1%	10,1%	1.304,3%	6,7%	6,7%	665,8%
2ndQuar/07	29,3%	41,9%	9.259,4%	28,8%	41,8%	1.709,3%	27,2%	35,7%	874,1%
3rdQuar/07	7,5%	52,4%	9.957,6%	15,7%	64,1%	1.993,7%	16,4%	58,0%	1.033,7%
4thQuar/07	4,8%	59,7%	10.436,6%	2,6%	68,4%	2.048,7%	9,8%	73,4%	1.144,6%
1stQuar/08	-1,7%	-1,7%	10.253,1%	4,1%	4,1%	2.136,6%	-4,1%	-4,1%	1.094,1%
2ndQuar/08	16,4%	14,4%	11.950,7%	11,6%	16,1%	2.395,0%	17,9%	13,2%	1.308,3%
3rdQuar/08	-32,9%	-23,3%	7.983,4%	-23,4%	-26,0%	1.480,9%	-38,7%	-30,7%	763,2%
4thQuar/08	-31,1%	-47,1%	5.470,1%	-17,6%	-50,1%	973,3%	-35,9%	-55,5%	453,7%
1stQuar/09	8,1%	8,1%	5.919,9%	5,1%	5,1%	1.027,5%	10,6%	10,6%	512,5%
2ndQuar/09	44,7%	56,41%	8.612,4%	52,0%	59,6%	1.613,5%	48,8%	64,6%	811,6%
3rdQuar/09	29,4%	102,4%	11.175,9%	34,8%	115,2%	2.210,2%	30,9%	115,5%	1.093,2%
4thQuar/09	20,4%	143,7%	13.472,6%	17,0%	151,9%	2.603,3%	13,2%	144,0%	1.250,7%

Average Net Asset Value for Dynamo Cougar (Last 36 months): R$ 894.761.554,31

(*) The Dynamo Cougar Fund figures are audited by Price Waterhouse and Coopers and returns net of all costs and fees, except for Adjustment of Performance Fee, if due.
(**) Index that includes 100 companies, but excludes banks and state-owned companies. (***) Ibovespa average.

Please visit our website if you would like to compare the performance of Dynamo funds to other indices:

www.dynamo.com.br

DYNAMO

DYNAMO ADMINISTRAÇÃO DE RECURSOS LTDA.
Av. Ataulfo de Paiva, 1351 / 7° andar. Leblon. 22440-031. Rio. RJ. Brazil. Phone: (55 21) 2512-9394. Fax: (55 21) 2512-5720

PRINTED IN RECYCLED PAPER