15. APPROACHING ECONOMIC ISSUES THROUGH EPIDEMIOLOGY – AN INTRODUCTION TO BUSINESS EPIDEMIOLOGY

Brăduț BOLOŞ[1]
Vladimir BACÂREA[2]
Marius MĂRUSTERI[3]

Abstract

In the tradition of transferring models and concepts from one science to another, our research explores the possibility of importing some concepts, definitions and approaches from human epidemiology to economic research, based on the extensive usage of medical terms and concepts in economy. The article explores some basic epidemiology concepts and their possible relevance to economic research, with the final goal to provide a new viewpoint over the economic phenomena, usable in economic crisis.

The article introduces the concept of "business epidemiology" as a possible scientific approach to the economic crisis.

Keywords: epidemiology; business disease; company health; research methodology; financial contagion

JEL Classification: E32, E60, F41

1. Prologue

Some economists have observed that the economic crisis, as a phenomenon, has spread throughout the financial markets, manifesting itself like a "financial disease" infecting the stock-exchange, and, from there, the world financial markets and beyond,

[1] *Petru Maior University of Târgu-Mures, Faculty of Economic and Administrative Sciences, Accounting and Finances Department, e-mail: bradut.bolos@ea.upm.ro.*
[2] *Medicine and Pharmacy University of Târgu-Mures, Faculty of Medicine, Research Methodology Department.*
[3] *Medicine and Pharmacy University of Târgu-Mures, Faculty of Pharmacy, Medical Informatics and Biostatistics Department.*

to the small businesses. This is sometimes described as a case of financial contagion, being metaphorically described by Nouriel Roubini as a "pandemic" (Roubini, 2008). The metaphors "financial disease" and "economic disease" were used, for a long time, to describe the economic crisis in countless contexts. As another example, Piia-Noora Kauppi, Managing Director of the Federation of Finnish Financial Services uses the expression "health of public finances" (Kaupi, 2010). Examples of usage of expressions like economic recovery, economic health, financial health, are included in scientific papers and in economic literature, as metaphors, in a wide variety of contexts. The money and the financial markets are in many cases described as the "circulatory system" of the economy by the finance authors.

In a declared "clinical analysis", Bertrand Candelon affirms: "The analogy to medicine is straightforward in the case of financial crisis, especially if one remembers the name given to the recent crises: the Asian flu or the Russian cold" (Candelon, 2008, p. 7). Thus, we have to observe the fact that there are medical terms and concepts associated with the economic crisis. Even linguistics researchers have noticed this trend. In the context of analysis of the economic argumentation, Rigotti and Palmieri affirm: "very often, financial/economic crisis as well as political and social crisis, are read in terms of illness, of disease, where the patients correspond to the concerned contexts in trouble – ranging from the market, to the country, from the industrial sector to single firms – and the failure of these organizations is frequently identified with their death" (Rigotti and Palmieri, 2010).

Thus, we consider the use of medical terms in economics as a fact, because, in order to explain their intuition and empirical observations regarding the crisis, and many other dangerous conditions of economies and businesses several scientists, politicians, journalists and managers have used these terms, and, as a consequence, we consider there is a need for a conceptual investigation using this medical-economical approach. "The use of sectors/lens has the advantage of highlighting, and, therefore, making easier to see certain qualities of whatever is being observed. It is a way of unpacking the confusion of the whole" (Buzan, Jones and Little, 1993, p. 31). As different authors use a "medical lens" aiming to see the economy in a more clear way, we should attempt to study this "lens" and to some extent perfect it.

The use of medical terms may be seen as simple use of metaphors and analogies, but just as well as a need for a better conceptual frame in economics. We do not argue against the fact that as they are, those metaphors may not describe exactly the phenomenon, because companies are not humans and the human diseases are a different matter than business diseases, but, nevertheless they may improve what we use now.

Our goal is to attempt to link the economic-medical metaphoric expressions to economic science concepts, and, in this case, to determine some facts that emerge from this kind of conceptualization.

Historically, from time to time, in the economic sciences several concepts and approaches have been imported from different sciences, like physics, meteorology, mathematics, biology and medicine. Using this perspective, in economics the "diagnostic" term and "neural networks" expressions, which came from medicine, are already accepted and widely used.

In our opinion, if a migration of concepts from the medical field is to be scientifically sound, the most usable science to be related to "pandemic" diseases of the economy is the Epidemiology. This is because Epidemiology is the medical science that deals with diseases affecting large numbers of people at a global scale, and with especially contagious (communicable) diseases.

Thus, the question is if Epidemiology-Economics migration of concepts could, and should help create a better understanding of economic crisis. If this is the case, which economic science should be researching this specific approach?

In a reverse logic, the epidemiology has imported some concepts from economic sciences, but from a medical management point of view. Epidemics have been studied from an economic point of view by several scholars [(Mullins, 1994), (Bloom and Canning, 2006)], and there are two established fields of research, the Economic Epidemiology, and the Pharma-economics. The Economic Epidemiology studies the economic impact of epidemics, in order to determine an economic manner of dealing with an epidemic. The Pharma-economics studies the optimal cost-efficient treatment procedures for drug prescription, as field of health management.

In order to avoid confusions of terms we will use the term "business epidemiology" as the epidemiological research of unspecified "business diseases". The premise of "business epidemiology" is that some conditions can be transmitted from a business to another and spread in a networked economy, if "financial contagion" can be seen as "epidemiological-like" transmissions from business to business and from market to market, with the final purpose to identify disorder's "treatments".

2. The disease concept in economics

In medical terms, a disease is described as an abnormal condition of an organism that impairs bodily functions. In Epidemiology, the social, or work-related disease is described as a human body disease generated by economic environment. Those diseases are poverty-linked disease (malnutrition) and work-related diseases (like silicosis for glass workers, led poisoning for workers that use lead, radiation exposure for uranium miners, depression generated by unemployment, headache generated by stress, and so on).

In economics, the term "disease" is not defined, but sometimes used in different contexts to describe abnormality of economic systems, ranging from company, branch, national, regional, even global economy, or a market or a government entity. In some cases, disease is associated with bankruptcy (or default) risk. "Disease" is both in medicine and in economics the opposite of "health".

In order to define properly the economic entities diseases, we should always identify the type of entity associated with abnormality. This is because economic phenomenon is seen in a different manner at different levels, so a market disease is not the same with a SME disease. They may be linked, they may be correlated or not, so we should approach them in a different manner.

In our opinion, most economic phenomenon that manifest at larger levels of the economy are generated by behavior regarding, related to, or influencing businesses.

The basic "business organisms" are the companies and their body comprises the combination of resources and processes reunited into the company system. From systemic viewpoint, both a human body and a company are seen as systems.

If we use the "medical lens" on companies and use the "disease" concept from medicine on them, we see companies that show abnormalities as "diseased", as long as those abnormalities impair their functions. We must emphasize the *impairment* of functions because "abnormal" may be seen as "original" and this is not implicitly a dangerous state.

If we need an expression that may sum the association between economic phenomenon and disease, we could use "economic disease". The functioning of companies is generally defined as business activity, so another correct association is "business disease".

"*Economic disease*" or "*business disease"* should be defined in this perspective as an abnormal condition of an economic entity that impairs its normal functions. We can use "economic disease" for an abnormality at macro-level and "business disease" for an abnormality at micro-level. Probably future evolutions may determine a different approach. A "business disease" example is the loss caused by management disorders; an "economic disease" example is a structural inefficiency of the economy.

What is the use of such an association of terms? Could the business disease concept help in some ways to explain better the economy? In our opinion it does, because it may help concentrate in a usable manner information and experience regarding complex, repetitive, negative phenomena that damage businesses. Our hypothesis, based on medicine experience and translated to economics is that a known disease is by far more likely to be cured, as compared to an unknown condition. This means that if we manage to identify a known disease and known approaches that may prevent, or treat such a condition, and concentrate all this on a disease description, with experience and research documented, and procedures to address it, we have a usable, easy to replicate solution to economic problems.

Since there is a wide variety of diseases, the first step in determining the existence of the disease is to ascertain if the signs and symptoms of a patient are normal or abnormal.

Case definition is important to define for each kind of disease, being the first step in an epidemic outbreak fight. In economic terms, the existence of a business disease should be defined as a combination of indicators decline (such as, but not limited to, turnover, profit and related indicators, assets, liabilities, number of employees, employee's wages, etc). All those indicators would suggest that a company may have a sort of disease or not. This can be done by using scores, Key Performance Indicators.

In medical terms, health may be defined as a state of complete good physical, mental and social status, comprising the lack of illness and infirmity and a dynamic adaptation and equilibrium between the human organism and the surrounding environment.

In economic and business terms, *health* may be defined as a state of good of all assets, management, workforce, public image and the ability to adapt the company to

the changes of the surrounding geographic, climatic, social, economic and political environment.

In medical terms, the disease is a consequence of the failure of the human body to adapt to biological, physical, chemical or social aggressions.

In business terms, the disease may be the consequence of the failure of a company to adapt to economic, social, environmental or political aggressions.

3. The Financial Contagion

There is a documented, researched business disease, known in Finance as "financial contagion", and there are already implemented procedures designed to prevent, contain and treat the financial contagion.

The contagion phenomenon is quite known to researchers, especially in Finances. The "financial contagion" and "financial contagion risk" concepts have been in use for quite some time related to the interbank market impact of a bank default. Researching financial contagion, Dirk Schoenmaker has proven, using data regarding bank failures in USA between 1880 and 1934, that "bank failures are dependent after controlling for macro-economic influences" (Schoenmaker, 1996). Investigating the contagion in the emerging markets, specifically Latin American countries, Rodrigo Valdez has discovered that "probability of repayment of a country is negatively affected by illiquidity of other countries" (Valdez, 1997).

We have identified studies made in Finland, Belgium, the United Kingdom, Germany, and Romania related to this topic, most of them focusing on the case of a sudden default of a major bank and the possible contagion to other banks, with various models used for this purpose.

Table 1

Data used for financial contagion research

Study	Objectives	Data used
(Dardac and Moinescu, 2006)	Bank default contagion risk caused by fraud	Interbank exposures matrix Systemic risk level Systemic risk severity
(Iyer and Peydró, 2006)	Financial contagion occurrence, case study in India, State of Gujarat	Interbank exposures, financial statements, press releases
(Van Lelyveld and Liedorp, 2006)	Contagion models, Netherlands data case study	Interbank lending matrix Survey

Researchers involved in this matter are usually familiar with banking industry, and more specific to the National Banks, so the reasons of their interest to direct interbank contagion are obvious.

Most banks should use risk management tools, as provided by Basel I and Basel II Agreements, designed, among other things, to diminish default contagion through the banking system. The national banks and governments are usually very sensitive to bank difficulties and tend to intervene rapidly in order to isolate and contain the case. The present situations suggest that systemic banking problems may "infect" governments as well (the 2010 Ireland case).

In our opinion, this system is, to some extent, flawed, as banks rarely go bankrupt accidentally, for internal causes only. Because banks are players of an oligopoly market, usually their behavior is likely to be copied by other banks, as long as profits are apparent. So the issue here is not the contagion of the "default', but the contagion of the behavior leading to default, and that spreads some time before the actual "death by bankruptcy". Another known issue, rarely taken into account, is that the financial contagion seen as banks' default generating other banks' defaults, may not be triggered by the banks themselves, but by banks' customers (creditors or debtors), and exposure alone may not be relevant. When market panic sets in, all usual premises become irrelevant, and the logic of panic behavior becomes the rule, with new premises. If a bank becomes bankrupt, it may trigger other banks to fail directly because of exposures, but that is not the main risk. The main risk is the "contagion" of financial market panic behavior.

We consider the interbank financial contagion as it was studied a fairly rare occurrence, but very spectacular. Bank failures are rare as compared to smaller size business failures. In a metaphoric way, bank failures are like air crashes, small business failures are like car crashes. There are thousands of business failures for one bank crash, so we have to assume that interbank financial contagion is just one of many diseases.

At World Bank level, the financial contagion is defined using three levels, a broad definition, a restrictive definition and a very restrictive definition.

The broad definition states: "Contagion is the cross-country transmission of shocks or the general cross-country spillover effects" (The World Bank, 2010). This is a macroeconomic level of the contagion, and international financial markets behavior is the focus of the definition. This also implies that contagion is an international phenomenon. We do not interpret contagion as a strictly international matter, as financial market shocks first appear and spread on a specific regional or national market.

The restrictive definition states: "Contagion is the transmission of shocks to other countries or the cross-country correlation, beyond any fundamental link among the countries and beyond common shocks. This definition is usually referred as excess co-movement, commonly explained by herding behavior" (The World Bank, 2010). Monica Billio and Massimiliano Caporin characterized this definition as the most controversial definition (Billio and Caporin, 2010), and for good reason. Shocks are visible and spectacular phenomena, but they are just a small part of the possible transmissions of factors that may trigger a crisis situation. Beyond that, shocks are short-term explosive events, but they may be the visible part of an underlying condition of economies that spread a long time before.

The very restrictive definition states: "Contagion occurs when cross-country correlations increase during 'crisis times' relative to correlations during 'tranquil times'" (The World Bank, 2010). This is also a debatable definition, because contagion most likely occurs during tranquil times and becomes visible during crisis times.

Another definition of contagion may be "the migration of market disturbances - mostly those having a negative impact on the market – from one country to another" (Ionescu, Vilag, Vasile and Toader, 2009).

"The default of an agent can generate a diffusion of bankruptcies across the network and the likelihood of this phenomenon depends on the structure of the network" (Gallegati, Delli Gati, Greenwald, and Stiglitz, 2008). This diffusion is actually a contagion, and the level of the diffusion studied is related to company level.

We do not intend to discuss either the World Bank definition or other definitions focused on international financial markets or international trade, as their definitions suit very well their purpose, and macroeconomic impact level; instead, we intend to focus on a much detailed level of contagion, as we consider companies the most important subject of contagion. Our definition of contagion, based on epidemiological approach is: a direct or indirect transmission of a business disease from a company to another. According to wider approaches, the definition we propose for contagion is: a direct or indirect transmission of a market, economy, and branch disease.

Thus, from our point of view, the "financial disease" is a transmission of financial disorders from a company to another. From this point of view, the interbank financial contagion is the transmission of financial disorders from a bank to another.

Contagion phenomenon does not limit to financial markets. In a networked economy, clusters of companies work together and generate a synergic mutual benefit. However, as a study made by Wu Bao, Chi Renyong and Shen Yan Zhejiang has shown: "inter-firm network would derive unexpected risks for clustered firm, and cause risk agglomeration in industrial cluster by diffusing and superimposing risk impact from individual firm" (Wu, Chi, and Shen, 2010). This risk accumulation is derived from inter-firm complex exposures, and is consistent with a different type of contagion, much more complex than the financial contagion.

"Financial crises often follow what appear to be bubbles in asset prices" (Franklin and Gale, 1998). In our interpretation, this means the crisis symptom follows other symptoms of a business disease. And the financial contagion aspect is just a dimension of a wider "economic health" issue.

In an epidemiological approach to business, we should have data regarding symptoms, risk factors, which should enable us to identify the presence and contagion of a business disease, especially known, or, even unknown, and a system in place that should monitor, investigate and deal with possible outbreaks before contagion becomes critical, and a widespread economic crisis sets in.

The main point and major significance of the financial contagion phenomenon is that this is a business disease, and that it spreads from business to business. Our concern is that there are other less obvious business diseases which are not as well documented, but may generate just as much loss to the economy.

However, as a "contagious business disease" by our approach, the "case definition" of a bank default should be a little different. Banks may be less exposed to contagion, as compared to other businesses, as they benefit from a wide range of systems designed to block the spread of such "disease".

4. Methods for identifying contagion

The studies we have mentioned before investigated several mathematical models usable as a base for future contagion studies. However, what has to be emphasized is the required data for such models, based on known interbank market exposures (for interbank contagion), or based on stock market data.

Exposures of the banks may be known in some countries, but there is no such available data regarding a wider array of companies. We do not know of any mean to determine all relations between all companies at national and international level, and their financial behavior. Thus, those models may be usable for "financial contagion" of the interbank lending market, but they lack the data required to determine financial contagion risk and possible ripple effects in other branches or at national economy levels. Therefore, the financial contagion is most likely to happen in all sorts of companies, so some system of research is obviously required.

In an ideal data accessibility heaven, type of Leontief[4] model could be used to create a representation of reletionships beween all companies, as an basis for known events ripple effects empiric determination.

In such a case, the general exposure matrix would be defined as a matrix containing all exposures of all companies to all companies. In reality, considering the size of such a matrix, the required data needed and the time required to collect, verify and process, this approach it is not likely to be feasible, even if today's computing and data transfer technology could suggest it may be technically possible. Another weak point of this study is that exposure is defined as receivables on long term or short term. Receivables do not show the whole picture, as size of the relationship between entities. Losing receivables may be less an issue as compared to losing turnover, especially if we consider upstream-downstream relationships. Thus, in order to use a systemic view and map the input-output relationships, we should use at least these two dimensions of exposures, but we can be sure that further research may identify other significant measurable direct relationships.

In a research over international trade contagion, Raja Kali and Javier Reyes use a network study approach (Kali and Reyes, 2010). They measured the connectedness of markets using some indicators specific to networks like node degree centrality, importance of country, maximum flow, using data from NBER-UN word trade database. Again, this is an approach highly interesting as a methodological inspiration, but unusable at this time for more detailed national, branch, regional networks, as data required is quasi-unavailable.

However, following this path, instead of a matrix, we can imagine a network, where each company is a node and relationships are the channels of contagion. In order to be functional, a model based on this framework would need a map of relationships, and this is a huge undertaking by itself. Since each company has different sensitivity to contagion, the model would imply the existence of some data regarding the company, allowing to measure or predict to some extent the reaction to contagions.

[4] *We refer to an input-output analysis similar as a concept to the one used by W. Leontief, but using companies, not branches, and inputs and outputs seen as financial flows between them.*

The data available should allow a determination of node degree, centrality, importance of company, maximum flow.

All this macro-models seem usable, but they have the same major flaw, they are based on old data, as time is needed to collect all the data, so they most likely would not be able to generate warnings early enough in most situations. Monitoring the required data for such macro-models, either based on a Leontieff table or network focused models is less likely to be feasible at micro-level. As XBRL itself and its use expand, and accounting evolves, such a system being put in place in a foreseeable future is not unthinkable. This would mean having real time financial and trade statements of some sort available online for whole economies, and maybe a stock market based on real-time fundamental data, instead of a market based on speculation over other player's response.

Thus, if systematic, large scale model-based research is less likely to be feasible, we are suggesting a change of perspective. Instead of researching huge networks we suggest to study negative phenomenon starting from the most basic subsystem, the company, and gathering information based on repetitive negative phenomenon, such as financial contagion.

What we propose is to see companies like living creatures, parts of an economic ecosystem (national or global market). This is by itself not a new approach, as there are many scholars that have seen businesses and economic structures as "living organisms", capable of self-sustainability and self-replication. Some of them introduced also the biological concept of autopoiesis in the study of economic systems [(Zeleny, 1997), (Boulding, 1980), (Teubner and Alberto, 1992)]. Milan Zelezny has characterized economic systems as being either self-sustaining (autopoietic), either sustained by other sustainable systems (heteropoietic), or resource depleting systems (alopoietic). In this view, a company can be defined as sustainable, thus healthy if it is alopoietic or heteropoietic in an autopoietic economy (macro-system). Thus, if we go further, we can define business disease as a condition of an entity that may generate the transformation of the economic macro-system from the autopoietic condition to an alopoietic condition. A contagion should be the transmission of such a business disease. Such contagions are cases of unsustainable assets valuation growth (assets ranging from tulip roots, stocks, land, derivates and any other kind of asset), generated by a contagion of over-valuation practice, or unsustainable consumption growth of non-regenerative resources (oil crisis).

Companies are constantly changing, evolving, and adapting to their environment, and interconnect between themselves. So, instead of attempting to identify all relationships, and all characteristics, we propose to focus the research on abnormalities, seen as business diseases. This view goes not from macro to micro-phenomenon but from micro to macro. Thus, instead of attempting to deal with contagion from top to bottom, we propose an approach that creates the means to research, accumulate information, and later have the means to identify and micro-manage contagion phenomenon. In order to define contagion, we should identify alopoetic behaviors, especially contagious behaviors that generate an alopoetic macro-system.

An "epidemiological" approach could be feasible, using standard procedures as means of identifying the pattern of a business disease (comprising the abnormality description, symptoms, the transmission channels, and the risk factors). Such studies could be used to issue general recommendations, cases signaling procedures, and intervention means, designed to contain the outbreak and reduce the contagion risk, and maybe save some of the diseased businesses. This is already done, to some extent, in all insolvency procedures, but insolvency reports are not standardized, as they are done (in Romania) mostly by lawyers focused on legal procedures rather than economics, and once issued, are not centralized and studied systematically in search of similarities. Moreover, the relationships with other insolvency cases are not mapped in any way. Because of this, at this time, we are lacking data that would enable us to determine clearly the existence of a business disease, and identify early symptoms. We may know to some extent huge financial contagions, like economic crisis at branch, national, regional, or global levels, but smaller contagions are rarely observed. If we accept as a fact the financial contagion, and accumulate data regarding it, new occurrences could be stopped by monitoring known risk factors, and treating smaller grade occurrences before they spread, thus diminishing the economic macro-spillovers.

In order to be able to identify systematically the contagious business disease, each insolvency case should generate data required for such analysis, including trade, credit and taxation figures, and a map of business relationships. The next step should be an attempt to link the insolvency cases by means of the direct trade relationships, and common trade relationships, and if such links are identified, they should be studied separately. This is an investigation similar to an epidemiologic investigation of transmittable diseases to humans, and in our view, it makes more sense than attempting huge scale data mining, on companies financial data, with debatable results. The statistical large scale study stage should be done later, in the research phase, when symptoms are clearly determined and risk factors for different business disease contagion clearly identified, with the purpose of verification.

If done properly, in time, we expect this process to have a huge impact on statistical surveys objectives, financial reporting, accounting standards, and auditing standards, as dangerous conditions should be identified, measured and reported to the creditors, investors, monitoring bodies of the financial markets, government and general public. As new disease will be identified, and data required for some sort of early warning system will be identified, this data will be included in reporting, as significant for the business future of the company. This is consistent as a process with the continuous evolution of the accounting and auditing standards. However, accounting alone cannot give the whole picture of the business disease, as human behavior is the drive of company behaviors, but is a good starting point, as much data is available.

Table 2

Relationship between diagnostic tests and disease

	Disease	
Indicator results	Present	Absent
Positive	True positive	False positive
Negative	False negative	True Negative

In terms of disease identification criteria, medicine uses laboratory analysis and symptom analysis. Usually, the tests used are interpreted statistically using a Gaussian function (normal distribution within a population) based on probability distribution. Taking into account the variable degree of precision for each test is required. Individually, the test used may indicate positive, negative, but also false positive and false negative results One indicator may not point out a disease, but the cumulative probability of several indicators points out to a disease, in high probability. This may also be the case with companies' diagnostics indicators.

In economic terms, if we use a selected group of Key Performance Indicators (KPI) for the diagnostic of a company, each can point out the presence or absence of a disease with a known probability. Based on known cases, the probability of such significance can be determined. However, the indication of the disease is done by the combined probability of the whole system of indicators.

As we have not yet studied a business disease in such a way, the indicators, the significance range values and probabilities for the presence of any business diseases are yet unknown. And as medical epidemiologic research experience has shown, such data are not easily obtained and scientifically validated. However, the approach shows promise, as it may help economic researchers to select the KPI systems, based on the probability of generating relevant failure risk. Moreover, different combinations of KPI may be used to refine the diagnostic of different diseases, after diseases have been identified, defined and researched.

Thus, in our view, researching business disease identification means determining the system of indicators that generate the highest accumulated probability to reveal either the presence or absence of a company's dangerous abnormality. This research approach could be extended to macroeconomic level, either to study macroeconomic entities diseases or, to model the contagion of such business disease in a wider context.

This stage of research should rely on insolvency reports for the identification of dangerous abnormal conditions, but at later stages could be based on other abnormalities reports.

5. Methods of researching a business disease

As epidemiologic methodology there are three basic types of study: the case study, the case control study and the cohort study.

The process of a "business epidemiologic" *case study* starts with monitoring insolvency situations. This can be done using insolvency reports already available as data source. Each insolvency report contains a sum of reasons for the insolvency. The first grouping should be based on those reasons, as the objective is to identify companies with the same insolvency causes.

The next step is based on economic analysis methods, and basic economic diagnostic indicators, and mainly contains a determination of past time indicators, and identification of correlation between known indicators of the group of "diseased" companies. This is the process of identifying the possible source of the business disease.

At this stage, all that can be determined is that there is a group of companies that apparently share the same failure reasons, and maybe have some common identifiable financial position characteristics and economic behaviors. The next step is to determine if there is a link between them, as being the presumed contagion channel. A contagion could be assumed if a common link exists, either direct or indirect (through an identifiable entity). This is required in order to identify the possible transmission means.

This approach is consistent with the "*case series*" design used in epidemiologic research. However, this type of study cannot be used in order to issue general recommendations in epidemiology, as they serve as epidemiologic hypothesis generation for further study. In medical epidemiology, the idea study design is to compare periods of time when the same patients are exposed to risk factors with periods when they are not exposed. In business epidemiology, the same rule should apply, comparing the periods of distress with the periods of health, if any.

As mathematical models usable, network propagation is consistent with graph theory, but seems feasible just for a small propagation study.

A simple approach, based on scoring methods is to weight some indicators in order to obtain a custom score for survivability prognosis, or use the Altman Z-Score, or Harrod-Domar model of scoring in order to identify some degree of abnormality. As an example, the presence of a business disease could be indicated by an unexpected failure of a company otherwise expected to be financially stable. As another example, the failure of an AAA rated company should show either a serious hidden underlying condition, or a contagion. Confirmed predictable failures usually mean known bad management and governance issues. They are unlikely to generate a serious contagion as banks usually have systems in place that should identify common risk factors and procedures in place designed to contain such cases. A higher than usual count of failures may be significant and may be a sign of a macro-systemic business disease, probably with a longer set-in timeframe.

The most significant cases are the ones when failure was unpredictable using usual methods. They show a possible new abnormality. In abnormal conditions, scores cannot be used as they are, but their methodology of determination can be used to emphasize a certain shift of risk, by using a more complex model.

The next phase in determining the existence and research of an epidemic business disease is the "*case control study*". In this phase, subjects exposed to different risk factors are compared with subjects who are not exposed. As an example, in economy, we can compare companies having similar size, activity, and other characteristics from an area with others from other areas (in order to identify some regional factors), companies having similar size and location but different branches (in order to identify branch-related factors), companies with similar location and branch but different size (for size-related factors) and so on. This way the risk factors significance can be statistically determined for each disease.

If an abnormal condition is supposed to be present, scoring of any kind is useless because the weight of indicators and intervals of score are determined using data collected in normal conditions. Even if we had scores determined for abnormal conditions, due to the rarity, variety, and scattering of those conditions, and the long

intervals of times between occurrences, it is unlikely that the accounting data they should be built upon would be consistent with present-day accounting standards. Accounting may not change very much over short periods, but for long periods changes are to be expected. So, a different method than scoring is required. In a supposed abnormal condition, the vectors representing the diseased companies should be compared with other vectors from the control group, containing companies that have no exposure to each risk factor.

The control group should come from the same population of companies and have a similar distribution with the diseased group. The most important part of generating a valid outcome is a correct selection of the control group companies.

The next step is constructing a simple 2X2 matrix (see Table 3).

The A/C ratio is expressing the odds of risk factor being present in a disease, while the B/D ratio represents the odds of being exposed and not getting the disease. The indicator used in epidemiology to express this is the Odd Ratio (OR), being the ratio of A/C to B/D. If OR is less than 1 the factor is a protective factor, if OR is close to 1 the association is unlikely, if OR is significantly larger than 1 the risk factor is likely to cause the business failure. In all cases, some statistical confidence tests are required.

Table 3

Odd Ratio Matrix

Risk Factor	Diseased group	Control group
Exposed	A	B
Unexposed	C	D

As a theoretical example, a group of 100 companies in process of insolvency is identified, having different size branches and locations. In order to test the risk factors, we choose a control group of 100 companies that have a better financial position, but the same branches and locations.

Table 4

Bank X OR matrix

Bank X Creditor	Disease present	Disease absent	Total
Exposed	49 (25%)	70 (35%)	119 (60%)
Unexposed	51 (26%)	30 (15%)	81 (41%)
Total	100 (50%)	100 (50%)	200 (100%)

OR= (49:51):(70:30)= 0.96:2.33=0.4118

A statistical significance test is required, so we determined by means of the Chi-square test that the two-sided P value is 0.0040, considered very significant, and that the row/column association is statistically significant (confidence interval: 0.2305 to 0.7357, confidence 95%, using the approximation of Woolf).

In this case, as values of the Odds Ratio are below 1, the bank X is apparently a protective factor.

Table 5

Client type Y OR matrix

Customer type Y	Disease present	Disease absent	Total
Exposed	35 (18%)	2 (1%)	37 (19%)
Unexposed	65 (33%)	98 (49%)	163 (82%)
Total	100 (50%)	100 (50%)	200 (100%)

OR= (35/65):(2/98) = 0.53:0.020=2.65385

Using Fisher's Exact Test, we determined that the two-sided P value is < 0.0001, considered extremely significant, and that the row/column association is statistically significant (confidence interval 6.131 to 113.54, confidence 95%, using the approximation of Woolf).

In this case, as OR is above 1; the client Y is likely to be a significant risk factor, and should be researched further. This is because even if most of the diseased group was not exposed, a much higher proportion of the control group remained healthy by not being exposed. As it is, probably the research should follow the branch of the customer Y, the region of the customer, the owner of the customer, in order to identify the cause of this, if any. As we can observe for this approach, this is not a straightforward approach, as disease in humans as well as disease in companies is not generated by a single factor, and sorting the risk factors can be misleading and debatable, but is nevertheless a necessary process.

In both cases, we have used epidemiological statistical freeware software that does the calculations and significance tests, and calculate the confidence intervals and P values.

As a method, this type of study is not very accurate, but can provide relatively easy some useful information regarding the risk factors involved. If the control group is not correctly chosen, results may be faulty. As a concept, the “case control” method is consistent with the benchmarking type of economic analysis, and the use of Odd Ratio is consistent with the survey methodology used commonly in social sciences. Apparently, there is nothing new in using epidemiological approach, except the way we interpret the data, and the way we suggest it should be concentrated on the information obtained. We should point out that in this type of research there are inherent difficulties regarding the data availability, especially from the companies that are not in difficulty. Companies may be reluctant or refuse to provide such data as exposures, bank relations and such, especially in turbulent times. In both cases, we have selected exposure for the example, but we have not defined the exposure measurement indicator, because the most significant indicator is yet to be determined, but it can be either receivables at the end of the year or yearly sales for customer type, and credits received for the bank X example. We do not limit the use of the method to financial exposures, as all types of exposures could be tested (such as, but not limited to: behavior types, branch, location, employee types, and employee behaviors).

A more powerful research tool is the epidemiologic *cohort study*. Such a study is based on selecting and monitoring subjects based on initial exposure status. As an

example, a study over customer type Y (following the example we have used before), considered as a risk factor, should use subjects that are initially non-exposed. The research subjects should be separated into two cohorts, one of them being subject to exposure, and one functioning as a non-exposed control group. The study will investigate the appearance of the disease under research in both cohorts. The measuring tool is the Relative Risk (RR) being the measure of difference between incidence appearance probabilities in the two cohorts. Based on probabilistic calculation, the relative risk indicates better the influence of the exposure. We say that X effect is RR times more frequent in exposed cohort than in the unexposed one.

The RR is a much more relevant estimation than OR, but it costs more, and has to be done over a wider timeframe.

All three types of studies are designed to sort the risk factors as accurately as possible. They are all derived from the probability study used in social sciences. Determining risks in different ways is common to economic science, and probability mathematics is also a common approach. What is different in our approach is the hypothesis to be tested, and this is that a certain abnormality can be identified as a specific business disease, and as a consequence, later on, after determining the risk factors, the occurrence probability can be lowered by controlling those risk factors, at macro-level, and, at micro-level, to generate awareness of scientifically determined risk factors for businesses, and ways to approach them.

The medical epidemiologic approach paradigm, based on the hypothesis that diseases occurrence probability is influenced by a combination of risk factors, each contributing to it, is very similar to some economics default risk approaches, but seems in our opinion more refined, as it approaches different diseases and determine risk factors, compared to a single risk, the default (or bankruptcy) risk.

We can imagine ways to model exposures in large scale models, based on correlations determined by surveys based on public data contained in financial statements, but not in such a detailed way as it is required for epidemiologic research. This points out that survey is the only method of obtaining data required for such a study, and that some kind of exposure measurement should be included in the financial statements in order to allow for later stage research over bottom to top contagion modeling process at macroeconomic level. Large scale research can only be based on available data, so dependent variables are based on financial statement derived data, and the independent variable should be the risk factors identified. Financial data are standardized, but the risk factors are unlikely to be. This means the risk factors should be obtained by other means. On smaller scale, for small numbers of companies this is feasible, however there is a confidence relativity derived from generalizing the conclusions. A 1:1000 probability becomes highly probable in 1.000.000 cases. If we investigate contagion cases, we can assume the occurrence can, even if unlikely, trigger a disproportionate size event.

6. Differences in approaching epidemics from medical and/or economic perspectives

There are differences between normality in medicine and normality in economy that we must underline.

Medicine has names for diseases, Economy has not. Even if this statement seems irrelevant, in our view it states that economic science concentrates information regarding abnormal failure of companies in a simple, bottom-line way, which has little relevance in the end. There is no such thing as a "financial diabetes", "commercial flue", in order to define known, identifiable and repeatable chains of events, sum of reasons, and composition of risks that lead to the failure of a business. Knowing a disease means usually knowing to a certain extent what is going to happen, and even the approach required in order to diminish the failure probability.

All companies report their health status through the financial reports, people do not. So, screening the population of companies should be easier. However, in times of crisis companies may get ill and die in large numbers before the next annual report. Even if there are some score methods that may show a failure probability (Altman Z-Score, Harrod-Domar), they provide little to no information about the reasons, and even less in terms of solutions.

The health system is expected to have some treatments or cures for all people's diseases. There are discussions whether the government should intervene and cure the "disease" of any company. However, a widely spread economic disease, affecting large numbers of companies, would usually justify the government intervention. The main reason for this is the experience of subjective, political and corruption-based public intervention. This is where an epidemiologic approach can be actually useful, in providing some objective reasons to select, direct and size the government intervention in a free market economy.

If self-medication and self-treatment is normal - but not recommended to people - "self medication" and "self treatment" is required from the companies, as they are expected to solve their own difficulties without government aid. Nevertheless, knowing that there is a disease and an accurate diagnostic is the first step for any kind of treatment both to humans and companies. In a free market paradigm, companies are expected to be able to survive by themselves. But being highly networked and inter-linked, companies may be able to absorb most of the shocks, however, sometimes, there are phenomena that propagate and replicate themselves within many, most, or even all the nodes of the economic network. These are rare events, which may occur beyond the timeframe of most managers' practical experience, but they can have devastating effects on the whole economic system.

The weak point of this migration of concepts seems to be the different nature of the subjects studied, as, obviously, companies are in many ways different than humans. Humans are more similar by nature and size as compared to companies, so there are significant issues to be researched relating to the use of frequency of occurrence and the resultant Odd Ratio and RR significance and confidence. One huge corporation failure may be more dangerous than thousands failures of SMEs.

In the financial literature, contagion risk is mostly studied in association with the "default" of a bank. Thus, the default condition is basically the first business disease supposed to be contagious. Using the "medical lens", this seems to be like considering "death" or "coma" a disease. From this point of view, the financial contagion, as it is studied now, looks like a human creating an epidemic after its death, and the probability of such an occurrence is obviously low. It is more likely such a contagion is spread before the default, while the underlying real cause of the default was not obvious.

Abnormalities that are transmitted through the economic network are contagion phenomena, and some multiply as they are replicated within the nodes of the network; some fade away as they consume their source or as they are contained by immune nodes and impermeable links. This is consistent as approach with different disease propagations in humans, but, the reasons why, the nodes sizes, the links that allow contagion between companies are different.

7. Taxonomy issues

The epidemiology can be defined as the branch of medical science dealing with the transmission and control of disease or a branch of medicine which studies the incidence and distribution of disease in a population, and uses such information to find the causes, modes of transmission, and methods for controlling the disease. The term "epidemiology" can be defined according to ancient Greek as the science that regards the entire population (epi – above, demos – people, logos - science). In that respect, there is an inherent extension of the medical science of epidemiology to all human populations, including human organizations, and an extension to economics is quite adequate.

The new research approach, "business epidemiology**"**, could deal with the study of incidence and distribution of business diseases (as described before) in a population of companies and could identify the incidence and the distribution of those diseases. In order to organize and unify the contagion and spillover effects information, some characteristics of diseases research should be used. We are suggesting that the following epidemiology concepts are highly significant in this approach.

The epidemiological approach on economics should use the same taxonomic approach regarding the basic concepts:

The source - defined as the economic phenomenon that could trigger the business disease. In this stage of research, we are considering that such sources could be (but are not limited to) abnormal behaviors that spread into the economy, or resource shortages of some kind. Such behaviors examples are tax evasion, payment terms habits, over-evaluation of assets, and under-evaluation of services, resource shortages could be related to agriculture variable results. If causality is determined, the probability of a "source" to trigger the "disease" should be studied. An entity can be seen as infected but not diseased.

The transmission means – being the path used by the source to spread its negative influence to other businesses. Some disorders could be transmitted by commercial relations from suppliers to consumers, from investors to entrepreneurs and such, or as mimetic behaviors. For example, payment delays from the government can trigger

delays in payments to a wide array of companies, to employees, and from all those to banks; an excessive demand for profits on the financial market can trigger high risk-high profit behavior; tax fraud wealth accumulation, if unpunished, can trigger mimetic tax fraud habits.

The receptivity – is defined as the responsiveness degree of the company to a certain negative economic phenomenon. This is mostly related to exposure to the diseased areas of the economy. For example, the percentage of receivables per a potentially dangerous customer could generate a higher receptivity. The receptivity should be measured by the combination of the existing risk factors.

The epidemic manifestation - forms of an outbreak in economics, usable to assess the size and entities required for the research and response to contagion:

Sporadic outbreak – defined as a rare occurrence of transmittable business disease. This is the case of a company behavior triggering abnormal behavior around it, affecting a few suppliers and some of its customers.

Epidemic outbreak – geographically wider spread occurrence of business disease. This is a case of an outbreak of abnormal behavior in a certain area, like over-evaluating land in a city.

Pandemic outbreak – a wide spread business disease occurrence, with multiple outbreaks sources. Examples: over-evaluating land, generalized tax fraud, over-evaluating shares on a financial market.

Seasonal outbreak – business disease that occurs in a certain period of the year. For example, winter cold generates over-consumption of energy for heat, summer heat generates over-consumption of energy for cold, and this may trigger energy-related abnormalities.

Natural outbreak – business disease induced by environment, government, NGO's and so on. A severe winter can generate several abnormalities in transports; a volcanic eruption can trigger air-transport abnormalities, which may propagate to touristic services, and so on.

The use of these concepts can help to focus the research of business diseases and the response mechanism required. In order to clarify the type of business diseases and to concentrate the information that should accumulate over time, all this should be organized and codified using a comprehensive system. This can be linked mainly to IFRS extension of XBRL taxonomy (Extensible Business Reporting Language) evolution, in order to allow comparable data collection systems. In a later stage, as XBRL or similar taxonomies are developed, the same taxonomies should be used to determine data required for KPI's. There are several taxonomies usable to identify subjects activity (ISIC, NAICS, NACE, ICB), countries (ISO 3166) areas, currencies (ISO 4217), and so on. As a basic methodology research, as XBRL standard financial data are used for dependent variables, subject activity, country, currency and such data can be used to provide non-numerical independent variables usable for regression, and suitable for automated processing.

From the risk assessment point of view, the development of business related taxonomies opens the way for more and more sophisticated models for contagion research, as data from different countries becomes comparable.

Conclusions

As contagion of the financial crisis is a fact, there is an obvious demand for a framework designed to deal with it. The research of contagion in banking and financial markets has opened an interesting and promising field of research in this direction. However, as contagion cannot be limited to banks, there is a clear and unavoidable evolution towards a generalized research on contagion. As contagion in human society has been studied already for health-related issues by epidemiology, it seems logical to us to use that knowledge in other research fields. As our investigation has shown, up to a point there are similarities that may be used and concepts that may explain the economic phenomenon contagion, but most importantly there are methods of research that can be adapted to economics.

It appears that the new concept of "business epidemiology" provides an original framework for economic analysis, which may generate a wide range of research topics and may be a solution to organize the government response to contagion, even in a free market economy. In a similar way to the response of governments and World Health Organization to human epidemics and pandemics, a global economic crisis may be approached in a coordinated manner by the proper governmental and global organizations.

The *business epidemiology* may allow integration of several research topics, such as systemic approaches, crisis management, public management in well defined and usable framework, similar with the one existent in the medical epidemiology field.

The methodology of epidemiology is pragmatically founded and already verified and certified by reality. As epidemiology is the science that is specialized in the research of contagion in human society, the methodology used is based on medical sciences but also on social sciences and statistics.

There are already well known and documented procedures, types of studies and researches, as well as international treaties that may be used as a base for the development of the business epidemiology field.

While data required for regression type of research based on exposures is quasi-unavailable, the challenge of the business epidemiologic approach will be to identify patterns of available indicators that can be used to identify the presence of absence of business diseases, and model the contagion that may be triggered.

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