

## The Liberty of the Crisis

No obstacle has been as constant or as difficult to overcome as the incertitude and the confusion regarding the true nature of liberty.  
If it is true that certain hostile interests have brought great losses,  
then wrong ideas have been even more detrimental.

**John E.E.D. Acton (Lord)**

The movement of ideas around the global crisis (meaning a moral one as well, alongside the economical crisis) tries to carve up material solutions in the name of the idea of liberty. In fact, for various – not always rational – reasons, the very content of freedom is being reloaded. The attempt is dissipated around the “for” or “against” options for regulation.

The confusion of one of principle: liberty is superimposed on the individually distributed will for power. The consequence of this confusion extends over the functions of the market, when the market is considered the infallible moderator of private interests in the match between their individual affirmation and their social confirmation.

How this could be achieved remains a mystery deepened by the current crisis as long as there will be no break from the vicious circle of fundamentalist or self-sufficient assumptions. Among others, the most persistent assumption – in the sense that it refuses change – is that one way or another, faster or slower, the crisis will pass by itself. Therefore there would be no need for intervention, nor even more so for a change of the vision that has generated the crisis.

The obvious (though not innocent) conclusion is that the economy is the direct expression of a theory of economics in which we would necessarily have to believe regardless of the consequences of its insufficiencies. And this due to an absolutely irrational argument: if we accepted another theory we would have opted for a pernicious ideology. The suggestion though stems from another sufficiency of an ideological nature: regulating the market would mean an attack on liberty!

Connecting the categories is illogical if only for the fact that it defies the rational limits for liberty. Liberty, in this formula, is denied the social acknowledgement sense of its individual fundament. The determinants of liberty would belong, apparently, only to the natural order in its Platonic sense, where lack of change represents the ideal. What

should not change? The structure of the order which produces crisis. Why should it not change? Because the crisis' ideal through the workings of which the natural order is being reproduced would be given up upon. Why should the market not be regulated? Because it should act like a centrifuge, meaning it should excessively exclude. What would this mean? Liberty would have degrees of fulfillment: many, very many in the center; few, even none at the periphery. The Paretian truth is the substance of the liberty guaranteed by the deregulated – at most self-regulated – market.

The bickering around the solutions for exiting the crisis is, basically, a problem of theoretical positioning on either the peak of neo-monetarism, or the one of neo-Keynesianism. Either way, it is an unfortunate positioning because it was proven to be creating ideologies.

The key for breaking the dispute is to situate ourselves away from the peaks of theoretically rarified options. We can find this key in the spontaneous order tailored by the sovereign rules of learning, the only process which respects nature's capacity of not taking deadly leaps from one peak to another. The key resides in following the common sense rule of following the middle path between the risks of the abyss or of the wall.

The method of marking the path, following the rule of seeing and doing that which bestows rational sense on the mechanisms of the market, is the one which minimizes the losses for many without maximizing the wins for only a few. There is no doubt that “marking the path” supposes rules of the game through which win and loss follow the sense of distribution given by the compromise between efficiency and equitability.

Thus liberty holds chances to come back to what it essentially is: an explicit expression of the will for democratic power, avoiding the Paretian loops of the deviant distribution of property.

Liberty cannot be anything other than humanization, a product of the moral rule which has polished human nature.

Marin Dinu

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# About Crisis. A Short and Joyless Description

■

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***Abstract.** Crisis clearly distinguishes itself from the large mass of economic phenomena through its provocative force, which fuels theoretical discourse. The more harmful, the more generous the energies it deploys and consumes for explanatory and obstacle overcoming purposes. The result is that every crisis teaches us a lesson. What interests us is who writes and who learns from this lesson, and if they do. Then we try to find why serious crises, like the current one, occur once or twice in a century. What is the role that big world market players have in crisis “preparation”, onset and resorption? Do solutions originate in the state’s support or in the market? Does globalization erase national borders in such situations? How and to what extent real economy may penalize a guilty party that constantly comes from nominal economy? What are the problems raised by such an outcome for the strategy to follow and for economic sciences in general, etc.?*

**Keywords:** crisis; Keynes; truth; compromise; market; state; human nature; speculation; indebtedness; personal calculation.

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## 1. Do lessons on crisis have a historical nature?

In order to answer the simplistic however, we believe, easily accountable for interrogation in the title, we are first tempted to make the following simple statement: crises teach us nothing or almost nothing, since they keep occurring at certain time intervals, ruining our plans and making us start over. Or, to be more precise, we could say that they teach us something, but this lesson is useless. Why? Because our knowledge, put into perspective by historical events, will serve the generations that follow us at centennial intervals.

We should however remind you that, starting with 1825, the world economy has had a cyclic development. Growth and progress were not brought about by linearity, but by winding developments, by uphill and downhill evolution, by phenomena such as crisis, depression, revival and boom. Heaps of books have been written and Nobel prizes have been won on this extremely interesting subject, which is the hard core of economic theory. Economic politics inspired by this theory managed a praiseworthy and at the same time noteworthy accomplishment; it managed to smooth sinusoidal curves and basically to prevent the turning of the wave top, called expansion, into a crisis. The cycle was thus reduced to two significant boom stages and recession. Crises were avoided or “managed” to become bearable. In two historic cases however economic policies failed to avoid serious crises: 1929-1933 and 2007-2009. These are two unheard of before situations, whose extent and consequences cannot be matched by any other economic

phenomenon. It is these phenomena, and especially the latter, that we have in view when trying to find the point of a lesson on crises.

We know therefore, from what others told us and from what we are currently experiencing, that the moment called crisis is a highest intensity implosion and explosion event, which includes an unmatched variety of economic phenomena and processes, and which has the largest geographical spreading and the highest temporal concentration. It is in its nature not to pass unnoticed. It is disturbing, it determines standpoints, it changes matrixes or governments, it revises and updates discourse, etc., in a word, it requires study and examination. And this is what it gets. The generation that experiences it writes the lesson down, through its most representative scientists. It should normally be passed on to be learned and considered. What actually happens is that it is historicized, packed and sent to the past to be labeled: “to whom it is interested in the subject”. Once “there”, this knowledge gets patina, becomes relative or is simply lost. If this phenomenon occurred more frequently, this knowledge would be like the words in a foreign language that you learn, you do not speak for a while but surprisingly comes back to you when you need it. Unfortunately, this is not the case, since the following big crisis is experienced by another generation, the third or fourth, and it is interpreted in another language and according to a new paradigm.

And one more thing: crisis does not teach us all the same thing. Although crisis is a sum of negative phenomena, it does not leave a desert behind it. During and after a crisis, most of the people have lost

something. They learn from their mistakes and their lesson takes the form of a set of sentences that teach their followers, a century later, what they should not do to avoid danger. Others, however, learn and pass on another lesson; one that teaches you not only to survive, but to make a profit during crises. As already explained, passing on this lesson (regardless of its nature) through time will probably be either put into perspective, or simply lost.

The extent of the phenomenon, as well as its dramatic consequences, should keep this lesson alive; it should be taught in class, as we like to put it. It should be included in a “National Economy” textbook, including success case reports as well as failure case reports, plus accounts of world crisis and the way in which national economy answered it and managed to overcome it. Such a book would round up the academic curriculum, it would give it meaning and make it more attractive, at least in some social education fields.

## **2. Crisis is a fundamentally economic phenomenon. Its moment of grace, peak and social character**

The world is *virtually* in crisis until the streets fill with unemployed people. Remaining in the virtual stage and preventing the wave from breaking in foams, by resorption, is a wise politics proof; the ultimate proof would be however preventing the wave from occurring altogether. The toughest lesson that crisis teaches us is that concerning such moments. Social breakouts are actually the extinction with sparks and tragedies of large economic latent conflicts,

present in all the cycle stages but manifesting themselves through explosions in the actual crisis stage, when mass unemployment reaches its peak. We speak of fact and idea conflicts, of insurmountable contradictions between production and consumption, real and nominal economy, micro, macro and global viewpoints; between the actual events and the theoretical orthodoxy, which provides neither explanations nor solutions for what happens in the real world. It is a time when economists are accused of everything, including imposture and occultism, and economic sciences look suspicious. Before the outrageous and dramatic show of the game field occupied by unemployed people, politicians are forced to acknowledge what they failed to acknowledge apriori, namely that economic balance means nothing without social peace. And they are forced to acknowledge it because, as J.M. Keynes put it talking about the “outcome” of the big crisis in the 1930’s, “...*Men will not always die quietly. For starvation, which brings to some lethargy and a helpless despair, drives other temperaments to the nervous instability of hysteria and to a mad despair. And these in their distress may overturn the remnants of organization, and submerge civilization itself in their attempts to satisfy desperately the overwhelming needs of the individual. This is the danger against which all our resources and courage and idealism must now co-operate*” (Keynes, 1919, p. 213). Keynes was an interventionist with liberal heart. He wrote these lines not out of any special fondness for the proletarian cause, but because the facts and events required such a conclusion. A good economic policy model

is successful only if it is grounded on the human factor, if its main coordinate-axis goal is full employment of the work force.

We insist on saying that such moments should be avoided, since they generally require “mad” solutions, which elude not only the economic status-quo logic, but logic in general. The choices are neither dilemmatic, nor metaphysical; they become one with and are imposed by the context. Let us consider *two examples*, which belong to the same area that made the brilliant Keynes to also write less brilliant texts. *First of all*, being preoccupied and even obsessed with finding labor market development solutions, he militates for discouraging savings and encouraging investments. Having the unemployment show before his eyes, he found investment sources and especially destination less important. He accepts any source of investment, including budget deficit (a classical dogma, he believes). Moreover, if an investment has a multiplication effect and generates jobs, it may even be an unproductive investment. According to this “logic”, Keynes states that “...if the Treasury were to fill old bottles with bank notes, bury them at suitable depths in disused coal mines which are then filled up to the surface with town rubbish, and leave it to private enterprise on well-tryed principles of laissez-faire to dig the notes up again... there need be no more unemployment and, ...the real income of the community, and its capital wealth also, would probably become a great deal greater than it actually is” (Keynes, 1970, p. 147). In other words, Keynes is trying to say that the streets filled with people are so dangerous to the future of social peace that even useless

work is acceptable as a “better than nothing” alternative. Taken out of their context, Keynes’ lines are simply absurd. We understand him only if we consider the time and the context this statement was made, which made it possible, in a country with healthy traditions that gave Europe princes, confronted with an explosive unemployment rate of up to 60% in the industrialized areas of the Ruhr basin, and we refer here to Germany, for a person such as Hitler to become “democratically” the country’s ruler only because he promised jobs. He actually kept his word, sending them to build roads and weapons. History has placed Hitler where he belongs, next to Stalin and other outrageous tyrants. The time of such statements is and must however be considered from this viewpoint, when such a crisis synthesizing context may be meaningfully “fructified” for the future of a nation. *Secondly*, Keynes is also known as the author of a childish reasoning: what does and what does not economy have during crisis? It has excessive work force and unused capital. It does not have money, real money, as the crisis is actually a crediting money crisis. And, forcing his way into the following conclusion, he suggests loud and clear that the gold standard is an annoying “barbarian relic”. Economy must be given what it misses and the printing press seems the perfect solution. Such reasoning is still encountered today, encouraged by the current crisis (see Krugman, 2008). The ones who can afford it will make such a statement. The choice between a visibly “painless” inflation and unemployment, which can only be an explosive tragedy, also requires such “mad” solutions.

### 3. Crisis – moment of truth and compromise

Crisis is a moment of *truth* to the extent it put things where they belong; it mainly places nominal economy, made larger by volatilization, on the fundament provided by real economy. It is a time when the institution of bankruptcy is called to drain and clear the ground, to do its job, to take out of the game the players who eluded or gave up good and healthy informal and formal practices, the ones who, selling illusions, not only compromised the game, but also altered the results with their poisons, turning the GDP in a huge and deceiving roll of cheese full of holes. In order for this to happen, the *market* needs to be left to do its job. Or, this happened neither in the 1929-1933, nor today. In other words, the sanitation mechanism is transformed and perverted.

Crisis is a moment of *compromise* because the fundamental institution in charge of continuously arranging and rearranging competitors depending on their results is seriously questioned. From this point of view, the ideas of the studies after 1929-1933 are not fundamentally different from the current ones. We find that then, like today, we developed on the right but we park on the left to find solutions and find our way out of the deadlock. And, once here, we call forth the presence of the *state* as the ultimate authority able to reconcile what has proven irreconcilable. We feel we should point out that even the purest liberals, starting with Smith, Ricardo, Mill, Locke or Ferguson and ending with Mises, Hayek, Friedman, Buchanan, Hazlitt or Rothbard, did not think that economy and society as a whole could

work with the state intervention. In a lawful state that also forces you to see and notice what cannot be noticed – the general rules concerning all and each of them – they offer the image of the *Great Society*, a picture of the civilized world, of a world that reached prosperity and welfare not by the support of the state and interventionism, but by means of the liberal train. The market has always been the fundamental institution that made it possible for the *human effort to flourish* as Mises synthetically put it; an institution which, together with private property and entrepreneurship freedom, define free world; an institution with strong optimizing features that forces individuals to take out only what is good in them in order to remain in the free competition game and also to support adjusting and reconcile individual action plans through the price feed-back mechanism (Hayek, 1990). Nevertheless, at times of acute crisis, the market is pointed at incriminatingly, when it should be left to clean and penalize excrescences and deviations from the general rule of the game. The actions taken are perverse and irrational. The market is reprehended and state interventionism is called forth and glorified. Instead of being left to live its moment of truth, economy is subjected to the cruel game of compromise. Why? Because it is now that can be noticed the perversity of this necessary harm called forth to “help”, the compromise with the state. Compromise and ultimate meanness, because these are its moments of grace. This is the time when it shows what it knows best: it privatizes profit and socializes loss. Now it is its chance to appear as an abstract entity beyond and above the people, the large category of

losers, and close to the few winners, without risking anathema. This happens because in these circumstances asking the state for support and regulation seems objectively necessary; tragic reality requires it. The “arguments” supporting its help are equally numerous and perverse.

*The spectrum of unemployment*, generated by an organization’s possibility of going bankrupt (companies, banks, insurance companies), weighting heavily on the contractual chain of reproduction, is a primary reason for economic analyses. These are “so large” that the USA government cannot afford to assist to the macro and global economic imbalances or to the social effects of the potential bankruptcy of companies such as Bear Stearns, Fannie Mae, Freddie Mac, Lehman Brothers, Merrill Lynch, Morgan Stanley, Goldman Sachs etc., the same way that the Benelux countries cannot be indifferent to what would happen if one of the biggest European banks, Fortis, collapsed; the same way that the Romanian government feels obliged to make waves in relation to the potential problems of the “Romanian” banking system, although over 90% of its assets are owned by Austrian, German, Italian and Greek banks. This means that governments cannot afford exposure; the lesson of the market is too tough and would certainly and irremediably render them unpopular. This is why they interfere and, via some authorized voices, they implement “compensatory mechanisms” generated, allegedly, from beneath market coordination. And therefore, they either nationalize (the Fortis case) or “take control” (the Fannie Mae and Freddie Mac), via the central banks (FED in the case of the USA), grant loans by

proportionally taking over a portion of the shares package, inject billions of dollars and Euros on the market and, finally, buy back the negative assets of some endangered banking or financial institutions. And all these under the pretense of the huge “responsibility”, of the concern for unblocking or preventing the stumbling of economy and of restoring the necessary faith for the normal development of business. And how can one gain or regain trust if not by giving a helping hand to the great ones which, simply due to their specific importance, design the anatomy and physiology of economy?

Another argument refers directly to the *endemic market fundamentalism*. Stiglitz, for example, does not shrink from declaring that “*neoliberalism is dead*” and that the current market economy is nothing but “*a system of corporate wealth, protected by market economy*”) (Stiglitz, 2008). Not believing that deregulation and liberalization lead to efficiency and growth, the Nobel prize laureate is willing to acknowledge, by comparison, a certain superiority of socialism in relation to neoliberalism “*Socialism takes care of people...neoliberalism helps corporations, not people*” (*Ibidem*). When an authorized voice, one that received the Nobel prize, sets the choir of anti-deregulation, it gathers up, effortlessly, the necessary team. And this is strong, in our case too. The philosophy of deregulation, which started with the Washington consensus, with the excessive rendering flexible of the labor market, the opening and the liberalization of the capital account, the imperfections of the financial market, doubled by the weakness of credit policies, etc., become targets that consume high

quantities of energy. In a synthesizing sentence, functioning as an explanatory thesis for all the damage caused by the current crisis, the well known voice of the aristocrat of thought and writing in the field of Romanian economy, that of Daniel Dăianu, puts it bluntly: “the main cause of this crisis consists in the insufficiency and inadequate regulation of the financial system. By this, adds the author, I also refer to the effects of the *Phil Gramm-Leach-Bliley Act of 1999...adopted by the USA Congress, and which produced another wave of deregulation of the financial industry, leading to the appearance of several “synthetic” products (derivatives), very little comprehended in terms of the degree of risk they involved*” (Dăianu, 2008, p. 5).

This would be the primordial cause, which tainted and brought, via a series of equally culpable transmission mechanisms, derivative products, harmful and abnormal in their turn: the transformation of loans into bonds, the disregard of a minimum level of prudence when taking risks, the misrepresentation of the evaluation operations performed by known rating agencies which concealed some collateral payment obligations – CDO or CDS, or of some unrestricted speculative and indebtedness operations such as leveraging, remuneration mechanisms and schemes for the persons with power of decision in some banking, financial or economic institutions, etc.

Once entered in the analysis perimeter where we are invited by mister Daianu, it is not polite to question his judgment. This is inappropriate and illogical because, we repeat, inside this matrix, reality, with its obvious stubbornness, shows that this is how

things are. The thing is that, if we step outside this perimeter, things look different from the surroundings. Briefly, “the blind faith in the efficient operation of the financial markets” and the lack of regulation are not responsible for all the things that surfaced following the crisis. As a matter of fact, an argument against the opinion according to which we are facing a crisis of open capitalism, caused by too much deregulation, comes from the very inside of the system struck by the crisis: Fannie Mae and Freddie Mac were not, by far, deprived of regulation and supervision and, despite all these, they were considerably struck; at the same time, most speculative funds, such as hedging, oases of almost complete deregulation, do not experience problems and are not threatened by the crisis. We believe that now, just like in ’29-’33, the primary cause is not an excess of *laissez-faire*, but on the contrary. The crisis is not a manifestation of a market and deregulation surplus, but of a market deficit.

Let us be clear. The market has never been an anarchical construction, but a game with well-defined rules; with numerous powers, as well as with imperfections. It appeared as a fundamental institution which serves as a solution to the unwanted evil, which exists within man. An intimately human construction, situated at the intersection point of the difficulties and counter-difficulties that define man and that “send” him, instinctively and objectively, on the land of exchange because “man almost always needs the help of his fellows” (Smith, 1962, p. 13). And it does this because only there, on the path of exchange and of competitive markets, will society stratify and position each man where he belongs,

according to the known criterion of consumed work. This is also the opinion of Mises, who sees the market as a fundamental “institutional arrangement”, with seen and unseen rules, a machine which efficiently consumes human energy, facilitating cooperation with the ultimately individual manifestation of action (Mises, 1985). The same view is shared by Buchanan, who sees the market as “that institutional process within which individuals interact (voluntarily) for pursuing individual objectives ((Buchanan, 1986, p. 87). Another leader of economic thinking, Hayek reveals the intimately contradictory meaning of this institution which, together with private property and the freedom of action, defines the free world. This is the normative component, through which one resorts to the market as a means of *coordination* of human activities; a means of optimizing the human effort, a “concrete abstraction” through which individual plans are adjusted (Hayek, 1990). Here is where conflictive reality finds its own compensatory means, thus showing that it is not irreconcilable (Hazlitt, 1988).

We could continue, in order to prove, once again, that the market is not the best possible solution but, nevertheless, humankind has yet to invent something better. If a single example contradicted this hypothesis, we would accept the necessary and healthy doubt. But, at the same time, the centralized plan and socialism, as portrayed by Stiglitz, have not paid off either.

We are certainly aware of the risk of our laudatory exposure of the market being stopped by means of a down to earth sentence: well, well, we know all these, but look that the excessively free market has

brought us! We return to the topic in order to clarify, once more, a couple of things.

*First of all*, the most zealous supporters of liberalism have come to realize that the market does not suffice for itself; that its normative valences do not manage to relieve tensions in a complex world. It needs rules. And the market has always functioned based on formal and informal rules. The more the economies grow in complexity, the more they resort to additional rules. The market of the United Europe is an example; one suffocated by rules. In other words, the philosophy of the open market accepts regulation; it accepts rules, imposed via normative means, and which establish the behavior poles of actors, the cooperation terms, the nature of the goods and services that enter the competitions as penalties for those that do not play by the rules. If we accept this premise, an extra level of regulation rendered necessary by a special circumstance should not lead the discussion to the state interventionism – market dichotomy. Regulation is normally performed by the government and the state, the main actor. In reality, regulation must not, within the requested and natural limits established only by the complexity of free competition, “fall” beyond the market. Within the natural limits it is assimilated to the market philosophy *per se*.

*Secondly*, the free market is not populated by all kind of actors and all kind of goods. The ones that elude or break the rules are eliminated. The damaged reputation and the ailing solvency resort either to the civil or to the criminal code. If we view things from the material perspective, the free market does not intend to turn the consumer into a

sovereign by intoxicating him with perishable, damaged or harmful products. Their circulation is not regulated, it is forbidden. The same should apply for the circulation of financial products that are packaged and re-packaged until they become “harmful”. The regulation of the financial market should establish the normal course of products that can circulate and should exclude those of financial engineering schemes. We consider that, not even with the strictest regulations will the harmful products of this market entirely disappear. As long as such products are expressly requested, the final path of punitive measures will be similar to the path where we ended up by forbidding alcoholic products (vodka) in Gorbaciov’s Russia, of drugs in Asian or European countries, of human trafficking or organized crime. Although we wish we were not right, the intimately and fundamentally “human” nature of the crisis has led us to this conclusion, as we intend to show in the following lines.

*Thirdly*, the market is a land of competition. Classics, as well as neoclassic, perceived it as a struggle between numerous and equal opponents, in term of competitive force. Such a competition can be won; with the help of high quality and low prices. Pure and perfect competition, as well as Hayek’s catalectic order, was portrayed as the optimized images of the free market. But, before reaching these unimaginable borders, we have to deal with the world of real cases, of competitive markets among unequal opponents, of the struggles between the big and the small, of monopolistic competition. Via its very nature, monopoly has always been an assault upon the market. When it

gains the dimensions of a corporation whose turnover exceeds the GDP of a developed state, the problem of regulation attracts more attention. When a small number of huge giants such as AIG, the largest American insurance company, or Fannie Mae and Freddie Mac, which own (owned) approximately a half of the mortgage loans granted to American consumers, starts to collapse, the reaction of some officials that are responsible for the economic safety and peace of America and of the world makes sense. We can understand why a Henry Paulson (general secretary of the Treasury of the United States) or Ben Bernanke (chairman of FED) is restless and sends alarming signals: such giants cannot die alone, their ramifications in the entire world economy are much too numerous and it is impossible for their drift not to affect or to cause significant problems for the markets in the entire world. If, under normal circumstances, the government – monopoly relation does not pose any problems, since the joining of the interests of public and private finances helps them cohabitate, things change in times of crisis. Called to perform its duty, the government observes that it has to solve a problem which would naturally be the task of the market. Bankruptcy eliminated from the game a partner that broke the market line. Meanwhile, this partner was assisted by the state in order to abandon the premises of free competition. Its power of negotiation exceeds the limits of the market. The government itself is powerless when it comes to “its own child”. The myth of the powerless state (Weiss, 29) becomes the reality of the powerless state. Its surgical extraction from the

consequent is not possible without a series of catastrophic consequences for the whole. Actions that can be easily performed by the scoop of bankruptcy prove to be unconceivable and without traumas through the forceps of the state. The only solution is for it to compromise itself. And it does, by helping “its product”, beyond and against the market.

*Fourthly, and summarizing,* the Washington consensus was not the commencement of the evil. Deregulation *per se* involves a surplus of freedom, shifted from the state to the market. And this surplus of freedom has turned out to be undisputed, emulative and innovative for the entire range of human activities. Incidentally, the initiator of the famous consensus, John Williamson (1989) came up with a set of measures, ten, to be specific, meant to support the developing countries that were affected by the crisis (also see Boyer, 2001). The critical attitude of some economists or economic analysts such as J. Stiglitz or G. Soros assimilated William’s statements, in terms of nature and meaning, to the fundamentalism of the free market. It is true that the liberalization of trade and deregulation were among the ten recommendations. But, from here to interpreting these prescriptions as promoting a kind of neoliberalism which transforms the market into a “fundamentalist” institution, the road is long. Following this path, sent under the form of doctrinarian orientation, in complete confusion (see Rodrik, 2006), China and India kept pace and succeeded. Other states that adopted the same fundamentalism have to deal with crisis and failure. As concerns the developed world, under the empire of the philosophy of this consensus, seen as a total opening towards

the market, the years that preceded the crisis were among the best. It is highly ungrateful and hypocritical to blame the engine when, too worked up, one encounters an obstacle. You can fix the engine and go on, but you cannot replace it with a scooter. And fixing it means indeed regulation, at the same time staying in the proximity of the engine. In other words, not all regulation measures are generated by the market. On the contrary, we remain inside it and we rethink its rules without doubting its stimulating, optimizing and auto-regulatory features; and the capacity of producing wealth, undisputed and incomparable with the wealth of other institutions. Following this idea, the imperative of the massive intervention of the state in order to fight “the blind market forces” has two risks: 1) the risk of contributing to the collapse of an institution which does not deserve such a treatment, not even in moments like this; 2) the risk of contributing to the irreversible compromising of the referee, and especially of the state.

At present it is difficult, if not impossible, to deconstruct an analysis which, via its conclusions, requires the presence of the state. We cannot persuade people that the firemen are not needed when the fire is already burning. It would have been better for the spark not to ignite anything; it would have been better to let the market solve the problem before stirring panic. After the fire is ignited, the intervention becomes “necessary” (Krugman, 2007). The problem is not why the state intervenes at this moment, but how we got to the point where such an intervention is necessary. As we have already stated, the regulation and supervision deficit was not the cause; and neither was the demolition of the

banking legislation, with all its consequences (simplification and proliferation of agency activities, financial “innovations” in relation to the securing and creation of synthetic products, positioned with great outputs, but irrelevant for the substance of the wealth in itself, the policy of cheap money, etc.) or the emphasis, for two decades, on a single paradigm, that of the deregulated market. The cause of the causes sends us back to the beginning of the ‘80s (Cifelli, 1986, Diaconu, 2005). Then, with Reagan starting off as president, the doctrine of the offer was successfully implemented (which also took from monetarism the idea of controlling monetary emissions, initiated by Friedman). The experiment took place in a context in which the Asian (mainly Japanese) competition had become torrential and was suffocating the American market on its own territory. Among other measures, reaganism also meant the putting into perspective of the known Sherman Law – the antitrust law of 1890 (May 1987), a set of antimonopoly laws concretized in normative acts aimed at regulating competition, price policies, mergers and acquisitions. The law wished to express the will of the public opinion, of putting an end to the monopolization tendency of the American economy and of preventing the domination of the automobile and oil industries by two important families, Ford and Rockefeller. Abuses, discriminatory practices, the control of the price policy, the creation of companies hidden under the umbrella of large monopolies, etc., were deemed to interfere with the spirit of free competition and were disapproved by the public opinion. These were the grounds of this Law. The government did not have to regulate the market, but the

abuse against the market. The antitrust law was primarily aimed at preserving free market competition. It required the intervention of the government in order to fight, with the help of legislation, against the main enemy of the free market – the monopoly. It is true that, once invited, the government followed the trajectory discovered by Mises some years later, by adopting the formula of an objective legislation according to which, once the state is invited into a specific segment, the economy, as a whole, will “*require more and more governing*” (Mises, 1944). Starting its journey in order to put into practice a social option, the prevention of monopolies, the government started to feed itself from the very substance of economy, by means of a gigantesque growth. By taking over and claiming responsibility for a series of actions and activities that were formerly the exclusive object of the market, either because such activities were denied by the market or because the state officials expanded their “responsibility” to several domains (Buchanan & Tollison, 1972) in order to justify their jobs and salaries. It does not surprise us that, in 1988, the American government were described as the biggest: employer, spender, owner, tenant, insurer, creditor, debtor and customer (Frederick and others, 1988). The growth tendency of the American government continued to progress from 1988 and until 2008. Despite all these, in 2007, when the crisis started, the USA government did not prove to be sufficiently powerful to counterbalance the power of some giants; of the companies that, unhindered by the antitrust law, managed to occupy either the entire economy or large pieces of it (possibility hinted at by R. Coase in its famous article

*The Nature of the Firm*). The state can no longer fight against such economic, financial and banking giants. They are aware of this and defy; either by sending their representatives for state help with the helicopter or by honoring their managers with bonuses from the borrowed money.

If the state is called to regulate, this is what he has to do: reestablish the rules of competition, defeat monopoly, reintroduce the spirit of free competition, which will lead to low prices and high quality. In other words, it has to give back to the market the role and the place it should have. If the market needs additional rules, they must concern its legislative coherence and the stability of the business environment. And if some harmful products already exist on its territory, they must not be regulated, they must be forbidden together to the other products that “move” them. Thus, we repeat, the risk of the state being compromised is very high. And this is due to the fact that, during times of crisis, more than during uneventful times, the state is wooed in order to guarantee contracts and in order to become corrupt; in order to offer safe jobs to those who failed in private businesses, ending up in bureaucracy and paralysis. Making use of its redistributive mechanisms, the state takes from those who have played by the market rules in order to make gifts to those that should be punished. The principle of equivalence is dismissed in favor of manipulative practices: the money does not go back to those from which it was taken, but to those which created holes, to companies that do not observe the rules of the game; to artificially built companies which will, in the future, compete with the ones that can face the crisis without the help of the state.

#### 4. Human nature and crisis repeatability

There is one hope-giving piece of information coming from crises history, namely that they are transitory; they come, they create serious trouble or disorder and they leave. A new cycle begins when they leave the scene. Regardless of its nature and duration (whether it is annual, decennial or centennial), a cycle always reaches a peak - crisis. What happens today, comparable only to what history witnessed from 1929 to 1933, belongs to the long centennial Kondratieff cycle. Should we be tempted, which is only natural, to compare the current crisis with the one that occurred at the beginning of the 20<sup>th</sup> century, we have every reason to believe, at least out of inertia, that this crisis also has a beginning and an ending. When it comes to establishing temporal landmarks only the big world players have a say in the matter. It is not by accident, and we intend to prove that, that the USA were the triggering factor of this phenomenon in both cases. The ending will undoubtedly be dictated by the same country. Contagion naturally spreads quicker in a globalized world. For these very reasons, this crisis requires adequate global or globalized answers. Despite its different amplitude and higher spreading speed, the primary deadlock-breaking impulse is still present: the “center” looks for refuge and solutions at the expense of the “periphery”. Regardless of the indebtedness level (states to states, companies to companies, companies to states and vice-versa, and all the above to the IMF, WB or EBRD) and nature, putting an end to this crisis depression, despite the cooperation

and aggregate effort calls, does not break away from the way of the world; a world of domination, having asymmetrical and irreversible effects, precisely as Fr. Perroux inspiringly described it, that is from the big to the small and never the other way around. The “accuracy” of this phenomenon, able to cover up any power abuse or discriminatory practices, turns indignation into futility. The world has gotten so much used to this way of the world, that the “periphery” states are “rightfully” and joyfully waiting to be announced when their ordeal is over.

It is undoubtedly true that this comparison would also reveal many other differences and similarities between now and then. There is hope lurking in the background: the current crisis should be shorter. The existing technical and material resources, intervention means and specific know-how entitle us to believe that. Moreover, beyond a certain limit, which is difficult to trace econometrically, the interested parties in overcoming this phenomenon are increasingly numerous and bigger. Leaving aside for now the technical-economic and political-financial causes accounting for and supporting this phenomenon called crisis, we focus on another cause, which accounts for, from a different point of view, both crisis occurrence and repeatability. We are trying, in other words, to answer a perfectly legitimate question: will what happened between 1929 and 1933 and what is happening today also happen in the near or distance future? Will this phenomenon occur again at the end of this century to support Kondratieff’s beliefs (1984) as well as the suppositions of other economic cycle theoreticians?

We dare give an affirmative answer, while not grounding our beliefs on technical causes. We rather think that it is human nature that actually accounts for the repeatability of such phenomena, which, due to their hideousness and devastating and offsetting effects, should be doomed as “unique”.

We do not claim that we do pioneering work when we say that human nature may account to a great extent for what is called economic cyclicity. Keynes’ psychological motives that “urge” individuals either to refrain from spending or, on the contrary, to increase their consumption appetite prove that the great economist was a good connoisseur of the human nature. People’s fondness of investments or consumption, their preference for cash, “average opinion” evolution, credit condition, “fundamental psychological law” accounting for individual consumption behavior depending on income evolution, caution, transaction and speculation motives, etc. Here are only some of Keynes’ concepts focusing on human nature.

Quite a large number of economists still ground their economic crisis studies on behavioral patterns (as adjustment responses to euphoria, panic, excess, indebtedness appetite, etc.), invoking greed as the all-comprising cause of crisis-generated chaos. Charles Kindleberger is a good eloquent example. Robert Aliber, Robert Solow, with whom Kindleberger actually wrote the famous book *Manias, Panics and Crashes: A History of Financial Crises* (2005), are greatly supported, in their opinions, by world known economists such as Paul Samuleson. Alan Greenspan, another highly respected voice in the crisis analysis world, states, post factum, after the onset of the current crisis,

whose origin he is actually familiar with, that *“...these economic and financial cycle models do not fully capture ... the innate human responses that result in swings between euphoria and fear that repeat themselves generation after generation with little evidence of a learning curve. Asset-price bubbles build and burst today as they have since the early 18th century... To be sure, we tend to label such behavioral responses as non-rational. Current practice is to introduce notions of “animal spirits”, as John Maynard Keynes put it. But forecasters’ concerns should be not whether human response is rational or irrational, only that it is observable and systematic. This, to me, is the large missing “explanatory variable” in both risk-management and macro econometric models”* (Greenspan, 2008, p. 522). When describing the phenomenon, Greenspan also uses two other concepts: “irrational effusiveness” and “euphoric bubbles”.

We did not use such a long quotation to comment upon it. It speaks for itself. We are only interested in the “explanatory variable”, which over-technical explanation leave aside, but which is fundamental if we want to grasp the very sources of crisis repeatability. The euphoric bubble’s historical nature draws our attention; it gradually fills with highly collectively irrational phrases and suddenly bursts, destabilizing everything around it, without however acquiring the strength of a lesson worth learning.

What we are trying to point out here, in a world of ideas created by the names quoted above, is that a propitious environment makes crisis triggering possible. It results from the action and reaction of two categories

of players: one that makes offers and another that stimulates demand. An assumption is necessary for an accurate understanding of the phenomenon: today, just as in the 1929-1933’s, the crisis actually started on the loan money field. Although the actual events in the 1929-1933’s suggested especially an over-production and consumption crisis, and in the 2007-2009’s a real estate market crisis, the panic on Wall-Street actually meant the same thing in both cases: the breaking of the loan trust chain. Built step by step, the “bubble”-permissive environment of over-packed and excessively-secured products was created by joint “contribution”; suppliers and buyers joined the dance of madness, in the thrall of a game built of trust and “human weakness”. Post factum, after the frenzy diminished and the game proved to be a sand castle, the guilty party is instinctively looked for and anathema is cast: on the stock exchange market that made it possible for illusion to be sold at tempting rates; on the banking system, which opened up to casino-type stock exchange operations and poisoned the market with uncovered products; on insurers, which gambled their payers’ money on the stock exchange market; on the obscure world of intermediaries, which facilitated the systematic emergence of synthetic products; on the rating agencies, which orchestrated the show giving good grades to doubtful initiatives, etc. If we are open to minimum objectivity, we should admit that stock exchanges, banks, insurance companies, etc., are not entities that breed by themselves. Their inputs and output call to the game a smaller or higher number of participants. Individuals, households, companies, dealers,

banks, insurance companies, stock exchanges, investment funds, pension funds, public institutions, etc., become actors on this stage; they join the game, each bringing their own particular contribution to it, and at the same time taking the same excessive risk and going deep in debt.

Synthetically speaking, a human being's reaction to risk takes the form of aversion. People do not like risks. From this point of view, M. Weber classified individuals in two categories: the ones that "eat well", and the ones that have a "peaceful sleep" (Weber, 1993, p. 28). To the first category, the businessmen, risk is the price for the desired profit. The other category, significantly bigger, includes passive investors, passive depositors who are not disturbed by any possible dialectics brought about by the profitable investment involving risks and stress or bank deposits with a safe interest equation; they prefer to be passive money savers in the absence of any entrepreneurial vocation. That is how Say, Schumpeter and, more recently, Knight (2005) put it. In short, taking risks and living with uncertainty is not everyone's "game". This happens in normal circumstances. But the time before the crisis is nothing but normal. It makes everyone leave their passiveness and invites them to invest, within the limits of their own budget and psychological structure. When the loan offer is irresponsibly permissive, it makes no sense to remain a passive money saver. When you can take a loan with nothing but your ID card, when you are not asked what your possessions are and if you are able to provide any surety, when you are allowed to draft your own refund schedule, to pay back whatever and whenever you want, if,

last but not least, no one needs to vouch for you, it is madness not to get loans. And you do it not because you really need it, but because you want to play the market. Why not buy two or three houses and as many pieces of land, even at extremely high prices, if you can sell them and make a profit before long. The price is not important. What matters is the positive difference obtained by resale. Everybody has this purely mercantile logic: creditors, who transfer the risks of unsecured loans to intermediaries; intermediaries, who secure mortgage loans; other intermediaries who provide loan security; commercial and investment banks that join the casino game tempted by quick earnings, preferring massive short-term debts and forgetting that in the long run they may walk into a trap; individuals or households that find it irrational not to take advantage of such offers. Risk exposure is no longer a problem because risk itself is underestimated. This picture is made whole and more clearly defined by opportunism, limited rationality and incomplete information. When all these are endorsed by scientists, the pleasure of living excessively well, even briefly, without worrying that you may be penalized in the long run is carefree. And this exactly what happened. In the country where the crisis originated, Oliver Williamson, agreeing with Herbert Simon's opinion (1997), replaces *homo oeconomicus rationalis* with an agent whose rationality has certain limitations, derived either from the latter's inborn features or from communication and reformation difficulties. Moreover, by defining lapidary opportunism as "the pursuit of one's personal interest by cheating", Williamson opens the door to

behavioral deviations having a false appearance of normality: deceit, lie, false promises or threats, manipulation, provision of distorted information, etc. (Williamson, 2005). Acknowledged as familiar human behaviors and theorized by excellent writers, such behaviors composed the background announcing the crisis. Business reputation or ethics have become obsolete. Agents with healthy behaviors were “forced” to understand that their tools were taking them out of the competition, so they joined the game; they got into debt, played the market, provided surety, security, blew bubbles and felt happy; no stress and no fears.

On the other hand, indebtedness and indebtedness level have always been human, and economic, we might add. Regardless of its level, individual, company, nations, etc., and up to a certain point it did not prevent progress. On the contrary, spending more than you earn has sometimes proved, in different historical circumstances and geographical areas, beneficial for individual and community development. When their own resources failed, business entities borrowed then, and “living off diseconomy” as Keynes said, borrowing and spending now relying on future income, proved a trend of modern economy. At least two things draw our attention if we want to keep dwelling on the subject.

*First of all*, the line or point up to which indebtedness is “normal”. In principle, indebtedness is considered from the viewpoint of and as deriving from the income-expense relation. When one’s expenses (consumption or investments) exceed one’s forces, loans and indebtedness are the solution. In other words, indebtedness depends on the current and future income. From this standpoint,

literature tackles two opinions; *one* belonging to Keynes, according to whom consumption depends on the current income swings, which means that additional money would satisfy “cash hunger” and would make loans cheaper; the *other* due to Milton Friedman who believes that only “permanent income” – the swing trend coming from a long period of time – has a say in the matter of human consumption or saving behavior. The latter states that economy stands intrinsic chances of stabilization: in the long run, depending on the “individual life plan” and with higher income, agents’ appetite for cash (savings) increases. In other words, a temporary and occasional cash infusion is not even considered; it is already insured by the very normal operation of economy, an economy which, given its normal growth, also needs a normal proportional growth of cash (Friedman, 1960). Even such reasoning, regardless of its nuances, does not drive indebtedness beyond supportability. As concerns the precise delineation of this supportability, which should separate normality from madness, econometric calculations are still being made. Beyond such a limit, people will undoubtedly fail to meet their payment obligations, and insolvency and bankruptcy will not be far. Determining the critical mass of agents whose indebtedness would jeopardize an entire economy is less clear and easy. We should add that, even if financial econometrics accurately succeeded in timely foreseeing and reporting the occurrence of a serious crisis, it would stand little chance to be taken seriously. When everybody is in a frenzy, they do not have time to listen to negative signals? When at a wedding party, people listen when you say

that the bride was stolen, but nobody will listen if you say the groom is dead. The current manifestations of this crisis entitle us to say that the line has been crossed. In 2005, two years before the crisis' onset, America had the highest indebtedness rate. At the same time, just as in 1933, the savings rate was negative. Despite that and despite all the warnings, loans went sky high. The offer was so generous that even subprime loans with profitability rates slightly (2-4%) exceeding those of the government bonds were successful. The failure or delays in paying back the loans, bank inability to make payments, stock exchange crash, incipient bankruptcies, etc. announced an imminent crisis and the destruction of a system. Nevertheless, the show went on until the giants started to fall. The individual life plans tailored according to the Nobel price winner Friedman's "permanent income" were not considered. Keynes' "animal spirits" have accounted for more.

*Secondly*, indebtedness, regardless of the entity undertaking it, has the same meaning: you borrow to spend more than you earn. The assumption according to which indebtedness capacity is limited is also common. Just as the statement according to which going into debt is not in itself a positive thing. There are high chances are you may feel more comfortable as a creditor than as a debtor. Also, the concept of deficit has timeless validity when defining the difference between inputs and outputs. Minor differences only lie in units of measurement, settling methods and especially in the consequences deriving from indebtedness. We say nothing unheard of here. We should bear however in mind that consumption or investment loans, based on

future income, have been increasingly higher and accompanied by increasingly significant risk exposure of all the economic game players. The way in which inborn aversion to risk influences financial flexibility, risk acceptance during boom periods, unflinching trust in future income, temporary financial imbalance spreading corroborated with economic strain stages, the "support" provided by the financial and banking system by its own examples (serious reduction of their own share in the total capital) etc. say a lot about the trend described above. We believe that debt consequences and coverage deserve special attention. Within an averaged-sized entity (family, company, etc.) indebtedness and debt settlement have the same address; the one undertaking the loan risk is also the one that, after crisis onset, is penalized for having dared to cross the danger line. His "pain" is a feedback of his own wrong calculations. This does not apply to large corporations or to the state. Their mistakes are not always paid for by the ones who made them. Massive state intervention, regardless of the manner in which this is done, actually means a socialization of losses. Neither great corporations nor the state can become bankrupt without avoiding serious imbalances. Also, in these cases, it is actually an innocent "human nature" that pays for the mistakes of another "human nature", who undertook great risk exposure. The fact that not only bubble makers, euphoric boom people, but the entire population is involved in paying for the mistakes of others, turns crisis not only into a psychological certainty of the fact that risk underestimation collides with the innate risk aversion, but also into a moment of maximum social strain, when the very basics of human cooperation are shaken to the grounds.

## References

- Boyer, P. *Antitrust Legislation*, The Oxford Companion to United States History, 2001, <http://www.encyclopedia.com/doc/1O119-AntitrustLegislation.html>
- Buchanan, J. (1986). *Liberty, Market and State*, New York University Press
- Buchanan, J., Tollison, R. (1972). *Theory of Public Choice: Political Applications of Economics*, The University of Michigan Press
- Cifelli Isagro, Anna, "Antitrust Reform: DOA Reagan's plan rankles business lobbies, consumer groups and Congressman Rodino", *Fortune Magazine*, March, 31, 1986, [http://money.cnn.com/magazines/fortune/fortune\\_archive/1986/03/31/67320/index.htm](http://money.cnn.com/magazines/fortune/fortune_archive/1986/03/31/67320/index.htm)
- Coase, R. H. (1997). *Natura firmei*, în Oliver Williamson, Sidney Winter (eds.), *Natura firmei. Origini, evoluție și dezvoltare*, Editura Sedona, Timișoara, pp. 26-41
- Dăianu, D., "Ar fi trebuit să se învețe din crizele anterioare", articol scris pentru *European Voice* și preluat și publicat de *Revista 22*, Nr. 40, 30 sept.-6 oct. 2008, p. 5
- Diaconu, B., *Legea și piața*, November 4<sup>th</sup>, 2005, <http://evado.ro/?p=27>
- Frederick, W., Davis, K., ș.a. (1988). *Business and Society: Corporate Strategy, Public Policy*, 6<sup>th</sup> Edition, McGraw-Hill International Editions
- Friedman, M. (1960). *Inflation et systèmes monétaires*, Calman-Lévy, Paris
- Greenspan, A. (2008). *Era turbulențelor: aventuri într-o lume nouă*, Publica, București
- Hayek, Fr. (1990). *Infatuarea fatală. Erorile socialismului*, Editura Antet
- Hazlitt, H. (1988). *The Foundations of Morality*, Lanham, MD: University Press of America
- Keynes, J.M. (1970). *Teoria generală a folosirii mâinii de lucru, dobânzii și banilor*, Editura Științifică, București
- Keynes, J.M. (1919). *The Economic Consequences of the Peace*, MacMillan and Co., London
- Kindleberger, Ch., Aliber, R., Solow, R. (2005). *Manias, Panics and Crashes: A History of Financial Crises*, Wiley, John&Sons Inc.
- Knight, F. (2005). *Risk, Uncertainty and Profit*, Casino Classics
- Kondratieff, N. (1984). *Long Wave Cycle*, Richardson & Snyder
- Krugman, P., "Betting the Bank", *The New York Times*, March 14, 2008, [http://www.nytimes.com/2008/03/14/opinion/14krugman.html?\\_r=1](http://www.nytimes.com/2008/03/14/opinion/14krugman.html?_r=1);
- Krugman, P. (2007). *The Conscience of a Liberal*, W.W. Norton & Co.
- May, J., "Antitrust in the Formative Era: Political and Economic Theory in Constitutional and Antitrust Analysis, 1880-1918", *Ohio State Law Journal* 50 (1987), pp. 257-395
- Mises, L. (1944). *Bureaucracy*, New Haven: Yale University Press
- Mises, L. (1985). *L'Action humaine. Traité d'économie*, PUF, Paris
- Rodrik, D., "Goodbye Washington Consensus, Hello Washington Confusion?", Jan. 2006, p.3-5, <http://ksghome.harvard.edu/~drodrik/lessons%20of%20the%201990s%20review%20jel.pdf>
- Simon, H. (1997). *Administrative Behavior: A Study of Decision Making Processes in Administrative Organization*, 4<sup>th</sup> ed., New York: Free Press
- Smith, A. (1962). *Avuția națiunilor. Cercetare asupra naturii și cauzelor ei*, Vol. 1, Editura Academiei Române, București
- Stiglitz, J., "Crisis points to need for new global currency", interviu cu Kiyoshi Okonogy, în *The Asahi Shimbun/ The International Herald Tribune*, November 5<sup>th</sup>, 2008, <http://www.asahi.com/english/Herald-asahi/TKY200811050060.html>
- Weber, M. (1993). *Etica protestantă și spiritul capitalismului*, Editura Humanitas, București
- Weiss, L. (2002). *Mitul statului lipsit de putere. Guvernarea economiei în era globalizării*, Editura Trei
- Williamson, J. (1989). *What Washington Means by Policy Reform*, în J. Williamson (ed.), *Latin American Readjustment: How Much has Happened*, Washington: Institute for International Economics
- Williamson, O., "Transaction Costs Economics" în C. Ménard, M. Shirley (eds.), *Handbook of New Institutional Economics*, pp. 41-65, Springer, 2005
- \*\*\*, "Reagan proposes easing antitrust rules (proposed antitrust legislation)", *National Petroleum News*, March, 1986, [http://findarticles.com/p/articles/mi\\_hb4898/is\\_198603](http://findarticles.com/p/articles/mi_hb4898/is_198603)

# Modeling Multivariate Volatility Processes: Theory and Evidence

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**Abstract.** *This article presents theoretical and empirical methodology for estimation and modeling of multivariate volatility processes. It surveys the model specifications and the estimation methods. Multivariate GARCH models covered are VEC (initially due to Bollerslev, Engle and Wooldridge, 1988), diagonal VEC (DVEC), BEKK (named after Baba, Engle, Kraft and Kroner, 1995), Constant Conditional Correlation Model (CCC, Bollerslev, 1990), Dynamic Conditional Correlation Model (DCC models of Tse and Tsui, 2002, and Engle, 2002). I illustrate approach by applying it to daily data from the Belgrade stock exchange, I examine two pairs of daily log returns for stocks and index, report the results obtained, and compare them with the restricted version of BEKK, DVEC and CCC representations. The methods for estimation parameters used are maximum log-likelihood (in BEKK and DVEC models) and two-step approach (in CCC model).*

**Keywords:** covariance; multivariate GARCH models; maximum likelihood estimation; two-step estimation; modeling.

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**JEL Codes:** C1, C3, C5.

**REL Codes:** 9B, 9F, 9G.

## 1. Introduction

Autoregressive conditional heteroscedasticity (ARCH), and the generalized ARCH (GARCH) models proved to be successful in capturing the time-varying variances of economic data in the univariate case. This has motivated many researchers to extend these models to the multivariate dimension (Tse, 2000). Multivariate volatilities have many important financial applications. About all, they play an important role in portfolio selection and asset allocation, and they can be used to compute the value at risk of a financial position consisting of multiple assets (Tsay, 2005). So, the application of multivariate GARCH (MGARCH) models is very wide. Some of the typical applications are: portfolio optimization (Kroner, Claessens, 1991), pricing of assets (Hafner, Herwartz, 1998) and derivatives, computation of the Value at Risk (Rombouts, Verbeek, 2004, Bauwens, Laurent, 2004), futures hedging (Park, Switzer, 1995, Yang, Allen, 2004, Bera et al., 1997, Lien, Luo, 1994), volatility transmitting (Karolyi, 1995) and asset allocation, estimation systemic risk in banking (Schröder, Schüler, 2003), determining of the leverage effect (De Goeij, Marquering, 2004, Kroner, Ng, 1998), estimation of the volatility impulse response function (Hafner, Herwartz 1998, 2006, Elder, 2003), nonlinear programming (Altay-Salih, Pinar, Leyffer, 2003), hedging the currency exposure risk (Kroner, Sultan, 1991, Valiani, 2004), calculation of the minimum capital risk requirements for portfolio of assets (Brooks et al., 2002), determining misspecification tests for MGARCH models (Tse, Tsui, 1999), modeling of the changing variance structure

in an exchange rate regime (Bollerslev, 1990), applying MGARCH models in the analysis of the individual financial markets (Minović, 2007b).

The focus of this article is to introduce the basic concept of multivariate volatility (GARCH) modeling. To first give a theoretical survey of these models. Then, I present the estimations (maximum log likelihood and two-step approach) of these models and give the comparative analysis. MGARCH models explain how the covariances move over time. Modeling a covariance matrix is difficult because of the likely high dimensionality of the problem and the constraint that a covariance matrix must be positive definite (Pourahmadi, 1999). The crucial stage in MGARCH modeling is to provide a realistic but parsimonious specification of the variance matrix ensuring its positivity. Obviously, a disadvantage of the multivariate approach is that the number of parameters to be estimated in the GARCH equation increases rapidly. This limits the number of assets that can be included (De Goeij et al. 2004). Models covered are the VEC (initially due to Bollerslev, Engle and Wooldridge, 1988), the diagonal VEC (DVEC), the BEKK (named after Baba, Engle, Kraft and Kroner, 1995), Constant Conditional Correlation Model (CCC, Bollerslev, 1990), Dynamic Conditional Correlation Model (DCC models of Tse and Tsui, 2002, and Engle, 2002). I calculate volatility for some selected securities listed at the Belgrade stock exchange ([www.belex.rs](http://www.belex.rs)). Trivariate GARCH models are estimated using daily data from the Belgrade stock exchange for two pairs of daily log returns for both stocks and index.

I also estimate the restricted version of BEKK, DVEC, and CCC models.

The rest of the paper is organized as follows. At the beginning of the second section I analyze the basic theory of multivariate time series. Modeling of dynamic interdependent variables is conducted with multivariate time series. I define time-varying means, variances and covariances for the  $N$  components-the conditional variance-covariance matrix. The rest of Section 2 presents a theoretical survey of multivariate GARCH formulations, containing the following models: VEC, diagonal VEC, and BEKK. Section 3 describes class of models that includes: Constant Conditional Correlation (CCC) and Dynamic Conditional Correlation (DCC) models. For each of the models classes, a theoretical review is provided, following a comparative analysis discussing their advantages and disadvantages. We presented two estimation methods: maximum log likelihood (this is estimator for the first class of the models, Section 2) and two-step approach (for the second class of the models, Section 3). Section 4 presents the empirical results from applying MGARCH (trivariate version of BEKK, DVEC, and CCC) models at the Belgrade stock exchange. In particular, I test how the covariances between chosen securities move over time. The Section 5 concludes.

## 2. Multivariate GARCH (MGARCH) models

### 2.1. Multivariate time series

Often the current value of a variable depends not only on its past values, but also on past and/or current values of other variables (Schmidh, 2005). Price movements in one market can spread easily and instantly to another market. Financial markets are more dependent on each other than ever before. Consequently, knowing how the markets are interrelated is of great importance in finance. For an investor or a financial institution holding multiple assets, the dynamic relationship between returns on the assets play an important role in decision making (Tsay, 2005). Modeling of dynamic interdependent variables is done using with multivariate time series. A multivariate time series  $r_t = (r_{1t}, r_{2t}, \dots, r_{Nt})'$  is a vector of  $N$  processes that have data available for the same moments in time (Schmidh, 2005).

Multivariate time series  $r_t$  is *weakly stationary* if its first and second moments are time-invariant. In particular, the mean vector and covariance matrix of a weakly stationary series are constant over time. For a weakly stationary time series  $r_t$ , we define its mean vector and covariance matrix as

$$\mu = E(r_t) = \begin{bmatrix} E(r_{1t}) \\ \vdots \\ E(r_{Nt}) \end{bmatrix} = \begin{bmatrix} \mu_1 \\ \vdots \\ \mu_N \end{bmatrix} = \text{const.} \quad (2.1)$$

$$\Gamma_0(k) = E[(r_t - \mu)(r_{t-k} - \mu)'] = \begin{bmatrix} \gamma_0 & \gamma_{12}(k) & \dots & \gamma_{1N}(k) \\ \gamma_{21}(k) & \gamma_1 & \dots & \gamma_{2N}(k) \\ \vdots & \vdots & \ddots & \vdots \\ \gamma_{N1}(k) & \gamma_{N2}(k) & \dots & \gamma_N \end{bmatrix}, \quad (2.2)$$

where the expectation is taken element by element over the joint distribution of  $r_t$ . The mean  $\mu$  is an  $N$ -dimensional vector consisting of unconditional expectations of the components of  $r_t$ . The covariance matrix  $\Gamma_0$  is an  $N \times N$  matrix. The  $i^{\text{th}}$  diagonal element of  $\Gamma_0$  is the variance of  $r_{it}$ , whereas the  $(i, j)^{\text{th}}$  element of  $\Gamma_0$  is the covariance between  $r_{it}$  and  $r_{jt}$ , and it is a function of  $k$  (Tsay, 2005).

A dynamic model with time-varying means, variances and covariances for the  $N$  components of  $r_t = (r_{1t}, r_{2t}, \dots, r_{Nt})'$  is:

$$r_t = \mu_t(\theta) + \varepsilon_t. \quad (2.3)$$

Here,  $\theta$  is a finite vector of parameters,  $\mu_t(\theta)$  is the conditional mean vector, and  $\varepsilon_t$

is an  $N \times 1$  vector of shock, or innovation, of the series at time  $t$  equal to:

$$\varepsilon_t = \Sigma_t^{1/2}(\theta) z_t, \quad (2.4)$$

where  $\Sigma_t^{1/2}(\theta)$  is an  $N \times N$  positive definite matrix. Furthermore, we assume the  $N \times 1$  random vector  $z_t$  to have the following first two moments:

$$E(z_t) = 0, \quad \text{Var}(z_t) = I_N, \quad (2.5)$$

where  $I_N$  is the identity matrix of order  $N$ . The conditional mean vector has the form:

$$\mu_t = E(r_t | I_{t-1}) = E_{t-1}(r_t), \quad (2.6)$$

where  $I_{t-1}$  is the information available at time  $t-1$ , at least containing  $(r_{t-1}, r_{t-2}, \dots)$ . To make this clear we calculate the conditional variance matrix of  $r_t$ :

$$\begin{aligned} \text{Var}(r_t | I_{t-1}) &= \text{Var}_{t-1}(r_t) = \text{Var}_{t-1}(\varepsilon_t) \\ &= \Sigma_t^{1/2} \text{Var}_{t-1}(z_t) (\Sigma_t^{1/2})' \\ &= \Sigma_t. \end{aligned} \quad (2.7)$$

Hence,  $\Sigma_t^{1/2}$  is any  $N \times N$  positive definite matrix such that  $\Sigma_t$  is the conditional variance matrix of  $r_t$ . Both  $\Sigma_t$  and  $\mu_t$  depend on the unknown parameter vector  $\theta$ , which can be split in most cases into two disjoint parts, one for  $\mu_t$  and one for  $\Sigma_t$  (Bauwens, 2005; Bauwens et al., 2006). Multivariate volatility modeling is concerned with the time evolution of  $\Sigma_t$ . We refer to a model for the  $\{\Sigma_t\}$  process as a volatility model for the return series  $r_t$  (Tsay, 2005).

The goal is to model the conditional variance-covariance matrix  $\Sigma_t$  which is an  $N \times N$  non-negative definite matrix. Different models for  $\Sigma_t$  have been proposed over the last two decades (Wang, Yao, 2005).

## 2.2. The VEC model

First, I introduce the VEC operator:

- VEC is the operator that stacks a matrix as a column vector:

$$\text{VEC}(\Sigma_t) = (\sigma_{11t}, \sigma_{21t}, \dots, \sigma_{N1t}, \sigma_{12t}, \sigma_{22t}, \dots, \sigma_{NNt})'. \quad (2.8)$$

- A useful property is:

$$\text{VEC}(ABC) = (C' \otimes A) \text{VEC}(B) \quad (\text{Bauwens, 2005}). \quad (2.9)$$

The general multivariate GARCH( $p, q$ ) model is given as:

$$\text{VEC}(\Sigma_t) = C + \sum_{i=1}^q A_i \cdot \text{VEC}(\varepsilon_{t-i} \varepsilon_{t-i}') + \sum_{j=1}^p B_j \cdot \text{VEC}(\Sigma_{t-j}), \quad (2.10)$$

where  $A_i$  and  $B_j$  are parameter matrices containing  $(N^*)^2$  parameters [with  $N^*=N(N+1)/2$ ], whereas the vector  $C$  contains  $N^*$  coefficients. We will assume that all eigenvalues of the matrix  $\sum_{i=1}^q A_i + \sum_{j=1}^p B_j$  have modulus smaller than one, in which case the vector process  $e_t$  is covariance stationary with unconditional covariance matrix given by  $\Sigma_t$  (Hafner, Herwartz, 2006).

A potentially serious issue with the unrestricted VEC model described by equation (2.10) is that it requires the estimation of a large number of parameters. This over-parameterization led to the

development of the simplified diagonal VEC model, by Bollerslev, Engle and Wooldridge (1988), where the  $A$  and  $B$  matrices are forced to be diagonal. The result is a reduction of the number of parameters in the variance and covariance equations to 18 for the trivariate case (Brooks et al., 2003).

### 2.3. The diagonal VEC model

Because of the simplification that it provides, the diagonal VEC model is frequently used. Each of its variance-covariance terms is postulated to follow a GARCH-type equation. The model can be written as follows (Tse, Tsui, 1999):

$$\sigma_{ij,t} = c_{ij} + \sum_{h=1}^p a_{hij} \varepsilon_{t-h,i} \varepsilon_{t-h,j} + \sum_{h=1}^q b_{hij} \sigma_{t-h,ij} \quad 1 \leq i \leq j \leq k, \quad (2.11)$$

where  $c_{ij}$ ,  $a_{hij}$  and  $b_{hij}$  are parameters. The diagonal VEC multivariate GARCH model could also be expressed as an infinite order multivariate ARCH model, where the covariance is expressed as a geometrically declining weighted average of past cross products of unexpected returns, with recent

observations carrying higher weights. An alternative solution to the dimensionality problem would be to use orthogonal GARCH or factor GARCH models (Brooks, 2002).

Now, we will present the diagonal VEC model in the form:

$$\Sigma_t = C_0^* + \sum_{i=1}^m A_i^* \square (\varepsilon_{t-i} \varepsilon_{t-i}') + \sum_{j=1}^s B_j^* \square \Sigma_{t-j}, \quad (2.12)$$

where  $m$  and  $s$  are non-negative integers, and  $\square$  denotes Hadamard product<sup>(1)</sup> (element by element matrix multiplication) (Tsay, 2005). Let us define the symmetric  $N \times N$  matrices  $A_i^*$  and  $B_j^*$  as the matrices implied by the relations  $A = \text{diag}[\text{vec}(A^*)]^{(2)}$ ,  $B = \text{diag}[\text{vec}(B^*)]$ , and  $C_0^*$  as given by  $C = \text{vec}(C_0^*)$  (Bauwens et al., 2006). The model which is represented by Eq. (2.12) is DVEC( $m, s$ ) model (Tsay, 2005).  $\Sigma_t$  must be parameter matrices, and only the lower

portions of these matrices need to be parameterized and estimated. For example, Silberberg and Pafka (2001) prove that a sufficient condition to ensure the positive definiteness of the covariance matrix  $\Sigma_t$  in Eq. (2.12) is that the constant term  $C_0^*$  is positive definite and all the other coefficient matrices,  $A_i^*$  and  $B_j^*$ , are positive semidefinite (De Goeij et al., 2004).

Each element of  $\Sigma_t$  depends only on its own past value and the corresponding product

term in  $\varepsilon_{t-1}\varepsilon'_{t-1}$ . That is, each element of a DVEC model follows a GARCH(1,1) type model. The model is simple, but it may not produce a positive-definite covariance matrix. Furthermore, the model does not allow for dynamic dependence between volatility series (Tsay, 2005).

We can construct a scalar VEC model:  $A = aU$  and  $B = bU$ , where  $a$  and  $b$  scalars and  $U$  is matrix of ones (Bauwens, 2005).

#### 2.4. The BEKK model

In order for an estimated multivariate GARCH model to be plausible,  $\Sigma_t$  is required

$$\Sigma_t = C_0 C_0' + \sum_{k=1}^K \sum_{i=1}^q A_{ki}' \varepsilon_{t-i} \varepsilon_{t-i}' A_{ki} + \sum_{k=1}^K \sum_{i=1}^p B_{ki}' \Sigma_{t-i} B_{ki}, \quad (2.13)$$

where  $C_0$  is a lower triangular matrix and  $A_{ki}$  and  $B_{ki}$  are  $N \times N$  parameter matrices. The BEKK representation in Eq. (2.13) is a special case of Eq. (2.10) (Hafner, Herwartz, 2006). Based on the symmetric parameterization of the model,  $\Sigma_t$  is almost surely positive definite provided that  $C_0 \times C_0'$  is positive definite (Tsay, 2005).

Engle and Kroner (1995) proved that the necessary condition for the covariance stationarity of the BEKK model is that the eigenvalues, that is the characteristic roots

to be positive definite for all values of the disturbances. Verifying that this holds is a non-trivial issue even for VEC or diagonal VEC models of moderate size. To circumvent this problem, Engle and Kroner (1995) proposed a quadratic formulation for the parameters that ensured positive definiteness. This became known as the BEKK model (Brooks et al., 2003). Its number of parameters grows linearly with the number of assets. Therefore, this model is relatively parsimonious and suitable for a large set of assets (De Goeij et al., 2004). The BEKK model is in the form:

$$\text{of } \sum_{i=1}^q \sum_{k=1}^K (A_{ik}^* \otimes A_{ik}^*) + \sum_{i=1}^p \sum_{k=1}^K (B_{ik}^* \otimes B_{ik}^*), \text{ should}$$

be less than one in absolute value. Hence, the process can still render stationary even if there exists an element with a value greater than one in the matrix. Obviously, this condition is different from the stationarity condition required by univariate GARCH model: that the sum of ARCH and GARCH terms has to be less than one (Pang et al., 2002).

The BEKK(1,1,K) model is defined as:

$$\Sigma_t = C_0 C_0' + \sum_{k=1}^K A_k' \varepsilon_{t-1} \varepsilon_{t-1}' A_k + \sum_{k=1}^K B_k' \Sigma_{t-1} B_k, \quad (2.14)$$

where  $C_0$ ,  $A_k$  and  $B_k$  are  $N \times N$  matrices of parameters, but  $C_0$  is upper triangular. One can also write  $C_0 \times C_0' = \Omega > 0$ . Positivity of  $\Sigma_t$  is guaranteed if  $\Sigma_0 \geq 0$ . Here, there are 11 parameters, against 21 in the VEC model (Bauwens, 2005). This model allows for dynamic dependence between the volatility series (Tsay, 2005).

The diagonal and scalar BEKK models can be defined as follows:

##### ■ The diagonal BEKK model.

Take  $A_k$  and  $B_k$  as diagonal matrices. For this case, the BEKK model is a restricted version of the VEC model with diagonal matrices (Bauwens, 2005; Franke et al., 2005).

- The scalar BEKK model.

$A_k = a_k \times U$ ,  $B_k = b_k \times U$ , where  $a$  and  $b$  scalars and  $U$  is a matrix of ones (Bauwens, 2005).

The diagonal BEKK model is given by the following equations:

$$\sigma_{11,t} = c_{11}^2 + a_{11}^2 \varepsilon_{1,t-1}^2 + b_{11}^2 \sigma_{11,t-1} \quad (2.15)$$

$$\sigma_{22,t} = c_{22}^2 + a_{22}^2 \varepsilon_{2,t-1}^2 + b_{22}^2 \sigma_{22,t-1} \quad (2.16)$$

$$\sigma_{12,t} = \sigma_{21,t} = c_{11}c_{22} + a_{11}a_{22}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + b_{11}b_{22}\sigma_{12,t-1} \quad (2.17)$$

This model exhibits essentially the same problems as the full BEKK model there is no parameter in any equation that exclusively governs a particular covariance equation. Hence, it is not clear whether the parameters for  $\alpha_{12}$  are just the result of the parameter estimates for  $\alpha_{11}$  and  $\alpha_{22}$ , or if the covariance equation alters the parameter estimates of the variance equations. In addition, the model is not very flexible and can therefore be

misspecified. However, if the covariance exhibits a different degree of persistence than the volatilities, it is clear that either the volatility or the covariance process is misspecified (Baur, 2004).

The BEKK(1,1,1) model  $\Sigma_t = \Omega + A' \varepsilon_{t-1} \varepsilon_{t-1}' A + B' \Sigma_{t-1} B$  can be written as a VEC model (subject to restrictions) using formula (2.9):

$$VEC(\Sigma_t) = VEC(\Omega) + (A \otimes A)' VEC(\varepsilon_{t-1} \varepsilon_{t-1}') + (B \otimes B)' VEC(\Sigma_{t-1}). \quad (2.18)$$

Hence, the BEKK model is weakly stationary if the eigenvalues of

$(A \otimes A) + (B \otimes B)$  are smaller than one in modulus, and then

$$VEC(\Sigma) = (I_{N^2} - (A \otimes A)' - (B \otimes B)')^{-1} VEC(\Omega) \quad (\text{Bauwens, 2005}). \quad (2.19)$$

## 2.5. Multivariate GARCH model estimation

Suppose the vector stochastic process  $\{r_t\}$  (for  $t = 1, \dots, T$ ) has conditional mean, conditional variance matrix and conditional distribution  $\mu_t(\theta_0)$ ,  $\Sigma_t(\theta_0)$  and  $p(r_t | \varsigma_0, I_{t-1})$  respectively. Here,  $\varsigma_0 = (\theta_0 \ \eta_0)$  is a  $k$ -dimensional parameter vector, and  $\eta_0$  is the vector that contains the parameters of the distribution of the innovations  $z_t$ . Importantly, to justify the choice of the estimation procedure, we assume that the model to be estimated encompasses the true

formulations of  $\mu_t(\theta_0)$  and  $\Sigma_t(\theta_0)$  (Bauwens et al., 2006).

The procedure used most often in estimating  $\theta_0$  involves the maximization of a likelihood function constructed under the assumption of an i.i.d. distribution for the standardized innovations  $z_t$ . The likelihood function for the i.i.d. case can then be viewed as a quasi-likelihood function (Bauwens et al., 2006).

Consequently, one has to make an additional assumption on the innovation process by choosing a density function, denoted  $g(z_t(\theta); \eta)$ , where  $\eta$  is a vector of

nuisance parameters. Thus, the problem to solve is to maximize the sample log-likelihood function  $L_T(\theta, \eta)$  for the  $T$  observations, with respect to the vector of parameters  $\varsigma = (\theta, \eta)$ , where

$$L_T(\varsigma) = \sum_{t=1}^T \log f(r_t | \varsigma, I_{t-1}), \quad (2.20)$$

with

$$f(r_t | \varsigma, I_{t-1}) = |\Sigma_t|^{-1/2} g(\Sigma_t^{-1/2}(r_t - \mu_t) | \eta), \quad (2.21)$$

and the dependence with respect to  $\theta$  occurs through  $\mu_t$  and  $\Sigma_t$ . The term  $|\Sigma_t|^{-1/2}$  is the Jacobian that arises in the transformation from the innovations to the observables. Note that

$$L_T(\theta) = -\frac{1}{2} \sum_{t=1}^T \log |\Sigma_t| - \frac{1}{2} \sum_{t=1}^T (r_t - \mu_t)' \Sigma_t^{-1} (r_t - \mu_t) \quad (\text{Bauwens et al., 2006}). \quad (2.22)$$

Under the assumption of conditional normality, the parameters of the multivariate GARCH models of any of the above

as long as  $g(\cdot)$  belongs to the class of elliptical distributions, it is a function of  $z_t' z_t$ , the maximum likelihood estimator is independent of the decomposition choice for  $\Sigma_t^{1/2}$ . This is because  $z_t' z_t = (r_t - \mu_t)' \Sigma_t^{-1} (r_t - \mu_t)$  (Bauwens et al., 2006).

The most commonly employed distribution in the literature is the multivariate normal, uniquely determined by its first two moments (so that  $\varsigma = \theta$  since  $\eta$  is empty). In this case, the sample log-likelihood, defined up to a constant, is:

specifications can be estimated by maximizing the log likelihood function  $\ell$ :

$$\ell(\theta) = -\frac{TN}{2} \log 2\pi - \frac{1}{2} \sum_{t=1}^T (\log |\Sigma_t| + \varepsilon_t' \Sigma_t^{-1} \varepsilon_t), \quad (2.23)$$

where  $\theta$  denotes all the unknown parameters to be estimated,  $N$  is the number of assets (the number of series in the system), and  $T$  is the number of observations,  $\varepsilon_t = r_t - \mu_t$ , and all other notation is as above. The maximum-likelihood estimate for  $\theta$  is asymptotically normal. This makes the traditional procedures for statistical inference applicable (Brooks, 2002). Maximizing the log-likelihood function requires nonlinear maximization methods, because it involves only first order derivatives. The algorithm introduced by Berndt (1974) is easily implemented and particularly useful for the estimation of multivariate GARCH processes (Cízek et al., 2005).

It is well-known that the normality of the innovations is rejected in most applications dealing with high-frequency data. In particular, the kurtosis of most financial asset returns is larger than three which means that they have too many extreme values to be normally distributed. Moreover, their unconditional distribution has often fatter tails than what is implied by a conditional normal distribution: the increase of the kurtosis coefficient brought by the dynamics of the conditional variance is not usually sufficient to match adequately the unconditional kurtosis of the data (Bauwens et al., 2006).

If the conditional distribution of  $e_t$  is not normal, then maximizing Eq. (2.23) is interpreted as quasi maximum-likelihood (QML) (Hafner, Herwartz, 2006). The QML-estimator is consistent under the main assumption that the considered multivariate process is strictly stationary and ergodic (Cížek et al., 2005). This quasi-maximum likelihood (QML) estimator is suitable for models which specify conditional covariances and variances because it correctly specifies the conditional mean and the conditional variance (Bauwens, Laurent, 2002).

Estimation of multivariate GARCH models is troublesome, because the number of parameters may be large even for a moderate vector dimension  $N$ . Suppose there is enough data available for estimation, the likelihood might still be relatively “flat” as a function of many parameters. Thus, it might be hard for optimization routines to find the global maximum. Therefore, constraints on the parameter space are in many cases indispensable (Deistler, 2006).

## 2.6. The comparative analysis

The difficulty in estimating a VEC, or even a BEKK, model is the high number of unknown parameters. Imposing several restrictions might only help moderately. It is not surprising that these models are rarely used when the number of series is larger than 3 or 4 (Bauwens et al., 2006).

Even in the simple case of two assets, the conditional variance and covariance equations for the unrestricted VEC model contain 21 parameters. As the number of assets employed in the model increases, the estimation of the VEC model quickly becomes infeasible (Brooks, 2002). Hence,

to reduce the number of parameters, Bollerslev, Engle and Wooldridge (1988) suggest the diagonal VEC (DVEC) model in which the  $A$  and  $B$  matrices are diagonal. Each variance  $\sigma_{ii}$  depends only on its own past squares error  $\varepsilon_{i,t-1}^2$  and its own lag  $\sigma_{ii,t-1}$ . Each covariance  $\sigma_{ijt}$  depends only on its own past cross-products of errors  $\varepsilon_{i,t-1}\varepsilon_{j,t-1}$ , and its own lag (Bauwens, 2005). This reduces the number of parameters to be estimated from 21 to 9 when  $N = 2$ ; and from 78 to 18 when  $N = 3$ . The reduction is quite restrictive, and implies that there is no “spillover effect” (Brooks, 2002, Bauwens, 2005). In the bivariate case: DVEC model contains 9 parameters while BEKK model contains only 7 parameters. This occurs because the parameters governing the dynamics of the covariance equation in BEKK model are the products of the some model’s parameters that come from its two variance equations. Another way to reduce the number of parameters is to use a scalar BEKK model. This means to have  $A_k$  and  $B_k$  equal to a scalar times a matrix of ones (Bauwens et al., 2006). BEKK model allows for dependence of conditional variances of one variable on the lagged values of another variable. Causalities in variances can then be modeled (Franke et al., 2005). From a numerical optimization point of view, the BEKK model also increases the nonlinearity of the constraints, by utilizing a higher order polynomial representation compared to VEC specification (Altay-Salih et al., 2003). For each BEKK model there is an equivalent VEC representation, but not vice versa, so that the BEKK model is a special case of the VEC model (Franke et al., 2005).

The crucial point in MGARCH modeling is to provide a realistic but parsimonious specification of the variance matrix ensuring its positivity. There is a tradeoff between flexibility and parsimony. BEKK models are flexible but require too many parameters for multiple time series of more than four elements. Diagonal VEC and BEKK models are much more parsimonious, but very restrictive for the cross dynamics. They are not suitable if volatility transmission is the object of interest, but they do a good job in representing the dynamics of variances and covariances (Bauwens et al., 2006).

### 2.7. Advantages and disadvantages

Obviously, a disadvantage of the multivariate approach is that the number of parameters to be estimated in the GARCH equation increases rapidly, limiting the number of assets that can be included. In order to reduce the number of parameters to be estimated, it is advisable to impose some restrictions on  $A$  and  $B$  without lowering the explanatory power of the model significantly (De Goeij et al., 2004). A disadvantage of the VEC model is that there is no guarantee of a positive semi-definite covariance matrix. A variance-covariance or correlation matrix must always be „positive semi-definite”. Among other things, this means that the variance-covariance matrix will have all positive numbers on the leading diagonal and will be symmetric around this leading diagonal (Brooks, 2002). By diagonalizing the model we constrain its dynamic dependence and may introduce bias in the estimates of the other parameters. For instance, only shocks in asset  $i$  can influence the conditional variance of asset  $i$ . This

assumption is quite restrictive and is obviously a disadvantage of the diagonal VEC model (De Goeij et al., 2004). An advantage of the way DVEC models are formulated is that the intuition of the GARCH model, found to be very successful, is retained (Tse, 2000).

An advantage of the BEKK model is that the conditional-variance matrices are always positive definite. This is an important advantage in simulation studies (Tse, 2000). The BEKK model allows for dynamic dependence between the volatility series. On the other hand, the model has several disadvantages. First, the parameters in  $A_{ki}$  and  $B_{ki}$  do not have direct interpretations concerning lagged values of volatilities or shocks. Second, the number of parameters employed is  $N^2(p+q) + N(N+1)/2$ , increasing rapidly with  $p$  and  $q$ . Limited experience shows that many of the estimated parameters are statistically insignificant that introduces complications in modeling (Tsay, 2005).

Modeling of multivariate GARCH models is challenging for several reasons: the model structure should be parsimonious but still flexible; positivity of the conditional variances should be ensured for all sample paths; and the vector GARCH process  $\varepsilon_t$  should be (wide sense) stationary (Deistler, 2006).

## 3. A new class of multivariate GARCH models

In the previous models, we specify the conditional covariances, in addition to the variances. Next, I review models where we specify the conditional correlations, in addition to the variances. This allows some flexibility in the specifications of the

variances: they need not be the same for each component. However, we face problem if we want to specify a positive-definite conditional correlation matrix (Bauwens, 2005). This section collects models that may be viewed as nonlinear combinations of univariate GARCH models. These models are Constant Conditional Correlation Model (CCC, Bollerslev, 1990), and Dynamic Conditional Correlation Models (DCC models of Tse and Tsui, 2002, and Engle, 2002). This allows for models where one can specify separately, on the one hand, the individual conditional variances, and on the other hand, the conditional correlation matrix or another measure of dependence between the individual series. The models in this category are less demanding in terms of parameters than the models of the first category (“direct generalizations of the univariate GARCH models”). This makes their estimation easier (Bauwens et al., 2006).

### 3.1. Constant conditional correlation model (CCC)

The first reparametrization of  $\Sigma_t$  is to use the conditional coefficients and variances of  $\varepsilon_t$ . Specifically, we write  $\Sigma_t$  as

$$\Sigma_t \equiv [\sigma_{ij,t}] = D_t \rho_t D_t, \quad (3.1)$$

where  $\rho_t$  is the  $N \times N$  conditional correlation matrix of  $\varepsilon_t$ , and  $D_t$  is  $N \times N$  diagonal matrix consisting of the conditional standard deviations of elements of  $\varepsilon_t$  (i.e.  $D_t = \text{diag}\{\sqrt{\sigma_{11,t}}, \dots, \sqrt{\sigma_{NN,t}}\}$ ).

Because  $\rho_t$  is symmetric with unit diagonal elements, the time evolution of  $\Sigma_t$  is governed by that of the conditional variances  $\sigma_{ii,t}$  and the elements  $\rho_{ij,t}$  of  $\rho_t$ ,

where  $j < i$  and  $1 \leq i \leq N$ . Therefore, to model the volatility of  $\varepsilon_t$ , it suffices to consider the conditional variances and correlation coefficients of  $\varepsilon_t$  (Tsay, 2005).

The conditional variances  $\sigma_{ii,t}$  are modeled by a univariate GARCH model. Hence,

$$\sigma_{ij,t} = \rho_{ij,t} \sqrt{\sigma_{ii,t} \sigma_{jj,t}} \quad \forall i \neq j. \quad (3.2)$$

Positivity of  $\Sigma_t$  follows from the positivity of  $\rho_t$  and that of each  $\sigma_{ii,t}$  (Bauwens, 2005).

As we said before, it is often difficult to verify the condition that the conditional-variance matrix of an estimated multivariate GARCH model is positive definite. Furthermore, such conditions are often very difficult to impose during the optimization of the log-likelihood function. However, if we postulate the simple assumption that the correlations are time invariant, these difficulties elegantly disappear (Tse, 2000).

Bollerslev (1990) suggested a multivariate GARCH model in which all conditional correlations are constant and the conditional variances are modeled by univariate GARCH models. This is so-called CCC model (constant conditional correlation) (Franke et al., 2005).

The constant conditional correlation model (CCC) is defined as

$$\rho_t = \rho = [\rho_{ij}], \quad \rho_{ii} = 1. \quad (3.3)$$

Hence,

$$\sigma_{ij,t} = \rho_{ij} \sqrt{\sigma_{ii,t} \sigma_{jj,t}} \quad \forall i \neq j, \quad (3.4)$$

and the dynamics of the covariances is determined only by the dynamics of the two conditional variances. There are  $\frac{N(N-1)}{2}$  parameters in  $\rho$  (Bauwens, 2005).

Because of its simplicity, the CCC model has been very popular in empirical applications. A specific member of the group of CCC models is obtained by further

$$\sigma_{ii,t} = c_i + \sum_{h=1}^p a_{hi} \varepsilon_{t-h,i}^2 + \sum_{h=1}^q b_{hi} \sigma_{t-h,i} \quad i = 1, \dots, k \quad (3.5)$$

$$\sigma_{ij,t} = \rho_{ij} \sqrt{\sigma_{ii,t} \sigma_{jj,t}} \quad 1 \leq i < j \leq k \quad (3.6)$$

and the NC model is its special case with  $\rho_{ij} = 0$  (Tse, Tsui, 1999).

The restriction that the constant conditional correlations, and thus the conditional covariances, are proportional to the product of the corresponding conditional standard deviations highly reduces the number of unknown parameters and thus simplifies estimation (Bauwens et al., 2006).

### 3.2. Dynamic conditional correlation model (DCC)

A new class of multivariate models called dynamic conditional correlation (DCC) model is proposed by Tse, Tsui, and Engle (using the parameterization in Eq. (3.1)). They are flexible like univariate GARCH models and parsimonious parametric models for the correlations. They are not linear but can often be very simply estimated using univariate or two step likelihood function based methods. DCC models perform well in a variety of situations (Engle, 2002). The models of Tse and Tsui (2002) and Engle (2002) are genuinely multivariate and are useful for modeling high dimensional data sets (Bauwens et al., 2006).

For  $N$ -dimensional returns, Tse and Tsui (2002) assume that the conditional correlation matrix  $\rho_t$  follows the model  $DCC_T(M)$  (Tsay, 2005):

constraining the correlations to be zero. This model is denoted as the nocorrelation (NC) model. Thus the CCC model is given by

$$\rho_t = (1 - \theta_1 - \theta_2) \rho + \theta_1 \psi_{t-1} + \theta_2 \rho_{t-1} \quad (3.7)$$

$$\psi_{ij,t-1} = \frac{\sum_{m=1}^M e_{i,t-m} e_{j,t-m}}{\sqrt{\left( \sum_{m=1}^M e_{i,t-m}^2 \right) \left( \sum_{m=1}^M e_{j,t-m}^2 \right)}} \quad (3.8)$$

$$e_{it} = \varepsilon_{it} / \sqrt{\sigma_{iit}} \quad (3.9)$$

where  $\theta_1$  and  $\theta_2$  are scalar parameters,  $\theta_1, \theta_2 > 0$  and  $\theta_1 + \theta_2 < 1$ .  $\rho$  is like in CCC, an  $N \times N$  positive-definite matrix with unit diagonal elements, and  $\psi_{t-1}$  is the  $N \times N$  sample correlation matrix using shocks ( $e_t$ ) from  $t = t - M, t - M + 1, \dots, t - 1$  for a prespecified  $M$ . A necessary condition to ensure positivity of  $\psi_{t-1}$  is that  $M \geq N$ . Notice that  $\psi_{ii,t-1} = 1$  for each  $i$  by construction (Tsay, 2005, Bauwens, 2005).  $\rho_t$  is a weighted average of correlation matrices  $(\rho, \psi_{t-1}, \rho_{t-1})$ . Hence,  $\rho_t > 0$  if any of three components is greater than zero (Bauwens, 2005). Notice further that the CCC model is nested in this model. Therefore, one can test  $\theta_1 = \theta_2 = 0$  to check whether imposing constant conditional correlations is empirically relevant (Bauwens et al., 2006).

Estimation of the two scalar parameters  $\theta_1$  and  $\theta_2$  requires special constraints to ensure positive definiteness of the correlation

matrix. This is a parsimonious model, but it can be difficult to apply it. The choice of  $p$  and  $M$  deserves a careful investigation (Tsay, 2005).

Engle (2002) proposes the model  $DCC_E(1,1)$ :

$$\rho_t = (diag Q_t)^{-1/2} Q_t (diag Q_t)^{-1/2} \quad (3.10)$$

where  $Q_t = (q_{ij,t})$  is an  $N \times N$  matrix, symmetric and positive, given by

$$Q_t = (1 - \theta_1 - \theta_2) \bar{Q} + \theta_1 e_{t-1} e_{t-1}' + \theta_2 Q_{t-1}, \quad (3.11)$$

where  $e_t = (e_{1t}, e_{2t}, \dots, e_{Nt})'$  is the standardized innovation vector with elements  $e_{it} = \varepsilon_{it} / \sqrt{\sigma_{iit}}$ .  $\bar{Q}$  is the unconditional covariance matrix of  $e_t$ , it is an  $N \times N$  matrix, symmetric and positive.  $\theta_1$  and  $\theta_2$  are non-negative scalar parameters satisfying  $0 < \theta_1 + \theta_2 < 1$ , which implies that  $Q_t > 0$  and  $\psi_t > 0$  (Tsay, 2005, Bauwens, 2005).  $Q_t$  is the covariance matrix of  $e_t$ , since  $q_{iit}$  is not equal to one by construction. If  $\theta_1 = \theta_2 = 0$ , and  $\bar{q}_{ii} = 1$ , we obtain the CCC model. Hence, one can test for CCC against  $DCC_E(1,1)$  (Bauwens, 2005).

In both DCC models all the conditional correlations have the same dynamics. This saves a lot of parameters compared to VEC and BEKK models, but is quite restrictive (especially when  $N$  is large) (Bauwens, 2005).

To conclude, DCC models enable us to use flexible GARCH specifications in the variance part. Indeed, as the conditional variances (together with the conditional means) can be estimated using  $N$  univariate models, one can easily extend the DCC-GARCH models to more complex GARCH-type structures (Bauwens et al., 2006).

### 3.3. Estimation

Univariate GARCH models have met widespread empirical success. However, the problems associated with the estimation of multivariate GARCH models with time-varying correlations have constrained the researchers in estimating only the models with limited scope or considerable restrictions. Large time-varying covariance matrices are needed in portfolio management and optimization, models of the term structure of treasuries or commodities, and large vector autoregressions (Engle et al., 2001).

Maximum likelihood method can be used for all these conditional correlation models. Nevertheless, some two-step estimation approaches have been developed to increase the computational efficiency, and have been used more often in practice (Wang, Yao, 2005). A feature allows for easy empirical application of the DCC models presented above is that they can be estimated consistently using a two-step approach. This makes the approach feasible when  $N$  is high. Engle and Sheppard (2001) show that in the case of a  $DCC_E$  model, log-likelihood can be written as the sum of a mean and volatility part (depending on a set of unknown parameters  $\theta_1^*$ ) and a correlation part (depending on  $\theta_2^*$ ) (Bauwens et al., 2006). The separation shows that a two-step estimation procedure is feasible and that variances and correlations can be estimated separately. The two-stage approach mainly has the advantage that the dimensionality of the maximization problem is reduced, accelerating the maximization process (Baur, 2004). Indeed, recalling that the conditional

variance matrix of a DCC model can be expressed as  $\Sigma_t = D_t \rho_t D_t$ , we get an inefficient but consistent estimator of the parameter  $\theta_1^*$  when the identity matrix

replace  $\rho_t$  (2.24). In this case, the quasi-likelihood function corresponds to the sum of likelihood functions of  $N$  univariate models:

$$QL1_T(\theta_1^*) = -\frac{1}{2} \sum_{t=1}^T \sum_{i=1}^N \left[ \log(\sigma_{iit}) + \frac{(r_{it} - \mu_{it})^2}{\sigma_{iit}} \right]. \quad (3.12)$$

Given  $\theta_1^*$ , and under appropriate regularity conditions, we get a consistent,

but inefficient, estimator of  $\theta_2^*$  by maximizing:

$$QL2_T(\theta_2^* | \theta_1^*) = -\frac{1}{2} \sum_{t=1}^T (\log |\rho_t| + e_t' \rho_t^{-1} e_t), \quad (3.13)$$

where  $e_t = D_t^{-1}(r_t - \mu_t)$ . The sum of the likelihood functions in (3.12) and (3.13), plus one half of the total sum of squared standardized residuals ( $\sum_t e_t' e_t / 2$ ) (which is almost exactly equal to  $NT/2$ ), is equal to the log-likelihood (2.24). This enables us to compare the log-likelihood of the two-step approach with that of the one-step approach, and that of other models (Bauwens et al., 2006).

Engle and Sheppard (2001) explain why the estimators  $\hat{\theta}_1^*$  and  $\hat{\theta}_2^*$ , obtained by maximizing (3.12) and (3.13) separately, are not fully efficient. This is because they are limited information estimators, and it is true even if  $e_t$  is normally distributed. However, one iteration of a Newton-Raphson algorithm<sup>(3)</sup> applied to the total likelihood

(2.24), starting at  $(\hat{\theta}_1^*, \hat{\theta}_2^*)$ , provides an estimator that is asymptotically efficient (Bauwens et al., 2006).

### 3.4. The comparative analysis

The assumption of constant correlation in the CCC model makes the estimation of a large model feasible and ensures that the estimator is positive definite. This is achieved by simply requiring each univariate conditional variance to be non-zero and the correlation matrix to be of full rank (Engle et al., 2001). The CCC model has a smaller number of parameters which makes it simple to estimate.

To show explicitly the difference between  $DCC_T$  and  $DCC_E$ , we write the expression of the correlation coefficient in the bivariate case: for the  $DCC_T(M)$  (Bauwens, 2005, Bauwens et al., 2006),

$$\rho_{12t} = (1 - \theta_1 - \theta_2) \rho_{12} + \theta_2 \rho_{12,t-1} + \theta_1 \frac{\sum_{m=1}^M e_{1,t-m} e_{2,t-m}}{\sqrt{\left( \sum_{m=1}^M e_{1,t-m}^2 \right) \left( \sum_{m=1}^M e_{2,t-m}^2 \right)}} \quad (3.14)$$

and for the  $DCC_E(1,1)$ ,

$$\rho_{12t} = \frac{(1-\theta_1-\theta_2)\bar{q}_{12} + \theta_1 e_{1,t-1}e_{2,t-1} + \theta_2 q_{12,t-1}}{\sqrt{\left((1-\theta_1-\theta_2)\bar{q}_{11} + \theta_1 e_{1,t-1}^2 + \theta_2 q_{11,t-1}\right)\left((1-\theta_1-\theta_2)\bar{q}_{22} + \theta_1 e_{2,t-1}^2 + \theta_2 q_{22,t-1}\right)}}. \quad (3.15)$$

Unlike  $DCC_T$ ,  $DCC_E$  does not model the conditional correlation as a weighted sum of past correlations. Indeed, the matrix  $Q_t$  is written like a GARCH equation, and then transformed into a correlation matrix. Dynamic conditional correlation (DCC) models allow for different persistence between variances and correlations, but impose common persistence in the latter (although this restriction may be relaxed). They allow for modeling a very large number of series. Easy to estimate extension of the CCC model, they have been used in studies of volatility transmission as an alternative to the BEKK model (Bauwens et al., 2006).

### 3.5. Advantages and disadvantages

The parameterization given by Eq. (3.1) is useful because it models covariances and correlation directly. Yet, it has several weaknesses. First, the likelihood function becomes complicated when  $N \geq 3$ . Second, the approach requires a constrained maximization in estimation to ensure the positive definiteness of  $S_t$ . The constraint becomes complicated when  $N$  is large (Tsay, 2005).

CCC model has the advantage of applicability without restriction to large systems of time series. On the other hand, the assumption of constant correlation is possibly quite restrictive. For example, in the empirical analysis of financial markets one typically observes increasing correlation in times of crisis or crash (Franke et al., 2005). The assumption that the conditional

correlations are constant may indeed seem unrealistic in many empirical applications. A group of authors have proposed a generalization of the CCC model by making the conditional correlation matrix time dependent (DCC model). An additional difficulty is that the time dependent conditional correlation matrix has to be positive definite for all  $t$ . The DCC models guarantee this when simple conditions are imposed on the parameters (Bauwens et al., 2006). That multivariate and univariate volatility forecasts are consistent with each other is a desirable practical feature of the DCC models. When new variables are added to the system, the volatility forecasts of the original assets will be unchanged. Correlations may also remain unchanged depending on how the model is revised. These DCC models, which parameterize the conditional correlations directly, are naturally estimated in two steps – the first is a series of univariate GARCH estimates and the second the correlation estimate. These methods have clear computational advantages over multivariate GARCH models. The number of parameters to be estimated in the correlation process is independent of the number of series to be correlated. This allows for estimation of very large correlation matrices (Engle, 2002).

## 4. Empirical results

In this section, I apply trivariate time series models. I estimate the multivariate

GARCH models using EViews program, Version 4.1, using daily data from the Belgrade stock exchange for two pairs of daily log returns for stocks and index. Daily log returns data are for BELEX15 index, Hemofarm stock, and Energoprojekt stock. They cover the period from October 3, 2005 to October 6, 2006. A first simple method to estimate the parameters of univariate and a trivariate GARCH models is the Berndt-Hall-Hall-Hausman (BHHH) algorithm. This algorithm uses the first derivatives of the quasi-maximum likelihood (QML) with respect to the number of parameters that are contained in multivariate GARCH models. This is an iterative procedure, thus BHHH algorithm needs suitable initial parameters (Franke et al., 2005). Additionally, I use computer program for modeling restricted version of trivariate BEKK model, and extend it on the trivariate case of DVEC and CCC models. For all calculations in the programs used, the number of iterations is 100 and the convergence criterion is  $1 \times 10^{-5}$  which ought to be considered a procedure with high precision.

#### 4.1. Data

I apply log-difference transformation to convert data into continuously compounded returns. The price series (log values) of both stocks and index are not stationary and but become stationary when they are first differenced. Let  $r_{1t}$ ,  $r_{2t}$ ,  $r_{3t}$  and be the log return series corrected for autocorrelation in the mean of BELEX15 index, Hemofarm and Energoprojekt stocks, respectively. Figure 4.1 shows the plots of daily log returns.

BELEX15 tracks free float capitalization of 15 most liquid,

continuously traded stocks. Maximum weight for each component is limited to 20%. BELEX15 is calculated and published both with intraday and closing values. Index base period is October 1, 2005, and base value was 1,000.00 index points (<http://www.sinteza.net/>). BELEX15 is not adjusted for paid dividends, and is not protected from dilution effect, that appears as a result of dividends' payout (<http://www.belex.rs/index-e.php>).

"Hemofarm Concern" is the biggest pharmaceutical company in Serbia. We observe from Figure 4.1 that in July 2006 price of Hemofarm stock rapidly grew. This happened because German Schtada Company bought 67% stocks of Hemofarm. After that price curve is flat, which means that the price of Hemofarm stocks was not changing.

"Energoprojekt" company is one of the most important firms in Serbia in the construction industry. Company got a job in Nigeria valued at 151 million euros in February 2006. We see that as the first peak of price jump on Figure 4.1. After that price again goes down until July 2006, when positive business results raise investment in Energoprojekt stock, with constant positive price trend from then on. Possible reasons for this are previous underpricing of Energoprojekt's fundamentals compared to similar companies in the Balkan region and the entrance of new funds to the Belgrade Stock Exchange without a broad offer of high quality stocks. Additionally, management of "Energoprojekt" was focused on activities which supported its stock price.

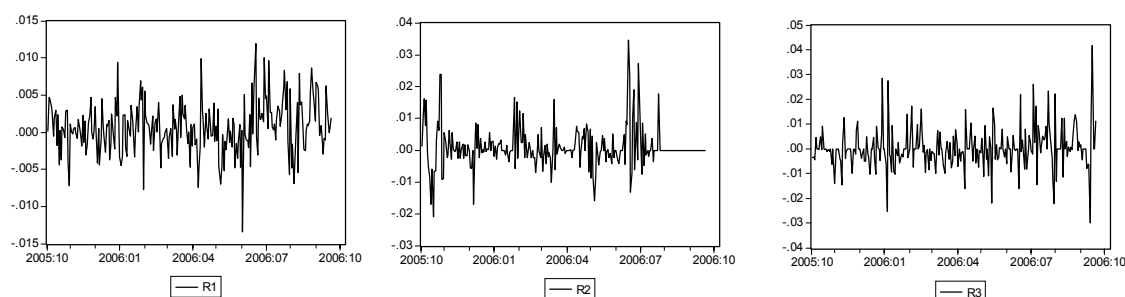


**Figure 4.1.** *The graphs of daily log returns of BELEX15 index ( $r_1$ ), Hemofarm ( $r_2$ ) and Energoprojekt ( $r_3$ ) stocks, respectively*

We observe on Figure 4.1 that the log returns of BELEX15 index, Hemofarm and Energoprojekt stocks offer evidence of the well known volatility clustering effect. It is a tendency for volatility in financial markets to appear in bunches. Large returns (of either sign) are expected to follow large returns, and small returns (of either sign) to follow small returns (Brooks, 2002).

I found that the correlation coefficients (only the first measure of correlation) between log returns of BELEX15 index and Hemofarm stock is 0.49; that between log returns of BELEX15 index and Energoprojekt stock is 0.40; and that between log returns of Hemofarm and Energoprojekt stocks about is 0.02. This means that these two stocks are unncorrelated.

Prior to modeling multivariate volatility processes, univariate GARCH analysis was performed. I used four steps in building a volatility model for each of the analyzed return series. The first step was to specify a mean equation by testing for serial dependence in the data, and building an ARMA model for the return series so as to remove any linear dependence. The second step, we to use the residuals of the mean equation to test for ARCH effects. The third

step was to specify a volatility model when the ARCH effects were statistically significant and perform a joint estimation of the mean and volatility equations. This allowed us to conclude that the right model for BELEX15 index is the ARMA(1,1)-GARCH(1,1), for Hemofarm stock is the ARMA(2,2)-IGARCH(1,1), and for Energoprojekt stock ARMA(0,0)-GARCH(1,1) model. Finally, in the fourth step, we checked the fitted models carefully: the Ljung-Box statistic of standardized residuals and its squared values showed that models are adequate for describing the conditional heteroscedasticity of the data (for detail see Minović, 2007a).

#### 4.2. Modeling of trivariate volatility processes

The methods for the estimation of parameters which I use are maximum log-likelihood and two-step approach. Although maximum log-likelihood method can be used for all three models (BEKK, DVEC and CCC), for CCC representation the first step of two-step approach is used. This is enough because CCC model has constant correlation coefficient, and the second step needs to be used only when the correlation coefficient is time dependent.

Using values from Table A.1 in Appendix A we have restricted trivariate BEKK model:

$$\hat{\sigma}_{11,t} = \underset{(0.0004)}{0.0017^2} + \underset{(0.0739)}{0.3495^2} \varepsilon_{1,t-1}^2 + \underset{(0.0879)}{0.7826^2} \sigma_{11,t-1}, \quad (4.1)$$

$$\hat{\sigma}_{22,t} = \underset{(0.0002)}{0.0001^2} + \underset{(0.0373)}{0.7682^2} \varepsilon_{2,t-1}^2 + \underset{(0.0058)}{0.8416^2} \sigma_{22,t-1}, \quad (4.2)$$

$$\hat{\sigma}_{33,t} = \underset{(0.0006)}{0.0016^2} - \underset{(0.0210)}{0.0055^2} + \underset{(0.3462)}{0.0003^2} + \underset{(0.0975)}{0.4283^2} \varepsilon_{3,t-1}^2 + \underset{(0.1607)}{0.6814^2} \sigma_{33,t-1}, \quad (4.3)$$

$$\hat{\sigma}_{12,t} = \underset{(0.0739-0.0373)}{0.3495 \cdot 0.7682} \varepsilon_{1,t-1} \varepsilon_{2,t-1} + \underset{(0.0879-0.0058)}{0.7826 \cdot 0.8416} \sigma_{12,t-1}, \quad (4.4)$$

$$\hat{\sigma}_{13,t} = \underset{(0.0004-0.0006)}{0.0017 \cdot 0.0016} + \underset{(0.0739-0.0975)}{0.3495 \cdot 0.4283} \varepsilon_{1,t-1} \varepsilon_{3,t-1} + \underset{(0.0879-0.1607)}{0.7826 \cdot 0.6814} \sigma_{13,t-1}, \quad (4.5)$$

$$\hat{\sigma}_{23,t} = \underset{(0.0002-0.0210)}{-0.0001 \cdot 0.0055} + \underset{(0.0373-0.0975)}{0.7682 \cdot 0.4283} \varepsilon_{2,t-1} \varepsilon_{3,t-1} + \underset{(0.0058-0.1607)}{0.8416 \cdot 0.6814} \sigma_{23,t-1}. \quad (4.6)$$

Similarly, the trivariate DVEC model has the form:

$$\hat{\sigma}_{11,t} = \underset{(0.0709)}{0.2006} \varepsilon_{1,t-1}^2 + \underset{(0.1549)}{0.5216} \sigma_{11,t-1}, \quad (4.7)$$

$$\hat{\sigma}_{22,t} = \underset{(0.0623)}{0.5952} \varepsilon_{2,t-1}^2 + \underset{(0.0168)}{0.6827} \sigma_{22,t-1}, \quad (4.8)$$

$$\hat{\sigma}_{33,t} = \underset{(0.1152)}{0.2479} \varepsilon_{3,t-1}^2 + \underset{(0.2135)}{0.3052} \sigma_{33,t-1}, \quad (4.9)$$

$$\hat{\sigma}_{12,t} = \underset{(0.0692)}{0.2545} \varepsilon_{1,t-1} \varepsilon_{2,t-1} + \underset{(0.0690)}{0.6431} \sigma_{12,t-1}, \quad (4.10)$$

$$\hat{\sigma}_{13,t} = \underset{(0.0716)}{0.1765} \varepsilon_{1,t-1} \varepsilon_{3,t-1} + \underset{(0.2062)}{0.3899} \sigma_{13,t-1}, \quad (4.11)$$

$$\hat{\sigma}_{23,t} = \underset{(0.1137)}{0.3630} \varepsilon_{2,t-1} \varepsilon_{3,t-1} + \underset{(0.2539)}{0.4663} \sigma_{23,t-1}. \quad (4.12)$$

Finally, the trivariate CCC model has the form:

$$\hat{\sigma}_{11,t} = \underset{(0.0913)}{0.1479} \varepsilon_{1,t-1}^2 + \underset{(0.3058)}{0.4973} \sigma_{11,t-1}, \quad (4.13)$$

$$\hat{\sigma}_{22,t} = \underset{(0.0534)}{0.5820} \varepsilon_{2,t-1}^2 + \underset{(0.0010)}{0.7085} \sigma_{22,t-1}, \quad (4.14)$$

$$\hat{\sigma}_{33,t} = \underset{(0.1057)}{0.2539} \varepsilon_{3,t-1}^2 + \underset{(0.1382)}{0.2269} \sigma_{33,t-1}, \quad (4.15)$$

$$\hat{\sigma}_{12,t} = \rho_{12} \sqrt{\sigma_{11,t} \sigma_{22,t}}, \text{ where } \rho_{12} = 0.4917, \quad (4.16)$$

$$\hat{\sigma}_{13,t} = \rho_{13} \sqrt{\sigma_{11,t} \sigma_{33,t}}, \text{ where } \rho_{13} = 0.3992, \quad (4.17)$$

$$\hat{\sigma}_{23,t} = \rho_{23} \sqrt{\sigma_{22,t} \sigma_{33,t}}, \text{ where } \rho_{23} = 0.0218. \quad (4.18)$$

Equations (4.1)-(4.6), (4.7)-(4.12) and (4.13)-(4.18) show that these models do not allow for dynamic dependence between the volatility series. From the equations for CCC model (from (4.13) to (4.18)) we can see that trivariate CCC model reduces to three univariate GARCH(1,1) models, where univariate GARCH models are estimated for each asset and then the correlation matrix is estimated via one step approach.

It is evident from the behaviour of conditional covariances (Figure 4.2) that

correlation between log returns for BELEX15 index-Hemofarm stock and between BELEX15 index-Energoprojekt stock is very unstable over time.

Then, all figures that show plotted covariances (Figure 4.2) as well as all those with variances (Figure A.1 in Appendix A) of daily log returns of Hemofarm stock, we can see significant autocorrelation. This is because Hemofarm, in the univariate case, follows Integrated GARCH (IGARCH) process.

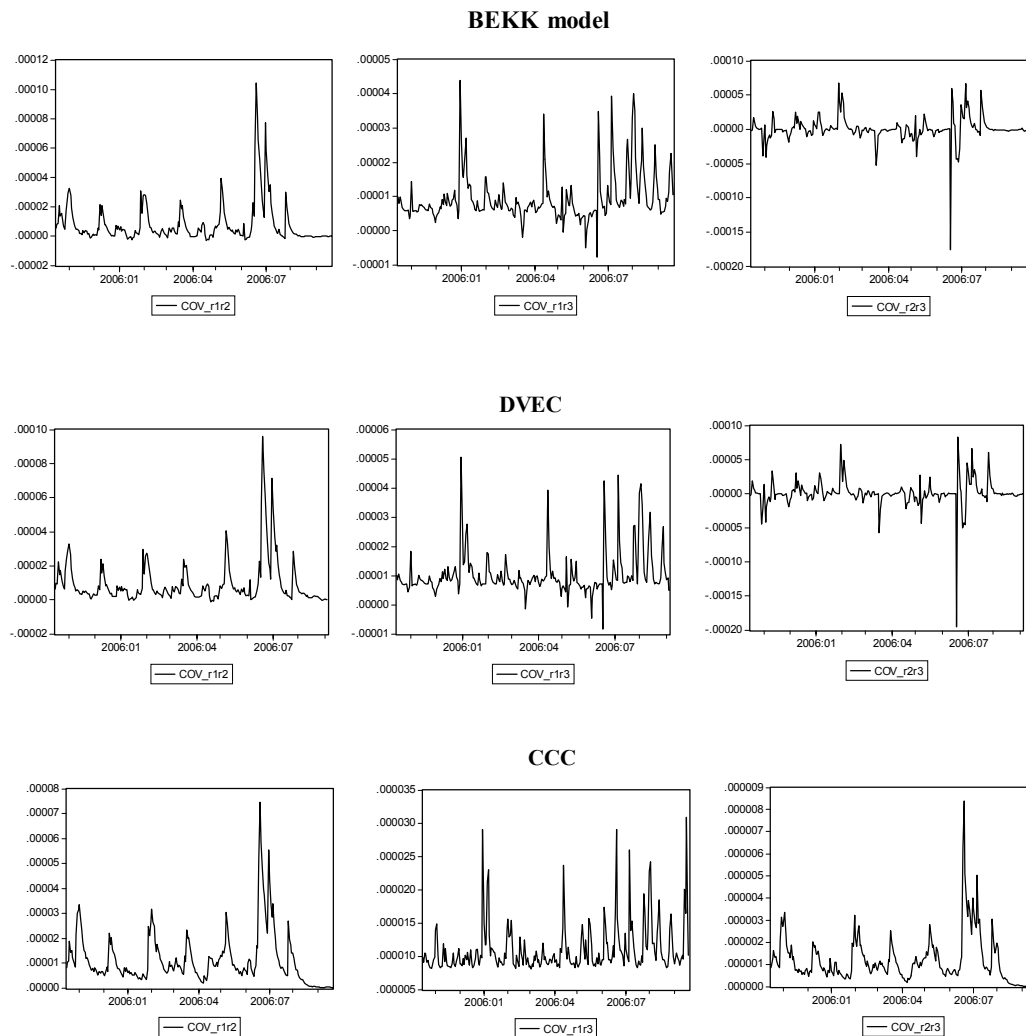


**Figure 4.2.** Estimated conditional covariance for daily log returns of BELEX15 index and Hemofarm stock ( $cov_{r_1r_2}$ ); BELEX15 index and Energoprojekt stock ( $cov_{r_1r_3}$ ); Hemofarm and Energoprojekt stocks ( $cov_{r_2r_3}$ ) in the trivariate BEKK, DVEC and CCC models, respectively

On the other hand, it has been frequently observed in multivariate estimation frameworks that volatility changes over time (see Figure A.1 in Appendix A). I showed in the trivariate case that BELEX15 is more volatile than Hemofarm and Energoprojekt stocks. In all the models, estimated conditional variance of Hemofarm stock has the greatest peak at the time that Hemofarm was sold. In the case of variance of Energoprojekt stock, the first peak was in February 2006. This coincides with the time a significant contract was signed. However, in order to choose the best model, diagnostic tests should be calculated.

#### 4.3. Analysis of the results

For diagnostic checking we used the Ljung-Box statistics of standardized residuals and those of its squared, and of cross product of standardized residuals (Tables 4.1 and 4.2). We observe that in trivariate case we have ARCH effect in variance equation of Hemofarm stock, except for DVEC model. The Q-statistics for checking whether there are any ARCH effects left in the residuals show that autocorrelation is not significant in variance equations for log returns of BELEX15 index and Energoprojekt stock.

**The Ljung-Box statistics of standardized residuals and those of its squared for log return of BELEX15 index, log return of Hemofarm and log return of Energoprojekt stocks, where the number in parentheses denotes  $p$ -value**

Table 4.1

| Q(36)               | BELEX15        | Hemofarm       | Energoprojekt  |
|---------------------|----------------|----------------|----------------|
| BEKK                | 25.628 (0.900) | 44.451 (0.158) | 31.161 (0.698) |
| DVEC                | 23.205 (0.951) | 43.256 (0.189) | 34.341 (0.548) |
| CCC                 | 22.976 (0.955) | 40.311 (0.247) | 26.675 (0.871) |
| Q <sup>2</sup> (36) |                |                |                |
| BEKK                | 29.221 (0.781) | 58.530 (0.010) | 38.323 (0.365) |
| DVEC                | 24.128 (0.935) | 47.444 (0.096) | 40.719 (0.270) |
| CCC                 | 26.468 (0.877) | 83.197 (0.000) | 34.328 (0.548) |

**The Ljung-Box statistics of cross product of standardized residuals, where the number in parentheses denotes  $p$ -value**

Table 4.2

| Q <sup>2</sup> (36) | BELEX15-Hemofarm | BELEX15-Energoprojekt | Hemofarm-Energoprojekt |
|---------------------|------------------|-----------------------|------------------------|
| BEKK                | 30.429 (0.730)   | 32.122 (0.654)        | 34.498 (0.540)         |
| DVEC                | 31.550 (0.680)   | 27.746 (0.836)        | 32.244 (0.648)         |

From Table 4.2 it is evident that there are no ARCH effects in covariance equations for BEKK and DVEC models for pairs BELEX15-Hemofarm; BELEX15-Energoprojekt, and Hemofarm-Energoprojekt. Thus, check of the models shows that they are appropriate: Q-statistics show that the models are adequate for describing the conditional heteroscedasticity of the data.

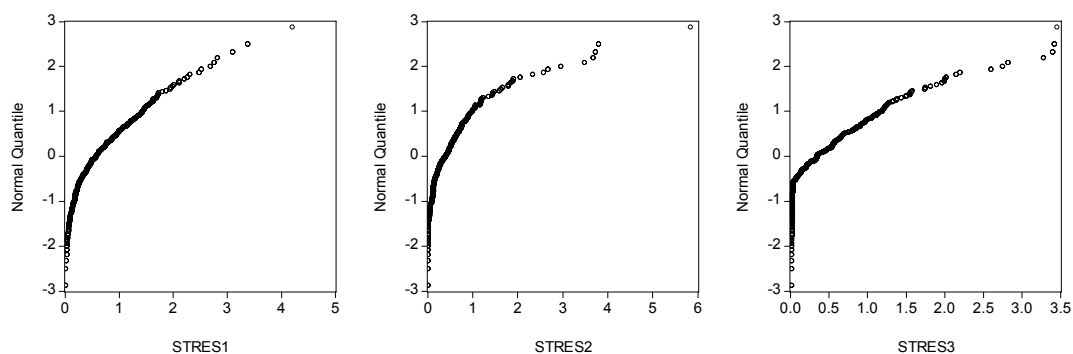


**Figure 4.3.** The QQ-plot of standardized residuals of BELEX15 index (stres1), Hemofarm (stres2) and Energoprojekt stocks (stres3) plotted against normal distribution in trivariate GARCH models

From Figure 4.3 we see that all the curves have a concave shape. This indicates that the distributions of standardized residuals are positively skewed with a long right tail. Thus, there is a significant deviation in the tails from the normal QQ-line for all three standardized residuals, and estimates are still consistent under quasi-maximum likelihood (QML) assumptions.

It is important to note that DVEC model would be the most appropriate model, because only that one does not show ARCH effect for the Hemofarm stock. BEKK and CCC model have a smaller number of parameters and they are much easier to estimate than DVEC model. Thus, the most “complicated” model proved to be the best model.

## 5. Conclusion

Volatility plays an important role in controlling and forecasting risks in various financial operations. For a univariate return series, volatility is often represented in terms of conditional variances or conditional standard deviations. Many statistical models have been developed for modeling univariate conditional variance processes (Wang, Yao, 2005). The univariate volatility models have a limitation – they model the conditional variance of each series independently of all other series. This could be a significant limitation for two reasons. First, to the extent that there could be “volatility spillovers” between markets or assets, the univariate model would be misspecified. Second, the covariances between series are of interest, as well as the variances of the individual series themselves, as is often the case in finance. While univariate descriptions are useful and important, problems of risk assessment, asset

allocation, hedging in futures markets and options pricing, portfolio Value at Risk estimates, CAPM betas, and so on require a multivariate framework. All the problems mentioned above require covariances as inputs. Multivariate GARCH models can potentially overcome both of these deficiencies of their univariate counterparts. In addition, there are many situations when empirical multivariate models of conditional heteroscedasticity can be used fruitfully (Brooks, 2002).

In this article I presented a summary of theoretical and empirical modeling with multivariate GARCH models. Because of heteroscedasticity, multivariate GARCH models are suitable for the estimation of volatility and correlation of multivariate time series. For the empirical work, the restricted BEKK, DVEC, and CCC models are preferable. This is because they are much easier to estimate, while maintaining a sufficient level of generality. These models are relatively simple in comparison to other unrestricted models version, which allows one to achieve reliable estimates of variances and covariances. We showed that even DVEC, CCC, and restricted version of BEKK models with a reduced number of parameters give results that are accurate to an acceptable degree. All analyzed models (BEKK, DVEC, and CCC) show similar behavior in variances and covariances.

The main finding is that conditional covariances exhibit significant changes over time for both stocks and index. Thus, I conclude that these models overcome the usual concept of the time invariant correlation coefficient. In the trivariate case, the restricted BEKK and DVEC, give results that are similar for each pair of log returns

of stocks and index, but those of CCC model are very different, covariance being positive and not of a negligible magnitude.

After a trivariate conditional heteroscedasticity model had been fitted, we used the Ljung-Box statistics (Q-test) of standardized residuals, those of the squared residuals, residuals, and of the cross product of standardized residuals to check for the model's adequacy. The overall result is that models perform well statistically.

## Notes

- <sup>(1)</sup> If  $X = (x_{ij})$  and  $Y = (y_{ij})$  are both  $m \times n$  matrices, then  $X \otimes Y$  is the  $m \times n$  matrix containing elementwise products  $(x_{ij} \times y_{ij})$  (Bauwens et al., 2006).
- <sup>(2)</sup> If  $v$  is a vector of dimensions  $m$  then  $\text{diag}(v) = I_m \times v$  (Bauwens et al., 2006).
- <sup>(3)</sup> The algorithm used to obtain parameter estimates is Newton-Raphson algorithm. This algorithm uses the matrix of analytic second derivatives of the log likelihood in forming iteration updates and in computing the estimated covariance matrix of the coefficients. Candidate values for the parameters  $\theta_{(i)}$  may be

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obtained using the method of Newton- Raphson by linearizing the first order conditions  $\partial F / \partial \theta$  at the current parameter values  $\theta_{(i)}$ :

$$g_{(i)} + H_{(i)} (\theta_{(i+1)} - \theta_{(i)}) = 0$$

$$\theta_{(i+1)} = \theta_{(i)} - H_{(i)}^{-1} g_{(i)}$$

where  $g$  is the gradient vector  $\partial F / \partial \theta$ , and  $H$  is the Hessian matrix  $\partial^2 F / \partial \theta^2$ . If the function is quadratic, Newton-Raphson will find the maximum in a single iteration. If the function is not quadratic, the success of the algorithm will depend on how well a local quadratic approximation captures the shape of the function (EViews 5 User's Guide).

## References

- Altay-Salih, A., Pinar M., Leyffer S., "Constrained Nonlinear Programming for Volatility Estimation with GARCH Models", August 11, 2003, <http://www.siam.org/journals/sirev/45-3/40011.html>
- Baur, D. October 2004. "A Flexible Dynamic Correlation Model". Working Paper. [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=377722](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=377722)
- Bauwens, L., "MGARCH-slides-LB-print", November 2005, Universit  catholique de Louvain
- Bauwens, L., Laurent, S., Rombouts, J.V.K., "Multivariate GARCH models: A survey", *Journal of Applied Econometrics*, February 2006, pp. 79-109
- Bauwens, L., Laurent S., "A New Class of Multivariate Skew Densities, with Application to GARCH Models", April 2002, revised April 30, 2004, <http://www.core.ucl.ac.be/econometrics/Bauwens/papers/2002-20-JBESfinal.pdf>
- Brooks, Ch. (2002). *Introductory Econometrics for Finance*, Cambridge University Press
- Brooks, Ch., Burke, S., Persaud, G., "Multivariate GARCH Models: Software Choice and Estimation Issues", *Journal of Applied Econometrics*, John Wiley & Sons, Ltd., Vol. 18(6), April 2003, pp. 725-734
- C zek, P., Wolfgang, H., Rafa, W., "Statistical Tools for Finance and Insurance", March 3, 2005, <http://www.xplore-stat.de/tutorials/>

- De Goeij, P., Marquering, W., "Modeling the Conditional Covariance Between Stock and Bond Returns: A Multivariate GARCH Approach", *Journal of Financial Econometrics*, Vol. 2, 2004, No. 4, pp. 531-564
- Deistler, M., "Multivariate Modeling of Financial Time Series", Dissertation, Mai 2006, [http://publik.tuwien.ac.at/files/pub-tm\\_4874.pdf](http://publik.tuwien.ac.at/files/pub-tm_4874.pdf)
- Engle, R., "Dynamic conditional correlation – A simple class of multivariate GARCH models", *Forthcoming Journal of Business and Economic Statistics*, Vol. 17, No. 5, 2002
- Engle, R.F., Sheppard, K., "Theoretical and Empirical properties of Dynamic Conditional Correlation Multivariate GARCH", September 7, 2001, <http://ideas.repec.org/r/nbr/nberwo/8554.html>
- Franke, J., Härdle, W., Hafner, Ch., Introduction to Statistics of Financial Markets, July 2005, <http://www.quantlet.com/mdstat/scripts/sfe/html/sfe.html>
- Hafner, Ch., Herwartz, H. "Volatility impulse response for multivariate GARCH models: An exchange rate illustration", *Journal of International Money and Finance*, 2006, pp. 1-22
- Minović, Jelena, "Univariate GARCH models: theoretical survey and application", *BALCOR 07*, Proceedings of International Conference, 2007, Zlatibor, Serbia.
- Minović, Jelena, "Application of multivariate GARCH models in Serbian financial market analysis", Proceedings of International Conference, 2007, *International Scientific Conference, Economic Faculty*, Belgrade, Serbia.
- Pang, Siu, Au-Yeung, Gannon, G., "Regulatory change and structural effects in HSIF and HSI volatility", October 2002, <http://www.docs.fce.unsw.edu.au/banking/seminar/2002/Gannon.pdf>
- Pearce, D.W. (1992). *The MIT Dictionary of modern economics*, MIT Press
- Pourahmadi, M. "Joint mean-covariance with applications to longitudinal data: Unconstrained parameterization", *Biometrika* 86, 3: 1999, pp. 677-690
- Schmidh, A. (2005). *Quantitative Finance for Physicists- An Introduction*, Academic Press
- Tsay, R.S. (2005). *Analysis of Financial Time Series*, Wiley, New Jersey
- Tse, Y.K., "A test for constant correlations in a multivariate GARCH model", *Journal of Econometrics* 98: 2000, pp. 107-127
- Tse, Y.K., Tsui, A.K.C. "A note on diagnosing multivariate conditional heteroscedasticity models", *Journal of time series analysis*, Vol. 20, No. 6, 1999, pp. 679-691
- Wang, M., Yao, Q., "Modelling multivariate volatilities: An ad hoc method", October 18, 2005, <http://stats.lse.ac.uk/q.yao/qyao.links/paper/wy04.pdf>
- Quantitative Micro Software. EViews 5 User's Guide Official the Belgrade stock exchange web site, <http://www.belex.rs>
- Brokerage web site, <http://www.sinteza.net/>
- <http://www2.gsu.edu/~mkteer/continuo.html#elliptical>

## Appendix A

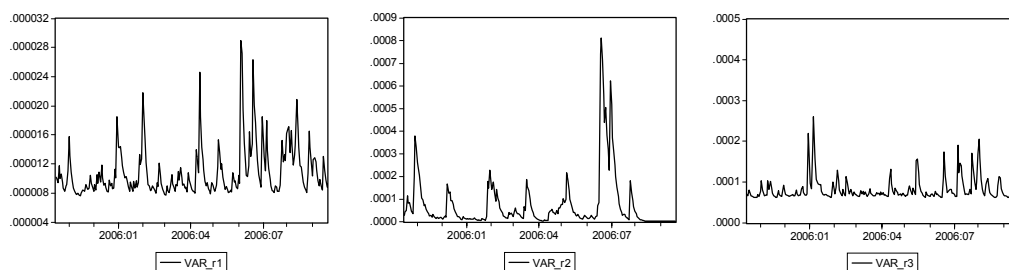
**Estimated parameters of trivariate BEKK, DVEC and CCC models. This table contains the coefficients, standard errors, z-statistics, log-likelihood and information criteria for trivariate BEKK, DVEC and CCC model**

Table A.1

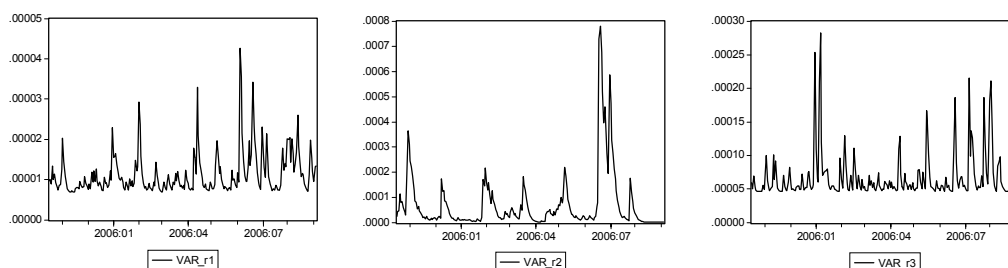
|          | BEKK    |        |          | DVEC    |        |         | CCC     |        |         |
|----------|---------|--------|----------|---------|--------|---------|---------|--------|---------|
|          | Coeff.  | S.E.   | z-Stat   | Coeff.  | S.E.   | z-Stat  | Coeff.  | S.E.   | z-Stat  |
| MU(1)    | -0.0003 | 0.0002 | -1.4536  | -0.0001 | 0.0002 | -0.3216 | -0.0001 | 0.0002 | -0.6120 |
| MU(2)    | -0.0006 | 0.0001 | -8.1946  | -0.0003 | 0.0002 | -1.6585 | -0.0006 | 0.0001 | -8.4620 |
| MU(3)    | -0.0005 | 0.0007 | -0.7305  | -0.0003 | 0.0006 | -0.5244 | -0.0003 | 0.0006 | -0.5453 |
| OMEGA(1) | 0.0017  | 0.0004 | 4.8070   | 0.0000  | 0.0000 | 1.9624  | 0.0000  | 0.0000 | 1.3449  |
| BETA(1)  | 0.7826  | 0.0879 | 8.9069   | 0.5216  | 0.1549 | 3.3679  | 0.4973  | 0.3058 | 1.6260  |
| ALPHA(1) | 0.3495  | 0.0739 | 4.7325   | 0.2006  | 0.0709 | 2.8288  | 0.1479  | 0.0913 | 1.6192  |
| OMEGA(2) | 0.0000  | 0.0000 | 0.0519   | 0.0000  | 0.0000 | 3.0426  | 0.0000  | 0.0000 | -9.3533 |
| BETA(2)  | 0.8416  | 0.0058 | 144.5231 | 0.6827  | 0.0168 | 40.5688 | 0.7085  | 0.0010 | 70.8697 |
| ALPHA(2) | 0.7682  | 0.0373 | 20.6101  | 0.5952  | 0.0623 | 9.5593  | 0.5820  | 0.0534 | 10.8965 |
| OMEGA(3) | 0.0016  | 0.0006 | 2.4940   | 0.0000  | 0.0000 | 2.6601  | 0.0000  | 0.0000 | 5.1316  |
| BETA(3)  | 0.6814  | 0.1607 | 4.2397   | 0.3052  | 0.2135 | 1.4291  | 0.2269  | 0.1382 | 1.6417  |

|                     | BEKK     |        |         | DVEC     |        |         | CCC      |        |        |
|---------------------|----------|--------|---------|----------|--------|---------|----------|--------|--------|
|                     | Coeff.   | S.E.   | z-Stat  | Coeff.   | S.E.   | z-Stat  | Coeff.   | S.E.   | z-Stat |
| ALPHA(3)            | 0.4283   | 0.0975 | 4.3925  | 0.2479   | 0.1152 | 2.1518  | 0.2539   | 0.1057 | 2.4011 |
| OMEGA(4)            | 0.0001   | 0.0002 | 0.2752  | 0.0000   | 0.0000 | 5.6805  | -        | -      | -      |
| BETA(4)             | -        | -      | -       | 0.6431   | 0.0690 | 9.3175  | -        | -      | -      |
| ALPHA(4)            | -        | -      | -       | 0.2545   | 0.0692 | 3.6794  | -        | -      | -      |
| OMEGA(5)            | -0.0055  | 0.0210 | -0.2643 | 0.0000   | 0.0000 | 2.2551  | -        | -      | -      |
| BETA(5)             | -        | -      | -       | 0.3899   | 0.2062 | 1.8905  | -        | -      | -      |
| ALPHA(5)            | -        | -      | -       | 0.1765   | 0.0716 | 2.4647  | -        | -      | -      |
| OMEGA(6)            | 0.0003   | 0.3462 | 0.0010  | 0.0000   | 0.0000 | -0.1434 | -        | -      | -      |
| BETA(6)             | -        | -      | -       | 0.4663   | 0.2539 | 1.8363  | -        | -      | -      |
| ALPHA(6)            | -        | -      | -       | 0.3630   | 0.1137 | 3.1918  | -        | -      | -      |
| Log likelihood      | 2886.269 |        |         | 2697.955 |        |         | 3534.373 |        |        |
| Avg. log likelihood | 11.8290  |        |         | 11.5792  |        |         | 14.4851  |        |        |
| Number of coeff.    | 15       |        |         | 21       |        |         | 12       |        |        |

## BEKK



## DVEC



## CCC

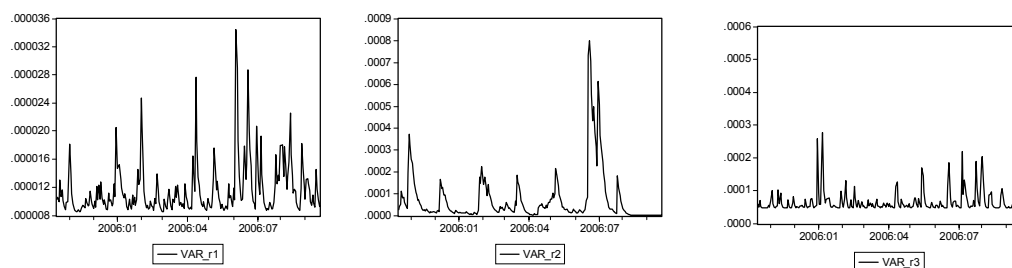


**Figure A.1.** Estimated conditional variances of daily log returns on BELEX15 index ( $var_{r_1}$ ), Hemofarm stock ( $var_{r_2}$ ) and Energoprojekt stock ( $var_{r_3}$ ), respectively in the trivariate BEKK, DVEC and CCC models

# On the Logically Vivid System

■

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***Abstract.** The paper represents an excerpt from an ambitious research program concerning the economic epistemology rebuilding (including, especially, new conjectures upon the subject – the subject-object package). It is aimed to propose and operate a logical approach and assessment of six crucial concepts used in modeling of a pseudo-natural process like the economic (or social) process: system, optimal economic process, sustainable economic process, logically vivid system, network, and emergence. Firstly, all these concepts are identified, described and characterized by a set of sufficient, respectively necessary predicates, in an attempt to define them logically. Secondly, based on the mentioned predicates, six theorems (and their converses) are formulated and demonstrated among the concepts concerned. This non-orthodox approach could open a road to recuperate the possibility for economic science (or economic theory?) to be rebuilt by new philosophical and logical bases.*

**Keywords:** logically vivid system; network; emergence; system; sustainability; economic process.

■

**JEL Codes:** A12, B59, Z19.

**REL Codes:** 2B, 5C, 5H.

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## 1. Preamble

The goal of the paper is to reevaluate the logic and epistemological bases of the economic science with the purpose to overpass several incoherencies or inconsistencies of the veridical, or at least verisimilar, modelling of the economic process.

The economic progress<sup>(1)</sup> has been considered (and still is) as an extension of the natural process, which is why both the economic science (or theory<sup>(2)</sup>) and the methodology and instruments associated to this science are of Newtonian origin, dreaming to describe this process in a dynamic, Laplacean manner.

In our opinion this situation caused a paradigm stalemate in what we call modelling<sup>(3)</sup> of the economic process, with obvious failures in all directions, including (and particularly) the macroeconomic forecast.

Given the quasi-impossibility to test<sup>(4)</sup> the theoretical-methodological hypotheses of the economic science, these hypotheses are fatally “theoretically closed”, i.e. their veridicity is generated by the acceptance (in a way, based on ... faith) of the theory or of the theoretical model.

Therefore, a possible critique or evaluation of the veridicity of some hypotheses substantiating the modelling of the economic process must address the original theory or theoretical model. This is the method to be used in this paper.

## 2. System

By system we will understand a clipping of reality (either objective, or subjective, or a mix of the two) which verifies the following sufficient predicates:

a. It has a *membrane*, which distinguished the particular clipping from its environment; we note this sufficient predicate with  $M_S$ ;

b. It contains a multitude (countable or not) of *composing elements* (discernible or not between them); we note this sufficient predicate with  $C_S$ ;

c. It is “fitted” with a multitude of *connexions* (of any kind: material – substantial or energetic –, informational, entropic etc.) between the composing elements, and between them and the environment; we note this sufficient predicate with  $X_S$ .

One can notice immediately that the sufficient predicates of the system are independent and consistent with each other.

The sufficient predicates (which also are required, once we can identify empirically at least one system), generate, once they are verified, the following two, new, necessary predicates:

d. It has *metabolism*<sup>(5)</sup>; we note this new, required, predicate with  $S_S$ ; the logic formula of generation is:  $(M_S \wedge \Phi_S) \rightarrow S_S$ , where  $\Phi_S$  is the structure of the clipping of reality, i.e.  $\Phi_S = C_S \wedge X_S$ ;

e. It has *qualitative identity*; which means that the system has a set of invariants (their nature is of no relevance) which are reproduced by the metabolism and which provide for the logic continuity of the system. Obviously, a system may undergo, in principle, evolutions (irreversible transformations) but the set of invariant parameters is required logically, to be able to speak of a significant time interval, of a system distinct from the environment (we

may give this set the name of set of identity parameters) and indistinct from itself.

Evidently, the two new predicates are independent and consistent with each other.

Therefore, noting with  $\Sigma_S$  the multitude of predicates sufficient for a system, with  $\Sigma_N^n$  the multitude of new, required, predicates and with  $\Sigma_N$  the multitude of necessary predicates, we will write sequentially:

$$\begin{aligned}\Sigma_S &= \{M_S, C_S, X_S\}, \Sigma_N^n = \{S_S, I_S\}, \\ \Sigma_N &= \{M_S, C_S, X_S, S_S, I_S\} = \\ &= \{M_S, C_S, X_S\} \cup \{S_S, I_S\} = \Sigma_S \cup \Sigma_N^n, \\ \Sigma_S \cap \Sigma_N^n &= \emptyset, \Sigma_S \cap \Sigma_N = \Sigma_S, \\ \Sigma_N^n \cap \Sigma_N &= \Sigma_N^n.\end{aligned}$$

Therefore, by system ( $\Sigma$ ) we understand that clipping of reality which verifies the predicates from the multitude  $\Sigma_N$ .

### 3. Optimal economic process

The optimal economic process is what we call an artefact, which is an entity whose appearance, although can be emergent<sup>(6)</sup> in nature, is generated in principle by an ad hoc deliberative decision. The optimal economic process is not just a simple effect of the natural process, but it maintains a permanent and continuous structural (thus causal<sup>(7)</sup>) connexion with the latter. The sufficient predicates of an optimal economic process which will therefore make the specific difference between it and the natural process (in other words, predicates which, once verified, qualify an original natural process as an optimal economic process) are the following:

a. It involves a *natural process*<sup>(8)</sup>: we note this sufficient predicate with  $N_{PEO}$ ; the economic optimal process can only exist if

the natural process exists (everything man could invent as far as possible from the nature, as will be shown below, the informational process or even more, the informatics process, also depend ultimately in the nature);

b. It involves the *presence of the human subject*: we note this sufficient predicate with  $U_{PEO}$ ; of course, the presence of the human subject must not be necessarily actual, it can be, for instance, integrated in the computer software running at the level of the process. The total absence of the human factor (or of its impact of any kind) disqualifies a process from the status of economic process;

One can notice immediately that the sufficient predicates are independent and consistent with each other. We consider therefore that a real process which verifies simultaneously the two sufficient predicates is an economic process.

These sufficient predicates (which obviously also are necessary predicates<sup>(9)</sup>) further generate two new, necessary predicates. Thus, we can say that the economic process:

c. Generate a *system*; the progress of the economic process based on the rational optimality can only take place within a system because both the objective-function and the restrictions (the two components of the optimisation model) must be “anchored” on a structure and delimited in a given modality in the real world (they have to verify the sufficient predicates of a system); we note this new necessary predicate with  $\Sigma_{PEO}$ ; the logic formula for its generation is:  $N_{PEO} \rightarrow \Sigma_{PEO}$ ;

d. Generate an *optimal purpose*<sup>(10)</sup>; the optimal purpose (therefore, the purpose in

the nature of a rationality based on optimality<sup>(11)</sup>, i.e. generally on unsustainable<sup>(12)</sup> interventions on the nature is the effect of the human factor); we note this predicate with  $O_{PEO}$ ; the logic formula for its generation is:  $U_{PEO} \rightarrow O_{PEO}$ .

In our opinion, the fundamental difference between the natural process and the economic process<sup>(13)</sup> lies just in the existence of the final cause (the purpose) of the economic process and the inexistence of the final cause in the natural process.

Therefore, noting with  $PEO_S$  the multitude of predicates sufficient for an economic process, with  $PEO_N^n$  the multitude of new sufficient predicates and with  $PEO_N$  the multitude of necessary predicates, we will write successively:

$$\begin{aligned} PEO_S &= \{N_{PEO}, U_{PEO}\}, \\ PEO_N^n &= \{\Sigma_{PEO}, O_{PEO}\}, \\ PEO_N &= \{N_{PEO}, U_{PEO}, \Sigma_{PEO}, O_{PEO}\} = \\ &= \{N_{PEO}, U_{PEO}\} \cup \{\Sigma_{PEO}, O_{PEO}\} = \\ &= PEO_S \cup PEO_N^n, \\ PEO_S \cap PEO_N^n &= \phi, \\ PEO_S \cap PEO_N &= PEO_S, \\ PEO_N^n \cap PEO_N &= PEO_N^n. \end{aligned}$$

Therefore, by an optimal economic process we understand that real process which verifies the predicates from the multitude  $PEO_N$ .

A few self-addressed *clarifying questions*:

(1) should any material exchange between the components of the inanimate nature form what we call an economic process?

answer: *no*, because the mentioned material exchange is an exchange which doesn't imply a purpose; we remain therefore within the framework of a natural process;

(2) furthermore, should the material exchange between the biologically living components of the nature and its inanimate components be termed as an economic process?

answer: the reply is no longer categorical, rather hypothetical: if we do not accept consciousness<sup>(14)</sup> in the non-human biologically living entities, than the answer is *negative*; otherwise, the answer is *positive* (not to further complicate the life of economists – who should elaborate again the entire economic theory –, we will accept subsequently that the non-human biologically living entities don't have consciousness); the answer, therefore, is also *negative*;

(3) in the modern societies there is a material exchange between men without involving directly nature or an identifiable natural process as such (for instance, stock exchange trading of shares); do we still have here an economic process observing the definition given above?

answer: *yes*, because the said material exchange is an exchange which relies ultimately also on the material exchange with the nature; therefore, this question allows us to show what a material exchange between man and nature means: it means a material exchange which can *ultimately* make the connexion with a natural process<sup>(15)</sup>;

(4) is this minimal distinction – at the level of the final cause – between the natural process and the economic process, sufficient to allow sophisticated analyses of the economic processes?

answer: *yes*, because man is not a non-natural entity. Man acquired, indeed, in time cultural distinction in relation with the nature

(cultural distinction which is the fundament of the fourth Aristotelian distinctive cause), which cause him to make severe mistake in its relation with nature<sup>(16)</sup>, but, after all, it is a natural entity. In other words, although with different shapes (and manifestations) from the nature, may still is natural, after all<sup>(17)</sup>.

#### 4. Sustainable economic process

The sustainable economic process is the next driving paradigm which will characterise the relations between man/society and nature. Sustainability, which seems to be the “paradigm” invented by the natural process, is imposed by the process of globalization, sustainability being, concomitantly, a response to the question raised by the process of globalization. The sufficient predicates of a sustainable economic process are the following:

a. it involves an *optimal economic process*<sup>(18)</sup>: we note this sufficient predicate with  $PEO_{PES}$ ; the sustainable economic process can only exist together with the original economic process, as shown before, optimal economic process;

b. it involves a *moral cod*: we note this sufficient predicate with  $M_{PES}$ ; the moral code must be understood here in all its generality<sup>(19)</sup>, meaning a moral code which is trans-generation (which takes into accounts the “right” to living of the future generations, trans-local (which takes into accounts the integrality of the earth as a common good of all mankind) and trans-economic (which takes into accounts not just the meritocracy in distributing the economic product of the society, but also the natural rights of all the people);

One can notice immediately that the sufficient predicates are independent and consistent among them. We consider therefore, than an optimal economic process which is “endowed” with a moral code is a sustainable economic process.

These sufficient predicates generate a new necessary predicate. With this meaning, we can say that the economic process is sustainable:

c. it generates *sustainability*; the progress of the economic process based on the rationality of sustainability will verify therefore the moral code in all its characteristics (as described above) and for an unlimited period (the only limitation can come exclusively from breaching the moral code); we note this new, required sufficient predicate with  $S_{PES}$ ; the logic formula for its generation is:  $(PEO_{PES} \wedge M_{PES}) \rightarrow S_{PES}$ .

Therefore, noting with  $PES_S$  the multitude of the predicates sufficient for an economic process, with  $PES_N^n$  the multitude of the new, necessary predicates and with  $PES_N$  the multitude of the necessary predicates, we will be able to write successively:

$$PES_S = \{PEO_{PES}, M_{PES}\}, \quad PES_N^n = \{S_{PES}\},$$

$$\begin{aligned} PES_N &= \{PEO_{PES}, M_{PES}, S_{PES}\} = \\ &= \{PEO_{PES}, M_{PES}\} \cup \{S_{PES}\} = \\ &= PES_S \cup PES_N^n \end{aligned}$$

$$PES_S \cap PES_N^n = \emptyset,$$

$$PES_S \cap PES_N = PES_S,$$

$$PES_N^n \cap PES_N = PES_N^n.$$

Therefore, by sustainable economic process we understand that real process which verifies the predicates from the multitude  $PES_N$ .

## 5. Logically vivid system

The real praxiological process within society is a mixed process in which we have an ineffable “mixture” of natural process and economic process. This is the reason why the distinction economic process – natural process plays only a conceptual and generally methodological function. This distinction helps us clarify our manner of thinking and even to be cognizant of the explicative theories (paradigms) which we accept, but a veridical description of reality involves certain indiscernibleness between the two categories of processes. This indiscernibleness is not related just to our capacity of observing/measuring but is, most probably, of ontological type. When the man (and the human society) appeared, reality witnessed such mixed processes: the natural process “lent” the economic process its three own causes, but also “borrowed” from the economic process, via the vivid logical system, the fourth cause – the purpose. Therefore, the typical processes which are taking place in the praxiological reality existing on our planet also are mixed processes.

Within this context, we consider that the vector (generating) difficulties existing in the economic knowledge and action arise just from ignoring this ontological indiscernibleness, i.e. because the subject (both the epistemic subject and the driving subject) has been removed from the “world”, from the systems which are object of knowledge<sup>(20)</sup>. Therefore, to be able to restore in discussion the logical and ontological bases of the Orthodox economic models, we will introduce the concept of *logically vivid system* (SLV).

By SLV we will understand a mixed system (with the meaning discussed above) which verifies the following sufficient predicates:

a. *there is a system*; we note this sufficient predicate with  $\Sigma_{SLV}$ ;

b. it has a *dissipative character* (evolution far away from equilibrium), i.e. it maintains (or even decreases) the entropy within its membrane at the expense of speeding up the entropy within its environment<sup>(21)</sup>; we note this sufficient predicate with  $D_{SLV}$ .

The debates on the sufficient predicates of a living system (with no specification concerning the “matrix” of the living – based on carbon, silicon, metal etc.) are heated and not yet settled. The pertinent ones (as alternative to our proposal) seem to be the positions which set self-reproduction as sufficient predicate (while others propose self-reparation; symmetrical arguments may say that self-reproduction is a species of self-reparation, and that self-reparation is a species of self-reproduction). In our opinion, the dissipative character of the clipping of reality, subject of our discussion, also contains logically these “ingredients” and it is conceptually more general. An important question arises, of course: how does the specific clipping “know” to behave in a dissipative manner, but the question can also be how does the specific clipping “know” to self-repair or self-reproduce. The answer might be the following: the dissipative system contains *internal* information which “requires” entropic self-maintenance. The information must be internal and not external because, in the latter case, we may have entropic maintenance generated by an external factor (we may also have reparation

or reproduction generated by an exterior factor). Although the postulation of the existence of this internal program (or information) is, somehow, metaphysical, the observable reality requires such postulation (it is true however, that that here, the required logical considerations seem to yield place to contingent considerations).

One can observe immediately the interdependence and consistency of the two sufficient predicates (which will, obviously, be necessary predicates too). Once a real system qualifies as SLV by the veracity of its sufficient predicates, it will generate, logically, three new, unnecessary predicates, as follows:

*c. self-poietic capacity* (self-generating, self-regenerating, self-organising, self-reproducing); we note this new, unnecessary predicate with  $A_{SLV}$ ; the logic formula generating this predicate is:  $D_{SLV} \rightarrow A_{SLV}$ ;

*d. non-linearity* (it doesn't allow predictions<sup>(22)</sup>, because predictions exclude novelty<sup>(23)</sup>), but only the decrease of incertitude concerning the future<sup>(24)</sup>; we note this new, unnecessary predicate with  $\bar{L}_{SLV}$ ; the logic formula generating this predicate is:  $D_{SLV} \rightarrow \bar{L}_{SLV}$ ;

*e. invariant of the total complexity*<sup>(25)</sup> (invariant, permanent maintenance<sup>(26)</sup> of the logical sum between the internal complexity of SLV and its external complexity – the external complexity is also called ecological complexity and it expresses the degree of SLV metabolism with its environment); we note this new, unnecessary predicate with  $I_{SLV}$ ; the logic formula generating this predicate is:  $(\Sigma_{SLV} \wedge D_{SLV}) \rightarrow I_{SLV}$ .

The three new, necessary predicates are, obviously, consistent and we will accept that they are independent too.

Therefore, noting with  $SLV_S$  the multitude of the predicates sufficient for a SLV, with  $SLV_N^n$  the multitude of the new, necessary predicates and with  $SLV_N$  the multitude of the necessary predicates, we may write successively:

$$\begin{aligned} SLV_S &= \{\Sigma_{SLV}, D_{SLV}\}, \\ SLV_N^n &= \{A_{SLV}, \bar{L}_{SLV}, I_{SLV}\}, \\ SLV_N &= \{\Sigma_{SLV}, D_{SLV}, A_{SLV}, \bar{L}_{SLV}, I_{SLV}\} = \\ &= \{\Sigma_{SLV}, D_{SLV}\} \cup \{A_{SLV}, \bar{L}_{SLV}, I_{SLV}\} = \\ &= SLV_S \cup SLV_N^n \end{aligned}$$

$$\begin{aligned} SLV_S \cap SLV_N^n &= \emptyset, \\ SLV_S \cap SLV_N &= SLV_S, \\ SLV_N^n \cap SLV_N &= SLV_N^n. \end{aligned}$$

Therefore, by a logically vivid system (SLV) we understand that system which verifies the predicates from  $SLV_N$  multitude.

## 6. Network

The network concept must be anchored within the system concept. We will therefore enunciate the sufficient predicates of the network (or better said, of the system organised<sup>(27)</sup> as network):

a. the quality of *system*; we note this sufficient predicate with  $\Sigma_R$ ;

b. *indiscernibleness* of the elements composing the system (there are no “statutory” privileges or privileges of definition at the level of the elements composing the system<sup>(28)</sup>); we note this sufficient predicate with  $I_R$ ;

c. universal *accessibility of the information* within the system, at the level of the system (any information input into the system or generated by the system, at the level of a system component, is immediately<sup>(29)</sup> available to any other

component of the particular system); we note this sufficient predicate with  $A_R$ .

One can observe immediately that the sufficient predicates of the network are independent and consistent among them.

The sufficient predicates, once verified, generate a new, necessary predicate:

*d. feedback spontaneity* of the system components<sup>(30)</sup> (the negative or positive feedback appears spontaneously and generalized in all system components); we note this new, necessary predicate with  $S_R$ ; the logical formula of derivation is:  $(I_R \wedge A_R) \rightarrow S_R$ .

Therefore, noting with  $R_S$  the multitude of predicates sufficient for a network, with  $R_N^n$  the multitude of new, necessary predicates and with  $R_N$  the multitude of unnecessary predicates, we may write successively:

$$\begin{aligned} R_S &= \{\Sigma_R, I_R, A_R\}, R_N^n = \{S_R\}, \\ R_N &= \{\Sigma_R, I_R, A_R, S_R\} = \\ &= \{\Sigma_R, I_R, A_R\} \cup \{S_R\} = R_S \cup R_N^n, \\ R_S \cap R_N^n &= \emptyset, R_S \cap R_N = R_S, \\ R_N^n \cap R_N &= R_N^n. \end{aligned}$$

Therefore, by network we understand that real system which verifies the predicates from  $R_N$  multitude.

## 7. Emergence

Emergence is, obviously, a process. But is it a natural process or an economic process? The question is deep and, therefore, the answer to it cannot be a short one; hence we will make some comments on it based on which we will try thereafter to identify, as usually, the sufficient and necessary predicates of this concept.

1. emergence rejects, by definition, any connotation related to a deliberate, planned,

conscious character of it. These specifications relay immediately to the answer that emergence is a natural process because these characteristics preclude the purpose (final cause). Indeed, the entire pre-human evolution on the planet is the effect of processes of emergence<sup>(31)</sup>, i.e. the spontaneous emersion of the novel quality<sup>(32)</sup>;

2. however, emergence processes have been also observed in the reality which includes the man (and society), i.e. the reality guided by a purpose. How can this happen? The explanation follows: as shown at pct.1 of these comments, emergence is something non-computational, non-algorithmic<sup>(33)</sup>. But this character refers to a top-down algorithm, which is an algorithm unable to allow its own evolution by its run. In the reality which includes man, the capacity of an algorithm to learn and to perfect (more generally, to modify), from its own experience generated by running, is an actual capacity. Therefore, the driving algorithms can be of bottom-up type. Which is the consequence of this fact? The consequence is that we may have at the same time purpose (verified by the design and implementation of a bottom-up algorithm) and novelty, which is emergence. Therefore, it is not impossible for the emergence processes to occur in mixed (economic and natural) processes too, and history shows not only that such emergence processes occur within the mentioned conditions, but that their speed and “density” is much higher, related to the cosmological scale, than of the purely natural processes;

3. therefore, the answer to our initial question, whether emergence is specific to the natural processes, or to the economic processes, might be the following:

emergence is specific to all the situations (processes, evolutionary arrangements) which allow novelty<sup>(34)</sup>, that is, to all the situations which allow to go beyond the simple morphological combination of the existing elements, either by accident<sup>(35)</sup>, or by algorithms which learn while running, or by an effect of synergy<sup>(36)</sup>.

We will say therefore, that emergence is a process which verifies the following sufficient predicates:

a. it involves a *system*; we note this sufficient predicate with  $\Sigma_E$ ; the sufficient character of this predicate results from the fact that the identification of an emergence process requires a clipping of reality, to be distinguished from the environment of the clipping or from other such clippings; if there is no system, the process of emergence is non-observable;

b. it is *non-deliberative*<sup>(37)</sup>, meaning that it is spontaneous (it is not the effect of a decision, singular or integrated within a particular program or strategy); we note this sufficient predicate with  $\overline{D}_E$ ;

c. it is *non-computational*<sup>(38)</sup> (or, which is not the same thing, it is non-algorithmable); we note this sufficient predicate with  $\overline{C}_E$ .

One can observe immediately that the sufficient predicates of the process of emergence are independent and consistent among them.

The sufficient predicates generate a new, necessary predicate:

d. it is *non-structural*, that is, it can not be inferred from the structure of the system in which the particular process takes place or might take place; non-structuralness is a

necessary predicate because if it would not be verified, than we might conclude that emergence is plannable<sup>(39)</sup>, which would contradict, for instance, the sufficient predicate of non-deliberativeness; we note this new necessary predicate with  $\overline{S}_E$ ; the logical formula generating this predicate is:  $(\overline{D}_E \wedge \overline{C}_E) \rightarrow \overline{S}_E$ . The non-structural character of the process of emergence is particularly important because it allows a high “creativity” in the generation of novelty.

Therefore, noting with  $E_S$  the multitude of the predicates sufficient for the process of emergence, with  $E_N^n$  the multitude of the new necessary predicates and with  $E_N$  the multitude of the necessary predicates, we may write successively:

$$E_S = \{\Sigma_E, \overline{D}_E, \overline{C}_E\}, E_N^n = \{\overline{S}_E\},$$

$$E_N = \{\Sigma_E, \overline{D}_E, \overline{C}_E, \overline{S}_E\} = \\ = \{\Sigma_E, \overline{D}_E, \overline{C}_E\} \cup \{\overline{S}_E\} = E_S \cup E_N^n,$$

$$E_S \cap E_N^n = \emptyset, E_S \cap E_N = E_S,$$

$$E_N^n \cap E_N = E_N^n.$$

Therefore, by emergence we understand that process which verifies the predicates from  $E_N$  multitude.

## 8. Six Theorems

Based on the predicates sufficient and necessary proposed for the logical definition of the concepts of *economic process*, *system*, *logically vivid system*, *network and emergence*, we may state several theorems useful in examining the reconfigurations required to substantiate a model of the economic process, implicitly of the economic prediction.

Following is a systematisation of the predicates obtained for the five concepts:

|                              | Sufficient predicates                                                                                                      | New, necessary predicates                                                                                                                        |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| System                       | <ul style="list-style-type: none"> <li>▪ Membrane</li> <li>▪ Composing elements</li> <li>▪ Connexions</li> </ul>           | <ul style="list-style-type: none"> <li>▪ Metabolism</li> <li>▪ Qualitative identity</li> </ul>                                                   |
| Optimal economic process     | <ul style="list-style-type: none"> <li>▪ Natural process</li> <li>▪ Presence of the human factor</li> </ul>                | <ul style="list-style-type: none"> <li>▪ System</li> <li>▪ Optimal purpose</li> </ul>                                                            |
| Sustainable economic process | <ul style="list-style-type: none"> <li>▪ Optimal economic process</li> <li>▪ Moral code</li> </ul>                         | <ul style="list-style-type: none"> <li>▪ Sustainability</li> </ul>                                                                               |
| Logically vivid system       | <ul style="list-style-type: none"> <li>▪ System</li> <li>▪ Dissipativity</li> </ul>                                        | <ul style="list-style-type: none"> <li>▪ Auto-poietic capacity</li> <li>▪ Non-linearity</li> <li>▪ Invariance of the total complexity</li> </ul> |
| Network                      | <ul style="list-style-type: none"> <li>▪ System</li> <li>▪ Indiscernibleness</li> <li>▪ Universal accessibility</li> </ul> | <ul style="list-style-type: none"> <li>▪ Feedback spontaneity</li> </ul>                                                                         |
| Emergence                    | <ul style="list-style-type: none"> <li>▪ System</li> <li>▪ Non-deliberativeness</li> <li>▪ Non-computational</li> </ul>    | <ul style="list-style-type: none"> <li>▪ Non-structuralness</li> </ul>                                                                           |

▪ **Theorem 1.** *Any sustainable economic process is an optimal economic process as well* ( $PES_N \subset PEO_S$ )

- **demonstration:** the theorem is obviously true, since one of the necessary (even sufficient) conditions of the sustainable economic process is to be an optimal economic process. As we have thus verified the generation of the sufficient predicates<sup>(40)</sup> of an optimal economic process by the necessary predicates of the sustainable economic process, the theorem *is* demonstrated.

▪ **Reciprocal of theorem 1.** *Any PEO is a PES* ( $PEO_N \subset PES_S$ )

- demonstration: it can be noticed immediately that none of the necessary predicates of PEO generates, with logical necessity, at least one of the sufficient predicates of PES, which is the “moral code”; it results that the reciprocal of theorem 1 *is not* true, which means that there are optimal economic processes which are not sustainable economic processes.

▪ **Theorem 2.** *Any optimal economic process is a logically vivid system* ( $PEO_N \subset SLV_S$ )

- **demonstration:** first, both the optimal economic process and the logically

vivid system are systems, therefore they verify the logical implication:  $\Sigma_{PEO} \rightarrow \Sigma_{SLV}$ ; second, dissipativeness is a necessary characteristic (in logic terms) of the presence of the human factor (therefore, of the purpose) within the economic process<sup>(41)</sup>, therefore it verifies the logical implication:  $U_{PEO} \rightarrow D_{SLV}$ . As we have thus verified the generation of the sufficient predicates of the logically vivid system by the necessary predicates of the optimal economic process, the theorem *is* demonstrated<sup>(42)</sup>.

▪ **Reciprocal of theorem 2.** *Any SLV is a PEO* ( $SLV_N \subset PEO_S$ )

- **demonstration:** it can be noticed immediately that none of the necessary predicates of SLV generates, with logical necessity, at least one of the sufficient predicates of the optimal economic process, the “presence of the human factor”; it results that the reciprocal of theorem 2 *is not* true, which means that there are logically vivid systems which are not sustainable economic processes.

▪ **Theorem 3.** *Any sustainable economic process is a logically vivid system* ( $PES_N \subset SLV_S$ )

- **demonstration:** from the first and second theorems it results that any sustainable economic process is a logically vivid system.

■ *Reciprocal of theorem 3. Any SLV is a PES* ( $SLV_N \subset PES_S$ )

- **demonstration:** from the reciprocals of theorems 1 and 2 it results that the reciprocal of theorem 3 *is not* true, which means that there are SLV which are not sustainable economic processes.

■ **Theorem 4.** *Any network is a SLV* ( $R_N \subset SLV_S$ )

- **demonstration:** first, both the network and the SLV are systems, therefore they verify the logical implication:  $\Sigma_R \rightarrow \Sigma_{SLV}$ ; second, feed-back spontaneity, together with the universal accessibility to any information (feed back included) provides for the dissipative capacity, verifying thus the logical implication  $(S_R \wedge A_R) \rightarrow D_{SLV}$ . As we have thus verified the generation of the sufficient predicates of SLV by the necessary predicates of the network, the theorem *is* demonstrated.

■ *Reciprocal of theorem 4. Any SLV is a network* ( $SLV_N \subset R_S$ )

- **demonstration:** it can be noticed readily that none of the necessary predicates of SLV (and no logical combination of them) can generate, with logical necessity, the sufficient predicate of the network called “indiscernibleness”; it results therefore that the reciprocal of theorem 4 *is not* true, which means that there are SLV which are not networks<sup>(43)</sup>.

■ **Theorem 5.** *Any living biological system (SBV)<sup>(44)</sup> is a SLV* ( $SBV \subset SLV$ )

- **demonstration:** it can be observed that the necessary predicates of SLV make

no reference to the microscopic foundation of SLV (carbon, silicon, metal, etc.); therefore, any such microscopic foundation is acceptable; since SBV foundation is carbon (at least this is what we can notice presently in our corner of the Universe), it results immediately that any SBV is a class of SLV. As we have thus verified the generation of the sufficient predicates of SLV by the necessary predicates of SBV, the theorem *is* demonstrated.

■ *Reciprocal of theorem 5. Any SLV is a SBV* ( $SBV \subset SLV$ )

- **demonstration:** since, as shown before, it seems that SBV is based on carbon, while SLV accepts any microscopic foundation, it results that the reciprocal of theorem 5 *is not* true, which means that there are SLV which are not SBV.

■ **Theorem 6.** *Any network implies a process of emergence* ( $R_N \subset E_S$ )

- **demonstration:** first, both the network and the process of emergence are systems, therefore they verify the logical implication:  $\Sigma_R \rightarrow \Sigma_E$ ; second, the sufficient predicate of network “indiscernibleness” generates, with logical necessity, the sufficient predicate of “non-deliberativeness” of the process of emergence (indeed, since there are no privileged components in the network, there are no hierarchies, therefore there are no deliberative decisions<sup>(45)</sup>), which verifies the logical implication:  $I_R \rightarrow \overline{D_E}$ ; third, the new necessary predicate „feed-back spontaneity” of the network generates with logical necessity the sufficient predicate of „non-computationality” of the process of emergence (indeed, spontaneity defies any algorithm, be it ex ante or ex post), which verifies thus the logical implication:  $S_R \rightarrow \overline{C_E}$ .

As we have thus verified the generation of the sufficient predicates of the process of emergence by the necessary predicates of the network, the theorem *is* demonstrated.

■ *Reciprocal of theorem 6. Any process of emergence involves a network* ( $E_N \subset R_S$ )

- **demonstration:** *first*, both the process of emergence and the network are systems, therefore they verify the logical implication:  $\Sigma_E \rightarrow \Sigma_R$ ; *second*, the sufficient predicate of “non-deliberativeness” of the process of emergence generates, with logical necessity, the sufficient predicate of “universal accessibility” of the network (meaning that since there are no processes of information concentration or selection due to reasons of deliberativeness, then the information is available distinctly in the system), which verifies thus the logical implication:  $\overline{D}_E \rightarrow A_R$ ; *third*, the new necessary predicate „non-structuralness” of the process of emergence, will generate with logical necessity, the sufficient predicate of “indiscernibleness” of the network, which verifies thus the logical implication  $\overline{S}_E \rightarrow I_R$ . As we have thus verified the generation of the sufficient predicates of the network by the necessary predicates of the process of emergence, the reciprocal of theorem 6 *is* true.

Therefore, theorem 4 could be reformulated as follows: *the network and the process of emergence are logically equivalent*.

We may note therefore, the following results, written formally, concerning the concepts discussed above:

$$(a) (\forall)PES_i, (\exists)PEO_j | PES_i \subset PEO_j$$

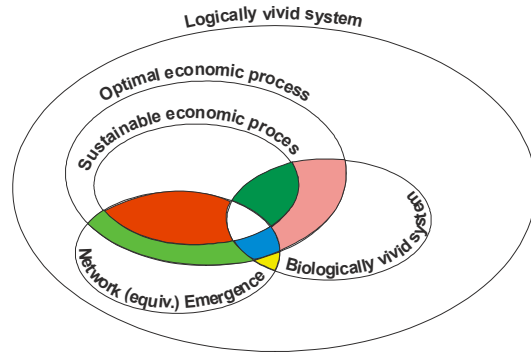
where “i” and “j” are two common counters ( $i, j \in N^+$ , where  $N^+$  is the multitude of the natural numbers, without the null element);

- (b)  $(\exists)PEO_i | (\forall)PES_j, PEO_i \not\subset PES_j$
- (c)  $(\forall)PEO_i, (\exists)SLV_j | PEO_i \subset SLV_j$
- (d)  $(\exists)SLV_i | (\forall)PEO_j, SLV_i \not\subset PEO_j$ ;
- (e)  $(\forall)PES_i, (\exists)SLV_j | PES_i \subset SLV_j$
- (f)  $(\exists)SLV_i | (\forall)PES_j, SLV_i \not\subset PES_j$
- (g)  $(\forall)R_i, (\exists)SLV_j | R_i \subset SLV_j$ ;
- (h)  $(\exists)SLV_i | (\forall)R_j, SLV_i \not\subset R_j$ ;
- (i)  $(\forall)SBV_i, (\exists)SLV_j | SBV_i \subset SLV_j$ ;
- (j)  $(\exists)SLV_i | (\forall)SBV_j, SLV_i \not\subset SBV_j$ ;
- (k)  $(\forall)R_i, (\exists)E_j | R_i \subset E_j$ ;
- (l)  $(\forall)E_i, (\exists)R_j | E_i \subset R_j$ ;

From the primary formal relations above, we may further extract the following logical consequences:

- a. of logical equivalence: from (k) and (l):  $(\forall)i, j, R_i \leftrightarrow E_j$ ;
- b. of logical possibility: from (c) and (e):  $(\Omega)i, j | (PES_i \subset R_j) \vee (R_j \subset PES_i)^{(46)}$ .

A synoptic presentation of the correlations of logical inclusion (necessary, possible or desirable) between the four concepts may be represented as follows:



As it can be seen, the logic “wrapper” of the four analysed concepts is the logically vivid system. Therefore, in our opinion, the reconstruction of the logical foundations of the economic epistemology and praxiology should be set on this concept. In consequence, the modelling of the economic

process (either abstract or instrumental – of quantitative or heuristic model) should rely on the same concept. The concept of logically vivid system must be previously developed enough, may be even as a theory of the logically vivid system.

## 9. Theses-conclusions

At least the following theses-conclusions can be inferred from the above considerations:

1. the deadlock (partially acknowledged) of the economic science concerning the veridicity and practicability of economic process modelling originates in the naturalist paradigm of this process;

2. the reinsertion of man (of the epistemic and praxiological subject) within the object of economic knowledge (which means to give up the epistemological principle of objectivation) is the key to identify the ways in which the economic process can be modelled veridically;

3. the economic process (and therefore, any structure of it – organisations, institutions and in general, any economic phenomenology) must be seen as logically vivid systems;

4. only with the paradigm of the logically vivid systems is it possible to solve coherently and consistently difficult impediments of the economic process modelling such as: the variation of the initial conditions (see the Oedipus effect), the qualitative change (see the emergence of novelty), the non-linearity, while providing for the epistemological simplicity (indispensable to understanding, therefore indispensable to integrating the results of the economic process within the values composing the quality of life);

5. the structural-causal prediction is doomed, in principle, to fail (by failure of

the prediction we understand not mere unacceptable deviations of what was predicted from the actual measurements at the end of the time horizon, but an unacceptable deviation from the veridicity<sup>(47)</sup> of the economic process); as shown before, the prediction of the economic process must be, in principle, normative, actually requiring *retrodictions* for the time horizon “future-present”, and not predictions for the time horizon “past-present-future”;

6. the novelty (qualitative change) requires the network, which is logically equivalent to the processes of emergence;

7. the logically vivid system, the network and the emergence are the pillars which should support a possible review of the logical bases of the economic epistemology and praxiology;

8. such a review should also involve the revaluation of the following issues of general economic methodology:

- the consideration of an economic space, and of an economic time (dependent as density and speed/acceleration, on the reference framework<sup>(48)</sup> - for instance, on the level and/or structure of development);

- revaluation of the presence of the linear overlap in our economic models (including at the level of the economic predictions);

- revaluation of the epistemological and even methodological/instrumental role of probabilities, which introduce an unnecessary or even harmful statistic ingredient, in our opinion, to the modelling of the economic process<sup>(49)</sup>;

- evaluation of the possibility to achieve the epistemological simplicity in the general modelling<sup>(50)</sup> of the economic process by the methodological linearization of the ontological (immanent) non-linearity

(which also exists in the economic process, as demonstrated above);

9. we consider that the rejection of the Newtonian paradigm of the economic process modelling (particularly of the economic phenomenology reversibility), with the simultaneous recovery of the

dynamic character of the description of the economic evolution (possibly by the replacement of the classical probability with the principle of the linear overlapping of the states) is an urgent necessity both for the economists and for the philosophers or logicians.

## 10. The evolution of the driving paradigms

- man and any artefacts containing it generate dissipative systems
- the dissipative systems are non-equilibrium systems
  - they are systems functioning far from the state of equilibrium (see I. Prigogine)
- the dissipative systems are ambivalent systems
  - driving systems: generate the contingent change
  - self-reflexive systems: generate knowledge
- primary knowledge: generated by problem solving (see K. Popper)
  - it is exclusively contextual (local – spatially and temporally)
  - it is empirical (reactive) – it generates solutions to the problems
- secondary knowledge: generated by the cognition of the primary knowledge
  - it is a-contextual
  - it requires the elaboration of theories (knowledge systems which save thinking); it is pro-active – generates problems.

### Paradigm of stability

- wide scale process reproducibility
- complete, natural or “naturalised” circular processes
  - homogenous speed of the entropy within the dissipative system and within the environment
- generates the phenomenology of localization
- it is a “dead” paradigm within the present civilization.

### Paradigm of optimality

- intra-temporal criterional extremisation of the processes
- it generates processes “with rest”, unintegrable naturally
  - accelerated speed of the entropy within the environment, compared to the dissipative system (entropy “pumping” into the environment)
- it generates the phenomenology of globalization
- it involves simultaneously primary knowledge and secondary knowledge
- it is the current paradigm of our civilization.

### Paradigm of sustainability

- inter-temporal criterional extremisation of the processes (sustainability criteria)
- complete, “naturalized”, circular processes
  - higher speed of the entropy within the environment, compared to the dissipative system, but lower that for the paradigm of optimality (lower “production” of entropy)
- it generates the phenomenology of fully integrated localization
- it involves simultaneously primary knowledge and empirical knowledge
- it is an “emerging” paradigm.

### Paradigm of viability

- It recaptures the entire paradigm of sustainability
- It adds the moral code of civilization
  - higher speed of the entropy within the environment, compared to the dissipative system, but lower that for the paradigm of sustainability (additional reduction of the “production” of entropy)
- it generates the phenomenology of service provisioning (transformation of the artefacts in logically vivid systems)
- it involves, simultaneously, primary knowledge and secondary knowledge
- it is a desirable paradigm, upon finalization of the globalization process.

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## Notes

- <sup>(1)</sup> The process, in general, represents a variation of the state vector of a certain entity to which a state vector is possibly (intelligibly) to assign. We are not interested here in a specific qualification of this variation (whether it is reversible or irreversible, periodical or singular, natural or artefactual, etc.).
- <sup>(2)</sup> We can easily demonstrate that the economic science is in principle non-theoretical, but this distinction between theoretical science and empirical (non-theoretical) science, is not relevant to the objective of this paper.
- <sup>(3)</sup> Here, the meaning of the notion of modelling is very wide, referring to any explicative demarche, theoretical or logic (it is by no means reduced to a quantitative, possibly equational description).
- <sup>(4)</sup> In a genuine meaning, hypothesis testing presumes the possibility of repeating the test (including the experimental design) by several independent persons or structures (for instance organisational structures at any level). Because social (and implicitly, economic) testing is not possible in laboratory time, but only in real (historic) time, and because the invariance (identity) of the initial conditions can not be maintained, test reproducibility is compromised.
- <sup>(5)</sup> Meaning an exchange of matter, energy and information with the environment. As it is known, the metabolism is the logical sum of the anabolism and catabolism.
- <sup>(6)</sup> The economic process, in the abstract meaning of the word (better said, in the meaning referring to the “first” appearance of a praxiological action of the man in relation with the nature), is, of course, an emergent process. In its concrete and, particularly, modern meaning, the economic process is no longer an emerging process (in the same way in which, for instance, in the analytics of the production functions, the natural factor no longer exists as such, rather being incorporated in the capital factor). In other words, one may say that the results of the non-emergent processes necessarily are artefacts, while the results of the emergent processes can be artefacts.
- <sup>(7)</sup> In the most general meaning (which, however, is not of distinct interest for us in this paper), this exchange between man (society) as dissipative system and nature presumes an exchange of entropy: low entropy from the nature towards the dissipative system and high entropy from the dissipative system towards the nature.
- <sup>(8)</sup> A natural process is that real process in which three (Aristotelian) categories of causes function: the material cause, the formal cause and the efficient cause.
- <sup>(9)</sup> The compulsory character of the sufficient predicates resides in the fact that empirically (therefore in terms of an experience to be communicated between subjects) there are, in the observable universe, processes which verify the sufficient predicates.
- <sup>(10)</sup> Obviously, the optimal purpose involves the operation of the final Aristotelian cause (*causa finalis*). The other three causes, also to be found in the natural process, are: a) the material cause (*causa materialis*); b) the efficient cause (*causa efficiens*); c) the formal cause (*causa formalis*).  
It is, however, extremely arguable whether the natural process requires the formal cause. It might rather seem that this type of cause is related to the final cause but, considering for instance the genetic code (provided we exclude the divine intervention in designing it), it seems however, that the natural process is also characterised, though, by the formal cause. We will subsequently accept the idea that the economic process differs from the natural process just by the existence of this fourth cause, the final cause (purpose).
- <sup>(11)</sup> We might wonder whether nature optimises. We consider that the answer is negative: nature’s “rationality” is towards sustainability, not towards optimality (the historical “evidence” is the long time required by the natural evolution, related to the rather short time required by the social evolution). By evolution we understand, of course, an irreversible loss of identity.
- <sup>(12)</sup> The unsustainable character of the economic process appears with the emergence of optimality as generalised driving paradigm. Globalization, which is the effect of the driving paradigm of optimality, becomes (the process has already started) the cause for replacing the paradigm of optimality by the paradigm of sustainability (which will be replaced in turn by the paradigm of viability).

formed of the logic sum of optimality and moral code). In the economic theory, the expression of the paradigm of optimality is the methodological individualism.

<sup>(13)</sup> Of course, the economic process can be replaced with a wider process (the widest process involving human action): the social process, the conclusions being, however, rigorously the same.

<sup>(14)</sup> In a general meaning, by consciousness we will understand the reflexive capacity to observe the self and to differentiate it from the environment. In a narrower meaning, but more useful to our present discussion, by consciousness we will understand the capacity to understand the significance of one's own action or of the actions of the other entities in the environment. Understanding (comprehension) implies intuition, while explanation implies reason.

<sup>(15)</sup> It is somehow curious how the new syntagm of the informatics society or of the knowledge society succeeded, for most of us, to break any ties with the natural process within the economic process specific to the new paradigm. As if it would be enough to draw bread on computer and to eat it. No matter how many links would science and technology introduce within the material exchange (or, many times, in the fully dematerialised exchange) between the people, ultimately it is about an exchange between man and nature (someone, sometime must simply bake that physical bread; do not mistake the fact that we can produce an increasing amount of artificial products for the fact that we still need the nature or the natural process – the production of artificial goods only takes us a few links farther from nature, but can not break us from it).

<sup>(16)</sup> Also see the opinions expressed within CCFM on the evolution of the driving paradigms in human mankind (especially the presentations within the Seminary of Methodology and Logic of the Economic Knowledge „Nicholas Georgescu-Roegen”, 4<sup>th</sup> session)

<sup>(17)</sup> We do not insist here on the complications raised by the emergence of artificial intelligence and even of the robots “candidate” to the status of logically living entities.

<sup>(18)</sup> We note that the first “species” of economic process which appeared was that of the optimal process (the degree of optimality is irrelevant – achieved by primitive rituals or through sophisticated econometric models running on computers).

<sup>(19)</sup> We would like to suggest a rather a-historical moral code, although we are conscious of the strong contextual print of the moral. Due to reasons of abstract reasoning, however, it is very useful, though, to accept the possibility of an a-contextual moral code.

<sup>(20)</sup> The rational knowledge of the economic universe is guided, as it is commonly known, by two fundamental principles: a) the principle of intelligibility (one can identify a logical explicative model – a paradigm – coherent, consistent and complete on the economic phenomenology which is the object of knowledge); b) the principle of objectivation (the cognitive subject is not part of the reality which is the object of knowledge; rather it is located outside the object of knowledge, which it doesn't influence by the approach of knowledge – in other words, the approach of knowledge is of von Neumann type). If there is no doubt on the legitimacy of the principle of intelligibility, things are more complicated concerning the principle of objectivation. Although the classical science achieved quite unimaginable progress exactly on the basis of this principle (from the ancient western science to the theory of relativity included) the new developments (particularly the psychology, biology, the quantum theory, the theories of cognition) can no longer ignore considering the knowing subject as part of the object of knowledge. We think it is about the time that the economic science (or theory) too, gives up the principle of objectivation (it is of course arguable whether giving up the principle of objectivation will undermine or not the principle of intelligibility as well. We hope to be able to maintain the latter principle because no acceptable replacement is foreseen. At least in the field of the economic science, the preservation of the principle of intelligibility, concomitantly with giving up the principle of objectivation, is expected to produce, as we understand things, a paradigmatic reconsideration of the entire economic phenomenology.

<sup>(21)</sup> Also see our study, Dissipative systems and sustainability, published in Theoretical and Applied Economy, no. 3/2008 (the ideas from the study also have been presented and debated within the 4/2007 session of the Seminar).

The study also proposes a demonstration of Prigogine's principle of the minimal production of entropy, as well

- as a logical model of the entropic interaction.
- (22) Predictions exclude novelty, being mere morphological combinations of the known elements. Hence, as we will subsequently show, logically speaking, in the economic process we have some kind of ... retrodictions (retrodictions obtained not by the simple reversal of the algebraic sign of time from the analytic of the reversible laws of process movement, but by target setting. We would have actual retrodictions only if we would replace mutually the initial conditions with the final conditions, which, as we will subsequently show, is impossible in the economic process).
- (23) As we will see further, novelty is associated to emergence, which is inconsistent with computability, namely, with the deliberative planning.
- (24) Although it is possible to argue against the independence of the three new necessary predicates (it seems that non-linearity might be regarded as a necessary consequence of the self-poietic capacity), we prefer to assume this possible logical non-rigorousness with the purpose to reveal the crucial importance of the predicate of SLV non-linearity, with fundamental consequences in the debate on the necessity of epistemological simplicity of the economic conjecture.
- (25) We notice here, that the invariant of the total complexity is not a necessary predicate of a general system. At the same time, there is no logical connection between the (relative) invariance of the set of identity parameters of a system and the invariance of its total complexity.
- (26) We may be fully entitled to speak of the character of continuity (so that we will ignore this possible attribute of the total complexity invariance), as long as the hypothesis of the quantum nature, at ontological level, of the macrocosmos is not yet accepted (although quantum nature at ontological level of the microcosmos is accepted and furthermore the principle of correspondence is introduced, which makes intelligible, at the level of the macroscopic epistemic subject, the directly non-intelligible world, at the microscopic level).
- (27) Here, the notion of "organised" doesn't necessary has an anthropomorphic connotation.
- (28) The inexistence of privileges regards concomitantly: a. location; b. role (function); c) potential. The hierarchical systems, unlike the network (or networked) systems do not verify this predicate.
- (29) Here, the term "immediately" has not a temporal significance (with no delay), rather a relational significance (with no intermediation).  
Therefore, having in view the objective existence of a lag in the transmission of, or access to system information (particularly in the case of a large and/or complex system), the idea we want to highlight is the direct availability of any existing information (input into the environment or generated locally), for any indiscernible component of the system.
- (30) Having in view that the feedback is an information generated by the system itself, it results that once this information appears in the system it is, according to predicate AR, available immediately to all the components of the particular system.
- (31) In other words, emergence is something that appears by itself, without a planned expectation, or an algorithm for it.
- (32) Let us observe that emergence, that is, novelty, appears in spite of the formal cause, which is also present, as argued before, within the natural systems. We may even say that emergence is something produced outside the algorithm of evolution (algorithm stipulated in the formal cause), something that occurs in a non-computational manner (by computational we understand the manner of action of an universal Turing machine, or approximately, the manner of action of an ordinary computer of our time, programmed top-down).
- (33) Non-aritmomorphic, as Nicholas Georgescu-Roegen would say.
- (34) It results immediately that emergence can not be predicted.
- (35) Such as the mutations in the evolution of the biological systems, for instance.
- (36) As it is known, synergy is the situation in which the multitude of the properties of an assembly of components has the cardinal higher than the cardinal of the reunion of the multitudes of the properties of the assembly's components.
- (37) It is obvious that we may accept, within the economic process, variations of the state vectors of the process, which are not, however, results of deliberative acts.
- (38) It is obvious that the predicate of non-deliberativeness is independent of the predicate of non-computability, because a decision (which is a deliberative fact) may coexist with non-computability. On the other hand, it

is possible to demonstrate, ex post, that a process which verified the predicate of non-deliberativeness may be described by an algorithm. For instance, the automatic stabiliser of the policies of macroeconomic adjustment is non-deliberative but computational, because it was designed so as to follow an automated procedure (which is what we usually call an algorithm) when its efficient cause is met.

<sup>(39)</sup> According to the postulate from the system theory, that the structure generates the function.

<sup>(40)</sup> As it can readily be noticed, it verifies even more than that, i.e. all the necessary predicates of the optimal economic process.

<sup>(41)</sup> It can be readily noticed that optimality doesn't necessarily generate dissipativeness (there also may be dissipative systems within a paradigm of sustainability; it seems that sustainability is nature's "patent" – while optimality is man's "patent"; man will return to nature's "patent" after the process of globalization ends).

<sup>(42)</sup> Here is, therefore, a logical motivation to consider the economic organisation a SLV and, therefore, to reconsider our microeconomic models from this perspective.

<sup>(43)</sup> A contingent example could be the hierarchical socio-economic systems.

<sup>(44)</sup> Evidently, the class of living systems in "prelogic" terms, can be expanded indefinitely, to include not only what we know from the observable Universe (for instance, the biological life based on carbon) but also the potential ones from the non-observable Universe, or from alternative imaginable Universes.

<sup>(45)</sup> Besides the case when we accept the existence of a sui generis deliberativeness of the assembly of indiscernible

(something similar to the way in which some analysts speak of the social conscience). Such a conjecture is, in our opinion, an unacceptable speculation.

<sup>(46)</sup> We noted with  $(\Omega)$  the functor of the logical possibility. We may even say that it would be desirable that part of PE is of R type, just so as the existence of the network at the level of the economic process (or at the level of a large part of the economic process) may generate, permanently and continuously, novelty

<sup>(47)</sup> We should observe that the veridicity (or veracity) of modelling losses significance when we discard the structural economic prediction (causal at the level of the efficient cause) and when we replace it with the normative "prediction" (causal at the level of the final cause). Within this context, instead of model veridicity we may put model verosimilarity or even better, model desirability.

<sup>(48)</sup> We consider this desiderate to be urgent including in what concerns the revaluation of the philosophy of European construction (construction which is, obviously, preponderantly normative, as intellectual project). We will observe, for instance, the existence of important elements of network organisation (including at the state level), or the existence of processes of emergence (see the operationalisation of the principle of subsidiarity) at the level of the European institutional construction.

<sup>(49)</sup> We will observe that the normative "prediction" doesn't even need probabilities, since they model an incertitude related to the efficient causality, not to the final causality, characteristic to the normative modelling.

<sup>(50)</sup> With the risk of looking pedant, we repeat that by the economic process modelling we understand the most general and abstract possible explanative description (theory, paradigm, conjecture) of this process.

# Analysis of Main Economic Factors Influence on Romanian Tourists Number Accommodated in Romania, using Anova Method

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**Abstract.** *Now, it is indisputable the role, increasingly important, that tourism plays in economic and social development. This is reflected particularly through the tourism movement, which by generating revenue contributes to the creation of GDP.*

*Size of tourist movement can be expressed through the following indicators: number of tourists, the number of check-in for nights, average length of holiday, density of tourist movements, the relative preference for travel, the revenue and the average number of tourists.*

*The aim of this paper is to identify the main influence of economic factors – total income of households and consumer price indices, registered in Romania in the period 2001-2007 –, on the evolution Romanian tourists number accommodated in Romania, using the dispersion analysis method ANOVA.*

**Keywords:** Romanian tourists; total income of households; consumer price indices; multifactorial regression model; variation analysis.

■

**JEL Codes:** C19, M00.

**REL Codes:** 7Z, 10B, 14F.

## 1. Introduction

Considered social-economic phenomenon specific to modern civilization, in recent decades, tourism has become one of the most important economic activities.

As demand for products in general, demand for services depends on a number of factors, and is derived from the consumer behavior which, under the restrictions of its budget, wants to maximize utility.

In literature, the experts grouped the factors that influence tourist's movement in leisure, income, offer and motivation. In practice however, the number of these factors is greater. The main economic factors which influence the demand for tourist products, respectively tourist movement are income and prices/tariffs.

Considered the main condition of tourist's movement existence, revenues are influencing the size and frequency with which it is manifested tourism demand. Hicks, in Value and Capital paper, introduce the concept of dynamic economic equilibrium. It emphasizes that any action is changed continuously by its effects, changing conditions generating the modification of equilibrium.

Prices and tariffs are another factor stimulating tourism. Prices and tourism demand are interrelated, due to tourism movement instability, the rigidity of supply, different manifestation of segments of customers.

Commensurable methods of the phenomena make possible the concrete assesses of hypostasis registered at micro and macroeconomic levels. It is necessary to describe each examined situation, the comparison between two or more collectivities and analysis the influence of involved factors.

A method of dispersion analysis is the ANOVA method – Analysis of Variance –

contoured by A. Fisher, involving grouping and studying interdependent that occurs during the event of economic phenomena and processes. Study of these connections involves building a regression model.

## 2. Defining econometric model

Due to permanent changes taking place at both macro and microeconomic, is necessary description and analysis of economic and social phenomena and processes and analyze the influence of factors which, in time, may change them. To highlight the degree of influence of different factors may apply multifactorial regression model, respectively dispersion analysis method ANOVA – *Analysis of Variance*.

ANOVA method implies defining a regression model, which involves: determining the regression equation, testing the validity of the regression model, establishment and testing correlation, and testing significance and estimation of linear regression model parameters on confidence intervals.

The *identification of regression equation* which shapes the link between the analyzed characteristics implies:

- identify variables:  $x_i$  and  $y_i$   
 $x_i$  – factorial variables;  
 $y_i$  – resultant variables.
- estimate parameters of linear regression model.

Linear regression model, where the analysis to be done, is based on linear regression equation, which is:

$$y_i = b_0 + b_1 \times x_{i1} + b_2 \times x_{i2}. \quad (1)$$

Parameters are determined, as with unifactorial model of linear regression, applying the least squares method. From the first order conditions, it is obtained the linear equations system:

$$\begin{cases} n \times b_0 + b_1 \times \sum_{i=1}^n x_{i1} + b_2 \times \sum_{i=1}^n x_{i2} = \sum_{i=1}^n y_i \\ b_0 \times \sum_{i=1}^n x_{i1} + b_1 \times \sum_{i=1}^n x_{i1}^2 + b_2 \times \sum_{i=1}^n (x_{i1} \times x_{i2}) = \sum_{i=1}^n (y_i \times x_{i1}) \\ b_0 \times \sum_{i=1}^n x_{i2} + b_1 \times \sum_{i=1}^n (x_{i1} \times x_{i2}) + b_2 \times \sum_{i=1}^n x_{i2}^2 = \sum_{i=1}^n (y_i \times x_{i2}) \end{cases} \quad (2)$$

*Testing the validity of the regression model* can be achieved with the ANOVA dispersion analysis method. This implies going through the following steps:

- establishing assumptions:
  - Null hypothesis –  $H_0$ : the model is not valid
  - Alternative hypothesis –  $H_1$ : the model is valid.
- applies F test (Fisher Snedecor) in relation to data;
- is set the significance  $\alpha$  limit and it is obtained the rejection limit;
- determine the statistics of F test;
- it takes final decision in testing the validity of the model depending on the  $F_c$  value:
  - if  $F_c > F_{\alpha; k; n-k-1}$ , then  $H_0$  is rejected, the regression model is statistically valid;
  - if  $F_c < F_{\alpha; k; n-k-1}$ , then  $H_0$  is considered true, the regression model is not statistically valid.

In statistics, the *multiple correlations* are used to measure the intensity of the connection between a factorial variable and resultant variable. In econometrics the multiple correlations is introduced also in the phase of linear regression model validation. If the result is closer to 0, the connection is weak (if  $R = 0$ , between variables is no connection), and a value closer to 1 indicates a stronger connection (if  $R = 1$  there is a perfect connection between variables).

*Testing significance of linear regression model parameters on confidence intervals*

has in view the collectivity size, respectively the statistical units observed. Since  $n < 30$ , it is applied Student test, and if  $n > 30$  one applies Z test.

### 3. Building the regression model

To determine and analyze the degree of dependency between the number of Romanian tourists accommodated in Romania, and total income of households and consumer price indices, it will be applied multiple regression method.

During 2001-2007, in Romania, the analyzed characteristics have registered the following evolution:

**Evolution of Romanian tourist's number, total income of households, and consumer price indices registered in Romania**

Table 1

| Years | Romanian tourists number* (thousands tourists) | Total income of households (lei, monthly per household) | Consumer price indices ** |
|-------|------------------------------------------------|---------------------------------------------------------|---------------------------|
| 2001  | 3960                                           | 521.79                                                  | 100                       |
| 2002  | 3848                                           | 658.51                                                  | 126.1                     |
| 2003  | 3952                                           | 795.09                                                  | 119.3                     |
| 2004  | 4280                                           | 1085.79                                                 | 112.6                     |
| 2005  | 4375                                           | 1212.18                                                 | 112.7                     |
| 2006  | 4836                                           | 1386.32                                                 | 105.6                     |
| 2007  | 5421                                           | 1686.74                                                 | 102.89                    |

\* Romanian tourist's arrivals in the establishments of touristic reception with functions of touristic accommodation in Romania.

\*\* Paid accommodation at hotel.

**Source:** Romanian Statistical Yearbook, National Institute of Statistics, 2008, pp. 826, 460.

Here are the steps followed for dispersion analysis method ANOVA. To facilitate the calculations and problem solving it has been used Excel software.

### Determine the regression equation

Analyzing characteristics: Romanian Tourist's number, total income of households and consumer price indices (see Table 1), determine:

$y_i$  – the number of Romanian tourists (arrivals of Romanian tourists in the

establishments of touristic reception with functions of touristic accommodation - thousands tourists)

$x_{i1}$  – total income of households (lei, monthly per household)

$x_{i2}$  – consumer price indices (paid accommodation at hotel)

Regression equation for model the link between the variables mentioned is:

$$y_i = b_0 + b_1 \times x_{i1} + b_2 \times x_{i2}.$$

In Table 2, are presented intermediate values necessary for apply the least squares method:

### Algorithm required for applying least squares method

| Years    | $x_{i1}^2$ | $x_{i2}^2$ | $x_{i1} \times x_{i2}$ | $y_i \times x_{i1}$ | $y_i \times x_{i2}$ |
|----------|------------|------------|------------------------|---------------------|---------------------|
| 2001     | 272264.80  | 10000      | 52179                  | 2066288.40          | 396000              |
| 2002     | 433635.42  | 15901.21   | 83038.11               | 2533946.48          | 485232.80           |
| 2003     | 632168.11  | 14232.49   | 94854.24               | 3142195.68          | 471473.60           |
| 2004     | 1178939.92 | 12678.76   | 122259.95              | 4647181.20          | 481928              |
| 2005     | 1469380.35 | 12701.29   | 136612.69              | 5303287.50          | 493062.50           |
| 2006     | 1921883.14 | 11151.36   | 146395.39              | 6704243.52          | 510681.60           |
| 2007     | 2845091.83 | 10586.35   | 173548.68              | 9143817.54          | 557766.69           |
| $\Sigma$ | 8753363.57 | 87251.46   | 808888.06              | 33540960.32         | 3396145.19          |

Knowing that  $n = 7$ ,  $\Sigma x_{i1} = 7346.42$ ,  $\Sigma x_{i2} = 779.19$  and  $\Sigma y_i = 30672$ , the system equations become:

$$\begin{cases} 7 \times b_0 + 7346.42 \times b_1 + 779.19 \times b_2 = 30672 \\ 7346.42 \times b_0 + 8753363.57 \times b_1 + 808888.06 \times b_2 = 33540960.32 \\ 779.19 \times b_0 + 808888.06 \times b_1 + 87251.46 \times b_2 = 3396145.19 \end{cases}$$

Where:  $b_0 = 4807.61$ ,  $b_1 = 1.17$  and  $b_2 = -14.85$ .

Regression line is defined by the next equation:  $y_i = 4807.61 + 1.17 \times x_{i1} - 14.85 \times x_{i2}$ .

### Testing the validity of the regression model

To confirm the establishment and use the model the approach was to verify the validity of the method. This is achieved in the following stages of analysis of linear regression model.

The established assumptions are:

- $H_0$ : the model is not valid (null hypothesis)
- $H_1$ : the model is valid (alternative hypothesis).

To use the F test, compared with the data was applied EXCEL software. The values obtained, necessary for analysis of the validity of regression model, are:

### ANOVA table with the necessary value for analysis the regression model

| ANOVA      |    |          |          |          |                |
|------------|----|----------|----------|----------|----------------|
|            | Df | SS       | MS       | F        | Significance F |
| Regression | 2  | 1846919  | 923459,4 | 37.95923 | 0.002505       |
| Residual   | 4  | 97310,66 | 24327,66 |          |                |
| Total      | 6  | 1944229  |          |          |                |

Knowing that the probability of occurrence of the results is 95% and the limit of significance  $\alpha = 0.05$  it was obtained the limit region of rejection:

$$F_{\alpha; k; n-k-1} = F_{0.05; 2; 4} = 6.94$$

For examined characteristics (Romanian tourists number, total income of households, consumer price indices),  $F_c = 37.95923 > F_{\alpha; k; n-k-1} = 6.94$ . In this case  $H_0$  is rejected; the regression model is statistically valid.

One other element which reflects the validity of the model is Significance F. If the value get for this element is less than 0,05,  $H_0$  is rejected. In Table 3 it is shown that Significance F = 0.002505 < 0.05, and the regression model is statistically valid.

#### Determining and testing the correlation

To determine correlation Excel software was used. The values obtained for the correlation (R), R Square ( $R^2$ ), the adjusted R Square ( $R^2$ ) and standard deviation of errors ( $s_e$ ) are presented in Table 4:

The values of parameters R,  $R^2$ ,  $\overline{R}^2$  and  $s_e$

Table 4

| SUMMARY OUTPUT        |          |
|-----------------------|----------|
| Regression Statistics |          |
| Multiple R            | 0.974653 |
| R Square              | 0.949949 |
| Adjusted R Square     | 0.924923 |
| Standard Error        | 155,9733 |
| Observations          | 7        |

The correlation value (Multiple R) is set to 0.974653, and shows that between the

number of Romanian tourists and total income of households, and consumer price indices registered in Romania in the period under review, there is a very strong connection.

R Square is set to 0.9499 and shows that the influence of the two factors (total income of households and consumer price indices) on the number of Romanian tourists accommodated in Romania is 94.99%, the remaining 5.01% is due to other random factors.

The value of standard error is 3165.991, and it shows that points are not placed near the regression right.

#### Testing the significance and estimation of parameters for linear regression model on confidence intervals

Estimators for regression parameters are determined by least squares method, and testing their significance has in view the size of the selected collectivity. Since  $n < 30$ , it is applied Student test.

In Table 5, an ANOVA table, are given the necessary elements for testing parameters and establish confidence intervals.

Elements necessary for testing parameters and establish confidence intervals

Table 5

|              | Coefficients | Standard Error | t Stat   | P-value  | Lower 95% | Upper 95% |
|--------------|--------------|----------------|----------|----------|-----------|-----------|
| Intercept    | 4807.605     | 907.8452       | 5.295622 | 0.006105 | 2287.023  | 7328.188  |
| X Variable 1 | 1.168771     | 0.165181       | 7.075682 | 0.002105 | 0.710154  | 1.627387  |
| X Variable 2 | -14.8456     | 7.416283       | -2.00175 | 0.115884 | -35.4365  | 5.745336  |

The above table shows the linear adjusting equation of the connection between indicators:

$$y_i = 4807.61 + 1.17 \times x_{i1} - 14.85 \times x_{i2}$$

The value of  $b_0$  is 4807.61 shows that if total income of households is remaining constant, respectively consumer price indices, the number of Romanian tourists

accommodated in Romania was set to a value of approximately 4808.

Analyzing the result for t test,  $t_c = 5.295622$ , and significance threshold  $P\text{-value} = 0.006105 < 0.05$ , we see that free time is statistically significant. This is reflected by the presence of the confidence interval, respectively  $2287.023 < b_0 < 7328.188$ .

$b_1$  coefficient value is approximately 1.1688 and shows that by increasing of 1 leu monthly per household, the number of Romanian tourists will increase by approximately 1 tourist. For this coefficient threshold of significance P-value is 0.002105 < 0.05, respectively  $t_{cb1} = 7.075682 > 2.571 = t_{0.025;5}$ , the coefficient is considered statistically significant.

The lower limit of the confidence interval of this parameter is approximately 0.710154, and the upper limit reaches 1.627387.

The coefficient  $b_2$  is -14.8456 and it shows that the decrease of 1% of consumer price indices will result in the decrease of the number of Romanian tourists with approximately 15 tourists. The threshold of significance P-value is 0.115884 > 0.05, and the result  $t_{cb2} = -2.00175 < 2.571 = t_{0.025;5}$  shows that this coefficient is not statistically significant.

#### 4. Conclusions

Analysis carried out on recent developments that took place in the tourism sector reflects the trend of increasing the number of domestic consumers of tourism products.

After testing the validity of the regression model, it was established that this model is statistically valid. Thus, it was observed that

between the number of Romanian tourists and total income of households, and consumer price indices registered in Romania in the period under review, there is a very strong connection, correlation has the value 0.974653.

The influence percentage of total income of households and consumer price indices, reflected by R Square, on the number of Romanian tourists accommodated in Romania is approximately 94.99%, the remaining 5.01% being the result of other random factors.

After the analysis performed it was established that the increase of 1 leu monthly per household will cause an increase of the number of Romanian tourists by approximately 1 tourist and the decrease of 1% of consumer price indices will result in the decrease of the number of Romanian tourists with approximately 15 tourists.

Generally, lower prices lead to increased tourism demand (increased tourists number, length of stay, frequency of travel etc.), and vice versa. However practice has shown that price is not the main motivator.

Holders of accommodation units in Romania have seen a growing number of customers, most of them being Romanian tourists. To Romanian tourists are added as a barrier for transit are removed and is created the necessary infrastructure, ever more foreign tourists.

#### References

- Andrei, T. (2003). *Statistică și econometrie*, Editura Economică, București
- Chow, G. (1989). *Econometrics*, McGraw Hill, New York
- Dougherty, Ch. (2007). *Introduction to Econometrics*, Oxford University Press
- Gogonea, R., Zaharia, M. (2008). *Econometrie cu aplicații în comerț-turism-servicii*, Editura Universitară, București
- Hannan, E.J., Deistler, M. (1988). *The Statistical Theory of Linear Systems*, New York Wiley
- Pecican, E.Ș. (2007). *Econometrie pentru... economiști*, Editura Economică, București
- Reinsel, G.C. (1997). *Elements of Multivariate Time Series Analysis*, Springer Varleg, New York
- Wonnacott, T.H., Wonnacott, R.J. (1990). *Introductory Statistics for Business and Economics*, New York Wiley
- Romanian Statistical Yearbook, National Institute of Statistics, 2008

# A Simple Early Warning System for Evaluating the Credit Portfolio's Quality

■

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***Abstract.** The last decade has witnessed the development of a vast literature devoted to the study of several phenomena like banking crises or episodes of vulnerability and distress, characterized by inadequate capitalization, impairment of the asset quality and of the credit institutions' rating. The purpose of this study is to design an early warning system in order to highlight at an earlier stage the likelihood of deterioration of the Romanian banking system credit portfolio's quality. We have applied an econometric model which constitutes a reference for this type of analysis, having as purpose the identification of a significant correlation between increasing weight of bad loans in total assets, on the one hand, and a number of macroeconomic variables and indicators of the banking system, on the other hand.*

**Keywords:** early warning system; logistic regression; probability of deterioration of the loans portfolio; *goodness-of-fit* tests; predictive ability.

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**JEL Codes:** E44, G01.

**REL Codes:** 10B, 11C.

## Introduction

The need for careful monitoring of credit portfolio quality has become a major concern of monetary policy makers, the more so as, in the context of current international financial crisis, the resources available to credit institutions must be managed with care and efficiency. This concern overlaps in both the dynamics of intrinsic factors associated with business lending in our country in recent years, as well as external factors of credit institutions. Intrinsic factors are represented, primarily, by deficiencies in the management of credit risk. External factors consist in the dynamics of demand for currency, optimistic expectations of households on revenue increase and intensifying of banking competition, which led to the existence of credit institutions with majority foreign capital, characterized by a different credit culture and corporate governance, business strategies well outlined and implemented, aggressive lending policies (especially in the case of small banks).

In order to quantify the likelihood of credit portfolio's quality deterioration, we have identified the mix of variables that will constitute our starting point in creating a monitoring model, structuring the study as follows: the first part, we presented the methodology used and we defined a series of logit models, based on financial indicators identified as relevant from a statistical viewpoint; in the second part, we applied several complementary statistical

tests to assess the predictive accuracy of each model used in the analysis. Ultimately this empirical approach has been a selection, from an extensive set of specifications of the logit model, of the one that meets the requirements of a good predictive capacity.

## 1. Assumptions and methodology used

The purpose of the statistical forecasting model that is the subject of this study is the ex-ante reporting of episodes of deterioration of credit portfolio's quality for the whole Romanian banking system. To this end, we opted to implement an econometric technique of reference for this type of analysis, namely a limited dependent variable model. We applied a multivariate logit model because the sample of observations we have is not balanced, the frequency of events of deterioration in credit portfolio's quality being much lower than that of non-deterioration events. Dependent variable, defined as the ratio of overdue and doubtful loans to total assets, is binary, taking value 1 for periods characterized by significant increase in the share of bad loans in total assets and 0 otherwise.

From the initial set of 32 financial indicators, selected so as to capture the full characteristics of both macroeconomic as well as specific banking system variables, after performing the univariate tests, we stored in the analysis a number of 9 indicators,

which have proved to be statistically significant, namely: M2/international foreign reserve (*M2forex*); money multiplier (*M2mult*); return on assets (*ROA*); the consumer price index (*CPI*); real exchange rate; government expenditure in GDP (*gc/GDP*); degree of openness of the economy; the relationship between the interest rate charged for loans and interest rate granted for non-

bank customer deposits (*lenddep*); the share of exports in GDP (*exp/GDP*).

Given the small size of the quarterly series of observations considered (small sample problem), but also to meet the requirements of creating a parsimonious warning model, with a reduced number of variables, we tested a series of simple logistic models composed by the dependent variable and at most two predictor variables.

**Specifications of the logistic models developed**

Table 1

| Predictor variables            | Predictive power (%) | -2LL   | Likelihood ratio test | Observations                                     |
|--------------------------------|----------------------|--------|-----------------------|--------------------------------------------------|
| M2/forex                       | 86.8                 | 17.969 |                       | -                                                |
| M2/forex<br>ROA                | 94.7                 | 14.786 | 3.183                 | -                                                |
| M2/forex<br>Cpi                | 89.5                 | 17.529 | 0.44                  | -                                                |
| M2/forex<br>real exchange rate | 89.5                 | 16.514 | 1.455                 | -                                                |
| M2/forex<br>Gc/gdp             | 92.1                 | 15.185 | 2.784                 | -                                                |
| M2/forex<br>Lend/dep           | 92.1                 | 10.024 | 7.945                 | Lend/dep has a good predictive ability           |
| M2/forex<br>openness           | 97.4                 | 7.787  | 10.182                | Openness has a good predictive ability           |
| M2 mult                        | 89.5                 | 24.376 |                       | -                                                |
| M2 mult<br>Cpi                 | 92.1                 | 16.985 | 7.391                 | Cpi has a good predictive ability                |
| M2 mult<br>Curs real           | 89.5                 | 22.116 | 2.26                  | -                                                |
| M2 mult<br>Gc/gdp              | 92.1                 | 14.632 | 9.744                 | Gc/gdp has a good predictive ability             |
| Cpi                            | 84.2                 | 27.608 |                       | -                                                |
| Cpi<br>real exchange rate      | 92.1                 | 22.608 | 5                     | real exchange rate has a good predictive ability |
| Cpi<br>Gc/gdp                  | 89.5                 | 24.228 | 3.38                  | -                                                |
| Cpi<br>Exp/gdp                 | 89.5                 | 13.451 | 14.157                | Exp/gdp has a good predictive ability            |
| Cpi<br>Openness                | 97.4                 | 8.799  | 18.809                | Openness has a good predictive ability           |
| real exchange rate             | 89.5                 | 28.981 |                       | -                                                |
| real exchange rate<br>Gc/gdp   | 86.8                 | 25.218 | 3.763                 | -                                                |
| real exchange rate<br>Lend/dep | 89.5                 | 10.208 | 18.773                | Lend/dep has a good predictive ability           |
| real exchange rate<br>Exp/gdp  | 92.1                 | 13.828 | 15.153                | Exp/gdp has a good predictive ability            |
| real exchange rate<br>openness | 94.7                 | 10.670 | 18.311                | Openness has a good predictive ability           |
| Openness                       | 92.1                 | 15.729 |                       | -                                                |
| Lend/dep                       | 92.1                 | 10.310 |                       | -                                                |

According to Wald test, the coefficients of predictor variables included in the regression equation are statistically significant only if their corresponding probability is lower than the threshold of 5%. Variables related to models: *M2/forex* and *ROA*, *M2/forex* and *openness*, *M2/forex* and *real exchange rate*, *M2/forex* and *CPI*, *M2/forex* and *lend/dep*, *M2/forex* and *gc/GDP*, *M2mult* and *real exchange rate*, *M2mult* and *gc/GDP*, *CPI* and *gc/GDP*, *real exchange rate* and *gc/GDP*, *real exchange rate* and *lend/dep*, *openness* and *real exchange rate* achieved a level of probability that exceeds the critical value of 5%, therefore they aren't statistically significant and, as such, those models should not be examined further.

The accuracy of Wald test is, however, directly influenced by the number of observations included in the sample analyzed. For a reduced sample size it is recommended caution with the interpretation of the results of Wald test, being preferred the likelihood ratio test. Since the size of our sample is of 38 observations, relating to the period between IIIrd quarter 1997 and IVth quarter 2006, we have considered that the analysis should be continued with all the models illustrated in the table above, by applying additional goodness-of-fit tests, in order to identify those independent variables with the best predictive ability of the probability of deterioration of credit portfolio's quality.

## 2. Criteria for evaluating the predictive performance of logistic regressions

To perform a statistically based, but also relevant discrimination between the predictive performance of the logistic

regression equations tested, it is necessary to apply several goodness-of-fit tests. We chose the most representative four statistical tests, which have a complementary nature, in order to progressively eliminate those models whose specifications do not meet the requirements of a good predictive ability, namely:

- Assessing the value of  $-2 \log \text{likelihood}$  ( $-2LL$ ). In the third column of Table 1 one can observe that, by including other independent variables into the initial model, the model fit improves, as illustrated by the decreasing value of  $-2LL$  for each logistic regression carried out. For example, the univariate model composed by the dependent variable and the explanatory variable *M2/forex* obtained a value of 17.969 for  $-2LL$ . Regression equations constructed after the introduction of a second explanatory variable (*ROA*, *CPI*, *real exchange rate*, *gc/ GDP*, *lend/dep* and *openness*) recorded lower values of  $-2LL$ . The lower the  $-2LL$  value is, the best the tested model is, through the ability of considered variables to indicate at an earlier stage a potential state of vulnerability. According to this criterion, models consisting of independent variables: *M2/forex* and *openness* (7.787), *M2mult* and *gc/ GDP* (14.632), *CPI* and *openness* (8.799), *real exchange rate* and *lend/dep* (10.208) are the most appropriate for making predictions.

- *The likelihood ratio test* calculates the chi-square statistics as a difference between  $-2LL$  for the full model and  $-2LL$  for the univariate model, comprising only one independent variable (nested model). Subsequently, the calculated statistics is

compared with its value in the table, for one degree of freedom and  $\alpha = 0.05$ .

In other words, the chi-square statistics quantifies the accuracy improvement of the logistic model as a result of including in the univariate model of an additional independent variable. The greater the calculated value of chi-square statistics is, the more significant will be the accuracy decrease in the case of exclusion of that additional variable from the model. A low value of the chi-square statistics indicates the absence of significant differences in the predictive ability of models compared (full model and the model from which we excluded an independent variable), therefore it is justified to keep in the further analysis the model with fewer predictor variables.

In Table 1, in the fourth column we have specified the values obtained for chi-square statistics, and on the column of remarks, we have mentioned those independent variables whose maintenance into the logistic regression equation is justified from a statistical viewpoint, since the calculated values for those models have a higher value than that in the table, which is of 3.84. Keeping in mind the results obtained by applying the two statistical tests outlined above, we considered appropriate to remove from the analysis the logistic models that do not meet the criteria of statistical relevance and accuracy. Therefore, in Table 2 we have presented the restricted set of models that will be subject to further discrimination according their predictive power.

■ *type I error and type II error.* Type I error reflects the probability that the warning model fails in forecasting episodes of deterioration of credit portfolio's quality.

Type II error implies that the model wrongly signals an event of damage, although the quality of the loans portfolio is satisfactory. Will be preferred that model whose type I error reaches the lower value (see Table 2) because the fundamental purpose of a forecasting model is the accurate ex-ante reporting of a potential deterioration of the banking activity.

**Undetected errors**

Table 2

| Nr. crt. | Predictor variables            | Type I error (%) | Type II error (%) |
|----------|--------------------------------|------------------|-------------------|
| 1        | M2/forex                       | 33%              | 6.89%             |
| 2        | M2/forex<br>openness           | 0                | 3.45              |
| 3        | M2 mult                        | 33               | 3.45              |
| 4        | M2 mult<br>Gc/gdp              | 33               | 0                 |
| 5        | Cpi                            | 55.55            | 3.45              |
| 6        | Cpi<br>Openness                | 0                | 3.45              |
| 7        | Real exchange<br>rate          | 44.44            | 0                 |
| 8        | Real exchange<br>rate Lend/dep | 22.22            | 6.89              |
| 9        | Openness                       | 22.22            | 3.45              |
| 10       | Lend/dep                       | 11.11            | 6.89              |

The undetected episodes of deterioration in the quality of loans portfolio, for the consolidated banking system, varies between 0% and 55.55% of all adverse events, while the percentage of false alarms is included in the range 0% - 6.89%. From this point of view, we can distinguish four models whose power of discrimination is satisfactory: *M2/forex* and *openness*, the *CPI* and *openness*, *openness*, *lend/dep*.

If, from a statistical viewpoint, the variables retained in the analysis show a good predictive ability, from an economic perspective, the sign of the coefficients attached to explanatory variables reflect the

influence of these variables on the values that the dependent variable can get. Thus, the “+” sign associated with a variable indicates an increased likelihood of deterioration of credit portfolio quality, as its value increases, while the sign “-” shows a negative correlation between the likelihood of loan portfolio impairment and the evolution of independent variables.

One can observe that the probability of deterioration is a positive function of variables *M2forex* and *CPI* because the coefficients’ sign is positive, in turn it is negatively correlated with variables *openness* and *lend/dep*. Thus, an increase of the consumer price index (*CPI* variable), and, implicitly, of the inflationary pressures, contributes to enhancing the state of vulnerability of the banking system. Due to erosion of purchasing power of population income, there is a significant risk of increasing the degree of indebtedness and debt service, with negative effects on the share of outstanding and doubtful loans in total assets.

The positive sign of the coefficient of *M2forex* variable indicates that an increase in the volume of M2 or a reduction in the level of international reserves held by central bank lead to an increased likelihood of deterioration of the loans portfolio. The growth of money in the economy attracts imports’ expansion, with a favorable effect on the size of *openness* indicator (degree of openness of an economy), while there is a magnification of the current account deficit. Probability of deterioration is negatively affected by

*openness* variable. Thus, increasing the share of outstanding and doubtful loans in total assets determines credit institutions to adopt a reserved attitude towards requests for funding, a more sensible assessment of the repayment capacity of borrowers, reducing the volume of loans granted. Consequently, some productive and investment activities will restrict, entailing a contraction of the volume of exports and imports, and hence a reduction in the *openness* indicator.

The ratio between the interest rate charged for loans and the interest rate granted for non-bank customer deposits (*lend/dep* variable) recorded a decline in the run of episodes of credit portfolio deterioration, being characteristic to periods of rapid expansion of lending activity, where credit institutions are less vigilant in assessing exposure to risk. In other words, a persistent decrease in the value of the indicator signals a potential deterioration, in the medium term, of the quality of loans portfolio.

To facilitate the interpretation of the alarm signals provided by logistic regression, it is necessary to define a probability threshold. If the probability estimated by the logit model it’s above this critical level, we say that we have an alarm signal of a potential deterioration in loan portfolio quality. For each alarm threshold between 0 and 100%, we have plotted the percentage of unsignaled deterioration events (type I error) and, respectively, the percentage of false alarms (type II error), compared for each of the four models.

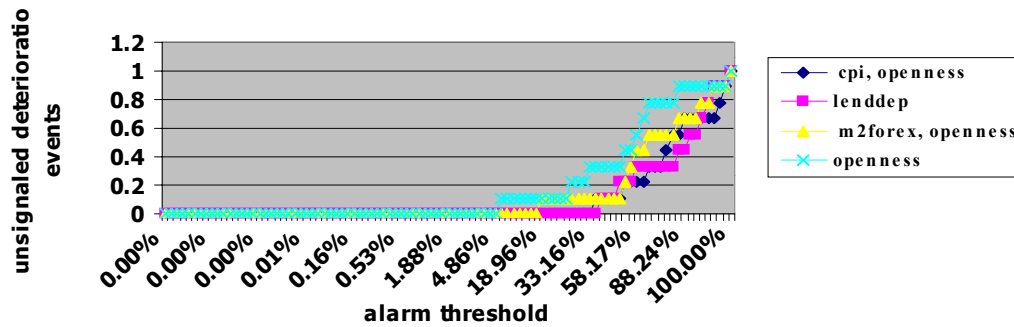


Figure 1. The percentage of unsignaled deterioration events

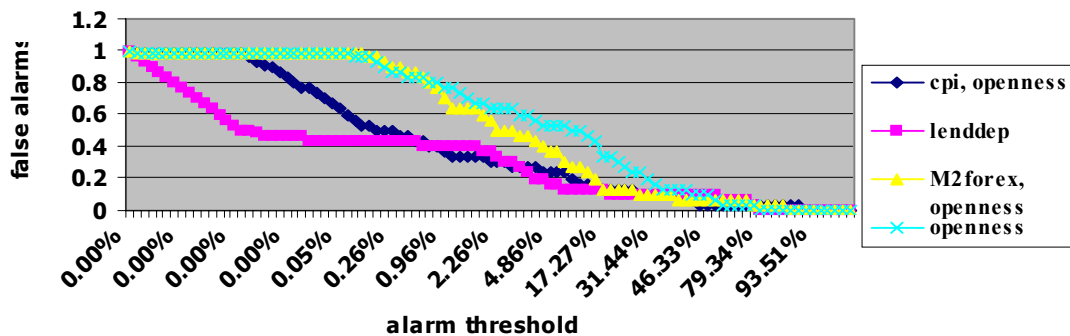


Figure 2. The percentage of false alarms

For a threshold equal to 0 any model identifies 100% of events of deterioration or crisis, and the number of false alarms is still 100%. An alarm threshold of 100% did not correctly identify any crisis, and, as such, there will be no false alarms. As the critical threshold value increases, the number of false alarms decreases, but also the percentage of deterioration events correctly identified decreases significantly, too. Will be preferred the model whose curve is nearest to the abscissa. One can observe that the model represented by the independent variable *lending/deposit rate* generates the lowest number of false alarms, and for certain values of the alarm threshold, it has the most correctly reported episodes of deterioration. Another model whose predictive performance is satisfactory consists of the explanatory variables *CPI* and *openness*.

For each of the two models it must be defined a probability threshold, which will be subject to a comparative analysis with the probabilities estimated through logistic regression, in order to anticipate events of credit portfolio quality deterioration. We have noticed that for an alarm threshold of 43%, both models provide a type I error of 11%. Regarding the percentage of false alarms, the univariate model *lending/deposit rate* has a type II error of 10% and the model composed by *CPI* and *openness* of 3.3%. For an alarm threshold of 50%, both models record an increase of type I error of up to 22%, but type II error for the model *lending/deposit rate* is reduced to 6.7%, while for the other model it does not change. In practice it is preferable to select a lower level of the threshold probability because the type I error (unsignaled episodes of deterioration

or crisis) is considered more costly than type II error.

In what follows, we have applied a final test to validate the conclusions drawn regarding the performance of the four logit models considered.

■ *The AUROC* (Area under the Receiver Operating Characteristics). According to the authors Hosmer, Lemeshow (2000), an

indicator value between 0.6 and 0.7 is acceptable, values between 0.7 and 0.8 indicate a good accuracy of predictions and a value close to 1 show a remarkable predictive ability. All four models recorded a value of AUROC indicator greater than 80% (see Table 3), therefore are suitable for making predictions, having a good power of discrimination.

**AUROC indicator**

Table 3

| Logistic model     | AUROC | Standard error <sup>a</sup> | Asymptotic Sig. <sup>b</sup> | Asymptotic confidence interval 95% |             |
|--------------------|-------|-----------------------------|------------------------------|------------------------------------|-------------|
|                    |       |                             |                              | Lower bound                        | Upper bound |
| M2/forex, openness | 0,956 | 0,033                       | 0,000                        | 0,000                              | 1,000       |
| Cpi, openness      | 0,976 | 0,022                       | 0,000                        | 0,000                              | 1,000       |
| Openness           | 0,841 | 0,070                       | 0,002                        | 0,705                              | 0,978       |
| Lend/dep           | 0,976 | 0,021                       | 0,000                        | 0,000                              | 1,000       |

a. under the assumption of a nonparametric distribution

b. null hypothesis : true area = 0.5

In the next figure we have illustrated the ROC curve, which allows the graphic visualization of the rate of false alarms compared to the percentage of correct predictions for all the possible values of the probability threshold.

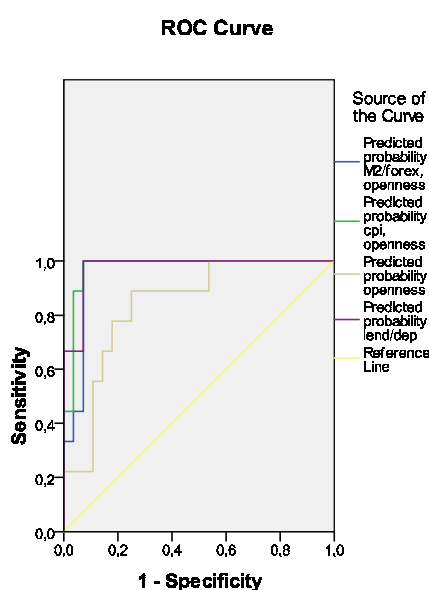


**Figure 3.** *The ROC curve plot*

It is noted that the logistic model represented by the *CPI* and *openness*, as well as the univariate one, represented by the variable *lend/dep* obtained a value of the AUROC indicator of 97.6%. Accordingly, it is difficult to assess which of these models is most suitable to be used as a simplified early warning system of the likelihood of deterioration of credit portfolio quality because both have notable performances.

In order to validate models' performance, we proceeded to test their predictive ability on a validation sample, and not on an out-of-sample one. Although the process of validation of the logistic models assumes the estimation for the period between first quarter 2007 and IIIrd quarter 2008, the insufficient number of quarterly observations available, and the

fact that in the period mentioned were not recorded events of severe deterioration of credit portfolio quality, led us to resort to a compromise. Thus, the set of observations for which the models were estimated ranges between IIIrd quarter 1997 – IVth quarter 1999, to ensure the existence of episodes of severe deterioration of credit portfolio quality, and first quarter of 2002 - III quarter 2008. Table 4 illustrates, in comparison, how has evolved the power of discrimination of considered models.

**Discrimination power (validation sample)**

Table 4

| Predictor variables | Predictive power (%) | Type I error (%) | Type II error (%) |
|---------------------|----------------------|------------------|-------------------|
| M2/forex            | 89.2                 | 22.22            | 7.14              |
| openness            |                      |                  |                   |
| Cpi                 | 94.6                 | 11.11            | 3.57              |
| Openness            | 81.1                 | 44.44            | 10.71             |
| Lend/dep            | 91.9                 | 11.11            | 7.14              |

The accuracy of predictions made by independent variables *M2/forex* and *openness* decreased by 8.2 percentage points from the original sample testing, Type I error registering an increase with 22.22 percentage points. The univariate logistic model composed of the independent variable *openness* had a predictive power decreased by 11 percentage points, the type I error increasing with 22.22 percentage points, while the univariate model in which the explanatory variable was *lend/dep* diminished its accuracy by only 0.2 percentage points and has maintained constant the proportion of type I errors, at 11.11%. The model represented by the

*CPI* and *openness* experienced a loss of accuracy by 2.8 percentage points, the type I error increasing with 11.11 points. It is noted that the logistic univariate model composed of the independent variable *lend/dep* was the most stable, keeping its power of discrimination relatively unchanged in both the original sample and the validation one.

## Conclusions

In the economic literature devoted to the creation and testing of early warning systems, some authors (Jagtiani, Kolari, Lemieux, Shin 2003, Davis, Karim, 2006) concluded that the accuracy of predictions of a simple logit model, with only two explanatory variables, outperforms the one of a complex multivariate model. The disadvantage of this type of models lies, however, in the fact that it is difficult to surprise comprehensively the roots of the distress phenomenon analyzed. In other words, will be selected those explanatory variables with a good predictive ability, maximizing the probability of correctly reporting the events of deterioration, to the detriment of the variables that contribute directly to trigger the adverse phenomenon analyzed.

Following the survey conducted, we reached the same conclusion: the best predictive performance is achieved by models with at most two independent variables. Thus, according to the statistical tests of goodness-of-fit done, the model represented by the independent variable

*lending/deposit rate* generates the lowest number of false alarms, and for certain values of the alarm threshold, have the most correctly reported episodes of deterioration. In addition, the estimation of the univariate model on the validation sample showed that the predictions generated were stable, the proportion of type I errors remaining constant and the predictive ability registering a decline of only 0.2 percentage points.

Another model with satisfactory performance, through the AUROC

indicator value, the percentage of type I errors and predictive ability is composed of explanatory variables *CPI* and *openness*. Although the results obtained from re-estimation have proved to be less stable than the model presented above, we recommend applying both models in a complementary manner, to obtain the best predictive performance and have an overall picture on the likelihood of deterioration of the quality of loans portfolio for the Romanian banking system.

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## References

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- Davis, E.P., Karim, D. (2006). *Comparing early warning systems for banking crises*, Brunel University and NIESR
- Demirguc-Kunt, A, Detragiache, E. (1999). „Monitoring banking sector fragility: a multivariate logit approach”, *IMF Working Paper*, WP/99/147, 1999
- Garson, G.D., „Logistic regression”, from *Statnotes: Topics in Multivariate Analysis*, 2007, <http://www2.chass.ncsu.edu/garson/pa765/statnote.htm>.
- Gaytan, A., Johnson, C.A., „A review of the literature on early warning systems for banking crises”, *Central Bank of Chile Working Papers* no. 183, 2002
- Jagtiani, J.A., Kolari, J.W., Lemieux, C.M., Shin, G.H. (2002). *The determinants and early detection of inadequate capitalization of US commercial banks*
- Jagtiani, J.A., Kolari, J.W., Lemieux, C.M., Shin, G.H., „Early warning models for bank supervision: simpler could be better”, *Economic perspectives* Q3/2003
- Moinescu, B., *Sistem de previziune a evenimentelor de deteriorare a ratingului CAAMPL*, Caiete de Studii nr. 23
- Morttinen, L., Poloni, P., Sandras, P., Vesala, J., „Analysing banking sector conditions: how to use macro-prudential indicators”, *ECB occasional paper* no. 26, 2005
- Sahajwala, R., Van den Berg, P., „Supervisory risk assessment and early warning systems”, *BCBS Working Papers* no. 4, 2000

# The Economic Crisis and its Effects on SMEs

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***Abstract.** Romania has ended a high growth cycle. The world economic crisis is worsening with every passing day and Romania increasingly feels the effects of this economic downturn. The sector of small and medium enterprises (SMEs) is the most dynamic in the Romanian economy, but it will also be one of the first to be hit by the global financial crisis the ripples of which have reached Romania as well. SMEs are now considered the most sensitive sector and worst affected by the economic climate. The economic crisis has prompted the member states of the European Union, too, to adopt packages of measures to counteract the effect of the crisis. Here below I will exemplify with the cases of Romania, the Italian Republic, the Federal Republic of Germany, the Slovak Republic and the Republic of Hungary.*

**Keywords:** economic crisis; SMEs; Romania; the Italian Republic; the Federal Republic of Germany; the Slovak Republic; the Republic of Hungary; anti-crisis measures; anti-crisis plan; economic recession; G20; the European Union; International Monetary Fund (IMF).

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**JEL Codes:** G01, M21.

**REL Codes:** 8Z, 14K.

Romania posted a record economic growth rate of about 7.8% in 2008, but specialists hold that this country is at the end of a cycle of high economic growth. As the economic crisis worsens, Romania increasingly feels the impact of the economic recession.

Considering the scope of the crisis, determined by such factors as the economic unsustainability in Romania, the excessive social measures, the fragility of the stock exchange, the absence of measures to protect Romanian capital and the lack of information for entrepreneurs, the Bucharest Executive has negotiated a financial package, in March 2009, with the International Monetary Fund, the World Bank, the European Bank for Reconstruction and Development (EBRD) and other international bodies. This package is designed to support the economy now in difficulty, by helping to cushion the adverse impact of the crisis.

The financial support package the international financial institutions have granted to Romania will amount to EUR 19.95 billion over the next years. The stand-by agreement with the IMF is worth EUR 12.95 billion. The European Union is to contribute EUR 5 billion, the World Bank – EUR 1 billion, and the EBRD, alongside other international financial institutions, will come up with another EUR 1 billion.

Romania will get the first installment of the EUR 5 billion loan from the European Commission in early July. Half

of the money from the EBRD will go to the banks, and the other half will go to the economy, including aid to companies, in the energy sector and infrastructure.

In this context, the Government of Romania has negotiated with the IMF a budget deficit amounting to 4.6% of the gross domestic product (GDP), although in December last year it had targeted a budget deficit no bigger than 2% of GDP. At the end of 2008, in keeping with the data available at that time, the Government in Bucharest had envisioned a growth rate of about 2.5%. However, at the beginning of 2009, the evaluation of the Romanian economy by the IMF experts indicated a negative growth of 4% and a budget deficit of 4.6% of GDP.

The Executive has come up with a program to fight the crisis, worth EUR 4 billion. Its main components are a 20% allocation from the 2009 budget for investment in infrastructure, payment of government debts and backlog subsidies, increasing the absorption of Community funds, and continuing and expanding the old-car buyback program.

As far as small and medium enterprises (SMEs) are concerned, it should be noted this is the most dynamic sector in the Romanian economy, generating nearly 80% of the GDP. SMEs, considered the most sensitive and most affected by the economic climate, will be among the first to be hit by the effects of the world financial crisis, which has spread to the Romanian economy as well.

The financial crisis adversely impacts most of the SMEs, reducing the development rate and increasing the number of bankruptcies. Startups in particular are most vulnerable, lacking the resources to survive the downturn.

Nevertheless, for a small number of SMEs, i.e. those that identify the changes in the market and react promptly, this period may prove favorable. In times of crisis, some SMEs, unlike the big companies, have the advantage of greater flexibility, being able to implement new services and launch new products more easily. Not bound by strategies devised at higher echelons and by the need to get approvals, SMEs can make decisions more easily and thus become much more efficient based on prompt action and solutions adjusted to market circumstances.

The main challenges most SMEs in Romania have to cope with as a result of the economic-financial crisis are sudden rises in the prices of raw materials, energy and food, liquidity and credit related problems, a marked decline in the demand for products and services, considerable variations in the exchange rate, and inflation. This phenomenon is spreading quite rapidly to a growing number of companies.

The adverse effects of the financial crisis are visible particularly in the case of SMEs in sectors like commerce, constructions and real estate.

Declining exports, diminished investment, and the liquidity blockage are

the main effects of the financial crisis, with repercussions on companies. According to estimates, over 90% of the more than 600,000 SMEs in Romania feel the pinch.

In the first half of the year, the number of SMEs going bankrupt has doubled over the same period the previous year. This is due to the fact that the credits for SMEs have declined by 30%, which has precluded their development and reduced their solvency.

Studies conducted by the National Association of Romanian Employers indicate that, should the current economic circumstances persist, 25% of the small and medium companies could close down this year and 90% of SME managers plan layoffs this year amounting to 10% of the personnel.

Most of the SME owners, i.e. 83%, have negative expectations about the profit they will make in 2009. 76% of the SMEs surveyed intend to adjust to the current economic situation by downsizing, whereas 16% are looking for investors to recapitalize their business. Over 60% of the SMEs hold that a relaxation of credit would help their business work better, and 34% of these believe that measures should be geared at easing the tax burden. Moreover, 55% of the small and medium enterprises consider that the agreement with the IMF is a good solution, while 34% say it is not.

As far as unemployment is concerned, the initial estimates of the Ministry of Labor, Family and Social Protection for

2009 – indicating the loss of 525,000 jobs – may well be exceeded by a wide margin. The jobless figure could rise to one million by the end of the year, as Romanians having lost their jobs in Spain and Italy return home in droves.

According to a survey the international market research company MEMRB conducted in Romania in early 2009, one of the most important solutions in times of crisis is to reorient to more profitable business areas. Furthermore, the survey shows that nearly 80% of the Romanian companies have taken recession-proofing measures, entrepreneurs cutting costs for services supplied by third parties and utility costs. Another finding of the survey is that the most infrequent initiative among SMEs is the launching of new products and services.

50% of the companies surveyed expect the crisis to end in late 2010. Most of the companies spotted the first signs of the economic and financial crisis in November 2008. Three in four companies in Romania consider the economic crisis equivalent to a drop in the demand for the products or services they supply.

The representatives of the National Association of Romanian Employers believe several measures are needed to save the SMEs, the most important of which are: resuming credits, VAT payment by companies on collecting, deduction of excise duty on gas, electricity and fuel, facilitation of government guaranteed loans, regulation of the price of raw materials by the Competition Council,

reorientation of the business to more profitable activities, deduction of social contributions, financing from banks and access to funds from CEC Bank and Eximbank.

Providing support for the SME sector in the context of the current economic crisis is a major solution apt to counter the adverse effects in the process of structural adjustment and economic recovery, generating economic and social alternatives.

In conditions of financial crisis, SMEs can support stability and macroeconomic growth, acting as a growth engine.

That is why action is being taken to release funds to finance small and medium enterprises, to identify solutions to preserve jobs and generate new ones.

The measures proposed for the SME sector in the anti-crisis plan include: tax exemption for reinvested profit, which, besides creation of new jobs, will determine the setting up of new SMEs and stimulate investment by companies that so far have refrained from investing; offsetting the VAT to be recouped with the VAT due to be paid or with other dues to the state budget; capitalization of CEC Bank and Eximbank; making the Counter-Guarantee Fund for SMEs operational; earmarking large funds from the state budget to promoting exports, and increasing the state's contribution to financing this activity.

The situation of the economy of the European Union is deteriorating in the context of the current financial crisis.

The new member states that are not in the eurozone faced, in the last months of 2008 and in 2009, sizable depreciations of their national currencies in terms of the euro.

Ireland, Greece, Spain, France, Latvia and Romania had already exceeded, in 2008, the maximum 3% deficit, and the European Commission envisages a further worsening in 2009. In the case of Romania, according to the EC, the budget deficit in 2008 reached 5.2% or nearly double the 2007 figure. Ireland posted a 6.5% deficit last year, from a surplus of 0.2% in 2007, Latvia 3.5%, Greece and Spain 3.4%, Spain slipping from a 2.2% surplus to the 3.4% deficit, and France 3.2%. Romania and Latvia not being part of the eurozone, financial sanctions cannot be applied to them but the target date for their adoption of the single currency can be delayed and, in case the EU recommendations are repeatedly ignored, cohesion funds may be suspended.

The economic and financial crisis affecting Europe and not only Europe has prompted the member states to adopt new anticrisis packages, after the initial ones which, focusing more on injecting liquidities to save the banks, failed to produce results. Currently, the measures envisaged are largely focused on encouraging demand based on fiscal incentives and support for certain sensitive economic sectors.

Austria, Belgium, Germany, France, the Netherlands, Luxembourg, Ireland and the UK have taken steps to bail out the

banks through capitalization, state guarantees or taking over control of the banks.

France, Germany, Italy, Slovakia, Spain and the UK have also chosen to provide aid to the automobile industry, one of the industries worst affected by the crisis.

To fight the crisis effects, the European Council adopted, in December 2008, the *European Economic Recovery Plan* worth EUR 200 billion, or 1.5% of the EU's GDP (EUR 170 billion provided by the member states and EUR 30 billion from the European Investment Bank), plus funds from the Community budget.

Below I will exemplify with the case of the Italian Republic, the Federal Republic of Germany, the Slovak Republic and the Republic of Hungary.

The Italian Republic, like the other countries in the eurozone, is currently grappling with a marked deterioration of the economy, although its financial sector is still sound enough. The International Monetary Fund forecasts three years in a row when Italy will see its GDP drop: -0.6% in 2008, -2.1% in 2009 and -0.5% in 2010.

In 2008 Italy's economy went down by 1%, this being the poorest performance since 1975, when its GDP had shrunk by 2.1% on the background of the oil crisis. The shrinking of the GDP was caused mostly by the 3.7% reduction of exports, a 3% drop in investment and a consumption decline of 0.5%. Imports in turn went down by 4.5%. According to the

National Statistics Institute in Italy – Istat, in 2007 Italy had posted a 1.6% growth rate.

The measures taken by officials in the Italian Republic are part of the European Commission's recovery plan. The package the Government in Rome adopted includes a bonus for low-income families, in the form of tax credit, and for companies – tax deductions and an increase in the funds for technical unemployment.

On the background of the economic crisis, as Italy's economy stagnates and the public debt exceeds the GDP, the Executive in Rome intends to inject EUR 80 billion in the market in the next two or three years. However, the public spending forecasted for the next years can reach EUR 110 billion, given the European resources and the Italian regional cohesion fund.

On January 12, 2009 the authorities of the Federal Republic of Germany announced an EUR 50 billion package of measures covering two years. Supplementing the package approved at the end of last year (EUR 32 billion), the new package is the largest ever since World War II and is aimed at providing support to Europe's biggest economy.

Germany's stimulus package amounts to EUR 82 billion spread out over two years, i.e. 1.6% of the GDP – the biggest injection of capital in Europe. The scope of the program compares to that of US President Barack Obama's plan worth USD 775 billion (2.8% of the GDP) spread out over two years.

According to this plan, employees' health insurance payments will be reduced, which will equally benefit employers and the employees, and the salary tax (first taxation level) will be cut from 15% to 14%. Moreover, under this plan, EUR 18 billion is earmarked for new investment in the construction and repair of roads, railways, schools and universities. The program also includes EUR 1.5 billion of aid for the automobile industry, and tax reductions of 2.9 billions due to grow to 6 billions as of 2010. Furthermore, in order to stimulate economic activity, guarantees of up to EUR 100 billion are to be granted for loans raised by German companies.

The effects of the crisis are increasingly visible and Germany's position as the world's top exporter is in danger. German specialists hold that Germany preserved its status as the world's top goods exporter in 2008 for the 6th straight year, the surplus trade balance accounting, according to the Federal Statistics Office, for 6.4% of GDP. By late 2008, however, German exports were seriously affected by the crisis, specialists saying 2008 was the last year Germany could stick to its position as the world's no. 1 exporter.

The latest estimates related to Germany, presented in *Financial Times Deutschland*, show that in 2010 the budget deficit could exceed 4% of the GDP.

According to the estimates of Germany's Central Bank (Bundesbank), the biggest economy in Europe is to shrink by 0.8% in 2009, after having significantly

slowed down in 2008 under the impact of the financial crisis. The Bundesbank has announced the German economy stands slim chances of recovering faster than the world economy as a whole, which is expected to pick up to a certain extent in 2010.

Several analysts also believe that in 2010 Germany may lose to China its position as the world's third largest economy.

As far as Slovakia is concerned, it boasts a stable business environment and confidence in the economy is high. The growth rate in 2008 was big, rising to over 7%.

Slovakia, having managed to align with the Maastricht criteria, benefits as of January 1, 2009 from the advantages of the single currency, from the stability ensured by this currency compared to the currencies of the countries that have not adopted the euro yet. Transition to the single currency eliminates certain risks, such as the risk related to exchange rates.

In February 2009, in Slovakia the Legislature approved a set of changes aimed at mitigating the effects of the world economic and financial crisis. The changes in point include a reduction of taxes paid by employees, streamlining of administrative procedures and a cut in the bureaucracy companies have to comply with. Another goal is to obtain a positive influence on businesses by improving the business climate. Commercial companies will thus be able to develop their business and create new jobs. Small companies with

an annual turnover of up to EUR 200,000 will not have to observe complicated accounting rules, but only to apply primary accounting. Introduction of this limit will benefit the business environment and will not affect state budget revenue. As far as the VAT is concerned, the deadline for recovering the VAT has been reduced from 60 to 30 days for monthly VAT payers. Concurrently, the Slovak Government has decided to focus on stimulating internal demand and accelerating the implementation of structural funds. Plans are being made for opening a financing line for SMEs, jointly with the commercial banks.

According to the European Commission, in 2009 Slovakia will post an economic growth of about 2% of GDP, while many EU member states are heading for recession. In the current circumstances, a risk for the Slovak economy arises from its specialization in automobile manufacturing, which contributed to a solid growth of industrial activity. Automobile production dropped 35.7% in December 2008 from year earlier, after a 16.9% drop in November, the Slovak National Institute of Statistics reports.

The current recession in Hungary, which started in 2008, will affect the Hungarian economy more harshly than specialists initially expected, notably because of the world recession, Hungary's being a small economy, dependent on exports.

In October 2008 Hungary – one of the countries worst hit by the current world

economic crisis – avoided financial collapse with the help of a support package worth USD 25.1 billion, coordinated by the International Monetary Fund. Specialists consider Hungary will face the most marked slump in two decades, as exports to Western Europe are shrinking, demand diminishes at the national level and unemployment grows.

Throughout 2008 Hungary's economy grew 0.6%, after having posted a growth rate of 1.1% in 2007 and of 4.1% in 2006.

The Hungarian government's estimations indicate the GDP will decline by 3% this year, that is, more than the figure advanced in previous estimates. Consequently the Executive in Budapest has revised its economic plans, as well as the budget, so as to make up for the diminished revenue. On the other hand, analysts believe the GDP could shrink by as much as 6%.

Therefore Hungary adopted a number of anti-crisis measures. Budget-related measures include reductions and increases in taxes, expenditure cuts, the aim being to diminish the taxes for both companies and employees, as well as higher taxation of consumption and properties. A 4% "solidarity" tax on the earnings of companies and persons with high incomes will be applied as of January 1, 2010, the value-added tax will grow from 20% to 23% as of July 1, 2009, and employees' contribution to social insurance will be reduced by 5%, from 32% to 27%, in two stages.

In the context of the current world crisis, London played host, on April 2, 2009, to the G20 Summit devoted to the financial and economic crisis.

The G20 (Group of Twenty), established in 1999, comprises: Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, United Kingdom, United States and the European Union.

The 20 account for 85% of the gross world product, for 80% of world exchanges and for two thirds of the world's population. The G20 meetings are also attended by the director general of the IMF and the president of the World Bank. The Group of Twenty is an informal forum that promotes discussion on themes related to global economic stability, and one of its aims is to help strengthen the world financial architecture and to provide the opportunity for debates on national policies and their coordination to the end of fostering economic growth and development.

The goals of the London Summit of the G20 were world economic recovery and establishment of real action to strengthen the financial system.

The main measures the G20 summiteers agreed on in London were:

- 5,000 billion dollars to be used by G20 to stabilize the world economy by the end of 2010, an effort that will increase the gross world product by 4%;

- Over 1,100 billion dollars granted to international financial institutions, of which 750 billion for the IMF, 100 billion for the Multilateral Development Banks, 250 billion for financing trade with a view to resuming world exchanges in the next two years, coming from special drawing rights (SDR) from the IMF;

- Establishment of a new Financial Stability Board, with a strengthened mandate, as a successor to the Financial Stability Forum; the FSB will include all G20 member state, the members of the Financial Stability Forum, Spain and the European Commission; it will collaborate with the International Monetary Fund in order to issue early warnings on the buildup of macroeconomic and financial risks;

- Institution of strict control over credit rating agencies and hedge funds, avoidance of protectionist measures and increase of credits made available to poor countries – 50 billion to support social protection in the poor countries;

- New regulations on the salaries and bonuses of big corporate managers;

- Banning of tax havens. The G20 leaders decided to put an end to tax havens that do not comply with international tax regulations and refuse to provide the financial information requested by authorities;

- Regulatory oversight of Credit Rating Agencies, that includes registration,

so that they should comply with the international codes of good practice, notably in order to prevent conflicts of interest.

A topic much debated in recent months as well as at the G20 Summit was the US plan for overcoming the current crisis: economic recovery based on allocation of supplementary funds from the state budget, an idea categorically rejected by the Europeans, at head with France and Germany, which emphasize regulation and control over the world finances. In case the crisis worsens, the G20 will make additional budgetary efforts and the USD 5,000 billion figure will be adjusted accordingly.

As the International Monetary Fund sees it, economic growth will slow down sensibly in the developed countries, whereas the developing countries and the Third World countries will sustain a major decline in their growth rates. Also, in 2009 China will keep its position as the country with the highest growth rate in the world – an estimated 6.7% (the lowest in two decades), after a 9% growth in 2008. India in turn will post a growth rate of 5.1% in 2009, down from 7.3% in 2008.

According to IMF estimates, the world economy is traversing the worst crisis since World War II, and is to post the lowest growth rate in the last 60 years: a meager 0.5%.

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## References

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- Cooper, G. (2008). *The Origin of Financial Crises* (Originile crizei financiare), Editura Vintage, SUA
- Dombrowski, U., Herrmann, C., Lackner T., Sonntag, S. (2009). *Modernisierung kleiner Unternehmen* (Modernizarea IMM-urilor: un concept integrat), Editura Springer, Germania
- Nicolescu, O. (2008). *Carta Albă a IMM-urilor din România*, București
- \*\*\*Planul de Guvernare 2008 – 2012, România
- \*\*\*Plan măsuri anticriză adoptat de Guvernul României, 2009
- \*\*\*Anuarul statistic al României 2008, Institutul Național de Statistică, București
- \*\*\*Plan măsuri anticriză adoptat de Guvernul Republicii Italiene, 2009
- \*\*\*Plan măsuri anticriză adoptat de Guvernul Republicii Federale Germania, 2009
- \*\*\*Economia Germană, al-4-lea trimestru 2008, Oficiul Național de Statistică, Germania
- \*\*\*Plan măsuri anticriză adoptat de Guvernul Republicii Slovacia, 2009