Monetary Policy and the Chaotic Structure of Net Cash Flow from Investment-Operating and Liquidity

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Abstract: - Monetary policy seeks to promote economic expansions or contractions by managing interest rates or money supply. The impact of these mechanisms on businesses depends on their ability to make predictions about the development of the market and the performance and profitability of their projects. Also, interest rates impact their ability to raise funds for operations, forcing them to make changes in liabilities, operations, investments and liquidity. However, many factors affect the investments, operations and liquidity of companies and it may be that economic expansion does not result in a gradual increase in the operation or investment of companies. The unpredictable evolution of the economy leads companies to adopt conservative strategies to avoid short-term indebtedness. Monetary policy should take into account the chaotic relationship existing between the assets of companies, investments, operations and liquidity; decreasing interest rates or increasing the money supply act upon a complex structure of financial relationships in companies, resulting in high unpredictability.

Key-Words: - **C**haos; monetary policy; net cash flow from investment, net cash flow from operating, working capital.

1 Introduction

Chaos theory permeates the relationship between monetary policy and corporate finances; some well-established laws result in non-lineal relationships, and a series of interconnected laws and concepts results in a chaotic formulation. Many empirical data reveal neither a simple nor a complicated lineal explanation [1, p. 19, 2, 3, 4], and their analysis does not easily fit a non-lineal model. So, the challenge remains to determine not only the models that fit empirical data, but also new procedures and logic that allow for data interpretations based on chaos theory.

Some phenomena are governed by stable laws, while others apparently are not, and the question that arises is whether the latter concern is governed by undiscovered laws, is purely random, or is a combination of random and deterministic factors. Chaos theory has contributed an understanding of phenomena that apparently are irregular with the intrinsic possibility of making predictions. Instead, many phenomena involve periodic or fluctuating behavior.

Sometimes, a phenomenon might be represented by simple dynamic models, taking the value of a variable as a function of time and the previous values of that variable. Such systems are deterministic in the sense that their equations can be solved and knowing the state at any point in time provides information regarding all future and previous states. In this sense, the behavior is entirely determined for all time [5]. In other instances, if the patterns of the phenomenon are not understandable and the activities appear irregular, the behavior could be difficult to model. Much effort has been invested in understanding the underlying processes that produce such patterns.

The previous discussion distinguishes two approaches. The first one assumes that where behavior is complicated, there are several factors influencing it; this leads to the creation of highly complex forecasting models. The second assumes that there is an underlying trend, but that observed variability is due to the presence of random shocks that make the pattern of behavior unclear. Then, the investigation has to make an immense effort to identify trends [5].

Sometimes, it might be thought that a seemingly random or complex behavior phenomenon could be chaotic. However, chaotic behavior is not stochastic or random; a chaotic system is entirely deterministic but appears to be merely random. Furthermore, chaotic systems do not necessarily require systems of complex equations to describe them. Remarkably, chaos may be generated from the simplest of non-linear equations where, in contrast to linear systems, the smallest of changes can lead to high variability. Simple causes may produce complex behavior and, in turn, a complex phenomenon does not involve complex causes.

Chaos systems comprise a conceptualization in a metaphorical language and a formulation (whenever possible) in a neo-reductionistic language, according to Richardson's terminology [2]. Metaphorical language includes definitions of the characteristics of chaos behavior, for instance, cumulative, scale and incremental changes and punctuated equilibrium with alternation between inertia and change [6]. This language also has been applied to the study of poverty [7]. Neo-reductionistic chaos comprises mathematical models, for instance, those explaining all the aforementioned chaos conditions by mathematical equations, such as Lyapunov exponents, chaotic orbits, basins of attraction and so on (see Alligood, Sauer, & Yorke [8]). Chaos is connected to the theory of catastrophes [9] and involves lack of predictability [10]; the evolution of the system is unpredictable even when it is mathematically formalized [11].

The use of these explanations has been demonstrated to be useful in economics [12, 13, 14] and in finance and accountancy [15]. In corporate finances, for instance, in the analysis of financial statements, it has been shown that changes in some items admit a chaotic conceptualization and that relationships among financial health indicators suggest a model of chaos [11, 15, 16, 17, p. 25]. Chaos also was analyzed in financial markets [18, 19], commodity indices [20], financial risk [21], and economic systems [22], among others.

In monetary models, the perfect foresight assumption implies that the agents in the model never make a forecasting mistake even though entrepreneurs might conclude that economic behavior follows a random process. This requires belief logic (see Smullyan [23]); they are always accurate and believe something which is true, just because they believe in it. This logic has been applied to financial statements analysis [17, p. 25].

However, when monetary stabilization policy is justified, simple policy rules might occur within a nonlinear framework which can reach the desired economic stabilization target, in contrast to some linear stochastic models in which the effectiveness of the policy is in question. The mathematics that produces the cyclical and chaotic dynamics is based on variations in parameters which lead to changes in the dynamic properties of the model [24]. When some of the parameters of the model can be set by policy authorities, the authorities have a great deal of control over the dynamic outcome.

In the analytical approach of providing a mathematical model, consider a discrete time dynamic model given by

$$\Delta M_t = G_\infty(\pi_t^e) \quad (1)$$

Where ΔM, is the monetary policy given through the expansion or contraction of the monetary supply, G_∞ comprises a parameter family that allows us to map a differentiable expression. These parameters relate expected inflation to money supply, allowing them to interact over time. They should be within the 0-1 rank, otherwise hyperinflation would happen; π^e is the expected inflation, which is given by

$$\pi_t^e = \frac{p^e - p_{t-1}}{p_{t-1}} \quad (2)$$

p^e is the expected price level in the economy at time t, and p_{t-1} is the price level at time t-1.

Accordingly, α Є[0, 1] parameterizes a family of differentiable maps $G_\alpha(\cdot)$, and $G_\alpha(0) = 0$ for every α, that is the null vector and is a fixed point of $G_\alpha(\cdot)$.

The current state, vector ΔM, is given by the function

$$\Delta M = G_{\infty}^{t}(\pi_t^e) \quad (3)$$

Where t represents the iterations of $G_\alpha(0)$; z_0 is the initial state vector. The map $G_\alpha(\cdot)$ displays continuous dependence on the parameter α. If the system is slightly perturbed from the steady state, the system described by equation (1) may evolve toward another steady state and the model is stable; otherwise the model is unstable.

The relationship between monetary policy and expected inflation rate (π^e) is defined, in the traditional quantitative theory of money, in terms of growth rates. If the well-known quantity equation of money ($MV=PY$) is rewritten in logs and then total differentiated, this equation is expressed as

$$m + v = \pi_t^e + y \quad (4)$$

Where lowercase letters denote growth rates, being the letters in equation (4) defined as the growth of the money supply (m), the percentage velocity of money changes (v), the expected inflation rate (π^e) and the real gross domestic economic growth (y). In general, the v value is assumed to be zero.

Monetary policy expands or contracts the economy by the mechanism of increasing or decreasing the money supply, what might result in increased inflation and/or real gross domestic product (GDP). The latter, real GDP, is associated with increased production by companies. Moreover, and based on the approximation by the Fisher equation

$$i_n = i_r + \pi^e \quad (5)$$

Where i_n = nominal interest rate, and i_r = real interest rate, when inflation rate is high, the nominal interest rate also is high, leading to lower production by companies, by reducing investment due to high nominal interest rates. In the short-term, companies have to anticipate the inflation rate at time t and determine the amount of money available to lend in order to formulate their investment model. An increase in production depends on investment and operation while, at the same time, maintaining liquidity.

Indeed the firm investment decisions depend on the interest real rate (i_r). However it is difficult for companies to determine which portion of the increase in the nominal interest rates (i_n) actually is translated into the real interest rates (i_r) and which is a result of anticipated inflation. The relationship between monetary policy and the identification of the expected inflation rate, and its effects on firm performance, could not be estimated from a linear point of view. In fact, changes in the inflation rates lead companies to anticipate changes in production costs, market behaviour, and the corresponding adjustments to its financial assets.

The monetary policy also is conducted through the central bank interest intervention. This mechanism works by increasing or decreasing the central bank interest rate, with an effect in the money supply. Interest rate intervention variations depend on the central bank expectancies of the inflation rate. It is well-known that these institutions have a given inflation rate as a target. In this sense, a dynamic relationship must be a given according to the initial economic conditions.

The dynamic process of the monetary policy in the economy is given, firstly, through changes in the short, and later, in the long-term interest structure. The reaction to the short-term interest rate is immediate and the structure of the long-term interest rates evolves according to the economic process over time. In fact, an expansive monetary policy, by the reduction of the nominal interest rate, affects the short interest rate and the lending of financial resources to firms. In this sense, firms' working capital costs go down and firms also increase their activity levels in order to increase their profits. In contrast, a tight monetary policy acts to reduce economy activity and, as a consequence, profits.

All organizations are also dynamic systems governed by nonlinear relationships. The organization is affected by the whole economy, which in turn, is interdependent with a larger environment. Multiple organizational actors, with various agendas, are reciprocally affected among themselves, and organizations coordinate their own actions and exchange information in a dynamical manner. Financial managers make risk decisions regarding the stability of their financial conditions and profits.

Therefore, some nonlinear results and loops may exist, rather than a linear process. The organizational behavior depends on a large number of agents with different perceptions about the economy and the degree of risk that affects their own financial decisions.

The previous phenomenon affects corporate financial conditions. Lower interest rates, resulting from an expansion of the money supply, drive enterprises to make financial decisions to enlarge their debt structure and to increase their ability to raise funds for operations in the long run. This is associated with the capacity of organizations to borrow money and invest it in their firms; at the same time, the amount of investment is associated with the size of the organization, as investment typically is a percentage of capital.

Accordingly, expansion of the economy could lead to increased business investment, business operations and liquidity.

Liquidity can be conceptualized as working capital. It is defined as a buffer, i.e., the strength of the company to cope with short-term obligations. The computerized form of working capital is

$$\textit{Working capital} = \textit{Current asset} - \textit{Current liability} \quad (6)$$

However, working capital is better conceptualized as a management tool than an equation, and many unsolved conceptual gaps remain regarding computerized working capital.

2 Problem Formulation

According to the discussion above, the associations between monetary policy and investment, operation and working capital could be nonlinear. The intention to produce linear effects on the whole economy by manipulating monetary supply or interest rate could have unpredictable results.

Usually, the assumed rational is that expansive monetary policy acts on a defined and monotonic increase in company capital and that favouring the affluence of money to companies (under the proper conditions) would lead to more net cash flow from operating and investment activities, and liquidity. All of this would be associated to the size of total assets, as large companies tend to take more advantage from good conditions to access the money.

However, this is a deductive antecedent-consequent formulation and it is false in the case that increases in net cash flow from operating and investment activities and liquidity do not follow a linear-monotonic incremental path. In this case, the results of applying an expansive monetary policy, based on the aforementioned variables, are unpredictable.

Total assets, as a measure of the size of the company, can provide an index to determine the existing relationship among the aforementioned items. Large companies tend to use advanced technology and receive more payoff [25], turn more to information sources and innovation [26], act independently, invest more in new products [27], have more intellectual capital [28] and information technology that increases their productivity [29].

Accordingly, if the total assets of companies do not determine the intake of capital, with bigger figures in net cash flow from operating and investment activities and liquidity in large companies, then monetary policy will not produce a linear-predictable effect on the economy.

To be effective, monetary policy must operate creating an expansive trend in the whole economy, despite some companies do not follow this trend; that is, there must be a relationship of net cash flow from operating and investment activities or liquidity to the size of total assets, or a relationship of net cash flow from operating activities and liquidity to investment. It means that monetary policy increases investment or net cash flow from operating activities or liquidity in a linear manner, according to the size of the company, or that investment increases net cash flow from operating activities or liquidity also in a linear manner.

However if these financial items do not have a linear relationship among them, monetary policy cannot have a linear effect with gradual increments according to company size, and its impact is nonlinear, chaotic or unpredictably.

To test this and provide an explanation, a conceptual-analytical research with a logical argumentation was conducted, based on data from the financial statements of 2321 firms and several macro-economic indicators of Colombian economy. Data are just introduced to support the logical discussion.

3 Problem Solution

Figures 1, 2, 3 and 4 show the relationships in a sample of the Colombian economy, one of the emerging markets, for the year 2010. Scatter plots are in $\log_{10}$.

They demonstrate that a non-linear relationship exists in every combination of values and that variations in total assets (Figures 1, 2, 3), or the other variables (Figure 4) result in high value variations in the others, moving values from the low middle to the high middle of the graph. In the figures, despite some apparently observed linear trends, oscillations between positive and negative values do not make linear prediction easy.

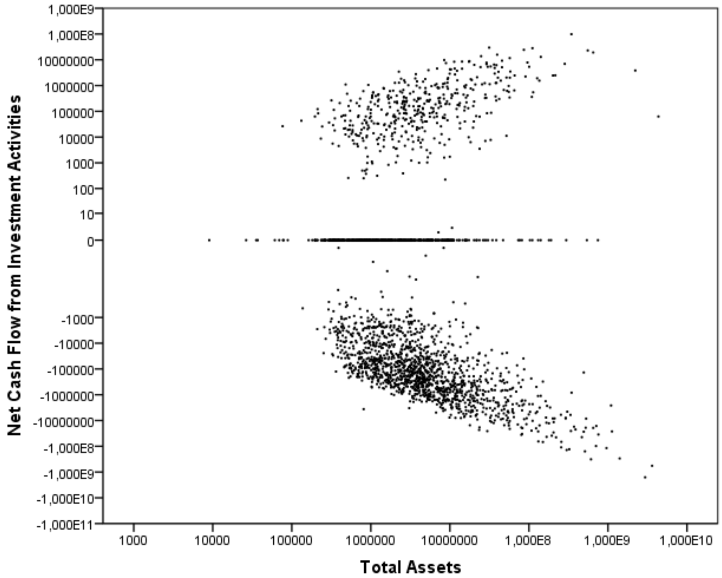

Figure 1. Scatter plot of net cash flow from investment activities by total assets.

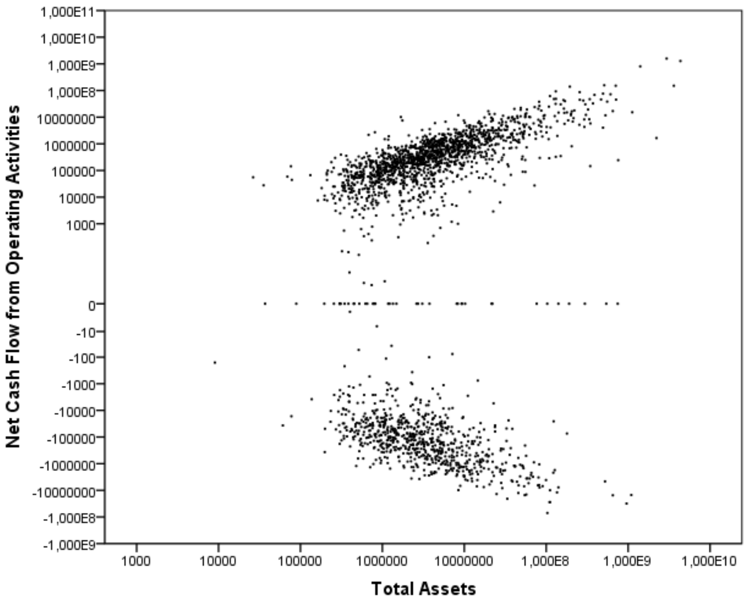

Figure 2. Scatter plot of net cash flow from operating activities by total assets.

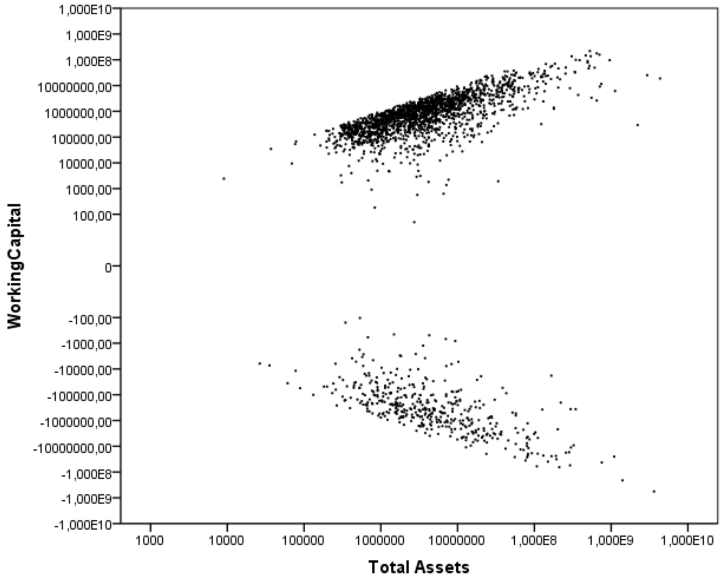

Figure 3. Scatter plot of working capital by total assets.

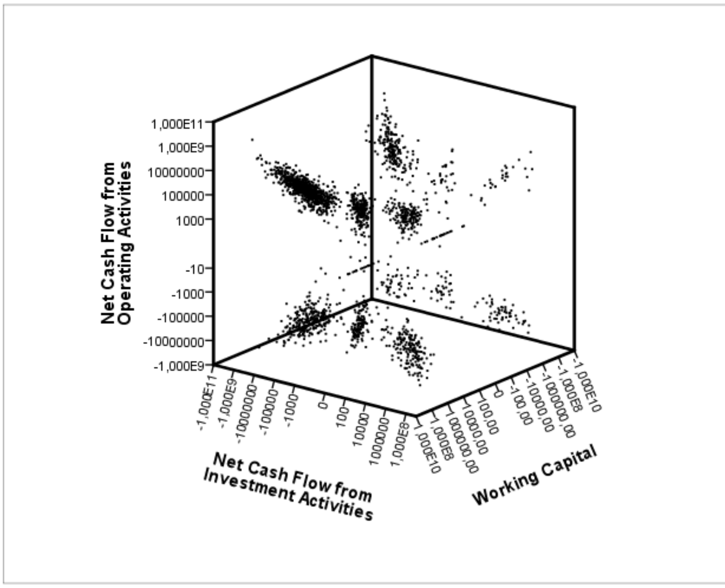

Figure 4. Scatter plot of net cash flow from investment activities, net cash flow from operating activities and working capital.

To provide a more in deep interpretation of the findings above, we will use one approach based on the analysis of the relationship between past and current data in a series, trying to identify the underlying system.

3.1 Recurrence and Phase Space in Corporate Finance Indicators

One approach to modelling the relationship between financial indicators is by recurrence analysis, a nonlinear technique that detects deterministic dependencies [18]. This consists of a simple dynamic model that takes the current value of a variable as a function of previous values of that variable across time. However, when the data of a sample of companies belongs to a point in time, as in the reporting of a financial statement at the end of year, time can be replaced by an ordering variable or values [17, p. 13]. The random sample must have the properties of the population from which it is extracted, so ordering the sample by a variable reflects the ordering properties in the population, according to that variable.

Sometimes, the population does not have a fixed interval between all adjacent pairs of values and it might be said that it does not strictly fit a time series model. However, there is no doubt that it is a representative picture of the phenomena in the real population, where many factors may influence this distribution of values.

According to this, the result of the recurrence analysis is a function of time in the following form

$$Y_t = F(Y_{t-n}) \quad (6)$$

were *t-n* is a delay. Associated phase space plot, consists of the function

$$X_t = F(X_{t+delay}) \quad (7)$$

The concept of delay (τ) implies that a single variable poses information about the other variables with which it interacts [30], and every delay results in a coordinate in an *m*-dimensional space where the original series is imbedded. Phase space is a representation of the attractor in the series. It represents all possible states of a system or allowed combinations of values of the system parameters, analogous to the evolution of the system over time [31].

Every delay *d* and number of dimensions *m* originate a vector

$$v(i) = \{x_i, x_i\text{-}d, x_i\text{-}2d,\ldots, x_i\text{-}(m\text{-}1)d)\} \quad (8)$$

It creates a family of vectors

$$V = \{\mathrm{v}(1), v(2), v(3), \ldots, v(N\text{-}(m\text{-}1)d)\} \quad (9)$$

Recurrence analysis uses a matrix *M*, were every point is 1 if the distance between them is less than a given threshold distance, and otherwise it is 0. The matrix point is,

$$M=\{\forall m_{ij} \mid m_{ij}= 0 \text{ if } |v_i–v_i| > \varepsilon; m_{ij} = 1 \text{ if } |v_i–\mathrm{v}_i| \le \varepsilon\} \quad (10)$$

were ε is the threshold distance, and m_{ij} is each element of the matrix *M*.

Phase spaces were obtained for the variables. A phase space $\mathbb{R}^m$ is a plot of all possible states of a system in a m-dimensional space; each point *y(t)* is plotted against every other point in the same data series but with a delay *y(t-d)* or an advancement *y(t+d)*. An m-dimensional space can be defined in the form

$$\{S(t), S(t\text{-}d), S(t\text{-}2d), \ldots, S(t\text{-}(m\text{-}1)d)\} \quad (11)$$

and every point *y(t)* is plotted in coordinates

$$\{S(t), S(t\text{-}xd))\},\ 1 \le x \le m\text{-}1 \quad (12)$$

Let us sort the sample of companies by the $\log_{10}$ of total assets and compute their phase space plot. Recurrence analysis, given the fact that total assets is the ordering variable, adopts the following form

$$Y_{TAt} = F(Y_{TAt-n}) \quad (13)$$

where *TA* is total assets, *t* is the ascending rank of the values of total assets and *Y* is the variable to plot. Dependence of *Y* on its previous values can extend to only one or to several of them.

Figure 5 shows the phase space plot of $\log_{10}$ of net cash flow from investment activities by ordering values of $\log_{10}$ of total assets, with a lag of τ =3, and 2 embedding dimension. Data have a distinctive pattern in the phase space reconstruction. This series shows that certain dependence exists between the size of the company and the amount of the investment, and that this dependence is nonlinear. Using a method of minimum, a rescaling of absolute and a criteria of 5 points in recurrence diagonal lines, coefficients of recurrence quantitative analysis provide information about the data series. It has a determinism (predictability in the system) of 34.26%, a recurrence of 51.99%, and a laminarity of 39.36% (this coefficient gives an idea of the number of recurrence points). Besides, it has an entropy (or equiprobability of events) of 2.69 and a trapping time (mean time in a specific state) of 8.35.

One expectation about the series would be that larger companies would devote a more substantial amount to investments in properties, plant and equipment, or even intangibles, than smaller ones. This could result in increased sustainability. However, investment is grouped around some dependence relationships with many white areas without investment. Large companies tend to replicate the models of investment of others with significantly fewer assets. This means that future data replicate previous data and nothing is new regarding investment in relation to the size of the companies. In regard to monetary policy or inflation, promoting an expansive policy by reducing interest rates or increasing monetary supply could not result in a sustained increase in company investment. Many companies would return to previous states of low investment.

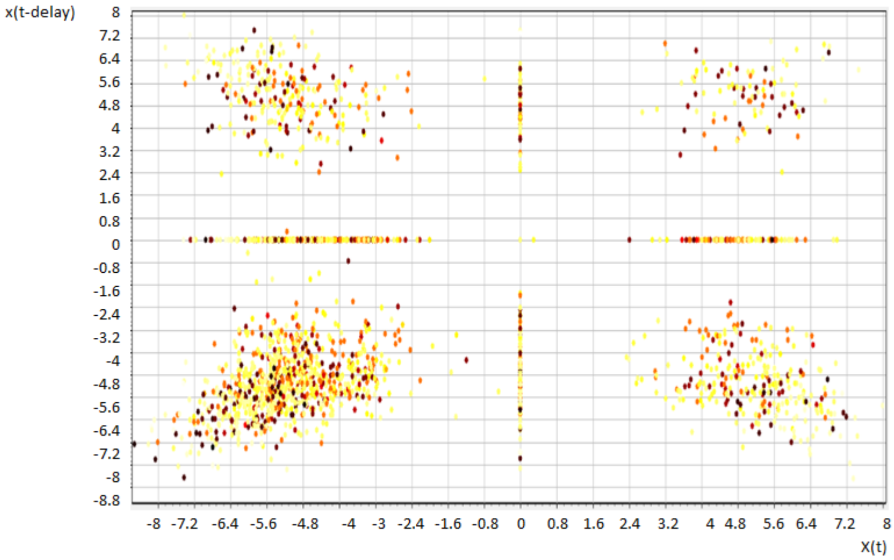

Figure 5. Phase space reconstruction of $\log_{10}$ of net cash flow from investment activities ordered by $\log_{10}$ of total assets.

This model has been observed several times in other financial item analyses (see Juárez [11, 15, 16, 17]) and seems to be a norm, in this case, of the Colombian economy, as an example of a type of emerging markets.

Otherwise, an increase in total assets could be related to an increase in working capital and net cash flow from operating activities. Certainly, total assets comprise more than those related to liquidity or operation, but exploring these relationships is worthwhile. Figures 6 and 7 show the plots of net cash flow from operating activities (lag τ=2 and embedding dimensions=2) and working capital (lag τ=2 and embedding dimensions=5) ordered by the log of total assets.

The phase space reconstruction is similar to the previous one. Attractor is prominent, and both of them take a pattern of data grouped in a few dependence values without any direction as long as companies increase in total assets. Working capital and net cash flow from operating activities seems to be returning to its past values, according to increases in the amounts of capital or properties that the company possesses.

Quantitative analysis, using a method of minimum, a rescaling of absolute and a criteria of 5 points in recurrence diagonal lines, shows that net cash flow from operating activities has a determinism of 64.78%, a recurrence of 65.52%, a laminarity of 59.31%, an entropy of = 3.30 and a trapping time of = 9.67. Working capital, using the same method, rescaling and number of points, has a determinism of 98.33%, a recurrence of 97.29%, a laminarity of 97.86%, an entropy of = 7.69 and a trapping time of = 105.93.

These patterns are similar to those of net cash flow from investment activities, so the same considerations apply. They show a structured phase space.

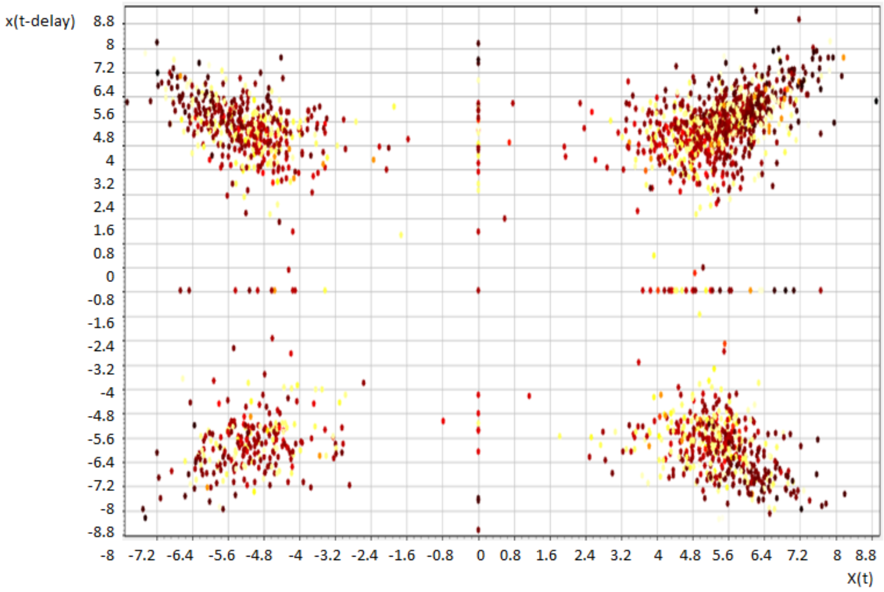

Figure 6. Phase space reconstruction of the $\log_{10}$ of net cash flow from operating activities ordered by $\log_{10}$ of total assets.

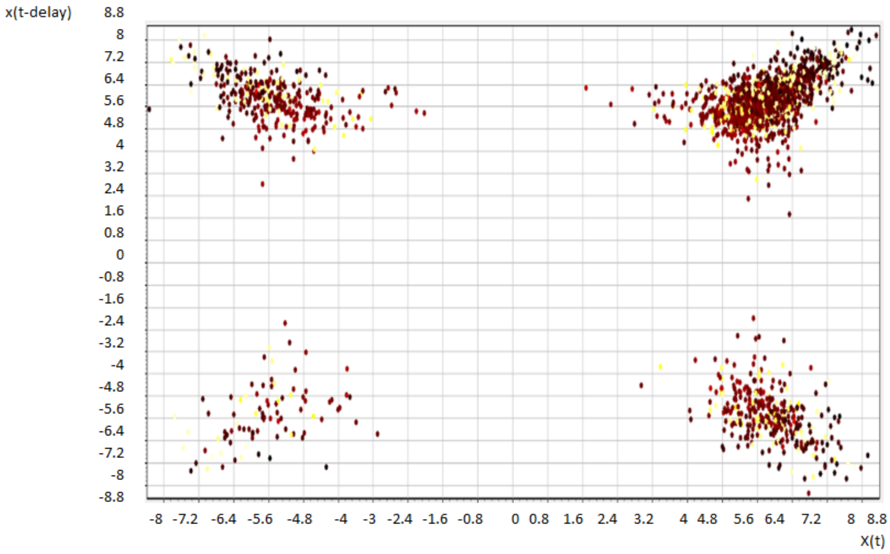

Figure 7. Phase space reconstruction of the $\log_{10}$ of working capital ordered by $\log_{10}$ of total assets.

In companies, investment is related to the nominal interest rate of lending money and the money supply. Interest rates affect working capital and the ability to raise funds for operations in the long run, forcing changes in liabilities and dividends policy. The effect of these mechanisms on business depends on their ability to make predictions about the development of the market and the performance and profitability of their investment projects. This results in a feeling of high uncertainty in the financial performance of companies and return on investment.

In addition, the relationships among net cash flow from operating activities, net cash flow from investment activities and working capital, must be reflected in the phase space analysis of two of them by ordered values of the other one. Let us take net cash of investment activities as the leading variable and plot net cash flow from operating activities and working capital. This is shown in Figure 8 for net cash flow from operating activities (lag τ=3; embedding dimensions=8) and Figure 9 for working capital (lag τ=1; embedding dimensions=8).

These figures show the same structure as previous ones, and data are grouped around some extreme dependence relationships in the phase space, in the past and future performance of the data series. According to this, the performance of the companies in operating activities or liquidity is distributed in some groups of delays and values, not following the increase in the results of investment activities in a linear manner.

Quantitative analysis, using a method of minimum, a rescaling of absolute and a criteria of 5 points in recurrence diagonal lines, shows that net cash flow from operating activities has a determinism of 95.83%, a recurrence of 96.61%, a laminarity of 97.74%, an entropy of 7.96 and a trapping time of 55.98. Working capital, with the same method, rescaling and number of points, has a determinism of 99.97%, a recurrence of 99.16%4, a laminarity of 99.50%, an entropy of 8.78 and a trapping time of 303.85.

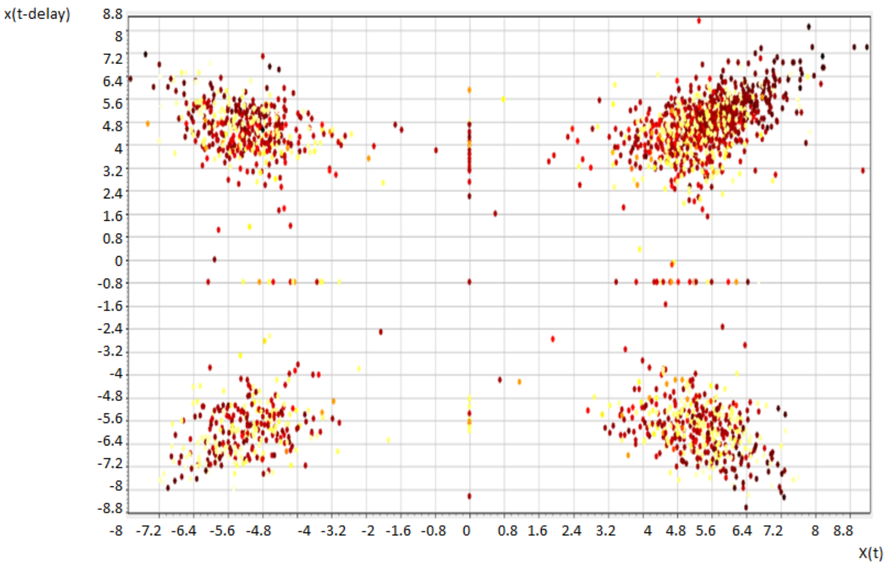

Figure 8. Phase space reconstruction of the $\log_{10}$ of net cash flow from operating activities ordered by $\log_{10}$ of net cash flow from investment activities.

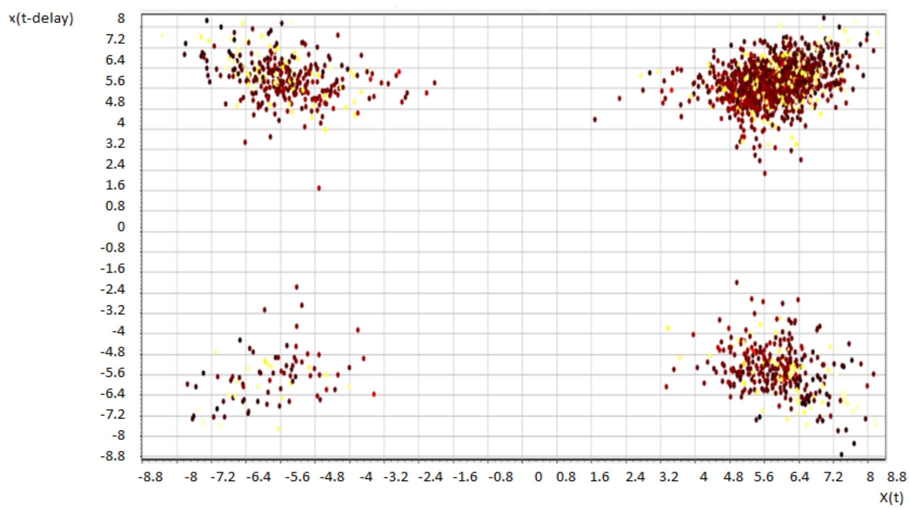

Figure 9. Phase space reconstruction of the $\log_{10}$ of working capital ordered by $\log_{10}$ of net cash flow from investment activities.

3.2 Monetary Policy and the Structure of Relationships in Financial Statements

Inflation creates panic because of the likelihood of uncontrolled prices, leading to rising production costs and values of assets, based on estimates. Adjustment by inflation requires the re-valuation of items in financial statements. However, the influence of the money supply and inflation on the financial performance of companies cannot be estimated from a linear viewpoint. The impact of the money supply or reductions in interest rates as means to determine the level of production or the economic expansion is on a fixed and reproductive structure of recurrence dependencies. This structure is not permeated by these economic policy actions, in a linear manner.

However, economic results are given in a linear appearance. For example, in Colombian economy, an example of emerging markets, regarding interest rates, it was 2.3% in 2010. In this year, inflation was around 2.4%; the increase in GDP was in the range 4.2% - 4.5% [32, p.1].

All of these data indicate a global impact on the economy and a gradual increase or decrease (with slight oscillations) in economic activity and, consequently, in business activity. However, despite an expansive monetary policy in 2010, with an interest rate of 2.3% and inflation of 2.4%, resulting in an increase of GDP, the phase space plots do not fit any gradual growth in companies, with large figures in large companies. On the contrary, successful companies fell to levels of investment comparable to those in which they engaged when they were much less significant.

It is assumed that inflation is combined with the levels of money supply to interact with the business financial position, creating a tendency toward investment. Nevertheless, when a complex structure of investment exists, it can lead to wrong investments, which compromise the future of the company and the results are unpredictable.

Financial position determined by debt level (Total assets/Total liabilities); concentration of indebtedness in the short-term (Current liabilities/Total liabilities) and long-term (Non-current liabilities/Total liabilities), solvency index (Total current assets / Total current liabilities) and working capital show that, despite the fact that 81% of all of the companies had positive working capital during the year 2010, only 15% had a favorable indebtedness position, 0% had a favorable concentration of indebtedness in the short term, 25% had a proper concentration of indebtedness in the long term, and 25% had a proper solvency index.

According to this, maybe companies are not willing to borrow money, even with an attractive interest rate, because of their weak financial position. Companies prefer to have liquidity, but by doing so, they face a delicate indebtedness position, especially in the short term. In addition, they have to cope with substantial changes in their financial position, produced by smaller changes in their investment or total assets, as phase space plots showed. Weak indebtedness position and a chaotic recurrence to liquidity and operating-investment positions as long as the company is larger, make the investment decision making difficult.

According to this, the risk is inherent in the structure of the relationship between these financial indicators, and it must be concluded that an increasing GDP is not the result of a gradual increase in company production, but it comes from radical changes in the profiles of production in some companies. Some of them will rise, and some of them will fall, but there is not a steady pace in the economy following changes in monetary policy.

Besides, despite a favorable nominal interest rate, banks implemented barriers and restrictions to obtaining credit and this can force companies to maintain a conservative position.

The amount of investment is not associated with the financial position of the companies or the size of their assets; in addition, their net cash flow from operating activities is related to assets or investment in a chaotic manner and the same happens to liquidity. Companies keep models based on past results along their history, but they are not in tune with their development. Inflation increases the value of their assets, but reduces the value of their money, and this leads to reduced investment, according to ancient models of survival. Companies create mechanisms to prevent the risk of inflation or the real interest rate, decreasing the power of purchasing and their uncertainty about inflation, reducing investment to avoid risk; this is reflected in the phase space plots, where companies show also significant long-term dependencies based on past investments, or investments made when they were smaller.

In addition, production could not increase when the money supply increases, but when conditions favor the use of an old strategy, in a conservative way. As net cash flow from operating activities comprises many different items, a balance must exist among them with a balanced increase when company growths; however, it brings about surprises in the result pattern, with a consistent return to the financial schemes of smaller companies. This link to previous investment states must be done, because companies change their investment models across time in economies with high financial risk.

However, this strategy does not prevent them from suffering the unpredictable effects of monetary policy, which act on the complex financial structure in all the companies. In this sense, the companies operate under the risk of small changes in investments or assets.

Liquidity follows the same line of returning to previous states. However, to have the working capital necessary to meet the short-term needs of larger companies, they should aim for more liquidity than is necessary for smaller ones. This is not happening however, and working capital in large companies tends to be the same as that in small companies. Although this does not reflect the entire company strategy, it provides some insights about it. Certainly, working capital, as a resource necessary for survival, deserves to be in accordance with the short-term obligations of the company. However, predicting the proper amount of working capital is not easy; small investment changes can radically disrupt the functionality of the working capital, as changes in total assets do. Again, companies return to previous states, breaking the ideal smooth and steady pace.

The effects of monetary policy on this complex structure are quite unpredictable, and it can provoke great turbulence in company activities, instead of stimulating them to accelerate or slow down in a smooth and coordinated manner.

4 Conclusion

In the problem formulation, it was stated that an expansive monetary policy could act promoting the affluence of money to companies creating more net cash flow from operating and investment activities and liquidity. Besides, it was proposed that all of this would be associated to the size of total assets.

Nevertheless, it was also stated that this would be false in case that increases in net cash flow from operating and investment activities and liquidity had not a pattern of linear-monotonic incremental path.

As was observed on several occasions, in the analysis of financial statements, the relationship between financial indicators does not follow a linear model with gradual increments in their financial situation, but it is subjected to the complex influence of monetary policy on the financial statements. The structure obtained in phase space plots of the relationship, among the financial statement items of total assets, investment and net cash flow from operating activities and liquidity, shows that the means by which monetary policy acts are highly unpredictable and, according to them, companies have to choose extremely conservative strategies to survive. This impedes them from developing a growth model of investment and operation that stands across time in tune with monetary policy.

According to this, growth in GDP must have its origin in the continuous reorganization of the economic sectors and not in the steady pace of the companies. Financial authorities should keep in mind the peculiar manner in which the performance of companies is related to their financial situation.

References:

[1] Juárez, F., & Contreras, F., *Liderazgo y Complejidad: Conceptualizaciones e Implicaciones para la Organización Actual*, EAE, Madrid. 2012.

[2] Richardson, K. A., Managing complex organizations: Complexity thinking and the science and art of management. *E:CO*, Vol. 10, No. 2, 2008, pp. 13-26.

[3] Sargut, G., & McGrath, R. G., Learning to live with complexity: How to make sense of the unpredictable and the undefinable in today's hyperconnected business world. *Harvard Business Review*, Vol. 1271, No. 9, 2011, pp. 69–76.

[4] Vasconcelos, F. C., & Ramirez, R., Complexity in business environments. *Journal of Business Research*, Vol. 64, 2011, pp. 236–241.

[5] Kemp, J., New methods and understanding in economic dynamics? An introductory guide to chaos and economics. *Economic*, Vol. 2, No. 1, 1997, pp. 1-26.

[6] Dooley, K. J., A complex adaptive systems model of organization change. *Nonlinear dynamics, psychicology and life science*, Vol. 1, No. 1, 1997, pp. 69–97.

[7] Juárez, F., Aplicando el lenguaje metafórico de la salud y la complejidad a la pobreza: Implicaciones para la investigación y el análisis de caso. *International Journal of Case Method Research & Application*, Vol. 23, No. 1, 2011, pp. 50-62.

[8] Alligood, K. T., Sauer, T. D., & Yorke, J. A., *Chaos: An Introduction to Dynamical Systems.* Springer-Verlag, New York. 1996.

[9] McKelvey, B., Avoiding complexity catastrophe in coevolutionary pockets: Strategies for rugged landscapes. *Organizational Science*, Vol. 10, No. 3, 1999, pp. 294–321.

[10] Brown, C. *Chaos and catastrophe theories, in: Quantitative applications in the social sciences*, (Vol. 107), M.S. Lewis-Beck, ed., Sage Publications, Thousand Oaks, CA. 1995.

[11] Juárez, F., Natural gas: Moving to chaos and complexity in financial statements, in S. B. Gupta (Ed.), *Natural Gas - Extraction to End Use*, InTech, Rijeka, pp. 287-304. 2012. Available from http://www.intechopen.com/books/natural-gas-extraction-to-end-use/natural-gas-moving-to-chaos-and-complexity-in-financial-statements

[12] Faggini, M., & Parziale, A., The failure of economic theory: Lessons from chaos theory. *Modern Economy*, Vol. 3, No. 1, 2012, pp. 1-10.

[13] Gangopadhyay, P., Rahman, M. A., & Elkanj, N., Quality Traps in Localized Competition. *Modern Applied Science*, Vol. 5, No. 5, 2011, pp. 3-9.

[14] Spronk, J., & Trinidad, J. E., Más de medio siglo en busca de una teoría sobre los mercados de capitales. *Estudios de Economía Aplicada*, Vol. 23, No. 1, 2005, pp. 29-44.

[15] Juárez, F., Applying the theory of chaos and a complex model of health to establish relations among financial indicators. *Procedia Computer Science*, Vol. 3, 2010a, pp. 982-986.

[16] Juárez, F., Caos y salud en el sector económico de la salud en Colombia. *International Journal of Psychological Research*, Vol. 3, No. 2, 2010b, pp. 29-33.

[17] Juárez, F., Chaos and complexity in financial statements, in S. Barnejee (Ed.), *Chaos and Complexity Theory for Management: Nonlinear Dynamics*, IGI Global, Hershey, PA, pp. 1-33. 2013.

[18] Bastos, J. A. Recurrence quantification analysis of financial markets, in S. Barnejee (Ed.), *Chaos and Complexity Theory for Management: Nonlinear Dynamics*, IGI Global, Hershey, PA, pp. 50-62. 2013.

[19] Sadek, A., Ahmed, E. M., & Ezzat, A., On dynamical behaviors and chaos control of the fractional-order financial system, in S. Barnejee (Ed.), *Chaos and Complexity Theory for Management: Nonlinear Dynamics*, IGI Global, Hershey, PA, pp. 34-49. 2013.

[20] Guhathakurta, K., Bhattacharya, S. N., Banerjee, S., & Bhattacharya, B., Nonlinear correlation of stock and commodity indices in emerging and developed market, in S. Barnejee (Ed.), *Chaos and Complexity Theory for Management: Nonlinear Dynamics*, IGI Global, Hershey, PA, pp. 63-82. 2013.

[21] Dekker, S. W. A. Drifting into failure: Complexity theory and the management of risk. in S. Barnejee (Ed.), *Chaos and Complexity Theory for Management: Nonlinear Dynamics*, IGI Global, Hershey, PA, pp. 241-253. 2013.

[22] Cole, S. Managing chaos in nonlinear economic systems: Globalization and destination tourism, in S. Barnejee (Ed.), *Chaos and Complexity Theory for Management:*

Nonlinear Dynamics, IGI Global, Hershey, PA, pp. 297-314. 2013.

[23] Smullyan, R. M., Logicians who reason about themselves, in J.Y. Halpern (Ed.), *Proceedings of the 1986 Conference on Theoretical Aspects of Reasoning about Knowledge*, Morgan Kaufmann Publishers, San Francisco, CA, pp. 341-352. 1986.

[24] Bullard, J., & Butler, A. Nonlinearity and chaos in economic models: Implications for policy decisions. *Economic Journal*, Vol. 103, 1993. pp. 849-867.

[25] Hyland P, Kennedy J, Mellor R (2004). Company Size and the Adoption of Manufacturing Technology. New Business Ideas & Trends, Vol. 2, No. 1, 2004, pp. 66-74.

[26] Gomes CM, Kruglianskas I, Scherer FL. Company Size Effect in Innovative Performance. Journal of Technology, Management & Innovation, Vol.4, No. 4, 2009, pp. 13-31.

[27] Kirtis AK, Karahan F. Differentiated marketing policies in terms of company size and sector during global recession. Journal of Global Strategic Management, Vol. 8, 2010, pp. 103-112.

[28] An Y, Davey H, Eggleton IRC. The Effects of Industry Type, Company Size and Performance on Chinese Companies' IC Disclosure: A Research Note, Australas. Account. Bus. Financ. J., Vol. 5, No. 3, 2011, 107-116.

[29] Dozier K, Chang D. The effect of company size on the productivity impact of information technology investments. Journal of Information Technology Theory and Applications (JITTA), Vol. 8, No. 1, 2006, pp. 33-47.

[30] Hanias, M. P., & Magafas, L., DemoscopoPhysics: A new and interdisciplinary research field, in S. Barnejee (Ed.), *Chaos and Complexity Theory for Management: Nonlinear Dynamics*, IGI Global, Hershey, PA, pp. 315-33. 2013.

[31] Guhathakurta, K., Banerjee, S., & Dan, P. K., Nonlinear dynamics of voltage fluctuation in power plants for strategic decisions, in S. Barnejee (Ed.), *Chaos and Complexity Theory for Management: Nonlinear Dynamics*, IGI Global, Hershey, PA, pp. 352-367. 2013.

[32] Ministerio de Comercio, Industria y Turismo. *Informe Económico 4 de 2010. Coyuntura Económica de Colombia*. Ministerio de Comercio, Industria y Turismo, Bogotá. 2010.