# FLUID VISCOSITY AND ANALOGIES IN ECONOMY

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#### Abstract

Viscosity is a phenomenon that is analyzed in Physics and can be identified in the economy as well, for example, in the case of distribution companies' activities. We consider that it can be highlighted particularly by the difficulty a new firm is facing when entering the market if the change in the number of active trading companies in the market is considered in relation to their sales amount. Furthermore, an economic phenomenon analogue of viscosity in Physics can be identified when considering the period of time during which money returns to the market according to the money-goods-money circuit.

Concretely, if by 2009, the business environment in Romania was fairly stable with steady increases in business figures, in the years 2009 and 2010 respectively it was severely affected by the economic crisis, as the real estate blockage led to an ending of new construction projects, as well as to a freeze of those being in different stages of construction. Starting with 2010, the price of building materials dropped at times steadily but relatively sharply other times, in this way affecting the activity of manufacturers, importers and distributors in the field. The effect is directly revealed by sales revenues as compared to those registered in previous periods. After the crisis, the major cause of weak sales is the price of promoting and selling the products.

The analysis refers to the trading companies specialized in the field of metallic materials for construction and light, medium and heavy metal fabrications active in Romania between 2005 and 2016. The products belonging to this commercial area with direct implications on the construction and real estate market in general are wire and wire mesh for reinforcement, longitudinally welded or laminated, rectangular or round pipes, profile type angles, tees, strip, strips and sheets in different shapes and sizes, black or thermally galvanized against corrosion.

As regards the price of metallic building products during the analyzed period, this is characterized by instability: an fairly large price increase period starting in 2005 was followed by a general decrease in the year 2010; in the period 2014-2015 prices were unstable with fluctuations of small intensities, whereas 2016 was characterized by a linear rise in price.

Both the changes in the number of operators on the market and the price changes during the analyzed period allow for an analogy between phenomena defined as viscosity in physics and a firm's difficulty to penetrate the market on the one hand, and the money-goods-money circuit on the other hand.

**Keywords:** viscosity, price, sales, variables, coefficients, regression, statistical tests

# JEL Classification: C01, L11, L61

## Introduction

Physics generally discusses viscosity in the case of fluids. Fluid viscosity is influenced to a certain extent by pressure, but mostly by temperature. Thus, at a low temperature the viscosity of the liquid is high and as the temperature rises, its viscosity diminishes. As a consequence, we can refer to its ability to flow more easily or its property to be more easily penetrated by other bodies, similar to certain processes in economy. Following this perspective, the present research aims to analyze the extent to which an emergent trading company can become part of a specific market according to the activities it carries out, taking into account the factors that characterize the respective business environment.

Generally speaking, the factors that characterize a business environment are sales in the field, promotion and sales prices of products or services, the quality of the products and services provided, the geographical area in which the activities are performed, etc.

In this paper we propose to analyze the extent to which a start-up building materials distribution company was able to enter the Romanian market on the basis of 2005-2016 active trading companies sales amount and the promotion and sale prices of marketed products.

Similar to the physical phenomenon according to which a liquid's ability to flow faster or more easily, depending on the increase or decrease in temperature, which leads to a lower or higher level of viscosity, we aim to analyze the extent to which the money-commodity-money circuit is influenced by metallurgical products promotion and sale price variation during the mentioned period.

#### Literature review

Gheorghiu, A. (2007) classifies different economic models and uses a range of physical models to analyze economic phenomena. Gheorghiu, A., Spanulescu, I. (2007) have studied aspects relating to the application of Physics and Mathematics in economic theories. Gligor, M., Ignat, M. (2003) analyzed the applications of theoretical Physics in macroeconomic modelling. Bulinski, M. (2007) addresses the field of Economics. Pecican E. S. (2005)

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addresses the regression models (multifactorial or linear one-factor), the significance and insignificance of dependence between variables. Isaic-Maniu A., Mitruț C., Voineagu V. (2004) analyze indexes and calculate them as a ratio of two averages, indexes of value, physical volume and prices. With regard to applications of viscozity to the study of economic phenomena, several studies can be mentioned. For example, Radner R. (2003) analyzes the setting of strategic prices for a service in relation to the viscosity of demand, and Giorgio Fabbri (2007) addresses optimal control problems and viscosity solutions.

### Research methodology, data, results and discussions

Relationships of dependence in the economy were quantified through the elaboration of several theories and methods, among which we refer to the calculation of relative quantities, elasticity, multiplier theory, connection theory (direct, inverse), statistical regression.

In order to quantify the distribution companies' sales volume effect on the resistance of a smaller or larger number of active firms on the market, as well as on the possibility of a new trading company to penetrate the market, a model often met in Econometrics is to be used, namely, the regression method. The results of the regression analysis are statistically verified (F-test, t test, etc.) to assess the significance of the influence the effect changing has as response to modification of the cause.

With a view to analyze the extent to which firms other than the existing ones may enter the profile market in relation to the existing ones' sales, we will use the linear regression model - the one-factor case.

The linear regression model - the one-factor case

$$y_t = a_0 + a_1 * x_t$$
where  $y_t, x_t = \text{factors}$ 
 $a_0, a_1 = \text{regression parameters}$ 
[1]

 $u_t = residual value$ 

We will take into account the number of active firms in the field, noted with Y, and the revenue obtained by these firms, noted with X, according to Table 1.

Multifactorial linear regression model in this case will be as follows:  $Y = C_1 + C_2 * X$  [2]

For the analysis, the annual revenues from receipts in the period from 2005 to 2016 were taken into account for seventeen trading companies in the aforementioned field that were active in the period under review.

The data obtained are quantified in Table 1.

Dependent Variable: Y Method: Least Squares Included observations: 17

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.350840	0.659999	14.16797	0.0000
X	6.91E-09	3.43E-09	2.011701	0.0626
R-squared	0.212472	Mean dependent var		10.05882
Adjusted R-squared	0.159970	S.D. dependent var		2.511737
S.E. of regression	2.302086	Akaike info criterion		4.615640
Sum squared resid	79.49401	Schwarz criterion		4.713665
Log likelihood	-37.23294	F-statistic	)	4.046939
Durbin-Watson stat	1.556458	Prob(F-statistic		0.062573

Data source: http://www.mfinante.ro/infocodfiscal.html

According to the results in the table, F-statistic is 4.04 and is higher than F tabelat = 3.63, which validates the model used.

Regarding the t-statistic for X, it records the value of 2.01, which is higher than the matched = 1.74. Also, the probability of error in the t-statistical test is 6.26%, which validates the model.

The positive sign of the coefficients indicates a direct relationship between the number of active companies in the analyzed period and the receipts recorded by them, which is confirmed by the economic theory.

In other words, the higher the receipts, the more permissive the market and the larger the number of companies active in that field of activity, and vice versa: the lower the sales, the higher the viscosity and the smaller the number of active companies. Similarly, in Physics, a liquid whose temperature rises becomes less viscous and, implicitly, more permissive, and during cooling becomes more viscous. Thus, its penetration by other external bodies becomes more difficult.

Taking into account the low value of R-squared of 0.21, we consider that there are other factors that influence the market. Therefore, the analysis will be resumed by introducing in the calculation the average sales price of the products.

The linear regression model - the multifactorial case  

$$y_t = a_0 + a_1 * x_t + \dots + a_k * x_{kt} + u_t$$
 [3]  
where  $y_t, x_t, \dots, x_{kt}$  = factors  
 $a_0, a_1, \dots, a_k$  = regression parameters

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Table 1

 $u_t$  = residual value In Table 2, Y symbolizes the number of active firms in the field; X, the income they earned; and P, the price of the products applied by these companies.

The linear multifactor regression model in the analyzed case will be as follows:

$$Y = C_1 + C_2 * X + C_3 * P$$
 [4]

All throughout the analysis, the original data matching the previously mentioned seventeen trading companies were used, plus the prices charged by each company between 2005 and 2016.

The data obtained are quantified in Table 2.

Table 2

Dependent Variable: Y Method: Least Squares Included observations: 17

Variable	Coefficient	Std. Error	t-Statistic	Prob.
С	-6.424134	3.820398	-1.681535	0.1148
Х	4.89E-09	2.43E-09	2.015397	0.0635
Р	0.023369	0.005619	4.158995	0.0010
R-squared Adjusted R-squared S.E. of regression Sum squared resid Log likelihood Durbin-Watson stat	0.647720 0.597394 1.593728 35.55956 -30.39492 1.488866	Mean dependent var S.D. dependent var Akaike info criterion Schwarz criterion F-statistic Prob(F-statistic)		10.05882 2.511737 3.928814 4.075852 12.87056 0.000673

Data source: http://www.mfinante.ro/infocodfiscal.html

In this case, we can say that prices have a major influence on the evolution of trading companies analyzed on the profile market confirmed by R-squared, which has values closer to the unit value than to zero.

As far as the F-statistic value is concerned, this time it is 12.87, higher than in the unifactorial case.

We find that the t-statistical test for X records the value of 2.01, which is higher than the ttabled = 1.75 and the t-statistic for P records the value of 4.15, being also higher than the tabulated. The probability of error in the t-statistical test is 6.35% for X, and 0.10% for P which validates the model.

Additionally, a direct relationship between prices and sales can be observed, an expected phenomenon, given the "viscosity" of the business environment. Wherever there are large sales, prices high enough to allow for generous margins which enhance commercial companies development, which can be defined as a "warm" business environment (which involves low viscosity and high fluidity), it is easier for a new firm to penetrate and develop, as opposed to the situation which can be characterized as an "ice" area (with a high viscosity and low fluidity) where everything tends to stop.

As follows, the present research focuses on a different aspect resulting from price changes, namely, the correlation of the average selling price of products with the period it takes for money to return to the circuit. Thus, for a product purchased in a given period, depending on the promotion and sales price, there are fewer or more days of retention until the amount including the margin for that product is collected.

The model used will be the one-factor linear regression.

Thus, we will note the number of days of return of money in the commercial circuit with D and the promotion and sale price with P. The analysis was made on the basis of the semestrial data for the period 2005 - 2016 and, therefore has 24 semesters.

The linear model of one-factor regression in the analyzed case will be as follows:

$\mathbf{D} = \mathbf{C}_1 + \mathbf{C}_2 * \mathbf{P}$	[5]
The data obtained are quantified in Table 3.	

The data obtained are quantified in Table 3:

Table 3

Variable Coefficient Std. Error t-Statistic Prob. C P -6.528678 0.0010 1.715064 -3.806668 0.031156 0.002496 12.48390 0.0000 0.876299 R-squared Mean dependent var 14.58333 Adjusted R-squared S.D. dependent var 3.888854 0.870676 S.E. of regression Akaike info criterion 1.398497 3.588328 Sum squared resid 43.02745 Schwarz criterion 3.686499 Log likelihood -41.05994 F-statistic 155.8477 Durbin-Watson stat 1.269789 Prob(F-statistic) 0.000000

Dependent Variable:D Method: Least Squares Included observations: 24

According to the results in Table 3, F-statistic has a much higher value than Ftabled, which validates the model used.

Regarding the t-statistic for P, it records the value of 12.48 and the probability of the error in the t-statistical test is almost zero, which validates the model.

At the same time R-squared records the value of 0.87 close to the unit.

When a period of product price increases occurs, the unit of time for the money invested in commodities to return increases. As prices fall, money returns faster in the money-goods-money circuit. Similar to the physical phenomenon of viscosity, rising prices imply "fluid cooling", in the sense that it somewhat amplifies the difficulty of immediate payment of purchases, which would be similar to increased viscosity. As "liquid heats up", which corresponds to cheapening products, it facilitates the possibility of immediate payment, which would be similar to a low viscosity.

#### Conclusions

According to the physical phenomenon when the decrease in liquids' viscosity takes place along with the increase in their temperature, entailing higher permissiveness to their penetration by other bodies, in economy the decrease in viscosity is due to sales increase, which allowes the entry of the new businesses, making the business environment more permissive by facillitating continuity and development.

In Physics, the increase in the temperature of the bodies regardless of their state of aggregation (gaseous, liquid or solid) leads to their expansion, namely to an increase in volume. Similarly, in economy, the less "viscous" a market is, namely the more business-friendly the business environment is, the more companies are developing, are growing in terms of business figures (increases in company volumes), facilitating the emergence of new firms with development potential.

As for the money-goods-money circuit, the phenomenon is similar, namely, rising prices lead to increases in the time it takes for the money spent on merchandise to return, and vice versa.

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