ELASTICITY AND SENSITIVITY. MODELS AND APPLICATIONS IN ECONOMY

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Abstract

The Romanian building materials market has faced uncertain times regarding the product promotion and sale price over the years. There were periods of continuous price decline, for example the uncertainty period that preceded the 2009-2010 economic crisis, a time when the real estate blockage led to new construction cessation as well as to the freeze on those being in different stages of construction. Starting with 2010, the price of construction materials has fallen at times steadily but relatively sharply other times in this way affecting the activity of manufacturers, importers and distributors in the field.

In the present article we are considering the increase in workload for the same amount of goods distributed to the end-user; the increase in workforce needs; the logistical expense rise; and last but not least profitability decrease. Such evolutions on the market have major implications on businesses concerning the need for internal reorganization and investment in technology to optimize current activities in order to align with the new requirements imposed by lower prices.

In the analysis that follows we refer to 2013 - 2016 time span. In the years 2010 - 2011 there was a slight drop in prices of 4% followed by a delicate period between 2013 and 2014, when a dramatic decrease of 22.7% affected the economic activity in the field.

The following oscillating 2014-2015 when the price began to rise and fall in the context of low economic activity directly influencing decision taking processes which became increasingly difficult for local entrepreneurs. The upward trend in prices began in 2015 - 2016 with an average increase of 4.67%.

This upward trend continued between 2016 and 2017 with an average increase of 23.73% and is still maintaining course at present according to data from the market.

In the present research I aim to analyze whether or not the demand for products was sensitive to price variation between 2013 and 2016.

As for the price of metallurgical products in construction, the analyzed interval is characterized by instability: a price decrease was follwed by slight fluctuations ending up with a steady rise period.

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 2013 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.

The present research findings highlight the fact the existence of a high degree of sensitivity in demand related to price change. The level of elasticity is maintained over time. Thus, as a result of the analysis, a -2.29 average was determined over the mentioned three-year period.

Keywords: elasticity, sensitivity, price, sales, quantity of goods, forecast

JEL Classification: C01, L11, L61

Introduction

In Physics, elasticity is a concept used to describe the property that the body possesses to come back to the initial form that the action of an external force has altered, as soon as the latter ceases its action. (Brenneke R., Schuster G. 1973)

The American economist A. Marshall (1890) took over the term *elasticity* from the language of Physics, changing its meaning. Thus, in economic studies, the elasticity coefficient provides a way to measure variance in demand in relation to price variation. The meanings of Physics and Economics have nothing in common but for, perhaps, the initial reaction of the variable as an effect of a changing in the factor.

Badouin Robert's example is suggestive: in Physics, we state that a rubber ball is elastic when it undergoes a deformation process due to the pressure exerted on it, as compared to a clay ball, for instance, as the rubber ball resume its initial form as soon as the pressure ceases.

We note that in Physics, the concept of *sensitivity* is closer to what economists define through this term. Thus, a balance is said to be perfectly elastic if it returns to the initial position as soon as the force that temporarily acted on it is suppressed. The balance is said to be sensitive when reacting to the slightest influence exerted on it.

However, in Economics, the two concepts (*elasticity* and *sensitivity*) exist without identification.

With concern to price, A. Marshall formulated the famous law of demand "there is a unique and universal law of demand, that it increases when

the price drops and falls when the price rises". But the relation between these two changes is not uniform if we refer to successive periods of time. The difference between the change extent over different time periods and in the case of different products would be due to the change in factors not taken into account as well as to the change in marginal utility. In this way, Marshall's law establishes a connection between the decrease in marginal utility (explained by psychological analysis of the individual) and elasticity (based on market data on the evolution of consumer demand).

If in Physics elasticity is a concept used to describe the bodies' property to resume its original shape as soon as external forces cease their action, in Economics elasticity measures the degree of a variable's variation in relation to the percentage variation of another variable.

Estimates of elasticity are usually made for very small variations of variables from which we can discuss about sensitivity. For example, we can discuss about the sensitivity of a demanded quantity of a product in relation to the change in price of another product.

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 modeling. Bulinski, M. (2007) addresses the field of economics. Isaic-Maniu A., Mitrut C., Voineagu V. (2004) analyzes indexes and calculates them as a ratio of two mediums, idioms of value, physical volume and prices.

Research methodology, data, results and discussions

The elasticity of demand to price is the sensitivity of variance in the demanded quantity of a certain product, in relation to its price, and is expressed by the relation:

$$E_{cp} = \frac{\frac{\Delta Q_i}{Q_j} \cdot 100}{\frac{\Delta P_i}{P_j} \cdot 100} = \frac{\Delta Q_i}{Q_j} \cdot \frac{P_j}{\Delta P_i} \qquad [1]$$

where: Δ = variation;

P_i si Q_i = the price and quantity of the good i;

In the case of a small Δ we refer to a punctual elasticity of demand, whereas a high Δ, will suppose a sensitivity of the demand response to the respective change in price, which is known as the *spring elasticity of the demand*.

The elasticity of demand to income is an indicator of sensitivity of a product demanded quantity in the context of a change in demanding consumers' income:

$$E_{cv} = \frac{\frac{\Delta Q_i}{Q_i}}{\frac{\Delta Y}{Y}} = \frac{\Delta Q_i \cdot Y}{\Delta Y \cdot Q_i} \quad [2]$$

where: E = elasticity;
Q_i = demanded quantity of product i;
Y = income.

Elaticity of input substitution signals the degree of sensitivity experienced by the optimum combination between the inputs labour force and capital in the context of their price variation:

$$E_s = \frac{variatia\ procentuala\ a\ \frac{K}{L}}{variatia\ procentuala\ a\ \frac{P_L}{P_K}} \quad [3]$$

where: $\frac{K}{L}$ = the optimum ratio between capital and workforce;

P_L = labour force price;
P_K = capital price.

If the two factors are used in equal proportions, then the elasticity of substitution is zero. In such cases when the elasticity of substitution is higher than zero, it means that the ratio capital-workforce responds to changes in relative prices of input factors.

As follows, we aim to analyze the elasticity of demand to price changes that occurred between 2013 and 2016 within the trading companies in the field of metallic materials for building and light, medium and heavy metal fabrications active in Romania at the time.

The analysis starts from the relationship:

$$E_{cp} = \frac{Q_{t+1} - Q_t}{Q_t} \cdot \frac{P_t}{P_{t+1} - P_t} \quad [4]$$

where
Q = sales amount of metallurgical products

Since sales in the *t + 1* period are influenced by price increases or decreases, we believe that a higher accuracy in describing the demand sensitivity to price changes would result from deflated sales from *t + 1* as compared to *t*.

Therefore, for deflation we will use the relationship:

$$Q_{t+1\ D} = \frac{Q_{t+1}}{i_{(t+1)/t}} \quad [5]$$

where:

the deflation index is $i_{(t+1)/t} = \frac{P_{t+1}}{P_t}$

p_{t+1} stands for the modified price according to the evolution of the market compared to the previous price p_t.

Deflationate sales taken into account in determining the elasticity will be noted in the table as „ 2014 D Sales" , „ 2015 D Sales" and „ 2016 D Sales" respectively.

The data on prices, their change and the calculation of elasticity are centralized in the tables below (Table 1 for 2013-2014, Table 2 for 2014-2015 and Table 3 for 2015-2016).

Analysis of elasticity during the period 2013-2014

This period is characterized by an overall drop in prices by 22.7% in the mentioned market in 2014 as compared to 2013. The reporting has taken into account the average sales price registered in 2014 compared to the average sales price in 2013 practiced by the analyzed companies.

Table 1

	Sales 2013	Sales 2014	Sales 2014 D	Price 2013	Price 2014	Deflation index	Elasticity
1	5415226	5678326	6841356	682	565	0,83	-1,53
2	74111812	78251395	95428530	609	500	0,82	-1,61
3	213477413	228158884	271617719	682	570	0,84	-1,66
4	115311256	139866950	172675246	603	491	0,81	-2,68
5	76066257	98365630	124513455	670	530	0,79	-3,05
6	182379644	201936427	249304230	627	510	0,81	-1,97
7	166689462	193823809	239288653	629	508	0,81	-2,26

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

Analyzing the 2013-3014 data registered in the context of sales prices decline, we find that in all companies increases in sales occured which, as a consequence, indicates a rise in the quantitative turnover and the volume of work.

The calculation of the elasticity coefficient led to absolute values greater than one, which indicates that sales are elastic to price in the case of all the analyzed companies.

The negative sign is the expected one given the reverse relationship between prices and sales.

A much higher sensitivity of demand to price variation is registered

for the companies 4, 5 and 7 during the mentioned period, cases in which the coeficient of elasticity reaches the value of -3.05.

Elasticity average for the analyzed companies in this period is -2.11, which confirms a general high sensitivity of demand to changes in prices.

Analysis of elasticity during the period 2014-2015:

The downward trend in prices continued during this period, when an overall price decline by 11.25% was experienced in the case of the mentioned companies in 2015 as compared to 2014. The percentage was calculated as a ratio of average prices among the two years.

The year 2015 was marked by low-intensity oscillations with increases and decreases in price by around 2%, which directly influenced the decisions of the managers in terms of acquisitions and implicitly influenced sales. At the same time, the end user was affected by these fluctuations, and more than often the projects were postponed and even carried forward the next year.

Table 2

	Sales 2014	Sales 2015	Sales 2015 D	Price 2014	Price 2015	Deflation index	Elasticity
1	5678326	6711220	7216365	565	524	0,93	-3,73
2	78251395	93158145	103509050	500	452	0,90	-3,36
3	228158884	204649507	235229318	570	498	0,87	-0,25
4	139866950	155782886	175036950	491	439	0,89	-2,37
5	98365630	104822820	117778449	530	470	0,89	-1,74
6	201936427	193187951	214653278	510	457	0,90	-0,61
7	193823809	194839532	214109375	508	460	0,91	-0,53

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

During this time all coefficients of elasticity also have the minus sign.

Unlike the previous period, we have three societies out of seven where the coefficients of elasticity are subunitary. These cases are registered in companies with very high turnover figures exceeding 200,000,000 lei, companies heavily affected by the price fluctuations in 2015:

- Company 3 during the period 2014-2015 $E = - 0,25$
- Company 3 during the period 2014-2015 $E = - 0,61$
- Company 3 during the period 2014-2015 $E = - 0,53$

For the companies analyzed during this period, the maximum value of the coefficient of elasticity is -3.73 and the average elasticity is -1.80, which also confirms a high general sensitivity of the demand to price variation.

Analysis of elasticity during the period 2015-2016:

This period is characterized by a change in the trend of prices, with successive increases, amounting to 4.67% over the entire period. This positive price evolution accelerated the purchases of goods and their storage with the purpose of selling with elevated margins compared to the previous period, even if the end user's demand decreased and the financial result at the end of the year was the expected one, namely the sales decrease originated in the increase in prices.

During this time, companies faced workforce and capital shortages, being forced to take administrative decisions depending on capital and yield, in order to avoid such situations as the need to diminish stocks to offset price rises. Roughly speaking, decline in stocks entails additional costs in terms of current business activity, thus leading the company to decline.

Table 3

	Sales 2015	Sales 2016	Sales 2016 D	Price 2015	Price 2016	Deflation index	Elasticity
1	6711220	7087111	6623468	524	560	1,07	-0,19
2	93158145	87449415	84085975	452	471	1,04	-2,32
3	204649507	178183553	174689757	498	509	1,02	-6,63
4	155782886	152507879	142530728	439	462	1,07	-1,14
5	104822820	89883000	86425961	470	490	1,04	-4,12
6	193187951	179931955	173011495	457	475	1,04	-2,65
7	194839532	170375048	163822161	460	480	1,04	-3,66

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

During the analyzed period, sales are broadly elastic to price variation, with the exception of company 1, in whose case E = - 0.19.

The respective company was the most affected having recorded the lowest sales amount among the group of companies analyzed, with a turnover of 7,087,111 lei at the end of 2016. Furthermore, the rise in prices ocurring in the period 2015-2016 in conjunction with the lack of capital for investment, absolutely necessary in the respective background, limited sales.

Close to the limit is the company on row 4 (Table 3), in 2015-2016 E = - 1,14. The rest of the companies recorded coefficients much higher than the unit value, indicating a high overall elasticity of sales to price changes.

For the companies analyzed during this period the maximum value of the coefficient of elasticity is -6,63 and the average elasticity is -2,96 which indicates the highest general sensitivity of demand to price change, in the bcontext of price increases.

For 2015 and 2016, the companies financial data being available, forecast was calculated.

If the coefficient of elasticity between *t* and *t + 1* periods is obtained, considering that its level maintais in the *t + 2* period as well, the forecast results as follows:

$$Q_{t+2} = \text{Ecp} \cdot \frac{P_{t+2}-P_{t+1}}{P_{t+1}} \cdot Q_{t+1\,D} + Q_{t+1\,D} \quad [6]$$

In order to keep the data accurate, taking into account the „Inflation Index" became necessary, $i_{(t+2)/(t+1)} = \frac{P_{t+2}}{P_{t+1}}$, so as to express the predicted data (sales) in terms of prices in the forecast year.

Forecast for the year 2015:

Table 4

	Sales 2014 D	Price 2014	Elasticity	Price 2015	Inflation index	Forecast	Real 2015
1	6841356	565	-1,53	524	0,77	7135070	6711220
2	95428530	500	-1,61	452	0,74	99927272	93158145
3	271617719	570	-1,66	498	0,73	287082883	204649507
4	172675246	491	-2,68	439	0,73	217931509	155782886
5	124513455	530	-3,05	470	0,70	166513515	104822820
6	249304230	510	-1,97	457	0,73	279199664	193187951
7	239288653	508	-2,26	460	0,73	280749958	194839532

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

Analyzing data obtained for the period 2015 found that for companies located in Table 4 on lines 1 and 2 resulted deviations 6.32% and 7.24% of projected sales, sales relative to actual 2015, according to data taken from Ministry of Finance. For these companies, we can say that the forecast is fairly accurate as it records an error of less than 10%.

For the other companies, errors are relatively high, which signals the existence of other factors specific to companies with high turnover.

Forecast for the year 2016:

Table 5

	Sales 2015 D	Price 2015	Elasticity	Price 2016	Inflation index	Forecast	Real 2016
1	7216365	524	-3,73	560	0,99	7380023	7087111
2	103509050	452	-3,36	471	0,94	116260040	87449415
3	235229318	498	-0,25	509	0,89	214955233	178183553
4	175036950	439	-2,37	462	0,94	187566244	152507879
5	117778449	470	-1,74	490	0,92	119491921	89883000
6	214653278	457	-0,61	475	0,93	207984505	179931955
7	214109375	460	-0,53	480	0,95	209345862	170375048

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

The elasticity calculated for the period 2014-2015 led to the forecasts presented in the penultimate column of Table 5. An error margin lower than 10% is the case for the company on the 1st row. For the remaining six companies we consider that the intervention of other factors, specific to big companies, led to relatively large deviations.

Conclusions

Physics has been a source of inspiration for economists throughout the last few centuries, and recent developments revealed the opportunity for new approaches in economics. Regarding the formal part of physics, namely, the search for constant values (coefficients), the attempt to describe phenomena researched through equations, including the development of models, represents a research direction in economics as well. Taking into consideration the particularities of each field, certain concepts and laws specific to physics were taken over by economists with a view to rigorously analyse economic processes.

In the case of trade with metallic materials for building and metal fabrications in 2013-2016 Romania, until 2015 most companies in the field registered sales increases againsta background of price depressions. However, it can be noticed that in 2016 (Table 3), when prices started to go up, the upward trend in sales has changed in the case of almost all analyzed companies.

As regards the knowledge items based on the coefficients of elasticity related to sales evolutions depending on the change in building materials prices for the seven representative companies on the Romanian market, the research indicates a high degree of sensitivity in each of the analysed periods. The average sensitivity for the first period is -2.11 (Table 1), for the second one, -1.80 (Table 2), and in the third one -2.96 (Table 3). Thus, the resulting general average for the three analyzed years is -2.29, well above the -1 threshold, which suggests a high overall sales sensitivity to price variation.

The lowest average coefficient of elasticity, namely -1,80 (Table 2), was recorded in the period 2014-2015, a time span directly influenced by the slight price oscillations in 2015. The maximum average coefficients, of -2,96 (Table 3), was determined for the period 2015-2016, due to the increase in prices.

Regarding the elasticity forecast (Table 4 and Table 5), it is particularly relevant for small firms. For large firms (lines 3-7, Tables 4 and 5), we consider that the particular intervention of administrative factors led to a general overvaluation of the forecasts.

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