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Estimating Production Uncertainty in the European Beer Industry using a Statistical Model

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ABSTRACT*. The uncertainty in the results of the investment evaluation creates conditions of risk in decision-making in the management of industrial units. The article estimates the uncertainty of production in the European Brewery industry using a statistical model.*
KEY WORDS*: investment, beverage industry, risk, uncertainty, investment evaluation, statistical methods*

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I. INTRODUCTION AND LITERATURE REVIEW

The purpose of this work is to highlight and evaluate - through a mathematical model - the effect of factors such as the production of the product, the per capita demand of the product, the revenue from direct consumption taxation, the number of industrial units of the product produced, the number of directly employed in the industrial sector in the uncertainty of the production of products in the industrial sector of beverages and in particular of brewing.

II. LITERATURE REVIEW

At the level of manufacturing firms, Price (1995) surveys some firms in the British manufacturing industry and examines the relationship between uncertainty, capacity, and investment. The uncertainty is measured by the variation of the GDP using a GARCH model, controlling for the effect of cumulative uncertainty on investments. Also, Price (1996), examining the same industry, investigates the long-run relationship between uncertainty and investment. Uncertainty is measured as the conditional variance of manufacturing output using a GARCH (1,1) model. The conclusions reached by Price in both studies show the negative effect of uncertainty on investments. Using an innovative measure of firm-level cash flow uncertainty, Bhagat and Obreja (2013) empirically show that uncertainty has a strong negative impact on firm employment and investment in both tangible and intangible assets. Toro-Gonzalez et al (2014) use models to estimate fluctuations in beer consumption, such as the Almost Ideal Demand System. Esposti et al (2017) examine the effect of local factors on industry activity with a sample of 866 firms. Liu et al (2017) present an improved quantitative risk assessment model to help risk managers identify direct relationships between specific risk events and investor decision variables.

III. RESEARCH METHODOLOGY

The main factors that influence a company's decision to make or not an investment is the following: the expected demand and price of the product to be produced, the amount of wages and raw materials that will shape the cost of producing the product, the change of production technology, the tax policy for profits (Lianos & Benos, 2013, Mankiw, 2002). The determination of the relationship of production with uncertainty is approached by a Multiple Linear Regression model with the method of least squares. The model is described by the relation:

$$UNCERTAINTY_i = b_0 + b_1 * PRODUCT_i + b_2 * CONSUM\_PER\_CAPITA_i + b_3 * NUM\_BREWERIES_i + b_4 * DIRECT\_EMPLOYMENT_i + b_5 * EXCISE\_DUTY\_REVENUES_i + \varepsilon_i \qquad i = 1, \ldots, 31 \tag{1}$$

where:

UNCERTAINTY:	Uncertainty, expressed as the standard deviation of the mean annual production quantity of the product (in HL) over the period 2015-21 for each country
PRODUCT:	Average annual production quantity of the product (in HL) in the period 2015-21 for each country

CONSUM_PER_CAPITA: Average per capita consumption of the product (in lt) in the period 2015-21 for each country

NUM_BREWERIES: Average number of industrial beer units in the period 2015-21 for each country

DIRECT_EMPLOYMENT: Average number of people directly employed in the product's industrial sector in the period 2015-21 for each country

EXCISE_DUTY_REVENUES: Average revenue from direct taxation (in €1,000,000) of the industrial sector in the period 2015-21 for each country

ε_i: Residuals, a random variable that includes all the remaining factors that cannot be considered in the model

DATA ANALYSIS

Table 1: Linear Multiple Regression Data (UNCERTAINTY, PRODUCT, CONSUM_PER_CAPITA, NUM_BREWERIES, DIRECT_EMPLOYMENT, EXCISE_DUTY_REVENUES) 2015-2021

COUNTRY	UNCERTAINTY	PRODUCT (HL)	CONSUM_PER_CAPITA (lt)	NUM_BREWERIES	DIRECT_EMPLOYMENT	EXCISE_DUTY_REVENUES (million €)
AUSTRIA	163	9296	105	281	3775	191,16
BELGIUM	403	20214	70	302	5841	192
BULGARIA	246	4876	75	29	2207	93,19
CROATIAN	465	3067	80	58	1566	83,64
CYPRUS	33	359	54	4	601	15,13
CZECH REPUBLIC	733	20412	139	506	5775	176,33
DENMARK	136	6035	62	206	4229	100,49
ESTONIA	50	1346	81	38	900	57,58
FINLAND	136	3901	74	98	1686	631
FRANCE	687	21379	33	1606	6726	906,52
GERMANY	3622	91604	97	1492	27362	634,4
GREECE	211	3836	34	50	2043	167,93
HUNGARY	283	5976	67	67	1922	118,87
IRELAND	1458	7278	75	71	1215	403,47
ITALY	1184	15959	33	805	5410	676,71
LATVIA	43	786	78	47	1400	42,48
LITHUANIA	189	3060	90	74	2300	82,41
LUXEMBOURG	36	268	66	24	119	5,14
MALTA	18	165	49	2	500	3,56
NETHERLANDS	1062	23736	67	676	5310	426,74
POLAND	1103	40268	97	263	9614	797,95
PORTUGAL	229	6728	49	107	2240	81,87
ROMANIA	342	16300	84	63	5847	138,43
SLOVAKIA	113	3036	70	74	1475	57,6
SLOVENIA	253	1905	78	84	709	86,81
SPAIN	1657	37011	49	399	8383	338,15
SWEDEN	176	4389	54	332	4719	426,58
NORWAY	110	2371	53	126	1275	612,96
SWITZERLAND	113	3492	54	984	2929	102,19
TURKEY	99	9671	12	14	2340	13,9
UNITED KINGDOM	2862	38654	68	1864	15917	4056,16

IV. RESULTS

Based on the available data for the period 2015 - 2021, the application of OLS to the model shows a good fit (F-test value = 38.563, p–value < 0.000) and explains 86.2 % (R2adj = 0.862) of variability of UNCERTAINTY (Table 2)

Table 2: Table of statistic $R^2$and degrees of freedom

Model	R	R Square	Adjusted R Square	R Square	F	df1	df2	Sig. F
1	,941	,885	,862	,885	38,563	5	25	,000

All TOL index are less than 0.500 which means a relatively high correlation of each explanatory variable with all the others, except for the CONSUM_PER_CAPITA variable with TOL = 0.855. (Table 3). Also, the Φj Condition Index < 10 for most variables and Φj Condition Index < 18 for another one, therefore there is a limited problem of multicollinearity, which can be considered as not creating a problem of reliability of the results.

Table 3: Degree of independence between explanatory variables

Dimension	Eigenvalue	Condition Index Φ_j		Tolerance (TOL)	VIF
1	4,731	1,000			
2	,910	2,192	PRODUCT	,050	19,812
3	,494	2,976	CONSUM_PER_CAPITA	,855	1,169
4	,160	5,236	NUM_BREWERIES	,278	3,596
5	.050	9,334	DIRECT_EMPLOYMENT	,039	25,457
6	,014	17,728	EXCISE_DUTY_REVENUES	,441	2,279

Before presenting the model results, it is worth mentioning that the necessary homoskedasticity check was performed. The errors are distributed in such a way that the specific assumption is not violated, and they follow the normal distribution (Diagram 1) The variance of the residuals is constant, for small and for large values of the dependent variable UNCERTAINTY (Diagram 2), ensuring that the coefficients of the model are truly unbiased.

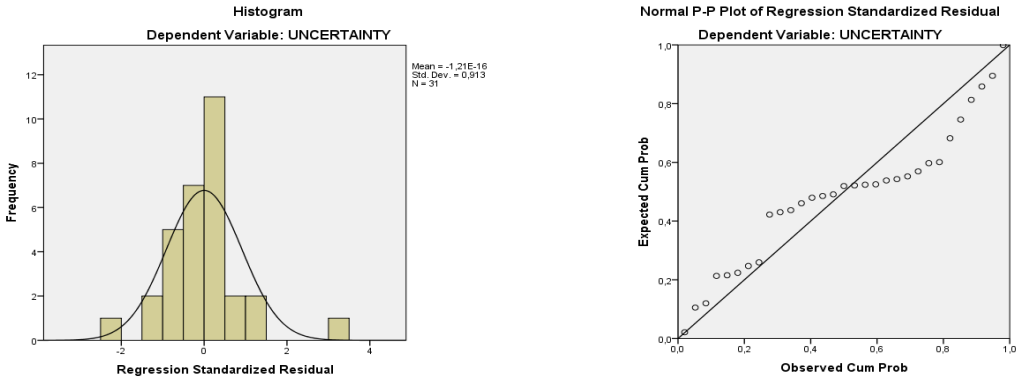

Diagram 1: Normal distribution of residuals

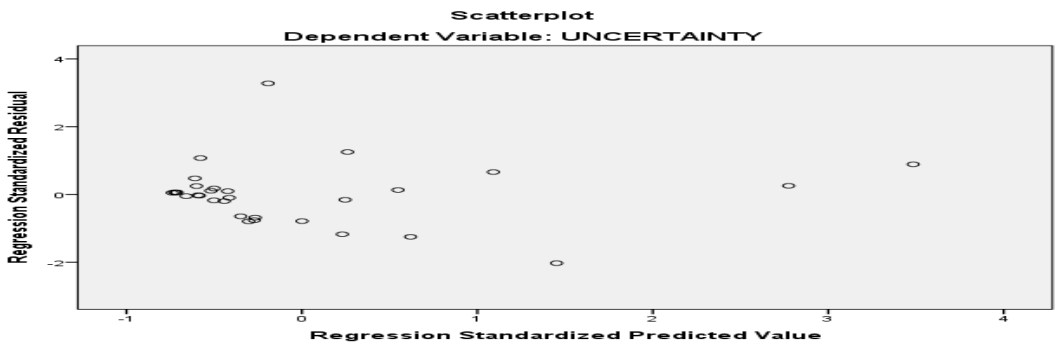

Diagram 2: Standardized residuals versus estimated values of the dependent variable

As can be seen from table 4, the factors PRODUCT and EXCISE_DUTY_REVENUES are statistically significant in terms of the interpretation of uncertainty (UNCERTAINTY) with p-value<0.05 while the factors CONSUM_PER_CAPITA, NUM_BREWERIES and DIRECT_EMPLOYMENT with p-value>0.05 do not influence the uncertainty (UNCERTAINTY). Ceteris paribus, an increase in the product produced (PRODUCT) and an increase in consumption tax revenues (EXCISE_DUTY_REVENUES) lead to an increase in uncertainty (UNCERTAINTY).

Table 4: Estimated coefficients of the model

		B	t	Sig	TOL	VIF
	(Constant)	1,890	,011	,992		
	PRODUCT	,041	3,010	,006	,050	19,812
	CONSUM_PER_CAPITA	,109	,043	,966	,855	1,169
	NUM_BREWERIES	,007	,033	,974	,278	3,596
	DIRECT_EMPLOYMENT	-,025	-,471	,641	,039	25,457
	EXCISE_DUTY_REVENUES	,387	3,295	,003	,441	2,279

Therefore, the model that describes the uncertainty is as follows:

$$UNCERTAINTY_i = 1{,}890 + 0{,}041 * PRODUCT_i + 0{,}109 * CONSUM\_PER\_CAPITA_i + 0{,}007 * NUM\_BREWERIES_i - 0{,}025 * DIRECT\_EMPLOYMENT_i + 0{,}387 * EXCISE\_DUTY\_REVENUES_i + \varepsilon_i \qquad i = 1, \ldots, 31$$

By removing the non-statistically significant variables, the model takes the following form:

$$\text{UNCERTAINTY}_i = 0{,}041 * \text{PRODUCT}_i + 0{,}387 * \text{EXCISE\_DUTY\_REVENUES}_i + \varepsilon_i \quad i = 1, \ldots, 31$$

V. CONCLUSIONS

Based on the above results for the interpretation of the model apply: An increase of 1 unit in the variable PRODUCT (production) leads to an increase in the variable UNCERTAINTY (uncertainty) by 0.041 units. Changes in the CONSUM_PER_CAPITA (per capita consumption), NUM_BREWERIES (number of industrial units) and DIRECT_EMPLOYMENT (direct employment) variables do not affect the UNCERTAINTY variable, as they are not statistically significant. An increase of 1 unit in the variable EXCISE_DUTY_REVENUES (consumption tax revenue), leads to an increase in UNCERTAINTY, which expresses Investments by 0.387 units. In conclusion, increasing trends in the factors of industrial beer production and consumption tax revenues lead to a small increase in uncertainty. The factors of directly employed in the industry, the number of industrial units and per capita consumption do not affect the uncertainty of production.

REFERENCES

[1] Bhagat, S. & Obreja, I. (2013). 'Employment, Corporate Investment and Cash Flow Uncertainty', Leeds School of Business University of Colorado at Boulder

[2] Esposti, R., Fastigi, M., Vigano, M., (2017). Italian craft beer revolution: do spatial factors matter? Journal of Small Business and Enterprise Development.

[3] European Beer Trends (Statistics Report/2022 Edition)

[4] Karnavas, C., (2024). 'Analysis of Determinants of Uncertainty in Production in the Brewing Industry: An Empirical Investigation', Aeichoros, (under edition)

[5] Lianos TH.P., Benos TH.E., (2013). Macroeconomic Theory and Practice. G' Edition. Athens: Ed. Benou, Ch. 1-2

[6] Liu, Jun Ying, Jin, Feng, Xie, Qunxia, & Skitmore, Martin, (2017). 'Improving risk assessment in financial feasibility of international engineering projects: A risk driver perspective', International Journal of Project Management, 35(2), pp. 204-211

[7] Mankiw, G., (2002). Macroeconomic Theory. Athens: Gutenberg. Chapters 1-2

[8] Price, S. (1995), "Aggregate uncertainty, capacity utilisation and manufacturing investment", Applied Economics. 27, pp. 147-154.

[9] Price, S. (1996). "Aggregate Uncertainty, Investment and Asymmetric Adjustment in the UK Manufacturing Sector", D.P. 441, Department of Economics, University of Essex.

[10] Toto-Gonzalez, D., McCluskey, J. J., Mittelhammer, R. C. (2014). Beer snobs do exist. Estimation of beer demand by type. Journal of agricultural and resource economics, 174-187