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Patterns and shifts in EU business numbers, size and performance in the manufacturing and energy sectors during 2007-2016

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Abstract

The article looks into the evolution of four business measures (number of enterprises, employment, productivity, profitability) observed annually in all 25 economic activities of the manufacturing and energy supply sectors, from 2007 to 2016, across the EU. It econometrically isolates the long-run trends and engages in subsectoral and spatial comparisons that provide potentially useful insights.

Keywords: *time trend, manufacturing & energy sectors, number of enterprises, employment, productivity & profitability*

JEL classification: *C23, J21, J24, L60, L94, M20*

1. Introduction

The article studies the evolution of four business measures across 25 secondary sector activities (see Table 1) in the 28 EU member-states (EU-28), from 2007 to 2016. That is, from the time of the international financial and economic crisis to the end of a long unemployment spell of over 8.5% in the EU-28. Thus, the article provides a broad, unified view of business life and performance that complements the individual sectoral and subsectoral analyses on such matters carried out in each member-state (e.g., O'Sullivan, 2000; Handrinos et al., 2005; Manolas, 2007; Zeli and Mariani, 2009; Anastassakou et al., 2011; Voulgaris et al., 2015; Koutroulis et al., 2018; the sources sited therein).

The four measures consist of: (a) the number of enterprises (N); (b) the number of persons employed (L); (c) the average value added per person employed, to capture labor productivity (Q/L); and (d) the ratio of gross operating surplus over turnover, as a proxy of profitability (Π), all of which jointly sketch the sectoral structure, competitiveness and performance features of businesses. These are analyzed over time via econometrics in order to: (i) Identify and isolate the long-run trends from the autonomous components and the principal medium-term deviations in each activity and member-state. (ii) Examine whether the long-run trends observed in recession-hit Greece varied from (or were similar to) the trends observed in the other member-states and –at a broader level– whether the long-run trends varied from one *common market* country to the other. (iii) Facilitate further research into the features and performance of businesses in the said sectors across the EU member-states.

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– Opinions or value judgments expressed in this article are the authors' own and do not necessarily reflect those of the Centre of Planning and Economic Research.

TABLE 1 Economic activities ordered by NACE code

10	Food products
11	Beverages
12	Tobacco products
13	Textiles
14	Wearing apparel
15	Leather etc.
16	Wood, cork, straw products
17	Paper, paper products
18	Printing, reproduction of recorded media
19	Coke, refined petroleum products
20	Chemicals
21	Pharmaceutical products and preparation
22	Rubber, plastic
23	Other non-metallic mineral products
24	Basic metals
25	Fabricated metal products
26	Computers, electronic-optical products
27	Electrical equipment
28	Machinery, equipment not classified elsewhere
29	Motor vehicles, trailers
30	Other transport equipment
31	Furniture
32	Other manufacturing
33	Repair/installation of machinery & equipment
35	Electricity, gas, steam, air conditioning

The NACE (Nomenclature statistique des Activités économiques dans la Communauté Européenne) is the EU statistical classification of economic activities.

The 25 activities are defined in a uniform manner across the EU (Eurostat, 2008) and comprise the manufacturing and energy sectors. The data used hereinafter are collected annually in the context of EU Council Regulation 58/97 (Eurostat, 2015) and were drawn from the Eurostat site (https://ec.europa.eu/eurostat/data/database, under the heading "Industry, trade and services", and sub-headings "Structural business statistics", and "Main indicators") in the summer of 2018.

The analysis is carried out on the basis of the most recent data. However, since the data are regularly updated and, consequently, change, in the following pages the conclusions are formulated based on the frequency of the findings rather than on individual findings.

The article is structured as follows: Section 2 describes the empirical approach. Section 3 looks into the findings by engaging in a number of subsectoral and spatial comparisons. Section 4 provides the conclusions.

2. The empirical time-series approach

The patterns of each measure are econometrically analyzed via Stata on the basis of a close variant of the well-established functional form described by Smith

and Duncan (1944), Fox (1968), Franzini and Harvey (1983), Tzortzopoulos (1985), Black (1992), Cameron (2005), Lee et al. (2019) and others:

$$y_{tc} = \beta_{0c} + \beta_{1c} t_i + \beta_{2c} t_i^2 + \sum_{i=0}^{3} \beta_{3ic} m_{itc}, \quad (1)$$

where 'y' stands for the regressand, i.e., for each of the four measures considered in each and every activity. (As each activity is studied in terms of four measures, we run 25 × 4 = 100 regressions.) Each equation is regressed separately, i.e., not as a system, and each regression involves annual data from most (usually from all) 28 EU member-states. 't' stands for time (t=1, ..., 10) and enters the expression both as an index and as the long-run trend variable in each member-state. The trend may be linear; however, the inclusion of its square allows for the consideration of non-linear features (including a peak or a trough). 'c' stands for the number of member-states; 'm' is in binary form and stands for an exceptionally high medium-term deviation or fluctuation from the trend observed in a member-state. (The *short term* is usually taken to denote an interval *smaller than or up to a year*, so the *medium term* is viewed as a somewhat broader interval of time. In this case, it turns out to span two to five years as suggested by Begg et al. (2008), Carnot et al. (2011), and others. Its algorithmic identification/derivation process is outlined below and, hence, the overall number of 'm's depends on the regressors-to-observations ratio.) The 'i's denote the number of these medium-term deviations in a member-state (i ϵ [0, 3] in the sense that in the end, the maximum number of such fluctuations in any one state is three (this happens occasionally); however, in most states it is equal to 0). The 'β's stand for the regressors' coefficients.

To produce a short expression with a high level of fitness, the estimation procedure runs as follows: (a) A preliminary OLS regression is performed using the autonomous components and the trends. As a rule, Germany is set as the reference, and in order to deal with heteroscedastic residuals, both the preliminary regression and all subsequent regressions (iterations) are conducted with robust standard errors. (b) The β_2s associated with *p-values* in excess of 10% and/or with β_1s featuring *p-values* in excess of 10% (i.e., *t*'s for which the rate of change in many analyses might be seen as trivial) are removed so as to preserve degrees of freedom. (It turns out that the impact on the model's fitness is negligible, if any.) (c) The expression is simplified further via successive regressions and post-estimation analyses through which pairs of β_0s, β_1s, and β_2s with similar values are grouped together. In particular, after each regression: (i) the recovered autonomous effects are grouped with the reference if their *p-values* exceed a certain threshold, and (ii) all recovered coefficients –ordered by type– are tested in pairs of successive size *for equality* and grouped together if the probability of error exceeds the aforementioned threshold. This threshold is initially set at 99%, falls in each iteration, and eventually reaches 10%. If the regressors-to-observations ratio is over 8.5%, the procedure continues until the ratio is reached. (In these cases, the threshold decreases from 10% to 5% or less.) (d) An additional regression is carried out, on the basis of which residual values are estimated for each and every observation. The top 5% highest positive (HP) and highest negative (HN) residual values are identified, and all successive HP (or all successive HN) observations in any one EU member-state are taken to denote a possibly exceptional (medium term) deviation. Other successions of HP observations or successions of HN observations in the same or in another member-state are taken to denote additional such deviations. Binary variables are constructed for each such succession, and a regression, akin to expression (1), is estimated. Each and every *one* in each and every such binary variable is experimentally replaced with a *zero*, and a regression is run for each modification. If the R^2 improves, the modification is kept; otherwise, it is replaced with the original value. More or longer such binary variables, involving observations with immediately lower HP or HN residual values, are considered until the regressors-to-observations ratio reaches 10%. An example of one such final expression is provided in Table 2. In both this and the other 99 analyses, the achievement of high goodness-of-fitness results cannot be overlooked.

To illustrate via this example, Table 2 provides the findings about the number of enterprises that engaged in the manufacture of textiles. We read it as follows: At the outset, Italy and Spain featured the most enterprises (lines 9-10), while Luxembourg and Slovakia had the least (line 2). Over time, the number of enterprises:

- increased in Germany, Latvia, the Netherlands, Luxembourg, the Rep. of Ireland (line 17), France, Poland (line 18);
- first decreased then increased in Greece and Spain (lines 12 and 22), Belgium, Portugal, Romania (lines 13 and 21), Croatia, Hungary, the United Kingdom of Great Britain and Northern Ireland (United Kingdom, hereinafter) (lines 14 and 21), Bulgaria and Lithuania (lines 15 and 21), as per the twice differentiable function with respect to time;
- first increased then decreased in the Czech Republic and Slovakia (lines 18-20);
- decreased in Italy (lines 11 and 23);

TABLE 2 The evolution of the number of enterprises (N) in the manufacture of textiles across EU member-states, 2007-2016

	Regressors	coefficients	p-values
	Autonomous effects		
1	Constant (DE, GR, FR, PL reference)	3,611	0.000
2	LU , SK	-3,735	0.000
3	CY, DK, EE, IE, LV, SI	-3,324	0.000
4	AT, BG, HR, FI, LT	-2,833	0.000
5	HU, NL	-2,183	0.000
6	BE, CZ, RO	-1,651	0.000
7	SE	-1,339	0.000
8	PT, UK	660	0.000
9	ES	4,245	0.000
10	IT	16,769	0.000
	Time trend		
11	IT	-1,150	0.000
12	GR, ES	-502	0.000
13	BE, PT, RO	-173	0.000
14	HR, HU, UK	-113	0.000
15	BG, LT	-85	0.000
16	AT, CY, DK, EE, FI, SI, SE	-8	0.037
17	DE, IE, LU, LV, NL	27	0.000
18	CZ, FR, PL	274	0.000
19	SK	368	0.000
	Time trend squared (to capture the rate of change)		
20	CZ, SK	-23	0.000
21	BE, BG, HR, FI, HU, IE, LT, LU, PT, RO, UK	9	0.000
22	GR, ES	31	0.000
23	IT	49	0.000
	Notable biennial or longer fluctuations		
24	SK 2008-2009	-481	0.000
25	PL 2012-2016	-992	0.000
26	NL 2013-2016	442	0.000
	Observations	266	
	Model fitness (R^2)	99.78%	

Source: Eurostat, own calculations.

Notes: No data on MT. Regressions are estimated with robust standard errors so as to address issues of heterogeneity and lack of normality. Four observations regarding a first or last year are missing. When their (missing) residuals are replaced by the residual of the nearest observation, a unit-root test for the residuals can be performed. It turns out that the residuals are stationary at the 1% level.

featured large positive fluctuations in the Netherlands during 2013-16 (line 26) and large negative fluctuations in Slovakia during 2008-09, and in Poland during 2012-16 (lines 24-25).

In the interest of brevity, we skip the presentation and analysis of each and every individual finding regarding the autonomous (initial) components and the medium-term fluctuations *apropos* the number of firms, employment, productivity, and profitability[1], and turn to the collective treatment of the respective long-run trend components across the manufacturing and energy sectors in the EU member-states.

3. The long-run patterns

According to the long-run trends recovered via regressions carried out in the way discussed above, it seems that there existed considerable heterogeneity in the evolution of:

N: In ten activities (namely, #17, 18, 20-21, 23, 25-29) the dominant pattern across the EU member-states was a decrease.[2] In five activities (#12, 14, 24, 33, 35) the dominant pattern was an increase. In three activities (#11, 13, 31) the dominant pattern was a trough followed by recovery: a V-shaped pattern.[3] (The extrema often occurred in different years.) In four activities (#10, 15, 30, 32) the dominant pattern may have been an increase.[4] (These results are associated with *p-values* in excess of 1%.) Likewise, in activity #22 the dominant pattern (involving 15 counties) may have been a decrease. In activity #16 about 30% of the countries (eight countries) exhibited an increase, while an equal number exhibited a V-shaped pattern; in activity #19 about 40% of the countries (eleven countries) exhibited an increase, while an equal number exhibited a decrease. Switching focus, in eight countries (Belgium, Bulgaria, Croatia, Cyprus, Finland, Italy, Spain, Sweden) the dominant pattern across activities was a decrease.[5] In seven countries (Czech Republic, Germany, Lithuania, the Netherlands, the Rep. of Ireland, Slovakia, Slovenia) the dominant pattern was an increase.[6] In six countries (France, Greece, Poland, Portugal, Romania, the United Kingdom) the dominant pattern was V-shaped.[7] In four countries (Austria, Denmark, Luxembourg, Malta) the dominant pattern may have been a decrease.[8] Hungary exhibited a decreasing pattern in 1/3 of all activities (ten activities) and a V-shaped pattern in an equal number of activities; Estonia exhibited an increasing pattern in 1/4 of all activities (i.e., seven activities) and may have exhibited an increase in an equal number of activities. (See Table 3.)

L: In twelve activities (#10, 13-14, 16-17, 20, 22-23, 25, 29, 30, 35) the dominant pattern across the EU member-states was V-shaped;[9] in the case of activities #13-14 (production of textiles, manufacture of clothing) there was probably no solid upward employment trend anywhere in the EU. In seven activities (#11, 15, 18, 26-28, 31) the dominant pattern was a decrease.[10] In three activities (#24, 32-33) the dominant pattern

1. The autonomous components offer insights on how a country or subsector of the economy performed at the outset. For instance, did it feature a large or small number of enterprises or people employed, a high or low level of productivity and profitability? The exceptional medium-term (say, two to three years) elements provide additional insights regarding the special circumstances or developments behind the favorable or unfavorable deviation from the long-run trend in a particular country or sector.

2. In the case of: activity #17 in seventeen countries; activities #23 and 26 in twelve countries (each); activities #18, 20, 21, 25 and 27 in ten countries (each); activity #28 in nine countries; activity #29 in eight countries.

3. In the case of: activity #11 in eleven countries; activity #13 in ten countries; activity #31 in eight countries.

4. In the case of: activity #10 in twenty-three countries; activity #32 in eighteen countries; activity #30 in ten countries; activity #15 in seven countries.

5. In the case of: Italy 16 activities; Croatia 14 activities; Spain 12 activities; Finland 11 activities; Belgium 10 activities; Sweden 9 activities; Cyprus 7 activities; Bulgaria 6 activities.

6. In the case of: the Netherlands 16 activities; Lithuania 14 activities; Germany and Slovakia 12 activities (each); the Rep. of Ireland 11 activities; Slovenia 9 activities; the Czech Republic 8 activities.

7. In the case of: Romania and the United Kingdom 13 activities (each); Greece and Poland 11 activities (each); Portugal 10 activities; France 7 activities.

8. In the case of: Denmark 10 activities; Malta 8 activities; Luxembourg 7 activities; Austria 6 activities.

9. In the case of: activity #13 in twenty countries; activity #14 in nineteen countries; activity #16 in sixteen countries; activity #25 in fifteen countries; activities #17 and 23 in thirteen countries (each); activities #10, 20 and 30 in twelve countries (each); activities #29 and 35 in eleven countries (each); activity #22 ten countries.

10. In the case of: activity #18 in twenty-three countries; activities #11 and 15 in fifteen countries (each); activities #28 and 31 in fourteen countries (each); activity #26 in thirteen countries; activity #27 in twelve countries.

TABLE 3 The evolution of the number of enterprises (N) in the manufacturing and energy supply activities across EU member-states, 2007-2016: The trend

NACE	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
10	+	+	+	\	+	+	+	+	+	+	+	+	+	+	+	+	+	\	+	+	+	+	+	\	+	V	+	+
11	/	V	/	–	/	V	–	V	V	V	V	V	–	\	/	/	–	–	/	–	V	V	/	V	/	/	V	V
12	–	–	\	/	/	/	–	/	/	/	/	V	\	\	/	/	–	/	/	/	/	V	–	\	\	–	/	/
13	–	V	V	–	Λ	/	–	–	V	–	/	V	V	V	/	\	V	/	/		/	/	V	V	–	–	V	V
14	–	–	V	/	/	/	–	–	V	–	/	\	\	V	/	\	V	–	–	–	/	V	V	V	/	/	V	V
15	+	\	+	+	\	/	+	+	V	\	V	\	\	\	/	V	/		+		/	V	V	V	/	+	/	/
16	V	/	–	/	–	/	–	/	\	\	/	\	V	V	–	\	V	–	/	–	/	V	V	V	\	/	V	V
17	\	\	V	\	Λ	\	\	\	/	\	\	\	\	\	/	\	V	\	/	\	V	Λ	\	V	\	\	V	V
18	\	\	Λ	+	V	\	\	+	\	\	+	V	\	V	Λ	\	/	+	+	+	Λ	V	V	V	\	+	\	\
19	\	\	\		\	\	–	\	/	/	\	/	\	/		\	–	/	/		/	/	/	/	\	/	\	\
20	\	\	/	\	Λ	Λ	\	/	\	\	V	V	V	\	Λ	\	/	\	/	\	/	V	V	V	/	/	V	V
21	–	\	\	\	V	\	/	\	\	Λ	\	Λ	/	\	Λ	\	–	\	+	+	/	/	V	–	–	+	/	/
22	–	\	–	+	–	–	–	–	\	–	V	\	\	V	Λ	\	–	–	–	–	/	V	–	\	–	–	V	V
23	V	+	\	V	Λ	/	\	V	\	\	+	\	\	\	Λ	\	/	/	V	\	/	V	\	V	\	+	\	\
24	–	–	\	/	/	/	–	/	/	/	/	V	\	\	/	/	–	/	/	/	/	V	–	\	\	–	/	/
25	\	–	\	–	/	/	\	–	\	\	–	\	\	V	Λ	\	/	–	–	–	/	/	\	V	\	–	V	V
26	V	V	V	\	\	\	\	\	\	V	V	V	\	V	Λ	\	\	\	+	\	Λ	/	\	V	V	V	V	V
27	+	\	–	–	Λ	Λ	–	+	\	–	\	\	\	\	Λ	\	–	–	+	–	Λ	\	V	\	–	\	V	V
28	V	\	V	–	\	–	–	V	V	\	V	\	\	V	Λ	\	/	–	/	–	Λ	/	\	\	\	V	V	V
29	Λ	V	+	\	Λ	\	\	+	\	\	V	V	/	\	Λ	\	V	+	/		Λ	\	+	V	Λ	/	V	V
30	+	\	+	+	/	/	V	+	\	\	+	V	\	V	/	\	+	+	/	+	Λ	/	V	Λ	+	+	/	/
31	V	–	–	\	Λ	–	V	/	\	\	\	\	Λ	V	V	V	/	/	V	–	/	/	\	V	/	/	V	V
32	+	+	+	/	+	/	+	/	+	+	Λ	+	+	+	/	+	+	Λ	/	\	/	+	+	+	+	+	/	/
33	Λ	/	/	+	/	/	+	/	V	/	+	V	/	Λ	/	/	/	+	/	+	/	V	V	/	/	/	/	/
35	/	/	/	+	/	/	Λ	+	Λ	+	/	V	/	Λ	/	/	/	+	/	\	/	/	/	/	V	/	/	/

Source: See Table 2.

Key for symbols:

Results associated with p-value ≤ 1 %
Peak followed by recession: Λ
Trough followed by recovery: V
No data: (blank)
Upward trend: /
Downward trend: \
Results associated with p-value > 1%
Upward trend: +
Downward trend: –

was an increase.[11] In one activity (#21) the dominant pattern (involving eleven countries) may have been a decrease. In activity #19 about 30% of the countries (eight countries) may have exhibited a decrease, while an equal number supplied very few or no observations; in activity #12 about 45% of the countries (thirteen countries) supplied very few or no observations. Switching focus, in thirteen countries (Bulgaria, Croatia, the Czech Republic, Denmark, Hungary, Latvia, Poland, Portugal, the Rep. of Ireland, Romania, Slovenia, Spain, Sweden) the dominant pattern across activities was V-shaped.[12] In ten countries (Belgium, Cyprus, Estonia, Finland, France, Greece, Italy, Lithuania, the Netherlands, the United Kingdom) the dominant pattern was a decrease.[13] In two countries (Austria, Germany) the dominant pattern was an increase.[14] Slovakia exhibited a V-shaped pattern in about 1/4 of all activities (six activities) and may have exhibited an increase in an equal number of activities; Luxemburg and Malta supplied no information on the matter or no information was published for identification purposes in eleven activities (each). (See Table 4.)

Q/L: In sixteen activities (#11, 13-18, 20-22, 26-28, 30-31, 33) the dominant pattern was an increase.[15] In three activities (#23, 25, 29) the dominant pattern was V-shaped.[16] In two activities (#24, 35) the dominant pattern was a peak followed by recession.[17] In activity #10 the dominant pattern (involving nineteen countries) was a decrease. In activity #32 the dominant pattern (involving seven countries) may have been a decrease; in two activities (#12, 19) most countries supplied very few or no observations.[18] Switching focus, in 22 countries (Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Italy, Latvia, Lithuania, the Netherlands, Poland, Portugal, the Rep. of Ireland, Romania, Slovakia, Slovenia, Spain, Sweden, the United Kingdom) the dominant pattern across activities was an increase.[19] In two countries (Cyprus, Greece) the dominant pattern was a decrease.[20] In two countries (Croatia, Hungary) the dominant pattern was V-shaped.[21] Again, Luxemburg and Malta supplied no information on the matter in twelve activities (each). (See Table 5.)

Π: In seven activities (#16, 20, 23-25, 31-32) the dominant pattern was V-shaped.[22] In eight activities (#13, 17, 22, 26, 28-30, 35) the dominant pattern was an increase.[23] In three activities (#10, 18, 33) the dominant pattern may have been an increase.[24] In activity #14 the dominant pattern (involving nine countries) was a decrease. In activity #15 about 30% of the countries (nine countries) exhibited an increase, while an equal number exhibited a Λ-shaped pattern. In activity #11

11. In the case of: activity #24 in twenty countries; activity #32 in seventeen countries; activity #33 in ten countries.

12. In the case of: Poland 17 activities; Bulgaria and Spain 16 activities (each); Romania 15 activities; the Czech Republic and Portugal 14 activities (each); Hungary 13 activities; the Rep. of Ireland 11 activities; Croatia and Latvia 10 activities (each); Sweden 9 activities; Slovenia 8 activities; Denmark 7 activities.

13. In the case of: Cyprus, Italy and the United Kingdom 12 activities (each); Finland, France and Greece 11 activities (each); Belgium, Lithuania and the Netherlands 10 activities (each); Estonia 8 activities.

14. In the case of: Austria 8 activities; Germany 7 activities.

15. In the case of: activity #22 in twenty-one countries; activities #13 and 28 in twenty countries (each); activity #17 in nineteen countries; activity #27 in eighteen countries; activity #30 in seventeen countries; activity #11 in sixteen countries; activities #15, 26 and 33 in fifteen countries (each); activities #16, 18 and 31 in fourteen countries (each); activity #14 in thirteen countries; activity #20 in twelve countries; activity #21 in nine countries.

16. In the case of: activity #29 in twenty-two countries; activites #23 and 25 in twenty-one countries (each).

17. In the case of activity #24 in fifteen countries; activity #35 in thirteen countries.

18. In the case of: activity in #12 sixteen countries; activity in #19 twelve countries.

19. In the case of: Sweden 17 activities; Estonia and Poland 15 activities (each); Germany and Slovenia 14 activities (each); the Czech Republic, Denmark, France, Latvia, Romania and the United Kingdom 12 activities (each); Italy and Lithuania 11 activities (each); Belgium, Bulgaria, Finland, the Netherlands, Portugal and Spain 10 activities (each); Austria, the Rep. of Ireland and Slovakia 9 activities (each).

20. In the case of: Greece 9 activities; Cyprus 7 activities.

21. In the case of: Croatia 9 activities; Hungary 7 activities.

22. In the case of: activity #23 in twenty-four countries; activity #25 in fifteen countries; activity #31 in fourteen countries; activity #20 in thirteen countries; activity #24 in twelve countries; activity #16 in ten countries; activity #32 in eight countries.

23. In the case of: activity #30 in fifteen countries; activities #22 and 26 in thirteen countries (each); activity #13 in eleven countries; activities #28 and 29 in ten countries (each); activities #17 and 35 in nine countries (each).

24. In each of activities #10 and 33 in nine countries. In activity #18 in eight countries.

TABLE 4 The evolution of employment (L) in the manufacturing and energy supply activities across the EU member-states, 2007-2016: The trend

NACE	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
10	/	+	V	+	V	/	V	+	V	+	+	V	–	V	+	V	V	/	+	/	+	V	V	V	+	–	+	V
11	–	–	\	\	V	\	–	V	V	\	/	\	\	\	–	V	\	\	\	\	V	V	–	V	\	\	\	\
12		\	\			\	V		\			V	V	/		V			V		\	V	V	V				\
13	V	V	V	\	V	V	V	V	V	\	V	V	V	V	\	\	V		V		V	V	V	V	\	V	V	\
14	\	V	V	V	V	V	V	V	V	\	V	V	\	V	V	V	V		\	V	\	\	V	\	V	V	V	\
15	\	\	\	\	\	\	V	\	V	\	\	V	/	V	\	V	\		\		\	V	V	V	\	\	V	/
16	V	V	V	–	\	–	–	V	\	V	\	\	V	V	V	\	V	–	V	–	\	V	V	V	V	V	+	V
17	V	\	V	\	V	+	\	\	V	V	V	\	V	V	/	\	/		\	V	V	/	\	V	\	V	\	V
18	\	\	–	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	\	–	\	V	\	\	\	/	V	\
19	–	–	V		\	/		–	/			V	/	\		\		–	–		\	V	–	V	–	–		\
20	/	+	V	+	V	/	/	+	V	V	V	V	\	V	V	\	\	–	–	+	+	V	V	\	V	V	+	\
21	/	/	/	–	–	/	/	\	V	–	V	/	/	/	–	V	–		–		\	\	–	–	V	–	–	–
22	/	\	V	\	V	/	–	\	V	–	V	\	V	–	V	\	V		V		V	–	V	/	\	–	/	–
23	V	V	V	\	V	\	+	V	V	\	\	+	V	V	V	\	V	\	V	\	\	V	\	V	+	\	\	\
24	+	+	+	\	+	+	+	–	\	+	\	+	+	+	+	\	+		+	+	+	+	+	–	+	+	+	\
25	/	\	–	–	V	/	–	V	V	V	\	\	V	V	V	V	V	–	\	–	V	/	V	V	V	V	/	V
26	V	\	V	\	V	V	+	\	V	\	\	\	V	\	V	\	\		+		\	V	V	V	Λ	\	\	\
27	/	Λ	V	\	V	Λ	\	Λ	V	\	\	\	V	V	V	\	/	\	\	\	Λ	V	\	V	\	V	V	\
28	/	\	V	\	V	\	\	\	\	\	\	\	V	/	/	V	\	\	\		V	V	V	V	V	\	V	\
29	V	\	/	+	V	V	+	+	V	+	\	+	+	V	+	\	V		\		V	V	V	/	V	+	/	V
30	V	V	V	+	/	+	V	+	+	\	/	\	\	\	V	V	V		V	+	Λ	V	V	\	V	V	+	+
31	\	\	V	/	\	V	\	\	V	\	\	\	\	V	V	V	V	+	\	/	\	V	\	V	\	\	/	V
32	/	/	+	\	+	Λ	+	/	+	/	Λ	+	+	+	+	V	+	/	/		+	+	+	+	+	+	+	+
33	Λ	/	V	+	/	/	+	+	V	Λ	+	V	+	Λ	/	+	+	+	+	/	/	V	/	V	V	/	/	+
35	Λ	/	V	Λ	V	V	V	V	\	Λ	/	V	\	V	V	/	\	/	V		/	Λ	V	\	/	Λ	\	V

Source: See Table 2.

Key for symbols:

Results associated with p-value ≤ 1 %
Peak followed by recession: Λ
Trough followed by recovery: V
No data: (blank)

Upward trend: /
Downward trend: \

Results associated with p-value > 1%
Upward trend: +
Downward trend: –

TABLE 5 The evolution of productivity (Q/L) in the manufacturing and energy supply activities across the EU member-states, 2007-2016: The trend

NACE	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
10	\	–	\	\	\	\	–	\	\	\	–	\	\	\	/	–	\	\	\		\	\	\	\	–	\	–	V
11	/	/	–	/	/	/	/	\	/	\	–	/	/	Λ	V	V	V		/	/	/	\	/	/	/	/	–	
12		+	+			Λ	/		/			+	+	+		\						+	/	Λ					
13	/	/	/	\	Λ	/	/	/	/	/	/	\	/	Λ	Λ	/	Λ		/		/	/	/	/	/	/	/	/
14	/	V	/	\	/	/	Λ	/	–	Λ	\	\	V	Λ	Λ	/	/		V	\	\	/	/	/	/	/	/	V
15	Λ	Λ	+	\	/	/	/	/	Λ	/	/	–	+	/	Λ	/	/		Λ		Λ	/	/	/	/	/	Λ	/
16	V	V	–	V	V	/	V	/	V	/	/	\	/	V	/	V	/	\	/	/	/	/	V	Λ	/	/	–	/
17	/	+	/	+	/	+	+	/	/	/	/	+	/	Λ	V	/	/		/	\	/	/	/	/	/	/	/	/
18	+	/	V	\	/	/	+	/	\	+	+	\	/	+	/	V	/	\	/	/	/	/	/	+	/	/	V	V
19	V	/			\	\		/	V			V		\		V			\		V	/	V		/	\		/
20	V	/	/	+	+	/	/	+	/	/	V	V	V	V	/	/	+	/	\	V	V	+	V	/	/	/	+	V
21	\	/	+	/	+	\	/	\	/	/	Λ	V	\	/	Λ	Λ	V		/		/	\	V	+	/	\	Λ	\
22	/	V	/	V	/	/	–	/	/	/	/	–	V	/	/	/	/		/		/	/	/	/	/	/	/	/
23	V	V	V	V	+	/	V	V	V	V	+	V	V	V	V	V	V	V	/	V	V	V	+	+	/	V	V	V
24	Λ	Λ	Λ	Λ	/	Λ	Λ	/	/	Λ	Λ	Λ	+	/	/	Λ	/	V	+	/	Λ	/	/	Λ	Λ	Λ	Λ	/
25	V	V	V	+	/	V	V	V	V	+	V	V	V	V	V	V	V	/	V	V	V	+	+	/	V	V	V	V
26	/	V	/	Λ	/	V	/	Λ	–	V	/	Λ	V	/	\	/	/		/		/	/	V	–	/	/	/	/
27	/	Λ	/	\	Λ	/	/	/	V	/	/	\	V	V	/	/	/	/	/	/	V	/	\	/	/	/	Λ	/
28	/	/	/	Λ	Λ	/	\	/	/	/	/	\	/	Λ	/	/	/	/	Λ		/	\	/	/	/	/	/	/
29	V	V	V	+	V	V	V	V	V	V	V	+	V	V	+	V	V		V		+	V	V	V	V	V	V	V
30	/	/	/	/	/	/	/	/	Λ	/	/	\	\	Λ	\	/	\		\	/	\	/	V	Λ	/	/	/	/
31	V	/	V	\	/	/	/	/	V	V	/	\	V	/	V	V	/	V	V	/	/	/	V	/	/	V	/	V
32	\	V	V	V	–	–	/	\	\	\	–	Λ	/		Λ	/	\	\	/		Λ	–	–	/	V	\	–	–
33	Λ	/	/	Λ	/	/	/	/	–	V	/	Λ	–	V	/	V	/	V	–	/	Λ	/	–	/	Λ	/	/	/
35	+	\	Λ	V	Λ	Λ	Λ	/	/	+	/	/	/	+	Λ	Λ	Λ	V	Λ		–	/	Λ	Λ	Λ	Λ	Λ	+

Source: See Table 2.

Key for symbols:

Results associated with p-value ≤ 1 %
Peak followed by recession: Λ
Trough followed by recovery: V
No data: (blank)

Upward trend: /
Downward trend: \

Results associated with p-value > 1%
Upward trend: +
Downward trend: –

about 20% of the countries (six countries) exhibited an increase, while an equal number may have exhibited an increase. In activity #27 about 20% of the countries exhibited an increase, another 20% exhibited a decrease, and an equal number may have exhibited a decrease; in two activities (#12, 19) most countries supplied very few or no observations.[25] Switching focus, in eight countries (Belgium, Denmark, Italy, Lithuania, the Netherlands, the Rep. of Ireland, Slovakia, Sweden) the dominant pattern across activities was an increase.[26] In five countries (Austria, Greece, Latvia, Poland, Spain) the dominant pattern was a decrease.[27] In eight countries (Bulgaria, Croatia, Cyprus, the Czech Republic, Finland, France, Portugal, Slovenia) the dominant pattern was V-shaped.[28] In two countries (Hungary, Romania) the dominant pattern was a Λ-shaped.[29] In Germany the dominant pattern (involving ten activities) may have been an increase. The United Kingdom exhibited a decrease in 1/5 of all activities (six activities) and an increase in an equal number of activities; Estonia exhibited an increase in 1/4 of all activities (seven activities) and may have exhibited an increase in an equal number of activities. Luxembourg and Malta supplied no information on the matter in fourteen and sixteen activities, respectively. (See Table 6.)

Reorganizing all this information reveals that, by and large:

- In thirteen activities (#10, 14, 16-18, 22, 25-27, 30-33) the number of enterprises and the number of employed people across EU member-states generally moved in the same direction (i.e., both increased or decreased throughout the period or peaked (reached bottom) simultaneously or in successive years) rather than the opposite;[30] in two activities (#12, 24) the said numbers generally moved in opposite directions, and in ten activities (#11, 13, 15, 19-21, 23, 28-29, 35) they moved in an intermediate manner.
- In five activities (#10, 15, 24, 27, 35) the number of enterprises and profitability across EU member-states generally moved in the same direction; in three activities (#26, 30, 33) the two generally moved in opposite directions; and in seventeen activities (#11-14, 16-23, 25, 28-29, 31-32) the two moved in an intermediate manner.
- In six activities (#20, 22, 25, 29-30, 33) the number of employed people and productivity across EU member-states generally moved in the same direction; in twelve activities (#11, 13-15, 17-18, 26-28, 31-32, 35) the two generally moved in opposite directions, and in seven activities (#10, 12, 16, 19, 21, 23-24) the two moved in an intermediate manner. (See Table 7.)
- In fifteen countries (Belgium, Bulgaria, Croatia, Denmark, Estonia, Finland, France, Greece, Italy, Malta, Poland, Portugal, Romania, Spain, the United Kingdom) the sectors in which the numbers of enterprises and of employed people moved in the same direction outnumbered the sectors in which the two moved in opposite directions. In two countries (the Netherlands, Slovakia) the sectors in which the numbers of enterprises and employed people moved in opposite directions outnumbered the sectors in which the two moved in the same direction. In the remaining eleven EU member-states, the number of sectors in which the numbers of enterprises and employed people moved in the same direction was about the same as the number of sectors in which the two moved in opposite directions.
- In ten countries (Austria, Germany, France, Greece, Lithuania, Malta, Poland, Rep. of Ireland, Slovenia, Slovakia) the sectors in which the number of enterprises and profitability moved in the same direction outnumbered the sectors in which the two moved in opposite directions. In four countries (Belgium, Italy, Spain, the United Kingdom) the sectors in which the number of enterprises and profitability moved in opposite directions outnumbered the sectors in which the two moved in the same direction. In the remaining fourteen EU member-states, the number of sectors in which the number of enterprises and profitability moved in the same direction was about

25. In the case of: activity #12 in thirteen countries, activity #19 in eleven countries.

26. In the case of: Italy, Lithuania, and the Rep. of Ireland 11 activities (each); Belgium 9 activities; Denmark and Sweden 8 activities (each); the Netherlands and Slovakia 7 activities (each).

27. In the case of: Greece 11 activities; Austria 10 activities; Poland 9 activities; Spain 8 activities; Latvia 7 activities.

28. In the case of: Cyprus and Portugal 14 activities (each); France 11 activities; Bulgaria and Slovenia 10 activities (each); Finland 9 activities; Croatia and the Czech Republic 8 activities.

29. In the case of: Romania 11 activities; Hungary 7 activities.

30. The former outnumbered the latter by three or more cases.

TABLE 6 The evolution of profitability (Π) in the manufacturing and energy supply activities across the EU member-states, 2007-2016: The trend

NACE	AT	BE	BG	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
10	V	V	V	\	+	+	–	+	\	+	+	–	\	+	/	+	+	V	V		–	\	V	Λ	–	/	Λ	+
11	+	/	–	V	–	+	Λ	–	\	Λ	Λ	V	/	V	/	+	/	+	V		/	\	+	\	/	\	+	\
12		/	\			/	\		\		Λ	\	\	\		\					\	\	/	Λ				\
13	–	/	/	V	Λ	/	V	/	/	V	/	/	–	Λ	Λ	/	Λ		–		/	–	V	Λ	/	V	Λ	/
14	\	/	V	\	V	\	Λ	/	\	/	V	\	V	Λ	/	/	/		\	Λ	\	\	V	Λ	/	/	Λ	\
15	Λ	V	+	V	/	+	+	+	Λ	Λ	/	–	–	Λ	Λ	/	+		Λ		Λ	+	+	Λ	–	+	Λ	+
16	V	\	V	V	V	+	/	+	V	+	V	\	/	+	+	V	+	\	+	Λ	+	V	V	Λ	+	V	/	/
17	+	\	/	V	V	\	/	+	+	/	V	\	/	/	/	/	/		\	\	\	\	\		+	+	/	Λ
18	\	+	V	V	/	+	Λ	\	\	V	V	\	\	+	Λ	/	+	\	\	/	V	V	+	+	V	+	+	/
19	V	/			V	\		/	V		\	V		\		V			\		V	V	V		\	\		V
20	V	/	V	V	Λ	Λ	/	V	/	–	V	–	V	V	Λ	/	V	/	\	V	V	V	V	Λ	V	/	/	–
21	\	+		V	V	\	/	\	/	/	+	+	+	\	Λ	/	/		/		+	\	V	Λ	+	V	Λ	\
22	\	V	/	V	–	–	Λ	/	/	V	/	\	V	Λ	/	/	/		–		/	–	/	/	/	V	/	/
23	V	V	V	V	V	V	V	V	V	V	V	\	V	V	V	V	V	V	/	V	V	V	V	\	+	V	V	V
24	V	V	/	Λ	/	V	+	V	V	V	+	V	/	V	/	+	+	+	V	/	/	V	V	V	+	+	+	+
25	V	V	V	V	V	+	+	+	V	V	V	+	V	+	/	V	/	V	V	+	V	+	V	+	/	V	/	/
26	/	/	/	–	Λ	/	Λ	\	/	\	/	Λ	V	/	\	/	/		/		\	–	V	–	/	/	/	Λ
27	\	–	\	–	Λ	–	V	Λ	V	–	V	\	V	V	/	Λ	/	/	/	/	–	\	\	\	–	/	Λ	Λ
28	\	/	V	Λ	/	–	Λ	/	–	\	\	–	/	Λ	/	/	/	–	Λ		/	\	/	Λ	/	V	–	Λ
29	\	–	/	V	/	/	/	–	/	V	V	\	–	\	–	–	/		/		\	Λ	–	V	–	/	/	/
30	\	/	/	/	/	/	/	/	/	/	/	\	\	Λ	\	V	\		\	/	\	/	/	Λ	/	/	V	\
31	V	V	V	V	/	+	/	+	V	V	V	V	V	/	/	V	/	V	+	Λ	/	+	V	Λ	V	V	+	+
32	\	V	V	V	\	+	/	\	\	\	/	Λ	/	/	\	/	V	\	/		Λ	V	V	/	V	V	+	+
33	\	+	\	Λ	\	+	V	+	\	V	V	Λ	\	+	V	+	+	V	\	+	Λ	\	V	+	+	Λ		Λ
35	V	+	/	/	V	+	+	/	\	+	/	\	/	Λ	/	Λ	V	V	V		/	/	+	/	Λ	V	V	\

Source: See Table 2.

Key for symbols:

Results associated with p-value ≤ 1 %
Peak followed by recession: Λ
Trough followed by recovery: V
No data: (blank)

Upward trend: /
Downward trend: \

Results associated with p-value > 1%
Upward trend: +
Downward trend: –

TABLE 7 Trends across the EU countries, 2007-2016

NACE codes	N & L direction		N & Π direction		L & Q/L direction	
	same	opposite	same	opposite	same	opposite
	(1)	(2)	(3)	(4)	(5)	(6)
10	8	1	10	0	1	3
11	3	5	2	1	2	8
12	2	5	4	4	0	2
13	4	3	4	3	1	5
14	6	1	4	6	1	5
15	8	7	5	2	2	8
16	12	2	2	1	1	3
17	12	1	6	7	3	6
18	10	1	6	4	6	11
19	4	4	3	5	3	2
20	3	4	5	7	5	2
21	5	6	5	4	5	5
22	7	2	5	3	6	3
23	7	5	3	2	3	1
24	0	5	5	2	2	2
25	7	2	2	1	6	2
26	7	3	2	5	2	8
27	3	0	6	3	6	10
28	3	2	6	7	4	10
29	5	3	4	3	8	0
30	6	0	4	7	5	1
31	8	5	3	2	4	8
32	16	1	2	2	1	4
33	13	1	1	5	7	3
35	5	6	9	2	2	10
Sum	**164**	**75**	**108**	**88**	**86**	**122**

Same direction: If in Tables 3-6 both variables were associated with the same symbol (/, \, –, +, and in the case of Λ or V the extreme occurred in the same year or ±1 year).

Opposite direction: If in Tables 3-6 both variables were associated with the symbols / and \, or V and Λ and the extreme occurred in the same year or ±1 year.

TABLE 8 Trends across the manufacturing and energy supply activities, 2007-2016

Country	N & L direction		N & Π direction		L & Q/L direction	
	same	opposite	same	opposite	same	opposite
	(1)	(2)	(3)	(4)	(5)	(6)
AT	3	3	3	0	4	4
BE	9	1	1	5	2	5
BG	5	2	4	3	0	1
CY	5	3	3	1	6	3
CZ	5	3	5	4	4	4
DE	3	5	9	4	7	9
DK	8	2	3	3	4	3
EE	7	1	4	2	2	7
ES	7	2	1	7	2	4
FI	8	0	4	2	1	7
FR	6	2	4	0	2	7
GR	11	0	7	2	9	2
HR	6	3	5	5	3	4
HU	5	4	4	5	5	2
IE	4	6	8	3	4	2
IT	13	1	1	10	1	7
LT	6	5	4	1	3	5
LU	3	2	1	1	1	4
LV	3	4	3	5	2	5
MT	4	0	3	0	2	2
NL	4	8	5	3	1	6
PL	7	1	6	2	5	1
PT	7	0	1	1	3	3
RO	8	2	2	4	1	4
SE	4	5	4	3	0	9
SI	3	2	6	3	3	4
SK	3	6	6	2	6	2
UK	7	2	1	7	3	6
Sum	**164**	**75**	**108**	**88**	**86**	**122**

Source: See Tables 3-6.

Same direction: If in Tables 3-6 both variables were associated with the same symbol (/, \, –, +, and in the case of Λ or V the extreme occurred in the same year or ±1 year).

Opposite direction: If in Tables 3-6 both variables were associated with the symbols / and \, or V and Λ and the extreme occurred in the same year or ±1 year.

TABLE 9 Trend increases in employment and productivity, 2007-2016

NACE codes	Countries
15	UK
17	LT, PL
18	SI
20	DE, DK
21	BE, DK, HU
22	AT, DE, RO, SK
25	AT, DE, PL, SK
27	AT, LT
28	AT, IE
30	CZ, FR
31	MT, SK
32	LV
33	BE, CZ, DE, IE, MT, SI, SK
35	FR

Source: See Tables 3-6.

the same as the number of sectors in which the two moved in opposite directions.

- In five member-states (Cyprus, Greece, Hungary, Poland, Slovakia) the sectors in which the number of employed people and productivity moved in the same direction outnumbered the sectors in which the two moved in opposite directions. In eleven countries (Belgium, Estonia, Finland, France, Italy, Latvia, Luxembourg, the Netherlands, Romania, Sweden, the United Kingdom) the sectors in which the number of employed people and productivity moved in opposite directions outnumbered the sectors in which the two moved in the same direction. (See Table 8.) (However, the desirable situation of a simultaneous employment and productivity increase throughout the period in question was rather rare: in about 5.16% of all cases. See Table 9.) In the remaining twelve EU member-states, the number of sectors in which employment figures and productivity moved in the same direction was about the same as the number of sectors in which the two moved in opposite directions.

In recession-hit Greece, despite the dominance of downward or mixed trend patterns, L increased in sector #21 (Table 4), Q/L increased in sectors #11 and 35 (Table 5), Π increased in sector #13 (Table 6), and N increased in sector #19 (Table 3). Though exceptional in the context of the country's long downturn, these rising trend patterns were not unusual in the EU context: indeed, they were observed in the same sectors in several other EU-28 states as well. (Tables 3-6.) Overall, they are very much consistent with broader developments in the said sector. By contrast, the upward trend in Q/L observed in activity #10 in the Republic of Ireland, and in L in activity #11 in France, #12 in Hungary, #18 in Slovenia and #27 in Lithuania may deserve a closer look. It is quite likely that in these instances something was done in a different way, and there may be lessons to be learned from it.

In our view, a closer look at the policies employed and circumstances in such cases, as well as in the cases of simultaneous employment and productivity increases mentioned (see Table 9), may turn out to be quite useful to agents and policy planners looking to identify features and practices that may be applied in other places and industries across the EU. Likewise, the exploration of what transpired at the time of a trend switch or a medium-term fluctuation (M_{ij}) identified via expression (1), may provide valuable insights regarding the replication of the situation or the avoidance of the situation altogether.

4. Conclusions

The article econometrically identifies the long-run trends during 2007-2016 in the 25 activities of the manufacturing and energy sectors across the EU member-states and finds considerable heterogeneity in the evolution of the number of enterprises, and of the employment, labor productivity and profitability patterns across both countries and activities. Interestingly, in sixteen activities (i.e., 64% of all activities), the majority of countries exhibited an increase in productivity; in 22 countries (i.e., 79% of all member-states), the dominant pattern across activities was an increase in productivity. The other long-run patterns regarding the business life and performance measures considered generally involved fewer activities and countries. However, the trends regarding the number of employed people and the number of enterprises (i.e., as industries became more competitive or oligopolistic), by and large, were in the same direction both in terms of activities across countries and in terms of countries across activities.

This lends some weight to the arguments that (a) in the EU more competition affects more output and, hence, the use of more labor and/or (b) the presence of a larger workforce in an industry affects the formation of more businesses in the said industry. At the same time, the trends regarding the number of employed people and productivity were, by and large, in opposite directions, both in terms of activities across countries and of countries across activities. The fortunate case of both increasing over time was rather rare, as was the case of a rising trend amid a general decline or mixed trend patterns in the other member states. However, there may be lessons to be learned from a closer look at what affected these upward trend patterns.

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References

Anastassakou J.N., Cavounidis J., Cholezas I., Chymis A., Kaditi E., Kanellopoulos C., Nitsi E. and Prodromidis P.K. 2011. *Market conditions and competition in the Greek economy.* Vol. 1: *Production of goods*. Coordinated by C. Kanellopoulos. (In Greek.) Athens: KEPE.

Begg D., Fisher S. and Dornbusch R. 2008. *Economics*. 9th edition. Maidenhead, UK: McGraw-Hill.

Black K. 1992. *Business Statistics*. St. Paul, MI: West Publishing.

Cameron S. 2005. *Econometrics*. Maidenhead, UK: McGraw Hill.

Carnot N., Koen V. and Tissot B. 2011. *Economic Forecasting and Policy*. 2nd edition. Houndmills, UK: Palgrave Macmillan.

Eurostat. 2008. *NACE Rev. 2*. Luxembourg: European Commission. (Available online via https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF.)

Eurostat. 2015. *Structural business statistics (SBS). Glossary*. Luxembourg: European Commission (Available online via https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Structural_business_statistics_(SBS).)

Fox K.A. 1968. *Intermediate Economic Statistics*. New York: Wiley.

Franzini L. and Harvey A.C. 1983. "Testing for deterministic trend and seasonal components in time series models." *Biometrica*, 70.3: 673-682.

Handrinos S., Altinoglou K. and Pepe A. 2005. *Evolution of SMEs in Greece. Estimation and comparability of efficiency and flexibility of SMEs and of large manufacturing enterprises*. (In Greek.) Athens: KEPE.

Koutroulis A., Athanassiou E., Cholezas I., Kanellopoulos N.C. and Kotsi A. 2018. *Development and prospects of the manufacturing industry in Greece.* (In Greek.) Athens: KEPE.

Lee C.F., Chen H.Y. and Lee J. 2019. *Financial Econometrics, Mathematics and Statistics: Theory, Method and Statistics*. New York: Springer.

Manolas N. 2007. *The Greek energy sector: Trends and prospects*. (In Greek.) Athens: KEPE.

O'Sullivan M. 2000. "The sustainability of industrial development in Ireland." *Regional Studies*, 34.3: 277-290.

Smith J. D. and Duncan A. J. 1944. *Fundamentals of the Theory of Statistics*. New York: McGraw-Hill.

Tzortzopoulos P. 1985. *Time series analysis. Trend-seasonality.* (In Greek.) 3rd edition. Athens: Oikonomiko.

Voulgaris F., Agiomirgianakis G. and Papadogonas T. 2015. "Job creation and job destruction in economic crisis at firm level: the case of Greek manufacturing sectors." *International Economics and Economic Policy*, 12.1: 21-39.

Zeli A. and Mariani P. 2009. "Productivity and profitability analysis of large Italian companies: 1998-2002." *International Review of Economics*, 56.2: 175-188.