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TERRITORIAL DIFFERENTIATION IN ENTERPRISE POPULATION DYNAMICS IN POLAND – CLUSTER ANALYSIS

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Abstract. Enterprise population processes are very similar to the processes observed in human population. The dynamics of enterprise population is conditioned by changes in basic processes: births, deaths and migrations. Similar techniques and models to those in demography can be applied in the evaluation of enterprise population dynamics. A methodological framework for business demography was set by Eurostat. The sum of birth and death rates shows the ability of enterprise market to adjust to changing economic conditions allowing to reallocate resources according to Schumpeter's creative destruction. This paper focuses on territorial differentiations in the processes of shaping enterprise population and their correlations with the economic development of the country. For this purpose the cluster analysis method was applied.

Key words: business demography, enterprise dynamics, Schumpeter's theory of enterprises, cluster analysis

BUSINESS DEMOGRAPHY – BACKGROUND

Business demography was used for the evaluation of enterprise population dynamics in Poland. The population of enterprises can be treated as a population that is influenced by typical processes such as births, deaths and migrations. All these processes can be analysed to assess their influence on the structure and dynamics of population.

The following quote of A. Noga gives us some insight into this new research discipline idea: "The analysis of this specific business 'demography' is a serious research method of the theory of economy which allows us to explain why some enterprises develop, other just exist staying 'alive' and other go bankrupt. Within the frame of this method different 'demographers' will assume different criteria according to which it can be said that an

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enterprise has already started or reached a specific size of activity, which influences processes in the meso and macro scale" [Noga 2009].

The analysis of business demography is usually presented in the following areas [Ptak-Chmielewska 2010a, 2010b]:

- number of births and birth rates,
- number of deaths and death rates,
- survival rates,
- influence on employment.

The classification used in comparisons is as follows:

- the size of a company measured by number of people employed,
- sector of enterprise's activity,
- geographical situation (UE, new members and candidate countries).

The dynamics of a given population is measured by the difference between its birth rate and death rate. Additionally, the flexibility of subpopulation adjustment to the changing market requirements is measured by "churn" rate. "Churn" rate is defined as the sum of birth rate and death rate. It is a measure of enterprise retention in the market.

The data for Poland are presented for years 1997–2009 and cluster analyses are done on voivodeship level. The analyses of births and deaths are based on data from REGON register and information on active enterprises published by CSO. Data cover only private enterprises without section J (financial activity, according to PKD 2004).

SCHUMPETER'S THEORY OF ENTERPRISES

Among popular economic theories, Schumpeter's theory of creative destruction is frequently cited in business demography [Schumpeter 1934]. The creation of new enterprises and closure of existing ones are key elements of the global dynamics of economy. The reallocation of assets from low productivity sectors (companies) to highly effective ones by creating new enterprises and elimination of ineffective enterprises is the main idea of this economic theory. Reallocation puts pressure on existing enterprises making them subject to increasing competitiveness in order to keep their position on the market. Weaker companies are eliminated and make room for new, more effective enterprises in the process of natural selection. This initiates the process of self-education of enterprises and shapes their life-cycle. "Churn" ratio, according to Schumpeter's theory, is a measure of turbulences on the market. This ratio is considered as the ability of the market to adopt the production structure to changing market requirements. In the case of highly competitive economies birth rate and death rate are rather high in the given period [Nunes and Sarmento 2010]. Economies with the majority of small and micro enterprises (as Poland) are characterized by a high level of "churn" ratio. The high level of this ratio in Poland indicates a high ability of enterprises to adapt to changing market conditions.

BASIC MEASURES OF BUSINESS DEMOGRAPHY

Birth rates and death rates are calculated as a proportion of entries and exits of enterprises during a reference year to the mean number of active enterprises in the reference

year (given in percent). The difference between these ratios gives the real dynamics of enterprise population in a given year. The sum of these ratios is a measure of enterprise retention in the market called "churn" ratio.

Birth rates and death rates are calculated according to the following formulae [Ptak-Chmielewska 2009]:

$$\text{birth rate}_t = \frac{\text{number of births}_t}{\text{mean number of active enterprises}_t} \cdot 100\% \quad (1)$$

$$\text{death rate}_t = \frac{\text{number of deaths}_t}{\text{mean number of active enterprises}_t} \cdot 100\% \quad (2)$$

The processes of births and deaths are presented for years 1997–2009 on the following figures (see Figure 1 and 2).

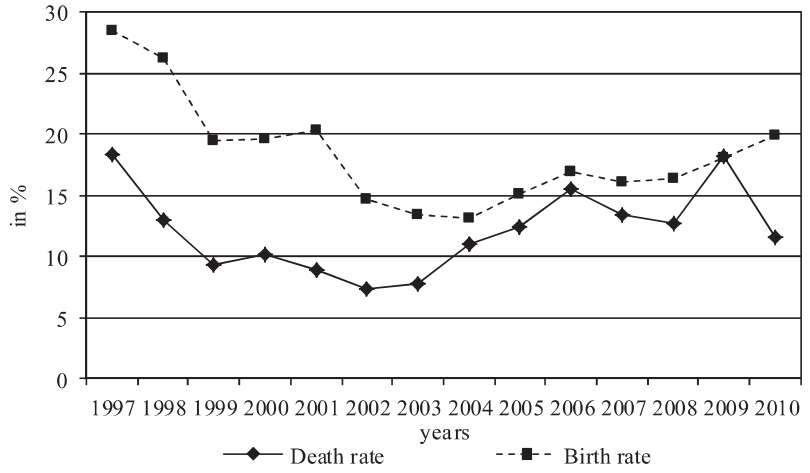

Fig. 1. Enterprise birth rates and death rates in Poland, 1997–2009
Rys. 1. Współczynnik „urodzeń" i współczynnik „zgonów" przedsiębiorstw w Polsce, 1997–2009
Source: CSO data in REGON register, CSO publications: Conditions of start-up... [2007, 2010b], Activity of non-financial enterprises… [2010a].
Źródło: Dane GUS z rejestru REGON, publikacje GUS: Warunki powstania i działanie... [2007, 2010b], Działalność przedsiębiorstw niefinansowych... [2010a].

The influence of economic conditions on entries and exits of enterprises from the market can be considered from the macro and micro perspective. Correlations between macroeconomic measures and business demography figures are presented in the following figure (see Figure 3). Some conclusions can be derived from correlations between factors determining an entry/exit of an enterprise from the market (and birth rates) and a macroeconomic situation on the market. For 19 EU countries a negative correlation was found (correlation ratio –0.44) between their birth rate and GDP as a measure of economic development. A positive but rather weak correlation was found between their unemploy-

Fig. 2. Difference between and the sum of birth rates and death rates in Poland, 1997–2010
Rys. 2. Różnica oraz suma współczynnika „urodzeń" i „zgonów" w Polsce, 1997–2010
Source: CSO data in REGON register, CSO publications: Conditions of start-up... [2007, 2010b], Activity of non-financial enterprises… [2010a].
Źródło: Dane GUS z rejestru REGON, publikacje GUS: „Warunki powstania i działania... [2007, 2010b], Działalność przedsiębiorstw niefinansowych… [2010a].

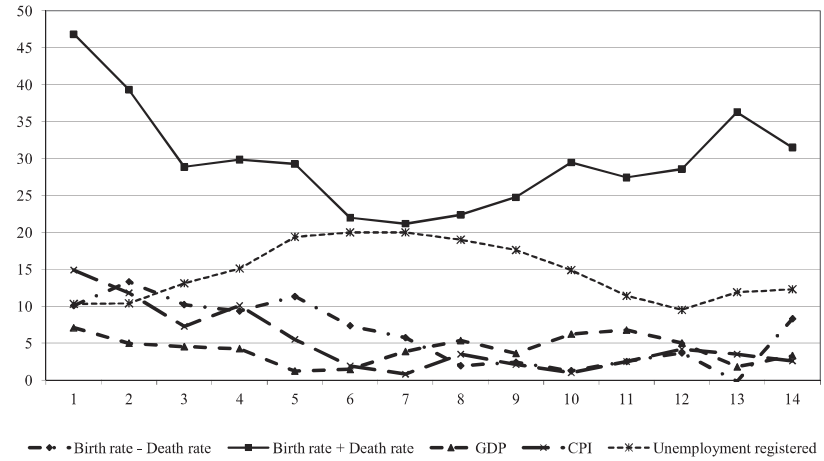

Fig. 3. Basic macroeconomic variables and business demography ratios, Poland 1997–2010
Rys. 3. Podstawowe zmienne makroekonomiczne i współczynniki demograficzne, Polska 1997––2010
Source: CSO data in REGON register, CSO publication: Conditions of start-up... [2007, 2010b], Activity of non-financial enterprises… [2010a].
Źródło: Dane GUS z rejestru REGON, publikacje GUS: Warunki powstania i działania... [2007, 2010b], Działalność przedsiębiorstw niefinansowych… [2010a].

ment rate and birth rate. In the event of high unemployment people are motivated to find a job by self-employment or start their own businesses. In such conditions what matters most is push factors. Both correlations are not supported by strong evidence to prove their significance. A Eurostat research report on 2004 denies the hypothesis assuming that high unemployment stimulates people to arrange self-employment. According to this report, high unemployment rate is only connected to weak economy. The report confirmed a correlation between the number of newly born enterprises and GDP. A high economic development level stimulates formation of new enterprises. There are also some opinions that there is a strong correlation between the enterprise population dynamics and the economic development in Poland [Szymański 2008]. A strong correlation was also confirmed in Ireland, Portugal and England but neglected in Belgium and no correlation was found in Italy and Austria. In Poland basing on the short time period 1997–2009 some correlations can be found between macroeconomic measures and demographic ratios (see Figure 3).

METHODS OF ANALYSIS

For the analysis of territorial differences in innovations of enterprises and a correlation with macroeconomic factors, cluster analysis methods were used (available in SAS).

A hierarchical cluster analysis with the average linkage method was used and confirmed by the *k*-means method. Segment profile was described by simple statistics:

- business demography variables: "churn" ratio (2003, 2008 – no data for 2009),
- macroeconomic variables: GDP per capita in PLN (2001, 2007), unemployment per 100 people in a working age group in % (2003, 2009), inflation CPI (2002, 2008).

Coverage of analysis: voivodeship (16 administrative regions). Time: two selected periods 2002/2003 and 2008/2009.

SELECTED RESULTS

For the purpose of cluster analysis Poland (16 voivodeships) was divided into 4 clusters (see Figure 4 and 5). The results for the hierarchical method were very close to the results obtained by the *k*-means method.

The results for 2002/2003 model:

- "East-wall" region characterized by high "churn" ratio and very low GDP level, very high unemployment rate and low inflation. The dynamics (difference between birth rate and death rate) of enterprise population is the lowest in comparison to other regions (see Table 1 and 2).
- Central-west region, where "churn" ratio is at medium level, GDP at medium level and medium level of unemployment and inflation in comparison to other regions (see Table 1).
- Mazovia Voivodeship is a separate region (cluster) where "churn" ratio is the lowest but the dynamics of enterprise population is the highest (see Table 1 and 2). GDP for this region is the highest and unemployment is the lowest whereas inflation is also high.

CLUSTER 1: Łódzkie, Małopolskie, Lubuskie, Opolskie, Kujawsko-Pomorskie
CLUSTER 2: Mazovia
CLUSTER 3: Lubelskie, Podkarpackie, Podlaskie, Świętokrzyskie, Warmińsko-Mazurskie
CLUSTER 4: Śląskie, Wielkopolskie, Zachodniopomorskie, Dolnośląskie, Pomorskie

Fig. 4. Results of clustering, according to 2002/2003 model
Rys. 4. Wyniki analizy skupień, dla modelu 2002/2003
Source: Own calculations.
Źródło: Opracowanie własne.

Results for 2008/2009 model:

There are no significant changes between the classification into clusters between 2002/2003 model and 2008/2009 model. A small shift had place within the central-west region.

- "East-wall" region is characterized by high "churn" ratio, very low GDP, high unemployment and low inflation. The dynamics of enterprise population in this region is the lowest compared to other parts of the country. In comparison to 2002/2003 "churn" ratio significantly increased and the dynamics of enterprise population decreased.
- In central-west region "churn" ratio increased to the level comparable to the "east--wall". GDP in this region is at the medium level, unemployment is also at the medium level and inflation is comparable to the east wall.
- As mentioned in the previous model, Mazovia Voivodeship is the only region with the lowest "churn" ratio and the highest enterprise population dynamics. GDP for this region is the highest and unemployment remains at the level comparable to the central-west region, inflation is the lowest, which is a big difference when compared to 2002/2003.

CLUSTER 1: Lubelskie, Podkarpackie, Podlaskie, Świętokrzyskie, Warmińsko-Mazurskie
CLUSTER 2: Mazovia
CLUSTER 3: Łódzkie, Małopolskie, Lubuskie, Zachodniopomorskie, Opolskie, Kujawsko-Pomorskie
CLUSTER 4: Śląskie, Wielkopolskie, Dolnośląskie, Pomorskie

Fig. 5. Results of clustering, according to 2008/2009 model
Rys. 5. Wyniki analizy skupień, dla modelu 2008/2009
Source: Own calculations.
Źródło: Opracowanie własne.

Table 1. Mean (and standard deviation) for variables used in cluster analysis, 2002/2003
Tabela 1. Średnia (i odchylenie standardowe) dla zmiennych wykorzystanych w analizie skupień, 2002/2003

Cluster	„Churn" ratio in 2003	GDP per capita in 2001 (PLN)	Unemployed per 100 population in working age group in 2003	Inflation 2002
1	23.91 (3.87)	17,775.6 (854.21)	13.94 (2.66)	1.52 (0.19)
2	21.32 (.)	31,844.0 (.)	11.30 (.)	1.60 (.)
3	26.30 (4.93)	15,114.2 (652.38)	14.72 (2.96)	1.16 (0.35)
4	22.71 (1.60)	20,886.6 (845.80)	13.70 (2.71)	1.54 (0.17)

Source: Own calculations.
Źródło: Opracowanie własne.

Table 2. Basic demographic ratios for clusters, 2002/2003 model
Tabela 2. Podstawowe współczynniki demograficzne dla skupień, model 2002/2003

Cluster	Variable	Number	Mean	Std	Min.	Max
1	Birth rate	5	15.078	1.298	13.65	17.06
	Death rate		8.832	2.676	6.78	13.50
	Dynamics[a]		6.246	1.637	3.56	7.59
2	Birth rate	1	14.480		14.48	14.48
	Death rate		6.840		6.84	6.84
	Dynamics		7.640		7.64	7.64
3	Birth rate	5	15.850	1.293	14.53	17.70
	Death rate		10.452	3.868	5.92	16.29
	Dynamics		5.398	2.987	1.41	8.61
4	Birth rate	5	14.542	1.088	13.30	15.77
	Death rate		8.168	1.743	6.40	10.56
	Dynamics		6.374	2.427	2.74	9.01

[a]Difference between birth rate and death rate.
Source: Own calculations.
Źródło: Opracowanie własne.

Table 3. Mean (and standard deviation) for variables used in cluster analysis, 2008/2009 model
Tabela 3. Średnia (i odchylenie standardowe) dla zmiennych wykorzystanych w analizie skupień, 2008/2009

Cluster	„Churn" ratio in 2008	GDP per capita in 2007 (PLN)	Unemployed per 100 population in working age group in 2009	Inflation 2008
1	30.83 (3.87)	22,268.0 (1318.2)	9.88 (1.49)	4.32 (0.15)
2	26.77 (.)	49,415.0 (.)	6.70 (.)	3.90 (.)
3	34.44 (4.93)	27,049.2 (975.6)	8.30 (1.51)	4.27 (0.12)
4	30.52 (1.60)	32,247.5 (1345.7)	6.57 (0.95)	4.32 (0.49)

Source: Own calculations.
Źródło: Opracowanie własne.

CONCLUSIONS

Basic conclusions from the above presented statistics and cluster analysis are as follows:

1. Enterprise population dynamics is decreasing despite an increase in birth rate. Only for Mazovia Voivodeship the dynamics of enterprise population is at the same high level.

2. Increasing level of "churn" ratio indicates growing competitiveness in the Polish market. The ability of enterprises to adapt to the market is increasing. This is particularly visible in the eastern part of the country.

3. The division into the "east-wall", central-west region and Mazovia Voivodeship is clear, and there are no significant changes in clusters between 2002/2003 and 2008/2009.

4. Differences in basic macroeconomic measures like GDP, inflation and unemployment between the "east-wall" and central-west region has decreased with time.

Table 4. Basic demographic ratios for clusters, 2008/2009 model
Tabela 4. Podstawowe współczynniki demograficzne dla skupień, model 2008/2009

Cluster	Variable	Number	Mean	Std	Min.	Max
1	Birth rate	5	17.360	1.634	15.65	19.19
	Death rate		13.468	0.883	12.46	14.49
	Dynamics[a]		3.892	0.758	3.19	4.72
2	Birth rate	1	17.000		17.00	17.00
	Death rate		9.770		9.77	9.77
	Dynamics		7.230		7.23	7.23
3	Birth rate	6	17.827	2.147	15.11	20.69
	Death rate		16.610	6.593	11.49	29.75
	Dynamics		1.217	5.173	–9.06	4.56
4	Birth rate	4	17.440	2.712	14.00	20.20
	Death rate		13.085	0.810	12.07	14.04
	Dynamics		4.355	2.482	0.77	6.16

[a]Difference between birth rate and death rate.
Source: Own calculations.
Źródło: Opracowanie własne.

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PRZESTRZENNE ZRÓŻNICOWANIE DYNAMIKI POPULACJI PRZEDSIĘBIORSTW W POLSCE – ANALIZA SKUPIEŃ

Streszczenie. Techniki i metody analiz stosowane w demografii mogą również służyć do oceny dynamiki populacji przedsiębiorstw w Polsce. Dynamika populacji przedsiębiorstw jest uwarunkowana zmianami w podstawowych procesach: urodzeń, zgonów i migracji. Ramy metodologiczne do nowej dziedziny, jaką jest demografia przedsiębiorstw, zostały określone przez Eurostat. Suma współczynnika urodzeń i zgonów pokazuje, jak szybko rynek przedsiębiorstw reaguje na zmiany w gospodarce, pozwalając na realokację zasobów zgodnie z zasadą Schumpeterowskiej kreatywnej destrukcji. Artykuł pokazuje terytorialne zróżnicowanie (na poziomie województw) procesów zachodzących w populacji przedsiębiorstw i ich powiązanie ze zróżnicowaniem rozwoju gospodarczego kraju. Zastosowane zostały w tym celu techniki analizy skupień.

Słowa kluczowe: demografia przedsiębiorstw, dynamika przedsiębiorstw, teoria Schumpetera, analiza skupień

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