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The Effect of the 2004 EU Enlargement on the Development and Similarity of the Insurance Sectors in the EU

ANNA DENKOWSKA*, STANISŁAW WANAT** & JOÃO PAULO VIEITO†

*Department of Mathematics, Cracow University of Economics, Kraków, Poland. Email: anna.denkowska@uek.krakow.pl
**Department of Mathematics, Cracow University of Economics, Kraków, Poland. Email: wanats@uek.krakow.pl
†School of Business Studies, Polytechnic Institute of Viana do Castelo and Applied Management Research Unit (UNIAG), Portugal. Email: joaovieito@esce.ipvc.pt

The enlargement of the European Union to new countries in 2004 introduced mechanisms to support the development of various social and economic areas, while also aiming to level the differences between the member states. The primary purpose of this study is to analyse the development and similarities of the insurance markets in the old and new member states of the EU after the enlargement in 2004. We examine the insurance sector of both groups of countries, i.e., those that were members before 2004 and those that joined in 2004, using Hellwig's development measure, which takes into account several characteristics. Additionally, we analyse the similarity of these countries using three statistical methods of unsupervised classification: Ward's method, the k-means method, and the Partitioning Among Medoids. Our results indicate that there was a significant variation in the insurance characteristics of these compared groups of EU members after 2004. In general, the insurance markets of the old and new EU countries developed differently. Since the enlargement in 2004, the insurance markets of the old and new EU countries have not yet aligned.

Introduction

The United Nations Conference on Trade and Development (UNCTAD) stated in 1964 that a robust domestic insurance and reinsurance sector is a vital element of economic growth. While a quote from three decades ago acknowledges insurance's

significance, it falls short of conveying the critical role that insurance plays in fostering economic development. Insurance is not just a 'hallmark of economic growth', but rather an indispensable aspect of the vast majority of contemporary economies (Skipper 1997).

Despite the importance of insurance in economic development, the specific connections between the two remain poorly comprehended. Unlike the abundance of supportive research available on banks, comprehensive studies on the matter are rare and mostly limited to anecdotal evidence. As a result, policymakers in numerous markets lack a full understanding of the role and significance of insurance in promoting economic development.

Following the rich literature on the subject, it is hard not to get the impression that until the subprime mortgage crisis in 2008, most of the investigation in the financial sector was focused on the banking sector. Only after this period did intensive research into the insurance sector begin to appear. Of particular interest is the analysis of all the consequences associated with the mutual opening of countries to trade and thus to the exchange of goods and services between international economies, including the insurance sectors. Many researchers, such as Eling and Luhnen (2010b), indicate a great need for continuing research on the insurance sector, concerning among others, the market structure, especially in an international context.

This study aims to answer several questions related to the development of the insurance sector in the Old15 countries compared with the countries that joined the EU in 2004. Did the EU enlargement affect any of these groups of countries during the years 2004–2018? To what extent were the insurance markets of the different countries similar? Or are the similarities due to the structural changes that followed the enlargement? Has the community goal been achieved yet? Have the differences between the member countries been resolved and equalized?

Research conducted by Jagric *et al*. (2018) shows that the insurance industry is not homogeneous and is not convergent in the ongoing process of EU integration. These conclusions are based on an analysis of the insurance sectors for a total of 23 EU and non-EU countries from 2003 to 2012. The motivation of our research is to check whether the conclusions obtained by Jagric *et al*. for data from 2003 to 2012 will be confirmed on data from 2004 to 2018 for 27 EU member states, using other methods and tools of multivariate data analysis.

Conducting a research paper to analyse whether the integration of new countries in the EU makes insurance converge in these countries can be a highly motivating and valuable undertaking for several reasons. First, as the EU continues to expand, it is important to understand how this expansion impacts various sectors of the economy, including the insurance industry. Second, studying the convergence of insurance in new EU member states can provide valuable insights for policymakers and stakeholders. Lastly, researching the convergence of insurance in new EU member states can help businesses and investors make informed decisions about where to allocate resources.

Overall, studying the convergence of insurance in new EU member states can provide valuable insights into the impact of EU expansion on various sectors of the

economy. By shedding light on trends, patterns, and potential policy implications, this research can help promote a more stable and prosperous insurance industry in these countries, while also informing investment decisions and promoting economic growth. This article is structured as follows: the next section provides an overview of the literature on the insurance sector, the section after presents the data that we use for our empirical analysis and describes the methodology that we use, and the final chapter presents our results, as well as our discussion and conclusions.

Literature Review and Hypotheses Development

The fifth stage of EU enlargement was the largest to date, with ten new countries joining the Union and increasing its population significantly. This transformation changed the dynamics of the EU's development and created new opportunities for economic, political, cultural, and legal growth (Toshkov 2017). While numerous reports and articles analyse the effects of the enlargement, the insurance sector is often overlooked. Therefore, we emphasize the need for continued research on the insurance sector in the context of the European Union's enlargement.

The European Commission produces annual reports analysing the overall economic, financial, and political situation of the EU, but little attention is paid to the insurance sector. The ECDG FISMA report (2020) briefly summarizes the development of the insurance sector based on EIOPA (2018) and mentions the sector's performance during the first stage of the pandemic that began in 2019. However, there is no detailed analysis of the changes taking place in the insurance sector since 2004 or a comparison of European Union insurance markets.

Numerous works analyse the efficiency of insurance companies using the frontier approach. The two main trends in technical efficiency measurement that emerged in the late 1970s were parametric stochastic frontier models (such as Stochastic Frontier Models (SFM), or Stochastic Frontier Approach (SFA)) and non-parametric deterministic data envelopment methods (Data Envelopment Analysis (DEA)). While both approaches yield consistent results, SFA measures fitness values higher than DEA (Berger and Humphrey 1997). This methodology has been used to study the insurance sector in works such as Fenn *et al.* (2008), Zanghieri (2009), Eling and Luhnen (2010a, 2010b), Jarraya and Bouri (2014), and Bahloul *et al.* (2013). Other works analysing the effectiveness of DEA include Barros *et al.* (2005), Barros *et al.* (2010), Cummins and Maria Rubio-Misas (2006), Bikker and Van Leuvensteijn (2008).

In their 2011 study, Kasman and Turgutlu (2011) analysed the insurance sectors of 15 European Union member countries from 1995 to 2005. Their findings suggest that there were significant economies of scale, particularly for small and medium-sized insurance companies. This implies that due to heightened competition, insurance firms had to optimize their costs and operations to remain competitive in the new business landscape.

Numerous articles have examined the link between the insurance sector and economic growth. Ward and Zurbruegg (2000) explored this relationship in nine

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OECD countries and discovered that the insurance industry Granger causes economic growth in some countries, while in others, the inverse is true. They concluded that the promotion of economic growth by the insurance sector is contingent on various national circumstances. Arena (2008) analysed data from 55 countries between 1976 and 2004 and established that both life and non-life insurance exert a positive and significant causal impact on economic growth. Wanat *et al*. (2019) scrutinized the causal connections between insurance market development and economic growth in ten transition European Union member countries between 1993 and 2013. Gonzalez *et al*. (2022) conducted a study that used panel cointegration techniques with data from 90 countries to examine the relationship between insurance market activity and economic activity. They found evidence in favour of panel cointegration between real insurance market activity per capita and real GDP per capita. Lastly, Ertl (2017) investigated the development of life and property insurance between 1994 and 2014 and discovered a significant insurance convergence effect that was present before the 2008/2009 financial crisis.

Kozarevic *et al*. (2013) analysed the development of the insurance sector in the Western Balkan Countries and their integration with the European Union, and Alvarez and Makunin (2018) presented a report concerning the insurance branch in selected CEE countries.

Previous research has used clustering methods and unsupervised machine learning techniques to produce low-dimensional representations of higher-dimensional data sets while preserving the topological structure of the data. Kohonen's Self-Organizing Maps (Kohonen 1982) and optimized spiral spherical Self-Organizing Maps, introduced by Jagric and Zunko (2013), have been applied in Jagric *et al*. (2015) and Jagric *et al*. (2018).

Authors such as Kwon and Wolfrom (2016) discussed analytical tools used by macroprudential supervision and insurance regulators, and Cummins and Rubio-Misas (2017) investigated the impact of integration on the effectiveness of life insurance markets in the European Union (EU) during the post-deregulation period of 1998–2011 and have pointed out gaps in the literature regarding research on the insurance sector. Our study, therefore, attempts to partially supplement existing literature. We are particularly interested in the results of analyses that examine the level of integration between the banking and insurance sectors. Based on an analysis of the literature and the goals of EU integration, we establish the main hypothesis for our research:

Hypothesis: The insurance sectors of the Old15 and New9 group Member States have become more similar after 15 years of integration.

It is expected that the insurance sectors in the European Union have become more similar after 15 years of integration because the integration process has led to the harmonization of laws and regulations in different areas, including insurance. The addition of the other nine countries to the EU in 2004 has also contributed to this process of harmonization. As a result, insurance companies in different member

Table 1. Data information

Life insurance penetration	Life premiums to GDP ratio indicates the level of development of the life insurance sector in a country
Property & Casualty insurance penetration	P&C premiums to GDP ratio indicates the level of development of the property and casualty insurance sector in a country
Life insurance density	Average life premiums per capita indicates the level of development of the life insurance sector in a country
Property & Casualty insurance density	Average P&C premiums per capita indicates the level of development of the property and casualty insurance sector in a country
Average value of total insurance assets (i.e. total Life, P&C, and Health sector) per one insurance company	Indicates the strength of an insurer from a country
Investment to GDP ratio	Indicates the strength of the country's insurance sector
Life insurance concentration	Market share of the top five Life insurance groups, indicates the competitiveness of the life sector in a country
Property & Casualty insurance concentration	Market share of the top five Property & Casualty insurance groups, indicates the competitiveness of the P&C sector in a country
Number of companies on the total market per 1 million inhabitants	Indicates the competitiveness of the insurance sector in a country

states have had to adapt to common regulatory standards and market conditions, and, in this way, we expect a higher convergence in the insurance sector across the EU. Furthermore, the increased competition that has arisen from the integration process has also driven insurers to adopt similar business practices and strategies to remain competitive. Overall, with the integration of the New9 countries into the EU, we expect a more unified insurance market, making it easier for insurers to operate across different member states and providing consumers with a greater choice and access to a wider range of insurance products and services.

Description of Data

To analyse the development and similarity of EU Member States by groups, we utilize the data published by the European Insurance and Occupational Pensions Authority (EIOPA) and from the Insurance Europe databases. These data allow us to assess the level of development, strength, and competitiveness of the insurance sectors of the surveyed countries from 2004 to 2018. In Table 1, the first four measures are

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commonly used to determine the level of development in the insurance market, while the next two variables are related to investments. The last three variables describe the competitiveness of the insurance sectors within each country. In Table 2 we present the descriptive statistics for 2004 and 2018 for the groups Old15 and New9.

Methods

To test the hypotheses that the insurance sectors of the Old15 and New9 group Member States have become more similar after 15 years, we conducted multivariate data analysis using selected methods. We study the development of the insurance sectors of EU countries after 2004, constructing the so-called development path: $g_i^{2004}, g_i^{2005}, \ldots, g_i^{2018}$, where for the countries $i = 1, \ldots, 24$ and for the year $t = 2004, \ldots, 2018$, g_i^t is a Hellwig's synthetic measure of development (HSMD) (Hellwig 1968; Roszkowska and Filipowicz-Homko 2021). This measure is made up of appropriately scaled Euclid's distances between the multidimensional vector of normalized values of variables characterizing the development of the insurance sector in a given country i in a given year t and the so-called development pattern. Due to the dynamic nature of the analysis, we take a multidimensional vector as the development pattern $z_{\text{dp}} = \left[z_{\max,1}, z_{\max,2}, \ldots, z_{\max,k}\right]$, the coordinates of which are the maximum values of the normalized variables (after prior conversion of the destimulant into stimulants) taken in all countries $i = 1, \ldots, 24$ and $t = 2004, \ldots, 2018$, i.e. $z_{\max,j} = \max_t \max_i z_{i,j}^t$.

Hellwig's linear ordering method is an elementary multivariate analysis method. The method is based on the concept of a binary relation that allows for ordering multidimensional objects. This binary relation is reflexive, antisymmetric, transitive, and connected, which allows for determining the better and worse object between two given objects, as well as whether they are identical. This method can be applied to various objects, such as countries in terms of economic development. Economic development is an aggregate variable whose realization is not directly measurable. The values of such variables are generated by observations of diagnostic variables that are directly measurable. The Hellwig measure, which ranges from 0 to 1, is used to compare the level of development of the insurance sectors of EU countries. In some cases, the Hellwig measure can take negative values, indicating that the analysed object is worse than others. The benchmark measure is 1, and the higher the value, the better the position of the country's insurance sector in the ranking.

In addition to the Hellwig measure, we use unsupervised classification methods to examine the similarity of insurance markets. Hierarchical methods, such as Ward's method, are used to create groups recursively by linking together the most similar objects. Other methods, such as the k-means method and the partitioning among medoids (PAM) method, are also used. The k-means method allocates objects to minimize within-group variance, while the PAM method selects medoids at each step and then allocates remaining objects to the closest medoid's group. Internal validity indexes, such as Calinski-Harabasz pseudo F statistics (Calinski and Harabasz

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Table 2. Descriptive statistics for 2004 and 2018 for the groups Old15 and New9

		Life insurance penetration		Property & Casualty insurance penetration		Life insurance density		Property & Casualty insurance density		Average value of total insurance assets per one insurance company		Investment to GDP ratio		Life insurance concentration		Property & Casualty insurance concentration		Number of companies on the total market per 1 million habitants	
		2004	2018	2004	2018	2004	2018	2004	2018	2004	2018	2004	2018	2004	2018	2004	2018	2004	2018
Minimum	New9	0	0.002	0.013	0.006	0.89	25.12	66.42	84.47	14.97	119.14	0.013	0.023	0.742	0.297	0.485	0.41	1.859	1.58
	Old15	0.007	0.01	0.01	0.009	158.04	173.54	172.75	153.43	70.77	473.9	0.041	0.075	0.393	0.497	0.387	0.383	3.113	1.653
Maximum	New9	0.144	0.034	0.031	0.023	1750.46	871.47	596.88	520.69	370.38	870.76	0.415	0.259	1	1	0.957	0.907	38.733	37.027
	Old15	0.069	0.096	0.03	0.044	2240.24	3994.19	1009.72	1577.47	2942.84	10543.36	1.279	3.153	0.975	0.915	0.913	0.952	208.81	161.128
1. Quart.	New9	0.001	0.009	0.015	0.012	5.61	132.87	107.78	195.66	36.14	190.19	0.046	0.058	0.754	0.66	0.739	0.697	3.237	2.639
	Old15	0.024	0.026	0.021	0.016	676.94	718.91	540.32	570.35	629.09	1378.35	0.265	0.325	0.555	0.6	0.52	0.515	7.142	4.276
3. Quart.	New9	0.016	0.015	0.027	0.018	148.23	336.24	364.47	357.47	272.4	654.77	0.146	0.109	1	0.817	0.897	0.884	9.515	7.741
	Old15	0.056	0.059	0.026	0.023	1802.19	2613.86	897.52	1040.08	1619.52	4577.68	0.626	0.849	0.761	0.776	0.7	0.758	27.688	13.833
Mean	New9	0.027	0.012	0.022	0.015	352.53	257.22	237.21	291.35	174.17	443.09	0.118	0.091	0.859	0.739	0.803	0.741	11.244	9.79
	Old15	0.039	0.044	0.023	0.02	1172.04	1842.95	695.43	840.95	1215.14	3532.9	0.502	0.736	0.658	0.674	0.616	0.652	28.359	21.71
Median	New9	0.009	0.011	0.027	0.013	75.05	169.57	176.25	242.43	177.2	429.19	0.08	0.077	0.843	0.745	0.839	0.77	7.513	3.102
	Old15	0.041	0.036	0.024	0.018	1141.42	1686.99	698.25	796.17	1017.08	2402.62	0.489	0.579	0.64	0.632	0.667	0.668	8.813	6.377
Stdev	New9	0.047	0.009	0.008	0.005	625.95	257.52	177.12	147.69	138.51	271.93	0.125	0.069	0.114	0.216	0.143	0.171	12.453	12.216
	Old15	0.021	0.026	0.005	0.009	682.79	1212.37	247.36	415.96	901.97	3063.36	0.305	0.729	0.165	0.116	0.161	0.177	51.922	40.988
Skewness	New9	1.639	1.071	–0.152	–0.088	1.31	1.37	0.77	0.35	0.16	0.19	1.363	1.41	0.296	–0.6	–0.999	–0.765	1.211	1.256
	Old15	–0.083	0.542	–1.051	1.148	0.07	0.31	–0.43	0.31	0.73	1.05	0.765	2.316	0.095	0.496	0.134	0.048	2.756	2.616
Kurtosis	New9	1.269	0.37	–2.009	–1.268	0.01	0.72	–0.83	–1.38	–1.71	–1.63	0.717	0.957	–1.877	–0.52	–0.031	–0.955	–0.107	–0.024
	Old15	–1.456	–1.044	0.171	1.16	–1.55	–1.39	–0.82	–0.96	–0.76	–0.2	0.456	5.162	–1.013	–0.94	–1.193	–1.14	6.747	5.975

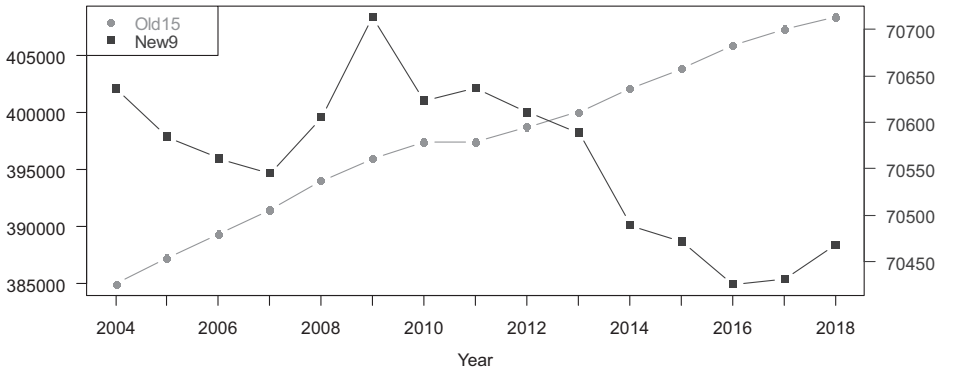

Figure 1. Comparison of the population (in thousands) of Old15 and New9 during 2004–2018

1974), average silhouette width, Dunn index (Dunn 1974), and Xie and Beni's index (Xie and Beni 1991), are used to determine the optimal number of clusters in the data. The final classification of objects is the result of comparing the results of respective grouping algorithms.

To the best of the authors' knowledge, this type of approach to studying the development and similarity of the insurance sectors of EU countries, using development paths and cluster analysis methods, has not yet been used in the literature. Its advantage is the inclusion in the analyses of many aspects of the insurance sectors, represented by individual diagnostic variables. One limitation is the selected set of diagnostic variables, which was partially determined by the availability of complete statistical data.

Results

The empirical results are presented in three steps: statistical analysis, market development analysis and analysis of the similarity of insurance markets.

Statistical Analysis

In the first step of our research, we analyse the development of EU insurance markets in the years 2004–2018, studying the development of both the Old15 and New9 countries simultaneously.

We begin the statistical analysis of the differences between the Old15 and the New9 countries by comparing the population numbers in Figure 1. In the Old15 countries, we observe an increase in population caused both by immigration from outside Europe and from the New9 countries. On the other hand, the population evolution in the New9 countries does not show a single trend. We can see that since 2004–2007, the population has been falling, then it fluctuated in the range of 70,600–70,650, and then it fell below 70,500, which has an impact on the overall level

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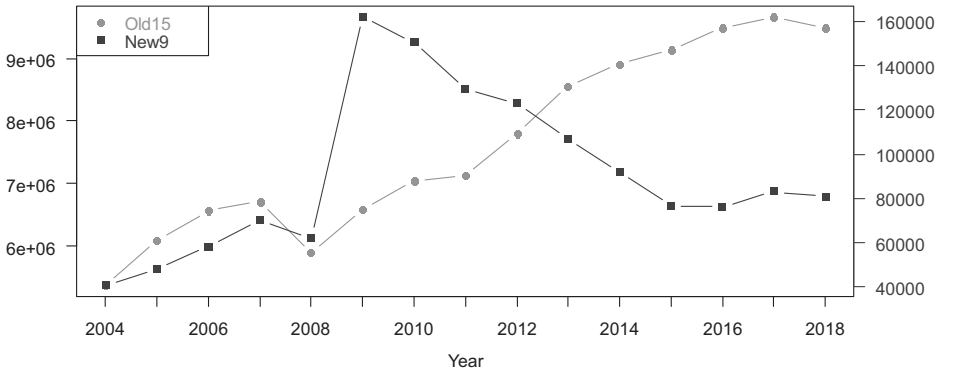

Figure 2. Investment portfolio on the domestic market (€ million) for Old15 and New9

of development of the insurance market according to the principle: the larger the population, the greater the potential.

The investment portfolio on the domestic market (Figure 2) after the crisis and decrease in 2008 in the Old15 shows a growing trend, while in the New9 it keeps decreasing.

Table 3 summarizes the number of companies, total assets in € billion, and in percent, and GDP in € billion for Old15 and New9 from 2004 to 2018.

One of the most fundamental indicators used to determine the level of development and competition within the insurance sector across different countries is the number of insurance companies per million inhabitants. Additionally, the number of insurers operating in the life insurance sector can be used to assess the level of development in this area. In Central and Eastern Europe, Poland boasts the largest insurance market, while a group of insurance companies from the UK, France, Germany and Italy hold the biggest share of the EU market. In the Old15 countries, the number of insurance companies appears to be on a decreasing trend, whereas, in the New9 countries, it appears to remain stable.

Another key indicator to consider is the total assets held by insurance companies. These assets play a significant role in determining the market share of insurance companies around the world. The value of assets managed by these companies is dependent on investment activities, particularly profits made by pension and investment funds. For individual customers, asset values are important as they impact the amount of their future retirement pension. Moreover, for a country's economic market, insurer assets can serve as potent capital support.

Experts predict that insurance savings will play a dominant role in determining the financial market's condition in the next five years. These forecasts are being realized, as we have seen an increase in asset values since the 2008–2009 crisis, except for the subprime crisis period. Both the Old15 and New9 countries have experienced GDP growth, except for a decline observed in 2008. During the sovereign debt crisis in European countries, GDP remained at an equal level, and since 2014, we have seen

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Table 3. Number of companies, total assets in € billion, total assets in percent, GDP in € billion

		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of Companies	New9	241	236	235	235	232	239	246	244	241	256	213	214	211	208	203
	Old15	3696	3635	3531	3464	3446	3366	3322	3234	3125	3153	2960	2901	2846	2782	2686
Total assets*	New9	57	52	62	74	73	77	83	79	90	89	94	95	97	105	102
	Old15	5670	6257	7416	7503	7014	6950	7484	7602	8316	8708	9209	9823	11,220	11,422	11,134
Total assets (%)	New9	1	0.8	0.8	1	1	1.1	1.1	1	1.1	1	1	1	0.9	0.9	0.9
	Old15	99	99.2	99.2	99	99	98.9	98.9	99	98.9	99	99	99	99.1	99.1	99.1
GDP*	New9	489	561	620	708	806	718	780	817	826	832	856	899	912	989	1061
	Old15	10,488	10,883	11,463	12,064	12,016	11,378	11,825	12,152	12,406	12,500	12,935	13,632	13,707	14,020	14,475

continuous growth. The level of economic development, as measured by GDP per capita, is strongly correlated with the development of the insurance market, which can be assessed by examining the gross written premium. Countries with low GDP per capita tend to exhibit a low share of gross written premium in the total premium.

Table 4 summarizes Gross Written Premium, Insurance Penetration, Insurance Density and Concentration for Old15 and New9 from 2004 to 2018.

Panels A and B illustrate the trends of Gross Written Premium (GWP) for Life, Property and Casualty (P&C), and Health insurance activities. Notably, GWP for Life is the most variable, with the Old15 Union being more responsive during the 2008 crisis and in 2011, after which the premium tends to increase. Conversely, in countries that joined the EU later, premiums have been steadily rising since their accession, with some stagnation during the crisis years, followed by a decrease, possibly linked to the decline in population in this part of Europe. Other than Life, premiums show a growing trend. GWP is a fundamental measure of the insurance industry's situation and market structure, with the growth rate of non-Life insurance premium collected by insurers indicating the insurance market's development degree's dependence on the amount of GDP.

In the Old15 countries, Life insurance dominates the market, while Health insurance is gradually gaining ground. On the other hand, Property insurance is the dominant category in the New9 countries, while Health insurance remains at a minimum. However, despite some small indications of progress, this trend raises concerns about a possible loss of confidence in long-term insurance. Additionally, during the crisis period, Gross Written Premiums for Life insurance decreased in the Old15 countries, while in the New9 countries, it increased.

Panel C presents the evolution of insurance penetration rate measures, which describe the relationship between the insurance premium and the Gross Domestic Product (GDP). This indicator quantifies the role of insurance in the national economy, with a higher ratio of the annual insurance premium to the GDP indicating a more extensive use of insurance for property, life, and health protection, and a higher level of insurance awareness in a given country. Panel C summarizes the insurance penetration values for the New9 and Old15 countries during the analysed period, showing that the percentage of penetration in the New9 countries varies depending on the type of insurance, with Property and Casualty (P&C) penetration being the highest, comparable with that of the Old15 countries. Life insurance penetration for the New9 countries decreases in 2008 and remains at a reduced level, while for the Old15 countries, it is variable and clearly decreases in 2008, then in 2011, and again in 2016. P&C penetration drops until 2008, then increases to reach a minimum again in 2015 in both groups of countries. Health insurance penetration has been stable for the Old15 countries since 2006, but it is almost ten times lower than the Life and P&C penetrations.

Panel D describes the insurance density, which is a more precise measure of the insurance sector's development than the level of GWP. It is defined as the gross written premium value per capita, and it enables drawing conclusions regarding the citizens' insurance awareness in a given country based on how much in financial

Table 4. Gross Written Premium in € million and in percent, Insurance Penetration, Insurance Density and Concentration in percent for Old15 and New9 from 2004 to 2018

		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
PANEL A: Gross Written Premium (€ million)																
Life	New9	6904	7791	10,107	13,132	14,249	13,278	14,607	13,510	15,289	13,778	12,920	12,208	11,074	11,818	10,895
	Old15	522,161	598,489	653,580	699,221	559,409	601,111	621,251	586,909	577,806	598,652	649,077	682,218	640,978	669,096	714,739
P&C	New9	9616	10503	11,356	12,650	12,409	12,594	13,052	12,562	13,330	12,944	12,767	13,149	14,114	16,521	17,342
	Old15	272,261	282,605	283,706	281,469	270,084	272,749	279,140	284,335	289,311	288,642	290,266	304,461	339,415	340,464	358,688
Health	New9	477	511	560	658	687	726	776	806	892	917	911	922	988	1078	1246
	Old15	56,918	59839	85,714	88,372	91,874	96,174	101,329	105,641	107,742	110,309	111,885	116,305	118,251	121,863	127,447
PANEL B: Gross Written Premium in percent																
Life	New9	40.6	41.4	45.9	49.7	52.1	49.9	51.4	50.3	51.8	49.8	48.6	46.5	42.3	40.2	37.0
	Old15	61.3	63.6	63.9	65.4	60.7	62.0	62.0	60.1	59.3	60.0	61.7	61.9	58.3	59.1	59.5
P&C	New9	56.6	55.9	51.6	47.8	45.4	47.4	45.9	46.7	45.2	46.8	48.0	50.0	53.9	56.2	58.8
	Old15	32.0	30.0	27.7	26.3	29.3	28.1	27.9	29.1	29.7	28.9	27.6	27.6	30.9	30.1	29.9
Health	New9	2.8	2.7	2.5	2.5	2.5	2.7	2.7	3.0	3.0	3.3	3.4	3.5	3.8	3.7	4.2
	Old15	6.7	6.4	8.4	8.3	10.0	9.9	10.1	10.8	11.1	11.1	10.6	10.5	10.8	10.8	10.6
PANEL C: Insurance Penetration																
Life	New9	0.0273	0.0184	0.0202	0.0245	0.0134	0.0157	0.0162	0.0151	0.0144	0.0142	0.0141	0.0134	0.0133	0.0133	0.0123
	Old15	0.0394	0.0468	0.0464	0.0471	0.0454	0.0487	0.0491	0.0432	0.0424	0.0439	0.0461	0.0437	0.0420	0.0425	0.0435
P&C	New9	0.0222	0.0214	0.0214	0.0207	0.0166	0.0175	0.0164	0.0159	0.0157	0.0148	0.0148	0.0145	0.0147	0.0148	0.0150
	Old15	0.0229	0.0228	0.0214	0.0207	0.0206	0.0215	0.0213	0.0209	0.0207	0.0208	0.0195	0.0189	0.0205	0.0203	0.0203
Health	New9	0.0027	0.0027	0.0022	0.0024	0.0021	0.0023	0.0023	0.0023	0.0025	0.0026	0.0025	0.0025	0.0026	0.0027	0.0027
	Old15	0.0043	0.0043	0.0068	0.0067	0.0070	0.0075	0.0077	0.0078	0.0078	0.0081	0.0080	0.0078	0.0080	0.0079	0.0080
PANEL D: Insurance Density																
Life	New9	352.5	258.2	293.6	384.0	205.4	222.3	242.1	233.0	219.3	217.3	225.6	230.0	239.1	257.3	257.2
	Old15	1172.0	1462.2	1537.2	1651.5	1609.6	1603.0	1688.3	1524.0	1544.1	1596.8	1750.9	1712.9	1698.2	1757.0	1843.0
P&C	New9	237.2	254.2	280.2	302.3	252.4	247.1	240.8	241.8	239.4	228.1	233.5	240.9	251.0	268.2	291.3
	Old15	695.4	721.8	713.9	728.7	719.3	710.1	742.1	745.4	751.6	768.3	732.6	738.2	810.2	821.8	841.0
Health	New9	36.0	38.8	35.1	42.7	38.1	40.4	40.2	41.8	44.5	46.7	45.2	46.9	50.4	55.0	59.2
	Old15	137.0	142.1	237.0	242.8	259.0	268.7	282.4	290.8	293.5	300.8	303.4	313.2	323.8	333.3	347.4
PANEL E: Concentration in percent																
Life	New9	85.9	84.6	83.1	82.5	82.0	80.5	76.3	75.7	75.2	77.3	77.9	73.5	73.2	75.0	73.9
	Old15	65.8	67.2	67.9	68.0	68.9	67.9	68.3	68.6	68.6	68.9	67.2	66.1	67.1	69.1	67.4
PC	New9	80.3	79.7	79.7	77.4	77.0	77.0	76.9	73.1	73.1	75.0	75.4	74.7	73.9	73.6	74.1
	Old15	61.6	60.9	62.1	62.2	62.1	61.8	61.8	62.5	63.2	63.4	63.2	65.3	65.6	64.8	65.2

resources a statistical resident spends on insurance. The density level is highest for Life, followed by P&C and lowest for Health; and in the New9 countries, it decreased in 2008 and remained at that level. For the Old15 countries, a decline was observed during the excessive debt crisis in the Eurozone, while for P&C, there were fluctuations, and for Health, a growing trend was noted.

Lastly, Panel E presents concentration, i.e. the market share, of the top five insurers. It is the information about how much of the market is owned by these five largest insurers in a given country. Lowering the value of concentration means increasing competition in the insurance market. An interesting situation took place for the Old15 in 2014, concentration for Life decreased while for P&C it increased. For the New9 members, concentration begins to decline in 2008 and only in 2012 did it start to rise again.

Market Development Analysis

We analyse two aspects (dimensions) of convergence of the insurance sectors. The first is the similarity (approaching) of the level of development (measured by the average level of Hellwig's development measure). The second is convergence in the sense of reducing the differences between countries in terms of development (i.e. reducing the difference between the level of development of individual countries and the average level of development of these countries). We measure this aspect of similarity by variance. The smaller it is compared with 2004, the greater the similarity. To illustrate the first aspect, we present the ranking of the development paths of the Old15 and New9 countries, determined using Hellwig's method, in Figure 3.

We do not observe any trends in either group. The Old15 countries, whose development is at a higher level, are marked in grey. The countries of the New9, whose level of development is much lower, are marked in black. It is clear that in the analysed period, the development paths of the two groups of countries are separated, which proves that the integration in 2004 did not significantly change the level of development of the insurance sectors in either of these groups. Throughout the entire period, one country significantly stands out: Greece, whose level of development is much lower than that of other countries in the Old15 group. Figure 3 presents the ranking (x-axis) and Hellwig's development measure (y-axis) for 2004 and 2018. The average level of development of the New9 countries remains constant while, for the Old15 countries, the average level of development slightly decreases. The change in Hellwig's development measure in 2018 compared with 2004 (in %) is shown in Figure 4 alphabetically.

To determine whether the average value of Hellwig's development measure for Old15 and New9 members is the same in individual years (an equal average would indicate similarity of the countries from both groups in terms of the level of development of insurance markets), two-sample Student's t-tests were conducted. The results, shown in Table 5, indicate that in each of the years, even those farthest from 2004 (the year of EU enlargement), the averages of the compared groups are

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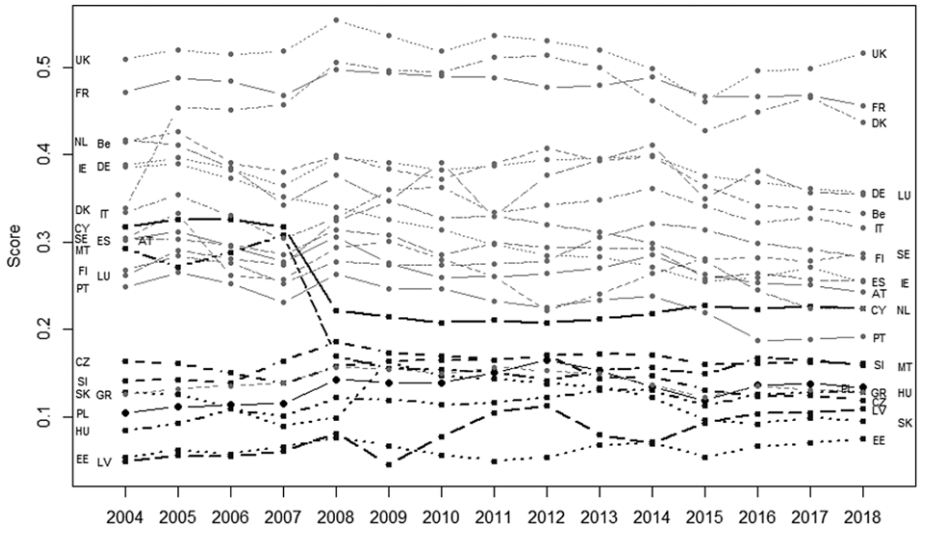

Figure 3. Development path of the Old15 and New9 during 2004–2018

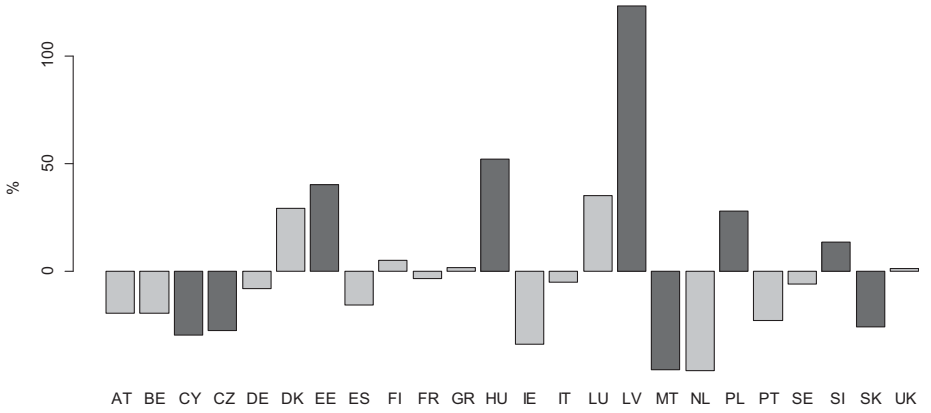

Figure 4. Change in Hellwig's development measure in 2018 compared to 2004 (in %)

significantly different from each other. This means that both groups of countries did not become similar in terms of the level of development.

The second aspect, i.e. the convergence in the sense of reducing the differences between countries due to development, is presented in Figure 5.

The results of the F-test to compare the variances of two samples (normality was checked with the Shapiro-Wilk normality test) are presented in Table 6. The results show the results of the F-test, which compares the variance of the development measure in the years 2005–2018 with the variance in 2004 for all EU countries together, as well as for the groups of Old15 and New9 members.

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Table 5. Results of two-sample Student's *t*-test

Year	*t*	*p*-value
2004	4.69798	0.00023
2005	5.21024	0.00007
2006	4.66029	0.00023
2007	4.17042	0.00066
2008	6.79774	0.00000
2009	6.37721	0.00000
2010	6.34837	0.00000
2011	6.17016	0.00000
2012	5.86270	0.00001
2013	6.22857	0.00000
2014	6.39621	0.00000
2015	6.27442	0.00000
2016	5.68666	0.00001
2017	5.51682	0.00002
2018	5.49146	0.00002

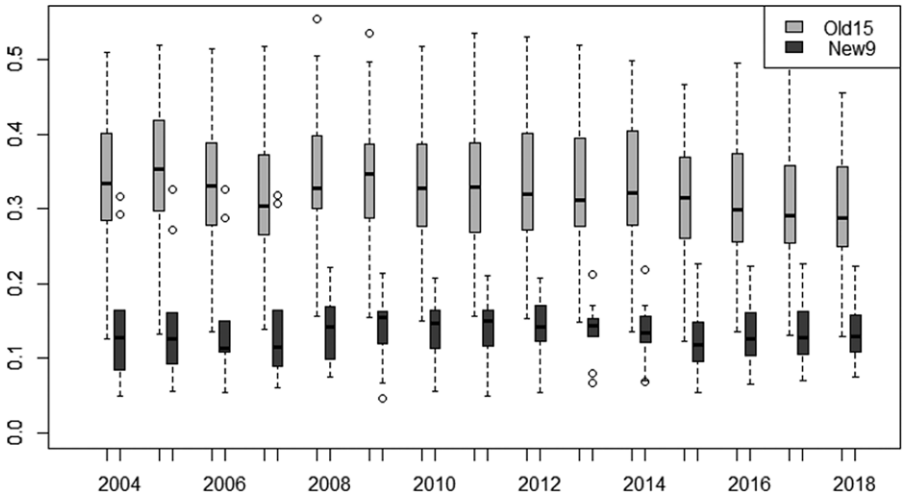

Figure 5. Development level of Old15 and New9 with the average in the years 2014–2018

The results presented in Table 6 confirm the absence of a reduction in the differentiation of the development measure, there is no convergence between the Old15 and the New9 EU members. However, convergence due to the reduction of the average difference from the mean can be observed starting from 2008 for the New9 members.

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Table 6. F test results

	Whole EU		Old		New	
Year	*F*	*p*-value	*F*	*p*-value	*F*	*p*-value
2005	1.097288	0.587135	1.066961	0.547403	0.909424	0.448233
2006	1.021562	0.520178	1.086495	0.560577	0.978109	0.487897
2007	0.96637	0.467665	1.126143	0.586386	1.041233	0.522085
2008	1.097279	0.587127	1.298225	0.684024	0.255742	0.035485
2009	1.045409	0.541944	1.263883	0.666365	0.316418	0.062004
2010	1.030721	0.528609	1.366618	0.716631	0.224411	0.024636
2011	0.995439	0.495675	1.374181	0.720034	0.214093	0.021519
2012	1.026976	0.525171	1.537341	0.784468	0.200369	0.017729
2013	1.045874	0.542362	1.455981	0.754408	0.201313	0.017976
2014	1.051968	0.547824	1.386803	0.725626	0.224187	0.024566
2015	0.85733	0.357574	1.078577	0.555273	0.246666	0.032132
2016	0.885105	0.386133	1.315268	0.692464	0.220439	0.023409
2017	0.867369	0.367918	1.341724	0.705148	0.21158	0.020794
2018	0.84961	0.34961	1.332275	0.700675	0.198006	0.017117

Analysis of the Similarity of Insurance Markets

In the third step of the research, we analyse the similarity of EU insurance markets in the years 2004–2018 using statistical methods of unsupervised classification. Clustering is performed using three methods: Ward's method, the k-means method, and the partitioning around medoids (PAM). The quality of clustering is evaluated and presented in Table 7, and the index validation clustering is calculated assuming that the number of groups is not smaller than two and not larger than six. The results of the cluster analysis are shown in Figure 6, and the Silhouette plots for this partition are presented in Figure 7.[a]

Analysing the results for 2004, we can see that the Silhouette index shows, depending on the adopted method, that the division into two or three groups is optimal, while the Calinski-Harabasz index prefers to focus on two or three groups. The remaining index, i.e., the Dunn index, depending on the method used, gives the optimal division into six groups (Ward's method and PAM method) or four groups (k-means method). The Xie-Beni index, depending on the method used, gives the optimal division into six groups (PAM method and Ward's method) or five groups (k-means method). Eventually, we decided to consider the division into three groups based on Ward's method, and we get three clusters, presented in Table 8.

Because of the results for 2018, and to be consistent, we opt for the clustering in three groups based on Ward's method. The obtained groups appear in Table 9.

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Table 7. Validation indices for data partitions for 2004 and 2018

	2004					2018				
	Number of clusters					Number of clusters				
Validation criterion	2	3	4	5	6	2	3	4	5	6
					Ward's method					
Silhouette	0.293	**0.313**	0.253	0.247	0.237	**0.656**	0.537	0.496	0.595	0.575
Calinski-Harabasz index	**10.888**	10.364	9.853	9.627	9.400	9.665	**10.160**	9.194	8.721	8.496
Dunn index	0.233	0.298	0.401	0.401	**0.418**	0.254	**0.328**	0.315	0.315	0.319
Xie-Beni index	1.895	1.426	1.143	0.936	**0.785**	1.436	1.050	1.376	1.154	**1.029**
					k-means					
Silhouette	**0.297**	0.272	0.249	0.246	0.297	0.300	**0.310**	0.189	0.176	0.221
Calinski-Harabasz index	9.480	**10.106**	9.662	9.251	9.480	10.805	**11.003**	9.806	9.609	10.716
Dunn index	0.237	0.357	**0.401**	0.358	0.237	0.192	**0.289**	0.162	0.244	0.206
Xie-Beni index	1.473	1.421	**0.934**	1.213	1.473	2.410	**1.755**	4.612	2.262	2.865
					PAM					
Silh0uette	0.285	**0.303**	0.223	0.252	0.240	0.208	**0.216**	0.179	0.134	0.137
Calinski-Harabasz index	**10.841**	10.239	8.722	9.622	9.572	8.604	**9.215**	8.957	7.970	7.374
Dunn index	0.234	0.299	0.298	0.401	**0.420**	0.201	0.263	**0.303**	0.295	0.289
Xie-Beni index	1.877	1.419	1.227	0.936	**0.766**	2.353	1.743	1.397	1.291	**1.179**

Note: Numbers in bold indicate the optimal number of groups with reference to a given criterion.

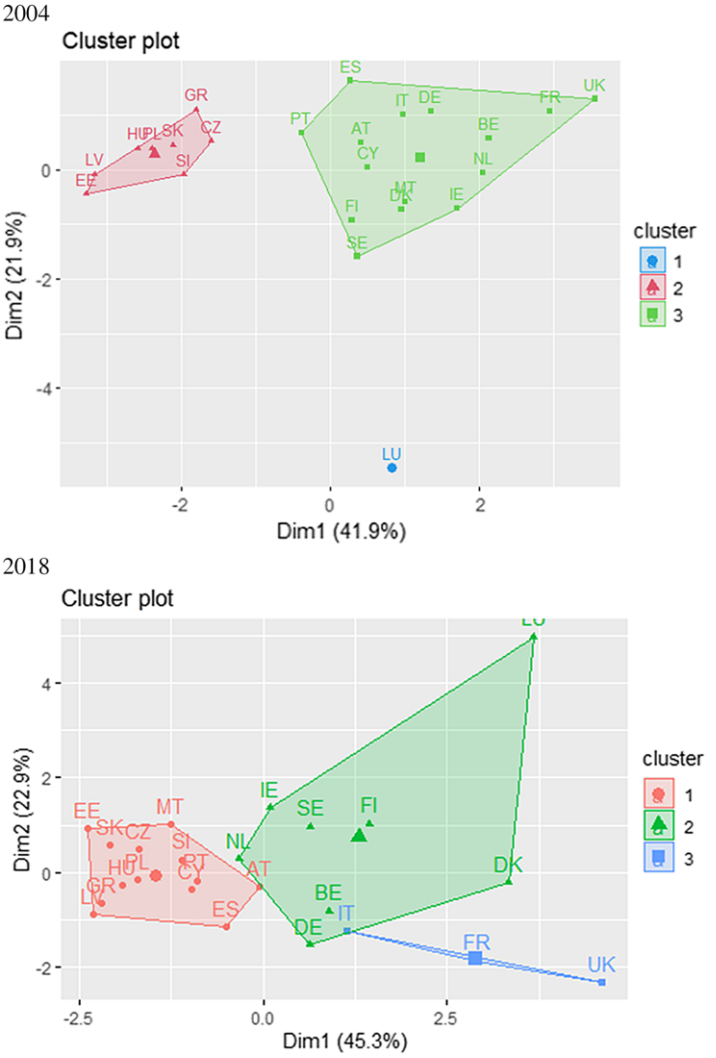

Figure 6. Cluster analysis results for 2004 and 2018

Discussion and Conclusions

A high share of insurance in the market structure is generally treated as a certificate of maturity of this market. Insurance awareness is a very important element of the prosperous economy of the country. It allows citizens to use the available insurance offer, which protects against the risk of adverse fortuitous events.

Insurance markets of individual countries develop under the influence of various factors, which can be divided into economic, demographic, cultural, social, and structural. They can affect the insurance market both positively and negatively. Economic factors are a very important element in the development of life and non-

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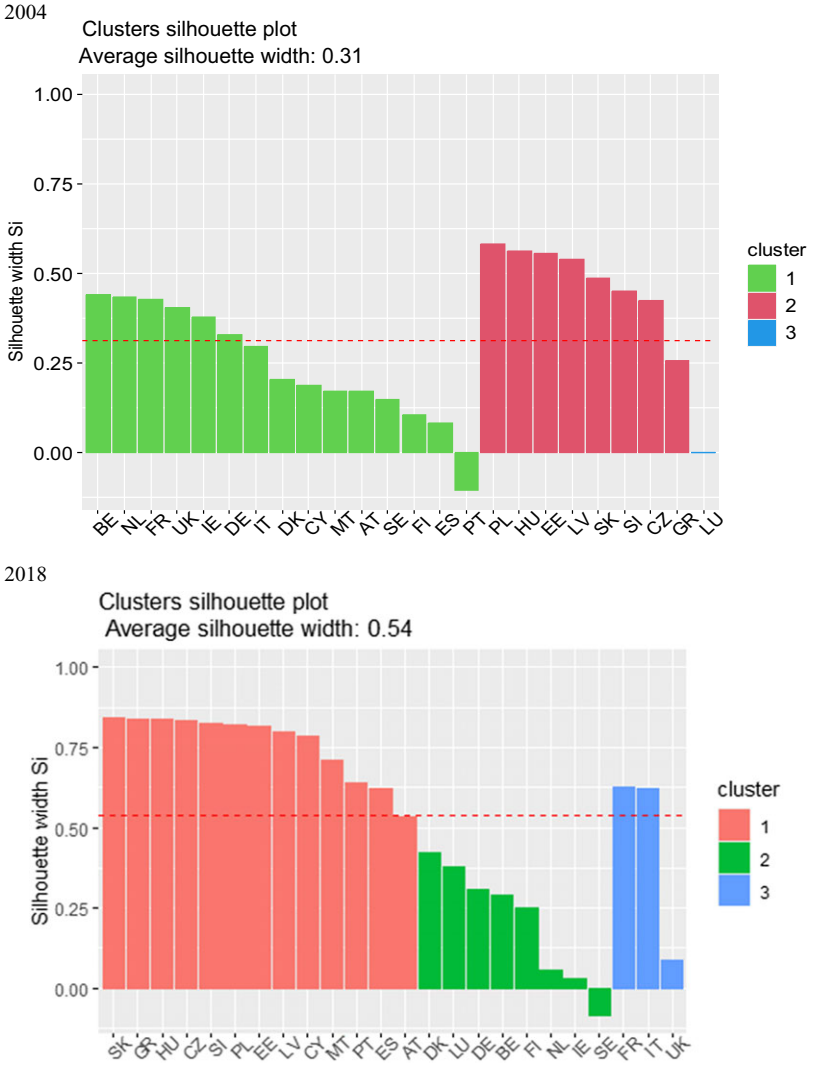

Figure 7. Silhouette plot for clustering in 2004 and 2018

life insurance. Insurance demand certainly largely depends on the amount of disposable income per capita – the higher the income, the higher the level of demand and development of life insurance, assuming a relatively low level of inflation. Low-income entities have a higher risk tolerance, so their insurance demand is low. On the other hand, entities that have larger assets at risk of loss report greater demand for insurance products. Demand for insurance services also depends on the price of this service, i.e. the insurance premium.

Other structural factors are also important in the development of insurance, such as the political decisions regarding the promotion of competition from foreign insurers or the direct provision of insurance by the public sector. Tax credit for the

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Table 8. The groups based on Ward's method for 2004

Cluster 1	Cluster 2	Cluster 3
Austria (AT), Belgic (BE), Cyprus (CY), Germany (DE), Denmark (DK), Spain (ES), Finland (FI), France (FR), Ireland (IE), Italy (IT), Malta (MT), Nederland (NL), Sweden (SE), United Kingdom (UK), Portugal (PT)	Czech Republic (CZ), Greece (GR), Hungary (HU), Latvia (LV), Poland (PL), Slovenia (SI), Slovakia (SK), Estonia (EE)	Luxemburg (LU)

Table 9. The groups based on Ward's method for 2018

Cluster 1	Cluster 2	Cluster 3
Slovakia (SK), Greece (GR), Hungary (HU), Czech Republic (CZ), Slovakia (SK), Poland (PL), Estonia (EE), Slovenia (SI), Latvia (LV), Cyprus (CY), Malta (MT), Portugal (PT), Spain (ES), Austria (AT)	Denmark (DK), Luxemburg (LU), Germany (DE), Belgic (BE), Finland (FI), Ireland (IE), Sweden (SE)	France (FR), Italy (IT), United Kingdom (UK)

purchase of pension insurance, as well as the level of development of social security systems, have a positive impact on the demand in the insurance market. In countries with low GDP per capita, security systems are usually underdeveloped. In richer countries, non-economic factors tend to limit the growth of Section I insurance, because a higher GDP per capita is accompanied by an increase in benefits from the social security system, which in turn has a negative impact on the development of life insurance.

The correct selection of factors is a condition for obtaining correct results in the study of the insurance structure of a given country. Between the groups of the Old15 and the New9 after 2004 there was a fairly large variation in the characteristics of insurance. In this work, multi-dimensional analysis was used to reveal similarities and differences between the individual countries in these groups of countries, in particular in 2005 and 2018.

The analysis of insurance sectors carried out in this paper indicates the persistent differences in the level of development between the analysed groups of the Old15 and New9 EU countries. And although we can observe a growing trend of some variables, e.g. Total assets, and GDP, the average level of development remains at the same level, because, for example, the number of companies is decreasing. We also note that selected variables, such as gross written premium, penetration, or density, react dynamically to crises. The analysis of the similarity also indicates a lack of any real integration in the European insurance sector. For a number of years, the New9

have not become similar to the Old15 members of the EU. In 2009, due to the subprime crisis, we also observed a breakdown of the group of Old15 states.

The presented research on the development and similarity of EU countries is innovative due to the methodology used – a multidimensional approach, and the long period of empirical research conducted.

The presented analysis leads us to reject the main hypothesis, in which we assumed that the insurance sectors in the studied groups Old15 and New9 became similar. Thus, it confirms the results of the research conducted by Jagric *et al.* (2018).

Countries that joined the Union in 2004, until 2018, have not overcome the differences in the structure of insurance sectors compared with Old15. The analysis of each group of Old15 and New EU9 countries is illustrated in the figures in the first, statistical analysis.

Further, based on Hellwig's method and using two samples of Student's *t*-test we confirm the differentiation of the development of insurance sectors in these groups. It shows that each country did not change the level of development of the insurance sector after 2004. At the same time, the results shown in Figure 5, and the F-test result in Table 6, permit us to confirm that, in the New9 group, the insurance sectors are converging. On the other hand, the lack of reduction in the differentiation of the development measure for all countries together and Old15 indicates that the insurance sectors in the group of all countries and in the Old15 group, unfortunately, do not converge.

Using clustering methods, we find that in each of the years under consideration, the countries that joined the EU in 2004 and additionally Greece, belong to the same groups (the only exceptions here are Malta and Cyprus in 2004). Moreover, these groups are characterized by the highest Silhouette clustering quality index (cf. Figure 7; in red on the left). This indicates a similarity between the insurance markets of these countries in 2004. In 2018, Portugal, Spain and Austria joined the group of all New9 countries along with Greece (Figure 7; in red on the right). After 15 years of common EU policy, this is the strongest group. Countries such as Austria, Spain and Portugal, which belong to the same group with New9, are at the end of the silhouette chart, which indicates a weaker belonging to this group (Figure 7; red colour). We can say that after 15 years of membership of the EU, the insurance markets of Poland, Estonia, Latvia, Slovakia, the Czech Republic, Hungary, Slovenia, Malta, and Cyprus still form a separate group and remain a very similar one to another group, New9. When compared with the insurance markets of the Old15 they are closest to Greece, Portugal, and Spain.

When examining the state of development of European Union insurance markets, it can be seen that a great distance still separates Central and Eastern European countries from Western market levels. Nevertheless, the insurance industry is developing very dynamically in these countries. In each analysed period, changes in the insurance structure of these countries can be seen. It is worth adding that the Polish insurance market has great potential for further development.

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Conflicts of Interest/Competing Interests

There are no conflicts of interest to declare.

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Note

a. We use the 'clusterSim' package developed by M. Walesiak and A. Dudek (Silhouette and Calinski-Harabasz index) and the 'clusterCrit' package developed by Bernard Desgraupes (Dunn and Xie-Beni index).

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About the Authors

Anna Denkowska is Professor at the Mathematics Department of the Cracow University of Economics (Poland); MSc and PhD in Mathematics (Jagiellonian University). Her research interests include functional analysis, singularity theory, statistics, risk modelling and network theory.

Stanisław Wanat is Professor at the Mathematics Department of the Cracow University of Economics (Poland); MSc in Mathematics (Jagiellonian University), PhD in Economics (Cracow University of Economics), DSc – Habilitation in Economics (Cracow University of Economics). His research interests include statistics, actuarial methods, risk modelling and forecasting.

João Paulo Vieito is Professor at the Polytechnic Institute of Viana do Castelo; MSc in Finance (Catholic University of Porto), PhD in Management Sciences – finance specialization, Faculty of Economics and Management (University of Porto), Managing Director at the School of Business Sciences at the Polytechnic Institute of Viana do Castelo, MBA in Operations Management (Portuguese Catholic University) and a degree in Management (ISCTE). His research interests include business administration, gender, gender studies, gender equality, gender differences, neuroeconomics, neurofinance, behavioural finance, gender and development, capital structure, stocks, sociology, markets, economy, finance, mergers, investment, banking, and financial risk management.