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https://doi.org/10.33995/wu2023.2.5
data wpływu: 12.04.2023
data akceptacji: 09.08.2023

Income elasticity of demand for agricultural insurance in Poland in 2006–2020

Knowledge of income elasticity of demand for individual products is necessary to forecast the volume and structure of demand. The purpose of this article is to estimate the income elasticity of different types of agricultural insurance in Poland and to indicate the consequences for future demand for this insurance. According to the results of the analysis carried out for the years 2000–2020, premium from crop insurance to the greatest extent – compared to other types of agricultural insurance – depends on both GDP and disposable income (per farmer's household or per person in the household). Income elasticity – respectively 3.05 in relation to GDP for compulsory crop insurance and 2.07 for voluntary crop insurance – indicates that these kinds of insurance should be classified as superior goods. Other types of agricultural insurance – farmer's liability insurance (income elasticity 0.78) and insurance of agricultural buildings (0.65) are normal goods. This means that with an increase in income, ceteris paribus, the share of farmers' expenditure on crop insurance in the budget allocated by them for the purchase of agricultural insurance will increase.

Keywords: agricultural insurance, income elasticity, risk management, crop insurance, demand for insurance

Introduction

Demand for insurance is affected by a range of factors. The most important ones with reference to property insurance are[1]: income, property, demographics, trust, judiciary efficiency and loan

1. T. H. Bednarczyk, *Ekonomiczne i instytucjonalne czynniki rozwoju ubezpieczeń*, „Wiadomości Ubezpieczeniowe", 2011 No 4, pp. 85–106; K. Poposki, J. Kjosevski, Z. Stojanovski, *The Determinants of Non-Life Insurance Penetration in Selected Countries from South Eastern Europe*, „Economics and Business Review", 2015 No 3, pp.. 20–37; G. Millo, G. Carmeci, *Non-Life Insurance Consumption in Italy : A Sub-Regional Panel Data Analysis*, „Journal of Geographical

terms as well as the market share occupied by insurance companies controlled by foreign firms. All these factors play a crucial role in particular with regard to voluntary insurance, where the insurance decision is not imposed and subject to sanctions.

In economics, elasticity is a measure which reflects the response of one quantity (dependent variable) to a change in another quantity (independent variable).[2] Income elasticity of demand is an expression of relative changes in demand which occur under the influence of relative changes in income.[3] Knowledge about income elasticity of demand for particular products is necessary for making predictions about the amount and structure of demand which result from changes in income due to economic growth or increase in affluence levels etc.[4] Knowledge of income elasticity of demand is especially indispensable when it comes to predicting the structure of consumer spending including insurance expenses.

Insurance is treated as one of the key instruments in risk management in agriculture, both locally (as proven by the outcomes of the Gospostrateg project completed in 2022, titled "Private insurance in holistic risk management oriented toward sustainability, implementing innovation and technology as well as preventing climate change") and internationally.[5] The degree of its prevalence in Poland when it comes to voluntary insurance is much lower than expected and raises a lot of controversy.[6] The crucial question in this context is whether too low income, mostly spent on staples, is the main hindrance on the demand side and whether its growth may possibly lead to the increase in demand.

The main goal of the present article is to answer the following question: what is the income elasticity of demand for particular agricultural insurance types and how it will affect the future demand for them? The subject literature so far, including research on the Polish market, has been rather insufficient.

To elucidate the issue above, an overview of the available subject literature has been conducted (1), along with calculations of the income elasticity index by means of a double log function based on the 2006–2020 data (2), and the results have been interpreted (3).

1. Literature review

Agricultural insurance encompasses a wide array of products. When it comes to property insurance intended for farmers, there are two types of *sensu stricto* obligatory insurance, i.e. insurance against

Systems", 2011 No 3, pp. 273–98; M.J. Browne, J. Chung, E.W. Frees, *International Property-Liability Insurance Consumption*, „Journal of Risk and Insurance", 2000 No 1, pp. 73–90; M.T. M. Garcia, *Determinants of the Property-Liability Insurance Market : Evidence from Portugal*, „Journal of Economic Studies", 2012 No 4 (2012), pp. 440–50.

2. S. Mynarski, *Analiza Rynku. Makromechanizmy*, Wydawnictwo Akademii Ekonomicznej w Krakowie, Cracow: 2000, p. 32.
3. D. Begg, S. Fischer, R. Dornbusch, *Ekonomia. Mikroekonomia*, wyd. II, Polskie Wydawnictwo Ekonomiczne, Warsaw: 2000, p. 134.
4. ibidem, p. 136.
5. cf.. e.g. *Study on Risk Management in EU Agriculture: Final Report*, ed. by O. Chartier, E. Cronin, Publications Office of the European Union, Luxembourg: 2017; OECD, *Managing Risk in Agriculture: Policy Assessment and Design*, OECD Publishing, 2011.
6. MRiRW, *Ubezpieczenia z uwzględnieniem stabilizacji dochodów jako instrumenty zarządzania ryzykiem w rolnictwie*, Warsaw, 29 September 2020.

fire and other random events for all buildings included in the farming household (further referred to as farm buildings insurance) and farmer's liability insurance due to owning a farm (further called farmer liability insurance). Also, there is one obligatory crop insurance[7] (the insurance obligation refers to 50% of the farmland acreage where crops are grown against at least one of the following five events: winter kill, spring frost, hail, drought or flood). Additionally, there is voluntary insurance covering crops, buildings (supplementary), liability, movable property and farm animals.

As for crop insurance, which absolutely dominate research subjects, a lot of various factors are listed which affect purchasing decisions, such as primarily[8]: income level, property, farm size, output value, production diversification, compensations received in the past (amount and frequency), price, liquidity, perceptions of threats as well as likelihood and amount of potential losses, exposure to threats, past shifts in yield and income; also, farmer's risk aversion and socio-demographic qualities, the scope and amount of insurance cover from the public systems, farming practices (e.g. level of fertilizing or watering), participation in mutual funds.

The findings of the research conducted in Poland with regard to demand for crop insurance emphasise the significance of such factors as[9]: past damage to the crops, compensations recei-

7. A terminology is used here which divides compulsory insurance into compulsory insurance *sensu stricto* and other compulsory insurance (*sensu largo*). Cf.. *Stan prawny ubezpieczeń obowiązkowych w Polsce: wykaz z komentarzem*, ed. E. Kowalewski, compiled by M. P. Ziemiak, co-compiled by W. W. Mogilski, „Wiadomości Ubezpieczeniowe" 2015, No 1 (supplement)., M. P. Ziemiak, *Stan ubezpieczeń obowiązkowych w Polsce w latach 2016–2021*, „Wiadomości Ubezpieczeniowe", 2022 No 3.

8. V. H. Smith, J. W. Glauber, Agricultural Insurance in Developed Countries: Where Have We Been and Where Are We Going?, „Applied Economic Perspectives and Policy", 2012 No 3, pp. 363–90; S. Cole, D. Stein, J. Tobacman, Dynamics of Demand for Index Insurance: Evidence from a Long-Run Field Experiment, „American Economic Review", 2014 No 5, pp. 284–90; V. A. Ogurtsov, M. A. P. M. van Asseldonk, R. B.M. Huirne, Purchase of Catastrophe Insurance by Dutch Dairy and Arable Farmers, „Review of Agricultural Economics", 2009 No 1, pp. 143–62; B. J. Sherrick, B. J. Barry, P. N. Ellinger, G. D. Schnitkey, Factors Influencing Farmers Crop Insurance Decisions, „American Journal of Agricultural Economics", 2004 No 1, pp. 103–14; G. Enjolras, F. Capitanio, F. Adinolfi, The Demand for Crop Insurance: Combined Approaches for France and Italy, „Agricultural Economics Review", 2012 No 1, pp. 5–22; K. H. Coble, T. O. Knight, R. D. Pope, J. R. Williams, Modeling Farm-Level Crop Insurance Demand with Panel Data, „American Journal of Agricultural Economics", 1996 No 2, pp. 439–47; V.H. Smith, B.K. Goodwin, Crop Insurance, Moral Hazard, and Agricultural Chemical Use, „American Journal of Agricultural Economics", 1996 No 78, pp. 428– 438; S. Cole, X. Giné, J. Tobacman, P. Topalova, R. Townsend, J. Vickery, Barriers to Household Risk Management: Evidence from India, „American Economic Journal: Applied Economics", 2013 No 1, pp. 104–135; M. P. M. Meuwissen, T. T. Assefa, M. A.P. M. Van Asseldonk, Supporting Insurance in European Agriculture: Experience of Mutuals in the Netherlands, „EuroChoices", 2013 No 3, pp. 10–16; C.M.R Tsikirayi, E. Makoni, J. Matiza, Analysis of the Uptake of Agricultural Insurance Services by the Agricultural Sector in Zimbabwe, „Journal of International Business and Cultural Studies", 2013 No 7, pp. 1–14; F. Liu, Ch. P. Corcoran, J. Taoa, J. Cheng, Risk Perception, Insurance Recognition and Agricultural Insurance Behavior – An Empirical Based on Dynamic Panel Data in 31 Provinces of China, „International Journal of Disaster Risk Reduction", 2016 No 20, pp. 19–25; H. Feng, X. Du, D. A. Hennessy, Depressed Demand for Crop Insurance Contracts , and a Rationale Based on Third Generation Prospect Theory, „Agricultural Economics", 2020 No 51, pp. 59–73; X. Du, H. Feng, D.A. Hennessy, Rationality of Choices in Subsidized Crop Insurance Markets, „American Journal of Agricultural Economics", 2016 No 99, pp. 732–56; A. Zubor-Nemes, J. Fogarasi, A. Molnár, G. Kemény, Farmers ' Responses to the Changes in Hungarian Agricultural Insurance System, „Agricultural Finance Review", 2018 No 2, pp. 275–88.

9. V. H. Smith, J. W. Glauber, *Agricultural Insurance in Developed Countries: Where Have We Been and Where Are We Going?*, „Applied Economic Perspectives and Policy", 2012 No 3, pp. 363–90; S. Cole, D. Stein, J. Tobacman, *Dynamics of Demand for Index Insurance: Evidence from a Long-Run Field Experiment*, „American Economic Review", 2014 No 5, pp. 284–90; V. A. Ogurtsov, M. A. P. M. van Asseldonk, R. B.M. Huirne, *Purchase of Catastrop-*

ved and their adequacy levels, farm location, soil quality, output value, economic size of a farm, investment subsidies, production specialization, ecological production, farm area size, dominant crop, perception of threats, opinion about the need for insurance and its cost, farm's income, annual average value of short – and long-term loans, financial help from the community, implementation of new technologies and plant varieties, age and education of the farmer in charge, acceptance for a highly specialised production on the farm, the manner in which the farm is linked to the market, intensity of organisation. Furthermore, the research devoted to *ex-ante* demand for the new crop insurance solution, i.e. index-based insurance against the consequences of drought in Poland (whose introduction has been broadly discussed for quite a long time) shows significance of: frequency of covering damage by insurance, the age of the insurer, their opinion about insurance, location, the degree of initial acceptance for the product (acceptance of the new index-based construction at a given price).[10]

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he Insurance by Dutch Dairy and Arable Farmers, „Review of Agricultural Economics", 2009 No 1, pp. 143–62; B. J. Sherrick, B. J. Barry, P. N. Ellinger, G. D. Schnitkey, *Factors Influencing Farmers Crop Insurance Decisions*, „American Journal of Agricultural Economics", 2004 No 1, pp. 103–14; G. Enjolras, F. Capitanio, F. Adinolfi, *The Demand for Crop Insurance: Combined Approaches for France and Italy*, „Agricultural Economics Review", 2012 No 1, pp. 5–22; K. H. Coble, T. O. Knight, R. D. Pope, J. R. Williams, *Modeling Farm-Level Crop Insurance Demand with Panel Data*, „American Journal of Agricultural Economics", 1996 No 2, pp. 439–47; V.H. Smith, B.K. Goodwin, *Crop Insurance, Moral Hazard, and Agricultural Chemical Use*, „American Journal of Agricultural Economics", 1996 No 78, pp. 428– 438; S. Cole, X. Giné, J. Tobacman, P. Topalova, R. Townsend, J. Vickery, *Barriers to Household Risk Management: Evidence from India*, „American Economic Journal: Applied Economics", 2013 No 1, pp. 104–135; M. P. M. Meuwissen, T. T. Assefa, M. A.P. M. Van Asseldonk, *Supporting Insurance in European Agriculture: Experience of Mutuals in the Netherlands*, „EuroChoices", 2013 No 3, pp. 10–16; C.M.R Tsikirayi, E. Makoni, J. Matiza, *Analysis of the Uptake of Agricultural Insurance Services by the Agricultural Sector in Zimbabwe*, „Journal of International Business and Cultural Studies", 2013 No 7, pp. 1–14; F. Liu, Ch. P. Corcoran, J. Taoa, J. Cheng, *Risk Perception, Insurance Recognition and Agricultural Insurance Behavior– An Empirical Based on Dynamic Panel Data in 31 Provinces of China*, „International Journal of Disaster Risk Reduction", 2016 No 20, pp. 19–25; H. Feng, X. Du, D. A. Hennessy, *Depressed Demand for Crop Insurance Contracts , and a Rationale Based on Third Generation Prospect Theory*, „Agricultural Economics", 2020 No 51, pp. 59–73; X. Du, H. Feng, D.A. Hennessy, *Rationality of Choices in Subsidized Crop Insurance Markets*, „American Journal of Agricultural Economics", 2016 No 99, pp. 732–56; A. Zubor-Nemes, J. Fogarasi, A. Molnár, G. Kemény, *Farmers ' Responses to the Changes in Hungarian Agricultural Insurance System*, „Agricultural Finance Review", 2018 No 2, pp. 275–88. *Protection Used by Polish Farmers*, 108st EAAE Seminar 'Income stabilisation in a changing agricultural world: policy and tools', Warsaw, Poland, 8–9 February 2008; A. Wicka, *Ubezpieczenia rolne jako metoda zarządzania ryzykiem w opinii rolników*, „Zeszyty Naukowe Uniwersytetu Szczecińskiego. Finanse, Rynki Finansowe, Ubezpieczenia", 2014 No 67, pp. 255–64; M. Kaczała, *Systemowe ryzyko suszy rolniczej a ubezpieczenia. Zadania dla państwa*, Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu, Poznań 2019, A Bezat-Jarzębowska, J. Herda-Kopańska, *Czynniki endogenne w rolnictwie a skłonność do korzystania z ubezpieczeń – ujęcie analityczne*', w *Analizy popytu i podaży na rynku ubezpieczeń rolnych*, ed. M. Soliwoda, Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej – Państwowy Instytut Badawczy, Warszawa 2021, pp. 265–91; A. Wąs, P. Sulewski, P. Kobus, G. Rawa, M. Gołaś, W. Ignaciuk, *Determinanty uczestnictwa polskich rolników systemie ubezpieczeń produkcyjnych*, w *Analizy popytu i podaży na rynku ubezpieczeń rolnych*, w *Analizy popytu i podaży na rynku ubezpieczeń rolnych*, ed. M. Soliwoda, Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej – Państwowy Instytut Badawczy, Warszawa 2021, pp. 292–321

10. M. Kaczała, D. Wiśniewska, *Factors Influencing Farmers' Decisions on Drought Index Insurance in Poland*, *The Third World Risk and Insurance Economics Congress (WRIEC), 2–6 August 2015, Munich*, 2014; J. Handschke, M. Kaczała, K. Łyskawa, *Koncepcja polis indeksowych i możliwość ich zastosowania w systemie obowiązko-*

The research which tackled the subject of income elasticity of demand showed that it is positive and usually higher than 1 for non-life insurance.[11] The same elasticity is found by research on crop insurance.[12] It is also assumed that income elasticity for insurance is generally contingent on the country development, i.e. it is higher in developing countries than in countries which are less developed or really advanced economies.[13] The latter hypothesis, however, with reference to aggregate data in life and non-life sectors raises doubts.[14]

2. Measurement of income elasticity of demand

2.1. Method of measurement

Income elasticity of demand can be measured in various ways[15], which affects the results obtained[16].

In order to examine the relation between the written premium[17] and the income at the macro level a power function can be used[18].

$$WP \doteq \alpha_0 \times I^{\alpha_1} \quad (1)$$

where:
WP = gross written premium
I = income
α_0, α_1 – function parameters

wych dotowanych ubezpieczeń upraw w Polsce, PIU, Warszawa 2015; M. Kaczała, K. Łyskawa, *Konstrukcja ubezpieczenia indeksowego suszy w zakresie wybranych upraw i jego akceptacja przez rolników w Polsce*, w *Weryfikacja praktyczna proponowanych produktów ubezpieczeniowych i skonstruowanie systemu holistycznego zarządzania ryzykiem (pilotaż)*, ed. M. Soliwoda, Instytut Ekonomiki Rolnictwa i Gospodarki Żywnościowej – Państwowy Instytut Badawczy, Warszawa 2022, pp. 318–45.

11. M. Beenstock, G. Dickinson, S. Khajuria, *The Relationship Between Property-Liability Insurance Premiums and Income: An International Analysis*, „Journal of Risk and Insurance", 1998 No 2, pp. 259–72; J. F. Outreville, *The Economic Significance of Insurance Markets in Developing Countries*, „The Journal of Risk and Insurance", 1990 No 3, pp. 487–98; T. Holzheu, G. Turner, *The Natural Catastrophe Protection Gap : Measurement , Root Causes and Ways of Addressing Underinsurance for Extreme*, „The Geneva Papers on Risk and Insurance – Issues and Practice", 2018 No 1, pp. 37–71; G. Millo, *The Income Elasticity of Non-Life Insurance: A Reassessment*, Working Paper WP1/2014.
12. F. Liu I in., *op. cit.*
13. R. Enz, *The S-Curve Relation Between Per-Capita Income and Insurance Penetration*, „The Geneva Papers on Risk and Insurance", 2000 No 3, pp. 396–406.
14. G. Millo, *The S-Curve and Reality*, „The Geneva Papers", 2016 No 4, pp. 608–25; Ch. Yuan, Y. Jiang, *The Marginal Propensity to Insure: An International Analysis*, „International Review of Economics & Finance", 2020 No 69, pp. 102–9.
15. S. Mynarski, *Analiza rynku. Problemy i* metody, Państwowe Wydawnictwo Naukowe, Warszawa 1987.
16. M. Sznajder, G. Adamczyk, *Ocena metod wyznaczania współczynnika elastyczności dochodowej popytu*, „Acta Scientiarum Polonorum. Seria Oeconomica", 2003 No 1, pp. 25–41.
17. "Insurance premium is a financial benefit offered by the policyholder to the insurance company in return for insurance cover" (D. Maśniak, *Prawo ubezpieczeniowe*, Wydawnictwo Uniwersytetu Gdańskiego, Gdańsk 2020, p. 19). Therefore it is a price which the policyholder pays for insurance service.
18. P. Zweifel, R. Eisen, D. L Eckles, *Insurance Economics*, 2nd ed.,Springer, 2021, p. 16.

This function when logarithmized takes the form[19]:

$$\ln WP \hat{=} ln\alpha_0 + \alpha_1 \times lnI \tag{2}$$

thus becoming a linear function (also called a log-linear one). Slope of this function α_1 is the measure of income elasticity for the gross written premium.[20] The slope is constant and independent of the income level. The form of a model makes it impossible to identify the limiting level (the function has no asymptote).

In the case when $\alpha_1 > 1$, the increase in expenditure on insurance is faster than the increase in the income and the written premium grows limitlessly in an accelerated manner. On the other hand, if $\alpha_1 = 1$, the written premium grows in a linear way in relation to income, while when $0 < \alpha_1 < 1$, the increase in spending on insurance is relatively lower than the increase in income, which means that the written premium grows, but the growth is slower. When $\alpha_1 < 0$, the increase in income leads to a drop in spending on insurance.

The analysis was conducted with reference to the types of insurance which present available data, i.e. crop insurance (both obligatory and voluntary), farm buildings insurance and farmer's liability insurance. The calculations were conducted on the basis of annual data from 2006 (when obligatory crop insurance was introduced) to 2020. The only aspect for which years 2006–2021 were taken into consideration was the gross written premium for obligatory crop insurance, as the data for 2021 was also available. According to Statistics Poland (GUS), the average price index of consumer goods and services in 2006–2020 amounted to 102.0 (in 2006–2021 it was 102.2 respectively), so for the sake of calculations nominal values of data were applied.

2.2 Research findings

At the macro level, income can be measured by means of GDP. It is a general measurement reflecting the overall condition of a given country's economy, i.e. its total production of goods and services. Fig. 1 presents the correlations between the nominal gross written premium for particular types of agricultural insurance and the nominal GDP in values of which logarithm has been taken.

19. This function is called a double logarithmic function and it was introduced in the description of relations between demand and income by S.J. Prais (S.J. Prais, *Non-Linear Estimates of the Engel Curves*, „The Review of Economic Studies", 1953 No 2, pp. 87–104).

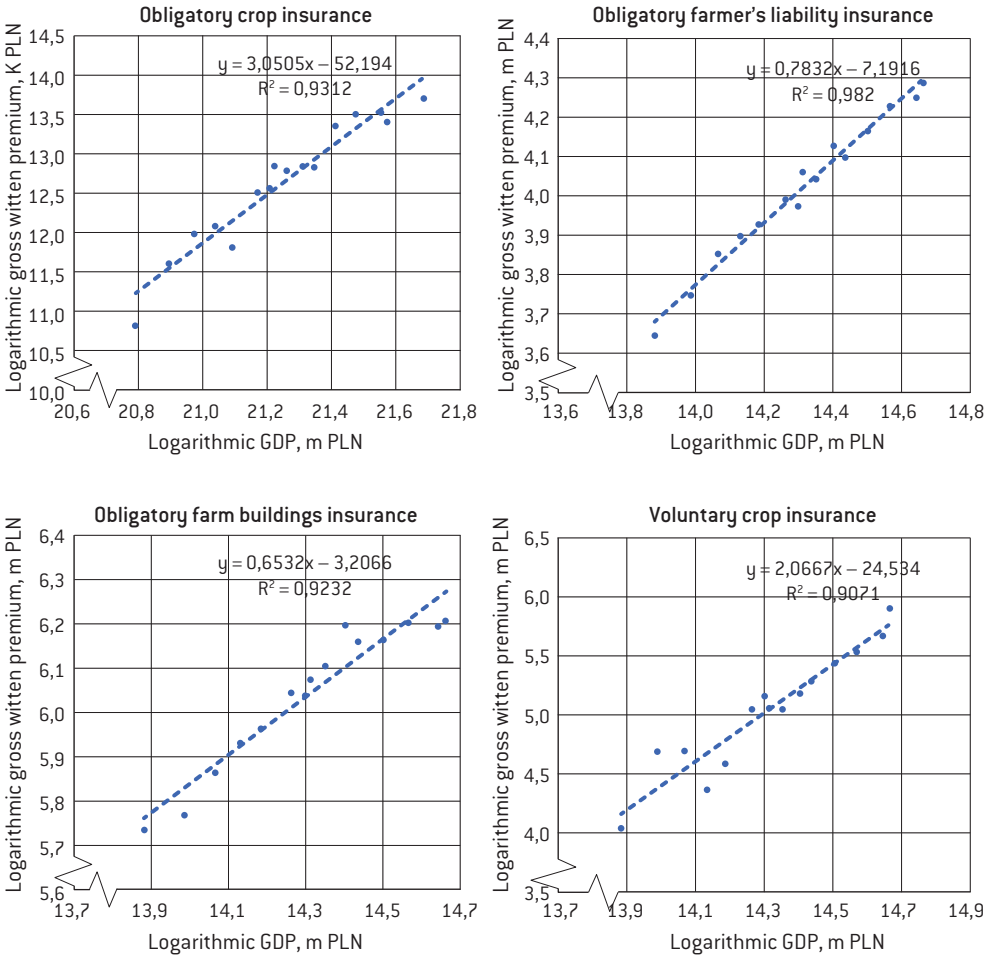
20. Income elasticity of the function is calculated by means of the following formula:

$$E_y = \lim_{\Delta x \to 0} \left(\frac{\Delta y}{y} \div \frac{\Delta x}{x} \right) = \frac{x}{y} \times \frac{dy}{dx} = \frac{x}{y} \times f'(x)$$

In the case of a power function:

$$E_y = (\alpha_0 \times x^{\alpha_1})' \times \frac{x}{\alpha_0 \times x^{\alpha_1}} = \frac{\alpha_0 \times \alpha_1 x^{\alpha_1 - 1} \times x}{\alpha_0 \times x^{\alpha_1}} = \alpha_1$$

Graph 1. Gross written premium for agricultural insurance and GDP in Poland in 2006–2020



Source: author's own computations based on data from Ministry of Agriculture and Rural Development (MRiRW) and Statistics Poland (GUS).

The presented correlations show that a 1% increase in GDP results, *ceteris paribus*, in the relatively fastest and more than proportional increase in written premium for crop insurance – more than twice as fast as the rate of GDP growth in voluntary insurance and three times as fast in compulsory insurance. On the other hand, the written premium for other obligatory agricultural insurance types is less than proportionate. The GDP increase of 1% results in, *ceteris paribus*, a growth in written premium of 0.65% for farm buildings insurance and 0.78% for farmer's liability insurance. It has to be emphasised that with respect to all non-life insurance in Poland (including agriculture insurance), income elasticity of demand measured in the aforementioned way amounts to 1.21 which is significantly lower than income elasticity for crop insurance and higher than elasticity for all other agricultural insurance types.

By using the formula (1) the correlation between GDP and the written premium for agricultural insurance can be presented in the following ways:

for obligatory crop insurance

$$WP_{obligatory\ crop} \hat{=} e^{-52,19} \times GDP^{3,05}$$

for voluntary crop insurance

$$WP_{voluntary\ crop} \hat{=} e^{-24,53} \times GDP^{2,07}$$

for obligatory farm buildings insurance

$$PS_{farm\ buildings} \hat{=} e^{-3,21} \times GDP^{0,65}$$

for obligatory farmer's liability insurance

$$PS_{farm's\ liablity} \hat{=} e^{-7,19} \times GDP^{0,78}$$

Due to the fact that GDP reflects the condition of the whole economy and does not refer solely to the agricultural sector, the analysis has been supplemented with additional study of written premium elasticity in relation to the disposable income of farmers' households per 1 household and to the disposable income of farmers' households per 1 person. The findings of the complete analysis have been presented in Table 1.

Table 1. Income elasticity of demand for agricultural insurance in Poland in 2006–2020 – estimation results

Insurance type	Elasticity in relation to GDP	Elasticity in relations to the disposable income of farmers' households	Elasticity in relations to the disposable income of farmers' households per 1 person
Obligatory crop	3,05**	2,56**	2,54**
Farm buildings	0,65**	0,48**	0,48**
Farmer's liability	0,78**	0,62**	0,62**
Voluntary crop	2,06**	1,70**	1,69**
Non-life insurance in Poland	1,21**	1,0**	1,0**

** statistical significance <=0,01

A coefficient of determination has been computed to verify the quality of the model (table 2).

Table 2. Coefficient of determination R^2 for particular models estimating income elasticity of demand for agricultural insurance in Poland in 2006–2020

Insurance type	Elasticity in relation to GDP	Elasticity in relations to the disposable income of farmers' households	Elasticity in relations to the disposable income of farmers' households per 1 person
Obligatory crop	0,93	0,84	0,84
Farm buildings	0,92	0,72	0,72
Farmer's liability	0,98	0,87	0,88
Voluntary crop	0,91	0,87	0,87
Non-life insurance in Poland	0,97	0,95	0,95

Additionally, it has been checked whether deviations from the model change sign frequently enough in order for a conclusion to be drawn that the form of model (2) may be a linear one. Furthermore, a series test was applied. In all the cases, except the model describing the correlation between the written premium for farm buildings and GDP, the condition of sufficiently high series number has been met.

Subsequently, the Durbin-Watson coefficient was calculated to assess whether the residuals from the log-linear model show autocorrelation, and in particular to evaluate whether any signs of the so-called spurious regression have not been obtained. Unfortunately, the results frequently turned out ambiguous (empirical values of the test statistics were inconclusive), which might be caused, among other things, by an insufficient number of observations. The inconclusive results referred to the correlations of written premium for obligatory crop insurance, farmers' liability, disposable income of a farmer's household and the latter per 1 person. A positive correlation was obtained in the case of elasticity of the written premium for non-life insurance in Poland against GDP. In order to eliminate it, an additional variable was introduced into the model, namely the GDP level from the previous year, thus assuming that the written premium in period t may also depend on the GDP level in period t-1. This approach eliminated the autocorrelation and the obtained coefficients for both exogeneous variables were significant and amounted to: for GDP_t=2.18, for GDP_{t-1}=-0.90. It is difficult to interpret these coefficients in the context of elasticity. Nonetheless, one can assert that there is a logical cohesion between the results and the magnitude of income elasticity of non-life insurance demand obtained in the primary model (the parameter 1.21 seems to reflect the cumulative effect of changes in GDP in the previous years). The lowest values of Durbin-Watson coefficient were obtained with reference to models concerning written premium for farm buildings insurance. They were – as opposed to all other models – lower than R^2. Introduction of last year's income as an additional exogeneous variable increased the Durbin-Watson coefficient to the extent that made it inconclusive. Therefore, another possible modification was undertaken in order to eliminate autocorrelation – a delayed dependent variable was introduced as an additional exogeneous variable (i.e. log was taken of written premium for farm buildings insurance from the previous year). This change made it possible to eliminate autocorrelation or to obtain negative one. However, due to the modification GDP became the only significant exogeneous variable, while disposable income and per capita income turned out to be insignificant. Assessment of written

premium elasticity against GDP amounted to 0.68. Hence, it was stated that in the case of a dynamic model the regression between the written premium for farm buildings insurance and the level of GDP appears to be no spurious relationship. On the other hand, the correlation between written premium for farm buildings insurance and disposable income of the farmer's household and disposable income of the farmer's household per I person may be apparent (random), so the obtained elasticity assessments (0.48 and 0.48 respectively) should be treated with caution. In the other cases which have not been discussed above no signs of apparent regression have been produced in any of the assessed models.

3. Discussion and conclusions

1) According to the findings of the above analysis, written premium for crop insurance is dependent to the largest degree – compared to other agricultural insurance types – on both GDP and disposable income (per farmer's household and per 1 person in this household). Elasticity rate against GDP – 3.05 for obligatory crop insurance and 2.07 for voluntary crop insurance respectively – indicates that these insurance types should be qualified as higher-order normal goods. The remaining agricultural insurance types are lower-order normal goods. In other words, crop insurance is a luxury good while other agricultural insurance types are necessities (indispensable goods) [21]. Hence, the general conclusion of the subject literature analysis that income elasticity of non-life insurance is greater than 1 and insurance is a higher-order good has been only partly corroborated.
2) On the basis of the calculated elasticity indexes one can assert that when income rises, *ceteris paribus*, the share of farmers' spending on crop insurance within the budget allocated to agricultural insurance purchases will grow as well. Income growth should also be accompanied by development of agricultural insurance, crop insurance in particular, as this insurance type has been available on the Polish market for relatively the shortest period of time. This assumption is justified by an observed connection between the level of economic development and the rise in importance of economic factors as opposed to non-economic ones when it comes to stimulating insurance development[22].
3) In the case when income elasticity is smaller than 1, expenses on insurance grow more slowly than the income. With reference to voluntary insurance, this may be caused by several factors. Firstly, an line with income growth, entities decide to finance potential losses using other instruments (e.g. self-insurance). Secondly, the value of the insured interest (e.g. property) declines in time (unless it is modernised), which causes the systematic decrease in the amount insured and consequently, in the premium. Thirdly, when the value of the insured good is constant or declining, its share of the total assets is also decreasing, which, considering constant or growing level of acceptable loss, diminishes the need to insure it to he same extent.
   When an insurance contract is obligatory – which is the case of farmer's liability insurance and farm buildings insurance – the above explanations are of limited use. Farmers need to secure

21. D. Begg, S. Fischer, R. Dornbusch, *op. cit.*, p. 134.
22. T. Bednarczyk, *op. cit.* incl. the literature quoted there:; S. Hussels, D. Ward, R. Zurbruegg, *Stimulating the Demand for Insurance*, „Risk Management and Insurance Review", 2005 No 2, pp. 257–78.

their interest with insurance regardless of their income levels. Due to the fact that the number of insurance contracts covering farmers' liability and farm buildings insurance is higher than the number of individual farms, one can assume that theoretically all the buildings and farmers have been insured.[23] In the case of farmers' liability insurance the amount of the minimum amounts of insurance coverage does not depend on the property value; the minimum guarantee is constant, regulated by an act and is only subject to abrupt changes.[24] It was increased twice in the period between 2006 and 2020.[25] Therefore one cannot speak about a decline in the value of insured object. On the other hand, it is difficult to determine on the basis of the available data whether the value of farm buildings has decreased, which could at least partly explain why income elasticity of this type of insurance is below 1. Capital expenditure on buildings and structures in both private and public sectors in agriculture and hunting accounted for 39.3% of all investments in 2006 and 44.3% in 2020 while undergoing significant fluctuations. Gross value of buildings and structures in agriculture and hunting in the private sector[26] increased remarkably (from PLN 60326.5m in 2006 to PLN 79648.7m in 2020). However, their share in the gross value of tangible assets dropped (from 58% in 2006 to 54.1% in 2020) despite the rise in the number of new buildings (e.g. in 2006 7842 farm buildings were commissioned, while in 2020 the number was 6512 and there also were significant fluctuations in the numbers of newly commissioned buildings).[27] There are no figures regarding change

23. According to the GUS data compiled in the *Rocznik statystyczny rolnictwa (Annual statistics in agriculture)* for particular years the number of completed contracts for farmer's liability insurance grew – from 1445 K. in 2006 to 1521 K. in 2020, similarly to the number of contracts for obligatory insurance of farming buildings – from 1443 K. in 2006 to 1715 K. in 2020. Hence, in 2020 the number of contracts for both types of insurance was much higher than the number of individual farms (1.31m) out of which only a part can be treated as "farms" as understood within the Act on compulsory insurance.

24. Should the guaranteed payment be set as higher than the minimum sum, the contract referring to the "surplus" amount is for voluntary insurance. J. Nawracała, *Komentarz do Ustawy o ubezpieczeniach upraw rolnych i zwierząt gospodarskich*, w *Kontrakty na rynku ubezpieczeń. Komentarz do przepisów i warunków ubezpieczenia*, ed. D. Fuchs, K. Malinowska, D. Maśniak, Wolters Kluwer, 2020.

25. The amount of the minimum guaranteed payment changed in 2007 and 2018 and in the case of personal damage it increased from 1.500.000 euros to 5 210 000 euros, whereas in the case of damage to property it went up from 300.000 euros to 1 050 000 euros.

26. The available GUS data from *Annual statistics in agriculture* for particular years concern the private sector and do not include the division into ownership types. It should be kept in mind, though that is the farmer who bears the obligation to sign an insurance contract covering buildings which are a part of the farm. A farmer is defined as an natural person who owns or co-owns a farm. Therefore, the obligation to insure the buildings that make up the farm does not apply to other entities owning it, including partnerships and companies under commercial law or agricultural cooperatives. With regard to civil partnerships, it is assumed that the holder of the farm is the partners of the partnership and not the partnership itself, which has no legal entity. In this case, each partner of a civil partnership who is a natural person is a farmer within the meaning of the law. J. Nawracała, *Komentarz do Ustawy o ubezpieczeniach obowiązkowych, Ubezpieczeniowym Funduszu Gwarancyjnym i Polskim Biurze Ubezpieczycieli Komunikacyjnych – Art. 44*, in *Prawo ubezpieczeń gospodarczych. Tom I, Komentarz*, ed. M. Serwach, Lex, 2010.

27. On the basis of the numbers of newly commissioned buildings it is difficult to draw conclusions as for changes in numbers of buildings eligible for insurance. It is due to the fact that the obligation to insure a farm building arises the moment the building is roofed. This means that a building which should be insured may be in the construction (shell) stage, as long as it is covered with a roof, or in the usage stage. In addition, the number of buildings whose technical condition has reached 100% of the standard deterioration, as well

in average deterioration of farm buildings although it can be noticed that within the studied period the degree of deterioration of tangible assets[28] increased from 74.6% in 2006 to 77.8% in 2020. Therefore, with regard to farm buildings insurance, it is difficult to give simple reasons for the level of income elasticity without considering other, additional micro – and macroeconomic factors.

4) Partial results of the study[29] do not indicate a significant impact of farm's income on demand for crop insurance. Therefore a question arises why the income elasticity rate is not only positive, but also high and statistically significant. It may result from the different level of the analysis (the analysis presented here concerns macro data, while other studies operate on data on the micro level i.e. individual farmer's decisions) as well as from the fact that the survey question about income is a sensitive one, which most respondents do not reply at all or submit an untrue amount.
5) One should bear it in mind that the form of the function describing the relation between demand and income affects the values of elasticity coefficients.[30] In this analysis the assumption was made that relations between income and demand are reflected by a power function. Its linear form is very well-matched and fulfils the criteria of the goodness of fit (except farm buildings insurance). It is not impossible, though, that the relation between income and demand for agricultural insurance may be different (e.g. S-shaped), which cannot be resolved with this amount of data.
6) It has been assumed here – like in many other publications – that demand for insurance is synonymous to the volume of consumption and is measure according to the written premium.[31] This approach also assumes that supply perfectly matches the changes in the price of the given good, which means that quantity equilibrium is mostly determined by demand. Due to the institutional conditions for compulsory crop insurance, the supply of which depends e.g. on the amount of budget subsidies, the initial analysis made in this paper should be extended in subsequent studies to distinguish between consumption and demand.
7) The research into income elasticity of agricultural insurance could be worth extending into other countries as well as other risk management instruments with the view to using conclusions thereof in order to verify the volume of allocated subsidies (EU subsidies constitute a substantial part of farming income) in the context of the applied risk management instruments. However, while making comparisons between countries, one should keep in mind their systemic heterogeneity (including legal system, social security system, fiscal and monetary policy, inflation rate, demographic structure, religious beliefs, return on financial investments, currency exchange rates).[32] When it comes to insurance, elasticity should be calculated with

as agricultural buildings scheduled for demolition on the basis of final decisions of the competent authorities, which are no longer subject to the insurance obligation, although they may be used on the farm, is unknown.

28. The only available index is the collective one, i.e. for buildings and constructions, machines, technical devices and tools as well as means of transport.
29. Kaczała i Wiśniewska, *op. cit.*; A. Wąs, P. Sulewski, P. Kobus, G. Rawa, M. Gołaś, W. Ignaciuk, *op. cit.*
30. M. Sznajder, G. Adamczyk, *op. cit.*
31. G. Millo, *op. cit.*, p. 5.
32. G. Millo, G. Carmeci, *op. cit.*

reference to particular product types due to the fact that it may vary substantially – as it has been shown.

The present research concerned four types of agricultural insurance in Poland. On the basis of data from the period between 2006 and 2020 an estimation of income elasticity for particular types of agricultural insurance was conducted and it was found that it is not uniform and depends on the product type. Compulsory and voluntary crop insurance are goods of a higher order (luxury goods), and other agricultural insurance types (third party liability of farmers and agricultural buildings) are goods of lower order, or necessities (indispensable goods). Therefore in the future, as long as the present relation between income and demand for agricultural insurance is retained, the increase in income measured by the volume of GDP or disposable income per farm should be accompanied by a relatively highest increase in demand for crop insurance and a relative decrease in demand for other agricultural insurance types. Due to the fact that the importance of economic factors relative to non-economic factors in stimulating the development of insurance increases along with the rise in the level of economic development, the growth in income should contribute at the same time to the development of the agricultural insurance market, especially crop insurance.

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Elastyczność dochodowa popytu na ubezpieczenia rolne w Polsce w latach 2006–2020

Znajomość elastyczności dochodowej popytu na poszczególne produkty jest konieczna do stawiania prognoz w zakresie wielkości i struktury popytu. Celem niniejszego artykułu jest estymacja elastyczności dochodowej poszczególnych rodzajów ubezpieczeń rolnych i wskazanie konsekwencji w zakresie przyszłego popytu na te ubezpieczenia. Zgodnie z wynikami przeprowadzonej analizy za lata 2006–2020 przypis składki z ubezpieczenia upraw w największym stopniu – w porównaniu do innego rodzaju ubezpieczeń rolnych – zależy zarówno od PKB, jak i rozporządzalnego dochodu (na gospodarstwo domowe rolników lub osobę w tym gospodarstwie). Wskaźnik elastyczności – odpowiednio 3,05 względem PKB dla ubezpieczeń przymusowych upraw oraz 2,07 dla ubezpieczeń dobrowolnych upraw – wskazuje, że ubezpieczenia te należy zakwalifikować jako dobra normalne wyższego rzędu. Pozostałe ubezpieczenia rolne – ubezpieczenia OC rolnika (wskaźnik elastyczności 0,78) oraz ubezpieczenie budynków rolniczych (0,65) są dobrami normalnymi niższego rzędu. Oznacza to, że przy wzroście dochodów, ceteris paribus, wzrośnie udział wydatków rolników na ubezpieczenia upraw w ramach budżetu przeznaczonego przez nich na zakup ubezpieczeń rolnych.

Słowa kluczowe: ubezpieczenia rolne, elastyczność dochodowa popytu, zarządzanie ryzykiem, ubezpieczenia upraw, popyt na ubezpieczenia

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