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Is Demand for Technologies Determined by Production Costs? The Case of Insurance Companies

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The article is a part of a global discussion about the influence of technologies on the insurance industry. For a long time, the insurance industry was known as a restrictive market with high barriers to innovations. The rapid development of Industry 4.0 puts insurers under pressure to implement new information and communication technologies into business processes to be competitive and to satisfy customers' expectations. Due to this, one of the main reasons for the demand for technologies is the reduction in the cost of the insurance production process. This study intends to answer the question about how production costs determine the demand for technologies among insurers. To answer this question, the research presents a case analysis of three major European insurance groups in the period 2008–2018. The analysis of the main production cost indicators (acquisition, claims handling and wages) and expenditures on information technologies in the insurance companies make the paper original. The research shows that there are no clear relations between the raising of direct insurance production costs and the demand for information technologies among insurers. This research contributes to the study of the development of information technologies in the insurance industry. Technologies still do not play a key role in the efficiency growth of insurance companies. It is mostly a sporadic factor.

Keywords: *Information Technologies; Insurance; Acquisition Costs*; *Wages; Claims Handling Expenses.*

Introduction

The use of technologies is one of the most important issues in the insurance business (International Association of Insurance Supervisors, 2018; Mizgier *et al*., 2018; Scardovi, 2017). Modern information and communication technologies (ICT) heavily influence the insurance value chain (Eling & Lehmann, 2018; Stoeckli *et al.,* 2018). Its strong impact on the processes of distribution, underwriting, pricing and handling of claims in insurance is recognised by the International Association of Insurance Supervisors (2018).

An insurance company is a specific financial institution that has to deal with an asymmetry of information and risk. Its activity is based on two tasks: 1) the possibility to estimate the probability of random events; 2) the decisions regarding risk-taking and financing or risk-avoiding. The ability to calculate the probability of random events is based on the elaboration of a database (statistics about previous losses). According to the law of large numbers, insurers predict that the future frequency of risk realisation will be similar to that of current ones. Thus, the main determinants of the insurance business are access to, collection and calculation of data. This estimation mechanism is created by an insurer (reinsurer) and is fundamental for risk pricing. According to the calculated level of risk, the client has to pay adequate insurance premiums. This value depends on different factors that influence hazards and increase the probability of risk realisation. Insurers gather premiums from clients and make an insurance fund that is used for financing different obligations: claims paid, forming of capital and reserves, salaries, investments, taxes, etc. To have a balance between financial inflow and outflow, the insurer has to formulate its risk pricing methodology. The basic rule of financial safety for the insurer can be defined as "the higher the risk – the higher the price (insurance premium)". Rotschild and Stiglitz (1976) perfectly described this problem of the equilibrium between low-risk and high-risk individuals (insured). In such circumstances, insurers deal with the asymmetry of information and as a consequence, they look for new tools that can help them make a more precise estimation of risk. It motivates insurers to use different technologies that can collect information about the randomness, measurability, and consequences of events.

Another factor that pushes insurers into digital technology is high competitiveness in the market. The opportunity to offer risk management services at a lower price is the main determinant of staying "alive" for insurers. They cannot compete through clear dumping because it provokes insolvency or even bankruptcy. Nevertheless, companies can stay more competitive by offering quality services and through cost-cutting. Among other outflows, the main expenses in the insurance activity (by type) are related to an acquisition, handling of claims, administrative work, etc. If one looks at the direction of the expenses, these include expenses related to staff, outsourcing, professional services, information technology (IT), commissions, etc. However, insurers have different types of expenses that could be cut or used more effectively. Such an effect can be achieved by the implementation of ICT in business processes. For instance, selling policies through websites helps insurers cut expenses for agents and get more clients; underwriting in agro insurance with programs and satellites allows for more precise risk estimation that is less time-consuming; handling of claims through devices cuts expenses for an average adjuster and makes the process of loss adjustment faster and cheaper. Therefore, insurance companies are looking for new opportunities to use information technologies (e.g. Omni-channels, Big data analytics, Internet of Things, telematics, voice biometrics and analysis, drones and satellites, etc.) (Bohnert *et al.*, 2019).

With the opportunities offered by Industry 4.0 (Nicoletti, 2021), the insurers should take an interest in technologies that can enable them to reduce costs and make their activity more efficient. However, there are no clear quantitative studies about insurance production costs as a factor of technology demand in the literature. Revealing the knowledge gap, the scientific problem is formulated as a **research question** of this paper: **how do production costs determine the demand for technologies in insurance companies?**

Insurers have a unique knowledge-based process of production (non-material). This paper considers the specific kind of production costs that appear just in the insurance business process which is a novelty.

Research method. The present analysis was carried out with the application of the ordinary least squares regression (OLS) for time-series data.

The paper is structured as follows. First, the authors discuss the literature regarding the nature and role of information and communication technology in the insurance industry. Second, they present the methodology of research and sampled companies. The third part of the article is a regression analysis of dependent and independent variables. In the last part of the article, the authors discuss the results.

Literature Review

The insurance industry was considered conservative and resistant to any innovations for a long time. As was mentioned by Campbell-Kelly (1992) the insurance industry has a highly information-intensive nature. Its traditional character comes from the specific insurance mechanism that is based on actuarial calculations (based on the theory of probability). For this purpose, insurance experts gather long-term statistics from different sources to make probability estimation clearer. The primary implementation of the technology in the insurance industry takes its roots from the moment when the financial industry started using computers to organize its activity. The specific issue that applied to the insurance service was that at the same time computers enabled the development of actuarial methods. Starting from the 1950s, the life insurance industry in the United States (US) was mentioned as one of the largest adopters of computer technology. An important role was played by tabulating machinery starting from the 1890s. It was especially well seen in the life actuarial industry where the tables of mortality and sickness required large amounts of data and arithmetical calculations. The background for the data collection in this field were punch cards that were used to record, tabulate and subtabulate information about the risk of mortality, sickness, withdrawal, etc. The first hand-written cards for the actuarial purpose were used by Finlaison for the "Report on the Sickness and Mortality in Friendly Societies" in the US in 1853 (Lindstone, 1946). Perforated cards with mechanical support started to be used after 1890 when Heller invented mechanical methods of tabulation that were used to collect mortality statistics (Coe *et al.*, 1948).

Insurance companies adopted basic tabulating systems to mechanize the existing and mostly manual processes of sorting, counting and adding data (Yates, 1993). The history of technology diffusion is different for each insurance market. As the US, West European or East European insurance companies were dependent on the stage of the general industrial development of their regions. In the US insurance market, the implementation of ICT can be divided into a few stages (Yates, 1993, p. 3):

- Up to 1910 adoption of initial tabulating technologies;
- 1910s-1920s acquisition of printing capabilities;
- 1920s-1930s incorporation of alphabetical tabulating capabilities.

The demand for information technologies was closely correlated with the development of insurance policies.

The more varied policies with less coverage (e.g. industrial insurance) the companies started to sell, the more complicated the insurance service handling became. The need to make the processes faster and more automatic was growing.

Among the processes and chains that compose the insurance service and brought the need to implement technologies at the beginning of the 20th century one can mention:

- the process of premium calculation, paying, monitoring of regularity and lags;
- recording agent performance;
- counting the claims payment;
- increasing requirements of the public regulator regarding statements (reports);
- recording the information about the insured person or subject (the longer the term of the insurance policy was, the more parameters had to be covered by the record);

Among the more important features of the insurance service of that period, sorting started to gain more significance than counting and recording (Yates, 1993, p. 14).

In the 20th century, there was a clear understanding that information and the ability to use it played the most important role in the insurance industry (Giles, 1969). The main difficulty of placing a value on information and its prompt collection is investigated and related to the estimation of probability and variance inherent to the application of judgment. In the 1970s wide opportunities of central computers were used to support underwriting activities, especially in accepting applications: if accepted, the application underwent overnight processing by the computer, which also calculated the premium, and after that, the output was mailed from central processing to the field office or printed via a remove printer (Appelbaum, 1987, p. 75).

The growing popularity of computers (International Business Machine Corporation (IBM), Univacs) in the middle of the 1960s created a new element in the insurers' budget. As companies had to buy specific software to cover insurance operations, such software was expensive and the companies "were pointing out that programming costs had far exceeded predictions, and the anticipated cost savings were not forthcoming" (Yates, 1995). To serve the insurance industry, special software like "Consolidated Functions

Ordinary" in 1962 by IBM, application "Total Information Processing System" in 1963 by Honeywell; "Advanced Life Information System" and "Property and Liability Insurance System" in 1964 by IBM; "Cybertek Computer Products" in 1969; "Life Insurance Administration System" in 1972 by Beta sites were created.

An important moment for the diffusion of the insurance ICT in 1969 was the decision of the company IBM to sell the hardware and software as separate products. Starting from 1990, IBM developed an Insurance Application Architecture (IAA) to offer the specific application for the insurance business model (and standardisation) due to its geographical market or market focus (Huschens & Rumpold-Preining, p. 671). Among the factors that influenced the demand for technologies in the insurance industry in the 1970s, there were the doubling inflation rate and the associated increase in interest rates that pushed companies to develop new products and to experiment with the redesign of jobs and reorganization of work (Pressman, 2003). Currently, modern insurers use numerous programs: for instance, standard applications Siebel as a Corporate Risk Management (CMR) solution, **S**ystems **A**pplications and **P**roducts (SAP) as a Human Resource system, DXC SICS as a reinsurance system, and The Insurance Application (TIA) as a core insurance system in Finland and Poland (Andersen, 2003, p. 49).

To present the development of information and communication technologies, it is useful to demonstrate the data regarding patents granted between 1985 and 2021. The available data from the World Intellectual Property Organization (WIPO) show the supply of new technological solutions for insurance. According to the International Patent Classification, the majority of solutions for insurance services are included in the group "*Data processing systems or methods in insurance, e.g. risk analysis or pensions* (G06Q 40/08)". The analysis of the data presents the dynamics of the granted patents' number. As it is seen, the number of patents drastically increased from 20 to 8464 in the period 1985-2020 (Figure 1).

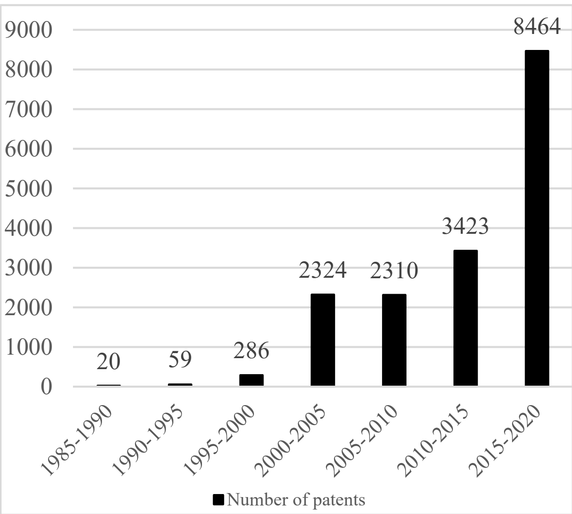

Figure 1. The number of Patents in the Group "Data Processing Systems or Methods in Insurance, e.g. Risk Analysis or Pensions (G06Q 40/08)" from 1985 to 2020. *Source: WIPO. (2021). https://patentscope.wipo.int/search/en/result.jsf?_vid=P11-KQM6ED-44730*

From the beginning of the 21st century, the financial sector has started to become a place where technologies are being rapidly created and diffused. This phenomenon established the foundation for the new direction in financial studies, called "FinTech". The core of "FinTech" lies in the implementation of information and communication technologies in financial services. The development of ICT was studied in the context of all financial services: banking (Lechman & Marszk, 2019; Mushtaq & Brudeau, 2019), insurance, the stock market and real estate.

Mushtaq and Brudeau (2019) investigated the role of ICT in financial inclusion in the area of commercial banking services and microfinance institutions. Their research was based on studying five factors: mobile phones, fixed lines, the internet, personal computers, and the price of a local call.

The impact of ICT at the customer level, the microfinance institutional level, the donor level, and the microfinance industry level was shown by Kauffman & Riggins (2012).

Nicoletti (2013) presented a global overview of the fundamental transformation of financial institutions through the implementation of ICT. Marszk *et al.* (2019) described the effects of ICT as a general-purpose technology for financial institutions through new financial products and a new pricing system. They argued that the financial market has started to become more "effective". Currently, there is a widely used term "**digitalisation of insurance**" (Stockli, 2016; Nicoletti, 2016; Schmidt *et al*., 2017; Cappiello, 2018) that means the implementation of ICT into insurance services.

The digital implementation process in the insurance industry was partly described in the approach "Digital Transformation Framework in the cases of selected German insurers" (Wiesboc *et al*., 2017). Cappiello (2018) showed the impact of digitalization on the insurance market through the creation of added value. He took into account Big Data, artificial intelligence/cognitive computing, predictive modelling, wearable devices, telematics, and the Internet of Things.

Basic aspects of the nature of the information technology (IT) in insurance were presented in Green Information Technologies (Essvale Corporation Limited, 2009).

Puelz (2010) analysed the role of technology for insurers based on the survey regarding the use of the Internet. He found that an online channel has helped in cost reduction, revenue enhancement and customer retention. Forman and Gron (2011) showed a relationship between vertical integration in the distribution construction of insurers and the adoption of the Internet network. Hitt (1999) suggested that high quality of IT management has an impact both on the overall expenditure and the insurer's efficiency.

Large international insurers who can create expensive but efficient and world-leading IT systems have huge advantages over smaller companies (Neylor, 2017). The reason is that software has substantial fixed costs of creation but very low costs of reproduction. Bigger companies can spread the cost over their worldwide networks.

The main aim of information and communication technologies in the insurance market is the creation, use of knowledge and exchange of information (Manning *et al.,* 2007; Engel, 1985).

The role of ICT has changed: it used to be an instrument for data processing, but after the implementation of Big Data analysis in the knowledge-based economy, it has become an instrument for creating new types of information.

Heeks (2017) explained the relationship between data, information and knowledge: data is processed into information, information is transformed into knowledge; knowledge explains information and processes data.

The insurance industry depends on the ability to convert raw data into intelligence – specific information about customers, markets, competitors and business environment (Sumathi & Sivanandam, 2006). Modern insurance business looks for opportunities to reduce the asymmetry of information under the condition of the rising cost of risks. Therefore, insurers are looking for new knowledge about the probability of risks. In this case, ICT is also helpful, especially in the processes of (Author, 2017):

- customer relationships (e.g. client interaction and channels),
- product development,
- distribution,
- pricing (underwriting),
- claim management.

Another problem that can be significantly improved by ICT is fraud management. Insurers can use a combination of techniques, including business rules, predictive modelling, text mining, database searches and exception reporting (Statistical Analysis System, SAS).

Hypotheses Development and Research Framework

The hypotheses originate from the broader question about the correlation between IT investments and financial companies' performance (efficiency, profitability, costs, etc.). Successful innovators' rents may come in the form of cost savings (Hippel, 1988, p. 58). Most literature in this context is focused on the banking sector (Table 1). Hunter and Timme (1991) proved that technological change lowered real costs by about 1.0 % per year in the case of large US commercial banks. The implementation of electronic payments in banking services has reduced the costs of these services by 50 % (Berger 2003). Based on the case of the technological transformation of Spanish banks, Toloba and Miguel del Rio (2020) mentioned that "…the cost of running an individual process after automation is generally negligible".

The main problem with clear identification of the determinants of the ICT demand is the fact that most benefits of ICT are long-term (sometimes with a few years delay) and intangible. New investments in high technology should increase firm efficiency, but only part of the estimated profits is earned in the planned period (Badescu & Garses-Ayerbe, 2009). Taking into consideration the innovative feature of technologies, it is important to admit that the benefits from the new technology are different as they depend on the moment of its implementation. Initially, innovations can decrease common expenses as their development and implementation constitute their own internal cost for the company. There is a link between the company size and the costs of its activity: the bigger the company, the lower the cost of such an activity. Based on the economic theory of scale, Nicherson and Sullivan (2003) confirmed that only the banks with a large share in the market invest in ICT.

Weisbrod explained how technological changes (R&D) have expanded the demand for insurance (Costa-Font *et al.*, 2012). Using ICT can attract new clients (for example if it is a platform for selling insurance products), which brings the benefits of scale effect. In this way, companies obtain larger productivity gains via cost reduction. At the same time, at the end of the 20th century, a new phenomenon of the "productivity paradox" of computers appeared, that Solow (1987) characterized: "*you can see the computer age everywhere but in the productivity statistics".*

Studying the history of the ICT implementation in the U.S. insurance companies, it was mentioned that at the beginning of the 20th century, the crisis of profitability was the main demotivator for large insurers to adopt new supporting techniques and technologies of information (Yates, 1992). But as was concluded by Yates (1993), the firms felt the need to keep costs down as they were pushed by the price competition on the market and their need to grow. It was especially well seen in the case of the biggest U.S. insurers "Metropolitan" and "Prudential" which moved from the fourth and fifth places in 1900 to the first and second in 1915 after the tabulation technology was implemented.

The correlation between insurance operational costs and investments into new technologies is not a well-understood phenomenon. There are different perspectives on the relations between expenses in insurance and technology investments, as each type of insurance (health, motor or Directors & Officers insurance, etc.) has a different appetite (and needs) for technologies. For example, the increasing insurance coverage boosts technology adoption in health care as a consequence of the correlation between higher degrees of private expenditure on health care and higher levels of Research and Development in health care in OECD countries (Costa-Font *et al.*, 2012). In some insurance products, the added value of new technology can be unequal or even lower than the costs of its implementation. In practice, companies are focused on the development of ICT in selected insurance directions.

It is considered that in more information-dependent sectors such as financial services, cost reductions through the ICT implementation have to be higher as they reduce the cost of access to information (Commission of the European Communities, 2001).

Table 1

The Impact of the ICT Implementation on the Efficiency Parameter of a Financial Institution

Determinant	Efficiency parameter (dependent)	Impact	Source
Banks			
Types of ICT	Profitability	Decrease	Romdhane, 2021
	Labour cost	Reduction	Furst et al. 2002
	Operational costs	Reduction	Berger, 2003
	Delegation of decision-making power to local managers	Decrease	Mocetti, Pagnini & Sette, 2017
	Operational costs	Reduction	Ho & Mallick, 2010
	Earning margins of banks	Partly increase	Campanella, Peruta & Giudice, 2017
	Production process	Cost saving	Egusquiza & De Miguel, 2002
	Internal communication costs	Reduction	Marinc, 2013
Insurance companies			
Types of ICT	Cost of operational solutions	Reduction	Andersen, Bebear & Kist, 2003
	Operational expenses	Optimization	KPMG&ACORD, 2019
	Operational expenses	Cost saving	Pressman, 2003
	Loss-adjustment and distribution costs, legacy system, fraudulent claims, accident rate, marketing costs	Reduction	Cappiello, 2013, p. 7-28
	Labour (clerks) costs	Reduction	Appelbaum, 1987

Source: own compilation

As was mentioned by Capiello (2013), among the costs that can be reduced by technological solutions there are management and administration costs associated with the distribution of traditional products. These include (1) costs of setting up a branch; (2) training costs of sales employees; (3) fees paid to intermediaries; and (4) administrative costs and others; loyalty costs; operational costs. On a large scale, the implementation of ICT in insurance companies in the U.S. was connected with the reduction in the number of labour staff (clerks) that was predicted to decrease from 924,000 to 568,000 from 1980 to 1990 (Appelbaum, 1987, p. 85).

The study by the META Group finds that insurance companies have historically spent 3 to 5 per cent of their annual written premium volume (revenue) on information technology (Pressman, 2003, p. 44). "Our strong focus on processes has in private lines reduced the administrative work in HQ to 10 per cent of sales forces (down from 40 to 60 per cent in the case of AXA). If executed correctly, shared service centres can increase efficiency and help reduce administrative costs and cost per transaction. (ING typically aims for a cost reduction of 30 per cent per transaction)" (Pressman, 2003). One of the ways in which ICT can help reduce costs is outsourcing, but in practice, the results can vary.

Having studied the literature on the topic of ICT, the authors noticed that there is a significant gap in the methodology of quantifying the influence of ICT on the insurance production process. Companies tend to implement ICT to increase their revenues; however, there is little evidence of results of this in their statements. This goal can be achieved by cutting off the expenses, thus, this is also the factor of a growing ICT demand. The article aims to verify the following hypothesis: the increases in ICT investments in insurance companies are driven by acquisition expenses (sales expenses), claims handling expenses, and wages expenses.

The insurance production process is a phenomenon that requires individual explanation. That is why there is no coherent theory that shows the specific insurance reverse production cycle. As a consequence, the theory lacks an explanation as to the linkage between production costs and information technologies in insurance companies. Muller (1981) analysed insurance production in the light of different theories and assumed that the fullest one that takes into account the knowledge-based core of insurance is the information theory. In the literature, the fundamental theories which explain insurance are based on risk theories: Knightian uncertainty, Expected Utility theory, Prospect theory. There are few theories that can partly give some understanding to the added value of technologies or new information that can be produced by it with regards to insurance activity: a theory of information asymmetry or a theory of transaction costs.

Due to the research question, it is needed to create a framework that shows the place and role of technologies in the process of insurance service production (Figure 2). The process of insurance service production can be described by a production function or a cost function (Cummins & Weiss, 1993). In the framework, the focus is on the cost approach. Generally, the cost approach is widely used in the studies of insurers' efficiency or productivity.

Each insurer has to achieve a goal – to be efficient. To accomplish this efficiency, they can operate on their production frontier which gives the maximum attainable output (2) for various input (3) vectors. Output in insurance can be defined according to risk-bearing and risk-pooling functions, so it is the sum of total losses paid net (Kasman & Turgutlu, 2011). However, insurers can operate on their cost frontier which gives the minimum level of cost for each level of output, taking input price as given. The frontiers present two approaches: deterministic and stochastic (Cummins & Weiss, 1993). The first one says that all insurers adopt the same process and that is why they face common cost frontiers, but costs could be determined by random events (due to the specificity of insurance risk realisation). The second one is a stochastic approach, assuming that firms may deviate from the minimum attainable cost levels for purely exogenous reasons as well as through inefficiency (Cummins & Weiss, 1993).

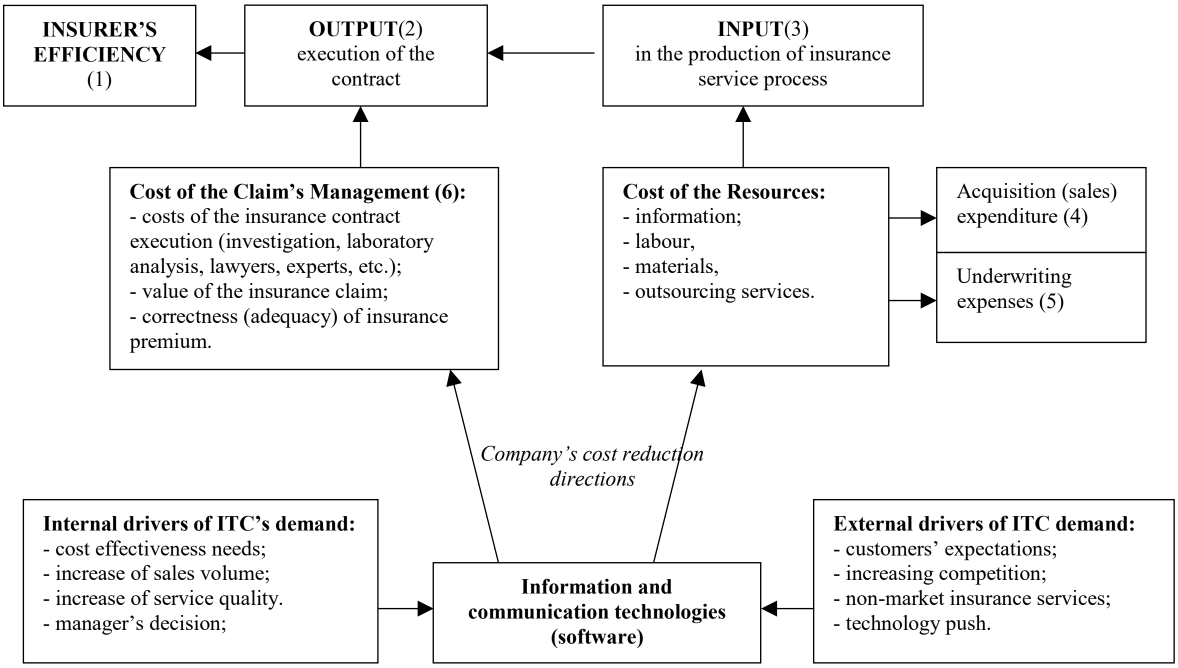

Figure 2. The Research Framework of the Technology's Influence Chain in the Insurance Company (based on the cost approach).
Source: own compilation

In practice, insurers usually use two directions to achieve an effective output-input result: reducing the costs (Reilly, 1988) together with increasing the sales. Some decades ago, through the implementation of computers on a large scale, insurance companies gained considerable productivity increases, by implementing the Management Information System (MIS) (Muller, 1981). According to the production process, the sources of costs in insurance are: acquisition (4) – agents, brokers, marketing, etc., underwriting (5) – risk estimation and claims management (6). Transaction costs that appear during the acquisition process can be cut by the use of communication programs between companies and salespersons, or salespersons and customers (like chatbots). Marketing tasks can be realised through the information and communication networks. Through the adoption of different technologies, companies may reduce the level of information asymmetry about risk probabilities, which helps to calculate more appropriate risk premiums. Due to the reverse production cycle, claims management costs appear after the insurance policy is sold, so it influences the output. Besides the direct claims payment (that is usually a "random" value in relation to time), insurance companies have some handling claims expenses. They make medical tests, consult lawyers, detectives, experts from different fields that examine the accidents. Due to the use of technologies, companies can reduce this kind of expenditure as transaction costs.

Research Method

Several studies presented the logical scheme of how to measure the linkage between the expenditure on (and investments in) information technologies and the results of insurance company activities. The study of the connection between a life insurer's IT expenditure and the efficiency of its activity based on financial data was made by Francalanci and Galal (1998). A few studies show the linkage between the IT budget (as a part of intangible assets) and the financial condition of companies from different points of view: between investment in computers and the company's market value (Brynjolfsson *et al.,* 2002). Harris and Katz (1991) compared the rate of IT expenditure and the total operating expenditure among large and small insurers, and named it an indicator of "IT intensity". Hitt (1991) suggested examining four ways the IT function can influence an insurer's IT costs and performance: IT strategy, management of the IT organization, IT work practices and technological choices through the regression.

To assess the link between the value of insurance premiums and IT expenses in the insurance company, Harris and Katz (1991) used time-lagged regression, because of the assumption that the change in the amount of IT expenditure is the result of the insurance premium growths in previous periods. To confirm this hypothesis, a few different time-lagged models were used: with a one-year lag, two-year lag, and three-year lag. Currently, the literature lacks knowledge about empirical methods for studying the influence and relations between IT and insurance company's growth.

The present analysis was carried out with the application of the ordinary least squares regression (OLS) for time-series data. The OLS models are the most commonly used econometric tools for examining the relationship between economic phenomena, enabling researchers not only to check if there is a correlation between selected indicators but also to evaluate the nature of this relation, i.e. to examine how the dependent variable is shaped by the selected explanatory variables. Using the data for 2008-2018, three independent variables are observed for 11 years which may cause a bias arising from a small sample size. In such cases, the bootstrapping method is used (Fisher & Hall, 1991). Nonetheless, in the case of the OLS regression performed, using the bootstrapping did not change the results.

The research was based on the analysis of the information about insurance companies' expenses: gross software values, wages, claims handling costs and acquisition costs. According to the limitation of the accounting methodology of ICT in insurance (Author *et al.,* 2019), the phenomenon of digitalisation was observed as the gross value of software in the company, which was applied in the models as a dependent variable. Software is a kind of information and communication technology. In the official reports, companies do not illustrate such a comprehensive parameter as ICT. Data was collected from notes to financial statements of three European insurance groups that were admitted by the European insurance and reinsurance federation.

In the research, the data used came from the AXA Group (France) – *Company AXA*, Aviva Group (United Kingdom) – *Company Aviva*, CNP Assurances (France) – *Company CNP*. The cases used for theory making based on case studies should not be sampled randomly, yet they should be chosen to replicate certain patterns or to show extreme or polar cases (Eisenhardt, 1989). Therefore, companies for the study were selected to represent the biggest insurance companies operating in Poland. Moreover, two companies show consistent patterns in their data, while the third one constitutes an opposite example of how the same phenomena can evolve in different enterprises. An additional criterion was the ability to find an ICT indicator in the company's statement and a similar definition of this indicator to maintain cohesion in the analysis. Nonetheless, the authors also took into consideration other values: gross written premium, total assets and profit (income) to show the size of their activity. These companies belong to the top 10 European insurance groups according to the criteria of gross written premiums and assets. Such a selection serves yet another purpose of the case study, that is to present contrasting examples but within a comparable category (Yin, 1994) while setting them in an economic reality (Eisenhardt and Graebner, 2007). Consolidated financial statements of the Groups have been prepared in accordance with International Financial Reporting Standards (IFRS).

As independent variables, the value of acquisition expenses, claims handling expenses and wages were chosen. These indicators are usually used in models as factors that describe the efficiency and profitability of the insurer. The price of expenses is proportionally put into the insurance premium: the higher the expenses, the higher the premium. Therefore, expenses are also a factor of competitiveness between insurers (OECD, 2005). Such costs, in general, must be kept as low as possible consistent with running the business effectively and providing a competitive service to the policyholder (Young, 1990). Today, insurers try to cut these types of costs through the use of information and communication technologies.

Variables

Value of Acquisition Expenses (X_1)

Acquisition is one of the main groups of expenses in the insurance activity. According to accounting principles (GAAP and IAS), this indicator includes all commissions for agents (and brokers, if any), policy issue costs (policy writing) and other fees (for example medical examination, if any) that are related to the acquisition of insurance contracts. It is the initial cost of the insurance process (Olivieri & Pitacco, 2015). Acquisition expenses are included in the rate of premium that is why one cannot clearly compare insurance premium and acquisition costs. Another specific feature has to be attributed to life insurance: because of the long-term nature of these contracts, commissions and other acquisition costs are greater than related premiums during the initial year of the contract (AICPA, 2018).

Claims Handling Expenses (X_2)

The process of claims investigation, evaluation and payment is known as the claims handling or claims adjustment process and is one of the most essential and basic functions of an insurance company (Apte *et al.,* 2010). Each claim settlement process requires a customized approach that takes into consideration the specific characteristics of the claim. The final stage in this process is the agreement between the insurer and the claim holder on the amount of compensation. Brooks *et al.* (2005) suggest that regular claims handling activities include the following steps: acknowledging and assigning the claim, identifying the policy, contacting the insured or the insured's representative, investigating and documenting the claim, determining the cause of loss and the loss amount, and concluding the claim.

Wages (X_3)

Staff salaries for a long time were the largest component of insurance management expenses (typically, it was about 8-12 per cent of gross written premiums for a non-life insurer) (Young, 1990). Nowadays the business model of insurers produces other than regular relations between workers and owners. Many different tasks are outsourced or performed under external employment contracts. That is why the number of workers or the value of wages (salaries) could not be informative enough in the sense of total expenses. But the approach based on the current companies' financial statements does not allow us to take into consideration the whole value. Nonetheless, the use of ICT is aimed at reducing this indicator by automation and computerisation of office processes.

The dependent variable is gross software value. Software value is an indicator that is widely used to describe the digitalisation process and the processes of using technologies (Strålin *et al.*, 2016; Weingarth *et al.*, 2019).

The value of software is included in intangible assets and developed for internal use for which direct costs are capitalised and amortised on a straight-line basis over the assets' estimated useful lives (AXA, 2019). The costs associated with research and maintenance of internally-developed computer software are expensed as incurred. The costs incurred during the computer software development phase are capitalised when the following recognition criteria are met (IAS, 2014):

• it is technically feasible to complete the software product so that it will be available for use;

• the management intends to complete and there is an ability to use or sell the software product;

• the software is expected to generate future economic benefits;

• sufficient resources are available to complete the development of the software;

• expenditures can be reliably measured.

Summary Statistics and Correlation Matrix

The aim of the research is to verify the relationship between the indicator y and factors x_1, x_2, x_3 to find the mathematical expression of the dependence, to determine the degree of influence of multiple factors on the indicator, to identify the potential multicollinearity of these factors and, if necessary, to eliminate it.

Descriptive statistics (Table 2) for the analysed variables include mean, median, standard deviation, skewness and kurtosis. Depending on the company size, there are differences in the average and median levels of the analysed variables, thus further research focuses on these companies separately and the models for individual companies are compared. The dependent variable, software gross value, ranges between 313.52M EUR in the company CNP to 2492.82M EUR in the company AXA, in companies Aviva and CNP showing a negative kurtosis, indicating that fewer observations are concentrated around the mean, in comparison to the normal distribution. The opposite is observed in the company AXA. Positive skewness in the companies AXA and CNP indicates that more observations than in the normal distribution are above the mean, while in the company Aviva this is reversed. Acquisition expenses take average values from 3363.91M EUR in the company Aviva to 11033M EUR in the company AXA, preserving a negative kurtosis in the companies AXA and CNP as well as a positive kurtosis in the company Aviva, which means that there is a higher concentration of observations around the mean in comparison to the normal distribution. Acquisition expenses are slightly positively skewed in all three companies, indicating that in the majority of observed years these expenses were lower than the mean. The range of claims handling expenses was from 130.32M EUR in the company CNP to 2202.82M EUR in the company AXA revealing a slight positive kurtosis in the companies AXA and Aviva, while in the company CNP, the kurtosis valued -0.8, demonstrating a dispersion of values higher than in the normal distribution. Claims handling expenses in the companies AXA and CNP are negatively skewed, signalling that the majority of observations are above the mean, while the company Aviva illustrates the opposite. Wages in the analysed companies vary from 302.93M EUR in the company CNP to 5804.18M EUR in the company AXA. The dispersion of values in the companies AXA and CNP is higher than in the normal distribution, while the contrary is observed in the company Aviva. Wages in the companies AXA and Aviva in the majority of analysed years tend to present values higher than the mean and the company CNP reveals a different pattern.

An analysis of the selected insurance companies showed that the data on the same factors differ significantly for different companies. For example, in 2015, the ratio of x_3 values for the company CNP (EUR 175M) and the company AXA (EUR 6020M) equals 34.4. This can be explained by different sizes of the companies and, accordingly, different market sizes of their services. Therefore, it is natural to investigate the relationship between the indicator y and factors x_1, x_2, x_3 in each case separately. Moreover, it indicates that the selected companies differ in terms of selected indicators, which makes the analysis valid. If it proves that with such differentiated data, we get the same degree of influence of factors on the indicator for all companies, it will prove the robustness of the conducted studies. Moreover, the multiple Tukey HSD (honestly significant difference) comparisons of means were conducted to test if the selected companies reveal significant differences in average levels in the observed variables (Bordens & Abbott, 2011, Mosteller & Tukey, 1977). Tukey test under the null hypothesis that there is no difference in means, is done after fitting the ANOVA (analysis of variance) model for each dependent variable separately. P-values of less than 5 % significance levels indicate that there is an “honestly significant difference” in each analysed pair. Computed p-values for each company and variable (Table 4) show that only acquisition expenses along with claims handling expenses in the companies Aviva and CNP reveal no significant difference in the average level during the analysed period. This also serves the purpose of the case study, incorporating differentiated cases in the chosen sample.

Table 2

Descriptive Statistics for the Analysed Variables

Company	Variable	Mean	Median	Standard deviation	Kurtosis	Skewness
AXA	Software gross value	2492.82	2200	674.42	0.56	1.12
Aviva		2004.82	2117	280.63	-1.08	-0.55
CNP		313.52	296.1	88.73	-1.12	0.38
AXA	Acquisition expenses	11033	10833	933.37	-1.41	0.42
Aviva		3363.91	3041	748.86	0.52	1.16
CNP		3416.46	3289	361.31	-1.21	0.57
AXA	Claims handling	2202.82	2247	139.42	0.28	-0.19
Aviva		222	186	66.48	0.36	1.16
CNP		130.32	130.1	26.17	-0.8	-0.47
AXA	Wages	5804.18	5782	260.53	-1.56	0.33
Aviva		1657.64	1447	450.84	0.78	1.27
CNP		302.93	313	81.67	-0.69	-0.42

Table 3

Pairwise Correlation Between Selected Variables

AXA	(1)	(2)	(3)	(4)
(1) y	1.000			
(2) x1	0.938*	1.000		
(3) x2	0.504	0.489	1.000	
(4) x3	0.882*	0.785*	0.191	1.000
Aviva	(1)	(2)	(3)	(4)
(1) y	1.000			
(2) x1	-0.221	1.000		
(3) x2	-0.462	0.364	1.000	
(4) x3	-0.436	0.290	0.959*	1.000
CNP	(1)	(2)	(3)	(4)
(1) y	1.000			
(2) x1	0.979*	1.000		
(3) x2	0.947*	0.911*	1.000	
(4) x3	0.497	0.465	0.314	1.000

* shows significance at the 0.05 level

The results presented above (Table 3) prove that there is a significant strong positive correlation between software gross value and acquisition expenses and wages in the company AXA, and a significant strong positive correlation between software gross value and acquisition expenses and claims handling expenses. Further verification of the relationship between the before-mentioned indicators will be conducted with the application of an econometric model.

Table 4

Pairwise Correlation Between Selected Variables

Company	Variable	Tukey p-value
AXA vs. Aviva	Software gross value	0.03
AXA vs. CNP		0.00
Aviva vs. CNP		0.00
AXA vs. Aviva	Acquisition expenses	0.00
AXA vs. CNP		0.00
Aviva vs. CNP		**0.98**
AXA vs. Aviva	Claims handling expenses	0.00
AXA vs. CNP		0.00
Aviva vs. CNP		**0.06**
AXA vs. Aviva	Wages	0.00
AXA vs. CNP		0.00
Aviva vs. CNP		0.00

Specification and Interpretation of the Model

The present analysis is carried out with the application of the ordinary least squares regression (OLS) for time-series data. The OLS models are the most commonly used econometric tools to examine the relationship between economic phenomena, enabling researchers not only to check if there is a correlation between selected indicators but also to evaluate the nature of this relation, i.e. to examine how the dependent variable is shaped by the selected explanatory variables.

Table 5

Regression Coefficients for Models with all Independent Variables

	(1) AXA	(2) Aviva	(3) CNP
x1	0.348^{*} (3.10)		
x2	0.863 (1.82)		
x3	1.216^{*} (3.40)		
x1		-0.0215 (-0.16)	
x2		-2.031 (-0.39)	
x3		0.0260 (0.03)	
x1			0.140^{**} (4.57)
x2			1.335^{*} (3.38)
x3			0.118 (2.00)
_cons	-10302.5^{***} (-6.07)	2485.1^{**} (4.77)	-374.5^{***} (-6.85)
T	11	11	11
R^2	0.955	0.217	0.985

t statistics in parentheses
$^{*}p< 0.05$, $^{**}p< 0.01$, $^{***}p< 0.001$

The results presented in Table 5 prove that the three estimated models, if all three independent variables are included, do not have significant relationships between regressors and the dependent variable. The first and the third model present a high level of quality (coefficient of determination exceeding 95%), whereas the second model is of a low quality (coefficient of determination of only 22%). Moreover, not all the independent variables are statistically significant. The further analysis involved reducing insignificant ones.

Table 6

Regression Coefficients after Backward Selection of Significant Independent Variables

	(1) AXA	(2) CNP
x1	0.462^{**} (4.37)	
x3	0.983^{*} (2.59)	
x2		2.976^{***} (9.74)
x3		0.241^{*}

	(1) AXA	(2) CNP
		(2.46)
_cons	-8309.0***	-147.1**
	(-5.64)	(-3.49)
T	11	11
R^2	0.934	0.941

t statistics in parentheses
$^{*}p< 0.05$, $^{**}p< 0.01$, $^{***}p< 0.001$

Company AXA

The multiple regression equation that links the indicator *y* and factors x_1, x_2, x_3 for the company AXA is:

$$y=-10302.48+0.35x_1+0.86x_2+1.22x_3$$

Hence, all regression coefficients are statistically significant except for b_2. A multiple correlation coefficient value r[x,y]=0.97745 is close to 1, which indicates that the impact of factors on the indicator for the company AXA is very high, and therefore software gross value is highly dependent on the factors: acquisition expenses, claims handling expenses and wages.

A sign of multicollinearity is the presence of an element $R_{xixj}>0.7$ in Table 3, which indicates a strong correlation between factors x_i and x_j.

Multicollinearity has a negative effect, meaning the redundancy of information carried by the regressors, and should be eliminated from the model. In order to do so, one factor, x_i or x_j, should be excluded from the model, and multicollinearity should be examined again. A factor is excluded from the model by the value R_{xixj}. The lower the value, the smaller the effect of the factor on the indicator, and the weaker the relation with other factors of the model. However, in econometrics, the priority is given not to the factor that is more closely related to the result, but the factor that, when strongly linked to the result, has the least close relationship with other factors.

In the correlation matrix for the company AXA, the element $R_{x1x3}=0.785>0.7$, which means that there is a strong correlation between factors x_1 and x_3.

We then evaluated the relationship of factors with the indicator *y*: $R_{yx1}=0.938>R_{yx3}=0.882$

Next, we evaluated the relationship of x_1 and x_3 with the x_2: $R_{x2x1}=0.489>R_{x2x3}=0.191$.

The advantage of the factor x_1 is small, but the strength of connection with another factor x_2 is much greater than that of the factor x_3.

Therefore, we leave the factor x_3 in the model and exclude the factor x_1 from further consideration.

Thus, the multiple regression equation $y=13465.31+1.68x_2+2.11x_3$ adequately describes the dependence of the indicator on the factors.

Subsequently, tests verifying OLS assumptions were conducted, in each case with the 5% significance level. The homoskedasticity of residuals was tested with the application of White's test, in which the p-value equalled 0.36, thus we failed to reject the null hypothesis, assuming that there is no heteroskedasticity in the model. The linearity of the model was verified with the application of Ramsey's RESET test for squares and cubes, with the p-value of 0.16, which indicates that we failed to reject the null hypothesis assuming that the specification is correct. The Durbin-Watson test revealed the p-value of 0.48, letting us conclude that we failed to reject the null hypothesis, assuming that there is no autocorrelation of residuals in the model. The normality of residuals distribution was tested with the application of the Jarque-Bera test, with the p-value of 0.41, hence we failed to reject the null hypothesis, assuming that the distribution of residuals is normal. Therefore, we can state that OLS is a correctly applied method for analysis of software gross value, depending on the wages and claims handling expenses. Moreover, the quality of the model is high since the coefficient of determination equals 0.85, which means that 85% of changes in software gross value are due to the changes in wages and claims handling expenses. The collinearity is not present in the model as the Variance Inflation Factor (VIF) for each regressor does not deviate much from 1 (1.04 for both independent variables).

Company Aviva

The multiple regression equation that relates the indicator *y* and factors x_1,x_2, x_3 for the company Aviva is:

$$y=2485.143-0.022x_1-2.031x_2+0.026x_3.$$

Hence, all the regression coefficients are statistically insignificant, except for b_0.

A multiple correlation coefficient value $r_{x,y}=0.46567$ means a moderate correlation of the indicator *y* with the *x* factors.

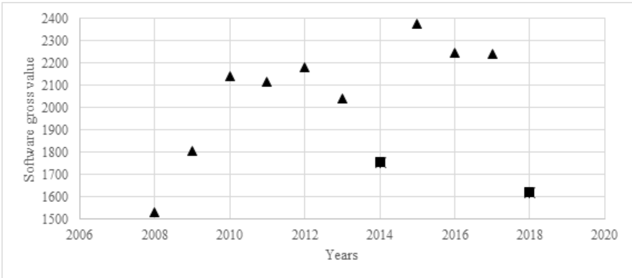

Figure 3. Anomalies in the Values of Software Gross Value

As proven in Figure 3, the data on the company Aviva's activity reveals two values of software gross value that significantly fall out of the overall trend of changes in its values: 2014 – EUR 1754M and 2018 – EUR 1623M. These two values also worsen the overall picture of the adequacy of the multiple regression equation, making it impossible to fit a high-quality econometric model. This means that the company Aviva has a different profile and strategy, not necessarily involving influencing software gross value by wages, claims handling expenses and acquisition expenses. The conducted analysis reveals that these variables do not affect the value of software gross value in the company Aviva, which indicates that the variation of variables between companies is sufficient, enabling distinguishing their profiles and strategies.

Company CNP

The multiple regression equation that presents the relation of the indicator *y* and factors x_1, x_2, x_3, for the company CNP is as follows:

$$y=-374.53+0.14x_1+1.33x_2+0.12x_3$$

Hence, all the regression coefficients are statistically significant, except for b_0.

A value of the multiple correlation coefficient $r_{x,y}=0.9926$ indicates that the degree of influence of the factors on the indicator *y* for the company CNP is very high, and, therefore, software gross value is highly dependent on the factors: acquisition expenses, claims handling expenses and wages. We evaluated the relationship of factors x_1 and x_2 to the indicator *y*: $R_{yx1}=0.979>R_{yx2}=0.947$

Then we evaluated the relationship of x_1 and x_2 with x_3: $R_{x1x3}=0.465>R_{x2x3}=0.314$

The advantage of the factor x_1 is small, but the strength of connection with another factor x_3 is greater than that of the factor x_2.

Therefore, we leave the factor x_2 in the model and exclude the factor x_1 from further consideration.

The next step involved an econometric verification of the above-presented model, i.e. whether the OLS assumptions are not violated, in each case with the 5 % significance level. The lack of heteroscedasticity of residuals was tested with the application of White's test, in which the p-value equalled 0.69, thus we failed to reject the null hypothesis, assuming that there is homoscedasticity in the model. The linearity of the model was verified with the application of Ramsey's RESET test for squares and cubes, with the p-value of 0.15, which indicates that we failed to reject the null hypothesis assuming that the linear function is correct in this case. In the Durbin-Watson test, the calculated p-value equalled 0.08, letting us conclude that we failed to reject the null hypothesis, assuming that there is no autocorrelation of residuals in the model. The normality of the residuals distribution was tested with the application of the Jarque-Bera test, with the p-value of 0.92, hence we failed to reject the null hypothesis, assuming that the residuals in the model are of a normal distribution. Therefore, we can state that OLS is a correctly applied method for analysis of software gross value, depending on wages and claims handling expenses, also for the company CNP. Moreover, the quality of the model is very high since the coefficient of determination equals 0.94, which means that 94% of changes in software gross value are due to changes in wages and claims handling expenses. The collinearity is not present in the model as the Variance Inflation Factor (VIF) for each regressor does not deviate much from 1 (1.11 for both independent variables).

The empirical verification was conducted with the application of econometric models and statistical tools. The analysis was performed for each company separately, as in the initial step we analysed the selected companies with the application of panel data models (both with fixed and random effects). Nevertheless, after the Breusch-Pagan Lagrangian Multiplier test for random effects, we obtained the p-value of 1.00, indicating that we failed to reject the null hypothesis, i.e. the OLS estimation is a sufficient and effective tool for such an analysis. Treating each company as an individual case, we verified whether the selected variables are correlated with one another, in each case eliminating indicators causing multicollinearity (which leads to the inclusion of redundant information). The empirical verification of research questions showed the relationship between selected indicators (in each case the discussed coefficients are significant at the 5 % significance level).

Discussion section

1. The company AXA showed that software gross value was correctly predicted to be influenced by wages and claims handling expenses in the company. An increase in claims handling expenses by EUR 1M causes an increase in software gross value of EUR 1.68M, while an increase in wages by EUR 1M results in an increase in software gross value in the company AXA by EUR 2.11M. This, interestingly, indicates the approach of the company AXA. With increasing expenses, this company tends to invest more in its software, which may be the result of the higher number of employees and claims, which may be difficult to manage without more sophisticated software. It is worth mentioning that software gross value revealed an average annual increase of 7.8 % each year, whereas claims handling expenses and wages increased by 1.7 % and 0.7 %, respectively. This proves that software investments in the company AXA are more intensive than the increases in its costs, in terms of wages and claims handling expenses.

2. The company Aviva showed no statistically significant relationship between software gross value and wages, acquisition expenses, along with claims handling expenses. This, likewise, may be an interesting finding – while the two remaining companies are strongly influenced by their expenses in terms of software investments, the company Aviva makes its decisions on software purchases and modernisations not based on its overall expenses. The reason behind such a result may be the presence of strong outliers in software gross value across the time – the changes of this variable cannot be represented by any mathematical function, and most significantly, not by a linear one, as there is an increase between the year 2008 and 2010, then a slight decrease in 2012, followed by a minor increase in 2012, followed by a sharp decrease by 2014. Then the increase that occurred in 2015 appeared to be a very significant one – by 35 % – followed by a decrease to 2018. Such fluctuations appeared to be anomalies, thus hindering the estimation of an econometric OLS model. What is interesting, software gross value in the company Aviva increased by 0.6 % on average each year, while other variables – acquisition costs, claims handling expenses and wages – decreased by 1.4 %, 6.7 %, and 6.7 %, respectively. This company is the only one among the selected companies that shows decreases in the selected indicators.

3. The company CNP showed a strong statistically significant relationship of software gross value with wages and claims handling expenses, which is similar to the company AXA. An increase of EUR 1M in wages causes an increase of software gross value by EUR 0.24M, while the EUR 2.98M increase in software gross value is due to a EUR 1M increase in claims handling expenses. Interestingly, software gross value in the examined period increased on average by 8.6 % every year, while wages revealed an increase by 2.8 % and claims handling expenses by 6.4%. This indicates that the company CNP invests in software with higher intensity than is the increase in its costs, measured by wages and claims handling expenses.

To sum up, the company AXA proved that higher investments in the acquisition activity, i.e. attracting customers, as well as higher wages expenses, i.e. investing in broader and/or better developed and qualified staff, provokes also higher investments in software. This can be explained by the fact that attracting new customers or preserving existing ones requires better labour, thus resulting in a greater demand for better and more efficient software. The company CNP proved that its software demand is driven by increasing claims handling expenses and wages. This is because handling more and more claims requires more staff and, consequently, more and better software to cut the costs and/or raise the quality of service. The company Aviva showed no significant correlation between software demand and its insurance production costs. This may be a result of a discordant, in comparison to the two remaining companies, strategy for handling the insurance business. Another possibility is that the company Aviva may have some problems – as may be indicated by intense fluctuations of the selected variables across time.

Limitation of the Research

The present research is limited to three cases of large insurance companies, sampled to present differentiated trajectories of implementing ICT and the influence of handling costs upon them. Future studies may further investigate the problems analysed in this paper by adding different size companies, presenting wider spectra of enterprises presenting different business strategies. Moreover, a longer period would enable to achieve more reliable and robust results. Furthermore, if the entities sampled for the analysis were selected with regard to geographical concentration, for example, aggregated in NUTS 2 regions, spatial econometric models could be used to present not only how the ICT demand in an individual company is determined by wages, claims handling expenses and acquisition expenses, but also how the neighbours influence this phenomenon.

Nevertheless, due to the limited availability of data, future research could be structured differently, applying different data collection methods, i.e. based on authors' own designed survey conducted in insurance companies, not on published data. This would enable authors to apply more sophisticated econometric methods and draw more appealing conclusions from their research.

Conclusions

Implementation of information and communication technologies can bring new opportunities for insurance business development. Different positive effects of this process are widely discussed in the literature (Pagano *et al.,* 2019; Gatteschi *et al*., 2018; Barros *et al*., 2017; Forman *et al.*, 2011; Neirotti *et al*., 2007). The research study showed the gap between the theoretical background and the practical realisation of digitalisation processes in insurance. Due to the scientific question, research results showed that there is no clear evidence of the influence of raising production costs on technology demand in the case of insurance companies. Selected companies revealed differentiated strategies towards their investments in software, as dependent on insurance production costs – wages, claims handling expenses and acquisition costs.

Possible implications The results of this study contribute to the present body of knowledge in insurance literature as well as practice. Among others, the research carried out in this study adds novelty to the existing literature by creating and validating the proposed framework to evaluate the selected factors of technology demand in insurance companies. Theoretical significance reveals itself in the uniqueness of this study because of its focus on the unique product cost factors such as acquisition costs and claims handling costs. Despite the opinion existing in the literature that one of the aims of the ICT implementation is cost cutting, this statement was just partly confirmed. Currently, companies possess various strategic goals, therefore the implementation of ICT cannot be called an independent strategy and it has a very individual character, serving different values of companies. Technologies still do not play a key role in the efficiency growth of insurance companies. It is mostly a sporadic factor rather than a strategy. Focusing on the emphasized aspects of this study, the leaders of insurance companies might improve their investment activities in ICT to decrease their production costs.

Direction for future research There is a range of research possibilities in the future to show other determinants of demand for technologies among insurers. They could include independent indicators that explain the financial performance of insurers. In this research, we are paying attention to the cost side of demand, but the next hypothesis for verification is whether better financial performance generates higher demand for technologies among insurers. The same aspect of IT spending and financial performance was raised by Neirotti & Paolucci, 2007. Besides, an interesting indicator of the technology demand are joint venture investments. Joint venture embraces investment in young companies (often Start-ups), that deal with the development and implementation of technology in the insurance business.

Deeper reflections concerning the demand for technology in insurance are directly connected with the problem of technology selection and domination. This problem was described by Dąbrowski (2016) and it deals with the factors of technology domination. The idea is that technologies prevailing at a given time may deviate significantly from the best possible solutions (Dąbrowski, 2016).

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