Annex No. 4

Summary of professional accomplishments and academic achievements

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Collegium of Economic Analysis
SGH Warsaw School of Economics

Contents

1. Comprehensive overview of academic activity, education and employment

Education
- 2006 - Doctor of Mathematics, Faculty of Mathematics, Physics and Computer Science, Maria Curie-Skłodowska University in Lublin
- 2001 - Master of Mathematics in the field of Applications of Mathematics, Faculty of Mathematics and Physics, Maria Curie-Skłodowska University in Lublin

Employment
- From 10.2007 - Assistant Professor at the Institute of Statistics and Demography, Collegium of Economic Analysis at the SGH Warsaw School of Economics
- 01.2007-09.2007 - Assistant Professor at the Department of Applied Mathematics at the Faculty of Management and Fundamentals of Technology of the Lublin University of Technology
- 10.2001-12.2006 - Assistant at the Department of Applied Mathematics at the Faculty of Management and Fundamentals of Technology of the Lublin University of Technology

1.1. Education, academic and didactic activity before obtaining the doctoral degree

In 1996, I started studying mathematics at the Faculty of Mathematics and Physics of Maria Curie-Skłodowska University (UMCS) in Lublin. In 2001, with a very good grade, I obtained a Master's degree in the field of Applications of Mathematics. Dr. Zofia Grudzień was the supervisor of my master's thesis entitled *Characteristic of continuous probability distributions based on record values and order statistics.*

After obtaining my master's degree in October 2001, I started to work as an assistant at the Department of Applied Mathematics at the Faculty of Management and Fundamentals of Technology at the Lublin University of Technology. As soon as I started I conducted classes in *Mathematics* as well as *Probability and Statistics*. At the same time I started academic collaboration with Dr hab. Wiesław Zięba, Associate Professor of UMCS, head of the Unit of Probability at the Faculty of Mathematics and Physics of Maria Curie-Skłodowska University in Lublin. At that time, my academic activity focused on issues related to statistics and probability. This cooperation resulted, *inter alia*, in the following publications:

- Wioletta Nowak, Wiesław Zięba, Types of conditional convergence, "Annales Universitatis Mariae Curie-Skłodowska, sectio A – Mathematica", 2005, No. 59, pp. 97-105.
- Dariusz Majerek, Wioletta Nowak, Wiesław Zięba, *On uniform integrability of random variables*, "Statistics & Probability Letters", 2005, No. 74, pp. 272-280, (JCR journal).

- Dariusz Majerek, Wioletta Nowak, Wiesław Zięba, *Conditional strong law of large number*, "International Journal of Pure and Applied Mathematics", 2005, No. 20(2), pp. 143-157.

In 2005 I moved to Warsaw, but due to my ongoing doctorate works and other professional commitments I worked in Lublin until September 2007.

In 2006, at the Faculty of Mathematics, Physics and Computer Science of Maria Curie-Skłodowska University in Lublin, I defended my doctoral dissertation entitled *Types of conditional convergence* and I received a Ph.D. in Mathematics. Dr hab. Wiesław Zięba was the supervisor of my doctoral dissertation, whereas Prof. Dr hab. Adam Paszkiewicz from the University of Lodz and Prof. Dr hab. Dominik Szynal from Maria Curie-Skłodowska University in Lublin were the reviewers.

My doctoral dissertation concerns research into conditional versions of selected theorems of the probability theory. Most of the phenomena we encounter in reality are conditioned by certain factors. In my dissertation, I focused on the properties of the conditional expected value that can serve as a tool for observing random variables through a certain filter. A question then arises as to how many observations of random variables for this filter can determine the analysed variables. In addition, the conditional expected value operator has wide applications in the studies of random variable sequences, in particular martingales and their generalisations, as well as in the theory of stochastic processes. The first aim of my doctoral thesis was to present the relationship between different types of conditional convergence. In my doctoral thesis a continuous transition from convergence in probability to almost sure convergence has been shown. Furthermore, it has been shown that conditional convergence in distribution results from conditional convergence in probability and the condition that needs to be met for these convergences to be equivalent was given. The second aim of my work was to show that too simple transfer of classical theorems of the probability theory to a conditional case can often lead to incorrect conclusions. Finally, additional assumptions that need to be made for selected theorems of the probability theory to remain true in the conditional version have been presented.

1.2. Academic and didactic activity after obtaining the doctoral degree

After obtaining my doctoral degree I continued to work as an assistant at the Department of Applied Mathematics at the Faculty of Management and Fundamentals of Technology of the Lublin University of Technology for several months. On January 1, 2007 I was appointed assistant professor at the same Department. This change was reflected in my growing didactic duties. On top of practical classes, I also conducted a self-written lecture on *Probability theory and statistics* for students majoring in Management and Marketing as well as Management and Production Engineering. These lectures covered descriptive and mathematical statistics with a wide range of analytical tasks of practical character, which were in line with the profile of the faculty.

At that time, my research and academic activity was still focused on the possibilities of generalising theorems of the probability theory into conditional versions. The result of my research work was the publication of two papers that presented and expanded the results of my doctoral dissertation:

- Wioletta Grzenda, Dariusz Majerek, Wiesław Zięba, (2007), *Comments to the paper "On uniform integrability of random variables"*, "Statistics & Probability Letters", No. 77, pp. 1644-1646, (JCR journal).
- Wioletta Grzenda, Wiesław Zięba, (2008), *Conditional central limit theorem*, "International Mathematical Forum", No. 3(31), pp. 1521-1528.

I received a team award of the third-degree from the Rector of the Lublin University of Technology for research achievements in the academic year 2006/2007.

In 2007, I started cooperation with Dr hab. Ewa Frątczak, Associate Professor of SGH, head of the Unit of Event History Analysis and Multilevel Analysis at the Institute of Statistics and Demography, Collegium of Economic Analysis at the SGH Warsaw School of Economics. At that time, I started intensive trainings in SAS 4GL programming.

In October 2007, I was hired as an assistant professor at the Unit of Event History Analysis and Multilevel Analysis at the Institute of Statistics and Demography, Collegium of Economic Analysis at the SGH Warsaw School of Economics. From then on, my academic and research interests have shifted towards econometric modelling. Leveraging my previous academic interests and knowledge of stochastic processes, I focused on the possibilities of using Bayesian methods in the modelling of demographic and socio-economic phenomena. I broadened my knowledge of Bayesian methods by participating in academic seminars. First I joined Prof. Dr hab. Wojciech Niemiro's seminar on Markov Chains and Monte Carlo Methods at the Unit of Mathematical Statistics at the University of Warsaw. Later I took part in selected academic meetings at the Department of Econometrics and Operations Research organised by Prof. Dr hab. Jacek Osiewalski at the Cracow University of Economics. In addition, I completed a monthly online training on Bayesian Modelling via MCMC, led by prof. Peter Congdon of the Queen Mary University of London.

Since I started working at the Warsaw School of Economics, I have published 20 scientific publications. In addition, I am the author and co-author of 4 academic course books. For my course books I received two individual second-degree awards and a first-degree team award of the Rector of the SGH Warsaw School of Economics in the field of didactic activity. I took part in 44 conferences and presented the results of my research at 16 of them. In 2015, I entered OPUS 9 competition organised by the National Science Centre and was granted funding to implement my project entitled *The modelling of parallel family and occupational careers with Bayesian methods*. I am currently finalising this project publishing papers and presenting its main findings at conferences. Most of my post-doctoral papers concern modelling of fertility behaviour of women and inequality analyses on the labour market in Poland.

I have been a very active academic, preparing and delivering lectures and running computer laboratory and practical classes at undergraduate, graduate and doctoral studies, many times largely exceeding the assistant professor's teaching load. In addition, I have prepared and conducted proprietary courses for three postgraduate studies. I have co-developed programs for the courses comprising on *SAS Statistical Data* Analysis specialty and certificate and for *Advanced Analytics - Big Data* and *Quantitative Methods in Economics and Information Systems*. I have coordinated programme preparation for *SAS programming* and *Data mining basic and advanced with text mining*. I have also been part of organisational teams and acted as the secretary of seven successive editions of Postgraduate Studies *Statistical Analysis and Data Mining in Business* at the SGH Warsaw School of Economics. In addition, I am a representative of dependent academics on the Board of the Collegium of Economic Analysis at the Warsaw School of Economics for the term 2016-2019. From October 2012 to September 2014, I was on maternity leave and then on parental leave. While on parental leave, I conducted some classes due to their unique character.

A detailed description of my academic research, organisational and teaching activities at the SGH Warsaw School of Economics to the present have been included in the further part of this document.

2. Description of the main academic achievement

My main scientific achievement under Article 16 paragraph 2 of the Act of 14 March 2003 on academic degrees and academic title, and on degrees and title in the Arts (Journal of Laws of 2016, item 882, as amended in Journal of Laws of 2016, item 1311.) is the **academic monograph**:

Wioletta Grzenda, (2019), "Modelling of professional and family careers with Bayesian methods", Warsaw: PWN Scientific Publisher, 285 pages (published in Polish).

Reviewers:
- Prof. Dr hab. Grażyna Trzpiot, University of Economics in Katowice,
- Dr hab. Jerzy Marzec, Associate Professor of Cracow University of Economics.

2.1. Presentation of a monograph - the key academic achievement

Aim of the research undertaken and its place in the literature of the subject
The life cycle of an individual consists of many careers: family, professional, migration and education. Some of them are implemented at the same time and affect each other. From the point of view of the order of events occurring within these careers, they can be complementary or competitive careers. In my monograph, I focused on two of them:

professional and family. The study of the interdependence of these careers has long been the interest of many researchers [Willekens, 1991], but due to the changing demographics and socio-economic situation, this issue remains open. According to E. Frątczak [1999], these careers are an example of competitive careers, because during their implementation, there is competition for individual's resources, which are permanent or limited. Based on the results of other studies [Ptak-Chmielewska, 2005; Kotowska, ed., 2009; Matysiak, 2009], it can be argued that previous conclusions on the nature of interdependence between these two careers were in some cases inconsistent.

The degree of interdependence between professional and family career may depend on the intensity of cultural and structural conflict [Liefbroer, Corijn, 1999; Muszyńska, 2006]. The cultural conflict refers to attitudes towards traditional social roles of women and men, and according to research [Kotowska, Sztanderska, Wóycicka, ed., 2007], it has weakened in Poland. The structural conflict, on the other hand, concerns the lack of appropriate institutional solutions enabling women to combine work with raising children. The lower economic activity rate, the lower employment rate and the higher unemployment rate among women as compared to men [CSO, 2015] may be a consequence of these conflicts in Poland.

The main purpose of my research presented in monograph was to acquire new knowledge about the interdependence between professional and family careers of Polish citizens. This goal was accomplished through a comprehensive analysis of procreative behaviours, forming relationships and making professional decisions using the Bayesian approach. The second purpose of this monograph was to demonstrate possibilities and usefulness of Bayesian methods in modelling demographic and socio-economic processes, as well as to present the benefits of Bayesian approach in their analysis. In the course of my research, whose results were presented in the monograph I analyzed a dozen or so detailed research problems, which I took in the form of the following two main hypotheses:

1. Possessing appropriate features of human capital by women positively influences their situation on the labour market and their fertility decisions, in addition, it eases the effects of breaks in work related to the birth of a child.
2. Using the Bayesian approach in modelling professional and family careers allows for a wider scope of their analysis than enabled by the classical approach.

The considerations presented in the monograph of women's fertility behaviour and their participation in the labour market were considered in the context of economic theories of fertility. The main theoretical concepts are economic theories of fertility of H. Leibenstein [Leibenstein, Kleer, Vielrose, 1963], G.S. Becker [1990; 1991; 1993] and R.A. Easterlin [1978; 1987] and the concept of a second demographic transition [Van de Kaa, 1987; Lesthaeghe, 1991; Sobotka, 2008]. Women who want to be professionally active decide to give birth to their first child at an older and older age, which may contribute to a smaller number of children [Kohler, Francesco, José, 2002; Kohler, José, 2002]. In recent years in Poland women most often give birth to their first child between the ages

of 25 and 29 [Frątczak, Grzenda, 2018]. Postponing maternity decisions may contribute to low fertility observed in recent years in Poland, which remains at 1.3 [CSO, 2014]. As a result, for many years the process of generation reconstruction in Poland has been permanently below the replacement level [Jóźwiak, 2013]. According to J. Czapiński and T. Panek [eds., 2015], difficulties with finding and keeping a job, and, consequently, poor financial situation of families, is one of the main factors influencing decisions whether and how many children to have. At the same time, the increase in professional activity and growing professional aspirations of young women may also have a limiting effect on fertility decisions.

As the findings presented in the paper indicate [Kotowska, Sztanderska, Wóycicka, ed., 2007], the economic model of the Polish family has been changing: women's incomes are more and more often not just a supplement to household budgets, but they constitute an equal source of income. However, the professional activity of women in Poland is still low compared to other European countries. In view of low fertility rates and low employment rates for women in Poland, the main goal of many scientific studies is to find out whether and under which conditions a greater participation of women in the labour market is possible without negative consequences for their family life [Kanji, 2011; Matysiak, 2011]. According to J.A. Urban and P.N. Olson [2005], worse than men, the situation of women in the labour market is one of the main factors influencing decisions whether and how many children to have. At the same time, the professional situation of women may be the result of traditional perception of social roles of women and men in the household. According to F. Willekens, the relationship between fertility and employment stems from individual characteristics of individuals, in particular their needs related to self-fulfilment in professional life [Willekens, 1991]. According to S. Drobnič and E. Frątczak [2001], this does not only refer to individuals, but also their families who play an important role in making professional and procreative decisions. The features of broadly understood human capital play a special role here. Their significance in the analysis of professional and family careers was already pointed out by G.S. Becker [1991; 1993].

The second goal of this monograph was to indicate the possibility of using the Bayesian approach [Gelman et al., 2000; Osiewalski, 2001; Bolstad, 2007] in the modelling of parallel careers. According to A. Zellner [1985], a proper use of the Bayesian approach can gives better results for econometric modelling than the classical approach. The research documented in the monograph was carried out using the following statistical models in the Bayesian approach: logit models and event history analysis models. According to J.G. Ibrahima, M.H. Chena and D. Sinha [2001], the use of the Bayesian approach is particularly recommended for survival models due to the occurrence of censored observations.

The main advantage of the Bayesian approach is the possibility of including additional information from outside the tested sample in the modelling process [Gelman et al., 2000; Lancaster, 2004; Bolstad, 2007]. The use of knowledge from outside the sample in statistical modelling may improve the quality of statistical conclusions. The accuracy and reliability

of estimates can be improved even by quite general prior information expressed by a prior distribution with high dispersion [Szreder, 1994]. According to A.E. Garthwaite, J.B. Kadane and A. O'Hagan [2005], the inclusion of additional knowledge in the process of statistical inference is more important than a slight improvement in the quality of modelling, which could be obtained by using other data analysis techniques.

In Polish studies the Bayesian approach is most often used in other than demographics areas of economics, mainly in banking, finance, risk theory and actuarial issues [Osiewalski, 2001; Pipień, 2006; March, 2008; Osiewalski, Pajor, 2010; Męczarski, 2015]. In addition, in these works models other than models of durations were considered, while the latter are particularly relevant from the perspective of analyses included in this monograph. In demographic and social research, the Bayesian approach is not yet widespread. In Poland, according to my knowledge, the first publication in which the Bayesian methods have been used for fertility research, is my paper submitted for publication in 2009 *The Analysis of women's fertility in Poland using the Bayesian Poisson regression model* [2012] (published in Polish) concerning the modelling of the number of children. Recently, the work of B. Osiewalska [2017] including modelling of reproductive behaviours of couples using the Poisson model (Zero-Inflated Poisson) in the Bayesian approach was also published. Other earlier papers focus on migration forecasting [Bijak, 2011] and a Bayesian comparison of procreative behaviour models [Osiewalski, Zając, 2011]. In foreign literature, the Bayesian approach in demographic research is mainly used in prognostic modelling. In some works [Alkema et al., 2011; Raftery et al., 2013] the Bayesian approach is used to predict the fertility rate, while in others [Raftery et al., 2013] to predict life expectancy. Also, in the review paper [Bijak, Bryant, 2016], on the use of the Bayesian approach in demographics, the authors focused on applying this approach to forecast demographic phenomena, while also pointing to its advantages in estimating complex models.

Thematic scope of the monograph

The discussed monograph consists of eleven chapters. Chapter 1 presents theoretical concepts of fertility and professional decisions and the main research problems.

Chapter 2 includes theoretical basis for the analysis of parallel careers: family and professional. It presents definitions of basic concepts in the field of career modelling and the importance of causality theory in the modelling of these careers. In addition, it contains a review of previously used methods and models in studies of professional careers and family careers.

Chapter 3 is devoted to selected issues of Bayesian inference. In the first part (Section 3.1) two paradigms used in statistical modelling are compared: classic approach and Bayesian approach. The advantages and disadvantages of using the latter are outlined. Section 3.2 touches upon the selection of prior distribution and the definition of its types. Section 3.3 contains selected methods for estimating econometric models and presents

Markov chain Monte Carlo methods and selected algorithms of these methods. Section 3.4 is devoted to Bayesian methods of comparison of competing models.

The next two chapters contain theoretical aspects of the considered statistical models. In chapter 4, the logit model is presented and its estimation in Bayesian approach. In addition, the ways of modelling unobserved heterogeneity are highlighted. Chapter 5 presents survival models in the Bayesian approach, parametric and semiparametric survival models as well as estimation methods of these models with fixed and random effects, and competing risks survival models.

Chapter 6 details data sources used in the monograph. These include data from the *Generations and Gender Survey* for Poland (GGS) and the *Labour Force Survey* (LFS). The advantages and limitations of using these data in modelling professional and family careers are presented.

The remaining chapters contain the results of my research. Chapter 7 contains the comparative analysis of professional careers of men and women. Data from LFS is used for modelling. The probability of not having a job, the time needed to find the first job, the transition from the job search to being employed status and the duration of the employment are modelled.

Chapter 8 presents the results of analyses of factors determining the age at marriage. Particular attention is paid to the links between professional life and the moment of getting married and the analysis of gender differences. In modelling GGS data is used. The modelling of the duration of period till the first marriage is carried out using parametric survival models in the Bayesian approach.

Chapter 9 is devoted to modelling key events from the family careers and professional careers of women. In the first subsection - using the Bayesian logit model - the impact of selected determinants on decisions about having children was analysed. In the next subsection, the time aspect in modelling these decisions is additionally accounted for. Such an approach made it possible to include in the analysis the characteristics of units that may change over time. The last two sub-chapters are devoted to identifying factors determining the duration of leave related to the upbringing of a child and the duration of employment relationship after childbirth.

Chapter 10 presents the results of research on the relationship between motherhood and professional activity. The analysis of interdependence between professional career and family career was carried out using data from GGS. The events analysed are the birth of a child in the case of family career and the termination of employment in the case of professional career. In addition, an attempt is made to answer the question whether professional career and family career are competitive or complementary.

The monograph ends with Chapter 11 containing a research summary and conclusions. Selected results of the studies included in the monograph are summarized below in this document.

The sources of information used in the study

The analysis of professional and family careers presented in the monograph was carried out based on two data sources: *Generations and Gender Survey* for Poland (GGS) and *Labour Force Survey* (LFS). The *Generations and Gender Survey* provides information on selected demographic processes, with an emphasis on the processes of family creation and making decision on having a child in relation to the labour market. It was therefore the basic source of information for the presented research. However, due to the fact that GGS does not fully allow for the reconstruction of respondents' careers, the analysis also uses data from the *Labour Force Survey*. Data from LFS constitute the main source of information on the situation on the labour market in Poland, making it possible to analyse career in various aspects.

The influence of factors determining family and professional decisions is constantly changing along with socio-economic and cultural changes in Poland. In this study, the most recent datasets from the same period were used - in the case of GGS, the basis for estimation were data from 2014 and 2015, and in the case of LFS data from 2015. In demography, the reproductive age of women is assumed to be 15 to 49 years. Due to the GGS database used and the very low fertility rate of women over 44 years of age, only those who were aged 18 to 44 at the time of the study were included in the modelling. Based on the timing of surveys used, the professional careers and family careers of Poles born between 1970 and 1991 were analysed.

The methodological context of the research

The analysis of the impact of selected traits on professional career and family career and modelling relationships between these careers was the subject of the research presented in this monograph. A deeper analysis of demographic processes and their determinants requires the construction of statistical models that enable us to study relationships between events occurring within the careers in question. Traditional methods of demographic analysis may be insufficient, as calculating indicators and measures in the analysis of fertility and professional careers in various cross-sections does not allow us to model causal relationships between the studied processes [Caselli, Vallin, Wunsch, 2005].

In the modelling of phenomena under consideration, a cause and effect approach was used, which required appropriate analytical methods. The analysis of events occurring within two careers in question was carried out using logit models and survival models. In the case of many competing terminating events, competing risk survival models were used. Many characteristics determining the behaviour of individuals are subject to changes over time. They also affect the analysed events to a different degree. The modelling therefore required the use of time-dependent variables and the method of episode splitting. Moreover, explanatory variables were included in the modelling process, which to a different extent affect the risk of occurrence of the examined event depending on its duration. Unobservable diversity of individuals and their individual preferences

were considered by applying models with random effects. The use of a wide range of econometric methods, including, to my knowledge, those not yet seen in modelling professional and family careers, such as parametric models for competing risks, enabled a comprehensive analysis of these careers, and a major extension of previous research concerning them, in turn. In addition, the advantages of using survival models in the study of professional and family careers were emphasised. It was shown that including time aspects in modelling certain events within these careers may lead to different conclusions than those obtained with classical regression models.

So far, the so-called classic approach was used for modelling professional career and family career. In this monograph whereas the use of Bayesian approach was proposed. This new approach to the modelling of the careers under consideration resulted in interesting insights into interdependences between them. The use of the Bayesian approach made it possible to use a priori knowledge at every stage of modelling. Therefore, the results obtained with the Bayesian methods constitute the entire knowledge on the studied phenomenon. The modelling process involved prior information from previous research, which, according to M. Szreder [1994], may provide better accuracy of estimation as compared to the results obtained using the classical approach. The advantages of informative prior distributions constructed on the basis of historical data as opposed to other informative prior distributions are also disused in the paper [Ibrahim et al., 2015]. In the absence of prior information and when large samples were considered in the Bayesian modelling, so-called non-informative prior distributions were used [Gelman et al., 2000].

By considering model parameters as random variables, a more comprehensive analysis of the studied careers was conducted. Instead of estimates of unknown parameters, posterior distributions of parameters were compared as they are the result of combining information in a sample with prior knowledge [Bolstad, 2007]. This made it possible to draw wider conclusions than those that could be obtained using classical approach. Modelling professional careers and family careers in the Bayesian approach also allowed for a wider range of methods that could be used to compare competing models. In this way the best method for modelling selected events within these careers could be selected - also when non-nested models were considered [Wasserman, 2000; Ando, 2010].

As Bayesian modelling requires the use of appropriate numerical methods, the Markov chain Monte Carlo (MCMC) methods are most often applied [Robert, Casella, 2004]. The use of MCMC methods for estimation enabled a better and faster estimation of unknown model parameters in situations when classical methods may be insufficient. This was particularly important for the estimation of models with unobserved heterogeneity, where numerical optimisation of the likelihood function may be difficult. Also for methods based on the partial likelihood function, J.G. Ibrahim, M.H. Chen and D. Sinh [2001] suggest the use of Bayesian approach and MCMC techniques. The Bayesian approach did not require the use of limiting distributions, which was particularly important for small samples.

It can be argued that the advantages of Bayesian approach in modelling professional careers and family careers allowed for their wider analysis as compared to the classical

approach. The detailed description of the methods used in this monograph together with their applications aimed also to advise Bayesian econometric models for modelling professional careers and family careers as well as indicate their benefits for analysing other demographic and socio-economic phenomena and processes.

Presentation of key research findings described in the monograph and conclusions

In this monograph, the impact of many socio-economic and demographic factors on marital, professional and fertility decisions of Poles was analysed. In the first stage of research documented in the monograph, the analysis of professional careers of men and women was made. The research considered separately the situation on the labour market of people looking for the first job and people who already have some professional experience. It has been shown that it is easier for young people to find a job right after graduation, as is also confirmed by research results for other countries [Kroft, Lange, Notowidigdo, 2013]. The importance of human capital and its changing impact on taking up employment depending on the duration of job search was also indicated. Considering the duration of the employment relationship, it was obtained that regardless of the method of termination of employment, education and sex have the greatest impact on the risk of transition from the state of having a job to the non-working state.

Based on the results obtained, it can be concluded that gender discrimination still persists on the labour market in Poland. This phenomenon was already addressed by Becker [2010], this publication is another and extended edition of his original work from 1957. He emphasised that despite the same productivity of men and women in various fields, including labour market, employers discriminate against women. My study found that only young women looking for their first job, who have potentially fewer household-related responsibilities, are faring better on the labour market compared to young men. In my monograph the importance of human capital was also indicated: the higher the qualifications of women defined by education, the lower the significance of gender differences in the chances of finding and keeping a job. In addition, based on the employment duration analysis, women were found to demonstrate a higher risk of termination than men, irrespective of how the contract of employment was terminated. The results of this comparative analysis of the situation of women and men on the labour market in Poland and the results of previous research [e.g. Landmesser, 2013] indicate that the situation of women is improving, but it is still difficult to talk about gender equality on the labour market in Poland. It can be concluded that as R. Castellano and A. Rocca [2017] point out, identified gender differences in the situation on labour market may be primarily the result of cultural factors.

The family situation also affects the situation of the individual on the labour market. The study has shown that the presence of a child under 15 in a household where the respondent is the head of the family or spouse results in a greater drop in the chances of having a job for women than for men. In addition, it was found that in the case of women with children, the time needed to find a job is longer compared to other women. This may

be due to the fact that women looking after children seek jobs that will enable them to combine work and childcare as it was later shown that the type of work performed by women has an impact on the length of leave connected with raising a child. According to the GGS research, despite numerous solutions that currently allow both parents to combine work and bringing up children, the duty of looking after children still rests primarily on women. As a result, there are differences in the chances of finding and keeping a job between women and men. This problem concerns also other European countries - legal measures minimise the impact of some barriers, but new limitations are created, related, for example, to globalization, which can slow down the emergence of a more egalitarian society [Scott, Crompton, Lyonette, ed., 2010]. As some scholars argue [McDonald, 2002], in line with the theory of gender equality, an increase in fertility rate may be achieved when gender equality is reflected in family-oriented institutions.

Considering the current reproductive behaviour of women and their participation in the labour market in the context of economic theory of the family [Becker, 1991], it is worth paying attention to changes to the traditionally understood family. This monograph examines not only the influence of factors related to the family situation on the status on the labour market, but also analyses how the level of education and professional qualifications affect family decisions. It may be argued that in accordance with the concept of the second demographic transition both women and men with higher education and a job delayed marriage. Moreover, it was found that having a job and higher education has a negative impact on the chances of having a child. The impact of human capital on women's procreative intentions was also indicated in previous works [Olah, Frątczak, ed., 2013]. This finding is also in line with Becker's theory of investing in human capital [1991], according to which investing in education leads to a fall in fertility. On the other hand, further analyses have shown that a mere analysis of chances of having children may be insufficient to formulate definitive conclusions about the significance of these factors. Analysing procreative decisions in the context of time aspects, it was found that the intensity of transitions from not having a child to having one is higher for working women compared to others and for women with higher education in comparison to women with lower level of education.

Another research aspect of this monograph was the analysis of the duration of leave related to raising a child. The problem is they are still used mainly by women. As the study found the differences in the risk of termination of employment for women and men are the greatest when we look at the termination of employment for reasons attributable to the employee or childcare. In addition, characteristics of human capital such as the level of education and having a job at the time of childbirth have a primary impact on the duration of leave related to the upbringing of a child. Women with higher education, whose partners and fathers were better educated, came back to work sooner after childbirth. It can be concluded that having a high professional status may facilitate combining professional and family responsibilities or increase motivation to get back to work faster. In addition, the type of job had a statistically significant effect on the length of leave related to raising a child.

Based on the obtained results, it can be stated that well-educated women with a higher professional position enjoyed shorter leaves related to raising a child. The fear that a longer absence from work may entail irreversible consequences for a career may motivate them to return to work more quickly. These consequences may include missed or postponed promotion opportunities or the loss of potentially higher income.

According to [Kotowska, Sztanderska, Wóycicka, ed., 2007], supporting and promoting cultural changes consisting in moving away from the traditional division of roles should help promote solutions enabling individuals to combine professional and family responsibilities. As P. McDonald [2002] argues, a change in the traditional perception of gender roles should result from promoting their equality. The study suggests that in Poland these changes are currently visible only in families where partners have a high level of education. For these families, the result obtained is in line with the Oppenheimer concept [1994, 1997] regarding pooling resources to ensure family well-being.

Another important research problem was the professional activation of women after breaks in professional careers related to childbirth. Based on the analysis of the duration of employment relationship after the birth of the child it was found that respondent's education, type of work and previous job experience have an impact on the risk of employment termination following childbirth. It was shown that the longer the break in professional career, the more difficult it is to return. In addition, women who take long leaves related to childcare may have lower chances of promotion, which is caused by a greater loss of human capital, mainly professional skills [Mincer, Ofek, 1982; Becker, 1991]. Also, in some works [Edin, Gustavsson, 2007; Zhang, 2008] the negative effect of longer leaves on future professional career has been indicated. It was easier for highly educated women with longer work experience before the birth of a child, to return to work after the breaks related to raising a child. On the other hand, the study has not indicated any statistically significant impact of characteristics of respondent's partner, help from the family or the use of institutional forms of childcare on the duration of the employment relationship after the birth of a child.

In the context of the research into the relationship between professional and family career, based on the analyses made it was found that the probability of not having a child is greater for women pursuing both careers than for women pursuing only a family career. On the other hand, it was found that the probability of not terminating the employment relationship is greater for women pursuing both careers than for women pursuing only a professional career. The procreative behaviours of women with an established professional position are consistent with the theory of rational choice. Namely, if the benefits of work are high and compensate for the reduction of women's participation in household duties, then women decide to have children without limiting their professional activity.

According to Becker's theory [1991], investing in professional and family careers simultaneously does not bring optimal benefits for women. The research confirms that at present women first invest in education and professional qualifications, and then decide to have a child. The detailed analysis of the careers discussed

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in the monograph can help in the search for new solutions that will enable women to participate more in the labour market, without compromising their family functions. It can be argued that characteristics of human capital related to education and professional qualifications play the biggest role in determining women's occupational position and their fertility decisions. Taking into account the results obtained, it can be concluded that there are no grounds to reject the hypothesis that appropriate characteristics of human capital of women positively affect their situation on the labour market and their procreative decisions and reduce the effects of breaks in professional career related to childbirth.

The monograph presents the results of comprehensive research on professional and family careers pursued in Poland after the period of political transformation. Due to the current demographic situation in Poland, women's professional activity in connection with their procreation decisions is an important aspect of the study. Professional and family careers are interdependent. The lack of conclusive studies on the nature of this dependence may result from the fact that it evolves over time along with the changing socio-economic situation. In addition, this dependence is determined by individual characteristics of women, therefore it is difficult to unconditionally indicate the direction of its dependence. The research methods used in this monograph made it possible to analyse the direction and impact of the factors in question on the probability of occurrence of the studied events within professional and family careers. They also allowed us to determine how long individuals remain in a given state. With advanced analytical methods and the latest available data, new findings have been obtained that update and significantly broaden the results of previous research.

2.2. Contribution to the academic discipline and possible applications of findings

Specification of own contribution

The results of analyses carried out by me and included in the monograph constitute a direct contribution to research on demographic phenomena and the labour market in Poland in recent years. In the monograph I presented a new approach to studies on human and social capital over a period of time in the context of women's fertility behaviours in connection with their activity on the labour market in Poland. With the use of the latest available data sets enabling the analysis of professional and family careers of Poles in a similar period and modern analytical tools, some of which have not yet been used to model demographic and socio-economic phenomena, the study shed new light on the co-existence of professional and family careers in Poland in the analysed period.

As my contribution to the development of economics in the studied areas I consider:

1. Identification of determinants of inequality in the labour market in Poland in recent years, taking into account their variability over time. Among others, I considered the variability of such traits as the level of education, place of employment, marital status and having a child. To model the events from professional career, I used both logit models and time duration models. I showed that considering the time aspect

in modelling certain events from this career may lead to conclusions different from those that were obtained using commonly used regression models. Moreover, I used parametric competing risks models in studies on these careers, which made it possible to take into account different determinants in the study of time until the occurrence of events competing with each other.

2. Deepening knowledge about factors influencing the fertility decisions of women, as well as their behaviour on the labour market in the context of having a child, in recent years in Poland. In my research, by my opinion, for the first time, I took into account both the variability of individual characteristics over time, as well as the variable influence of these characteristics on the occurrence of an event depending on its duration, which enabled a more accurate assessment of the impact of these factors on the studied phenomena.

3. Expanding knowledge in the field of the mutual conditions of family and professional careers in Polish society in recent years. To model causality between the studied careers, I used both conditional and unconditional models of competitive risks, which made it possible to study the time until one of many possible events occurred, both when they were dependent and independent.

4. Deepening knowledge in the field of research into the decreasing supply of labour in Poland in the context of current demographic situation in Poland. In research, I focused mainly on women withdrawing from the labour market due to childcare. I pointed to the need to include time-dependent variables in modelling unemployment.

5. An indication of the changes taking place in recent years in Poland related to interdependences of professional career and family career. I compared the results of my research with other previous studies, which enabled me to specify behaviours, which in recent years have been subject to rapid changes, as well as those that have not changed. In addition, I identified areas that require urgent actions, due to low fertility observed in recent years in Poland.

6. Including in modelling of professional and family careers unobservable diversity of the examined individuals using models with unobserved heterogeneity. I used for this purpose models with random effects.

7. Proposing the use of the Bayesian approach to model professional and family careers and connections between them. Until now, the so-called classical approach has been used to model professional and family careers. By adopting a different approach, I was able to gain a wider knowledge on these careers by:
   i.   Including prior information from outside the sample in the modelling process; in modelling the so-called small samples, I used prior informative distributions, which allowed me to improve the accuracy of parameter estimations for the analysed models,
   ii. investigating model parameters as random variables; I compared parameter distributions, not constant values,

iii.   the possibility of using formal statistical tests to compare the results obtained for the selected subsamples, in order to statistically verify the differences in the impact of the studied factors on the analysed events for the considered subgroups of respondents,

iv.   using a wider range of methods to compare competing models, which allowed me to choose the best model to model selected events within these careers - also when non-nested models were analysed; I compared different models using various tests, including Bayes factor,

v.   no need to use limiting distributions in modelling; when considering small samples, I carried out the estimation of the models using the Markov chain Monte Carlo simulation methods.

Possible applications of findings

In the presented monograph I pointed out many important factors determining selected events occurring in the course of professional and family careers of Poles. Based on them, I formulated recommendations for actions that could have a positive impact on increasing the professional activity of Poles as well as on increasing fertility in Poland. In my research, I paid particular attention to women, because their professional activity remains at a lower level compared to men in Poland [CSO, 2016] as well as compared to women in other European countries [Eurostat, 2018]. Based on the results presented in the monograph, it can be concluded that some professional and procreative behaviours of Poles have changed in recent years, but there are still many areas requiring appropriate actions given the aging of Polish society.

In my conclusions, I focused on the importance of characteristics describing the level of education. In the case of women having education, at least higher, reduces the risk of not having a job to a greater degree than it does for men. Women with higher education were the least exposed to the termination of employment by dismissal by the employer or contract expiry, compared to other women. It can be concluded that having a proper level of education by women provides them with greater stability of employment. However, it does not significantly affect the behaviour of women when they decide to give up their job or have to quit for other reasons, independent of the employer. In addition, in the case of women with higher education, the probability of not terminating the employment relationship was at a similar level regardless of whether the woman pursued only a professional career, or a professional and family career, which contradicts popular beliefs and constitutes a practical conclusion. In the context of returning to work after a break related to childcare, it was found that for the whole examined period the probability of not terminating employment relationship after childbirth was higher for women with higher education in comparison to less-educated women. It can be concluded that when women have appropriate qualifications the inequalities in the labour market related to gender and performing family functions are reduced. Therefore, it is important

to develop appropriate mechanisms to reduce the risk of job loss for women with lower education and to invest in their non-formal education.

In addition, the results of my other studies concerning the chances on labour market in the context of gender equality and reported in the monograph indicate that women are exposed to a greater risk of termination of employment than men, regardless of how the contract of employment is terminated. These differences are most evident for terminating the employment relationship due to reasons other than dismissal by the employer or contract expiry, including, inter alia, reasons attributable to the employee or childcare. Therefore, it can be assumed that if one person in the household has to give up work, it is still more often a woman than a man, therefore, it is necessary to look for new solutions that involve men more heavily in household duties.

In the context of discussions on the extension of leave related to raising a child, it is important to take into account the consequences of breaks from work that are too long. I demonstrated that looking after a child for a longer period of time makes it substantially more difficult to return to work. Therefore, it is crucial that women stay in touch with employers during their break from work related to raising a child. The solution may be taking commissioned work or earlier return to part-time employment. It is worth noting that women with higher education as well as those, whose partners and fathers were better educated returned faster to work after childbirth. The type of work performed was also important; self-employed women returned to work earlier than women who were employed. Undoubtedly, it is easier for women to return to work after the birth of a child, when the potential working time is more flexible. The Labour Code, for a few years, contains provisions allowing different organization of working time, but it is important that employers agree to flexible working hours, especially for parents of young children.

It is also worth paying attention to the activities in the field of family policy, which should support women's professional activity to a greater extent so that they can combine informal childcare and domestic duties with professional work. Given the current demographic situation in Poland, it is necessary to look for new solutions that can increase the employment of women and at the same time increase fertility rates. They should reflect expectations and take into account changes in the social roles of modern women. These include, among others, introducing legal regulations limiting discrimination against women in the labour market, and above all, promoting existing solutions that are not applied. In the monograph, I showed that now having higher education and work may no longer adversely affect the decision to have children. In addition, having a proper job is more important for women in making fertility decisions than using institutional forms of childcare. It is also important to disseminate findings such as presented in my monograph greater probability of termination of employment for women pursuing only a professional career than for women pursuing a professional and family career.

To sum up, the results obtained in the monograph that is my main academic achievement may be used to develop guidelines for population policy and social policy, in particular family policy that includes labour market solutions.

3. Presentation of other publication achievements

A series of papers about the labour market in Poland

1. Wioletta Grzenda, (2011), *Analysis of job changes in Poland using the Bayesian method*, "Econometrics", No. 31(194), pp. 102-112.
2. Wioletta Grzenda, (2011), *The use of decision tree models and logistic regression to analyze demographic and socio-economic factors affecting the chances of finding a job*, (published in Polish), "Economic Studies", No. 95, pp. 271-277.
3. Wioletta Grzenda, (2012), *Bayesian exponential survival model in the analysis of unemployment duration determinants*, "Acta Universitatis Lodziensis. Folia Oeconomica", No. 269, pp. 191-196.
4. Wioletta Grzenda, (2012), *An analysis of unemployment duration determinants among young people using semiparametric Cox model*, (published in Polish), „Statistical Review", Special number, pp. 123-139.
5. Wioletta Grzenda, Michał Buczyński, (2015), *Estimation of employee turnover with competing risks models*, "Folia Oeconomica Stetinensia", No. 15(23), pp. 53-65.
6. Wioletta Grzenda, (2017), *The analysis of chances of young and middle-aged people for having a job using Bayesian logistic regression model*, "Quantitative Methods in Economics", No. 8(1), pp. 27–37.
7. Wioletta Grzenda, (2017), *Modelling the duration of the first job using Bayesian accelerated failure time models*, "Acta Universitatis Lodziensis. Folia Oeconomica", No. 4(330), pp. 19-38.
8. Wioletta Grzenda, (2018), *An Analysis of the determinants behind having an additional job by employees*, "Economic and Environmental Studies", No. 2, pp. 611-627.
9. Wioletta Grzenda, (accepted 2018), *Socioeconomic aspects of long-term unemployment in the context of the ageing population of Europe, the case of Poland*, "Economic Research-Ekonomska Istraživanja", (JCR journal, IF 1.137).

After obtaining my doctoral degree and starting work at the SGH Warsaw School of Economics, I focused on modelling socio-economic and demographic processes in my academic and research work. The first focus area of my academic interests is modelling economic activity of the population in Poland based on microdata.

The aim of the first paper from this series entitled *Analysis of job changes in Poland using the Bayesian method* was to analyse factors determining workers' mobility in the years 1950-1988. The Bayesian Poisson regression model was used to model occupational mobility. The study was conducted in three selected age groups. Thanks to the Bayesian approach, despite the small cardinality of one of the subsamples, it was possible to conduct a comparative analysis of the results obtained. In the modelling of the number of employment periods, the following determinants were considered: place of residence, gender, education level, intention to continue education within the next two years, intention

to relocate in the next two years, having a family, number of children in the family, socio-professional group and age at first job. It was received, among others, that the gender of the respondent had a statistically significant impact on professional mobility, but the scale of influence of this feature depended on the age of respondents. However, no statistically significant relationship was found between the respondent's family situation and his professional mobility.

In the paper entitled *The use of decision tree models and logistic regression to analyse demographic and socio-economic factors affecting the chances of finding a job* the differences resulting from the use of the models mentioned in the title to analyse the characteristics of professionally active people were presented. The data set used in the study came from the research of the Central Statistical Office *Budgets of Households* 2009. A division of professionally active people into employed and unemployed was used to build a dichotomous dependent variable. Moreover, modelling included *inter alia* the following determinants: sex, marital status, level of education, information whether the respondent is still improving their skills, place of residence and age. The logistic regression model made it possible to assess the scale of the impact of these factors on the chances of finding a job, whereas the decision tree model made it possible to determine the hierarchy of explanatory variables. It was received, among others, that the most important feature that differentiates people professionally active due to having a job is their age. Reassuming the use of various classification models gave the opportunity to compare the results obtained, and thus enabled a deeper analysis of the issue.

The aim of the paper entitled *Bayesian exponential survival model in the analysis of unemployment duration determinants* was to identify demographic and socio-economic factors affecting the length of time out of work. The data used in the study came from the research of the Central Statistical Office *Budgets of Households* 2008. The Bayesian exponential survival model was used to model the transition from being unemployed to finding employment. The advantage of survival models in the study of professional activity is the ability to include the entire professional history of the examined individual in the study. A characteristic feature of the used distribution is the hazard function that is constant over time, which often results in the reduction of the application possibilities of this model. Therefore, its usefulness in modelling the studied phenomenon was verified before the evaluation and interpretation of the obtained results. The Gibbs sampling was used to estimate model parameters. As a result of the analysis, it was obtained that among the explanatory variables selected for modelling: gender, marital status, education level, information about whether the respondent is still improving their skills, the Polish region where the respondent lives and the age at the time of the study, only two turned out to be statistically insignificant: marital status and information about whether the respondent is still improving their skills.

The paper *An analysis of unemployment duration determinants among young people using semiparametric Cox model* analyses the situation of young people aged 15 to 35 in the labour market in Poland in the period 2008-2009. Particularly high unemployment rate

is often observed among people starting their professional career as compared to older people. The purpose of this paper was to identify factors determining how long young people stay unemployed. The research was based on two sets of data: *Budgets of Households* 2008 and *Budgets of Households* 2009. The Bayesian semiparametric Cox model was applied for individual data. With this survival model it was possible to analyse the combined impact of selected explanatory variables on the time of being out of work, without the need for explicit specification of the underlying hazard. The estimation of the parameters of the considered models was carried out in Bayesian approach using the Markov chain Monte Carlo methods. On the basis of the results obtained, during the period considered young women were not in a significantly different situation on the labour market in Poland than men. In addition, it was received that unmarried people had lower chances to find a job than those in a relationship, while those with higher education were the most likely to find a job compared to the least-educated people.

In the next paper entitled *Estimation of employee turnover with competing risks models*, written together with my graduate student M. Buczyński, we focused on the analysis of employee fluctuation. The process of outflow of employees from the organization is an unavoidable phenomenon. It can be defined and analysed in different ways. The purpose of this paper was to analyse of employee turnover in a given enterprise using the competing risk survival models. The use of this research method to model employee turnover made it possible to take into account different ways of terminating the employment relationship and to identify factors affecting the duration of employment relationship in the studied enterprise. It was received that the main factors determining the length of employment of an employee in the enterprise include the remuneration system and remuneration.

The aim of the paper entitled *The analysis of chances of young and middle-aged people for having a job using Bayesian logistic regression model* was to analyse the chances of having a job using the Bayesian logistic regression model. Young and middle-aged people were considered in the study. The modelling was based on data from two last rounds of the *Generations and Gender Survey* (GGS) for Poland conducted as part of the *Generations and Gender Programme* (GGP), i.e. 2011, 2014 and 2015. With these data another range of characteristics could be included to model unemployment as compared to commonly analysed ones with the use of BAEL data. The study considered, among others, such characteristics as marital status, financial situation of the household, health status and for young people the fact of living with their parents. The Bayesian approach was used in modelling, which made it possible to include in the study information from earlier analyses.

The paper entitled *An Analysis of the determinants behind having an additional job by employees* includes the analysis of characteristics of people who, in addition to having their basic job, undertake additional work. There are many potential factors which determine having another job. These include varied needs of individuals, such as the desire to improve their material status, family situation, or the opportunities

arising from human capital. In this study, apart from the aforementioned needs, the characteristics of individuals, such as age, sex, place of residence and the features of the main workplace have been included. Unfortunately, some determinants of the studied phenomenon cannot be clearly observed or are generally unobservable. Hence, the models with unobservable heterogeneity, which were used in this study, are key to modelling this type of phenomena. The purpose of this paper was to show the demographic profile of a two-job worker. As a part of the study, the assessment of the impact of selected determinants on having an additional job by employees was made.

The objective of the last paper from this series entitled *Socioeconomic aspects of long-term unemployment in the context of the aging of Europe, the case of Poland* was to analyse socio-economic aspects of long-term unemployment in the context of the aging European society based on data on Poland. Low fertility rates and the rising proportion of persons aged 65 or more are among the key factors taken into account in the context of declining labour supply in most European countries. In the face of threats resulting from the currently observed changes in the age structure of the European population, an important challenge for labour markets is to increase the economic activity of those whose share in the labour market is insufficient to date. This paper focuses on long-term unemployed, i.e. people unemployed for 12 months or more. Social groups that have the greatest difficulty to get out of long-term unemployment were indicated and the effects of long-term unemployment depending on its duration were assessed in the context of aging population. Most importantly the study illustrated how the impact of factors determining finding a job by long-term unemployed persons changes over time depending on the length of unemployment.

A series of papers on the modelling of procreative behaviours of Polish women

1. Ewa Frątczak, Wioletta Grzenda, (2011), *Fertility tables based on staging process, (published in Polish), Selected problems of demographic and social development of Poland and methods of their study,* "Works and Materials of the Faculty of Management at the University of Gdańsk", No. 2(3), pp. 7-20.
2. Wioletta Grzenda, (2012), *Fertility analysis of women in Poland using Bayesian Poisson regression model,* (published in Polish), "Statistical Review", No. 59(2), pp. 181-200.
3. Wioletta Grzenda, Ewa Frątczak, (2018), *Cohort patterns of fertility in Poland based on staging process – generations 1930-1980,* "Statistics in Transition new series", No. 19(2), pp. 315-330.

The second focus area of my research is analysing fertility behaviours of women. One of my first publications from this series was a paper prepared jointly with Dr hab. Ewa Frątczak, prof. SGH entitled *Fertility tables based on staging process*. This paper includes preliminary findings on female fertility in Poland for the generation of 1910-1986. Based on CSO data from the "Women's Fertility" survey carried out at the National Population

and Housing Census in 2002, fertility tables for five-year age groups were developed. They were constructed based on the model of traditional tables of life. This required the development of a proprietary computer program which was used to determine the stage probabilities of successive births, which were graphically presented and interpreted.

At the same time, I conducted individual research on the procreative behaviour of Polish women using the Bayesian methods. The results of these studies have been published in the paper entitled *Fertility analysis of women in Poland using Bayesian Poisson regression model*. The purpose of this paper was to examine the fertility behaviour of Polish women by identifying factors that determine it. The Bayesian Poisson regression model was used for modelling. The use of this model made it possible to determine the direction and scale of the impact of selected factors on the number of children that women had, while the Bayesian approach made it possible to include prior information in the modelling process. The estimation of model parameters was carried out using the Gibbs sampler. The study was based on individual data from the Polish retrospective study "Family changes and fertility patterns in Poland" (1991). The results obtained were compared with the relevant studies for Poland and other countries.

The last paper in this series entitled *Cohort patterns of fertility in Poland based on staging process – generations 1930-1980* includes the results of further research on stochastic fertility tables carried out with Dr hab. Ewa Frątczak, prof. SGH. Poland, as a transition country in the region of Central and Eastern Europe has experienced unprecedented demographic changes. The main purpose of this paper was to analyse and assess changes in fertility among women in Poland. Many studies on changes in reproductive behaviour use a cross-sectional approach, but this approach may be insufficient in some cases. This paper presents stochastic fertility tables for five-year generations from 1931-1935 to 1976-1980. This approach made it possible to assess changes in the fertility pattern in longitudinal terms. The obtained results were interpreted in the context of current demographic situation in Poland.

A series of publications in the field of econometric modelling and theory of probability

1. Wioletta Grzenda, Dariusz Majerek, Wiesław Zięba, (2007), *Comments to the paper "On uniform integrability of random variables"*, "Statistics & Probability Letters", No. 77, pp. 1644-1646.
2. Wioletta Grzenda, Wiesław Zięba, (2008), *Conditional central limit theorem*, "International Mathematical Forum", No. 3(31), pp. 1521-1528.
3. Wioletta Grzenda, Maciej Górkiewicz, (2012), *Exploring the 3D Surfaces with Modified Method of Steepest Descent*, "Applied Medical Informatics", No. 30(2), pp. 1-6.
4. Wioletta Grzenda, (2013), *The significance of prior information in Bayesian parametric survival models*, "Acta Universitatis Lodziensis. Folia Oeconomica", No. 285, pp. 31-39.

5. Wioletta Grzenda, (2015), *The Advantages Of Bayesian Methods Over Classical Methods In The Context Of Credible Intervals*, "Information Systems in Management", No. 4(1), pp. 53-63.
6. Wioletta Grzenda, (2016), *Informative versus non-informative prior distributions and their impact on the accuracy of Bayesian inference*, "Statistics in Transition new series", No. 17(4), pp. 763-780.
7. Wioletta Grzenda, (2016), "Bayesian modelling, theory and examples of applications", (published in Polish), Warsaw: Publishing House of Warsaw School of Economics, 253 pages

After obtaining my doctoral degree, my academic and research activity was first still focused on the possibilities of generalising theorems of the probability theory into a conditional version. During this time, I published in co-authorship two papers that used and expanded the results included in my doctoral thesis. In the first paper prepared jointly with Dr hab. W. Zięba, prof. UMCS and Dr D. Majerek from Lublin University of Technology entitled *Comments to the paper "On uniform integrability of random variables"* the theorem presented in our previous paper on the uniform integrability of a sequence of random variables was supplemented by the condition of almost sure convergence. The second paper prepared together with Dr hab. W. Zięba, *Conditional central limit theorem*, concerns the generalisation of the central limit theorem into conditional version. In this paper, additional assumptions are made, which allow this theorem to be generalised in this way.

Another paper from this series entitled *Exploring the 3D Surfaces with Modified Method of Steepest Descent*, written together with Dr. M. Górkiewicz from the Higher School of Social and Technical Sciences in Radom, examines the advantages of replacing one multiple regression model with many models estimated for different levels of the qualitative variable. The investigated problem was illustrated in 3D space. The selection of the best model based on information criteria and various adjusted versions of the determination coefficient R^2 was considered. In addition, the results of the estimation of the parameters of polynomial regression models were compared using the maximum likelihood estimation and least squares method.

In the next stage of my academic and research activity, my interests concerned various aspects of Bayesian modelling. The paper entitled *The significance of prior information in Bayesian parametric survival models* analyses the impact of prior distribution on posterior distribution on the example of parametric survival models. The prior distribution of the parameter is a probability distribution that expresses the entire knowledge of the researcher about the estimated parameter before actual data is checked. At the same time, so-called non-informative prior distributions often present in the literature, express the lack of the researcher's preliminary knowledge about the estimated parameters of the model. In order to show the importance of prior

information and its impact on posterior distribution, different parametric survival models were estimated selecting different a priori distributions.

In the paper entitled *The advantages of Bayesian methods over classical methods, the context of credible intervals* contains considerations on credible intervals in the classical and Bayesian approach. The aim of the paper was to show the benefits of using the highest posterior density regions. In the classical approach, model parameters constitute unknown but fixed constants, so an unknown parameter value can be covered by the obtained credible interval or not. In the Bayesian approach, the estimated parameters are random variables, and the credible intervals, called posterior density regions, can be determined exactly at a predetermined level of probability. Then it can be stated how likely it is for an estimated parameter to belong to the Bayesian area of credibility. This paper provides empirical examples illustrating the advantages of the considered highest posterior density regions.

The last paper in this series is entitled *Informative versus non-informative prior distributions and their impact on the accuracy of Bayesian inference*. This work presents the benefits resulting from the use of the Bayesian approach in the construction of predictive models, on the example of the Bayesian multiple regression and logistic model. This paper analyses the impact of various a priori information on the quality of the predicted models in question. To compare the predictive effectiveness of competing models, that were estimated according to the Bayesian approach, in addition to commonly used measures, the calculation of ROC and Lift posterior curves was proposed. The data from Central Statistical Office of Poland describing unemployment in individual districts in Poland has been used in this research. Markov Chain Monte Carlo methods (MCMC) were applied in modelling. Based on the obtained results, it can be concluded that additional knowledge from outside the tested sample and appropriate prior distribution selection ensure higher accuracy of classification and quality of prediction.

In this presented series I also included a book entitled *Bayesian modelling, theory and examples of applications*. As outlined in its introduction, this publication is an extension of my earlier book *Introduction to Bayesian statistics (published in Polish)*. The first part of this book covers the basics of Bayesian statistics, definitions of various types of prior distributions, selected algorithms of the Markov chain Monte Carlo methods and the application of the Bayesian theorem to various types of distributions. The new contribution to this publication includes topics concerning estimation of generalised linear models in the Bayesian approach and is about 50% of the entire book. This part presents the theoretical basis of Bayesian modelling for generalised linear models and indicates the advantages resulting from the use of the Bayesian approach in modelling socio-economic phenomena. In addition, three research problems were analysed with the use of these methods:

- The impact of selected poviat characteristics on wages. The study used individual data on poviats in Poland. The data sets were created based on information posted

on the websites of the Central Statistical Office. The study focused on the average monthly gross wages and salaries in thousands (PLN) in poviats in Poland in 2014.

- The evaluation of the impact of selected characteristics of young people on the chances of taking up self-employment. The employment rates for young people in recent years are very low compared to the general public not only in Poland but also across Europe (e.g. Eurostat research). Young people who have difficulties in finding a job or are dissatisfied with working for companies are increasingly trying to work on their own. The study attempted to identify characteristics that determine self-employment by people aged 18 to 30 and their extent.

- Household characteristics that affect the number of its members. Research into the decisions about shared living or family size requires an extensive analysis of many aspects because these decisions may result from the preferences of people making such decisions, the interdependence of people living in a joint household, as well as other factors characterising the household. This study focused on the last group of factors. Modelling was carried out using CSO data *Budgets of Households* 2010.

Modelling using Bayesian methods often requires the use of computer packages. Therefore, the above-mentioned book presents the possibilities of using SAS, WinBUGS and R programs for the estimation of analysed models.

Other publications

1. Wioletta Grzenda, Marta Dorszyńska, (2017), *The analysis of the relationship between individual characteristics of people and the feeling of being discriminated*, (published in Polish), "Economic Studies. Academic works of University of Economics in Katowice", No. 326, pp. 55-74.

In addition to three main themes of my research, which I have already presented, I published a paper on the feeling of being discriminated with my graduate student M. Dorszyńska. The primary objective of this study was the assessment of the scale and direction of the impact of selected demographic and socio-economic characteristics on the feeling of being discriminated. The logistic regression model has been used in this analysis. The paper reveals that age, being religious, sex, family backround, being in a relationship, the level of life satisfaction, the evaluation of socio-economic situation in the country and the country of residence have a significant impact on the feeling of being discriminated. Moreover, latent class model was used to examine the impact of the feeling of being discriminated on the opinions and views expressed by the person.

4. Other academic and research activity

4.1. Managing national research projects

During my work at the SGH Warsaw School of Economics, I have been the leader of 3 own research grants, 5 statutory grants, and recently the head of the OPUS grant. The results of studies carried out as part of these projects have been published in the form of academic papers and monographs presented in sections 2 and 3 of this summary and have been presented at many academic conferences.

My main achievement in the field of research project management was the independent development of a project that, as part of the OPUS 9 competition announced by the National Science Centre in 2015, obtained funding, taking the 10th place on the ranking list. The title of this project is "The modelling of the parallel family and occupational careers with Bayesian methods", No. 2015/17/B/HS4/02064. I have been executing this project since 2016 and it is currently at the final stage of implementation, the objective of which is the dissemination of main findings. The aim of this project was to obtain new insights into the interdependencies of both careers, resulting mainly from the application of Bayesian modelling in their analysis. Family and professional careers are undertaken at the same time, so in search of mechanisms of cause and effect it was important, apart from analysing the course of each of them separately, to examine the relationships between them. The analysis of these careers was carried out using selected statistical models, mainly survival models on the Bayesian ground. It is based on two sources of data. The first was the *Generations and Gender Survey* (GGS-PL) survey, which is carried out by the Institute of Statistics and Demography of Warsaw School of Economics and is part of the international GGP research program. The second source of data was the *Labour Force Survey* (LFS) conducted by the Central Statistical Office. The main effect of the research carried out as part of this project was the development of a monograph entitled "Modelling of professional and family careers with Bayesian methods" (published in Polish) which is my main academic achievement presented in section 2 of this self-review.

In 2010-2016, I was the leader of five statutory research projects at the Institute of Statistics and Demography at Collegium of Economic Analysis of SGH Warsaw School of Economics. These were the following researches:

The years 2015-2016
Generalised linear models in Bayesian approach, the role of prior information
no. KAE/S15/18/15
The aim of this study was to analyse the impact of various types of prior distributions on posterior distributions. The study considered generalised linear models in Bayesian approach. The main focus was on the advantages of informative prior distributions. The inclusion of additional prior information in the modelling process may affect the results as compared with the estimation in which only information from the sample is used. The study presents practical examples of using Bayesian generalised linear models.

The obtained results were compared and evaluated in terms of selection of prior distributions. The estimation of all models was carried out using the Markov chain Monte Carlo methods.

The years 2013-2014

Fertility tables based on staging process

no. KAE/S/44/13

The aim of this study was to analyse the fertility of Polish women on the basis of stochastic fertility tables. Women's fertility behaviours are conditioned by many different factors and are constantly changing over time, so fertility tables may be the right statistical tool to analyse them. As part of the study a program code was developed for estimating stochastic fertility tables based on the Poisson process, with a full range of parameters describing various stages of the fertility process. The development of the code was preceded by a theoretical review of models based on staging process and a formal mathematical record of the model used to estimate stochastic fertility tables. The result of the research was the development of fertility tables for women in Poland for the 1931-1980 generation for one-year and five-year age groups based on the NSP 2002.

The year 2012

Labour market research using Bayesian survival models

no. 03/S/0044/12

The aim of this study was to identify demographic and socio-economic factors affecting the length of time when young people remain unemployed using the Bayesian semiparametric Cox model. The modelling was carried out using individual data from the Central Statistical Office "Budgets of Households" from 2008 and 2009. In the study the relationship between selected factors and the length of unemployment for people aged 15 to 35 has been analysed.

The year 2011

Selected issues of Bayesian statistics

no. 03/S/0044/11

As part of this study, a comparative overview of selected statistical methods in the Bayesian approach was prepared together with examples of their applications. Selected algorithms of the Monte Carlo Methods based on Markov chains were presented, including the properties of the generated Markov chains, the methods of selection of chains implementation and the assessment of their convergence. The following algorithms were considered: Metropolis, Metropolis-Hastings and Gibbs Sampling. The programs: SAS and WinBUGS were used for the estimation.

In 2011, I was also the leader of the research carried out as part of the Young Scientists' Research. Research title: *Characteristics and classification of economically active people in the context of chances for finding a job*, KAE SGH, no. 03 / BMN /0005/11.

This study presents the possibilities of using the logistic regression model and the decision tree model to characterise professionally active people in the study of the labour market situation in Poland in 2009. The data used in the study came from the survey of the Central

Statistical Office "Budgets of Households". The aim of the study was to analyse the reasons of being unemployed by identifying and assessing demographic and socio-economic factors affecting the chances of finding a job.

In addition, I was the leader of the following own researches:

The year 2010

Introduction to Bayesian statistics

no. 03/E/0040/10

As part of this study, the first chapters for the book *Introduction to Bayesian Statistics* were prepared. The first chapter contains selected issues of the probability theory necessary to understand Bayesian statistics. The second chapter presents the possibilities of using the Bayesian theorem for different types of distributions, the first subsection of this chapter is devoted to the discrete distribution, and the second subchapter to continuous distributions, mainly normal distribution, which is most often used in statistical inference. The next chapter includes the basic forms of statistical inference: point estimation, interval estimation and verification of statistical hypotheses. In each case, the classic and Bayesian approach was compared, including differences in their application and examples illustrating them.

The year 2009

Bayesian estimation of the Poisson regression model

The aim of this study was to analyse determinants affecting the total number of children that women in Poland have. For modelling, the Bayesian Poisson regression model was used, which allowed for assessing the combined effect of various factors on the number of children. The use of the Bayesian approach made it possible to include in the modelling process additional information from outside the sample. In the study, subjective prior distributions were adopted based on other previous information and CSO data. In modelling the number of children that women have, the following determinants were taken into account inter alia: place of residence, education, marital status, employment and religion.

The year 2008

Data Processing - SAS (co-leader).

This research was aimed at the substantive and technical development of a publication regarding data processing in SAS 4GL language. This study included the following issues:

- Introduction to the SAS System.
- Databases in the SAS System.
- Data processing in SAS 4GL.
- Elements of the SQL language in SAS.
- Data aggregation.
- Reporting in SAS.

4.2. Presentation of research results at conferences

The results of my research carried out after obtaining my doctoral degree were disseminated at many national, national of international reach and international conferences.

Presentation of research results at international conferences

1. Wioletta Grzenda, 3-6.10.2018, presentation of the paper entitled "Modelling long term unemployment in Poland using accelerated failure time models in Bayesian approach", ESA RN21 Midterm Conference "Potentials and Limits of Quantitative Research in the Social Sciences", Cracow, Poland.
2. Monika Wilińska, Jolanta Perek-Białas, Wioletta Grzenda, 15-21.07.2018, presentation by co-author of the paper entitled "If Not Work, Does It Mean Care? - Work and Family (im)Balance Women Aged 45+ in Poland", XIX ISA World Congress of Sociology, Toronto, Canada.
3. Ewa Frątczak, Wioletta Grzenda, 31.08.2016-3.09.2016, presentation by co-author of the poster entitled "Fertility Changes in Poland - Cohort Approach", EPC - Demographic Change and Policy Implications, Mainz, Germany.
4. Wioletta Grzenda, Ewa Frątczak, 4-5.11.2011, presentation of the poster entitled "Cohort fertility patterns in Poland based on the staging process", Cross-border Biostatistics Meeting Applied Biostatistics in Life Sciences, Szeged, Hungary.
5. Wioletta Grzenda, 1-4.09.2010, presentation of the poster entitled "Analysis of job changes in Poland using the Bayesian method", European Population Conference 2010, Vienna, Austria.

Presentation of research results at national conferences, including these of international reach

1. Wioletta Grzenda, 5-7.11.2018, presentation of the paper entitled "Survival modelling of repeated events using the example of changes in the place of employment"[1], XXXVII Scientific Conference on Multivariate Statistical Analysis MSA 2018, Łódź.
2. Wioletta Grzenda, 28-30.11.2018, presentation of the paper entitled "An Analysis of the determinants behind having an additional job by employees", XII Science Conference MASEP 2018, Measurement and Assessment of Social and Economic Phenomenon, Łódź.
3. Wioletta Grzenda, 20-21.06.2016, presentation of the paper entitled "The analysis of chances of young and middle-aged people for having a job using Bayesian logistic regression model", XVII Scientific Conference - Quantitative Methods in Economic, Warszawa.

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[1] All presentations in this group were delivered in Polish

4. Wioletta Grzenda, 7-9.11.2016, presentation of the paper entitled "Modelling the duration of the first job using Bayesian accelerated failure time models", XXXV Scientific Conference on Multivariate Statistical Analysis MSA 2018, Łódź.
5. Wioletta Grzenda, Ewa Frątczak, 23-24.06.2015, presentation of the paper entitled "Cohort patterns of fertility in Poland", XII Scientific Conference of Young Demographers, Poznań.
6. Wioletta Grzenda, 16-18.11.2015, presentation of the paper entitled "Bayesian estimation of prediction models and its impact on the accuracy of regression and classification", XXXIV Scientific Conference on Multivariate Statistical Analysis MSA 2018, Łódź.
7. Wioletta Grzenda, 27-28.11.2014, presentation of the paper entitled "The advantages of Bayesian methods over classical methods in the context of credible intervals", Information Systems in Management, Warszawa.
8. Wioletta Grzenda, 18-20.04.2012, presentation of the paper entitled "Bayesian semiparametric Cox model in the study of determinants of unemployed young people", Congress of Polish Statistics 2012, Poznań.
9. Wioletta Grzenda, 19-21.09.2011, presentation of the paper entitled "Characteristics and classification of professionally active people in the context of chances of finding a job", Contemporary demographic problems in the era of globalisation - positive and negative aspects, Ustroń.
10. Wioletta Grzenda, 7-9.11.2011, presentation of the paper entitled "The significance of prior information in Bayesian parametric survival models", XXX Scientific Conference on Multivariate Statistical Analysis MSA 2018, Łódź.
11. Wioletta Grzenda, Maciej Górkiewicz, 1.12.2011, presentation of the paper entitled "The advantages of replacing one model of multiple regression with many models estimated for different levels of the qualitative variable", Scientific meeting of the Polish National Group of the International Society for the Clinical Biostatistics, Warszawa.
12. Wioletta Grzenda, Ewa Frątczak, 20-22.09.2010, presentation by co-author of the paper entitled "Cohort patterns of fertility based on staging process", Research methods and interpretation of demographic and social processes, Sopot.
13. Wioletta Grzenda, 8-10.11.2010, presentation of the paper entitled "Bayesian exponential survival model in the analysis of unemployment duration determinants", XXIX Scientific Conference on Multivariate Statistical Analysis MSA 2018, Łódź.
14. Wioletta Grzenda, 21-23.2009, presentation of the paper entitled "Using Bayesian methods in the studies on the labour mobility of Poles", Social and economic consequences of changes in demographic processes, Polanica.

In addition, I have taken part in more than 30 conferences without delivering a presentation and in many seminars at various universities where I gave speeches.

I developed my competences in the field of programming skills and the use of specialised computer packages for analytical tasks, among others, during certified trainings:

1. 16-17.02.2015, *SAS Data Integration Studio*, Warsaw
2. 15.06.2010, *Introduction to data mining*, Warsaw.
3. 16-18.06.2010, *Applications and techniques of data mining*, Warsaw.
4. 5.09.2009-24.10.2009, *Bayesian Modelling via MCMC*, online.

4.3. Reviewing publications in journals

I was a reviewer of three papers in the following journals:

1. Statistics in Transition new series - 1 paper,
2. Quantitative Methods in Economics (Metody Ilościowe w Badaniach Ekonomicznych) - 1 paper,
3. Works and Materials of the Faculty of Management at the University of Gdańsk (Prace i Materiały Wydziału Zarządzania Uniwersytetu Gdańskiego) - 1 paper.

4.4. International cooperation

In 2016, I started cooperation with Dr Monika Wilińska from Jönköping University, Sweden. Together with Dr hab. Jolanta Perek Białas (SGH Warsaw School of Economics/Jagiellonian University), we focus on research into the professional activity of women aged 45+ in the context of combining work and family responsibilities. The result of this research is the paper entitled "Grandmothers and non-grandmothers in the Polish labour market: the role of family issues", which is currently in the review process.

In addition, I am a member of the following international academic organizations:
- European Association for Population Studies, EAPS, from 2010,
- International Society for Clinical Biostatistics, ISCB, from 2011.

I have taken an active part in international conferences organised by these organizations, during which I presented the results of my research.

5. Summary of academic achievements

After obtaining the doctoral degree, I published 18 scientific papers; in addition, one more paper has been accepted and is in the publishing process (JCR list, IF 1.137). Most papers have been published in in national journals of international reach and in English. I am a sole author of 12 of them, including the paper from the JCR list accepted for publication. The results of my research were presented at 5 international and 14 national conferences. One of my main achievements is obtaining a grant from the National Science Centre for the implementation of my project entitled *The modelling of parallel family*

and occupational careers with Bayesian methods approach as part of the OPUS 9 competition, within which I carried out comprehensive research, the results of which I included in the monograph which is my main scientific achievement. Below and in the table No. 1 I summarised my academic achievements, details can be found in bibliometrics (Appendix No. 6). This overview also includes the paper approved for publication in September 2018 entitled "Socioeconomic aspects of long-term unemployment in the context of the ageing population of Europe, the case of Poland". The confirmation of its acceptance for publication is included in Appendix No. 8.

The total number of points for publications according to the Ministry of Science and Higher Education based on the year of publication: **293**, including after obtaining the doctoral degree: **279**.

Total impact factor according to the Journal Citation Reports (JCR), based on the year of publication: **1.753**

Number of citations according to the Web of Science database (WoS): **2**

Hirsch index according to the Web of Science database (WoS): **1**

Number of citations by Google Scholar: **109**

Hirsch index according to Google Scholar: **6**

Table 1. Publication achievements **after obtaining the doctoral degree.**

Type of publication	Quantity	Number of points according to MNiSW
Papers in journals with Impact Factor	2	28
Papers in national academic journals in English	10	101
Papers in national academic journals in Polish	5	36
Papers in foreign academic journals without Impact Factor	1	5
Authorship / co-authorship of book publications	6	109
Papers in foreign journals not scored	1	0
Total	**25**	**279**

6. Organisational activity

My organisational activities since the beginning of work at Warsaw School of Economics consist of, among others, the implementation of the following tasks:

1. Since October 2016, I have been the representative of dependent academics on the Board of Collegium of Economic Analysis of the Warsaw School of Economics.
2. Since 01/09/2015 I have been the secretary of *Postgraduate Studies Statistical Analysis and Data Mining in Business* at Warsaw School of Economics. So far, this course has been launched both in the winter and summer, therefore I have been its secretary seven times.

3. I have been an approx. nine-time member of the final exam committee at *Postgraduate Studies Statistical Analysis and Data Mining in Business.*
4. I have been a two-time member of the sub-committee for qualifying tests for the master's courses at Warsaw School of Economics.
5. For many years I have been co-editing the website of the Unit of Event History Analysis and Multilevel Analysis
6. I have coordinated works on developing programs for courses such as *Data mining* (major lecture, 30 hours), *SAS Programming* (specialization lecture, 30 hours) and *Designing research and methods of statistical analysis I* in the field of statistical analysis methods (major lecture, 60 hours).
7. I have participated in the project "Doctoral studies in English as a tool to strengthen the position of SGH within the European Higher Education Area and the European Area of Research and Innovation", Contract No. UDA-POKL.04.01.01-00-205/09. I participated in the study visit at EM Lyon Business School and The Grenoble Ecole de Management in 2010. This project was co-financed by the European Union from the European Social Fund under the Human Capital Operational Program - Measure 4.1.1 "Strengthening and development of the didactic potential of the university" carried out under the supervision of the Ministry of Science and Higher Education.
8. I have been/was the coordinator of the following major/specialisation subjects:
   - *Data Mining* (master's course – 30-hour subject, 2-3 academic teachers)
   - *Advanced data mining* (master's course – 30-hour subject, 2-3 academic teachers)
   - *Data mining - basic and advanced, text mining* (master's course – 30-hour subject, 2-3 academic teachers)
   - *Advanced Statistical Analysis Methods* (master's course – 30-hour subject, 4-5 academic teachers)
   - *Designing research and methods of statistical analysis I* (bachelor's course – 60-hour subject, 4-5 academic teachers)

7. Didactic activity

7.1. Delivering lectures for students

During my professional career, I have delivered lectures at two universities. The scope of my didactic activity was wide, I have taught mathematics, theory of probability, statistics, econometric modelling, data mining and programming in SAS 4GL. I have been giving lectures, conducting practical classes and computer laboratories (SAS, WinBUGS and R). All classes include my own contribution, covering either the preparation of entire classes or the elaboration on selected blocks of classes. I have given numerous lectures for groups of hundred people and more (*Statistics, Statistical methods I, Designing research and methods of statistical analysis I, Data mining*). For the practical classes, I have developed

my own sets of tasks along with answers for students self-study. A reflection of my teaching activity is doubling the assistant professor's teaching load in the recent years according to the following list:

- in the academic year 2017/2018 226% of assistant professor's teaching load,
- in the academic year 2016/2017 218% of assistant professor's teaching load,
- in the academic year 2015/2016 203% of assistant professor's teaching load,
- in the academic year 2014/2015 218% of assistant professor's teaching load,

Below there is a detailed list of courses I have been giving so far.

Delivering lectures for students in Warsaw School of Economics

I have delivered courses at the bachelor's obligatory, major (*Quantitative Methods in Economics and Information Systems*) and competition courses:

1. *Statistics* (lecture, exercises) – years 2007-2012, 2014-2015
2. *Statistical Methods I* (lectures, exercises and computer laboratories) – years 2007-2011, since 2017
3. *Designing research and methods of statistical analysis I* (block: mathematical statistics: lectures, exercises and computer laboratories) – years 2010-2017
4. *SAS Programming* (computer laboratories) – since 2007

I have delivered courses at the master's course in *Advanced Analytics – Big Data* and *Quantitative Methods in Economics and Information Systems*:

1. *Data mining* (lectures, computer laboratories) – years 2010-2012, since 2014
2. *Advanced data mining* (lectures, computer laboratories) – years 2016-2017
3. *Data mining - basic and advanced, text mining* (lectures, computer laboratories) – years 2014-2016
4. *Event History Analysis with SAS* (computer laboratories) – years 2007-2011
5. *Advanced Statistical Analysis Methods* (own block: *Selected issues of Bayesian estimation*: lectures, computer laboratories) – years 2008-2016
6. *Statistical Methods II* (own block: *Methods, simulation models: Markov Chain Monte Carlo Method*: lectures, computer laboratories) – years 2007-2008

I have delivered lectures at the Doctoral Level Studies in Collegium of Economic Analysis

1. *Statistical methods* (own block: *Selected issues of Bayesian statistics*: lectures, computer laboratories) – years 2007-2009

I have delivered lectures at the Postgraduate Studies:

- *Postgraduate Studies Statistical Analysis and Data Mining in Business:*
  1. *Advanced Statistical Analysis Methods* – years 2008-2010
  2. *Event History Analysis* – years 2008-2011
  3. *Customer segmentation - basket analysis* – since 2015

- *Postgraduate Studies Analytical Academy – Statistical Analysis and Data Mining in Business*
  1. *Advanced business models in Enterprise Miner, high-performance data mining, predictive models – evaluation – years 2016-2018*
- *Postgraduate Studies Analytical Academy with SAS, R & PYTHON*
  1. *Data mining in SAS & R – since 2018*

Delivering courses for students at Lublin University of Technology

I delivered courses as part of the following master's courses – *Management and Marketing* and *Management and Production Engineering*
  1. *Probability theory and statistics* (lecture, practical classes) 2006-2007
  2. *Mathematics* (practical classes) – 2001-2007

7.2. Other didactic achievements

Supervising Master's theses and final thesis at Postgraduate Studies

During my work at SGH Warsaw School of Economics, I supervised 34 master's theses in the fields of *Quantitative Methods in Economics and Information Systems* and *Advanced Analytics – Big Data*. In addition, 10 students are currently attending my master's seminar. In their master's theses, my students analyse not only socio-economic phenomena, but also often solve real business problems. I show my graduate students new trends in analytics and encourage them to continue their academic and research activity. With two of them, once they defended their master's theses, I published academic papers on the issues raised in their works.

In addition, I was the supervisor of over a dozen final thesis at *Postgraduate Studies Statistical Analysis and Data Mining in Business*.

Reviews of master's and bachelor's theses

Until now, I have been a reviewer of 4 master's theses and 1 undergraduate thesis in the fields of *Quantitative Methods in Economics and Information Systems* and *Advanced Analytics - Big Data*.

Student research group advisor

In 2011, I was involved in collecting documents needed to create the Student Business Analytics Research Group. I acted as a co-supervisor of this organisation and I was involved in the section devoted to programming in SAS 4GL before going on maternity leave. The aim of this association was to enable its members to deepen their knowledge on the use of advanced statistical analysis (BA) methods for practical business applications. The first stage of its activity was to broaden the knowledge of its members in the field of SAS 4GL programming, mainly in macroprogramming and the use of advanced analytical tools.

Textbooks and chapters in textbooks

An important part of my didactic activity is publishing textbooks. This is mainly due to the fact that so far, on the Polish publishing market, limited availability of publications from the presented thematic scope has been observed, which, moreover, is part of my classes. The "Data Processing in SAS" handbook, that I coordinated works on and developed the largest part of the content of, is currently the most popular publication on the SAS 4GL programming field chosen not only by students of various universities who attend programming classes in SAS, but also by practitioners (over 1600 copies of this book have been sold so far). Publications in the field of Bayesian methods are also among the few published in Polish covering the issues presented in them. They have been used not only in the didactic process, but have been also cited in academic papers.

I am the author or co-author of the following academic textbooks:

1. Wioletta Grzenda, Selected problems of Bayesian estimation, [In:] "Advanced statistical analysis methods", (published in Polish), Ewa Frątczak (ed.), Warsaw: Publishing House of Warsaw School of Economics, 2012, pp. 419-501.
2. Wioletta Grzenda, "Introduction to Bayesian Statistics", (published in Polish), Warsaw: Publishing House of Warsaw School of Economics, 2012, 147 pp.
3. Wioletta Grzenda, Aneta Ptak-Chmielewska, Karol Przanowski, Urszula Zwierz, "Data Processing at SAS", (Second edition, revised and supplemented), (published in Polish) Warsaw: Publishing House of the Warsaw School of Economics, 2012, pp. 86-175.
4. Wioletta Grzenda, Aneta Ptak-Chmielewska, Urszula Zwierz, "Data Processing in SAS. Version 9.1.", (published in Polish), Warsaw: Publishing House of the Warsaw School of Economics, 2009, pp. 84-141, 148-160.

Awards

I received the following awards for academic activity:

1. The individual Award of the Rector of the SGH Warsaw School of Economics of the second degree in the field of didactic activity for the publication "Bayesian modelling, theory and examples of applications", 2017.
2. The individual Award of the Rector of the SGH Warsaw School of Economics of the second degree in the field of didactic activity for the textbook entitled "Introduction to Bayesian statistics", 2013.
3. The team Award of the Rector of the Warsaw School of Economics of the first-degree in the field of didactic activity for the textbook entitled "Advanced statistical analysis methods", 2013.

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