Master of Actuarial and Quantitative Risk Management

Full Program Proposal

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Department of Mathematics

The Ohio State University

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I. PROPOSAL SUMMARY

I.1) Program Summary

The OSU Mathematics Department proposes a new Master's Program to prepare students for a career in quantitative risk management in the financial industry and related business sectors, and in actuarial risk management in the insurance industry.

The math department has been offering an undergraduate degree in actuarial science for more than 35 years. We have produced hundreds of successful actuaries for insurance industry and actuarial consulting services in the state of Ohio and beyond. In recent years, the introduction of financial markets into insurance business and the development of computational power and tools for data analysis have changed the traditional actuarial practice significantly. These changes require actuaries to be trained and knowledgeable in new areas, and the changes have brought challenges and opportunities to higher education. The Master degree in Actuarial and Quantitative Risk Management (MAQRM) is developed to meet this requirement.

The professional societies of actuaries have their own education requirements and professional standards. In order to meet these requirements and to be designated as an associate or fellow of these societies, all actuaries have to pass a sequence of exams administered by the societies and need to complete approved college courses in various areas. Candidates usually start this process in college with passing of a couple of the exams and continue the process several years after graduation to complete it.

The MAQRM program will offer advanced course work beyond typical undergraduate curriculum in order to help students in completing all the preliminary requirements by the professional societies. In addition, the program will provide unique skill training in the emerging areas to prepare students for the new challenges in the insurance industry, which is a big part of Ohio's economy.

This proposal for an MAQRM degree program has gained strong support by numerous institutions within the university, including the College of Arts and Sciences, the division of Natural and Mathematical Sciences, and the Graduate School.

I.2) Request for the Approval of the MAQRM Degree Program

We, hereby, request that a graduate degree with the title *"Master of Actuarial and Quantitative Risk Management"* at the Graduate School of the Ohio State University (OSU), to be administered by the Department of Mathematics, is approved and recognized by the State of Ohio. The degree request already has the support of the relevant OSU offices including the Board of Trustees of the university.

The guiding principles, content standards, and specific degree requirement are described in detail in this document.

II. PROGRAM DESCRIPTION

II.1) Rationale and Mission

1.i) GENERAL VISION

There have been increasing interactions between actuarial science and financial mathematics in the last a couple of decades, especially after the recent financial crisis. Pricing and hedging in insurance have posed new challenges to mathematical finance, and the development of financial mathematics has provided more opportunities to the insurance industry.

There are two types of risks: one from insurance losses and the other from the capital market. The risks related to insurance losses are studied in the traditional actuarial science, and the quantitative study of the risks from capital market is the subject of financial mathematics. As the offers in long term investments with various types of guaranteed returns become more and more popular, there has been an increasing demand for actuaries who have the skills to model and manage risks from the capital market perspective as well as for financial mathematicians who are able to work with risks from insurance losses. This master degree program in quantitative risk management is proposed in response to the need from both academic research and industrial practice.

The program is different from the traditional actuarial programs and the financial math programs in that it will provide students with opportunities in both fields, separately or in combination.

1.ii) DEMAND AND OPPORTUNITY

The increasing need for graduated level knowledge and skill in actuarial science and financial math is evident from a wide range of successful job placements of regular graduate students of ours that meet the growing demands of the AQRM industry. More specifically, many of our former graduate students and post-docs in mathematics or statistics who had exposures to

actuarial science or financial math have been hired by companies including *Nationwide*, *AEP*, *Progressive Insurance*, *J. P. Morgan Chase*, *Capital One*, *Bank of America*, *State Auto Insurance*, *Cincinnati Financial*, *Motorists Group*, and several other financial institutions. We recently received requests of cooperation at the graduate level from *Nationwide*, *Cleveland Clinic*, *Cincinnati Financial*, and *Progressive Insurance*. The demands for graduate students in AQRM are increasing, and job opportunities are waiting for qualified students.

Further evidence for the need for the proposed program is the increasing number of our own undergraduate students in actuarial science or in financial math who have continued with graduate studies upon their graduation from OSU. Our students have been admitted to master or Ph.D. programs in schools like *Oxford*, *Columbia*, *Carnegie Mellon*, *University of Chicago*, *Cornell*, *Wisconsin*, *UCLA*, *UIUC*, to just name a few. A Master's program in AQRM at OSU will , therefore, also provide a critical opportunity for our own students to extend their training to a more competitive level.

There is no program in the state of Ohio which is similar to the one we are proposing. A one-year *Specialized Masters in Business – Risk Management* is being developed at Fisher College of Business at OSU and Fisher also has Risk Management Tracks both in their undergraduate and graduate curriculum, but these programs approach risk management from a general business point of view. Their orientation is much less quantitative and they do not cover the topics from actuarial and financial mathematics.

The program we are proposing will be the first actuarial and financial math program among the higher education institutions in the state of Ohio.

In the long term, some undergraduate and graduate programs in Ohio may benefit from the planned development of online versions of courses in the MAQRM curriculum. This may eventually lead to similar programs in Ohio modeled after our proposed MAQRM.

1.iii) The OSU Location and the Strength of Undergraduate Actuarial Program

The OSU location is in many ways an ideal environment for MAQRM. Insurance has been playing a big role in Ohio's economy. Many insurance companies are headquartered in the state, including

- *Progressive and Westfield Insurance* in Cleveland
- *Nationwide*, *State Auto*, *Grange Insurance*, and *Motorists Group* in Columbus
- *Cincinnati Financial*, *Western & Southern*, *Great American*, *WellPoint*, and *Ohio National* in Cincinnati

and many other companies. Actuarial consulting in health care and pension and retirement management has a big presence in Ohio. Large consulting firms like *Towers Watson*, *Mercer*, and *Aon Hewitt* all have major actuarial department in Ohio. Surrounded by so many insurance companies and consulting firms, MAQRM will have easy access to expertise in business, and will provide plenty internship and employment opportunities for students.

Over more than 35 years, we have established a strong undergraduate program in actuarial science, and we have produced hundreds of high quality actuaries for insurance industry and

actuarial consulting services. Many of our former students have become executives and leaders in their field, and we have made a big contribution in educating actuaries.

We have developed strong ties with business through various educational collaborations that expose students to real life applications of actuarial mathematics. The following are two examples.

(a) Actuarial Practicum Class:

Each spring, experts and leaders from 10 to 12 companies come to lecture and to conduct class projects. The topics are from real actuarial practice and the projects are from real business problems. Students are exposed to different practicing areas, and get a closer look at the actuarial profession. Topics from emerging theory and practice, and professionalisms are also covered. Some lectures are open to interested graduate students.

(b) Information Session and Seminar:

Each autumn, representatives from 12 to 15 companies come to the math department to conduct information sessions or seminars. They introduce their business and companies, and tell students what quality and skill they are looking for from students. Many companies also conduct some small projects during these sessions.

The MAQRM program will build on and further develop these types of collaborations and make use of other existing infrastructures of our highly successful undergraduate program. It will strengthen the tie with the actuarial business that we already have, and will expand the cooperation with many companies at a graduate level.

Last, but not least, the national and international academic visibility, strength, and versatility of the OSU Department of Mathematics itself add to the unique advantages and opportunities for the proposed degree program.

II.2) Program and Degree Design

2.i) Curriculum Overview and Rationale

The basic guiding principle in the MAQRM program design is to provide students with a solid theoretical foundation in actuarial and financial mathematics and provide opportunities to connect their theoretical background to real life situations. MAQRM is a well focused and professionally oriented program. While the curriculum will equip students with traditional core knowledge, training, and skill needed for practice, the rapid development of technology and new applications of mathematical and statistical theory in practice will require graduates to acquire new knowledge and skill independently. Being able to do so from first mathematical or theoretical principles provides a decisive intellectual advantage. Thus, a solid theoretical foundation in mathematics and statistics will empower a practitioner with the ability to adapt to changing practice quickly and the ability to spot trends and assume leadership. Therefore, MAQRM will emphasize not only on practical knowledge, but also on rigor in mathematical and statistical theory.

The curriculum is designed with two types of students in mind. The fist type consists of those who graduated from a solid undergraduate program in actuarial science, like the one at OSU. These students usually have passed three or more actuarial exams. The second group of students comprises those who do not have a strong background in undergraduate actuarial science, but who want to pursue a career in actuarial and quantitative risk management. This group includes, in particular, students with an undergraduate degree in actuarial science from a less developed program, or students with undergraduate majors in math, statistics, engineering, economics, business finance, or other related fields.

The curriculum covers topics of all the preliminary education requirements by the professional societies, the Society of Actuaries (SOA) and the Casualty Actuarial Society (CAS), including the actuarial exams and Validation for Educational Experience (VEE).

2.ii) CURRICULUM STRUCTURE

The proposed MAQRM degree will require the completion of 33 graduate credit hours. The general types of courses are outlined next. Detailed descriptions can be found in Sections IV.1.iii) and IV.3) below.

(a) Core Actuarial Courses

In addition to two graduate level courses in probability and statistics (Math 6301, 6302), the core actuarial courses cover three areas, mathematical methods in financial economics (Math 5632course), life contingencies (Math 5630-5631 sequence), and loss models (Math 5633-5634 sequence). Well prepared students may have had two areas completed already in their undergraduate study, but a less prepared student may have to take courses in two or all three areas.

These courses correspond to the later preliminary actuarial exams. We have been running the financial economics course and the life contingencies sequence for years, and we recently developed and offered the loss model sequence.

(b) Courses in Risk Management and Modeling

MAQRM offers two directions beyond the core actuarial requirement: quantitative finance or predictive modeling. The basic course requirement in quantitative finance is a two-semester sequence in stochastic calculus for finance (the new Math 5635-5636 sequence to be developed), and in predictive modeling is courses in regression and statistical analysis. Both directions will require additional courses in numerical methods and special topics (a new course to be developed).

All of these topics are becoming increasingly important in practice.

(c) Practicum (Math 5588)

Exposure to real world business problems is vital to any professionally oriented program, and it is especially so for MAQRM. It has been proved in our undergraduate actuarial science program that the practicum class provides an excellent platform for students to connect the theory they learned in classroom to real practice, and to apply the knowledge and skill they acquired to various projects in a teamwork environment. As mentioned earlier,

OSU's location advantage gives us easy access to expertise in the profession, and we have received tremendous educational support from local insurance and actuarial consulting businesses. The program will continue and expand the success of our undergraduate practicum course at graduate level. In future years another inspiring resource of practitioners are alumni of the MAQRM program with whom we attempt to keep in touch through various means (see Section III.4.i)).

The Practicum will be mandatory for all students in the program. Supervising faculty of the MAQRM program will also help students to find internship opportunities, which usually take place during the summer between the first and second year.

(d) Other Electives

The MAQRM curriculum offers more elective courses for students to choose from in order to fulfill the pertinent hour requirements. These include courses in differential equations, numerical analysis, and applied statistics. The variety of elective courses gives students flexibility and options to adapt their curriculum according to their interests and career choices.

2.iii) Thesis and Non-Thesis Options

MAQRM can be completed with or without a thesis. The thesis option requires a minimum of 33 (semester) hours of course work, 3 credit hours of thesis study, and a thesis with an oral exam.

Any student who elects the thesis option is required to select a thesis advisor by the beginning of the autumn semester of the second year and is expected to complete the thesis early in the following spring semester. The advisor needs to be regular faculty member of the mathematics department. In addition to a faculty advisor, a mentor from business is also required who can be either selected by the student or assigned by the department. The mentor from industry is usually required to be at least an associate and preferably a fellow of one of the afore mentioned professional societies. In most cases, thesis topics will be based on the projects from the practicum class or internships.

Following university standards for Master’s degrees, the thesis is defended in a two hour oral examination. The examination committee consists of the mathematics advisor and a second graduate faculty member. The business mentor will normally be added to the thesis committee as an external member. As required by university rules the thesis will be submitted to the OhioLINK ETD data base, but will also be disseminated via the department’s web pages

The non-thesis option requires a minimum of 33 hours of course work as well as satisfactory performance on comprehensive exams that will simultaneously fulfill the university master examination requirements. The latter will be a four hour long written exam. It consists of two parts of approximately two hours each testing one of six areas that the student can choose from. The possible subjects are as follows:

1. Financial mathematics and economics
2. Stochastic calculus with applications in finance
3. Predictive Modeling

4. Numerical analysis
5. Life contingencies
6. Loss models

The examinations will be designed by instructors and approved by the MAQRM program committee (MAQRMPC, see Section III.1) below). They are expected to be offered during each spring semester. Additional offering in other semesters may be considered as the program grows in size.

The content will be mainly based on course materials but may also lean on content of the professional exams (below). The examination committee deciding on passing will generally consist of the advisor and faculty administering the respective portions. Results will be reported to and monitored by the MAQRMPC and the department's Graduate Studies Committee (GSC).

In accordance with university rules the examination committee for the non-thesis option will also consist of two graduate faculties of whom one is the formal advisor from the mathematics program. The latter may be Dr. Ban, Dr. Guan, Dr. Overman, Dr. Falkner, or Dr. Stan (who is eligible for graduate status) all of whom have expertise on the mathematical side of these subjects. The second committee member is also a graduate faculty from OSU by may be from another unit such as the statistics department or the business school.

Dr. Ban will usually be a member in exams on the first three subjects and Dr. Overman for the fourth subject. For exams involving the fifth and sixth subject R. Evans and D. Heyer, respectively, will usually serve as added members (on a petition basis) in addition to the two official graduate faculty members.

The exam will be administered and graded by the regular faculty members. The outcome of an exam is on a pass/fail basis and a pass requires the concurrence of all members of the examination committee. The main criterion for passing is a strong understanding and command of the tested course material that allows the candidate to apply the learned theoretical methods to real problems in finance and actuarial science a meaningful and effective way.

2.iv) Development and Exemptions

The curriculum template allows flexible adjustments in order to further develop and improve the MAQRM program. Although this proposal contains concrete course requirements and we expect most students to follow the proposed curricula, the program leaves the possibility to substitute requirements and add new electives.

The process requires the student to petition to the Graduate Studies Committee with the support of the advisor and provide an adequate rationale. Criteria for the committee review of such petitions include maintaining the general academic level of requirements, the function of a requirement towards the educational goals of the degree, as well as whether the change in requirement appropriately fits the MAQRM program. The approval of such a petition in an individual case should typically result also in a respective adjustment of the program rules after further discussion.

This adjustment process is an established routine in the Master of Mathematical Sciences (MMS) program, where it has been very effective in allowing the degree program to evolve in response to new professional needs while maintaining academic standards.

2.v) Relation to Other Degrees at Ohio State

The MAQRM degree program is in all fiscal and topical aspects clearly distinct from all other graduate degree programs offered by the mathematics department and is thus expected to have no impact on any of them.

III. Administration and Recruitment

III.1) Administration and Advising

1.i) Institutional Support

The MAQRM degree program has been proposed and designed by the OSU Department of Mathematics. It will be run and administered by the department and its faculty under auspices of the OSU Graduate School and the OSU College of Arts and Sciences, which supervise university academic standards, and fully support the degree program.

The curriculum includes elective courses offered by the Department of Statistics which will oversee the corresponding courses it offers. A letter of concurrence had been included and all stipulations in the letter have been addressed. Particularly, the college has expressed its support of the MAQRM program and will thus work with Statistics on required resources for the course offerings as the program grows larger. In addition, the mathematics and statistics departments have a long and successful track record of constructive collaborations, including shared requirements for other degrees, recent joint faculty appointments, and the hosting of the Mathematical Biosciences Institute.

1.ii) Program Committee

The MAQRM program and its students will be under the supervision of the Graduate Studies Committee (GSC) of the OSU Mathematics Department. The members and chair of the GSC are appointed by the chair of the department.

A MAQRM program committee (MAQRMPC) will be formed which will run the program, monitor academic content such as exams and courses, organize advising, and report to the GSC. It will initially be consist of the current actuarial science faculty and staff, but more members will be added later. Many actuaries, financial specialists, and other practitioners have expressed strong interests to work with our new program, so we expect to have plenty of mentors from the industry to work with our students.

The initial composition of the MAQRMPC is as follows:

- *Prof. Chunsheng Ban*. (Program Director, Department of Mathematics)
  Role: Ban will work with business to arrange internships, industry mentors, and placement. He will be the coordinating advisor for the program. He will also oversee the stochastic

calculus, loss models and financial economics courses.

- *Prof. Thomas Kerler*. (Vice Chair of Graduate Studies, Department of Mathematics)
  Role: Kerler will oversee program and data management, general advising, recruitment, admission, and advertisement.
- *Prof. Jean Lafont*. (Chair of Graduate Studies Committee, Department of Mathematics)
  Role: Lafont will oversee evaluation of student performance and development of program requirements through the GSC.
- *Rick Evans*. (Instructor and Mentor, Department of Mathematics)
  Role: Evans will oversee the sequences in life contingencies and loss models, and will help to advise students.
- *Dan Heyer*. (Industry Advisor, Nationwide Financial)
  Role: Heyer will serve as industry advisor. He will also oversee the topics course.

Additionally, the chair of the department, Professor Luis Casian, will collaborate with the committee on institutional support and serve as an ex-officio. Vitae of all MAQRMPC members are included in the appendix of this proposal.

1.iii) Advising and Evaluation of Students

MAQRM students will be included in the annual evaluation of all graduate students conducted by the GSC each spring, based on academic performance data and letters submitted by advisors. At least one member of the MAQRMPC will be involved directly in the evaluation. Modifications to the program are submitted to the GSC by the MAQRMPC, and there will be reviews of the performance of the program by the committee once a year (at least in the beginning years) by the GSC based on summary performance reports issued by the MAQRMPC.

Each student in the program will be assigned a faculty advisor and a possible mentor from the industry. As for all other degree programs the initial assignment of preliminary advisors will be coordinated by the vice-chair for graduate studies. The MAQRMPC will assist the vice-chair in determining initial advisors and will assure that students are able to find graduate faculty members for their thesis and examination committees. The latter committees as well as thesis and examination topics will be approved by the GSC prior to graduation up on the recommendation of the MAQRMPC. Students and advisors will be provided with advising guidelines, course offerings, program requirements, and sample schedules which subsume the function of traditional advising sheets.

Industry mentors will co-advise students on the course selection and study plans, in particular, in regard to relevance for professional career planning. They will also help students in their theses and serve, given appropriate involvement and approval, as members in the master examination committees for either thesis or non-thesis option.

III.2) Faculty and Staff Resources, Facilities

In order to ensure quality, the program will start with a smaller cohort of about five to ten students. In future years it is anticipated to grow to about twenty students per year as we gain experience.

Since we plan to start the program with small numbers of students we expect to cover essentially all courses by existing regular faculty and, only initially, staff a few courses by part-time lecturers with a strong background in the area. As the program grows, however, there will be a need to hire at least one regular faculty, which will be facilitated by the additional revenue that the program eventually generates. The hiring needs and funding plans have been discussed and have found support also with the relevant deans of the university.

We will invite qualified practitioners to lectures in the topics course and the practicum course. These courses will have graduate faculty as instructors of record who will be responsible for assessment and assigning grades. Several of our former Ph.D. students and post-docs are working in quantitative risk management related fields in Columbus. They were good instructors while they were at OSU. Given their experiences in mathematical research and teaching and their practical experience, they would be excellent candidates to assist regular faculty in the instruction of our practice related courses.

There will be additional classroom needs for the new courses at an estimate of two courses per semester. Since the courses will likely be offered late in the afternoons, the chances for classroom conflicts will be minimal.

III.3) Recruitment and Admission

3.i) Advertisement and Attracting Underrepresented Groups

Recruitment for the MAQRM degree will draw on the recruitment infrastructure that our graduate program has built for other degree programs. Our recruitment efforts will target potential applicants at the regional, national, and international level. We note that we receive may inquiries every year from both domestic and international students about the possibility of a graduate program in financial mathematics every year – even without having such a program in place or advertising for such a program. International students, particularly from China and other Asian countries, often cite financial support from their companies or governments of their home countries.

(a) School Visits & Conference Travel

Members of the department routinely travel to institutions and events which present opportunities to advertise our graduate program. Many of these recruitment trips target particularly qualified students from underrepresented groups but also aim to attract strong students to our graduate program in general.

Conferences that have been visited on a regular basis by the vice-chair for graduate studies of other representatives of our department include the following:

- Annual National Conference of SACNAS (Society for Advancement of Chicanos and

Native Americans in Science) with about 4,000 mostly Hispanic attendees from all STEM fields.

- Annual Field of Dreams Conference (Math Alliance) with about 200 minority participants in mathematical sciences.
- Annual SIDIM (Seminario Interuniversitario de Investigación Matemática) event organized collaboratively by the mathematics departments of most universities in the Puerto Rico territory.
- The SUMSRI summer program held annually at Miami University, Oxford, Ohio.
- Nebraska Conference for Undergraduate Women in Mathematics.

All of these events provide opportunities to advertise the MAQRM program. In addition, the vice-chair and other members of the department have visited individual mathematics departments of colleges and universities across the United States and Puerto Rico.

(b) Ohio State Summer Schools and Recruitment Events

The Department of Mathematics and other OSU units host several summer events that attract talented students from school all over the country. Attendees are routinely made aware and exposed to our degree program offerings. The most notable events are as follows:

- Young Mathematicians Conference (YMC) is an annual undergraduate research conference in mathematics that has been hosted by our department since 2003 and which attracted 153 applications from 223 undergraduate researcher in 2015.
- Sampling Advanced Mathematics for Minority Students (SAMMS) is an annual 4-week summer program, in collaboration with the University of Puerto Rico – Mayagüez, in which approximately 20 minority students are exposed to a graduate school environment with several mini-courses, research activities, and professional development activities.
- Graduate/Professional Student Recruitment Initiative and Visitation Day organized by the OSU Office of Diversity and Inclusion every year.
- Various undergraduate research opportunities including the RUMBA (sponsored by MBI) and the SROP and McNair programs.

(c) Local, Industry, and Alumni Contacts

As noted earlier the undergraduate actuarial program will be a natural source of potential applicants. Since it shared much of the same advising faculty with the proposed MAQRM program advertisement and assessment of potential recruits will be very effective.

Existing contacts with insurance and financial companies will allow us to advertise the MAQRM program among professionals who seek to take leaves from their jobs in order to improve their career opportunities through the MAQRM training.

Among OSU departments we may expect applications from those partnering with us in a respective track and who have access to either undergraduate majors with strong mathematical background or doctoral students who like to pick up a master degree in mathematics in order to strengthen their academic record.

Finally, former students (see Section 4.i) below) will be an excellent resource to advertise our program in relevant workplaces and assist in our recruitment efforts.

(d) Email-Announcements

Likely the most effective tool of advertisement are email announcements providing basic information, links to our web pages, and, if applicable, requests to forward the information to undergraduate academic counselors, advisors, and mentors. The emails lists are mined from the following sources:

- The institutional membership listings of the American Mathematical Society, which typically generate 2500 email addresses of administrative contacts in mathematics and statistics departments across the United States.
- Email addresses collected during conference and other recruitment travel described above. Department representatives routinely collect personal information during visits and information is extracted from available participant lists of these events.
- Applicants and participant lists of the YMC, SAMMS, and other summer events mentioned in item (b) above. These generate typically over 200 individual email addresses. They often also include mentoring faculty involved in these events.
- Miscellaneous other sources include prospective student data forwarded by other OSU units involved in recruitment, special contacts obtained by colleagues, email inquiries to our program, sign-ups to our program newsletter, or contacts described in item (c) above.

The announcements and invitations to apply are typically sent in early or mid autumn. About 2500 generic emails are sent to institutional contacts and over 400 personalized emails are sent to prospective applicants in the junior and senior years. Contact information for individual prospective applicant is systematically stored in a data base of our program that currently comprises nearly 2000 contacts.

(e) Poster, Journal Ads, Web-Pages, Professional Listings

Each year the department sends out posters to about 1000 mathematics departments that advertise our graduate program. These include both domestic and international schools. Moreover, the department will have a detailed description of the MAQRM program on the department web site. Finally, MAQRM will be listed on respective web pages of the American Mathematical Society, MMA, and special organizations as, for example, the Society of Actuaries.

3.ii) Application and Admission

(a) Application Cycles

Admission to the program will only be once a year for the autumn quarter. Thus applications will be accepted and reviewed only once a year. The deadline for applications will usually be on February 1st.

(b) Applications Prerequisites & Admission Standards

Below the list of minimum admission requirements:

- A cumulative, undergraduate GPA 3.5 on a 4.0-scale or above (or 87% of the grade scale on other grade scales). International grades will be evaluated according to customary grade equivalences established by OSU Graduate Admissions.
- Strong course work in calculus up to and including Multivariable Calculus.
- Strong course work in probability and statistics.
- Solid scores on the general GRE tests.
- Though it is not required, satisfactory score in the math subject test of the GRE is recommended.
- Excellent English skills. Foreign students will need to present both TOEFL and GRE verbal scores.
- A credible interest in actuarial science or mathematical methods in finance.

The GPA requirement in the first item is imposed to guarantee overall quality. Exceptions can be made for records in which the GPA in quantitative subjects is considerably higher than in non-quantitative ones.

The course requirements in following items are the minimum expectations to ensure the most basic preparations for the MAQRM course requirements. In general, coursework will be considered the strongest measure of mathematical preparations and investment, and we expect applications to be competitive. A successful applicant file is, therefore, expected to contain coursework much beyond the listed minima, which will be used mainly as a pre-screening tool.

The requirement regarding English skills exists to make sure a student has the communication skill needed for the team work and presentation components of the projects in the practicum and the topics classes. The circumstance that this requirement will place an emphasis on domestic applicants or applicants that will eventually enter the US workforce is not entirely unintended, although we still expect significant participation by qualified international students in the program. The last requirement is somewhat vague and subjective – it allows us to discard applications of students who have apparently no interest in subject of the degree program.

Beyond the above lists of formal requirements the goal is to admit only students who have demonstrated a level of academic excellence in their undergraduate work that would predict solid performance in our required courses as well as the ability to complete an independent thesis. This assessment will depend on the combined academic profile that is shaped by letters of recommendations, grades, quality of courses and programs, and other academic records submitted in the application.

(c) Review Process & Admission Targets

Applications are screened for completeness and fulfillment of minimum requirements by the vice-chair. Two faculty members familiar with the program will review the pre-screened applicant files and record comments and a score for each file. Scores are use to establish a preliminary ranking which serves as the starting point for a discussion on final admission decisions and wait-lists by the reviewing faculty and the vice-chair.

(d) Diversity

Past experience with our undergraduate actuarial science program has shown that the enrollment is well balanced between genders and underrepresented groups. We will continue and extend our efforts in recruiting in underrepresented groups, and we are expecting similar enrollment patterns in the proposed master degree program. The recruitment resources described in Paragraphs 3.i.a) and 3.i.b) above will ensure a diverse applicant pool and applicants from underrepresented groups will receive special attention by the admissions committee.

We have also noticed that there has been an increasing enrollment of international students, especially Chinese and Korean students. Although not normally considered underrepresented groups they still contribute to the general cultural diversity of the program.

III.4) Evaluation & Development of the Program

4.i) TRACKING POST-GRADUATION CAREER

The performance of the MAQRM degree program is to a great extent measured by the placements of graduates, either as employees in the private of public sectors or in advanced academic programs. Generally, keeping track of the careers of graduates can be challenging. Methods we are implementing also for our doctoral students include the following:

- Development of web-based tracking tools. Graduates will be regularly sent emails in which they are asked to update their information in a simple web form. A basic version of this has been scripted and put to use by the department. More sophisticated versions are in development with the IT service of the Arts and Science College.
- Contacting thesis advisors and mentors who typically keep in touch with former advisees over the first years after graduation.
- Using resources of the Ohio State Alumni Association.
- Web searches by paid students assistants. Although time consuming this can be very effective and costs remain reasonable.

The tracking of alumni will serve, more generally, to build an alumni network from which the MAQRM will greatly benefit beyond the mere job placement data. Possibilities for former students to reengage in the program in recruitment and participation in instructional activities have already been mentioned in Sections II.1.iii.a) and 3.i.c) above.

4.ii) FURTHER DEVELOPMENT

The MAQRMPC committee, in collaboration with the GSC and the chair, will periodically explore and move forward further developments of the degree program.

- An immediate further development is to put some of the courses online. Several higher education institutions in Ohio and some insurance companies have shown great interests in online courses on topics from advanced actuarial science and modeling. The OSU Office of Academic Affairs and the OSU College of Arts and Sciences have been actively involved in exploring the possibility to offer the MAQRM online. In response the mathematics department has taken first steps to

develop online versions of several of the MAQRM courses. We will draw from experiences the department has gathered with recently published online versions of other mathematics courses. There have also been changes to the education requirements imposed by the professional societies. The Casualty Actuarial Society has consolidated some of its existing requirements in statistics and has added new material to form a new exam, namely the Exam S. The topics course in the curriculum of this proposal will cover some of the new material required in Exam S. The MAQRM supervising faculty will consider developing a new course to cover the new material separately from the topics course together with more advanced material in predictive modeling.

- We have been suggested to cooperate with the Certificate in Quantitative Finance (CQF), an online financial engineering program and a finance designation which is well received by the financial and insurance industry. Cooperation with CQF will strengthen the practical portion of our program, and their experience and connection with business will be very valuable to us. We are exploring possibilities and ways to cooperate.

IV. APPENDIX

IV.1) Itemized MAQRM Requirements

1.i) PREREQUISITES

Students are expected to have completed advanced calculus, calculus based probability, and elementary economics. They are also expected to have some working knowledge in a computer programming language. The equivalent OSU courses include Math 2153 (calculus), Math 4530 or Stat 4201 (probability), Economics 2001 and 2002, CS&E 1222 or 1223 (computer programming).

Theory of interest at the level of Exam FM, an actuarial exam administered by the Society of Actuaries and the Casualty Actuarial Society, is required. The equivalent OSU course is Math 3618. If a student does not meet this prerequisite, Math 3618 can be taken during the first semester of a student's MAQRM study.

1.ii) REQUIREMENTS

- Thesis option: At least 30 credit hours of required or elective coursework, 3 credit hours of thesis study, a master thesis and an oral exam based on the thesis.
- Non-thesis option: At least 33 credit hours of required or elective coursework and comprehensive exams, oral or written, in two areas from financial math and economics, stochastic calculus, differential equations, numerical analysis, life contingencies, or loss models.

1.iii) COURSES

(a) Required Courses (12 credit hours)

- Financial Economics: Math 5632 (3 credits)
- Probability/Statistics Sequence: Stat 6301 and 6302 (6 credits)
- Practicum in AQRM: Math 5588 (3 credits) New Course

(b) Elective Courses (2 or 3 sequences, 12--18 credit hours from the following list)

- Stochastic Calculus for Finance: Math 5635 and 5636 (6 credits) New sequence
- Life Contingencies: Math 5630 and 5631 (6 credits)
- Loss Models: Math 5633 and 5634 (6 credits)
- Topics in Risk Management: Math 5637 (3 credits; can be repeated for up to 6 credits) New course
- Numerical Analysis: Math 5601 and Math 5602 (6 credits)
- Master Thesis Research: Math 6999 (3--6 credits)

(c) Other Elective Courses (9--15 credit hours from the following list)

- Real Analysis: Math 5201, 5202 (6 credits)
- Differential Equations: Math 5401, 5402 (6 credits)
- Numerical Linear Algebra: Math 5603 (3 credits)
- Regression Analysis: Stat 6450 (4 credits)
- Time Series: Stat 6550 (2 credits)
- Applied Stochastic Process: Stat 6540 (3 credits)
- Applied Multivariate Analysis: Stat 6560 (3 credits)
- Applied Survival Analysis: Stat 6605 (3 credits)
- Introduction to SAS: Stat 5740 (2 credits)

IV.2) Sample Schedules

The schedules below provide examples for both thesis and non-thesis option, one for students with sufficient background in the theory of interest and another for students who need to take Math 3618. The credits from Math 3618 will count neither towards program requirements nor to the university's minimum hour requirement. In the tables below credits in bold face are the ones counting towards the 36 or 39 required hours.

2.i) SAMPLE 1 (THESIS-OPTION, WITH MATH 3618 BACKGROUND)

Year	Semester	Courses			Hours
Year 1	Autumn	STAT 6301 (3 cr)	MATH 5632 (3 cr)	MATH 5633 (3 cr)	9
	Spring	STAT 6302 (3 cr)	MATH 5634 (3 cr)	Elective (3 cr)	9
Year 2	Autumn	MATH 5635 (3 cr)	STAT 6450 (3 cr)		6
	Spring	MATH 5636 (3 cr)	MATH 6999 (3 cr)	MATH 5588 (3 cr)	9
				Total	**33**

2.ii) SAMPLE 2 (NON-THESIS-OPTION, STARTING WITH MATH 3618)

Year	Semester	Courses			Hours
Year 1	Autumn	STAT 6301 (3 cr)	MATH 5630 (3 cr)	[MATH 3618 (3 cr)]	6
	Spring	STAT 6302 (3 cr)	MATH 5631 (3 cr)	STAT 6450 (3 cr)	9
Year 2	Autumn	MATH 5632 (3 cr)	MATH 5633 (3 cr)	Elective (3cr)	9
	Spring	MATH 5634 (3 cr)	STAT 6550 (3 cr)	MATH 5588 (3 cr)	9
				Total	**33**

IV.3) Descriptions of Special Course

3.i) Stochastic Calculus for Finance 1 & 2

Course Number: Math 5635, 5636

Credits: 3 sem. hrs. each, total 6 sem. hrs.

Design/Instruction: Chunsheng Ban, Barbara Keyfitz

Course Goals: The purpose of the sequence is to provide students with a solid mathematical foundation in stochastic calculus and to expose students to application of the theory in finance and modeling of financial markets.

Topics List:

- Probability: random variables and their distributions, convergence, change of measure
- σ-algebras and conditioning, conditional expectations
- Brownian motions
- Ito's integrals, Ito's lemma, Black-Scholes equation
- Pricing under risk neutral measure
- Martingale representation, fundamental theorem of asset pricing
- SDE, PDE, Feynman-Kac Theorem
- Exotic options, American options
- Interest rate models

Course Text: *Stochastic Calculus for Finance II*, Steven Shreve (Springer)

3.ii) AQRM Practicum

Course Number: Math 5588

Credits: 3 sem. hrs.

Design/Instruction: Chunsheng Ban, and various practitioners

Course Goals: The purpose of the course is to expose students to real world problems from actuarial and risk management practice, and to improve students' communication skills. Most classes will be presentations by visiting practitioners on topics drawn from their fields of expertise. Students will also give presentations on selected topics.

Topics List:

- Quantitative risk management in life insurance
- Enterprise risk management

- Risks in pension and retirement management
- Healthcare design and management
- Market segmentation and price optimization
- Simulations and other computational issues
- Predictive modeling

3.iii) TOPICS IN AQRM

Course Number: Math 5637

Credits: 3 sem. hrs.

Design/Instruction: Chunsheng Ban and Dan Heyer

Course Goals: The purpose of the course is to introduce more advanced modeling and computational tools and methods used in risk management practice, and to expose students to applications of these advanced methods in real practice.

Topics List:

- Types of risks
- Monte Carlo methods, simulation
- Interest rate and volatility
- Linear models and regression in insurance
- Generalized linear models
- Predictive modeling methods

Course Texts:

- *Financial Risk Management*, Steven Allen (Wiley)
- *Monte Carlo Methods in Financial Engineering*, Paul Glasserman (Springer)
- *Predictive Modeling Applications in Actuarial Science*, E. Frees, R. Derrig and G. Meyers (Cambridge)

IV.4) Selected Responses to the PDP Review

In 2014 a Program Development Plan was submitted that was reviewed by six institutions in Ohio on which the full program proposal is based. In this section we will briefly address various review comments about our Program Development Plan we received from six universities in Ohio. We use acronyms for institutions as listed below to indicate their comments. Italic type indicates our responses or notes.

[CS]	Cleveland State University	[UC]	University of Cincinnati
[MU]	Miami University, Oxford	[BG]	Bowling State University
[UA]	University of Akron	[UD]	University of Dayton

4.i) DEMAND, CONFLICTS, EMPLOYMENT

a. [UC] How do they expect the graduates of this program to differ in their career trajectory from the graduates of the undergraduate actuarial science degree? Not clear how the program would share resources with the actuarial (UG) program.

b. [CS] It seems to me that students finishing an undergraduate degree with the prerequisite coursework listed at the top of Appendix would be much more attracted to a traditional actuary program than the AQRM program as traditional actuary programs tailor curriculums to the actuary exams and the VEE courses. It is not as clear to me that students going into the AQRM will have a crystal clear career path open to them unless they also have passed several actuary exams. It seems to me that the AQRM will be more attractive to professionals and/or actuaries who have been working for a number of years who see that they need the specialized knowledge of the AQRM curriculum to further their careers.

> *The graduates of MAQRM will have similar career paths as those with a traditional undergraduate or graduate degree in actuarial science. However, the graduates from MAQRM will have extra training and education beyond a traditional program in either financial mathematics/quantitative finance or predictive modeling, which have become more and more important in practice, and will make our graduates more competitive in the job markets.*
>
> *We do expect professionals and actuaries who have been in the business to take some of our courses, or even to complete the degree. This possibility has been mentioned at various places in the recruitment plan in Section III.3).*
>
> *Though the curriculum of MAQRM is not designed just for students to prepare for the actuarial exams, a graduate from MAQRM will have completed coursework required by all the preliminary exams of SOA/CAS. Upon graduation from the MAQRM program, a*

> *student is expected to be able to pass at least three actuarial exams, and four or more if the student enters MAQRM with an undergraduate background in actuarial science.*

4.ii) RECRUITMENT

a. [BG] Although there are no competing masters programs in actuarial science in Ohio, there are programs that have a high percentage of Masters graduates entering the actuarial profession. For example, the Master of Science in Applied Statistics (MSAS) at BGSU has a long record in this area, with many MSAS alumni in the actuarial profession. In addition, there are nearby competing masters level programs in actuarial science at Ball State (Muncie, Indiana), Univ. of Michigan, and U. Illinois, so the potential pool of out-of-state fee paying students would seem more limited than described in the proposal.

b. [CS] The proposal calls for cohorts of approximately 20 with half to three quarters paying out of state tuition. There is no recruitment plan for out of state or foreign students.

> *Recruitment plan discussed in Section III.3.i) above does include advertisement with international schools via posters, web pages, and institutional emails. Our MMS program also routinely attracts many international applications (sometimes close to half of the applicant pool) although this program is far more domestically oriented and English standards are much higher than for the MAQRM program. Our experience with undergraduate actuarial science program shows that we have a balanced enrollment between domestic and international students, and between in-state and out-of state students, and we expect to see the same pattern in the MAQRM program.*

4.iii) TARGETED STUDENTS

a. [UC] The prerequisites are less than requiring a math major, and would not be sufficient preparation for some of the courses they list among the electives.

b. [UD] In the discussion on Evidence of Need, with the combination of actuarial science and financial mathematics, there is the feeling that the target population is a well-educated, mature student body with possible work experience. Under prospective enrollment, it is stated clearly that the target population is undergraduate students. But again, standards are high with a minimum admitting GPA of 3.5/4. On page 6, however, under prerequisites, the list of required prerequisite courses, though broad, is at a sophomore level.

> *As mentioned in Section II.2.i)the MAQRM program targets not only undergraduate actuarial science or math students, but also strong students from other related majors, such as statistics, economics, actuarial science, and quantitative/insurance business majors. That the overall prerequisite in math or actuarial science is set at a sophomore or junior level is because we consider students from undergraduate majors in statistics,*

> *economics, engineering, business finance, and other related fields. The relatively high admission requirement in GPA or GRE is to guarantee overall quality such that admitted students can complete the program successfully.*
>
> *Even though the proposed stochastic calculus sequence covers more advanced topics that require rigor and preciseness at a very high level, experience from other institutions (Carnegie Mellon for example) shows that good students with solid background in calculus and calculus based probability will be able to handle the material.*
>
> *As described in Section III.3.ii) the recruitment committee will consider the entire coursework record of an applicant, regardless of major. Confidence in the ability to master the MAQRM course requirements based on prior preparations will be the most important criterion in admission decisions. The same standards, concerns for curricular success, and emphasis on course preparations are being applied by our admission committees for our other degrees (MMS and PhD).*

4.iv) CURRICULUM, COURSES

a. [UA] the student may benefit from courses which also focus on the risk management process, the operational aspects of the insurance industry or an in-depth course on investments. Depending on the student's undergraduate coursework, the prospective student for the proposed graduate program may hold no or little knowledge in these areas. Having the quantitative skills provided by the MAQRM program is valuable; however, having the ability to understand how the information created impacts the overall operation of the employer is also critical.

b. [BS] Note that the SOA and Casualty Actuarial Society (CAS) lately have split with respect to preliminary education, with CAS now requiring a new exam S (Statistics) instead of MLC (life contingencies). Ohio has a large presence in the Property/Casualty side of the insurance business, but the proposed curriculum seems to be focused on the Life/Pension/Financial side; CAS educational requirements should not be overlooked. The program would be more attractive to property/casualty employers if it included a course in Generalized Linear Models. It is also somewhat surprising that there is no requirement or elective that covers what are now standard tools in modern statistical methods: Monte Carlo methods, computational statistics, simulation, etc.

c. [MU] My only concern is the use of quantitative risk management in the title of the program. To use the term management implies a context for application and I see limited contexts in the curriculum. Also in the area of risk management there are well-regarded industry standards for risk management (e.g. see GARP http://www.garp.org/). I fear that such a title may mislead prospective students as I see little in the curriculum that deals with applications of risk management outside of actuarial risk. I suggest dropping the term quantitative risk management from the program title.

d. [MU] In the event that the program proposers wish to include risk management as part of

the curriculum, courses that include more in-context application would be needed. In addition I am surprised to see the relative emphasis on stochastic calculus and limited use of numerical and simulation analysis. Most large-scale and applied risk problems use simulation due to the complex interaction and co- dependency of stochastic variables.

> *The practicum and the topics courses will cover in-context application and advanced methods in simulation and computation (See Section IV.3) for details). We indeed consider property and casualty insurance. The predictive modeling material in the topics course is included for this purpose. As discussed in Section III.4.ii) we will develop a separate course to address the need from P & C insurance as well as topics required for the new Exam S. This will also leave more room for the topics and practicum courses to cover simulation and computation.*
>
> *Considering that the MAQRM is a two-year terminal degree and that the number of hours needs to remain reasonable in order for the program to be affordable and marketable some curricular choices need to be made. As noted in Section II.1.ii) the theoretical foundations of AQRM tend to constitute the greater need since they more flexibly applied and more difficult to acquire outside of an academic environment.*

4.v) COLLABORATION

a. [BS] Ideally, we would like to see financial economics, stochastic calculus, advanced topics in financial math, and possibly loss models courses in this program offered as distance learning or online; we have students who would like to take these courses, but we do not have the depth in this area of our faculty to offer all of them at our institution. Long term, we would possibly like to explore whether we can have our masters students earn a certificate or degree in actuarial science or MAQRM through combining courses at BGSU and OSU.

b. [UC] Not sure if there are any opportunities for collaboration. I think this program could be of interest to some of our math majors who are looking for a focused master degree, as an alternative to a degree in the college of business. Perhaps some articulation agreement for students who complete some of the coursework at UC (as part of the undergraduate degree) before enrolling in their program would be possible.

> *The College of Arts and Sciences, the Office of Distance Education, and the Department of Mathematics have met to discuss possibilities to offer an online version of the MAQRM. As noted in Section III.4.ii) our department is starting to work on individual online courses as a first step. To put the whole degree online needs more resources and takes time. We will start with putting a couple of advanced courses online.*
>
> *We are open to any suggestion on further collaboration with other higher education institutions in Ohio, and we are willing to work with the College of Arts and Sciences, the Graduate School, and the university to explore any such possibilities.*

IV.5) Biosketches of MAQRM Program Committee

- Chunsheng Ban
- Rick Evans
- Luis Casian
- Thomas Kerler
- Jean-François Lafont

IV.6) Letters of Support and Concurrence

- Support Letter of NMS Dean
- Concurrence from Fisher College of Business
- Concurrence from Statistics Department

Chunsheng E. Ban

EDUCATION

08/90	Purdue University, Department of Mathematics Doctor of Philosophy
08/85	Purdue University, Department of Mathematics Master of Science
01/82	Beijing Normal University, Department of Mathematics Bachelor of Science

PROFESSIONAL EXPERIENCE

10/08–present	**Ohio State University, Columbus** Associate Professor of Mathematics Director, Actuarial Science
10/96–09/08	**Ohio State University, Mansfield** Associate Professor of Mathematics
06/90–09/96	**Ohio State University, Mansfield** Assistant Professor of Mathematics
06/83–06/90	**Department of Mathematics, Purdue University** Teaching/Research Assistant

SELECTED PUBLICATIONS

2014 *The Pricing of Mortgage Insurance Premiums under Systematic and Idiosyncratic Shocks* (with Ming Pu and Gang-zhi Fan), J. of Risk and Insurance, 2014. doi: 10.1111/jori.12052

2002 *On the Milnor fiber of a quasi-ordinary surface singularity* (with L. McEwan and A. Némethi), Canadian J. Math., **54** 2002, 55–70.

2001 *The embedded resolution of* $f(x, y) + z^2 : (\mathbf{C}^3, 0) \to (\mathbf{C}, 0)$ (with L. McEwan and A. Némethi), Studia Scientiarum Mathematicarum Hungarica **38** 2001, 51–71.

2000 *Simultaneous Resolution of Quasi-ordinary Singularities* (with L. McEwan) Singularities in Algebraic and Analytic Geometry (Contemporary Mathematics **266**), Amer. Math. Soc. Providence 2000, 65–75.

2000 *Canonical resolution of quasi-ordinary surface singularities* (with L. McEwan) Canadian J. Math., **52** 2000, 1149–1163.

1993 *Whitney stratification and equisingular family of quasi-ordinary singularities*, Proc. Amer. Math. Soc., **117** 1993, 305–311.

COLLABORATORS & AFFILIATIONS

Collaborators

Ming Pu
School of Insurance
Southwestern University of Finance and Economics, China

Lee McEwan
Department of Mathematics
The Ohio State University

András Némethi
Alfréd Rényi Institute of Mathematics
Hungarian Academy of Sciences

Graduate Advisor

Joseph Lipman
Department of Mathematics
Purdue University

C. Richard Evans, FSA, MAAA
5906 Ivystone Court
Dublin, Ohio 43016
Phone: Home (614) 792-5463
Cell (614) 264-0957

Education
Society of Actuaries: FSA (March, 1999)
Member of American Academy of Actuaries 1992- present
University of Missouri - Columbia, Missouri
MS Industrial Engineering 1981
MS Applied Mathematics 1977
Geneva College - Beaver Falls, Pennsylvania
BS Mathematics 1975

Employment
The Ohio State University 1996 - present

Full time lecturer of actuarial science 2012 - present
Part time lecturer of actuarial science 1996 - 2012

Taught numerical analysis, interest theory, life contingencies
and financial economics
Presenter at Actuarial Practicum
Speaker at Actuarial Club Meetings
Mentored many students
Developed company relations
Held SOA Exam preparations for interest theory
and numerical analysis
Assisted in constructing updated actuarial program 2007

Nationwide Financial 1989 - 2012

2003: Senior Life Actuary
2002: Senior Health Actuary
2000: Health Actuary
1999: Associate Health Actuary
1993: Sr. Assistant Health Actuary
1991: Assistant Health Actuary

1989: Actuarial Assistant - Pension and Health

Responsibilities

Individual Protection - Experience Reporting 2003-2012
Responsible for reinsurance issues, system conversions,
process automation, mortality and persistency studies,
regulation research, x factor analysis
Managed a staff of five
Represented Nationwide in 2 legal depositions
Lead of Sarbanes-Oxley controls review
Member of Enterprise Persistency Team Responsibility for
Life Financial Reporting 2007 including year end and
quarterly financial reporting, reserves,
and reinsurance accounting
Chairperson, Actuarial Recruiting Team 1994-2007
Member of Recruiting Team 2007-2012
Chairperson, Student Issues Team 2003-2007
Member, Student Issues Team 2007-2012

Director - Individual Health Actuarial 1998-2003
Oversee wind down of individual health business
Oversee rate management, product development, compliance and sales
Responsible for major medical, medicare supplement and disability products
Over see a staff of 7 including actuaries, compliance and sales employees
Chairperson - Health Management Team
Member - Diversity Workplace Committee
Representative - Agent Response Committee
Member - SOA Exam 8 Committee

Past Health Projects/Responsibilities 1990-1998

Member of Project Checkup Task Force
Member of Disability Marketing Team
Member of Individual Health Systems Team
Member of Product Development Team
Pricing and development of new disability products
Reinsurance negotiations
State strategy reviews
Disability quoting capabilities for agents

Member of Enterprise Cost Containment Team
Disability training for operations members
UCR pricing schedule
Member of EDI team
Development of a quoting program for Nationwide HMO
Open enrollment and conversion filings for Nationwide HMO
HMO reserving
Automation of reinsurance premium calculation
Agent persistency bonuses
Experience analysis for major medical and disability
Rate comparisons

Pension responsibilities 1989

Pricing group single premium cases for terminating DB plans
Rewrote QBASIC programs to handle non-standard plans
Priced Master Annuity Trust cases
Documentation of pricing methodology
Generated daily GIC rates
Guidance to underwriting department on data conversions

Otterbein College - Westerville, Ohio 2007

Taught life contingencies during leave of absence of chair

Tarkio College - Tarkio, Missouri 1983-1989

Associate professor of mathematics 1987-1989
Assistant professor of mathematics 1983-1987

Chairman of mathematics department
Responsible for class scheduling
Developed mathematics major program
Student advisement
Chairman of student advising committee
Member of financial, student retention and rolling contract committee

Argonne National Laboratories - Chicago, Illinois 1985

Faculty research summer participant Performed case studies using the IDYNEV traffic model Helped design a computer aided tutorial

Publications and Conference Presentations

ESRD: Resource Forecasting by Predictive Model Automation of Data Base used by the Missouri Kidney Program The Missouri Medical Data System and its Uses in Planning ESRD Forecasting Limitations

Membership in Professional Societies and Organizations

Society of Actuaries American
Academy of Actuaries Columbus
Actuarial Club
Tri-State Actuarial Club
Tau Kappa Epsilon

Honors and Awards

The Ohio State University Mortar Board Award
Outstanding Young Man of America Tarkio
College Faculty Member of the Year Tarkio
College Senior Cane Award
Outstanding Teaching Assistant - Mathematics and Computer Science, UMC
W. E. Cleland Mathematics Prize - Geneva College

BIOGRAPHICAL SKETCH LUIS CASIAN

Born in Mexico.
US citizen

APPOINTMENTS

The Ohio State University

- Professor & Department Chair, 10/10-
- Professor, 10/04 -
- Associate Professor, 10/90 -9/04
- o Assistant Professor, 10/88-9/90

Previous institutions

- M.I.T. Department of Mathematics, Assistant Professor 7/86-7/88
- University of Utah, Department of Mathematics, Instructor 7/85-6/86
- The Institute for Advanced Study, School of Mathematics (Princeton), Member 9/84-8/85

PROFESSIONAL PREPARATIONS

- PhD, Massachusetts Institute of Technology (MIT), May 1983
- Master of Science, Centro de Investigacion del Instituto Politecnico (Mexico City), June 1980
- BS degree in Mathematics, Universidad Autonoma Metropolitana, Iztapalapa (Mexico City), June 1978

SELECTED AWARDS

1990 *Alfred P. Sloan Research Fellow*

FIVE PRODUCTS RELEVANT TO PROPOSAL

Selected Publications

(1) (with Collingwood) *Complex geometry and the asymptotics of Harish-Chandra modules II*, **Inventiones Mathematicae** 86, 255-286, **1986**.

(2) (with Stanton) *Schubert Cells and Representation Theory*,
Inventiones Mathematicae 137, 461-539, **1999**.
Surikaisekiken Kokyuroku, **1400**, 39-87, **2004**, (mathAG/0404345).

(3) (with Y. Kodama) *Toda lattice, cohomology of compact Lie groups and finite Chevalley groups*, **Inventiones Mathematicae** 165,163-208,**2006**

(4) (with Kodama) *Singular structure of Toda lattices and Cohomology of certain compact lie Groups,* **Journal of Computational and Applied Mathematics,** 202, 56-79, **2007.)**

(5) (with Kodama) *On the cohomology of real Grassmann manifolds* (http://arxiv.org/abs/1309.5520)

ADDITIONAL PRODUCTS-RECENT INVITED TALKS

- Plenary talk *Cohomology of real Grassmannians and KP flow,* VI International Symposium, HAMSYS 2010, Mexico City, November 2010.
- Invited speaker, Pre-College Research Symposium, San Juan, Puerto Rico *Waves in shallow water and their hidden geometry, December 10, 2011*
- Invited speaker, IV Latin American Conference on Lie Groups and Geometry, *Cohomology of real Grassmann manifolds and Integrable Systems,* CIMAT, Guanajuato, Mexico, August 27-31, 2012.
- Invited speaker, Geometry Seminar, *Cohomology of real Grassmann manifolds,* University of Sao Paulo, Brazil, May 17, 2013.

SYNERGYSTIC/ORGANIZATIONAL/ADMINISTRATIVE ACTIVITIES:

- Established a partnership with the Mathematics Department at the University of Puerto Rico, Mayagüez. This partnership resulted in a four-week summer program for under-represented minorities in Mathematics with faculty and student participation from both institutions.
- Established a partnership with the Mathematics Department at the University of Sao Paulo, Brazil, involving undergraduate students and faculty exchanges.

Development of new programs

- As Chair of the Math Department oversaw the development of the first MOOC (in calculus) at OSU with 35,000 registered students (Spring 2013).
- As Chair of the Math Department oversaw the introduction of a new masters programs in Mathematics Computation. One more masters program, in Quantitative Risk Management, is already in the final stages of approval at OSU.

COLLABORATORS, MENTORS

(1) *Collaborator:* Yuji Kodama, Robert Stanton (both at The Ohio State University) and David Collingwood (University of Washington).

(2) *Postdoctoral mentor* Henryk Hecht , (University of Utah).

Biographical Sketches

Thomas Ker er

Appointments

2014 – present: The Ohio State University. Professor of athe ! atics.

2002 – 2014: The Ohio State University. ''ssociate Professor of athe ! atics.

1##$ - 2002: The Ohio State University. "ssistant Professor of athe ! atics.

%&#$'#&#$: U(Berkeley) Berkeley) (''. *esearch +ello ,.

1##2 ' 1##%: –arvar. University) Ben/a ! in Peirce 0ect1rer) ''ssistant Professor of athe ! atics.

1#2#'1##2: 3T– 45rich) Theoretical Physics. Teaching ''ssistant.

1#2$'1#2#: 3T– 45rich) athe ! atics. Teaching ''ssistant.

Professional Preparations

2002 - present: The Ohio State University. ''ssociate Professor of athe ! atics. 6,ith ten1re7

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Oct. 1#2%: =or.iplo ! e in athe ! atics an. Physics.

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Selected Awards

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n @S+&8 S 0E>2$22 ABo1ng athe ! aticians (onferenceC. 200E 6P.<.) D%%)>427.

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Five Products Relevant to Proposal

n "Universality in Quantum Hall Systems" Nucl Phys B 354 61##17 >$#'41E (with J Frohlich)

n "N n!semisim"le # '' l $ical Quantum Fiel% #he ries & r '!(ani& l%s with) rners". Lecture Notes in Mathematics 1765 Springer'=erlag) 2001. Gi H >E% pages. (with V. Lyubashenko)

n "Quantum$r u"s* Quantumcate$ ries an% Quantum&iel%the ry" Lecture Notes in Mathematics 1542) Springer =erlag) 1##>. Giii H 4>$ pages 6Secon. 3.ition) 1##%7. 6,ith 9. +r:hlich7

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Five Additional Products

- "2ri%$e% 3in1s an% #an$le 4resentati ns &) 0 r%ism)ate$ ries" Adv Math 141 61###7 20E'221.
- "#he 3awrence!5rammer!2i$el w .e"resentati ns & the 2rai% 6r u"s via $U_q(sl_7)$ ". Adv Math 228 620117 1$2#'1E1E. 6,ith (raig 9ackson7
- "8n the) nnectivity &) 0 r%isms an% Hal&!4r 9ective #QF#+s". Commun Math Phys 198 61##27 %>%'%#0.
- ""!(%ular #QF#+s* (iln r # rsi n* an% the)ass n!3esc " /nvariant". Geom Topol Monogr 4 620027 11#'141.
- 6eneal $y & N n"ertur0ative Quantum!/nvariants & '!(ani& l%s: #he Sur$ical Family". Lecture Notes in Pure and Applied Physics 184) arcel 8ekker 61##$7 %0>'%4E.

Synergistic/Organizational/Administrative Activities

- 2002'present: ice!Chair "or Graduate #tudies 6Ohio State athe!atics 8epart!ent7.

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- 2011'present: Co!organi'ing and design o" #ampling Advanced Mathematics "or Minority #tudents 6S'' S7. (o1rse staffing) participant recr1it!ent) organiFation oversight) gra.1ate st1.ies relate. activities) relations ,ith !inority serving instit1tions.
- 200>'2012: (rgani'er o" the)oung Mathematician Con"erence – an ann1al 1n.ergra.1ate research conference ,ith co!petitive a.!ission 6E0'E> st1.ent participants fro! 120H applicants) 10'1> !entors) 2'12 gra.1ate progra! representatives) > high profile plenary speakers7.
- Con"erence (rgani'er: ABor.ers in >'8i! TopologyC) OSU 200> 6@S+ f1n.e.7.

  '' S Special Sessions on J1ant1! Topology: Sectional eeting K 102%) OGfor.) O–) arch 200E. Sectional eeting K #$#) (ol1!?1s) O–) Septe!?er 2001. 6also local organiFer7.
- 2004'2002: *reshmen Calculus Coordinator% Preparation of sylla?i) eGa!s) I1iFFes) an. eGercises) !anage!ent of online co1rse an. ho!e,ork !anage!ent tools 6LeBLorM& oo.le7) policies) conflict !anage!ent) gra.ing an. assess!ent for ann1ally N2%00 st1.ents) N1% lect1rers) an. N4% teaching assistants.
- OrganiFation of n1!ero1s general research se!inars an. ,orking gro1ps aro1n. special topics in lo,' .i!ensional an. I1ant1! topology.

Colla orators and Students

- Collborators% 95rg +r:hlich 6a.visor7) Pieral?erto archetti) Ur?an St1.er) 3!!an1el Thiran) B1ri Bespalov) =olo.y!yr 0y1?ashenko) =la.i!ir T1raev) (raig 9ackson) Ji (hen) Bilong Lang.
- Graduated Ph+ students% atthe, SeI1in 620127) 9enny ;eorge 6201>7.
- Current Ph+ students% ''leGan.er Borlan.) Bilong Lang.
- Masters Theses% Tho!as 9ohnson 6200E7) (raig 9ackson 620007.
- Post!+octoral Mentors% 8avi. MaFh.an 61##2'1##%7) Pierre 8eligne 61##%&#$7.
- Post!+octoral Mentees% Ji (hen 62004'200E7) (raig 9ackson 6200E'200#7) ''nh Tran 62012'20147

Jean-François Lafont
Biographical Sketch.

A. Professional preparation.

Undergraduate Institution: Colgate University, B.Sc. Mathematics (1996).
Graduate Institution: University of Michigan, M.Sc. Mathematics (1998), Ph.D. Mathematics (2002).
Postdoctoral Institution: Binghamton University, Topology, 2002-2005.
Postdoctoral Institution: The Ohio State University, Topology, 2005-2007.

B. Appointments.

2012-	Associate Professor, The Ohio State University.
2007-2012	Assistant Professor, The Ohio State University.
2005-2007	Zassenhaus Assistant Professor, The Ohio State University.
2002-2005	Riley Assistant Professor, Binghamton University.

C. Publications related to proposal.

1. 'Rigidity of high dimensional graph manifolds' (joint with R. Frigerio and A. Sisto), 147 + xv pages as a preprint, submitted to *Astérisque.*

2. '4-dimensional locally CAT(0)-manifolds with no Riemannian smoothings' (joint with M. Davis and T. Januszkiewicz), *Duke Math. J.* **161** (2012), pp. 1–28.

3. 'Simplicial volume of closed locally symmetric spaces of non-compact type' (joint with B. Schmidt), *Acta Math.* **197** (2006), pgs. 129-143.

4. 'EZ-structures and topological applications' (joint with F.T. Farrell), *Comment. Math. Helv.* **80** (2005), pgs. 103–121.

5. 'Finite automorphisms of negatively curved Poincare Duality groups' (joint with F.T. Farrell), *Geom. Funct. Anal.* **14** (2004), pgs. 283–294.

D. Other significant publications.

1. 'Large scale detection of half-flats in CAT(0) spaces' (joint with S. Francaviglia), *Indiana Univ. Math. J.* **59** (2010), pgs. 395–415.

2. 'Lower algebraic K-theory of certain reflection groups' (joint with B. Magurn and I. Ortiz), *Math. Proc. Cambridge Philos. Soc.* **148** (2010), pp. 193–226.

3. 'Splitting formulas for certain Waldhausen Nil-groups' (joint with I. Ortiz), *J. London Math. Soc.* **79** (2009), pp. 309–322.

4. 'Blocking light in compact Riemannian manifolds' (joint with B. Schmidt), *Geom. Topol.* **11** (2007), pgs. 867–887.

5. 'On submanifolds in locally symmetric spaces of non-compact type' (joint with B. Schmidt), *Algebr. Geom. Topol.* **6** (2006), pgs. 2455-2472.

D. Synergistic Activities.

- Guest editor for *Pure Appl. Math. Q.*, Volume **8**, Issues **1** & **2** - the Farrell-Jones special issues.
- Co-organizer of the conference 'Geometry, Topology, and Dynamics in Negative Curvature' (GTDNC), (an official satellite conference to the 2010 ICM), held in Hyderabad, India, August 2-7, 2010.
- Coordinator of the special year in 'Geometric group theory and topology', Ohio State University, 2010-2011.
- Co-editor for the proceedings of the GTDNC conference, co-editor for the proceedings of the OSU special year.
- Co-organized the conference 'Geometry and Topology in Samos', held in Samos, Greece, June 11-15, 2012.

E. Collaborators & Other Affiliations.

Thesis Advisor, Postdoctoral Sponsors: R. Spatzier (Univ. of Michigan), F.T. Farrell (Binghamton Univ.), M. Davis (OSU)
Recent Collaborators: G. Arzhantseva (Univ. Vienna), D. Constantine (Wesleyan Univ.), M. Davis (OSU), F.T. Farrell (Binghamton Univ.), T. Januszkiewicz (Wroclow Univ.), B. McReynolds (Purdue Univ.), A. Minasyan (Univ. Southampton), I. Ortiz (Miami Univ.), C. Pittet (Univ. Marseille), B. Schmidt (Mich. State Univ.), R. Sanchez-Garcia (Univ. Southampton).
Co-editors (not listed above): I. J. Leary (Univ. Southampton), C.S. Aravinda (TIFR - CAM)

College of Arts and Sciences

186 University Hall
230 N. Oval Mall
Columbus, OH 43210

Phone (614) 292-8908
Fax (614) 292-8666

February 15, 2013

Joseph A. Alutto
Executive Vice President and Provost
Office of Academic Affairs
203 Bricker Hall
190 North Oval Mall
Campus

Dear Joe:

The Master of Quantitative Risk Management (MQRM) proposed by the Mathematics Department has the support of the Division ofNatural and Mathematical Sciences ofthe College of Arts and Sciences.

The program is based on the extensive experience that Mathematics has gained its undergraduate actuarial program as well as needs identified by specific employers. The Program Development Plan lays out a well conceived rationale and curriculum.

The MQRM program is an excellent proposed addition to the graduate degree offerings of the university that captures one of the current needs of the insurance and finance industries. As well, it has the potential to produce new revenue for the university.

In recent years, risk management has been playing a more and more important role in all areas of business practice in general, and in insurance and financial institutions in particular. Insurance and Risk Management consulting have been important components of Ohio's economy. There has been an increasing demand for high quality employees in quantitative risk management throughout the state of Ohio and the nation. The mathematics department's proposal is timely to meet this need. The proposed program is innovative and unique in combining financial and actuarial mathematics to provide a new education platform for quantitative risk management that no other higher institutions have had in the state. To my knowledge, this will be the first such program in Ohio, and one of the few in the whole nation.

The mathematics department at OSU has been running a very successful undergraduate program in actuarial science. It has been producing high quality actuaries to consulting firms and insurance companies, and is highly regarded by the business world. With its rich tradition in actuarial education, its wide connection with business, and its experience in running the Master's program in mathematical sciences, I believe that the mathematics department will deliver a very successful program in quantitative risk management.

Sincerely,

Divisional Dean, Natural and Mathematical Sciences
College of Arts and Sciences

FISHER
COLLEGE OF BUSINESS

October 2, 2013

To: Chunseng Ban

From: Karen Hopper Wruck and Ingrid Werner

RE: Letter of support from Fisher College

Thank you for the materials regarding your proposed Master in Actuarial and Quantitative Risk Management. We appreciate you taking the time to share these materials and discuss them with us.

As you are aware, we plan to propose a Specialized Master in Business — Risk Management Track sometime within the next academic year. Our program will target a different student audience and contain very different, but complimentary content and materials.

We concur with the offering of the proposed Master in Actuarial and Quantitative Risk Management with the understanding that we can rely on your timely review and support of our degree as it comes to the proposal stage.

As we discussed in our meetings, should you see opportunities for collaboration between our faculties as our programs develop, please do not hesitate to reach out and we will do the same.

Office of the Dean

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Telephone: 614-292-2666 – Fax: 614-292-7999
fisher.osu.edu

Department of Statistics

404 Cockins Hall
1958 Neil Avenue
Columbus, OH 43210

Tel: (614) 292-2866
Fax: (614) 292-2096
stat.osu.edu

Peter F. Craigmile
Associate Professor
Tel: (614) 292-0291
pfc@stat.osu.edu

September 10, 2013

Department of Mathematics,
Division of Natural and Mathematical Sciences
College of Arts and Sciences

Dear Prof. Chunsheng Ban

The chairs and curriculum committee in the Department of Statistics have looked over your proposal for the Master in Quantitative Risk Management program. We give concurrence for this degree program subject to the following stipulations.

1. We note that Stat 6302 is a statistical theory course and not a probability course. We would be uncomfortable with Mathematics teaching a replacement for this course. Please note that we have designed our Stat 6301/Stat 6302 to be one sequence. The audience is intended primarily for our Masters of Applied Statistics program; the second course requires the first.

2. Currently we can handle about 5 new students a year in Stat 6301/6302. If the numbers in these classes were higher than this, some cost sharing would need to be negotiated so that we can keep up the level of quality teaching for our Masters of Applied Statistics program.

3. The time series course, Stat 6550, is currently taught every second year. Again with appropriate external funding this could be increased to every year.

4. We suggest that Stat 6605 (Applied Survival Analysis), a course concerning the statistical methods appropriate for life analysis, might be appropriate to the study of quantitative risk, and could be considered as an elective.

Sincerely,

P Craigmile

Peter F. Craigmile, Ph.D.
Curriculum Chair, Department of Statistics.

cc: Mark Berliner, Chair, Department of Statistics
cc: Bill Notz and Elizabeth Stansy: Vice chairs, Department of Statistics