NVAO • NETHERLANDS

RESEARCH MASTER BUSINESS DATA SCIENCE (JOINT DEGREE)

Erasmus University Rotterdam, University of Amsterdam, Vrije Universiteit Amsterdam

PANEL REPORT

MARCH 2020

NVAO • NETHERLANDS

RESEARCH MASTER BUSINESS DATA SCIENCE (JOINT DEGREE)

Erasmus University Rotterdam, University of Amsterdam, Vrije Universiteit Amsterdam

LIMITED INITIAL ACCREDITATION PANEL REPORT

MARCH 2020

Contents

1 Executive summary

The Accreditation Organisation of the Netherlands and Flanders (NVAO) received a request for an initial accreditation procedure regarding a proposed Research Master Business Data Science (joint degree research master) at Erasmus University Rotterdam, University of Amsterdam and the Vrije Universiteit Amsterdam. NVAO convened an expert panel, which studied the information available and discussed the proposed programme with representatives of the institution and the programme during a site visit. The following considerations have played an important role in the panel's assessment.

Standard 1. Intended learning outcomes
The English-taught research master Business Data Science is a two-year (120 EC) joint programme, offered by three universities in the Amsterdam-Rotterdam Consortium (ARC: Erasmus University Rotterdam, University of Amsterdam, and the Vrije Universiteit Amsterdam), preparing talented and motivated students to enter high quality PhD programmes in the field of Business and management. The programme combines advanced knowledge of data science methods and techniques with thorough knowledge of scientific theories and models in business economics and business administration. The panel appreciates this innovative combination, because it connects well with developments in academia and practice, both at the national and international level. An additional strength of the intended learning outcomes is that they are very much research oriented and prepare students for an academic career. Overall, the panel considers the programme as very ambitious, with its focus on research, research techniques and related topics, its multidisciplinary and international approach, targeted at future PhD candidates. Three strong partners join forces in this selective research master, aiming for the best candidates and results. The programme meets standard 1.

Standard 2. Teaching-learning environment
The panel is convinced that the programme provides a careful balance between courses on data science and a number of relevant business fields. Specific learning objectives of all courses are evidently linked to the overall intended learning outcomes. Coordination mechanisms within and between courses ensure the coherence of the programme. The programme pays attention also to skills and uses innovative teaching methods, such as the research hackathon and the seminar series, which are a real addition to the programme. The panel agrees with the argumentation of the programme to choose English as its language of instruction.

The technical level of courses is high, which is reflected in the strict admission criteria of the programme. The admission process is careful and will guarantee that the selected student body is highly motivated and qualified. The panel appreciates that the programme takes differences in background knowledge into account, e.g. by offering two levels of econometrics courses. The panel advises to keep track of possible deficiencies in knowledge at the start of the programme, to see if there might be a need for a premaster or more focus on specific skills, such as programming, in the first part of the programme.

The students will benefit from a relatively small-scale programme in an environment that reinforces group building. The programme supports this by providing funding for social activities for students. The number of contact hours is 9.5 per week, which for e.g. in the natural sciences would be relatively low, but is reasonable for a study programme in economics and business studies. Other strong points are the personalised approach to students, including the close monitoring of their progress, and the extensive study facilities. Students constitute half of the programme committee. This committee has an explicit role and in the design stage already gave critical feedback on several aspects of the programme.

The panel is convinced of the high quality of the teaching staff and research environment. All staff members involved are active researchers with a strong reputation. The quality of research of the three partner institutes was assessed as high in the most recent research assessment. This makes the programme very competitive not only at the national but also at the international level. During the site visit the staff's commitment was evident. There is a clear cooperation between different lecturers and a clear coordination between courses. The Director of Graduate Studies has an important role in the

programme and its coordination. The appointment of a deputy director may be useful to pick up issues in the absence of the Director of Graduate Studies. The panel concludes that the programme meets standard 2.

Standard 3. Assessment
The panel considers the system of assessment to be valid, reliable, transparent and with proper checks and balances. The link between learning objectives and assessment methods is clear. The panel appreciates the use of diverse assessment methods. There is a good and compulsory peer review system in place for the construction of exams. Assessment matrices, guidelines and rubrics are useful tools to ensure the quality of assessments and exams. The lecturers confirmed the implementation of these quality control measures. The Examinations Board will regularly check the exams and theses. The level of the exams is appropriate for a research master programme.

The programme management has made a convincing argument that the retake policy benefits the programme. The panel considers the presence of a compensation rule very welcome. As the retake policy could still be problematic for individual cases, the panel recommends to evaluate this policy pro-actively and create a safe environment for students to present their experiences. The programme meets standard 3.

Qualification and field of study
The panel advises to award the degree Master of Science to the research master Business Data Science. The panel supports the programme's preference for the CROHO field of study Economics.

Extension of programme duration
The panel is convinced that the proposed programme is a solid research master, organised in an active research environment by experienced researchers, for a small and highly selected group of students. The panel, therefore, supports the programme's wish for a programme duration of 120 EC and advises the Minister of Education, Culture and Science to grant this request.

The panel comes to the conclusion that the programme meets the standards and advises NVAO to take a positive decision regarding the quality of the proposed programme wo-master Research Master Business Data Science (joint degree) at Erasmus University Rotterdam, University of Amsterdam and the Vrije Universiteit Amsterdam.

The Hague, 30 March 2020

On behalf of the assessment panel convened for the initial limited accreditation assessment of the Research Master Business Data Science (joint degree) at Erasmus University Rotterdam, University of Amsterdam and the Vrije Universiteit Amsterdam,

Prof. dr. dr.h.c.mult. Frank Witlox
(Chair)

dr. Marianne van der Weiden
(Secretary)

2 Introduction

NVAO received a request for an initial accreditation procedure including programme documents regarding a proposed wo-master Research Master Business Data Science (joint degree research master). The request was received on 20 November 2019 from Erasmus University Rotterdam, University of Amsterdam, and the Vrije Universiteit Amsterdam.

An initial accreditation procedure is required when a recognised institution wants to award a recognised bachelor's or master's degree after the successful completion of a study programme. The procedure for initial accreditation is slightly different as compared to the approach for programmes that have already been accredited. Initial accreditation is in fact an ex ante assessment of a programme. The programme becomes subject to the normal accreditation procedures once initial accreditation has been granted.

To assess the programme, the NVAO convened an international panel of experts (see also Annex 1: Composition of the panel). The panel consists of:
Chair
- Prof. dr. dr. h.c.mult. Frank Witlox, senior full professor of Economic Geography at the Department of Geography of Ghent University, Belgium, Doctor honoris causa in Geography at the University of Tartu (Estonia), Doctor honoris causa from the Odessa National Polytechnic University (Ukraine);

Panel members
- Prof. dr. Viola Angelini, associate professor, Department of Economics, Econometrics and Finance, Faculty of Economics and Business, University of Groningen;
- Prof. dr. Stan van Hoesel, full professor Operations research, University Maastricht, member Data Science lectorate Zuyd Hogeschool Heerlen;

Student member
- Lennart van Doremalen MSc, graduated in Experimental Physics at University Utrecht, PhD candidate in Subatomic Physics at University Utrecht.

On behalf of the NVAO, ir. Lineke van Bruggen was responsible for the process-coordination. Dr. Marianne van der Weiden acted as the panel's secretary and drafted the experts' report.

This composition reflects the expertise deemed necessary by NVAO. (Annex 1: Composition of the panel). All panel members and the secretary signed a statement of independence and confidentiality.

The panel has based its assessment on the standards and criteria described in the NVAO Assessment framework for the higher education accreditation system of the Netherlands (Stcrt. 2019, nr 3198).

The panel members prepared the assessment by analysing the documents provided by the institutions (Annex 3: Documents reviewed). The panel organised a preparatory meeting on 12 March 2020. During this meeting, the panel members shared their first impressions and formulated questions for the site visit.

The site visit took place on 13 March 2020 in Amsterdam. During this visit, the panel was able to discuss the formulated questions and to gather additional information during several sessions (Annex 2: Schedule of the site visit). Afterwards, the panel discussed the findings and considerations and pronounced its preliminary assessments per theme and standard. At the end of the site visit, the initial findings were presented to the institutions.

Based on the findings, considerations and conclusions the secretary wrote a draft advisory report that was first presented to the panel members. After the panel members had commented on the draft report, the chair endorsed the report. On 26 March 2020 the advisory report was sent to the lead institution, which was given the opportunity to respond to any factual inaccuracies in the report. The institution replied on 28 March. No corrections were suggested. Subsequently the final report was endorsed by the panel chair. The panel composed its advice fully independently and offered it to NVAO on 30 March 2020.

3 Description of the programme

3.1 General

Country	Netherlands
Institutions	Erasmus Universiteit Rotterdam (lead institution), Universiteit van Amsterdam, Vrije Universiteit Amsterdam
Programme	Business Data Science
Level	master
Orientation	academic (research master)
Specialisations	--
Degree	Master of Science
Location(s)	Amsterdam and Rotterdam
Study Load (EC)	120 EC
Field of Study	Economics (as confirmed by the panel)

3.2 Profile of the institutions

Erasmus Universiteit Rotterdam (EUR) is a young university (its present form dates back to 1973), with a distinct global perspective. It offers a variety of degree programmes in the areas of arts, social sciences, health and life sciences, law and economics. The programmes are concentrated in six faculties. The research master Business Data Science is located in the School of Economics.

Universiteit van Amsterdam (UvA) is a research university, founded in 1632. UvA comprises 5,000 staff and 30,000 students, representing a hundred different nationalities. The university offers academic and research-intensive degree programmes, performs disciplinary and interdisciplinary scientific research and applies the resulting knowledge to relevant societal issues. The research master Business Data Science is part of the Faculty of Economics and Business.

The Vrije Universiteit Amsterdam (VU) was founded in 1880 and offers more than 50 bachelor and 100 master degree programmes in a variety of disciplines. Its teaching and research are organized along four themes: Connected World, Governance for Society, Human Health and Life Science, and Science for Sustainability. The core values of the VU are responsible, open and personally engaged. The research master Business Data Science is offered by the School of Business and Economics.

3.3 Profile of the programme

The English-taught research master Business Data Science is a two-year (120 EC) programme, preparing talented and motivated students to enter high quality PhD programmes in Business. The programme's central focus is on the performance of academic research within business disciplines, such as entrepreneurship and innovation, finance, human resources and organisation, marketing, and logistics and supply chains, applying the possibilities of data science. The availability of big data from a growing range of interconnected, interactive and interoperable devices and the concurrent development of powerful quantitative techniques give rise to new perspectives and paradigms in scientific practice. Utilising the combined knowledge of three top schools enables the programme to train specialists who can extract insights out of big data to solve business-related problems.

The programme combines advanced knowledge of data science methods and techniques, from econometrics, statistics and computer science, with thorough knowledge of scientific theories and models in business economics and business administration. The programme consists of three pillars: acquiring skills, building knowledge and aligning skills and knowledge. The table below presents an overview of the curriculum.

Acquiring skills	Building knowledge	Aligning skills and knowledge
Business data science as the underlying theme of the programme		
Data science foundation (51 EC) - Mathematics, - Statistics - Bayesian Econometrics - Econometrics - Microeconometrics - Time-series - Simulation analysis & Optimization - Causal Inference & Experimentation - Parallel Computing & Big Data - Supervised Machine Learning - Unsupervised Machine Learning - Deep Learning - Natural Language Processing	Business Foundation (26 EC) - Business Foundation - Decision Theory for Business - Seminar Series - Research Hackathon I - 5 electives	Research Practice (43 EC) - Skills Workshops - Research Hackathon II - Research Clinic - Research Master Thesis - Research Assistantships Opportunities
Transferable skills Workshops on Scientific Integrity, Transparent Algorithms, Ethical Data Analysis, Academic Writing and Presentations		

4 Assessment per standard

This chapter presents the evaluation of the standards by the assessment panel. The panel has reproduced the criteria for each standard. For each standard the panel presents (1) a brief outline of its findings based on the programme documents and on documents provided by the institution and the site visit, (2) the considerations the panel has taken into account and (3) the panel's conclusion. The panel presents a conclusion for each of the standards, as well as a final conclusion.

The assessment is based on the standards and criteria described in the NVAO Assessment framework for the higher education accreditation system of the Netherlands (Stcrt. 2019, nr 3198). Fundamental to the assessment is a discussion with peers regarding the content and quality of the new programme.

Regarding each of the standards, the assessment panel gives a substantiated judgement on a three-point scale: meets, does not meet or partially meets the standard. The panel subsequently gives a substantiated final conclusion regarding the quality of the programme, also on a three-point scale: positive, conditionally positive or negative.

4.1 Standard 1: Intended learning outcomes

The intended learning outcomes tie in with the level and orientation of the programme; they are geared to the expectations of the professional field, the discipline, and international requirements.

Outline of findings
The research master Business Data Science prepares talented and motivated students to enter high quality PhD programmes in Business. The multidisciplinary research programme ties the foundations of data science to different business fields and aims to train specialists who can extract insights out of big data to solve business-related problems. Graduating students will write a research thesis that is potentially publishable in one of the internationally peer-reviewed journals in the field. The programme helps students to jumpstart their PhD trajectory through solid research training and direct experience in research through the interaction with faculty and research assistantships opportunities.

The programme has formulated intended learning outcomes in terms of knowledge, skills and attitude and linked these to the Dublin descriptors at master's level. In the area of knowledge, the graduates will have advanced knowledge and broad understanding of quantitative data science research methodology (statistics, econometrics, machine learning, management science) and its key application areas, such as entrepreneurship, finance, human resources, marketing and supply chain analytics. Graduates will also have an understanding of business and management that allows them to follow the scientific debates in these sciences and to successfully embark on independent study in at least one specialised field of research in business or management. Skills are focused on the ability to design and execute original research under academic supervision and to present and defend their research to an audience of academic researchers. In terms of attitude, the emphasis is on scientific integrity and responsibility and the attitude to keep track of developments in their field of interest. During the site visit, the panel heard from the programme committee that its input was used to further strengthen the formulation of the learning outcomes, especially with respect to the academic training.

As a benchmark, the programme compares itself with leading Economic and Business Schools in the USA (MIT Sloan School of Management, University of Massachusetts and Carnegie Mellon Tepper School of Business) and in Switzerland (University of Zurich). In the Netherlands, a few master's programmes educate specialists in data science, but no comparable two-year research master at the intersection of data science, economics and business is currently on offer.

The research master has a Scientific Council, whose members are professors in relevant fields and who are affiliated with one of the three Schools of the Amsterdam-Rotterdam Consortium (ARC). The intended learning outcomes and the curriculum have been developed in close cooperation with this

council and with the Heads of Departments of the three Schools. The ARC also offers the Tinbergen Institute (TI) MPhil in Economics. Parts of the curriculum and the facilities will be shared between the MPhil and the research master in Business Data Science. The three contributing Schools will offer 20 PhD positions annually, specifically intended for graduates of the research master. It is expected that some students will apply to PhD programmes elsewhere.

Another option for graduates is to enter the business community. Representatives of the professional field, consisting of two academics and one business specialist from various fields, met with the panel during the site visit. They confirmed the need for these specialists at PhD level.

Considerations
The panel is convinced that the research master in Business Data Science is a strong programme. The learning outcomes combine data science with applications to the business environment, while other master programmes tend to deal with either one of the two elements. This combination is innovative and connects well with developments in academia and practice, both at the national and international level.

There seems to be a clear demand for graduates of this programme. Several PhD positions will be available at the three universities and, in addition, the industry sector is expected to fund a number of PhD positions. The panel appreciates that the research master thinks beyond the PhD stage, aiming to prepare strong candidates for a future as assistant professors, which shows the programme's high ambitions.

The link with the Dublin descriptors at master level convincingly shows that the intended learning outcomes are formulated at the appropriate level. The learning outcomes are very much research oriented and well prepare students for an academic career as a business data scientist. There is a clear connection between the learning goals of each course and those of the programme. It is clear that the formulation of the learning outcomes has been taken seriously and that many have contributed to the process.

Overall, the panel considers the programme as very ambitious, with its focus on research, research techniques and related topics, its multidisciplinary and international approach, targeted at future PhD candidates. Three strong partners join forces in this highly selective research master, aiming for the best candidates and results.

Conclusion
The programme meets standard 1.

4.2 Standard 2: Teaching-learning environment

The curriculum, the teaching-learning environment and the quality of the teaching staff enable the incoming students to achieve the intended learning outcomes.

Outline of findings
<u>Curriculum structure and content</u>
The research master in Business Data Science is a two-year programme, consisting of 120 EC. The programme is designed around three pillars:
(1) acquiring skills: building a solid data science foundation and exposing students to a variety of methodological approaches,
(2) building knowledge in business science and a particular sub-discipline,
(3) aligning skills and knowledge in research practice.

Year 1 starts with an overview of the business problems that data science can address, and then focuses on the primary objective of the first year, i.e. to build a solid data science foundation and expose students to a variety of methodological approaches. In year 2, students focus on a given business sub-

discipline. Options are: (1) quantitative finance, (2) management science (consisting of entrepreneurship and innovation, marketing science, human resources and organisation) and (3) supply chain analytics. First year students will address problems in all business fields, while second year students will focus on addressing the problems linked to their field of interest in the field courses. In the research clinic, research hackathon and master thesis, students will integrate business and data science and show that they are able to identify relevant problems and address these issues using cutting-edge techniques. Prior to the site visit, the panel received the course manuals (including assessment details) for all first year courses and most of the second year courses. During the site visit, these were also made available in print, together with the handbooks used in the various courses.

The information dossier contains a table, indicating the connection between the programme's intended learning outcomes and the various curriculum components. The ARC Educational Board and the Director of Graduate Studies will safeguard the coherence between the various curriculum components in various ways: through faculty meetings, by discussing the course content, learning objectives and assessment with the individual lecture before the start of a course, by organising course and programme evaluations with the students, by providing templates for course manuals and assessment methods and by providing assessment guidelines. During the site visit, the members of the lecturer team confirmed that they share course materials and exchange experiences both within (co-teaching) and across courses in order to increase the substantive cohesion within the programme.

A limited number of the courses are existing courses of the TI MPhil programme: the courses on econometrics, programming, mathematics and statistics in year 1, and the course on Bayesian econometrics and the field specific courses in Quantitative finance in year 2. The lecturers assured the panel that these will be geared to Business Data Science students, both by offering different levels of courses in econometrics (regular and advanced), and by bringing in a broader set of examples as an illustration. The technical level will be the same, but applications will be different.

Teaching methods

The teaching methods aim at activating students as much as possible, as described in the information dossier. Most courses will be taught in a mixed format, combining lectures with tutorials. Tutorials will focus on exercises, on the application of theory discussed in the lectures, and on practicing skills, and therefore require active student participation. During a course, students will work on assignments. Students are stimulated to explore their research interests and options throughout the programme. They can choose out of several electives to tailor the curriculum to their interest. They select a research topic of their choice and solicit potential supervisors.

A number of special courses aims to help students to get a comprehensive view on research in business data science. In the seminar series, the research groups at the three faculties are introduced and scholars relate ongoing research projects in their research groups. After having attended all seminars in the series, students select a research topic, write a research proposal and discuss the proposal with a professor. In the research hackathon (partly in year 1 and partly in year 2), students will analyse big data sets from scholars and companies and identify possible solutions with the help of specialised second-year research master students or PhD students. This course will make students think about how to approach the problems that arise in the various disciplines and allow them to put their knowledge to the test and apply it to different fields. While during the first year, they will focus on different business problems, second-year students will dedicate their attention to the assignments related to their field of interest. The research clinic is designed to stimulate students to generate new research ideas drawing from the existing literature. A series of workshops provides students with an overview of (1) scientific integrity, transparent algorithm and ethical data management issues, (2) the review process, (3) grant application procedures, and (4) academic presentations.

On average, students will have 9.5 contact hours per week per block. Based on the experience with the neighbouring TI MPhil programme in Economics, the programme management expects that students will be at the premises almost fulltime and will use the chance to approach lecturers in the corridors. Given the limited admission to the programme (see below), classes will usually be small: the maximum staff-student ratio will be 1:30. A minimum of five students is required for a field course to be actually

taught. Some field-specific courses are open for qualified external students as well, e.g. of the TI MPhil in Economics, which means that those classes may be larger.

The language of instruction in the research master is English. The argumentation for this choice is the international orientation of the course content and research projects, the working environment at the Schools involved and the labour market for which the students are prepared: PhD candidates write their thesis in English and publish in international journals.

Admission

Admission to the research master is selective. A maximum of 30 students will be admitted each year. Selection is aimed at ensuring a high-quality, small-scale programme. Admission is determined by an Admissions Board, consisting of research fellows affiliated with the participating Schools and chaired by the Director of Graduate Studies. Eligible candidates must have a bachelor's degree, preferably in econometrics, operations research or data science. International applicants must submit valid GMAT and/or GRE results (minimum GMAT score 700, GRE Quantitative score 160). Students whose native language is not English must demonstrate an excellent command of English, through a degree from a Dutch university or an institution at which English is the language of instruction, or through sufficiently high scores on a recognised proficiency test (TOEFL or IELTS). The candidates' motivation is assessed on the basis of a written letter of intent, including a research proposal. Further, candidates are requested to submit a writing sample (optional), such as a bachelor's or master's thesis, two letters of recommendation and a curriculum vitae with their passport. The Director of Graduate Studies interviews all candidates selected by the Admissions Board for a final screening.

Staff

The teaching faculty assigned to the research master Business Data Science consists of faculty members of the three participating universities (EUR, UvA and VU). The curricula vitae provided in the information dossier, present an overview of their academic experience in the fields of data science and/or business and economics. Assistant professors usually co-teach with a senior faculty member. All staff members involved have a PhD and a university teaching qualification (BKO basiskwalificatie onderwijs). All lecturers are experienced in teaching in English and have a strong international, scientific orientation. Lecturers employed at EUR and VU must have a C1 level of English, based on the Common European Framework of Reference for Languages. Many members have obtained the Cambridge Proficiency in English qualification.

Research environment

In 2015, the research output of the three Schools was assessed by an international committee. The committee report was attached to the information dossier. The average grade awarded for quality, societal relevance and viability of almost all research groups involved in the research master Business Data Science was 4 (very good) on a scale of 1-5. Evidence of the active research environment at the three Schools is provided on the individual university websites and ARC research data are presented in its annual report. The information dossier contains the annual report of the Tinbergen Institute 2018 and an overview of research seminars and workshops, organised in 2019.

The programme aims at maximising the students' exposure to and interaction with a thriving research environment. ARC organises a range of research seminars, workshops and conferences. Students are encouraged to engage in these activities and make contact with the various research groups and individual researchers to explore research options. For first year students, attendance at the seminar series on current research topics is even mandatory.

Facilities

Most classes will be organised at the ARC venue in Amsterdam (Zuidas) with assigned classrooms, student work places and IT facilities. Opening hours are from 7 AM to 11 PM. The dossier mentions that some classes will be offered at the Woudestein campus at EUR in Rotterdam, also providing good facilities. ARC reimburses travel costs for coursework and provides selected students with scholarships. Students are assisted with immigration procedures and housing. ARC will (financially) support a social programme for students, to be organised by the student council, in order to enhance the social cohesion

among students. Students will be actively involved in the programme's quality assurance by their representation in the Programme Committee. This committee will be a joint committee, shared with the TI MPhil programme.

The small scale of the programme allows intensive counselling and monitoring of the individual students by the Director of Graduate Studies. All first-year students will have an intake interview with her, followed by further meetings halfway through the first academic year and at the end of the academic year, to discuss the student's progress. The Director will monitor if students are able to find a supervisor by December 1 of the second year, and assist them if necessary. Access to study advisors, study counsellors and university psychologists is available at all three universities.

Considerations
On the basis of the documentation and the site visit, the panel is convinced that the research master programme in Business Data Science provides a careful balance between courses on data science and a number of relevant business fields. Specific learning objectives of all courses are evidently linked to the overall intended learning outcomes. Coordination mechanisms within and between courses ensure the coherence of the programme. The programme pays attention also to skills and uses innovative teaching methods, such as the research hackathon and the seminar series, which are a real addition to the programme. Working on assignments during the courses will give students the opportunity to actively develop their research skills. The panel agrees with the argumentation of the programme to choose English as its language of instruction. In order to further improve the programme, the panel advises to monitor the contents of individual courses and their contribution to the programme, e.g. Parallel computing and Supply chain analytics.

The technical level of courses is high, which is reflected in the strict admission criteria of the programme. The admission process is careful and will guarantee that the selected student body is highly motivated and qualified. Applicants may send in a thesis or other writing sample. The entry requirements state that this sample should be in English. The panel wonders if this will put students from a Dutch-taught bachelor programme at a disadvantage and advises to clarify the purpose of the sample (English proficiency or academic writing skills) or to consider also accepting a Dutch thesis / writing sample. The panel appreciates that the programme takes differences in background knowledge into account, e.g. by offering two levels of econometrics courses. The panel advises to keep track of possible issues in knowledge at the start of the programme, to see if there might be a need for a premaster or more focus on specific skills, such as programming, in the first part of the programme.

The students will benefit from a relatively small-scale programme in an environment that reinforces group building. The programme supports this by providing funding for social activities for students. The number of contact hours would for some sectors be relatively low, but is reasonable for a study programme in economics and business studies. The number of contact hours is reasonable. The opportunity to choose courses in the second year and the option to choose courses outside of the programme make the programme student-centered. Other strong points are the personalised approach to students, including the close monitoring of their progress, and the extensive study facilities. Students constitute half of the programme committee. This committee has an explicit role and in the design stage already gave critical feedback on several aspects of the programme.

The panel is convinced of the high quality of the teaching staff and research environment. All staff members involved are active researchers with a strong reputation. The quality of research of the three partner institutes was assessed as high in the most recent research assessment. This makes the programme very competitive not only at the national but also at the international level. During the site visit the staff's commitment was evident. There is a clear cooperation between different lecturers and a clear coordination between courses.

The Director of Graduate Studies has an important role in the programme. The panel appreciates this as a strong point, both in ensuring the programme's coherence and in monitoring the students' progress and welfare. The panel was reassured that the scientific council is available to support in decision making and can temporarily handle the Director's absence. The appointment of a deputy director may

be useful as well in order to make explicit who will pick up issues in the absence of the Director of Graduate Studies.

Summarising, the panel considers the research master in Business Data Science a well-balanced programme, with an impressive and committed teaching team in a strong research environment. Students are selected on the basis of a careful admission procedure and have ample opportunities to develop their research skills in a student-centered programme.

Conclusion
The programme meets standard 2.

4.3 Standard 3: Assessment

The programme has an adequate system of student assessment in place.

Outline of findings
Assessment policy
The information dossier describes the institutional framework for assessments. Educational principles underlying the assessment policy are constructive alignment (assessment is to be consistent with the objectives of the course and the learning outcomes of the programme), the use of tutorials to discuss exercises and assignments to support the learning process, graded homework assignments in all core courses and the choice of intense examination, without scheduled retakes. Assessments are governed by the requirements set out in the Teaching and Examination Regulations (TER). The Assessment plan describes how the quality of assessments (validity, reliability and transparency) will be ensured and monitored.

Requirements are set of all aspects of examination of core courses, such as peer review, an answer model, assessment rubrics, course blueprint, examiner availability during written sit-in exams, and the responsibilities of teaching assistants. Validity and reliability of assessments are ensured by the use of assessment matrices and rubrics, test blueprints and peer review. Lecturers are required to use peer review when constructing examinations, to make sure that the formulated questions are clear and unambiguous. Guidelines for the assessments and exams are provided by the Director of Graduate Studies. The Study guide provides concise information to the students about the courses, including the assessment, while students can find more detail in the course manuals. This information is monitored and approved upfront by the Director of Graduate Studies. The Examinations Board monitors the consistent application of the requirements across courses and evaluates the quality of assessments (see below). Exams are marked within fifteen workdays and students can inspect their graded work, the assignments and the standard applied for marking within 28 days after results are released.

During the site visit, the panel discussed the programme's choice to not allow retakes within an academic year. The panel wondered if this policy would lead to a lower level (in order to avoid any failures in a course) or, if this would not be the case, to undue high stress levels among students who cannot afford to fail. In response to this concern, the lecturers referred to the compensation rule, included in the TER. This rule means that student may compensate up to three grades of 5 in a core course with a 7.5 or higher obtained in other (related) core courses. One 5 may be compensated in course sequence A (comprising courses related to mathematics, statistics and econometrics), and up to two 5's in course sequence B (most other theoretical core courses). The compensation rule applies across years, except for students who have not earned at least 48 EC of first year's credits by August 1 of the first year and/or have not completed the seminar series. In case of exceptional circumstances, e.g. verifiable illness of a student, the Examinations Board will grant a retake during the same academic year. During the conversation with the lecturers the panel was informed that the retake policy is similar to the one at the TI and has been the subject of extensive discussions among staff and with students. The advantage for students is that they can start a new block with a clean slate, without concerns about retakes. The programme management is aware of the risk of work stress and is planning to systematically evaluate the retake policy with the students and, if necessary, adjust it.

Assessment methods

The Assessment plan clarifies how the programme enables students to achieve the intended learning outcomes and how this will be assessed. For each course, a set of learning objectives has been established. The assessment is designed to test whether or not the student has achieved those learning outcomes. Assessment matrices are drawn up for each course, showing the relationship between the learning outcomes and the method of assessment. These matrices and draft exams were available for the panel before and during the site visit.

Depending on the content and objectives of a course, one or more types of assessment are used, such as assignments, mid-term tests, written examinations and oral examinations. All examinations use open questions. Assignments may include data analysis exercises, presentations, the writing of papers and group discussions. The Assessment plan describes the types of assessment used in the programme and their relative weights in the grade for each course.

The thesis is the final examination of the research master and is meant to provide evidence that the student has achieved the programme's learning objectives. In the information dossier, the thesis is described as an integrative assessment in which students integrate all learning outcomes. The grading guidelines are, therefore, a reflection of the programme's learning goals. The thesis is evaluated on the basis of choice of research topic and scientific approach, knowledge of the subject area, application of research methods and techniques, contribution to the field, reporting style, oral presentation and defence of the thesis. Students must defend the thesis before a committee in a public meeting. The committee consists of the supervisor(s) and at least two other committee members, who were not involved in the supervision. As a rule, at least one member will be affiliated with a different university or School from that of the thesis supervisor. The two committee members who were not involved in the supervision decide upon the final grade, based on the paper itself, the process as reported by the supervisor and the presentation and defence of the thesis. Each thesis is checked for plagiarism before the assessment takes place. The Thesis manual and Thesis evaluation form were available for the panel. During the site visit, the panel was provided with a few examples of TI MPhil theses, including assessment forms.

Examinations Board

The Examinations Board will be a shared board for the TI MPhil and the research master Business Data Science. The Board consists of four members: one member of each participating School and an external member, who is a specialist in the field of assessment. At least one of the three members is an expert in the field of Business Data Science. The Examinations Board monitors the quality of the assessments by evaluating the passing and failing percentages of each exam, deviations in the drop-out rate of a course, outcomes of student evaluations and a survey among recent graduates. In addition, the Board reviews a sample of graded exams four times per year and a sample of graded theses once per year. For this exercise, the Board reviews a complete course file (course description, learning goals, course syllabus, test including the answer model, and students' work) and uses a checklist to review the validity of the exam. During the site visit, the panel met with the chair of the Examinations Board who explained its procedures.

Considerations

The panel considers the system of assessment to be valid, reliable, transparent and with proper checks and balances. The link between learning objectives and assessment methods is clear. The panel appreciates the use of diverse assessment methods. There is a good and compulsory peer review system in place for the construction of exams. Assessment matrices, guidelines and rubrics are useful tools to ensure the quality of assessments and exams. The lecturers confirmed the implementation of these quality control measures. The Examinations Board will regularly check the exams and theses. The level of the exams is appropriate for a research master programme.

The programme management has made a convincing argument that the retake policy benefits the programme. The panel considers the presence of a compensation rule very welcome. As the retake

policy could still be problematic for individual cases, the panel recommends to evaluate this policy pro-actively and create a safe environment for students to present their experiences.

Conclusion
The programme meets standard 3.

4.4 Qualification and field of study (CROHO)

The panel advises to award the degree Master of Science (joint degree) to the research master Business Data Science. The panel supports the programme's preference for the CROHO field of study Economics.

4.5 Extension of programme duration

The institutions that are responsible for the proposed research master Business Data Science maintain that a two-year programme, consisting of 120 EC, is necessary to achieve the intended learning outcomes. Students must acquire advanced knowledge in (a sub-discipline of) business data science and build up a thorough research experience, by experiencing and working through the full research cycle during the programme. The quality of research of the three partner institutes was assessed as high in the most recent research assessment (2015). The panel is convinced that the proposed programme is a solid research master, organised in an active research environment by experienced researchers, for a small and highly selected group of students. The panel, therefore, supports the programme's wish for a programme duration of 120 EC and advises the Minister of Education, Culture and Science to grant this request.

4.6 Conclusion

Overall, the research master Business Data Science is a strong programme, well linked to the current development in business academia and practice. The list of academics involved is impressive and the lecturer team is highly committed. The intake procedure will ensure a strong and motivated student body. The programme is well-coordinated and student-centered. The assessment system is thorough and meets the quality criteria. All standards are met. The panel assesses the quality of the programme as positive.

4.7 Recommendations

From the start of the programme, the panel advises to monitor and evaluate
- the contribution of individual courses to the overall programme objectives;
- possible deficiencies in students' knowledge at the start of the programme;
- the retake policy and its effect on individual students.

Given the central role of the Director of Graduate Studies, the appointment of a deputy director may be useful in order to make explicit who will pick up issues in the absence of the Director.

5 Overview of the assessments

Standard	Assessment
Intended Learning outcomes *Standard 1: The intended learning outcomes tie in with the level and orientation of the programme; they are geared to the expectations of the professional field, the discipline, and international requirements*	Meets the standard
Teaching-learning environment *Standard 2: The curriculum, the teaching-learning environment and the quality of the teaching staff enable the incoming students to achieve the intended learning outcomes.*	Meets the standard
Student assessment *Standard 3: The programme has an adequate system of student assessment in place.*	Meets the standard
Achieved learning outcomes *Standard 4: The programme demonstrates that the intended learning outcomes are achieved..*	Not applicable
Conclusion	Positive

Appendix 1: Composition of the panel

Chair

- Prof. dr. dr.h.c.mult. Frank Witlox is senior full professor of Economic Geography at the Department of Geography of Ghent University, Belgium. He holds a PhD in Urban Planning (Eindhoven University of Technology), a Master's Degree in Applied Economics and a Master's Degree in Maritime Sciences (both University of Antwerp). He is also a Visiting Professor at the Faculty of Science and Technology (Department of Geography) of the University of Tartu (Estonia), and is the International Head of the Mobility Lab. As of April 2017 he is also an appointed Visiting Professor/High-end Foreign Expert at the Nanjing University of Aeronautics and Astronautics (NUAA, China), College of Civil Aviation, and since September 2018 a 100 Talents Program laureate of Jiangsu Province. Since 2019, he is a Visiting Professor at the Gran Sasso Science Institute (GSSI) – School of Advanced Studies in Social Sciences (L'Aquila, Italy). In 2018 he was conferred an honorary doctorate (Doctor honoris causa) in Geography at the University of Tartu (Estonia). In 2020 he received the same honors (Doctor honoris causa) from the Odessa National Polytechnic University (Ukraine).

Member

- Prof. dr. Viola Angelini is Tenure Track Professor (adjunct hoogleraar) at the Department of Economics, Econometrics and Finance, Faculty of Economics and Business of the University of Groningen. She is also Program Director of the MSc Finance and the MSc International Financial Management at the same university. In 2008 she obtained a joint Ph.D. in Economics from the Universities of York and Padua. She maintains a large network of national and international collaborations: she is Research Fellow of the Network for Studies on Pensions, Ageing and Retirement (Netspar), Affiliated Researcher of the Netherlands Interdisciplinary Demographic Institute (NIDI), External Affiliate of the Health Econometrics and Data Group (HEDG) of the University of York and Research fellow of the Center for Research on Pensions and Welfare Policies (CeRP) of the University of Turin.

Member

- Prof. dr. ir. Stan van Hoesel, full professor Operations research, University Maastricht, member Data Science lectorate Zuyd Hogeschool Heerlen. He studied discrete mathematics at Eindhoven University of Technology, and obtained a PhD in operations research at Erasmus University Rotterdam in 1991. His research focuses on applying combinatorial optimization models with data mining techniques on logistics problems from industry. He was co-founder of the master Global Supply Chain Management in Venlo, he started the track Business Intelligence in the master IB at the school of business and economics from Maastricht University, and he was involved in the set-up of the Business Intelligence and Smart Services institute in Heerlen.

Student member

- Lennart van Doremalen MSc, graduated in Experimental Physics at University Utrecht, PhD candidate in Subatomic Physics at University Utrecht. During his studies, he was co-founder of the student party Lijst Helder and student representative for this party in UU's University Council. From 2009 until 2010, he was the student board member of the Department of Physics. In 2012, he organised the International Conference of Physics Students (ICPS) in collaboration with fellow students. In addition, Lennart was an active member of the national student union LSVb, the local student union VIDIUS, and fulfilled several functions as board member or advisor next to his studies. He is also co-founder of the Utrecht municipality council party Student & Starter.

Process coordinator
Ir. Lineke van Bruggen, NVAO

Secretary
Dr. Marianne van der Weiden.

Appendix 2: Schedule of the site visit

The panel visited Erasmus Universiteit Rotterdam, Universiteit van Amsterdam and the Vrije Universiteit Amsterdam on 13 March 2020 as part of the external assessment procedure regarding the wo-master Research Master Business Data Science (joint degree).

09.00 – 09:30	Short deliberation NVAO panel (confidential)
09:30 – 10:30	Representatives from management
10:30 – 11:30	Lecturer team
11:45 – 12:15	Representatives of the Examination Board and Programme Committee
12:15 – 13:15	Panel meeting during lunch (confidential)
13.15 – 13:35	Representatives from the professional field
13:35 – 14:15	Panel meeting (confidential)
14.15	Presentation of initial findings

Appendix 3: Documents reviewed

Programme documents presented by the institution

- Information dossier
- Appendices to the information dossier:
  - Macro-efficiency application file and positive decision
  - Amsterdam-Rotterdam Consortium agreement
  - Partnership agreement Research Master Business Data Science
  - Biographies of the Director of Graduate Studies, members of the Scientific Council and faculty of the research master
  - Study Guide 2020-2021
  - Teaching and Examination Regulations 2020-2021
  - Assessment Plan
    - Example of course manuals
    - Assessment rubrics
    - Test blueprints
    - Assessment criteria
    - Exam tips
    - Example of exams and answer models
    - Course manual of the research master thesis
  - Evidence to the active research environment within the Schools of EUR, UvA and VU
- Documents made available during the site visit
  - Handbooks
  - Course materials year 1
  - Annual report Programme Committee 2018-2019
  - Annual report ARC Examination board 2018-2019
  - Interim programme assessment Tinbergen Institute (TI) 2018
  - Thesis assessment forms TI 2017-2019 + assessment evaluations 2018-2019
  - Course evaluations TI 2018-2019

Appendix 4: List of abbreviations

ARC	Amsterdam-Rotterdam Consortium
Ba	bachelor's degree
EC	European credit point
EUR	Erasmus University Rotterdam
hbo	professional higher education
Ma	master's degree
NVAO	Accreditation Organisation of the Netherlands and Flanders
TER	Teaching and Examination Regulations
TI	Tinbergen Institute
UvA	University of Amsterdam
VU	Vrije Universiteit Amsterdam
wo	Academic orientation

The panel report was ordered by NVAO for the initial accreditation of the programme Research Master Business Data Science (joint degree) of Erasmus University Rotterdam (lead institution), University of Amsterdam and Vrije Universiteit Amsterdam

Application no.: 009126

NVAO

Nederlands-Vlaamse Accreditatieorganisatie
Accreditation Organisation of the Netherlands and Flanders

Parkstraat 28 • 2514 JK Den Haag
P.O. Box 85498 • 2508 CD The Hague
The Netherlands

T +31 (0)70 312 23 00
E info@nvao.net
www.nvao.net