NATIONAL RESEARCH UNIVERSITY HIGHER SCHOOL OF ECONOMICS

Course Syllabus for Measurement of Science, Technology and Innovation

Approved by

Academic Council

of the Master's Programme

Minutes AC2

Developer	Konstantin Fursov Candidate of Sciences (PhD), Associate Professor, Leading Research Fellow, Institute for Statistical Studies and Economics of Knowledge
No. of credits	6
Contact hours	64
Independent study (hours)	164
Year of study, degree programme	Master's programme "Governance of Science, Technology and Innovation" 1st year, 3rd module, compulsory
Study format	No use of on-line courses

1. Course Description

Abstract

Decision-making in the science, technology and innovation (STI) domain requires evidence expressed in various indicators for measuring key aspects of generation and dissemination of new scientific and technical knowledge for innovation development and sustainable economic growth. Understanding of such indicators is important to explain how national STI systems are functioning to provide evidence for better policies and informed decision-making. The course introduces the basic approaches and methodologies to design measurement concepts, elaboration of indicators, approaches to data collection and interpretation of the results. Focus is made on the international standards and best national practices of STI measurement. Such include analysis of R&D inputs and outputs, technological and non-technological innovation, scientometrics, analysis of patent data, etc. Moreover, the course is complemented with a review of recent initiatives in indicator development and vision of the future development of STI studies.

The course is delivered to the first-year master students of the Master Program 'Governance of Science, Technology and Innovation' at the National Research University Higher School of Economics (HSE). The course length is 228 academic hours of which 64 hours are classroom hours for lectures and seminars and 164 hours are devoted to self-study. Academic control forms are two home works, a mid-term test, and a written exam. The course contains six sections, which are mutually exclusive but collectively exhaustive to cover the subject.

Pre-requisites

No pre-requisites

2. Learning Objectives

- Provision students with basic knowledge on international standards, methodology and best practices of STI statistics
- Developing skills of collection and interpretation of policy-relevant data for evidence-based decision-making
- Training analytical and critical thinking skills

3. Learning outcomes (competencies)

- Knowledge of international standards in STI statistics and its domains
- Knowledge of approaches used for collection of statistical data on STI
- Ability to select relevant data sources and construct main STI indicators
- Skills for choosing appropriate data sources and indicators for analysis of STI development and use these results for policy advice
- Skills to make effective searches in citation and patent databases

4. Course Plan

The course spans one academic module. The teaching is based on selected writings and experiences of faculty members. In addition, selected reputed scholars and experts are invited bringing together views from different perspectives on the meaning of statistical indicators for science, technology and innovation to provide in-depth learning opportunities for all students.

Lectures

Lectures are designed to deliver theoretical frameworks and international experiences. The course is accompanied by seminars, some sessions will feature additional foreign experts.

Seminars

Accompanying seminars introduce and develop new skills of using different sources of information and tools for constructing statistical indicators, data analysis and interpretation.

Seminars consist of practical sessions, group tasks and short presentations on the issues considered in the course or master-classes that will provide students indispensable skills for measuring science, technology and innovation issues.

During seminars, students will learn how to construct indicators, make effective searches in citation and patent databases, and give interpretation to the measurement results. In addition, they will learn about different sources of statistical information used in STI studies.

Reading List

Literature recommended for reading is assigned to the course topics presented in the Course Contents below.

Table 1 – Thematic Plan and Assessment Formats

Section	Topic	Total	Lectures	Seminars	Self-study	Expected learning outcomes (ELO) to be assessed	Assessment formats
Introduction	An overview of STI statistics and indicators	12	2	2	8	– Knowledge of international standards in STI statistics	N/A
R&D statistics	R&D statistics	24	4	4	16	– Knowledge of conventional approaches used for collection and interpretation of statistical data on R&D – Ability to select relevant data sources, construct and analyze main R&D indicators	– A quiz-test – Group task and presentation of results – Home Assignment (a mini-essay around 1000 words answering the question asked)
	Measurement of human resources in science and technology	14	2	2	10		
Scientometrics	Measurement of R&D outputs	14	2	2	10	– Knowledge of conventional approaches used for collection and interpretation of data on publications and patents – Skills to make effective searches in citation and patent databases – Ability to construct and interpret bibliometric and patent indicators	
	Basics of bibliometric indicators	24	2	2	20		
	Indicators of intellectual property rights	24	2	2	20		
Mid-term test		12	0	2	10	All above (Sections 1 to 3)	A 60-minute written task
Technology statistics	Statistics on technology	14	2	2	10	– Knowledge of international conventions and recommendations for collection and interpretation of data on technology development – Skills for choosing appropriate data sources and indicators for analysis of Digital Economy, technology intensity and international exchange	– A quiz-test – Group task and presentation of results – Home Assignment (a mini-essay around 1000 words answering the question asked)
	Measuring Digital Economy	14	2	2	10		
	Measurement of technology intensity and international trade	24	4	4	16		
Innovation statistics	Innovation statistics	24	4	4	16	– Knowledge of conventional approaches used for collection and interpretation of statistical data on innovation – Ability to select relevant data sources, construct and analyze main innovation indicators	
	New areas for innovation measurement	14	2	2	10		
Practical applications	Interpretation of statistical data	14	2	2	10	– Skills for choosing appropriate data sources and indicators for analysis of STI development and use these results for policy advice	
Total		**228**	**32**	**32**	**164**		

Course Contents

1. An overview of STI statistics and indicators

Statistical studies of STI are based on the complex approach to the measurement of components that constitute national systems of knowledge production and innovation development in accordance with their role in the economy. The lecture introduces the scope and history of STI measurement; it draws a line around its basic principles and international standards in the field and provides links to other areas of statistics.

- The basics: national innovation system, linear/non-linear model of innovation, R&D
- Scope of STI statistics (e.g. types of STI activities)
- History of STI statistics
- Basic principles of STI measurement
- International standards for STI statistics
- STI within the framework of general statistics

Basic literature:

Gault, F. (ed.) (2013). Handbook of Innovation Indicators and Measurement. Cheltenham, UK: Edward Elgar.
URL: https://www.elgaronline.com/view/9780857933645.xml (accessed 21.08.2019).

B. Godin (2009). The Making of Science, Technology and Innovation Policy: Conceptual Frameworks as Narratives, 1945-2005. Montreal: Centre – Urbanisation Culture Société de l'Institut national de la recherche scientifique.
URL: http://www.csiic.ca/PDF/TheMakingOfScience.pdf (accessed 21.08.2019).

Godin, B. (2006). The linear model of innovation: The historical construction of an analytical framework. Science Technology and Human Values, 31(6), 639–667.
URL: https://doi.org/10.1177/0162243906291865 (accessed 21.08.2019).

Additional literature:

Godin, B. (2006). Measurement and Statistics on Science and Technology: 1920 to the Present. London: Routledge.

Gokhberg, L. (2002). Science and technology indicators in Russia and the European Union. Luxembourg: Eurostat.

2. R&D statistics

The internationally recognized methodology for collecting and using R&D statistics, the Frascati Manual is a widely accepted essential tool for statisticians worldwide. It includes definitions of basic concepts, data collection guidelines, and classifications for compiling statistics. The lecture introduces basic guidelines for measurement of R&D provided in the FM and implementation of the introduced principles at national and international levels.

- Measurement needs and methodological framework
- OECD Frascati Manual
- Basic definitions and conventions
- Classifications
- R&D personnel

- R&D expenditure
- National and international R&D surveys

Basic literature:

OECD (2015). Frascati Manual: Guidelines for Collecting and Reporting Data on Research and Experimental Development. Paris, OECD.
URL: https://read.oecd-ilibrary.org/science-and-technology/frascati-manual-2015_9789264239012-en# (accessed 21.08.2019).

OECD (2017). OECD Science, Technology and Industry Scoreboard 2017: The Digital Transformation. OECD Publishing.
URL: https://read.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-scoreboard-2017_9789264268821-en#page1 (accessed 21.08.2019).

OECD Main Science and Technology Indicators Database. Paris, OECD.
URL: https://www.oecd-ilibrary.org/science-and-technology/data/oecd-science-technology-and-r-d-statistics_strd-data-en (accessed 21.08.2019).

Additional literature:

Gokhberg, L. (2002). Science and technology indicators in Russia and the European Union. Luxembourg: Eurostat.

UNESCO (2015). *UNESCO Science Report: Towards 2030*. UNESCO Publishing.
URL: http://unesdoc.unesco.org/images/0023/002354/235406e.pdf (accessed 21.08.2019).

3. Measurement of human resources in science and technology

With the recognition of S&T as an important source of innovation and growth, the need to ensure the adequate supply and career management of R&D and other categories of personnel engaged in scientific performance became one of the key points in the organization of national research systems. The lecture provides an overview of different methodological frameworks that are at hand to help produce relevant sets of data on stock and flows of human resources in science and technology (HRST) as well as indicators on their demographic, career, mobility or skill characteristics.

- Definitions and classifications
- Measuring stock and flows of HRST
- International surveys on careers and mobility of doctorate holders
- Measuring skills for innovation

Basic literature:

OECD (2015). Frascati Manual: Guidelines for Collecting and Reporting Data on Research and Experimental Development. Paris, OECD.
URL: https://read.oecd-ilibrary.org/science-and-technology/frascati-manual-2015_9789264239012-en# (accessed 21.08.2019).

OECD/Eurostat (1995). Measurement of Scientific and Technological Activities: Manual on the Measurement of Human Resources Devoted to S&T – Canberra Manual. OECD Publishing.
URL: https://doi.org/10.1787/9789264065581-en (21.08.2019).

Gokhberg, L., Shmatko, N.A., Auriol, L. (2016). The Science and Technology Labor Force: The Value of Doctorate Holders and Development of Professional Careers. Springer

International Publishing, Switzerland.
URL: https://link.springer.com/book/10.1007/978-3-319-27210-8 (accessed 21.08.2019).

Additional literature:

Auriol, L., M. Misu and R. Freeman (2013). Careers of Doctorate Holders: Analysis of Labour Market and Mobility Indicators. OECD Science, Technology and Industry Working Papers, No. 2013/04, OECD Publishing, Paris.
URL: https://doi.org/10.1787/5k43nxgs289w-en (accessed 21.08.2019).

Auriol, L., M. Schaaper and B. Felix (2012). Mapping Careers and Mobility of Doctorate Holders: Draft Guidelines, Model Questionnaire and Indicators – Third Edition. OECD Science, Technology and Industry Working Papers, No. 2012/07, OECD Publishing.
URL: https://search.proquest.com/openview/5edb4bc09880c6bcbf735030a7c3c5f6/1?pq-origsite=gscholar&cbl=54496 (accessed 21.08.2019).

Auriol, L. (2010). Careers of Doctorate Holders: Employment and Mobility Patterns. OECD Science, Technology and Industry Working Papers, No. 2010/04, OECD Publishing.
URL: https://www.oecd-ilibrary.org/docserver/5kmh8phxvvf5-en.pdf?expires=1548513008&id=id&accname=guest&checksum=BEA280BDE407F9F860178D133B96198C (accessed 21.08.2019).

4. Measurement of R&D outputs

Measuring R&D performance is often associated with assessment of publication and patent activity of research organizations, social groups or individuals. Wider implementation of this approach follows well-established traditions in this field of studies as well as growing demand from policymakers for particular indicators of R&D output. Other characteristics of scientific production (infrastructure capabilities, technology, innovation, social impacts, etc.) are put aside as a self-contained topic. On the other hand, professional discussions on statistical measurement of R&D until recently put aside the problem of accounting for scientific outputs. The lecture is aimed at building a bridge between these traditions and reflecting the scope for measuring scientific performance in general and R&D outputs in particular.

- Scope of measuring R&D outputs
- Scientometrics and other methods for measuring scientific performance

Basic literature:

Freeman C., ed. (1987). Output Measurement in Science and Technology: Essays in Honor of Yvan Fabian, Elsevier Science Publishers B.V., Amsterdam.
URL: https://www.sciencedirect.com/book/9780444703309/output-measurement-in-science-and-technology (accessed 21.08.2019).

García-Valderrama, T., & Mulero-Mendigorri, E. (2005). Content validation of a measure of R&D effectiveness. R and D Management, 35(3), 311–331.
URL: https://doi.org/10.1111/j.1467-9310.2005.00392.x (accessed 21.08.2019).

Godin, B. (2006). On the origins of bibliometrics. Scientometrics, 68(1), 109–133.
URL: http://www.csiic.ca/PDF/Godin_33.pdf (accessed 21.08.2019).

Additional literature:

Coccia, M. (2004). New models for measuring the R&D performance and identifying the productivity of public research institutes. R and D Management, 34(3), 267–280. URL: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2577984 (accessed 21.08.2019).

Lyall, C., Bruce, A., Firn, J., Firn, M., & Tait, J. (2004). Assessing end-use relevance of public sector research organisations. Research Policy, 33(1), 73–87. URL: https://www.sciencedirect.com/science/article/abs/pii/S0048733303000908 (accessed 21.08.2019).

5. Basics of bibliometric indicators

Bibliometrics combines a variety of methods allowing to measure research outputs and to analyze social structures of scientific production. Its tools are useful for research evaluation, comparing sciences, understanding tendencies of scientific growth, etc. The lecture gives an introductory overview of the principles of bibliometric analysis, usage of key indicators and recommendations for using data sources.

- Indicators and methods
- Data sources: an overview
- Using bibliometric databases
- Data analysis and interpretation

Basic literature:

Bar-Ilan, J. (2008). Informetrics at the beginning of the 21st century—A review. Journal of Informetrics, (1), 1–52. URL: https://www.sciencedirect.com/science/article/abs/pii/S1751157707000740 (accessed 21.08.2019).

Bellis, N. (2009). Bibliometrics and Citation Analysis: From the Science Citation Index to Cybermetrics. Scarecrow Press. URL: https://selembarpapyrus.com/wp-content/uploads/2017/09/Bibliometrics-and-Citation-Analysis-Nicola-de-Bellis.pdf (accessed 21.08.2019).

Hicks, D., Wouters, P., Waltman, L., de Rijcke, S., & Rafols, I. (2015). bibliometrics: The Leiden Manifesto for research metrics. Nature, 520(7548), 429-431. URL: https://www.nature.com/polopoly_fs/1.17351!/menu/main/topColumns/topLeftColumn/pdf/520429a.pdf?origin=ppub (accessed 21.08.2019).

Moed H. et al. (2004). Handbook of Quantitative Science and Technology Research. Kluwer academic publishers. URL: https://pdfs.semanticscholar.org/60c3/e307aed05dbee13a5448c7b48b1289d3fccf.pdf (accessed 21.08.2019).

Additional literature:

Gingras, Y. (2016). Bibliometrics and research evaluation: Uses and abuses. MIT Press.

Garfield, E. (1979). Is citation analysis a legitimate evaluation tool? Scientometrics, 1(4), 359–375. URL: https://link.springer.com/article/10.1007/BF02019306 (accessed 21.08.2019).

Garfield, E., Sher, I. H., & Torpie, R. J. (1964). The use of citation data in writing the history of science. DTIC Document.
URL: www.garfield.library.upenn.edu/papers/useofcitdatawritinghistofsci.pdf (accessed 21.08.2019).

Igami, M. and A. Saka (2007). Capturing the Evolving Nature of Science, the Development of New Scientific Indicators and the Mapping of Science. OECD Science, Technology and Industry Working Papers, 2007/1, OECD Publishing.
URL: https://www.oecd-ilibrary.org/docserver/300005636714.pdf?expires=1548515303&id=id&accname=guest&checksum=424E74B80BD95E311CE4B3A8D1FF857A (accessed 21.08.2019).

Okubo, Y. (1997). Bibliometric Indicators and Analysis of Research Systems: Methods and Examples. OECD Science, Technology and Industry Working Papers, 1997/1, OECD Publishing.
URL:
http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=OCDE/GD(97)41&docLanguage=En (accessed 21.08.2019).

Price, D. J. S. (1979). Networks of Scientific Papers-The pattern of bibliographic references indicates the nature of the research front. The Scientific Journal, ed. Meadows, AJ, London: ASLIB, 157–162.
URL: http://garfield.library.upenn.edu/papers/pricenetworks1965.pdf (accessed 21.08.2019).

6. Indicators of intellectual property rights

The lecture is designed to provide students with basic theoretical and practice-oriented knowledge and skills, needed to employ methods of patent analysis for various research tasks. It will discuss research potential of patent statistics, specify the key indicators used in Russian and global studies, provide brief and comprehensive instructions for patent information' user.

Key topics:

- Types of IP
- Indicators of IP stock and flows
- Patent databases
- Analysis of patent statistics

Basic literature:

OECD (2009). Patent Statistics Manual. Paris, OECD. Chapters 2, 5.
URL: https://www.oecd-ilibrary.org/science-and-technology/oecd-patent-statistics-manual_9789264056442-en?_ga=2.144710388.1110762815.1548511417-2109889095.1504430158 (accessed 21.08.2019).

Archibugi D. (1992) Patenting as an indicator of technological innovation: a review. Science and Public Policy. Vol.19 (1). P.357 – 368.
URL: https://doi.org/10.1093/spp/19.6.357 (accessed 21.08.2019).

Additional literature:

Archibugi D., Pianta M. (1996) Measuring technological change through patents and innovation surveys. Technovation, Vol.16 (9). P. 451 – 468.
URL: http://www.danielearchibugi.org/downloads/papers/2017/11/Archi-Pianta_Technovation.pdf (accessed 21.08.2019).

Jenkins D. (2004) The Industrial Application of Patent Analysis: an Empirical Study. Bourthmouth: Bournemouth University. Chapter 2.
URL: http://eprints.bournemouth.ac.uk/3719/ (accessed 21.08.2019).

OECD (2006) Glossary on Patent Terminology. Paris: OECD.
URL: https://stats.oecd.org/glossary/detail.asp?ID=2023 (accessed 21.08.2019).

Schmoch, U. (2008) Concept of a technology classification for country comparisons. Final report to the World Intellectual Property Organisation (WIPO), Fraunhofer Institute for Systems and Innovation Research, Karlsruhe, Germany.
URL:
https://www.wipo.int/export/sites/www/ipstats/en/statistics/patents/pdf/wipo_ipc_technology.pdf (accessed 21.08.2019).

7. Statistics on technology

There is a widespread and increasing interest in the development of indicators for measuring technology development, dissemination and social and economic impacts. Though over the last 50 years relevant statistics allowing for standardized and internationally harmonized measurement of S&T have been established, there is still lack of knowledge on how technologies could be measured. The lecture summarizes international state of the art in technology measurement and introduces elements of an integrated approach for technology measurement.

- Scope of statistics on technology
- Statistics on advanced manufacturing technologies
- Biotechnology statistics
- Nanotechnology statistics

Basic literature:

Cozzens, S., Gatchair, S., Kang, J., Kim, K.-S., Lee, H. J., Ordóñez, G., & Porter, A. (2010). Emerging technologies: quantitative identification and measurement. Technology Analysis & Strategic Management, 22(3), 361–376.
URL: https://pdfs.semanticscholar.org/c666/401c624e61c2d6f411b67ab30b034ef651b4.pdf (accessed 21.08.2019).

Gokhberg, L., Fursov, K., Miles, I., & Perani, G. (2013). Developing and using indicators of emerging and enabling technologies. In F. Gault (Ed.) Handbook of Innovation Indicators and Measurement. Cheltenham: Edward Elgar Publishing Ltd., 349-380.
URL: https://www.elgaronline.com/view/9780857933645.xml (accessed 21.08.2019).

Marx, L. (2010). Technology: the emergence of a hazardous concept. Technology and Culture, 51(3), 561–77.
URL: https://www.jstor.org/stable/pdf/40927986.pdf?seq=1#page_scan_tab_contents (accessed 21.08.2019).

OECD (2009). Biotechnology Statistics. Paris, OECD.
URL: https://www.oecd.org/sti/42833898.pdf (accessed 21.08.2019).

Palmberg C., Dernis H., Miguet C. (2009). Nanotechnology: an Overview Based on Indicators and Statistics. STI Working Paper, DSTI/DOC(2009)7. Paris, OECD.
URL: https://www.oecd-ilibrary.org/docserver/223147043844.pdf?expires=1548516011&id=id&accname=guest&checksum=577A74C74414B260C994EDA7F5DDE991 (accessed 21.08.2019).

Additional literature:

Freeman, C. (1998). The economics of technical change. Trade, Growth and Technical Change, Cambridge, 16–54.
URL: https://www.jstor.org/stable/24231814 (accessed 21.08.2019).

OECD (2010). The Impacts of Nanotechnology on Companies: Policy Insights from Case Studies, OECD Publishing.
URL: https://www.oecd-ilibrary.org/science-and-technology/the-impacts-of-nanotechnology-on-companies_9789264094635-en (accessed 21.08.2019).

Schatzberg, E. (2006). Technik comes to America: changing meanings of technology before 1930, Technology and Culture, 47(3), 486–512.
URL: https://www.jstor.org/stable/40061169?seq=1#page_scan_tab_contents (accessed 21.08.2019).

8. Measuring Digital Economy

The lecture introduces key principles and best practices in measuring Information Society and Digital Economy, i.e. ICT supply and demand, infrastructure, usage by businesses, households and individuals, e-skills. It starts with an overview of basic definitions of and international statistical standards (OECD, Eurostat, ITU) and continues with approaches to construction and use of indicators to measure different aspects of Information Society development.

- Scope of statistics on Information Society and Digital Economy
- Statistics on the ICT sector
- Statistics on ICT use in the economy
- Measuring ICT use in households and by individuals, e-skills
- Statistics on e-government

Basic literature:

Eurostat (2013). Methodological Manual for Statistics on the Information Society. EC, Eurostat.
URL: https://ec.europa.eu/eurostat/documents/3859598/5896837/KS-BG-06-004-EN.PDF/9cf80df6-415c-447b-b107-be97aa339a73?version=1.0 (accessed 21.08.2019).

ITU (2011). Handbook for the Collection of Administrative Data on Telecommunications/ICT. Geneva, ITU.
URL: https://www.itu.int/en/ITU-D/Statistics/Pages/publications/handbook.aspx (accessed 21.08.2019).

ITU (2014). Manual for Measuring ICT Access and Use by Households and Individuals. Geneva, ITU.
URL: http://www.itu.int/pub/D-IND-ITCMEAS-2014 (accessed 21.08.2019).

OECD (2011). Guide to Measuring the Information Society. Paris, OECD.
URL: https://read.oecd-ilibrary.org/science-and-technology/oecd-guide-to-measuring-the-information-society-2011_9789264113541-en#page1 (accessed 21.08.2019)

UNCTAD (2009). Manual for the Production of Statistics on the Information Economy. Geneva, UNCTAD.
URL: https://unctad.org/en/pages/PublicationWebflyer.aspx?publicationid=1079 (accessed 21.08.2019).

Additional literature:

OECD (2019). Vectors of digital transformation. OECD Digital Economy Papers, No. 273, OECD Publishing, Paris.
URL: https://doi.org/10.1787/5ade2bba-en (accessed 21.08.2019).

OECD (2017), OECD Digital Economy Outlook 2017, OECD Publishing, Paris.
URL: https://doi.org/10.1787/9789264276284-en (accessed 21.08.2019).

OECD (2013). The Internet Economy on the Rise: Progress since the Seoul Declaration Outlook, Paris, OECD.
URL: http://www.oecd.org/internet/internet-economy-on-the-rise.htm (accessed 21.08.2019).

9. Measurement of technology intensity and trade

The lecture summarizes key principles for measuring technology intensity and trade in accordance with international standards and best practices in the area and include two subtopics.

9.1 Measuring technology intensity

In many countries high-tech sectors of economy and enterprises are key drivers of economic growth, productivity enhancement, efficient employment, and social development. This section is devoted to review of methods, metrics and available sources of statistical data for high technology analysis, as well as multiple ways of its application.

Basic literature:

Hatzichronoglou, T. (1997) Revision of the High-Technology Sector and Product Classification.
URL: http://www.oecd-ilibrary.org/science-and-technology/revision-of-the-high-technology-sector-and-product-classification_134337307632 (accessed 21.08.2019).

High-tech statistics. EUROSTAT.

URL: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/High-tech_statistics (accessed 21.08.2019).

Additional literature:

ISIC REV. 3 Technology intensity definition (2011), OECD.

URL: http://www.oecd.org/dataoecd/43/41/48350231.pdf (accessed 21.08.2019).

UNIDO (2013): Industrial Development Report 2013. Sustaining Employment Growth: The Role of Manufacturing and Structural Change, UNIDO.
URL:
http://www.unido.org/fileadmin/user_media/Research_and_Statistics/UNIDO_IDR_2013_main_report.pdf (accessed 21.08.2019).

9.2 Measurement of international technology trade

Technology balance of payments (TBP) remains one of the key indicators for measuring international technology trade. This section refers to the key definitions and methodology for calculation and interpretation of TBP data.

Key topics:

- TBP framework
- TBP transactions
- Interpreting TBP data

Basic literature:

OECD (2005). Handbook on Economic Globalisation Indicators. Paris, OECD.
URL: https://www.oecd-ilibrary.org/industry-and-services/measuring-globalisation-oecd-economic-globalisation-indicators-2005_9789264012394-en (accessed 21.08.2019).

IMF Balance of Payments Compilation Guide (1995). Washington, DC, USA: International Monetary Fund.
URL: https://www.imf.org/external/pubs/ft/bopcg/1995/bopcg.pdf (accessed 21.08.2019).

Additional literature:

Grosse, R. (1996). International Technology Transfer in Services. Journal of International Business Studies, 27, 781–800.
URL: https://link.springer.com/article/10.1057/palgrave.jibs.8490153 (accessed 21.08.2019).

Madhok, A. (1996). Know-how-, experience-and competition-related considerations in foreign market entry: An exploratory investigation. International Business Review, 5(4), 339–366.
URL: https://www.sciencedirect.com/science/article/abs/pii/0969593196000170 (accessed 21.08.2019).

Metz, B., & Turkson, J. K. (2000). Methodological and Technological Issues in Technology Transfer: A Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press.
URL:
http://documentacion.ideam.gov.co/openbiblio/bvirtual/005133/ipcc/tectran/IPCC_SRTT.pdf (accessed 21.08.2019).

Rouach, D. (2003). Technology Transfer and Management-Guidance for Small and Mediumsized Enterprises'. Tech Monitor, 20(3), 21–28.
URL:
https://www.researchgate.net/publication/282069575_Selecting_the_appropriate_technology_transfer_method_to_reach_the_technology_localization (accessed 21.08.2019).

10. Innovation statistics

Innovation statistics is aimed at measuring new or significantly improved goods or services, technological, organizational, ecological or other advances as well as their role in economic development. The core definition of innovation for the use in statistical measurement was codified 20 years in the Oslo Manual to recognize new technological products and manufacturing processes. Since then its initial coverage was extended from manufacturing to the entire market economy. The lecture introduced basic methodological principles of innovation statistics as well as examples of their implementation at national and international levels.

- Methodological framework and measurement needs
- OECD Oslo Manual
- Basic definitions and conventions
- Measuring innovation activities

- Indicators on objectives, obstacles and outcomes of innovation
- National and international innovation surveys

Basic literature:

Fagerberg, J., Mowery, D.C. & Nelson, R.R. (2006). The Oxford Handbook of Innovation, Oxford University Press, USA.

Gault, F. (2010). Innovation strategies for a global economy development, implementation, measurement and management, Ottawa: International Development Research Centre. URL: https://www.idrc.ca/en/book/innovation-strategies-global-economy-development-implementation-measurement-and-management (accessed 21.08.2019).

Gault, F. (ed.) (2013). Handbook of Innovation Indicators and Measurement. Cheltenham, UK: Edward Elgar.
URL: https://www.elgaronline.com/view/9780857933645.xml (accessed 21.08.2019).

OECD/Eurostat (2018). Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris/Eurostat, Luxembourg.
URL: https://read.oecd-ilibrary.org/science-and-technology/oslo-manual-2018_9789264304604-en#page1 (accessed 10.12.2018).

Organisation for Economic Co-operation and Development (2009). Innovation in Firms: A Microeconomic Perspective. Paris: OECD.
URL: https://read.oecd-ilibrary.org/science-and-technology/innovation-in-firms_9789264056213-en#page1 (accessed 21.08.2019).

Additional literature:

Archibugi, D. (2001). Pavitt's taxonomy sixteen years on: a review article. Economics of Innovation and New Technology, 10(5), 415–425.
URL: https://www.tandfonline.com/doi/pdf/10.1080/10438590100000016 (accessed 21.08.2019).

Cohen, W.M. (2010). Fifty Years of Empirical Studies of Innovative Activity and Performance. In Handbook of the Economics of Innovation, Vol. 1. North-Holland, 129–213.
URL: https://www.sciencedirect.com/science/article/pii/S016972181001004X (accessed 21.08.2019).

Diamond, A.M. (2004). Zvi Griliches's contributions to the economics of technology and growth. Economics of Innovation and New Technology, 13(4), 365–397.
URL: https://www.tandfonline.com/doi/abs/10.1080/10438590410001629043 (accessed 21.08.2019).

Griliches, Z., Pakes, A. & Hall, B.H. (1988). The value of patents as indicators of inventive activity, National Bureau of Economic Research Cambridge, Mass.
URL: https://www.nber.org/chapters/c8351.pdf (accessed 21.08.2019).

Grupp, H. & Mogee, M.E. (2004). Indicators for national science and technology policy: how robust are composite indicators? Research Policy, 33(9), 1373–1384.
URL: https://www.sciencedirect.com/science/article/pii/S0048733304001180 (accessed 21.08.2019).

Pavitt, K. (1984). Sectoral patterns of technical change: Towards a taxonomy and a theory. Research Policy, 13(6), 343–373.
URL: https://www.sciencedirect.com/science/article/pii/0048733384900180 (accessed 21.08.2019).

11. New areas for innovation measurement

Modern innovation studies go far beyond an enterprise perspective covering variety of actors and interactions between them. The aim of the lecture is to give an overview of these studies, providing a background for discussion on further development of innovation measurement.

- Service innovation
- Open innovation
- User innovation
- Public sector innovation
- Social innovation

Basic literature:

Arundel, A. and D. Huber (2013). From little to too much innovation? Issues in measuring innovation in the public sector. Structural Change and Economic Dynamics, Vol. 27. URL: https://www.sciencedirect.com/science/article/pii/S0954349X13000611 (accessed 21.08.2019).

Chesbrough, H. (2012). Open Innovation. Research Technology Management, 55(4). URL: http://eds.b.ebscohost.com/eds/detail/detail?vid=0&sid=992afbdd-e3eb-4e62-bc2e-6bcdaacc48d7%40pdc-v-sessmgr06&bdata=JnNpdGU9ZWRzLWxpdmU%3d (accessed 21.08.2019).

Hipp, C., & Grupp, H. (2005). Innovation in the service sector: The demand for service-specific innovation measurement concepts and typologies. Research Policy, 34(4), 517–535. URL: https://www.sciencedirect.com/science/article/pii/S0048733305000417 (accessed 21.08.2019).

Murray, R., Caulier-Grice, J., Mulgan, J. (2010). The Open Book of Social Innovation. NESTA. URL: http://www.nesta.org.uk/sites/default/files/the_open_book_of_social_innovation.pdf (accessed 21.08.2019).

OECD (2010). Measuring Innovation: A New Perspective. OECD Publishing. URL: https://www.oecd-ilibrary.org/science-and-technology/measuring-innovation_9789264059474-en?_ga=2.110705987.731819364.1548659744-1103589207.1457873498 (accessed 21.08.2019).

von Hippel E. (2017). Free Innovation. Cambridge, Massachusetts, USA: MIT Press. URL: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2866571 (accessed 21.08.2019).

Additional literature:

Miles, I. (2010). Service Innovation. Handbook of Service Science, 511.

URL: https://link.springer.com/book/10.1007/978-1-4419-1628-0 (accessed 21.08.2019).

OECD (2012). OECD Observatory of Public Sector Innovation. URL: http://www.oecd.org/governance/oecdobservatoryofpublicsectorinnovation.htm (accessed 21.08.2019).

OECD (2015). The Innovation Imperative: contributing to productivity, growth and well-being. Paris: OECD Publishing. URL: https://read.oecd-ilibrary.org/science-and-technology/the-innovation-imperative_9789264239814-en#page1 (accessed 21.08.2019).

Phills Jr., J. A., Deiglmeier, K., & Miller, D. T. (2008). Rediscovering Social Innovation. Leland Stanford Jr. University.
URL:
http://www.ssireview.org/images/articles/2008FA_feature_phills_deiglmeier_miller.pdf (accessed 21.08.2019).

12. Analysis and interpretation of statistical data

Variety of statistical indicators on STI development require accurate analysis and explanation for advisory and policymaking at different levels. While manuals allow the 'routines' of data collection and interpretation, dynamic economic and social processes as well as specific policy needs require deeper understanding of the facts and tendencies behind the figures. The lecture is focused on available aggregate indicators used for international comparisons and rankings, main sources of information and future perspectives of STI measurement.

- Aggregate indicators and rankings
- International comparisons
- "Blue-sky" issues and the future of STI measurement

Basic literature:

Gault, F. (ed.) (2013). Handbook of Innovation Indicators and Measurement. Cheltenham, UK: Edward Elgar.
URL: https://www.elgaronline.com/view/9780857933645.xml (accessed 21.08.2019).

Graversen, E. K., & Siune, K. (2008). Statistical Indicators for R&D and Innovation-A guide for Interpretation and Valuation. Synthesis Report Deliverable. The Danish Centre for Studies in Research and Research Policy
URL:
http://ps.au.dk/fileadmin/site_files/filer_forskningsanalyse/dokumenter/Diverse/D10_Guide_for_valuation.pdf (accessed 21.08.2019).

OECD (2007). Science, Technology and Innovation Indicators in a Changing World: Responding to Policy Needs. OECD Publishing.
URL:
http://www.oecd.org/sti/inno/sciencetechnologyandinnovationindicatorsinachangingworldrespondingtopolicyneeds.htm (accessed 21.08.2019).

The Global Innovation Index 2018: Energizing the World with Innovation. Cornell SC Johnson College of Business, INSEAD, WIPO.
URL: https://www.wipo.int/publications/ru/details.jsp?id=4330 (accessed 21.08.2019).

National Science Board (2018). Science and Engineering Indicators 2018. Arlington VA: National Science Foundation.
URL: https://www.nsf.gov/statistics/2018/nsb20181/ (accessed 21.08.2019).

Additional literature:

A global perspective on science, technology and innovation (STI). UNESCO Institute for Statistics.
URL: http://www.uis.unesco.org/ScienceTechnology/Pages/default.aspx (accessed 21.08.2019).

OECD (2010). Measuring Innovation: A New Perspective. OECD Publishing.
URL: https://www.oecd-ilibrary.org/science-and-technology/measuring-

innovation_9789264059474-en?_ga=2.110705987.731819364.1548659744-1103589207.1457873498 (accessed 21.08.2019).

OECD (2017). OECD Science, Technology and Industry Scoreboard 2017: The Digital Transformation. OECD Publishing.
URL: https://read.oecd-ilibrary.org/science-and-technology/oecd-science-technology-and-industry-scoreboard-2017_9789264268821-en#page1 (accessed 21.08.2019).

OECD (2018). OECD Science, Technology and Innovation Outlook 2018: Adapting to Technological and Societal Disruption. OECD Publishing, Paris
URL: https://doi.org/10.1787/sti_in_outlook-2018-en (accessed 21.08.2019).

OECD (2017), OECD Digital Economy Outlook 2017, OECD Publishing, Paris.
URL: https://doi.org/10.1787/9789264276284-en (accessed 21.08.2019).

UNESCO (2015). UNESCO Science Report: Towards 2030. UNESCO Publishing.
URL: http://unesdoc.unesco.org/images/0023/002354/235406e.pdf (accessed 21.08.2019).

5. Grading system

The overall course grade G (10-point scale) is calculated by the formula:

G = 0.2*S + 0.1*MTT + 0.2*HA + 0.5*E,

and includes results achieved by students in their exam (*E)*, seminar *(S)*, mid-term test *(MTT)* and two home assignments *(HA)*; it is rounded up to an integer number of points.

Seminar (S)

Seminars consist of practical sessions, group tasks and short presentations on the issues considered in the course or master-classes that will provide students indispensable skills for measuring science, technology and innovation issues.

During seminars, students will learn how to construct indicators, make effective searches in citation and patent databases, and give interpretation to the measurement results. In addition, they will learn about different sources of statistical information used in STI studies.

Typical tasks: group work and tasks, short reports, oral presentations.

Home assignment (HA)

A home-prepared written task prepared within a week period on the topic announced in the middle or in the end of each lecture. HA are to be submitted by the beginning of the seminar coming a week after the task was announced. A student is asked to submit *two any* of the HAs during the course. One student can submit *no more than three* home tasks during the course on voluntary basis (two highest grades are taken into consideration for final grade calculation).

Format: mini-essay around 1000 words answering the question asked. HA (if not mentioned specifically) should include:

- a short introduction (why the issue matters);
- a reasoned (evidence-based) written reply to the question asked;
- a short conclusion (the main finding).

6. Examination type

A mid-term test (MTT) and a final exam (E) are in class written task comprising four closed questions (single answer or multiple choice) and up to four open-ended questions (around 8

questions in total) to be answered in brief within 60 minutes (MTT) and in a more comprehensive way in 120 minutes (E). Full answer value is 5 points for closed questions each and 20 points for open-ended questions each (100 points in total recalculated into 10-point scale).

7. Examples of Assessment Materials

Examples of MTT and E questions:

1. Explain the role of international organizations in the development of STI measurement. Give a brief characteristic of key players and existing international standards in the area as well as your ideas on how interaction between international organizations and national statistical agencies (offices) is organized.

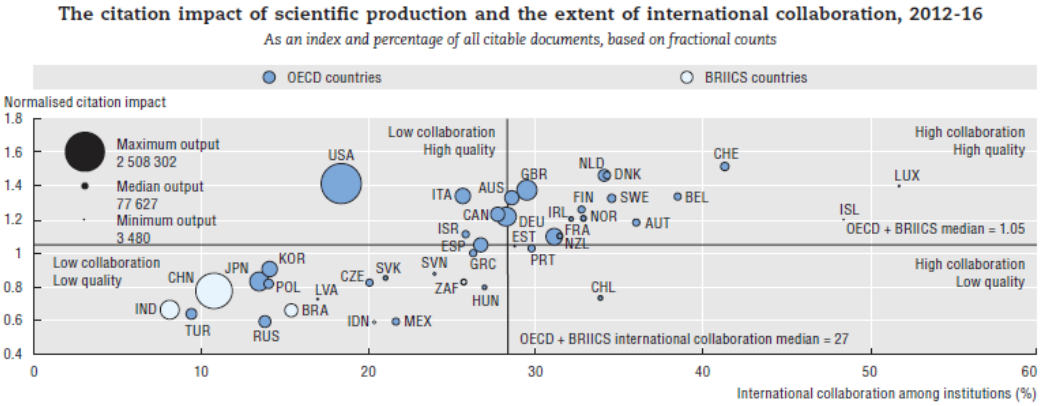
2. What are the key aims of STI statistics and measurement nowadays? How do you understand UNESCO principle of the 'openness' of statistical data?

3. What are the main groups of innovation indicators? Give an overview and explain basic principles of their construction, measurement and interpretation.

4. What is high-tech in terms of statistical measurement? How industries can be classified according to their technology level? Which criterion stands behind?

5. What methodologies (approaches) could be used for estimating the economic impact of innovation? Which factors should be taken into account.

6. Using the graph below, please explain what role international collaboration may play in scientific development of a country.



Source: OECD (2017), "The citation impact of scientific production and the extent of international collaboration, 2012-16: As an index and percentage of all citable documents, based on fractional counts", in Research excellence and collaboration, OECD Publishing, Paris, https://doi.org/10.1787/sti_scoreboard-2017-graph103-en.

7. Methods of instruction

The course combines lectures and seminars through a participatory sessions and group work. Lectures are designed to clarify major theoretical concepts and international experiences employed in regional STI policy studies. Seminars are aimed at sharing the students' reflections on the approaches introduced in the literature and developing analytical and practical skills required to professionally discuss topics aroused during the course. The students are expected to be ready for discussions using the recommended readings and lecture materials.

8. Resources

The list of required and optional readings is presented in the Course Contents as distributed between the topics. Lecture materials and other information needed for group tasks implementation and home assignments, as well as the list of records, will be available at the HSE Learning Management System (LMS). No specialized software or equipment is required. Students are recommended to use HSE e-Library to access the publications and recommended open-source databases and software from the list below.

HSE Library e-resources: https://library.hse.ru/en/e-resources

Software support, including open-source database software:

OECD iLibrary. URL: https://www.oecd-ilibrary.org/
UNESCO (UIS Statistics): http://data.uis.unesco.org/#
OECD (OECD Data): https://data.oecd.org/
OECD Education database: http://www.oecd.org/education/database.htm
European Commission (Eurostat Database): https://ec.europa.eu/eurostat/data/database
National Science Foundation: https://nsf.gov/statistics/2018/nsb20181/
WIPO Statistics: https://www.wipo.int/ipstats/en/
World Bank high tech commodity trade statistics:
http://data.worldbank.org/indicator/TX.VAL.TECH.CD/countries
http://data.worldbank.org/indicator/TX.VAL.TECH.MF.ZS/countries
UN COMTRADE Database:
http://comtrade.un.org/data/
http://comtrade.un.org/db/
International Telecommunication Union: http://www.itu.int/en/
The United Nations Conference on Trade and Development (UNCTAD): http://new.unctad.org
ICT in figures in Russia: http://pluto.netlight.ru/en/

9. Special equipment

- laptop
- multimedia projector
- screen

10. Organization of Studies for Persons with Limited Mobility and Disabilities

If necessary, learners with limited mobility or a disability (as per his/her application), as well as per his/her individual rehabilitation programme, may be offered the following options for receiving learning information with due consideration of his/her individual psycho-physical needs (e.g., via eLearning studies or distance technologies):

- for persons with impaired vision: enhanced fonts in hard copy documents; e-documents; audio files (transfer of study materials to an audio-format); hard copy documents with the use of Braille; individual consultation with a facilitated communicator; individual assignments and mentoring;
- for persons with hearing impairments: in hard copy; e-documents; video materials with subtitles; individual consultation with a facilitated communicator; individual assignments and mentoring;
- for persons with a muscular-skeleton disorder: in hard copy; e-documents; audio-files, individual assignments and mentoring.