

**Institute for International Science and Technology Policy**  
The George Washington University

Cornerstone

**INTERNATIONAL SCIENCE AND TECHNOLOGY POLICY**

IAFF 6141.10  
BELL 109  
T 17:10-19:00  
Fall 2021

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**Note Fall 2021:** This course will be delivered in-person with online accommodations (permission required)

## **Overview**

This course provides a comprehensive overview of the policy issues related to the support, use, management, and regulation of science and technology. It addresses US domestic as well as international issues, is concerned with governmental policies as well as non-governmental decisions, and it is focused on both the economics and politics of science and technology issues.

In today's world, scientific discoveries and technological innovations influence almost every aspect of human existence. Many changes induced by these innovations have been extremely positive, bringing advances in health, communications, material wealth, and quality of life. At the same time, Science and Technology have helped create apparently intractable problems, including new risks to human health, pollution of the natural environment, and the existence of weapons capable of mass destruction. Given all of these impacts, making effective and fair choices regarding technologically complex issues is one of the most challenging tasks of modern governance.

Especially demanding is policy-making for international economic competition, which is increasingly defined in terms of technological competence. The diffusion of centers of technological excellence around the world and the progressive convergence of local markets in terms of consumer tastes and preferences have obliged actors to adopt a more global outlook: not only do firms compete internationally, but they also depend on each other's technological, organizational, financial, and marketing strengths to stay afloat. In this course we examine a number of important characteristics of the new international context that are currently related to the technological competence of firms and nations.

## **Goals**

This course is intended to impart: knowledge of the institutions that shape international science and technology policy, with a focus on the U.S. institutions surrounding the George Washington University; familiarity with policy research and key indicators that shape science and technology policy; an overview of historical and current science and technology policy issues, with a focus on issues under consideration by policymakers in institutions surrounding GW; the skill of policy analysis – the ability to dissect a problem in science and technology and connect the elements of that problem to the relevant institutions; and the skill of policy formulation – the ability to craft a science or technology policy in a way that might promise success, drawing on historical and/or international experience.

These goals are assessed in the two major exams and the policy exercise. Each exam will have questions that are intended to assess mastery of the categories of knowledge, described above, that are developed in the class. The exams are cumulative, in the sense that they make use of the lectures, reading material, and class discussions. They may also introduce new material as well. In general, they consist of a series of short essay questions with short essay answers. They are take-home exams.

## **Learning Outcomes**

Students will be able to critically analyze science and technology policy proposals and supporting data with reference to historical trends and key policy institutions.

Students will be able to formulate science and technology policy proposals, support proposals with relevant data or indicators, and critically evaluate their potential effectiveness.

Students will be able to evaluate the economic, political, and social contexts of actual or proposed science and technology policy actions in terms of historical and contemporary settings.

## **Out of Class and Independent Learning Expected per Week**

For this 3-credit graduate class students are expected to spend at least 350 minutes per week outside the classroom on preparation and class assignments.

## Grades

The final grade will be computed in the following way:

- Class participation: 25%
- This portion of the grade is based on students' attendance, frequency and quality of participation in class discussion. There are two components. First, active engagement in class discussions during lectures, as prompted. Second, replying to a set of standard questions after each class lecture (posted on Blackboard).
- Policy memorandum: 25%
- This portion of the grade is based on student performance on a short policy exercise. A policy-related question will be distributed on **October 5**. Students will work individually to prepare a 1-2 pages memo to a policy decision-maker in a couple of days.
- Final Examination: 50%
- Students work individually. The examination will be a collection of short essays based on class discussions and readings during the course. A set of three questions will be distributed on **November 30** (last class). Answers will be due a week later.
  - Grades will be based upon the full set of attributes that are important to good policy papers, including accuracy, clarity, logic, and relevance. Referencing sources of information sources is highly desirable.

## Class Policies

Class attendance is expected. There will be no allowance for late work, except by prior arrangement with the instructor. Arrangements for make-up work must be made with the instructor. The instructor has the discretion to grant or refuse requests for late work or make-up work. Students are always welcome to discuss grades with the Professor. However, students wishing to formally contest a grade are required to write a memo outlining their case, along with supporting examples from the submitted assignment.

## University Policies & Services

***Academic Integrity Code.*** Academic dishonesty is defined as cheating of any kind, including misrepresenting one's own work, taking credit for the work of others without crediting them and without appropriate authorization, and the fabrication of information. For details and complete code, see: [studentconduct.gwu.edu/code-academic-integrity](http://studentconduct.gwu.edu/code-academic-integrity)

***Sharing of Course Content.*** Unauthorized downloading, distributing, or sharing of any part of a recorded lecture or course materials, as well as using provided information for purposes other than the student's own learning may be deemed a violation of GW's Student Conduct Code.

***Use of Student Work (FERPA).*** The professor will use academic work that you complete during this semester for educational purposes in this course during this semester. Your registration and continued enrollment constitute your consent.

***Accommodations for Students with Disabilities.*** Any student who may need an accommodation based on the potential impact of a disability should contact the Disability Support Services office at 202-994-8250 in the Rome Hall, Suite 102, to establish eligibility and to coordinate reasonable accommodations. For additional information see: [disabilitysupport.gwu.edu/](http://disabilitysupport.gwu.edu/)

***Religious Observances.*** In accordance with University policy, students should notify faculty during the first week of the semester of their intention to be absent from class on their day(s) of religious observance. For details and policy, see: [students.gwu.edu/accommodations-religious-holidays](http://students.gwu.edu/accommodations-religious-holidays).

***Mental Health Services 202-994-5300.*** The University's Mental Health Services offers 24/7 assistance and referral to address students' personal, social, career, and study skills problems. Services for students include: crisis and emergency mental health consultations confidential assessment, counseling services (individual and small group), and referrals. For additional information see: [counselingcenter.gwu.edu/](http://counselingcenter.gwu.edu/)

***GW Security and Safety Policy.*** In the case of an emergency, if at all possible, the class should shelter in place. If the building that the class is in is affected, follow the evacuation procedures for the building. After evacuation, seek shelter at a predetermined rendezvous location.

## Readings

You are requested to purchase the book:

Homer A. Neal, Tobin L. Smith, and Jennifer B. McCormick (2008) *Beyond Sputnik: U.S. Science Policy in the 21<sup>st</sup> Century*, University of Michigan Press, Ann Arbor.

An extensive report by UNESCO (737 pages) provides excellent background material on various countries/regions around the world, difficult to find elsewhere in such a comparative manner. The report has been published just recently:

United Nations Educational, Scientific and Cultural Organization *UNESCO Science Report 2021: The Race Against Time for Smarter Development*, UNESCO Printing. [open source] [<https://www.unesco.org/reports/science/2021/en/download-the-report>]

*All other readings will be posted on Blackboard, except for selective large reports that you can locate on the internet.*

# Summary Schedule of Class Meetings

## INTRODUCTION

- 8/31 Course Introduction  
Megatrends / Technology Trends in Context of Future Research Policy  
Pandemics in Human History

## SCIENCE, TECHNOLOGY AND INNOVATION (STI) POLICY

- 9/7 U.S. STI System:  
Foundations of STI Policy – Historical Overview of STI Development  
Current and Evolving Issues
- 9/14 Institutions – R&D Funding
- 9/21 National Defense – Civilian Public Procurement
- 9/28 STI Policy in Europe:  
European Union, Framework Program  
European Union Country Members
- 10/5 STI Policy in Japan, Korea & Emerging Economies

## CORE TECHNOLOGY AREAS

- 10/12 Digital Economy:  
The New Knowledge-Driven Socio-Economic Paradigm;  
4<sup>th</sup> Industrial Revolution; Advanced Manufacturing
- 10/19 Artificial Intelligence; The Data Economy;  
Distributed Ledger Technologies
- 10/26 Energy, Environment, Climate
- 11/2 Pharmaceuticals, Public Health
- 11/9 Space:  
Space Futures  
Low Earth Orbit

## SYSTEM MANAGEMENT AND THE FUTURE

- 11/16 STEM Education, S&E Workforce, Jobs
- 11/23 Entrepreneurship, Innovative SMEs
- 11/30 The Future of STI Policy: Globalization, Grand Challenges, Other Challenges

## Analytical Schedule of Meetings and Readings

Core readings are unmarked. Readings marked with an asterisk (\*) are recommended.

8/31 COURSE INTRODUCTION

*(i) Course Introduction*

Piper, Kelsey (2018) “Human History in One Chart”, *Vox*, Nov.8.

*(ii) Megatrends / Technology Trends in Context of Future Research Policy*

Organization for Economic Cooperation and Development *Science, Technology and Innovation Outlook 2016*, Paris: OECD. [Chs 1, 2]  
[Ch1] “Megatrends Affecting Science, Technology and Innovation”  
[Ch2] “Future Technology Trends”

- \* McKinsey & Co (2021) “The Top Trends in Tech – 2021”  
<https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/the-top-trends-in-tech>

*(iii) Pandemics in Human History*

Alfani, Guido and Murphy, Tommy E. (2017) “Plague and Lethal Epidemics in Pre-Industrial World”, *Journal of Economic History*, 77(1): 314-343.

### SCIENCE, TECHNOLOGY AND INNOVATION (STI) POLICY

9/7 U.S. STI SYSTEM I

*(i) Foundations of STI Policy – Historical Overview of STI Development*

Neal, Homer A., Tobin L. Smith, and Jennifer B. McCormick (2008)  
*Beyond Sputnik: U.S. Science Policy in the 21<sup>st</sup> Century*, University of Michigan Press, Ann Arbor. [Chs 1, 2]  
[Ch 1] “Science Policy Defined.”  
[Ch 2] “U.S. Science Policy before and after *Sputnik*.”

- \* Bush, Vannevar, “Science the Endless Frontier,” Washington, Government Printing Office 1945.  
<http://www.nsf.gov/od/lpa/nsf50/vbush1945.htm>

*(ii) Current and Evolving Issues*

Neal, Homer A., Tobin L. Smith, and Jennifer B. McCormick (2008),  
op.cit. [Chs 3-4]  
[Ch 3] “The Players in Science Policy”  
[Ch 4] “The Process of Making Science Policy”

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U.S. STI SYSTEM II

*(i) Institutions – R&D Funding*

Neal, Homer A., Tobin L. Smith, and Jennifer B. McCormick (2008),  
op.cit. [Chs 6-9]  
[Ch 6] “Universities”  
[Ch 7] “Federal Laboratories”  
[Ch 8] “Industry”  
[Ch 9] “The States”

National Science Board (2020) *The State of U.S. Science and Engineering 2020*, National Science Foundation.  
“R&D: National Trends and International Comparisons”  
<https://nces.nsf.gov/pubs/nsb20203/>

United Nations Educational, Scientific and Cultural Organization (2021)  
*UNESCO Science Report 2021*, UNESCO Printing. [Ch 5]  
[Ch 5] Vonortas, Nicholas S. with Brennan Hoban and Connor Rabb  
“United States of America”  
[\[https://www.unesco.org/reports/science/2021/en/download-the-report\]](https://www.unesco.org/reports/science/2021/en/download-the-report)

- \* Executive Office of the President of the United States, Office of Management and Budget (OMB) & Office for Science and Technology Policy (OSTP), “Multi-Agency R&D Priorities for Fiscal Year 2023 Budget”, August 2021.

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U.S. STI SYSTEM III

*(i) National Defense – Civilian Public Procurement*

Neal, Homer A., Tobin L. Smith, and Jennifer B. McCormick (2008),  
op.cit. [Chs 11, 13, 18]  
[Ch 11] “Science for National Defense”  
[Ch 13] “Scientific Infrastructure”  
[Ch 18] “Science and Homeland Security”



Vonortas, Nicholas S., “Innovation and Public Procurement in the United States”, in Charles Edquist, Jakob Edler, Nicholas S. Vonortas, and Jon Mikel Zabala (eds.) *Public Procurement for Innovation*, Edward Elgar, 2015.

Flagg, Melissa and Jack Corrigan (2021) “Ending Innovation Tourism: Rethinking the U.S. Military’s Approach to Emerging Technology Adoption”, *CSET Brief*, Center for Security and Emerging Technology, July.

\* “Cloning DARPA”, *The Economist*, June 5, 2021.

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## STI POLICY IN EUROPE

### (i) *European Union, Framework Program*

United Nations Educational, Scientific and Cultural Organization (2021)  
*op. cit.* [Ch. 9]

[Ch 9] Soete, Luc, Sylvia Schwaag Serger, Johan Stierna, and Hugo  
Hollanders “European Union”

European Commission *Horizon Europe - the Framework Programme for  
Research and Innovation.*

[https://ec.europa.eu/info/research-and-innovation/funding/funding-  
opportunities/funding-programmes-and-open-calls/horizon-europe\\_en](https://ec.europa.eu/info/research-and-innovation/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en)

### (ii) *European Union Country Members*

European Commission *European Innovation Scoreboard 2021*, European  
Commission, Luxembourg: Publications Office of the European Union.  
[ES, Chs 2, 3, 4, 5]

[ES] “Executive Summary”

[Ch 2] “Innovation Performance and Trends”

[Ch 3] “Innovation Dimensions”

[Ch 4] “Benchmarking Innovation Performance with non-EU Countries”

[Ch 5] “Country Profiles”

[https://ec.europa.eu/growth/industry/policy/innovation/scoreboards\\_en](https://ec.europa.eu/growth/industry/policy/innovation/scoreboards_en)

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## STI POLICY CANADA, JAPAN, KOREA & EMERGING ECONOMIES

United Nations Educational, Scientific and Cultural Organization (2021),  
*op.cit.* [Chs 4, 7, 8, 13, 16, 22, 23, 24, 25]

[Ch 7] Latin America

[Ch 8] Brazil

[Ch 13] Russian Federation

[Ch 16] Israel

[Ch 22] India

[Ch 23] China

\* [Chs 4, 24, 25] Canada - Japan - Republic of Korea

“The World Turned Upside Down: A Special Report on Innovation in Emerging Markets”, *The Economist*, April 17, 2010.

### ***Policy Exercise (Memorandum) posted***

## **CORE TECHNOLOGY AREAS**

### *10/12 DIGITAL ECONOMY I*

#### ***(i) The New Knowledge-Driven Paradigm; 4<sup>th</sup> Industrial Revolution***

Schwab, Klaus (2016) “The Fourth Industrial Revolution: What it means, How to Respond”, World Economic Forum.

<https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/>

#### ***(ii) Advanced Manufacturing***

Organization for Economic Cooperation and Development *Science, Technology and Innovation Outlook 2018*, Paris: OECD. [Ch2]

[Ch2] “Artificial Intelligence and the Next Production Revolution”

\* Bonvillian, William (2017) “Advanced Manufacturing: A New Policy Challenge”, *Annals of Science and Technology Policy*, 1(1):1-131.

\* “Virtual Realities”, Technology Quarterly, *The Economist*, October 3, 2020

[1] Reaching into other worlds

[2] Reality bytes

[3] The promise and the reality

[4] Getting better

[5] What is real, anyway

\* “A Printed Smile”, *The Economist*, April 30, 2016.

### *10/19 DIGITAL ECONOMY II*

#### ***(i) Artificial Intelligence; The Data Economy;***

World Intellectual Property Organization (2019) *WIPO Technology Trends*

*2019: Artificial Intelligence*, Geneva: WIPO. [ES, Chs 1-2]  
[ES] “Executive Summary”  
[Ch 1] “Introduction”  
[Ch 2] “Trends in Artificial Intelligence”

“The Data Economy”, Special Report, *The Economist*, February 22, 2020.  
[1] Mirror worlds  
[2] Digital plurality  
[3] Spreading out  
[4] The new AI-assembly line  
[5] Virtual nationalism  
[6] And the winner is....

- \* “Steeper than Expected: AI and Its Limits”, Technology Quarterly, *The Economist*, June 13, 2020.  
[1] Reality check  
[2] Not so big  
[3] Algorithms and armies  
[4] Machine, learning  
[5] Road block  
[6] Autumn is coming

*(ii) Distributed Ledger Technologies*

Padilla, Pierre, Nicholas S. Vonortas, Yury Dranev, Veronika Belousova, and Emmanuel Boudard (2019) *Analysing the Deployment of Blockchain and Distributed Ledger Technologies in the Financial Sector*, Background Report prepared for The World Bank Flagship Report “Europe 4.0: Addressing the Digital Dilemma”.

10/26 ENERGY, ENVIRONMENT, CLIMATE

*(i) Energy*

International Energy Agency (2021) “World Energy Investment 2021”, IEA  
“Executive Summary”  
“R&D and Technology Innovation”

*(ii) Environment, Climate Change*

“The Climate Issue”, *The Economist*, September 21, 2019.

“Climate Brief”, *The Economist*, 2020 (various)  
[1] “Politics of climate action”, April 25  
[2] “Modelling the greenhouse effect”, May 2

- [3] “Carbon cycle”, May 9
- [4] “Bad times”, May 16
- [5] “Burn”, May 23
- [6] “Softening the blow”, May 30

\* Intergovernmental Panel on Climate Change (2021) *AR6 Synthesis Report: Climate Change 2022*, IPCC, Geneva Switzerland.  
<https://www.ipcc.ch/report/sixth-assessment-report-cycle/>

\* “Business and Climate Change”, Special Report, *The Economist*, September 19, 2020.  
 [1] The great disrupter  
 [2] A grim outlook  
 [3] Costs of carbon  
 [4] Guilty by emission  
 [5] Green machines  
 [6] Directing the disruption

11/2 PHARMACEUTICALS, PUBLIC HEALTH

Kliff, Sarah (2016) “The True Story of America’s Sky-High Prescription Drug Prices”, *Vox*, November 30.

Congressional Research Service (2019) “Drug Pricing and the Law: Pharmaceutical Panel Disputes”, *In Focus*, Washington: CRS, May 17.

“Personalized Medicine”, *The Economist*, March 14, 2020.

\* “Pandemic-proofing the Planet”, *The Economist*, June 27, 2020.

\* DiMasi, Joseph A., Henry G. Grabowski, and Ronald W. Hansen (2016) “Innovation in the Pharmaceutical Industry: New Estimates of the R&D Costs”, *Journal of Health Economics*, 47: 20-33.

11/9 SPACE

*(i) Space Futures*

“The Next 50 Years in Space”, *The Economist*, July 20, 2019.

- [1] The next 50 years in space
- [2] Using the force
- [3] Star laws
- [4] Apollo’s sister

*(ii) Low Earth Orbit*

Besha, Patrick and Alexander MacDonald (eds) (2016) *Economic Development of Low Earth Orbit*, National Aeronautics and Space Administration (NASA). [Selectively]

- \* Scott, Troy J. and Nicholas S. Vonortas (2019) “Microgravity Protein Crystallization for Drug Development: A Bold Example of Public Sector Entrepreneurship”, *Journal of Technology Transfer* (online). <https://doi.org/10.1007/s10961-019-09743-y>

**SYSTEM MANAGEMENT AND THE FUTURE**

11/16 STEM EDUCATION, S&E WORKFORCE, JOBS

Neal, Homer A., Tobin L. Smith, and Jennifer B. McCormick (2008), op.cit. [Chs 15, 16]  
[Ch 15] “Science, Technology, Engineering, and Mathematics Education”  
[Ch 16] “The Science and Engineering Workforce”

National Science and Technology Council (NSTC) (2018) Committee on STEM Education “Charting a Course for Success: America’s Strategy for STEM Education”, Executive Office of the President of the United States.

NCSES (2021) “Women, Minorities, and Persons with Disabilities in Science and Engineering”, Report, National Center for Science and Engineering Statistics, U.S. National Science Foundation. [NSF 21-321]

- \* “Future of Work”, Consultancy.eu / Deloitte (2021)

11/23 ENTREPRENEURSHIP, INNOVATIVE SMEs

Pascoe, Cheryl E. and Nicholas S. Vonortas (2014) “University Entrepreneurship: A Survey of U.S. Experience”, in Nicholas S. Vonortas, Phoebe C. Rouge and Anwar Aridi (eds) *Innovation Policy: A Practical Introduction*, Springer. [Ch 3]

Waggoner, Danny (2014) “High Risk Finance”, in Nicholas S. Vonortas, Phoebe C. Rouge and Anwar Aridi (eds), *ibid.* [Ch 6]

Heaton, Sohvi, Donald S. Siegel, and David J. Teece (2019) “Universities and Innovation Ecosystems: A Dynamic Capabilities Perspective”, *Industrial and Corporate Change*, 28(4): 921-939.

- \* Fairlie, Robert and Sameeksha Desai (2021) “National Report on Early-Stage Entrepreneurship in the United States:2020”, Kauffman Foundation, February.

11/30 THE FUTURE OF STI POLICY: GLOBALIZATION, GRAND CHALLENGES, OTHER CHALLENGES

Neal, Homer A., Tobin L. Smith, and Jennifer B. McCormick (2008), op.cit. [Chs 17, 19]

[17] “Globalization and Science Policy”

[19] “Grand Challenges for Science and Society”

Edler, Jakob and Jan Fagerberg (2017) “Innovation Policy: What, Why, and How”, *Oxford Review of Economic Policy*, 33(1): 2-23.

Kuhlmann, S. and A. Rip (2018) “Next-Generation Innovation Policy and Grand Challenges”, *Science and Public Policy*, 45(4): 448-454.

- \* UNhappy Birthday”, Special Report, *The Economist*, June 20, 2020. Antonio Guterres’ 4 horsemen

<https://www.un.org/sg/en/content/sg/speeches/2020-01-22/remarks-general-assembly-priorities-for-2020>

- \* Organization for Economic Cooperation and Development (2021) “OECD Science, Technology and Innovation Outlook 2021: Times of Crisis and Opportunity”, OECD Publishing, Paris.

***Final Exam posted***

# Useful Resources

## I. Organizations (selectively)

AAAS R&D Budget and Policy Program

<http://www.aaas.org/spp/rd/>

White House Office of Science and Technology Policy (?????)

<http://www.ostp.gov>

The National Academies (NAS, NAE, IOM, NRC)

<http://nas.edu/>

National Science Foundation (NSF)

<http://www.nsf.gov>

National Science Board

<http://www.nsf.gov/nsb/>

NSF Science and Engineering Statistics

<http://www.nsf.gov/statistics/>

Organization for Economic Cooperation and Development (OECD)

<http://www.oecd.org/>

United Nations Conference on Trade and Development (UNCTAD)

<http://unctad.org/en/Pages/Publications.aspx>

United Nations Industrial Development Organization (UNIDO)

<http://www.unido.org/>

The World Bank

<http://www.worldbank.org/>

The European Union (EU)

Directorate-General (DG) Research and Innovation

<http://ec.europa.eu/research/index.cfm?pg=dg>

DG Connect

<http://ec.europa.eu/dgs/connect/en/content/dg-connect>

DG Enterprise and Industry

[http://ec.europa.eu/enterprise/index\\_en.htm](http://ec.europa.eu/enterprise/index_en.htm)

European Space Agency

<http://www.esa.int/ESA>

## Core Academic Journals (selectively)

*Science and Public Policy*

<http://spp.oxfordjournals.org/>

*Research Policy*

<http://www.journals.elsevier.com/research-policy/>

*Journal of Technology Transfer*

<http://link.springer.com/journal/10961>

*Technovation*

<http://www.journals.elsevier.com/technovation/>

*Economics of Innovation and New Technology*

<http://www.tandfonline.com/toc/gein20/current#.Uhgjqd9Y0M>

*Industrial and Corporate Change*

<http://icc.oxfordjournals.org/>

*Research Evaluation*

<http://rev.oxfordjournals.org/>

*Issues in Science and Technology* (National Academy of Sciences)

<http://www.issues.org/>

*IEEE Transactions on Engineering Management*

<http://www.andromeda.rutgers.edu/~ieeetem/>

*R&D Management*

[http://onlinelibrary.wiley.com/journal/10.1111/\(ISSN\)1467-9310](http://onlinelibrary.wiley.com/journal/10.1111/(ISSN)1467-9310)

*Technology Analysis and Strategic Management*

<http://www.tandfonline.com/toc/ctas20/current#.UhhMTOD9Y0M>

*Technological Forecasting and Social Change*

<https://www.journals.elsevier.com/technological-forecasting-and-social-change>

GW's Aladin system (Gelman Library) typically offers remote access to such organizations and journals and extensive download privileges to publications. It also provides free of charge the vast collections of international organizations such as the OECD, the World Bank, and the United Nations.