General Course Information:

ELEN E6767x or y: INTERNET ECONOMICS, ENGINEERING AND THE IMPLICATIONS FOR SOCIETY

Instructor Information

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Prerequisites

Recommended preparation: CSEE W4119 or E6761 or ability to comprehend and track the development of sophisticated mathematical models involving economics, information and networks in industry. Prerequisites include knowledge of basic microeconomics, optimization methods, and a strong urge to learn the economics of markets enabled by the Internet and applications of economic principles in industry and society.

Course Description

In living memory there have been several very significant technological shifts, such as the Internet, renewable energy, and now AI, each followed by comparable societal impact. The goal of this course is to achieve some understanding of the underlying processes, their drivers, with special focus on their commonality. This requires combining elements of economics, game theory, engineering, and the theory of organizations. Course topics include various models of market structures in economics, and industry segments. Mathematical models and analyses are used extensively as tools. Future research directions are highlighted.

The course starts with basic microeconomics of pricing, market structures, i.e., competitive, oligopoly and monopoly, social welfare maximization and the theories underlying approaches to regulations of large firms. Next, the underpinnings of the far-reach of economics in policy-making are examined via topics such as Arrow's theory of R&D investments, Learning-by-Doing in firms, and Jevon's Paradox as it relates to AI and energy investments. This is followed by game theory concepts, revenue allocations in network coalitions, ISP settlements, and network externalities, which lead up to Internet-enabled two-sided markets, i.e., platform economics, that are ubiquitous today. The course next covers economic principles in networking and network design, i.e., the network as an economic system, which includes "price of anarchy", and the "tragedy of the commons". Economic models are used to investigate market-based alternatives to regulation, and some implications of deregulation of the electrical power industry. Next the societal impact of AI is examined via the EU's 2024 AI Act and also the mechanics of AI in algorithmic pricing. Students do projects researching and applying concepts learnt in the course to topical issues, such as the societal impacts of AI, renewable energy, and the regulation of Big Tech.

Course requirements: Two papers; project with oral presentation; homework

Approximate schedule:
Weeks 1-3: Basic Economics, including Pricing, Fairness, Efficiency, and Stability; Market Models; Natural Monopoly and Regulation; Economic ideas in Policy-Making
Weeks 4 – 6: Internet - Fundamental Models, Relations and Structures: Network Externalities; Two-Sided (Platform) Market Economics
Weeks 7-8: Applications of Economics and Game Theory (e.g., Core of the Game, Shapley Value) to networking, climate change, the deregulated electric power industry
Week 9-10: Students' presentations on projects
Week 11- 12: Economic Principles in Engineering and Society
Week 13: Approaches to Internet Governance around the world

Grading policy:
25% active participation
10% homework
15% mid-term paper
25% project and oral presentation
25% final exam paper

For CVN students, the "active participation" requirement is composed of brief weekly summaries of take-aways from the class lectures and discussions during the week.

Reading:

Basic Economics, Pricing, Markets & Regulation

Hal Varian, "Intermediate Microeconomics, A Modern Approach", Eighth Edition, W.W. Norton
Review of basic economic concepts: utility, demand, consumer and producer surplus, social welfare, competitive markets, monopoly markets, price discrimination, nonlinear pricing

R. Braeutigam, "Optimal Policies for Natural Monopolies", chapter in "Handbook for Industrial Organizations", Vol. 2, Ed. R. Schmalensee and R. Willig, North-Holland, 2007

S. Borenstein, "The Private Net Benefits of Residential Solar PV: The Rise of Electricity Tariffs, Tax Incentives, and Rebates", National Bureau of Economic Research Working Paper 21342, July 2015

Economics for Policy

H. Averch and L.L. Johnson, "Behavior of the firm under regulatory constraint", American Economic Review, 52, 1962, 1053-1069

R.J. Gilbert and D.M.G. Newbery, "Preemptive Patenting and the Persistence of Monopolies", The American Economic Review, June 1982

K. Arrow, "Economic Welfare and the Allocation of Resources for Invention", RAND Corp, 1962

H.D. Saunders, “The Khazzoom-Brookes Postulate and Neoclassical Growth”, The Energy Journal, 13, No. 4, 1992, 131-148

Cooperation in Networks and Revenue-Sharing Concepts from Game Theory

M.O. Jackson, “Allocating the Value”, Sec 12.1.2 in “Social and Economic Networks”, Princeton University Press

P. Linhart, R. Radner, K.G. Ramakrishnan and R. Steinberg, “The Allocation of Value for Jointly Provided Service”, Telecommunication Systems, 4 (1995), 151-175

R.J. Gibbens, F.P. Kelly, G.A. Cope and M.J. Whitehead, “Coalitions in the International Market”, Proc. ITC-13, 1991, 93-98

R.T.B. Ma, D.M. Chiu, J.C.S. Liu, V. Mishra and D. Rubenstein, “Internet Economics: The Use of Shapley Value for ISP Settlement”, IEEE/ACM Trans. Networking,18 (3), June 2010, 775-787

Internet-Enabled Market Models: Network Externalities, Two-Sided Markets

J. Rohlfs, “A Theory of Interdependent Demand for a Communications Service”, Bell J. Economics, 5(1), 16-37, Spring 1974

A. Gersho and D. Mitra, “A Simple Growth Model for the Diffusion of a New Communication Service”, IEEE Trans. Systems, Man and Cybernetics, SMC-5 (2), March 1975, 209-216

W.B. Arthur, “Self-Reinforcing Mechanisms in Economics”, chapter 7 in “Increasing Returns and Path Dependence in the Economy”, University of Michigan Press, 1994

M. Armstrong, “Competition in Two-Sided Markets”, Rand J. Economics, 37, no.3, Autumn 2006, 668-691

J.-C. Rochet and J. Tirole, “Two-Sided Markets: An Overview”, March 12, 2004

D.S. Evans and R. Schmalensee, “The Industrial Organization of Markets with Two-Sided Platforms”, Competition Policy International, 3(1), Spring 2007

Economic Reasoning in Society and Engineering Systems

D. Autor, “Externalities, the Coase Theorem and Market Remedies”, MIT, 2010

R.A. Berry and R. Johari, “Economic Modeling in Networking”: Chapter 2, “Welfare”; Chapter 3, “Static Games”, “Nash Equilibrium”, “Efficiency Loss”; Sec. 5.2, “Pigovian Taxes”

E.E. Sauma and S.S. Oren, “Alternative Economic Criteria and Proactive Planning for Transmission Investment in Deregulated Power System”, in “Economic Market Design and Planning for Electric Power Systems”, IEEE & Wiley, 2010

D. Mitra and A. Sridhar, "Consortiums of ISP-Content Providers Formed by Nash Bargaining for Internet Content Delivery", Proc. IEEE INFOCOM 2019

Economic & Societal Implications of AI Applications

European Commission, Working Document, Impact Assessment of Artificial Intelligence Act, "Laying Down Harmonised Rules on Artificial Intelligence (AI Act) and Amending Certain Union Legislative Acts", 2021

E. Calvano, G. Calzolari, V. Denicolo, S. Pastorello, "Artificial Intelligence, Algorithmic Pricing, and Collusion", American Economic Review, 2020, 110 (10):3267-3297

Projects Concerning Technology and Society

(i) Is there a substantial danger that AI and automation will exacerbate societal problems, such as inequality and unemployment? If so, what precautionary actions should society take?

(ii) Is there need for regulations for safeguarding society from the danger of unfettered AI/ML? If so, what should be the main areas of focus?

(iii) With regard to new, young industries, is industry and society best served by market-based mechanisms or by rules and regulations set by regulatory agencies and Congress?

(iv) What are the right antitrust and regulatory approaches towards those corporations that have become so gigantic that competing against them is almost impossible?

Industry Structure, Various Approaches from Around the World

"Next Generation Connectivity: A review of broadband Internet transitions and policy from around the world", Berkman Center, Harvard University, Feb 2010

Stokab, "Stockholm IT-Infrastructure", 2012

Singapore: IDA Fact Sheet Next Generation Nationwide Broadband Network (June 2012) http://www.ida.gov.sg/images/content/Infrastructure/nbn/images/pdf/NextGenNBNFACTSHEET.pdf