

Statement of Richard Schmalensee, Ph.D.
To the Australian Energy Regulator

July 29, 2022

Introduction

I am Howard W. Johnson Professor of Management, Emeritus and Professor of Economics, Emeritus at the Massachusetts Institute of Technology (MIT). I served as Dean of the MIT Sloan School of Management from 1998 through 2007 and as a Member of the U.S. President's Council of Economic Advisers from 1989 through 1991.

My various books and articles have been cited more than 38,000 times in the academic literature.¹ I am a Fellow of the Econometric Society, a Member of the American Academy of Arts and Sciences, and the 2012 Distinguished Fellow of the Industrial Organization Society. I have served on the Executive Committee of the American Economic Association and serve on the Executive Committee of the Board of the National Bureau of Economic Research. A copy of my Curriculum Vitae is an appendix to this statement.

I have been asked by ENA to evaluate Dr. Martin Lally's (2021) characterization of Schmalensee (1989) and its implications. Specifically, I have been asked to answer two questions:

1. Do you agree with the characterization of Schmalensee (1989) that appears in Lally (2021)?
2. If an economic regulator seeks to reach "*an unbiased estimate of the expected efficient return, consistent with the relevant risks involved in providing regulated network services*" to be applied over a defined regulatory period, does Schmalensee (1989) have any implications for the way that return should be estimated?

¹ Google Scholar, visited 7/22/2022. Schmalensee (1989), which is the focus of this Statement, contributed 78 of those citations; to my knowledge none of them have been critical.

The short answer to both questions is “No!” I consider these questions in order in more detail after providing an overview of Schmalensee (1989) and the related literature.

Overview of Schmalensee (1989)

Schmalensee (1989) was concerned with the effects of depreciation methods on accounting rates of return of regulated firms, taking as given regulators’ determination of the allowed cost of capital. It was inspired by work, notably Fisher-McGowan (1983), showing that for two unregulated firms with the same fundamental economic rate of return, different depreciation methods could induce dramatically different accounting rates of return. Only in the very special case of so-called economic depreciation, first discovered by Hotelling (1925), will economic and accounting rates of return always be equal.

A brief overview of this work is useful to set the stage for Schmalensee (1989).² Consider an unregulated asset with an initial cost of I , a lifetime of T periods, and market-determined net cash flow X_t in period t , for $t = 1, \dots, T$. As what follows should make clear, a period here and below is simply the interval over which net cash flow is measured and depreciation is assessed. If the investment’s net present value is zero using ρ as the discount rate, ρ is the **economic rate of return** on the investment:³

$$(1) \quad NPV_U = -I + \sum_{t=1}^T \frac{X_t}{(1+\rho)^t} = 0.$$

² I provide a similar overview in Schmalensee (1989a, pp. 962-964) in continuous time. Throughout the relevant literature and Schmalensee (1989) there is no explicit treatment of risk, though in the real world a firm’s cost of capital is affected by its risk.

³ If the X_t change sign, it is possible for equation (1) to be satisfied by more than one value of ρ , but this rarely occurs in practice.

The attractiveness of an asset (or of a firm that is a bundle of assets) to a perfectly informed investor depends on its fundamental economic rate of return relative to the relevant market-determined cost of capital for investments of similar riskiness.

To consider the accounting rates of return computed for this asset, let B_t be its book value at the start of period t and let D_t be depreciation charged in period t :

$$(2) \quad B_i = I - \sum_{t=1}^{i-1} D_t = \sum_{t=i}^T D_t, \quad i = 1, \dots, T.$$

(This equation with $i=1$ implies that the D_t sum to I .) The asset's **accounting rates of return** are given by

$$(3) \quad r_t = \frac{X_t - D_t}{B_t}, \quad t = 1, \dots, T.$$

Comparing equations (1) and (3), one might think that accounting rates of return, which could vary over time, could never provide a reliable measure of the underlying economic rate of return. However, Hotelling (1925) showed that the r_t will all equal ρ if and only if the depreciation schedule is such that B_t is always equal to the *NPV* of the investment's future net cash flows, using ρ as the discount rate. As Fisher-McGowan (1983) stress, this bears little resemblance to actual accounting depreciation methodology,⁴ so that in practice accounting rates of return – for individual assets or firms that are collections of assets – can diverge dramatically from the underlying economic rates of return.

In the 1980s I regularly taught the economics Ph.D. course on public utility regulation at MIT, and Frank Fisher was a colleague (and my former dissertation advisor). Having worked through the literature just described, I wondered when, if ever, the accounting rates of return of

⁴ In Schmalensee (1989a, p. 964), I did show that if the X_t and the B_t both decline exponentially at the same rate, accounting and economic rates of return will always be equal. But this is a very special case, which has been generally ignored in the literature.

regulated firms provided a reliable measure of their underlying economic rates of return, with which regulators and investors are primarily concerned. The fundamental difference between the two contexts is that the regulator-determined allowed cost of capital, which I will denote as ρ , determines the net cash flows the regulated firm is permitted to earn, while in the unregulated context the market-determined net cash flows determine the economic rate of return.

Suppose initially that the regulator sets a constant **allowed rate of return**, ρ , for the life of the asset described above. In practice, regulators generally attempt to set allowed rates of return to match investors' market-determined required rates of return, but *nothing in Schmalensee (1989) depends on how the allowed rates of return are determined*. Suppose also that in every period there is perfect price regulation, i.e., the regulator requires that the firm's accounting rate of return, given by equation (3), equal ρ . Then one can solve (3) for the regulation-permitted net cash flows:

$$(4) \quad X_t = \rho B_t + D_t, \quad t = 1, \dots, T.$$

The fundamental result proven in Schmalensee (1989) is that the *NPV* of this regulated investment, computed using the regulator-determined allowed rate of return as the discount rate as in standard economic rate of return calculations, is always zero regardless of how depreciation is assessed:

$$(5) \quad NPV_R = -I + \sum_{t=1}^T \frac{X_t}{(1+\rho)^t} = -I + \sum_{t=1}^T \frac{\rho B_t + D_t}{(1+\rho)^t} = 0.$$

That is, if the regulator determines *in any way whatever* that the regulated firm should earn an economic rate of return of ρ , and it requires the firm's accounting rate of return always to be ρ , the firm will in fact earn an economic rate of return equal to ρ . That is, the *NPV=0* principle, as I understand it is called in Australia, will be satisfied.

In stark contrast to the unregulated case, the method of depreciation is completely irrelevant. The level of ρ is not irrelevant in any fundamental sense, of course: the higher the value chosen by regulators, the more profitable the regulated firm is allowed to be and, on average, the higher the prices paid by its customers. On the other hand, if ρ is set below the firm's actual, market-determined cost of capital, the firm will not meet investors' expectations and will have difficulty financing similar investments in the future.

When I showed a draft of Schmalensee (1989) to my MIT colleague Stewart Myers, he pointed me to a much earlier paper of his in which he had asserted the same basic result, though without proof:

If a regulatory commission decides to allow a return R , and adjusts the utility's prices frequently enough that the utility always earns R on a book basis, then the utility will always earn the same true return R . (Myers 1972, note 38).

Myers (1972) clearly asserts that this statement is true for *any* regulator-determined R , and he implicitly asserts that it is true regardless of how depreciation is computed. This is perfectly consistent with Schmalensee (1989). The only mention of periodicity in Myers' assertion is the requirement that "the utility *always* earns R on a book basis," where *always* must mean whenever depreciation is charged and the accounting ("book basis") rate of return is computed.⁵

My 1989 paper basically generalized this assertion to permit the regulator to set a different allowed rate of return for each period of the project's lifetime and provided a proof. Because both Dr. Lally (2021) and the AER (2022) consider two-period examples, it is worth presenting the two-period special case from Schmalensee (1989). Suppose the regulator somehow sets allowed rates of return ρ_1 in period 1 and ρ_2 in period 2. Then under the

⁵ Indeed, as I point out in note 4 in Schmalensee (1989), this fundamental result holds if depreciation is assessed and the accounting rate of return is computed continuously, and the regulator-determined allowed cost of capital may also vary continuously.

assumption of perfect price regulation, so that accounting rates of return equal allowed rates of return in each period, equation (2) in Schmalensee (1989) becomes

$$(6) \quad NPV_R = -I + \frac{X_1}{(1+\rho_1)} + \frac{X_2}{(1+\rho_1)(1+\rho_2)} = -I + \frac{\rho_1 I + D_1}{(1+\rho_1)} + \frac{\rho_2(I-D_1) + (I-D_1)}{(1+\rho_1)(1+\rho_2)} = 0.$$

To prove that this $NPV=0$ result is true in this special case for *any* values of ρ_1 , ρ_2 , and D_1 , simply multiply both sides by $(1+\rho_1)(1+\rho_2)$ and collect terms involving I and D_1 .

If capital market conditions make it appropriate to set the allowed rate of return in period 2 equal to ρ_2 , it is appropriate to use that rate to discount period 2's end-of-period returns back to the start of that period. It is then appropriate to use the allowed rate of return in period 1, ρ_1 , to discount those discounted returns, along with period 1's end-of-period returns back to period zero.

Moreover, this $NPV=0$ result holds even if ρ_2 is unknown at the beginning of the first period. All that is required is that it is known that the regulator will set the allowed return equal to ρ_2 (the market-determined required return) whatever that turns out to be.

Because of Myers (1972) and several other earlier statements of the assertion that depreciation doesn't matter under perfect price regulation, which I rather grandly labelled *The Invariance Proposition*, Schmalensee (1989) only claimed to be an expository note.

Dr. Lally's (2021) Mischaracterization of Schmalensee (1989)

Let me now turn to the first question that ENA has asked me to address: whether or not I agree with the characterization of Schmalensee (1989) that appears in Lally (2021). Dr. Lally (2021, p. 7) asserts that:

A fundamental requirement of regulation is the $NPV=0$ principle, i.e., at the time a firm invests in regulated activities, the present value of its future cash flows must be equal to its initial investment. Schmalensee (1989) shows that satisfying this principle requires that, at the commencement of each regulatory cycle (when

the allowed cost of capital is set), the term to which the allowed cost of capital relates matches the term of the regulatory cycle.⁶

Dr. Lally does not show how this conclusion follows from the analysis in Schmalensee (1989). Instead he introduces a rather different two-period model to support it, and AER (2022) presents two different two-period models to support the same conclusion. As I discuss below, all are fundamentally inconsistent with the model presented in Schmalensee (1989) and summarized above.

In fact, Dr. Lally's characterization of Schmalensee (1989) is almost exactly backwards. Schmalensee (1989) shows that the $NPV=0$ principle will be satisfied for *any* choices of allowed rates of return as long as accounting rates of return in each period are constrained by price regulation to equal the corresponding allowed rates of return. Of course, it is universally understood that to avoid granting rents to regulated firms while still maintaining adequate investment incentives, the regulator should set allowed rates of return to match the rates that investors require. There is no serious discussion in Schmalensee (1989) about how that should be done: I was not then nor am I now an expert in applied corporate finance, and, in particular, I have no opinion on how the AER should determine the actual, market-based costs of capital of the firms it regulates.

What is perhaps most odd about Dr. Lally's characterization of Schmalensee (1989) is the assertion that it shows that "the term to which the allowed cost of capital relates matches the term of the regulatory cycle." It is a general principle that the allowed cost of capital should be an estimate of the relevant efficient expected return demanded by investors. I have no idea why Dr. Lally thinks that Schmalensee (1989) implies that

⁶ He makes the same assertion in Lally (2004, p. 18). He doesn't support this assertion using the Schmalensee (1989) framework there either.

this estimate must depend precisely on how often it is computed. Schmalensee (1989) is agnostic about how investors might go about determining their required return.

Schmalensee (1989) certainly does not “show” that the term of the allowed return must match the term of the regulatory cycle. Efficient regulation generally requires that the allowed rate of return must be consistent with the return required by investors – however they determine it.

It is my understanding, for instance, that the AER will shortly develop a framework for determining allowed rates of return and will revise that framework every four years. I also understand that it will use that framework to make annual changes in allowed rates of return. It is not clear to me why Dr. Lally says that bonds with five-year maturities rather than one-year maturities should be used in this process – or why, as a general matter, investors should care how frequently allowed rates of return are computed.

The two-period analysis in Lally (2021, pp. 7-8), in which each period is one year, begins by assuming, in the notation above, that ρ_2 is set at the start of period 2. He then asserts that the discounted value of period 2’s revenues at the start of that period is given by

$$(7) \quad V_1 = \frac{\rho_2(I - D_1) + (I - D_1)}{(1 + r_2)},$$

where r_2 is “the one-year cost of equity prevailing at time 1”. He goes on to compute the value of the regulated asset at time zero:

$$(8) \quad V_0 = \frac{[\rho_1 I + D_1] + E(V_1)}{(1 + r_1)} = \frac{\rho_1 I + D_1}{(1 + r_1)} + \frac{\rho_2(I - D_1) + (I - D_1)}{(1 + r_1)(1 + r_2)},$$

where r_1 is “the one-year cost of equity prevailing at time [zero].” He does not explain why the r 's, which do not appear in Schmalensee (1989), are the appropriate discount rates rather than, as in Schmalensee (1989) and equation (6), above, the estimated market costs of capital, the ρ s.

In an amazing bit of sleight of hand, Dr. Lally then asserts that in order for V_0 to equal I , so that $NPV=0$ is satisfied, the ρ s must be set equal to the r s. He does not note that replacing the r s with the ρ s, as in equation (6) above from Schmalensee (1989), accomplishes the same thing in a much more logical fashion.

The AER (2022) offers two defenses of the same Lally proposition. The first (pp. 103-104) essentially starts from the first equality in equation (8) and assumes an all-equity firm. It argues that the ρ s should be set so that $V_0=I$ and $NPV=0$ is satisfied. It is being assumed, however that r_1 , the expected return on equity in period 1, is unaffected by regulatory decisions and that it may accordingly differ from the firm's market-determined cost of capital in that period. I have no idea how this assumption can be defended.

The AER's second defense (pp. 109-110) uses a two-period numerical example, the core of which can be explained using the notation and framework adopted here. The hypothesis is that the first period allowed rate of return, ρ_1 , is set equal to the firm's long-term cost of capital, the economic rate of return that investors require, as assessed at time zero. At the start of period 2, the regulator decides that the long-term cost of capital has changed to ρ_2 , and the allowed rate of return is adjusted accordingly. In the notation above, the AER advances the following equation for V_0 under these assumptions:

$$(9) \quad V_0 = \frac{\rho_1 I + D_1}{(1 + \rho_1)} + \frac{\rho_2(I - D_1) + (I - D_1)}{(1 + \rho_1)^2}.$$

Comparing equations (6) and (9), the difference is that the cost of capital as assessed in period 1 is assumed by the AER to discount cash flows during period 2 even though, by hypothesis it has changed between the two periods. I have no idea how this assumption can be defended either.

What Schmalensee (1989) Does *Not* Imply

Let me now turn to the second question that ENA has asked me to answer:

If an economic regulator seeks to reach “*an unbiased estimate of the expected efficient return, consistent with the relevant risks involved in providing regulated network services*” to be applied over a defined regulatory period, does Schmalensee (1989) have any implications for the way that return should be estimated?

As noted at the outset of this Statement, the answer is “No!” Even after a rather careful review of Schmalensee (1989), I cannot understand how Dr. Lally arrived at his view of what that paper implies for real-world determination of regulated firms’ allowed rates of return. Fundamentally, Schmalensee (1989) takes the regulator-determined allowed rates of return as exogenous; the proof of *The Invariance Proposition* does not depend in any way on how the allowed rates of return are determined. The few places where determination of the allowed rates of return via the cost of capital is mentioned briefly in passing in Schmalensee (1989) have no implications for the decision-making of the AER or of any other regulatory agency. Schmalensee (1989) is an essay in economic theory, not a paper on estimating firms’ cost of capital in practice.

Schmalensee (1989) deals with a very idealized world without risk, competition, or taxes. It is asserted (p. 294) that “[u]nder certainty, [the period t cost of capital] is just the one-period interest rate in period t ” – implicitly the riskless rate for a year or some shorter period. This is obviously correct in very abstract theory but completely irrelevant for long-term investments in the real world: neither Dr. Lally nor anyone else to my knowledge has argued that regulated firms’ operate under certainty or that costs of capital are equal to short-term risk-free rates.

There is a brief discussion (p. 296) of a “weak defense” for the use of the T -period long rate in assessing the cost of capital at the outset, once and for all, for an asset lasting T periods, on the grounds that the long rate reflects expected future short rates. While that “weak defense” is qualified in note 7, it is not rejected.

Finally, in a discussion of uncertainty, Schmalensee (1989, p. 297) contemplates a world in which the regulator agrees to compute the cost of capital in each future period and to set each future period’s allowed rate of return equal to that cost of capital. From the point of view of time zero, future values of ρ are stochastic, but it is argued that the market value of the utility asset is then certain (since promises are kept), while the market value of a bond is stochastic when future short-term interest rates are uncertain. While this discussion may be of some (modest) theoretical interest, it has few if any implications for the world in which we live.

Summary

Dr. Lally (2021) cites Schmalensee (1989) for the proposition that the $NPV=0$ condition is satisfied only if the regulator sets allowed rates of return in one particular way. Dr. Lally is simply wrong. Schmalensee (1989) shows that, properly computed, $NPV=0$ holds *however* the allowed rates of return are determined. Economic efficiency of course, requires that the allowed rate of return is always commensurate with the return that investors require.

Schmalensee (1989) proves one theoretical result, *The Invariance Proposition*, in which the regulated firm’s allowed rates of return are taken as exogenous. Neither that result nor any of the less formal discussions in the paper have any implications for how the AER or any other regulator should attempt to produce “an unbiased estimate of the expected efficient return, consistent with the relevant risks involved in providing the regulated network services.” At the most abstract level, the regulatory task is conceptually a simple one – determine the return that

market investors require and set each period's allowed rate of return and accounting rate of return to match it. Of course, the current debate at the AER indicates that this conceptually simple task is generally complex in practice.

References

- AER (Australian Energy Regulator), (2022), “Draft Rate of Return Instrument Explanatory Statement,” <https://www.aer.gov.au/publications/guidelines-schemes-models/rate-of-return-instrument-2022/draft-decision>.
- Fisher, F. M. and J. J. McGowan, (1983), “On the misuse of accounting rates of return to infer monopoly profits,” *American Economic Review*, 73 (March), 82-97.
- Lally, M., (2004), “Regulation and the choice of the risk-free rate,” *Accounting Research Journal*, 17(1),
- Lally, M., (2021), *The appropriate term for the allowed cost of capital*, Report for the AER.
- Myers, S. C., (1972), “The application of finance theory to public utility rate cases,” *Bell Journal of Economics*, 3 (Spring), 58-97.
- Schmalensee, R., (1989), “An expository note on depreciation and profitability under rate-of-return regulation,” *Journal of Regulatory Economics*, 1, 293-298.
- Schmalensee, R., (1989a), Inter-industry studies of structure and performance, Volume II, Chapter 16 in Schmalensee, R. and R. Willig (eds), (1989), *Handbook of industrial organization*, North-Holland.

Appendix: Professor Schmalensee's Curriculum Vitae

EDUCATION

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
S.B., Economics, Politics and Science, 1965
Ph.D., Economics, 1970

EMPLOYMENT

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
2012- Howard W. Johnson Professor of Management, Emeritus, and
Professor of Economics, Emeritus
2007-12 Howard W. Johnson Professor of Management
2001-07 John C Head III Dean, MIT Sloan School of Management
1998-00 Dean, MIT Sloan School of Management (Interim, July-October 1998)
1996-98 Deputy Dean, MIT Sloan School of Management
1991-99, Director, MIT Center for Energy and Environmental Policy Research
2008-12
1988-99 Gordon Y Billard Professor of Management
1986-12 Professor, Department of Economics
1979-12 Professor, MIT Sloan School of Management
1977-79 Associate Professor, MIT Sloan School of Management
1970 Assistant Professor, MIT Sloan School of Management (Spring)
1967-69 Instructor, MIT Sloan School of Management
PRESIDENT'S COUNCIL OF ECONOMIC ADVISERS
1989-91 Member
1967 Junior Staff Economist (Summer)
UNIVERSITY OF CALIFORNIA, SAN DIEGO
1974-77 Associate Professor, Department of Economics
1970-74 Assistant Professor, Department of Economics

VISITING APPOINTMENTS

2008 Executive in Residence, Rady School of Management; U. of California, San Diego (Winter)
2007 Distinguished Visiting Scholar, Tuck School of Business, Dartmouth College (Fall)
1985-86 Visiting Professor, Harvard Business School
1985 Visiting Professor, CORE, University of Louvain, Belgium (Spring)
1980-81 Visiting Scholar, Department of Economics, Harvard University
1973-74 Visiting Associate Professor and Research Fellow, Department of Economics,
University of Louvain, Belgium

EDITORIAL SERVICE

Editor in Chief, 2005-08; Chairman, Editorial Advisory Board, 2008-: *Competition Policy International*
Editorial Board: *Journal of Economics and Management Strategy*, 1992-98
Associate Editor: *Journal of Economic Perspectives*, 1992-98
Associate Editor: *International Journal of Industrial Organization*, 1982-89
Board of Editors: *American Economic Review*, 1982-86
Founding Editor, 1978-89; Co-Editor, 1989-: MIT Press Series, *Regulation of Economic Activity*
Associate Editor, 1977-81; Board of Editors, 1981-89: *Journal of Industrial Economics*

PROFESSIONAL ASSOCIATIONS

American Economic Association: Committee on Government Relations, 2009-12; Executive Committee, 1993-95; Budget Committee, 1993-95; Nominating Committee, 1987; Advisory Committee on Meetings Program, 1986, 1989, 1994
Econometric Society: Chair, Local Arrangements Committee, 1985 World Congress; Chair, Program Committee, 1980 North American Fall Meeting; Program Committee, 1980 World Congress
Second World Congress of Environmental Economists, Program Committee, 2002

CONSULTATING AND GOVERNMENT SERVICE (SELECTED):

Global Economics Group, Director, 2011-
National Climate Assessment Development & Advisory Committee, 2011-14
LECG, LLC: Director, 2004-2011
National Academies/National Research Council: Panel on Transportation and a Sustainable Environment, 1994-97; Committee on National Statistics, 1998-2001; Panel on Cost-of-Living Indexes, 1999-2001; Coordinating Committee on the Transition to Sustainability, 2000-2001; Committee on America's Climate Choices, 2008-2011; Committee for a Study of Freight Rail Transportation and Regulation (Chair), 2014-15; Committee on the Social Cost of Carbon, 2015-16.
U.S. Environmental Protection Agency: Environmental Economics Advisory Committee, 1992-96, 1998; Clean Air Act Compliance Analysis Council, 1992-98, Chairman 1992-96
Antitrust Division, U.S. Department of Justice, consultant, 1991-92 (1992 Merger Guidelines)
NERA Economic Consulting: Special Consultant 1981-89, 1991-2004
Bureau of Economics, U.S. Federal Trade Commission: consultant, 1972-81 (Antitrust Policy)

AWARDS AND OTHER PROFESSIONAL ACTIVITIES (SELECTED):

Asia School of Business, Board of Governors, 2015- (Co-Chair 2015-18)
Associate Scholar, Harvard Environmental Economics Program, 2013-2018
Director, National Bureau of Economic Research, 2013- (Executive Committee 2018-)
Chicago Booth IGM Economic Experts Panel, 2012-
Distinguished Fellow, Industrial Organization Society, 2012
John Kuszczek Memorial Lecture, Bank of Canada, 2011
Energy Board Member, Bipartisan Policy Center, 2011-13
Stackelberg Lecture, University of Milan, Bicocca, 2010
Keynote Speaker, World Congress of Environmental and Resource Economists, 2010
Resources for the Future, Director 2009-18, Board Chair 2014-18, Chair Emeritus 2018-
Master Class, Rafael del Pino Foundation, Madrid, 2009
Carpenter Lecture, Babson College, 2008
J.-J. Laffont Lecture, CRESSE Summer School, Greece, 2008
Member, National Commission on Energy Policy, 2006-2010
Director, International Data Group, 2004-2017
European Investment Bank Lecture, European University Institute, Florence, 2002
Director, MFS Investment Management, 2002-2004
Advisory Council, Tsinghua School of Economics and Management, 2001-07
Fathauer Lecture in Political Economy, University of Arizona, 2000
Director, International Securities Exchange, 2000-2009
Member, International Academy of Management, 1998-
Member, American Academy of Arts and Sciences, 1995-
Edward A. Hewett Prize, American Association for the Advancement of Slavic Studies (with P.L. Joskow and N. Tsukanova), 1995
Revista de Análisis Económico Lecture, Econometric Society Latin American Meeting, 1994
Director, MIT Press, 1994-2007

Research Associate: National Bureau of Economic Research, 1992-2013
Director: Long Island Lighting Company, 1992-98
Donald Gilbert Memorial Lecture, University of Rochester, 1992
American Council for Capital Formation Center for Policy Research: Board of Directors, 1991-2010;
Environmental Policy Fellow, 1997-98
Fellow, Econometric Society, 1982-
Invited Speaker, Econometric Society World Congress, 1980

PUBLICATIONS

INDUSTRIAL ORGANIZATION

- “Multi-Sided Platforms” (with D.S. Evans), In *The New Palgrave Dictionary of Economics*, Palgrave Macmillan (eds.), Palgrave Macmillan, London, 2017.
- Matchmakers* (with D.S. Evans), Boston: Harvard Business School Press, 2016. French and Korean editions 2017, Chinese and Japanese editions 2018, Vietnamese edition 2019.
- “Pricing the Razor: A Note on Two-Part Tariffs,” *International Journal of Industrial Organization*, 42 (September 2015): 19-22.
- “An Instant Classic: Rochet & Tirole, Platform Competition in Two-Sided Markets,” *CPI Journal*, 10:2 (Autumn 2014): 175-180.
- “On a level with Dentists?” Reflections on the Evolution of Industrial Organization.” *Review of Industrial Organization*, 41 (November 2012): 157-79.
- “Why is Platform Pricing Generally Highly Skewed?” *Review of Network Economics*, 10 (December 2011), Issue 4, Article 1, 11 pages.
- “Jeffrey Rohlfs’ 1974 Model of Facebook: An Introduction,” *Competition Policy International*, 7 (Spring 2011): 301-12.
- “Failure to Launch: Critical Mass in Platform Businesses” (with D.S. Evans), *Review of Network Economics*, 9 (December 2010), Issue 4, Article 1 (26 pages).
- "Comment on "Pharmaceutical Price Discrimination and Social Welfare" (by Frank R. Lichtenberg)," *Capitalism and Society*, 5 (2010), Issue 1, Article 5. DOI: 10.2202/1932-0213.1067. Available at: <http://www.bepress.com/cas/vol5/iss1/art5>
- “Innovation and Evolution of the Payments Industry” (with D.S. Evans). In *Moving Money* (R.E. Litan and M.N. Baily, eds.), Washington: Brookings Institution, 2009, pp. 36-76.
- “Standard-Setting, Innovation Specialists, and Competition Policy,” *Journal of Industrial Economics*, 57 (September 2009): 526-52.
- “New Risks, New Products, and New Regulations: Insurance for the 21st Century,” *ICFAI Journal of Risk and Insurance*, 4 (July 2007): 7-18.
- “Pick your Pricing” (with D.S. Evans). *Chief Executive*, July/August 2007.
- Catalyst Code* (with D.S. Evans), Boston: Harvard Business School Press, 2007. Korean edition, 2008; Polish edition, 2010; Chinese edition, 2011.
- “El Debate Sobre las Tasas de Intercambio: Una Visión de Conjunto” (with D.S. Evans). *Papeles de Economía Española*, Número Extraordinario, 2006, pp. 2-17.
- Invisible Engines: How Software Platforms Drive Innovation and Create Value* (with D.S. Evans and A. Hagiu), Cambridge: MIT Press, 2006. Korean edition, 2008; Chinese edition, 2010.

- "A Survey of the Economic Role of Software Platforms in Computer-Based Industries," *CESifo Economic Studies*, 51 (2005): 189-224. (Reprinted, with minor changes, as "Software Platforms." In *Industrial Organization and the Digital Economy* (G. Illig and M. Peitz, eds.). Cambridge: MIT Press, 2006, pp. 31-70.)
- "Payment Systems and Interchange Fees," *Journal of Industrial Economics*, 50 (June 2002): 103-122.
- Paying with Plastic: The Digital Revolution in Buying and Borrowing* (with D.S. Evans), Cambridge: MIT Press, 1999. Second edition, 2005; Chinese edition, 2006; Korean edition, 2011.
- "Comment on 'Competition, Information, and Development,' by Jean-Jacques Laffont." In *Annual Bank Conference on Development Economics 1998* (B. Pleskovic and J.E. Stiglitz, eds.), Washington: The World Bank, 1999, pp. 262-266.
- "Privatization in Russia: What Should Be a Firm?" (with P.L. Joskow). *International Journal of the Economics of Business*, 2 (1995): 297-327. Reprinted in *Transaction Cost Economics: Recent Developments* (C. Menard, ed.), Brookfield, VT: Edward Elgar, 1997, pp. 86-126.
- Review of R. Wilson, *Nonlinear Pricing*. *Journal of Political Economy*, 102 (December 1994): 1288-1291.
- The Economics of the Payment Card Industry* (with D.S. Evans). Cambridge: National Economic Research Associates, Inc., 1993.
- "Sunk Cost and Market Structure: A Review Article." *Journal of Industrial Economics*, 40 (June 1992): 125-134.
- "Comment on Mannerling and Winston (on the US auto industry)." *Brookings Papers on Economic Activity: Microeconomics*, 1991: 107-110.
- "Empirical Models of Rivalrous Behavior." In *Industrial Structure in the New Industrial Economics* (G. Bonanno and D. Brandolini, eds.), Oxford: Oxford University Press, 1990, pp. 138-167.
- "Economías del Tamaño Empresarial y Poder de Mercado" and "Innovación y Posición Competitiva." In *Concentración Empresarial y Competitividad: España en la C.E.E.* (Xavier Vives and Jordi Gual, eds.), Barcelona: Ariel Economía, 1990, pp. 55-67 and 119-131.
- "Comment on Katz and Ordover (on R&D)." *Brookings Papers on Economic Activity: Microeconomics*, 1990: 194-197.
- Handbook of Industrial Organization, Vols. I & II* (ed., with R. D. Willig), Amsterdam: North-Holland, 1989.
- "Intra-Industry Profitability Differences in U.S. Manufacturing: 1953-1983." *Journal of Industrial Economics*, 37 (June 1989): 337-357.
- "An Expository Note on Depreciation and Profitability under Rate-of-Return Regulation." *Journal of Regulatory Economics*, 1 (September 1989): 293-298.
- "Good Regulatory Regimes." *RAND Journal of Economics*, 20 (Autumn 1989): 417-436.
- "Inter-Industry Studies of Structure and Performance." In *Handbook of Industrial Organization*, Vol. 2 (R. Schmalensee and R. D. Willig, eds.), Amsterdam: North-Holland, 1989, pp. 951-1009.
- "Industrial Economics: An Overview." *Economic Journal*, 98 (September 1988): 643-681. Reprinted in *Surveys in Economics*, Vol. 2 (A.J. Oswald, Editor), Oxford: Basil Blackwell, 1991, pp. 51-89.
- "Perceptual Maps and the Optimal Location of New Products: An Integrative Essay" (with J.-F. Thisse). *International Journal of Research in Marketing*, 5 (1988): 225-249.

- Review of D. J. Teece, ed., *The Competitive Challenge*. *Journal of Economic Literature*, 26 (December 1988): 1779-1780.
- "Advertising." In *The New Palgrave*, Vol. 1 (J. Eatwell, M. Milgate, and P. Newman, eds.), New York: Macmillan, 1987, pp. 34-36.
- "Industrial Organization." In *The New Palgrave*, Vol. 2 (J. Eatwell, M. Milgate, and P. Newman, eds.), New York: Macmillan, 1987, pp. 803-808.
- "George Stigler's Contributions to Microeconomics and Industrial Organization." In *The New Palgrave*, Vol. 4 (J. Eatwell, M. Milgate, and P. Newman, eds.), New York: Macmillan, 1987, pp. 499-500.
- "The Empirical Renaissance in Industrial Economics: An Overview" (with T. F. Bresnahan). *Journal of Industrial Economics*, 35 (June 1987): 371-378.
- "Collusion versus Differential Efficiency: Testing Alternative Hypotheses." *Journal of Industrial Economics*, 35 (June 1987): 399-425.
- "The Performance of Coal-Burning Electric Generating Units in the United States: 1960-1980" (with P. L. Joskow). *Journal of Applied Econometrics*, 2 (April 1987): 85-109.
- "Competitive Advantage and Collusive Optima." *International Journal of Industrial Organization*, 5 (December 1987): 351-367.
- The Empirical Renaissance in Industrial Economics* (ed., with T. F. Bresnahan), Oxford: Basil Blackwell, 1987.
- "Advertising and Market Structure." In *New Developments in the Analysis of Market Structure* (J. E. Stiglitz and G. F. Mathewson, eds.), Cambridge: MIT Press, 1986, pp. 373-396.
- "Econometric Diagnosis of Competitive Localization." *International Journal of Industrial Organization*, 3 (March 1985): 57-70.
- "Do Markets Differ Much?" *American Economic Review*, 75 (June 1985): 341-351.
- "Gaussian Demand and Commodity Bundling." *Journal of Business*, 57 (January 1984): S211-S230.
- "Advertising and Entry Deterrence: An Exploratory Model." *Journal of Political Economy*, 91 (August 1983): 636-653.
- "The Impact of Scale and Media Mix on Advertising Agency Costs" (with A. J. Silk and R. Bojanek). *Journal of Business*, 56 (October 1983): 453-475.
- Review of C. C. von Weizsacker, *Barriers to Entry*. *Journal of Economic Literature*, 21 (June 1983): 562-564.
- "Product Differentiation Advantages of Pioneering Brands." *American Economic Review*, 72 (June 1982): 349-365. ("Errata," *AER*, 73 (March 1983): 250).
- "Commodity Bundling by Single-Product Monopolies." *Journal of Law and Economics*, 25 (April 1982): 67-71.
- "The New Industrial Organization and the Economic Analysis of Modern Markets." In *Advances in Economic Theory* (W. Hildenbrand, ed.), Cambridge: Cambridge University Press, 1982, pp. 253-285.
- "Comment on Beales, Craswell, and Salop (on information failures)." *Journal of Law and Economics*, 24 (December 1981): 541-544.
- "Output and Welfare Implications of Monopolistic Third-Degree Price Discrimination." *American Economic Review*, 71 (March 1981): 242-247.

- "Monopolistic Two-Part Pricing Arrangements." *Bell Journal of Economics*, 12 (Autumn 1981): 445-466.
- "Economies of Scale and Barriers to Entry." *Journal of Political Economy*, 89 (December 1981): 1228-1238.
- "Market Structure, Durability, and Quality: A Selective Survey." *Economic Inquiry*, 17 (April 1979): 177-198.
- "A Model of Advertising and Product Quality." *Journal of Political Economy*, 87 (June 1978): 485-504.
- "Entry Deterrence in the Ready-to-Eat Breakfast Cereal Industry." *Bell Journal of Economics*, 9 (Autumn 1978): 305-327. Reprinted in *Market Strategy and Structure* (J.M.A. Gee and G. Norman, eds.), London: Harvester Wheatsheaf, 1992, pp. 84-111.
- "Advertising, Concentration, and Profits: Comment." In *Issues in Advertising: The Economics of Persuasion* (D. C. Tuerck, ed.), Washington, D.C.: American Enterprise Institute, 1978, pp. 280-284.
- "A Note on Economies of Scale and Natural Monopoly in the Distribution of Public Utility Services." *Bell Journal of Economics*, 9 (Spring 1978): 270-276.
- "Using the H Index of Concentration with Published Data." *Review of Economics and Statistics*, 59 (May 1977): 186-193.
- "Comparative Static Properties of Regulated Airline Oligopolies." *Bell Journal of Economics*, 8 (Autumn 1977): 565-576.
- "Resource Exploitation Theory and the Behavior of the Oil Cartel." *European Economic Review*, 7 (April 1976): 257-279.
- "Advertising and Profitability: Further Implications of the Null Hypothesis." *Journal of Industrial Economics*, 25 (September 1976): 45-54.
- "A Model of Promotional Competition in Oligopoly." *Review of Economic Studies*, 43 (October 1976): 493-507.
- "Is More Competition Necessarily Good?" *Industrial Organization Review*, 4 (1976): 120-121.
- "Brand Loyalty and Barriers to Entry." *Southern Economic Journal*, 40 (April 1974): 579-588.
- "Market Structure, Durability, and Maintenance Effort." *Review of Economic Studies*, 41 (April 1974): 277-287.
- "Advertising and Economic Welfare." In *Advertising and the Public Interest* (S. F. Divita, ed.), Chicago: American Marketing Association, 1974, pp. 82-97.
- "A Note on the Theory of Vertical Integration." *Journal of Political Economy*, 81 (March/April 1973): 442-449.
- "A Note on Monopolistic Competition and Excess Capacity." *Journal of Political Economy*, 80 (May/June 1972): 586-591.
- The Economics of Advertising* (Vol. 80, Contributions to Economic Analysis), Amsterdam: North-Holland, 1972.
- "Consumer's Surplus and Producer's Goods." *American Economic Review*, 61 (September 1971): 682-687.
- "Regulation and the Durability of Goods." *Bell Journal of Economics and Management Science*, 1 (Spring 1970): 54-64.

ENERGY & ENVIRONMENT

- “Energy Storage Investment and Operation in Efficient Electric Power Systems” (with C. Junge and D. Mallapragada), *Energy Journal*, 43:6 (forthcoming): 79-102.
- Armstrong, R., Chair, and Yet-Ming Chiang, Co-Chair. *The Future of Energy Storage* (Participant), Cambridge: MIT Energy Initiative, 2022.
- “Competitive Energy Storage and the Duck Curve,” *Energy Journal*, 43:2 (2022): 1-16.
- “Electricity Price Distributions in Future Renewables-Dominant Power Grids and Policy Implications” (with D.S. Mallapragada, C. Junge, C. Wang, H. Pfeifenberger, and P.L. Joskow), MIT CEEPR WP-2021-017.
- “To Make Decarbonization Work, We Need Prices,” *Milken Institute Review*, May 25, 2021. Available at <https://www.milkenreview.org/articles/to-make-decarbonization-work-we-need-prices>.
- “Policy Evolution under the Clean Air Act” (with R.N. Stavins), *Journal of Economic Perspectives*, 33:4 (Fall 2019): 27-50.
- “Learning from Thirty Years of Cap & Trade” (with R.N. Stavins), *Resources*, Issue 201 (May 2019), 13-20.
- “Handicapping the High-Stakes Race to Net Zero,” *Milken Institute Review*, v. 20, n. 3, (Third Quarter 2018), pp. 34-45.
- “The Design of Environmental Markets: What Have We Learned from Experience with Cap and Trade?” (with R. Stavins), *Oxford Review of Economic Policy*, 33:4 (Winter 2017): 572-588.
- “Lessons Learned from Three Decades of Experience with Cap-and-Trade” (with R. Stavins), *Review of Environmental Economics and Policy*, 11:1 (Winter 2017): 59-79.
- “Lessons Learned from Cap-and-Trade Experience” (with R.N. Stavins), in R.N. Stavins and R.C. Stowe, eds., *Market Mechanisms and the Paris Agreement*, Harvard Project on Climate Agreements, October 2017, pp. 21-23. Available at https://www.belfercenter.org/sites/default/files/files/publication/2017-10_market-mechanisms-paris_v5.pdf
- Cropper, M.L. and R.G. Newell, Co-Chairs. *Valuing Climate Damages* (Participant), Washington: National Academies Press, 2017.
- ”The Future of the U.S. Electric Grid,” in *Perspectives on Complex Global Challenges* (E. Paté-Cornell, W.B. Rouse, and C.M. Vest, eds.). Hoboken, NJ: Wiley, 2016, pp. 73-79.
- “The Performance of U.S. Wind and Solar Generators,” *Energy Journal*, 37:1 (January 2016): 123-151.
- “The Future of Solar Energy: A Personal Assessment,” *Energy Economics*, 52: Supplement 1(December 2015): S142-S148.
- The Future of Solar Energy* (Chair), Cambridge: MIT Energy Initiative, 2015.
- Mellilo, J.M., T.C. Richmod, and G.W. Yohe, Eds. *The Third National Climate Assessment* (Participant), Washington: U.S. Global Change Research Program, 2014.
- “The SO₂ Allowance Trading System: The Ironic History of a Grand Policy Experiment,” (with R.N. Stavins), *Journal of Economic Perspectives*, 27 (Winter 2013): 103-22.
- “The Future of the (U.S.) Electric Grid,” (with H.D. Jacoby and J.G. Kassakian). In *Handbook of Energy and Climate Change* (R. Fouquet, ed.), Cheltenham, UK: Edward Elgar, 2013, pp. 125-139.

- “From ‘Green Growth’ to Sound Policies: An Overview,” *Energy Economics*, 34 (Supplement 1, November 2012): S2-S6.
- “Evaluating Policies to Increase the Generation of Electricity from Renewable Energy,” *Review of Environmental Economics and Policy*, 6 (Winter 2012): 45-64.
- “Policy Challenges and Technical Opportunities on the U.S. Grid” (with T.D. Heidel and J.G. Kassakian), *IEEE Power & Energy Magazine*, May/June 2012, 30-37.
- “Gridlock in 2030?” (with T.D. Heidel and J.G. Kassakian), *Public Utilities Fortnightly*, 150 (January 2012): 22-28.
- Carnesale, A. Chair. *America’s Climate Choices* (Participant), Washington: National Academies Press, 2011.
- The Future of the Electric Grid* (Co-Chair with J.G. Kassakian), Cambridge: MIT Energy Initiative, 2011.
- Harnessing Renewable Energy in Electric Power Systems* (ed., with B. Moselle and J. Padilla), Washington/London: RFF Press, 2010.
- “Toward a Low-Carbon Future in Electricity?” (with B. Moselle and J. Padilla). In *Harnessing Renewable Energy in Electric Power Systems* (B. Moselle, J. Padilla, and R. Schmalensee, eds.), Washington/London: RFF Press, 2010, pp. 1-4.
- “Renewable Electricity Generation in the United States.” In *Harnessing Renewable Energy in Electric Power Systems* (B. Moselle, J. Padilla, and R. Schmalensee, eds.), Washington/London: RFF Press, 2010, pp. 209-232.
- “Epilogue – Whither Renewable Generation?” (with B. Moselle and J. Padilla). In *Harnessing Renewable Energy in Electric Power Systems* (B. Moselle, J. Padilla, and R. Schmalensee, eds.), Washington/London: RFF Press, 2010, pp. 328-333.
- “Epilogue.” In *Post-Kyoto International Climate Policy: Implementing Architectures for Agreement* (J.E. Aldy and R.N. Stavins, eds.), Cambridge: Cambridge University Press, 2010, pp. 889-898.
- Markets for Clean Air: The U.S. Acid Rain Program* (with A.D. Ellerman, P.L. Joskow, J.P. Montero, and E.M. Bailey), Cambridge: Cambridge University Press, 2000.
- “Household Gasoline Demand in the United States” (with T.M. Stoker). *Econometrica*, 67 (May 1999): 645-662.
- “Economic Development and the Structure of the Demand for Commercial Energy” (with R.A. Judson and T.M. Stoker). *Energy Journal*, 20 (1999): 29-57.
- “Commentary.” In *Climate Change Policy: Practical Strategies to Promote Economic Growth and Environmental Quality* (C.E. Walker, M.A. Bloomfield, and M. Thorning, eds.), Washington: American Council for Capital Formation, Center for Policy Research, 1999, pp. 33-38.
- “Kyoto’s Unfinished Business” (with H.D. Jacoby and R.G. Prinn). *Foreign Affairs*, 77 (July/August 1998): 54-66. Reprinted in *Economics of the Environment: Selected Readings*, 4th Ed. (R.N. Stavins, ed.), New York, Norton: 1999, pp. 517-526.
- “An Interim Evaluation of Sulfur Dioxide Emissions Trading” (with P.L. Joskow, A.D. Ellerman, J.-P. Montero, and E.M. Bailey). *Journal of Economic Perspectives*, 12 (Summer 1998): 53-68. Reprinted in *Economics of the Environment: Selected Readings*, 4th Ed. (R.N. Stavins, ed.), New York: Norton, 1999, pp. 455-471.
- “The Market for Sulfur Dioxide Emissions” (with P.L. Joskow and E.M. Bailey). *American Economic Review*, 88 (September 1998): 669-685.

- “World Carbon Dioxide Emissions: 1950-2050” (with T.M. Stoker and R.A. Judson). *Review of Economics and Statistics*, 80 (February 1998): 15-27.
- “The Political Economy of Market-Based Environmental Policy: The US Acid Rain Policy” (with P.L. Joskow). *Journal of Law and Economics*, 41 (April 1998): 37-83. Reprinted in *Economics of the Environment: Selected Readings*, 4th Ed. (R.N. Stavins, ed.), New York: Norton, 1999, pp. 603-645.
- “Tradable Emissions Rights and Joint Implementation for Greenhouse Gas Abatement: A Look Under the Hood.” In *The Impact of Climate Change Policy on Consumers: Can Tradable Permits Reduce the Cost?* (C.E. Walker, M.A. Bloomfield, and M. Thorning, eds.), Washington: American Council for Capital Formation, 1998, pp. 39-55.
- “Greenhouse Policy Architectures and Institutions.” In *Economics and Policy Issues in Climate Change* (W.D. Nordhaus, ed.), Washington: Resources for the Future, 1998, pp. 137-158.
- “Commentary.” In *Climate Change Policy, Risk Prioritization, and Economic Growth*, Washington: American Council for Capital Formation Center, for Policy Research, 1997, pp. 65-69.
- “What Does Stabilizing Greenhouse Gas Concentrations Mean?” (with H.D. Jacoby and D.M. Reiner). In *Critical Issues in the Economics of Climate Change* (B.P. Flannery and C.A.B. Grezo, eds.), London: IPIECA, 1997, pp. 225-244.
- “Commentary.” In *Strategies for Improving Environmental Policy and Increasing Economic Growth*, Washington: American Council for Capital Formation, Center for Policy Research, 1995, 32-35.
- Review of J. Broome, *Counting the Cost of Global Warming*; William R. Cline, *The Economics of Global Warming*; and Alan S. Manne and Richard G. Richels, *Buying Greenhouse Insurance: The Economic Costs of CO₂ Limits*. *Journal of Economic Literature*, 32 (June 1994): 738-741.
- “Green Costs and Benefits: The Buck Stops Where?” In *Environment Strategy America 1994/95* (W.K. Reilly, ed.), London: Campden, 1994, pp. 16-17.
- “The Costs of Environmental Protection.” In *Balancing Economic Growth and Environmental Goals*, Washington: American Council for Capital Formation Center for Policy Research, 1994, pp. 55-80. (Italian translation: “I costi della protezione ambientale,” *Energia*, 15 (December 1994): 30-48.)
- “Comparing Greenhouse Gases for Policy Purposes.” *Energy Journal*, 14 (1993): 245-255.
- “Symposium on Global Climate Change.” *Journal of Economic Perspectives*, 7 (Fall 1993): 3-10.
- “Commentary.” In *U.S. Environmental Policy and Economic Growth: How Do We Fare?* Washington: American Council for Capital Formation Center for Policy Research, 1992, pp. 48-51.
- “A Comprehensive and Balanced Energy Policy.” *Environmental Forum*, 8 (May/June 1991): 41-42.
- “How Should We Address Economic Costs of Climate Change?” In *Global Climate Change: The Economic Costs of Mitigation and Adaptation* (J.C. White, ed.), New York: Elsevier, 1991, pp. 73-76.
- “Commentary.” In *Environmental Policy and the Cost of Capital*, Washington: American Council for Capital Formation Center for Policy Research, 1990, pp. 104-7.
- “Estimated Parameters as Independent Variables: An Application to the Costs of Electric Generating Units” (with P. L. Joskow). *Journal of Econometrics*, 31 (April 1986): 275-305.
- “Adversary Hydro Relicensing Applications: Using Economic Efficiency Criteria” (with P. L. Joskow). *Public Utilities Fortnightly*, 114 (20 December 1984): 22-28.
- “Estimating Effective Concentration in Deregulated Wholesale Electricity Markets” (with B. W. Golub). *RAND Journal of Economics*, 15 (Spring 1984): 12-26.

- "Cartel Deception in Markets for Nonrenewable Resources" (with T. R. Lewis). *Bell Journal of Economics*, 13 (Spring 1982): 263-271.
- "Optimal Use of Renewable Resources with Nonconvexities in Production" (with T.R. Lewis). In *Essays in the Economics of Renewable Resources* (J. Mirman and D.F. Spulber, eds.), Amsterdam: North-Holland, 1982, pp. 95-111.
- "Cartel and Oligopoly Pricing of Nonreplenishable Natural Resources" (with T.R. Lewis). In *Dynamic Optimization and Mathematical Economics* (P. T. Liu, ed.), New York: Plenum, 1980, pp. 133-156.
- "On Oligopolistic Markets for Nonrenewable Natural Resources" (with T. R. Lewis). *Quarterly Journal of Economics*, 95 (November 1980): 475-491.
- "Appropriate Government Policy Toward Commercialization of New Energy Supply Technologies." *Energy Journal*, 1 (April 1980): 1-40.
- "Nonconvexity and Optimal Harvesting Strategies for Renewable Resources" (with T. R. Lewis). *Canadian Journal of Economics*, 12 (November 1979): 677-691.
- "Life-Cycle Costing for Consumers of Energy-Conserving Devices" (with S. S. Penner and M. R. Brambley). *Energy*, 3 (July/August 1978): 415-419.
- "Promoting Competition in Tomorrow's Markets for Solar Energy Systems." In *The Solar Market: Proceedings of the Symposium on Competition in the Solar Energy Industry*, U.S. Federal Trade Commission, Washington, D.C.: U.S. Government Printing Office, 1978, pp. 119-135.
- "Nonconvexity and Optimal Exhaustion of Renewable Resources" (with T. R. Lewis). *International Economic Review*, 18 (October 1977): 535-552.
- Measuring External Effects of Solid Waste Management* (with R. Ramanathan, W. Ramm, and D. Smallwood). Washington, D.C.: U.S. Environmental Protection Agency, Socioeconomic Environmental Studies Series, 1975.
- "The Computer Model of Energy Production without Fast Breeder Reactors" and "The Computer Model of Fast Breeder Demands and Prices" (with P. W. MacAvoy). Appendices E and F in P.W. MacAvoy, *Economic Strategy for Developing Nuclear Breeder Reactors*, Cambridge: MIT Press, 1969, pp. 186-199.

ANTITRUST & REGULATION

- "Strengths and Weaknesses of Traditional Arrangements for Electricity Supply," in *Handbook on Electricity Markets* (Jean-Michel Galchant, Paul Joskow, and Michael Pollitt, eds.). Cheltenham: Edward Elgar, 2021, ch. 2, pp. 13-35.
- Antitrust Analysis of Platform Markets: Why the Supreme Court Got It Right in American Express* (with D.S. Evans), Boston: Competition Policy International, 2019.
- "The Role of Market Definition in Assessing Anticompetitive Harm in Ohio v. American Express" (with D.S. Evans), *CPI Antitrust Chronicle*, Spring 2019. Available at <https://www.competitionpolicyinternational.com/the-role-of-market-definition-in-assessing-anticompetitive-harm-in-ohio-v-american-express/>
- "Microsoft v. Motorola (2015)," (with H.H. Chang), in *The Antitrust Revolution, 7th Ed.* (John E. Kwoka, Jr. and Lawrence J White, eds.). Oxford: Oxford University Press, 2019, pp. 294-311.
- "Two-Sided Red Herrings" (with D.S. Evans), *CPI Antitrust Chronicle*, Fall 2018. Available at <https://www.competitionpolicyinternational.com/two-sided-red-herrings/>

- “Applying the Rule of Reason to Two-Sided Platform Businesses” (with D.S. Evans), *University of Miami Business Law Review*, 26: 1 (April 2018), 15 pp. Available at <https://repository.law.miami.edu/umblr/vol26/iss2/3>.
- “Ignoring Two-Sided Business Reality Can Also Hurt Plaintiffs” (with D.S. Evans). *CPI Antitrust Chronicle*, Spring 2018. Available at <https://www.competitionpolicyinternational.com/ignoring-two-sided-business-reality-can-also-hurt-plaintiffs/>.
- “Brief for *Amici Curiae* Prof. David S. Evans and Prof. Richard Schmalensee in Support of Respondents.” In the matter of *State of Ohio, et al., v. American Express Company, et al.* before the U.S. Supreme Court (Case 16-1454), filed January 23, 2018.
- “Network Effects: March to the Evidence, Not to the Slogans” (with D.S. Evans), *CPI Antitrust Chronicle*, August 2017. Available at <https://www.competitionpolicyinternational.com/wp-content/uploads/2017/09/CPI-Evans-Schmalensee.pdf>. Reprinted as “Debunking the ‘Network Effects’ Bogyman,” *Regulation* 40 (4, Winter 2017/18): 36-39.
- “Brief of Dr. David S. Evans and Prof. Richard Schmalensee as *Amici Curiae* in Support of Appellants-Cross Appellees.” In the matter of *U.S. Airways v. Sabre* before the Second Circuit Court of Appeals (Case 17-960), filed July 26, 2017.
- “Reforming the U.S. Coal Leasing Program” (with K. Gillingham et al), *Science*, 354: 3616 (December 2, 2016), 1096-1098.
- “The Staggers Act at 35: Railroad Economics and Regulation” (with W.W. Wilson), *Review of Industrial Organization*, 49:2 (2016): 127-131.
- “Modernizing U.S. Freight Rail Regulation” (with W.W. Wilson), *Review of Industrial Organization*, 49:2 (2016): 135-159.
- “The Antitrust Analysis of Multi-Sided Platform Businesses,” (with D.S. Evans). In *Oxford Handbook of International Antitrust Economics* (R.D. Blair and D.D. Sokol, eds.), Oxford: Oxford University Press, 2015, pp. 404-447.
- Modernizing Freight Rail Regulation* (Chair), Washington: Transportation Research Board, 2015.
- “Deregulation: Introduction and Overview.”(with P.W. MacAvoy) In *The Causes and Effects of Deregulation*. (2 Vols., P.W. MacAvoy and R. Schmalensee, eds.), Cheltenham, UK: Edward Elgar, 2014, pp. ix-xv.
- The Causes and Effects of Deregulation*. (2 Vols., ed., with P.W. MacAvoy), Cheltenham, UK: Edward Elgar, 2014.
- “AT&T/T-Mobile: Does Efficiency Really Count?” (with H. Chang and D.S. Evans), *CPI Antitrust Chronicle*, 10 (October 2011), Article 2, 5 pages. Available at <https://www.competitionpolicyinternational.com/file/view/6564>.
- “The Net Effects of the Proposed Durbin Fee Reductions on Consumers and Small Business” (with D.S. Evans and R.E. Litan). *The Lydian Journal*, Issue 5, March 2011, Available at <http://www.pymnts.com/journal/>
- “Should New Merger Guidelines Give UPP Market Definition?” *GCP: The Antitrust Chronicle*, December 2009, Release 1. Available at <https://www.competitionpolicyinternational.com/dec-091/>
- “Thoughts on the Chicago Legacy in Antitrust.” In *Where the Chicago School Overshot the Mark: The Effect of Conservative Economic Analysis on U.S. Antitrust* (R. Pitofsky, ed.), New York: Oxford University Press, 2008, pp. 11-23.

- “Economic Analysis of Class Certification,” *Global Competition Policy*, June 2008, Release 2. Available at <http://www.globalcompetitionpolicy.org/index.php?&id=1184&action=907>.
- “Pricing Patents for Licensing in Standard-Setting Organizations: Making Sense of *FRAND* Commitments” (with A. Layne-Farrar and A.J. Padilla), *Antitrust Law Journal*, 74 (2007): 671-706.
- “The Industrial Organization of Markets with Two-Sided Platforms” (with D.S. Evans), *Competition Policy International*, 3 (Spring 2007): 151-179. Also in W.D. Collins, ed., *Issues in Competition Law and Policy*, Chicago: American Bar Association, 2008, pp. 667-693.
- “The Economics of Interchange Fees and Their Regulation: An Overview” (with D.S. Evans). In *Interchange Fees in Credit and Debit Card Industries: What Role for Public Authorities?* Kansas City: Federal Reserve Bank of Kansas City, 2005, pp. 77-120.
- “*United States v. Microsoft*: Did Consumers Win?” (with D.S. Evans and A.L. Nichols). *Journal of Competition Law and Economics*, 1 (September 2005): 497-539
- “Sunk Costs and Antitrust Barriers to Entry,” *American Economic Review*, 94 (May 2004): 471-475.
- “The Retailer Class Action Antitrust Case Against the Card Associations” (with H.H. Chang and D.S. Evans). In *The Payment Card Economics Review, Vol. 2*, Cambridge: payingwithplastic.org/National Economic Research Associates, Winter 2004, pp. 123-141.
- “Interchange Fees: A Review of the Literature.” In *The Payment Card Economics Review, Vol. 1*, Cambridge: payingwithplastic.org/National Economic Research Associates, 2003, pp. 25-44.
- “Has the Consumer Harm Standard Lost its Teeth?” (with H.H. Chang and D.S. Evans). In *High-Stakes Antitrust: The Last Hurrah?* (R.W. Hahn, ed.), Washington: Brookings Institution Press, 2003, pp. 72-116.
- “Some Economic Aspects of Antitrust Analysis in Dynamically Competitive Industries” (with D.S. Evans). In *Innovation Policy and the Economy*, Vol. 2 (A. Jaffe, J. Lerner, and S. Stern, eds.), Cambridge: MIT Press, 2002, pp. 1-49.
- “Comments” (On Robert E. Litan and Carl Shapiro, “Antitrust Policy in the Clinton Administration”). In *American Economic Policy in the 1990s* (J.A. Frankel and P.R. Orzag, eds.), Cambridge: MIT Press, 2002, pp. 493-499.
- “Lessons from the Microsoft Case.” European Investment Bank Lecture Series, Florence: European University Institute, 2002.
- “The Economics of the Microsoft Case: A Post-Trial Primer” (with D.S. Evans). In *Trial and Error: United States v. Microsoft* (P. Beckner and E.R. Gustafson, eds.), Washington: Citizens for a Sound Economy, 2001, pp. 70-86.
- “A Monopolist would *Still* Charge More for Windows: A Comment on Werden’s Reply” (with B. Reddy, D.S. Evans, and A. Nichols). *Review of Industrial Organization*, 18 (May 2001): 273-274.
- “A Monopolist would *Still* Charge More for Windows: A Comment on Werden” (with B. Reddy, D.S. Evans, and A. Nichols). *Review of Industrial Organization*, 18 (May 2001): 263-268.
- “An Analysis of the Government’s Economic Case in *U.S. v. Microsoft*” (with D.S. Evans and A.L. Nichols). *Antitrust Bulletin*, 46 (Summer 2001), pp. 163-251. Reprinted in *Microsoft, Antitrust and the New Economy: Selected Essays* (D.S. Evans, ed.), Boston: Kluwer: 2002.
- “Antitrust Issues in Schumpeterian Industries.” *American Economic Review*, 90 (May 2000): 192-196.
- Did Microsoft Harm Consumers? Two Opposing Views* (with D.S. Evans; F.M. Fisher and D.L. Rubinfeld), Washington: AEI Press, 2000.

- “Bill Baxter in the Antitrust Arena: An Economist’s Appreciation.” *Stanford Law Review*, 51 (May 1999): 1317-1332.
- “Some Economic Principles for Guiding Antitrust Policy Towards Joint Ventures” (with H. Chang and D.S. Evans). *Columbia Business Law Review*, 1998 (1998): 223-329.
- “An Analysis of the Welfare Effects of Long-Distance Market Entry by an Integrated Access and Long-Distance Provider” (with P.J. Hinton, J.D. Zona, and W.E. Taylor). *Journal of Regulatory Economics*, 13 (March 1998): 183-196.
- “Joint Venture Membership: Visa and Discover Card (1993)” (with D.S. Evans). In *The Antitrust Revolution, 3rd Ed.* (J. Kwoka and L. White, eds.), Oxford: Oxford University Press, 1998, pp. 286-309.
- “A Guide to the Antitrust Economics of Networks” (with D.S. Evans). *Antitrust Magazine*, 10 (Spring 1996): 36-40.
- “Antitrust Issues Related to Networks.” Statement before the U.S. Federal Trade Commission, December 1, 1995.
- "Economic Aspects of Payment Card Systems and Antitrust Policy Toward Joint Ventures" (with D.S. Evans). *Antitrust Law Journal*, 63 (Spring 1995): 861-901.
- "The Benefits of Releasing the Bell Companies from the Interexchange Restrictions" (with P.S. Brandon). *Managerial and Decision Economics*, 16 (July-August 1995): 349-364.
- "What Have We Learned About Privatization and Regulatory Reform?" *Revista de Análisis Económico*, 10 (November 1995): 21-39. (Remarks in Roundtable Discussion, pp. 303-312.)
- "Competition Policy in Russia During and After Privatization" (with P.L. Joskow and N. Tsukanova). *Brookings Papers on Economic Activity, Microeconomics*, 1994: 301-374. [Awarded the 1995 Edward A. Hewett Prize by the American Association for the Advancement of Slavic Studies.]
- "Agreements Between Competitors." In *Antitrust, Innovation, and Competitiveness* (T. M. Jorde and D. J. Teece, eds.), Oxford: Oxford University Press, 1992, pp. 98-118.
- "The Potential of Incentive Regulation." In *The Market for Energy* (D. Helm, J. Kay, and D. Thompson, eds.), Oxford: Clarendon Press, 1989, pp. 178-187.
- "Regulation and Antitrust in the Bush Administration." *Antitrust Law Journal*, 58 (1989): 475-480.
- "Standards for Dominant Firm Conduct: What Can Economics Contribute?" In *The Economics of Market Dominance* (D. Hay and J. Vickers, eds.), Oxford: Basil Blackwell, 1987, pp. 61-88.
- "Horizontal Merger Policy: Problems and Changes." *Journal of Economic Perspectives*, 1 (Fall 1987): 41-54.
- "Ease of Entry: Has the Concept Been Too Readily Applied?" *Antitrust Law Journal*, 56 (1987): 41-51.
- "Incentive Regulation for Electric Utilities" (with P. L. Joskow). *Yale Journal on Regulation*, 4 (Fall 1986): 1-49.
- "Comments." In *Telecommunications Access and Public Policy* (A. Baughcum and G. R. Faulhaber, eds.), Norwood, N.J.: Ablex, 1984, pp. 76-80.
- Markets for Power: An Analysis of Electric Utility Deregulation* (with P. L. Joskow), Cambridge: MIT Press, 1983.
- "Antitrust and the New Industrial Economics." *American Economic Review*, 72 (May 1982): 24-28.
- "Another Look at Market Power." *Harvard Law Review*, 95 (June 1982): 1789-1816.

- "Remarks (on conglomerate mergers)." In *The Conglomerate Corporation* (R. D. Blair and R. F. Lanzillotti, eds.), Cambridge: Oelgeschlager, Gunn & Hain, 1981, pp. 365-368.
- "Income-Distributional Concerns in Regulatory Policymaking: Comment." In *Studies in Public Regulation* (G. Fromm, ed.), Cambridge: MIT Press, 1981, pp. 112-117.
- "On the Use of Economic Models in Antitrust: The ReaLemon Case." *University of Pennsylvania Law Review*, 127 (April 1979): 994-1050. Reprinted in *Antitrust Law and Economics* (O. E. Williamson, ed.), Houston: Dame, 1980, pp. 97-153.
- The Control of Natural Monopolies*, Lexington: D.C. Heath (Lexington Books), 1979.
- "Valuing Changes in Regulated Firms' Input Prices." *Southern Economic Journal*, 43 (January 1977): 1346-1351.
- "Estimating the Costs and Benefits of Utility Regulation." *Quarterly Review of Economics and Business*, 14 (Summer 1974): 51-64.
- OTHER**
- "Puzzles and Surprises in Employment and Productivity in U.S. Manufacturing After the Great Recession," *International Productivity Monitor*, No. 35 (Fall 2018): 1-23.
- "Comment on 'Market and Management Failures' (by Pankaj Ghemawat)," *Capitalism and Society*, Vol. 12, Issue. 1 (May 2017), Article 6.
- "Socialism for Red States in the Electric Utility Industry," *Journal of Competition Law and Economics*, 12:3 (September 2016), 477-494.
- "Where's the 'B' in B-Schools?" *Business Week*, November 27, 2006, p. 118.
- Management: Inventing and Delivering Its Future* (ed., with T.A. Kochan), Cambridge: MIT Press, 2003. Chinese and Korean editions, 2004.
- "Introduction" (with T.A. Kochan). In *Management: Inventing and Delivering Its Future* (T.A. Kochan and R. Schmalensee, eds.), Cambridge: MIT Press, 2003, pp. 1-13.
- "Ways I Have Worked." *The American Economist*, 40 (Fall 1996): 37-43. Reprinted in *Passion and Craft: How Economists Work* (M. Szenberg, ed.), Ann Arbor: University of Michigan Press, 1998, pp. 243-255.
- "Is There a Role for Benefit-Cost Analysis in Environmental Health and Safety Regulation?" (with K.J. Arrow, M.L. Cropper, G.C Eads, R.W. Hahn, L.B. Lave, R.G. Noll, P.R. Portney, M. Russell, V.K. Smith, and R.N. Stavins). *Science*, 272 (12 April 1996): 221-222. Reprinted in *Economics of the Environment: Selected Readings*, 4th Ed. (R.N. Stavins, ed.), New York: Norton, 1999. pp. 319-324.
- "Continuity and Change in the Economics Industry." *Economic Journal*, 101 (January 1991): 115-121. Reprinted in *The Future of Economics* (J.D. Hey, ed.), Oxford: Basil Blackwell, 1992, pp. 115-121.
- Economics*, 2nd Ed. (with S. Fischer and R. Dornbusch), New York: McGraw-Hill, 1988. Multiple foreign language editions.
- "Imperfect Information and the Equitability of Competitive Prices." *Quarterly Journal of Economics*, 99 (August 1984): 441-460.
- "George Stigler's Contributions to Economics." *Scandinavian Journal of Economics*, 85 (March 1983): 77-86.
- "Risk and Return on Long-Lived Tangible Assets." *Journal of Financial Economics*, 9 (June 1981): 185-205.

- "Qualitative Asymptotic Synthesis in Simple Optimal Control Problems." *Economic Letters*, 5 (1980): 349-352.
- "Advertising and Aggregate Consumption: An Analysis of Causality" (with R. Ashley and C. W. J. Granger). *Econometrica*, 48 (July 1980): 1149-1168.
- "Common Stock Volatility Expectations Implied by Option Premia" (with R. R. Trippi). *Journal of Finance*, 33 (March 1978): 129-147.
- "Public Investment Criteria, Insurance Markets, and Income Taxes." *Journal of Public Economics*, 6 (November 1976): 425-445.
- "Another Look at the Social Valuation of Input Price Changes." *American Economic Review*, 66 (March 1976): 239-243.
- "An Experimental Study of Expectation Formation." *Econometrica*, 44 (January 1976): 17-41.
- "Alternative Models of Bandit Selection." *Journal of Economic Theory*, 10 (June 1975): 333-342.
- "Option Demand and Consumer's Surplus: Reply." *American Economic Review*, 65 (September 1975): 737-739.
- "Theory, Fact, and Policy: A Reply to Professor Barten." *Recherches Economiques de Louvain*, 41 (March 1975): 63-66.
- "Consumer Behavior versus Economic Theory." *Recherches Economiques de Louvain*, 40 (September 1974): 261-276.
- Applied Microeconomics: Problems in Estimation, Forecasting and Decision-Making*, San Francisco: Holden-Day, 1973.
- An Introduction to Applied Macroeconomics* (with E. Kuh), Amsterdam: North-Holland, 1973. Japanese edition, 1975.
- "Option Demand and Consumer's Surplus: Valuing Price Changes Under Uncertainty." *American Economic Review*, 62 (December 1972): 813-824.

July, 2022