
The Supernetwork Sentinel

The Newsletter of the Virtual Center for Supernetworks
Winter 2009



Welcome to the Winter 2009 edition of **The Supernetwork Sentinel**, the newsletter of the Virtual Center for Supernetworks at the Isenberg School of Management, UMass Amherst. **The Supernetwork Sentinel** is published in Fall, Winter, and Summer editions. Its purpose is to keep you informed of events, activities, and successes of the Virtual Center for Supernetworks, the Center Associates, and the Supernetworks Laboratory for Computation and Visualization. In this newsletter, we include an essay on the economic crisis and financial contagion. We also give information on recently received distinctions, from plenary talks to invited seminars and national awards. We provide news about exciting upcoming events. As always, we include a list of our recent publications.

We wish everyone a Happy New Year!

Anna Nagurney
John F. Smith Memorial Professor
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UMass Amherst PhD Alumni and Current PhD Students with Professors Anna Nagurney and Senay Solak at the INFORMS National Meeting in Washington, DC

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Financial Networks, Contagion, and the Present Economic Crisis

Anna Nagurney and Patrick Qiang

The study of financial networks dates to Quesnay, who, in his 1758 book, *Tableau Economique*, conceptualized the circular flow of financial funds in an economy as a network. Copeland, in the early 1950s, studied the relationships among financial funds as a network and asked the question, "Does money flow like water or electricity?" The advances in information technology and globalization have further shaped today's financial world into a complex network, which is characterized by distinct sectors, the proliferation of new financial instruments, and with increasing international diversification of portfolios. Recently, financial networks have been studied using network models with multiple tiers of decision-makers, including intermediaries.

As we are seeing today, our financial networks are highly interconnected and interdependent and, hence, any disruption that occurs in one part of the network may produce consequences in other parts of the network, which may not only be in the same region but a continent away. For example, the unforgettable 1987 stock market crash was, in effect, a chain reaction throughout the world; it originated in Hong Kong, propagated to Europe, and, finally, the United States. More recently, notable financial crises have included the Mexican meltdown in 1994 - 1995, sometimes referred to as the "Tequila Effect," and the Asian flu crisis of 1997 - 1998, which spread financial contagion, that is, the transmission and impact of financial crises (Kali and Reyes (2005)). The losses due to this Asian financial crisis, have been estimated at \$3 trillion in GDP and \$2 trillion in equity on financial markets.

The Severe Acute Respiratory Syndrome (SARS) crisis, which began in November 2002 and was pronounced by the World Health Organization to be contained on July 5, 2003, claimed 812 lives with more than 8,400 people infected. According to deLisle (2003), SARS seemed to parallel the Asian financial crisis of the 1990s and just like the "Asian contagion" SARS spread quickly along the pathways made possible by globalization. However, rather than international capital mobility that allowed for possible attacks by speculators on vulnerable currencies, it was the global mobility of humans through air travel that made the quick spread of SARS possible and, as noted by deLisle (2003), unpredictable. Toronto, Canada was the area most affected by SARS outside of East Asia, with more than thirty deaths among approximately 200 infections. SARS cost Canada, during its duration, tens of millions of dollars per day in economic terms.

The world is now reeling from the effects of the financial credit crisis, with leading financial services and banks closing, including the investment bank Lehman Brothers, others merging, and the financial landscape being changed for forever. The domino effect of the U.S. economic troubles has rippled through overseas markets and pushed countries, such as Iceland, to the verge of bankruptcy. The root of the financial problems is considered to have stemmed from the U.S. housing market with a huge number of bad loans, which could not, subsequently, be repaid. Many of the sub-prime loans had been bundled and then sold to investment banks, some of whom had, in turn, borrowed money for these transactions, thus, further complexifying the number of decision-makers or agents and the financial linkages. Ultimately, businesses could not obtain financial resources since so many banks and financial institutions were failing, which, in turn, have caused thousands of families to lose their homes.

It is, therefore, crucial for the decision-makers in financial systems, the managers, executives, and regulators, to be able to identify a financial network's vulnerable components in order to protect the functionality of the network. As an illustration, Merrill Lynch management well understood the criticality of their operations in the World Trade Center and established contingency plans. Upon the 9/11 terrorist attacks, management was able to switch operations from the World Trade Center to the backup centers and the redundant trading floors near New York City. Therefore, the company managed to mitigate the losses for both its customers and itself (Sheffi (2005)).

We have proposed a unified network performance measure (Qiang and Nagurney (2008)) that can be used to assess the network performance in the case of either fixed or elastic demands in a variety of critical infrastructure networks from transportation and logistic networks to electric power generation and distribution networks. The measure captures flow information and user/decision-maker behavior, and also allows one to determine the criticality of various nodes (as well as links) through the identification of their importance and ranking. In a recent study (Nagurney and Qiang (2008)) we have constructed a novel financial network performance measure, which is motivated by our unified network measure. The financial measure evaluates the financial network performance in the context where there is noncooperative competition among source fund agents and among financial intermediaries. Our financial network performance measure has now been applied to identify the importance and the ranking of financial

network components (Nagurney and Qiang (2008)). Financial networks, as extremely important infrastructure networks, and whose behavior has much in common with that of other infrastructure networks, including transportation networks (Liu and Nagurney (2007)), have a great impact on the global economy, and now we have developed rigorous analytical, computer-based tools that can assess global, system-wide impacts from local disruptions. Such research outcomes could not be more timely.

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The UMass Amherst INFORMS Student Chapter Recognized with Award at National Meeting

On October 14, 2008, the UMass Amherst INFORMS (Institute for Operations Research and the Management Sciences) Student Chapter received the *Magna Cum Laude Award* at the National INFORMS Meeting, which was held in Washington, DC. The chapter was recognized for its activities for the year 2007. The Chapter Officers for 2008-2009 are: Center Associate Amir Masoumi, President; Center Associate Min Yu, Vice President; Milad Ebtehaj, Treasurer; and Deanna Kennedy, Secretary. Patrick Qiang, last year's Chapter President, is the webmaster. For more information about the Student Chapter, see:

<http://student.som.umass.edu/informs/>



Trisha Woolley, Professor Nagurney, and Deanna Kennedy in Washington, DC

The Fall 2008 UMass Amherst Speaker Series Organized by the INFORMS Student Chapter Was a Huge Success



Tom Vanderbilt signing copies of his book, *Traffic*, in the Supernetworks Lab

This past semester, we were delighted to be able to host a list of exceptional speakers in our Fall 2008 Speaker Series. The roster included: Professor Daron Acemoglu, the Charles P. Kindleberger Professor of Applied Economics at MIT, Dr. Grace Lin, the Chief Technology Officer and Director of Innovation and Emerging Solutions — Supply Chain Management at IBM Global Business Services in Yorktown Heights, N.Y., Professors Ahmed Ghoniem and Senay Solak, new Assistant Professors in the Department of Finance and Operations Management at the Isenberg School of Management, Professor Kevin Fu of the Computer Science Department at UMass Amherst, and Tom Vanderbilt, the best-selling author of the book, *Traffic*. The speakers

attracted wide audiences and media coverage and we thank them all for their exceptional talks and visits to the Isenberg School of Management at UMass Amherst. For additional information, see: <http://student.som.umass.edu/informs/>

Support for the speaker series is provided by the Isenberg School of Management and its Department of Finance and Operations Management, the John F. Smith Memorial Fund, and INFORMS. Anna Nagurney, the John F. Smith Memorial Professor at the Isenberg School of Management, serves as the Faculty Advisor to the Chapter and its speaker series, which is now in its tenth semester of operation; <http://supernet.som.umass.edu/informs/speakernew.html>

The Spring 2009 UMass Amherst Speaker Series

Following the success of the Fall 2008 Speaker Series, we are delighted to announce the confirmed speakers for Spring 2009. Professor Ellis Johnson of Georgia Tech, who is a member of the National Academy of Engineering, will be speaking on February 20, 2009. Professor Alex Pentland of MIT, whose research on networks, sensing, and signal processing has attracted vast media attention, including multiple coverage in the *New York Times*, will be speaking on April 3, 2009. Professor Hillel Bar-Gera of Ben-Gurion University in Israel will be speaking on April 24, 2009. Professor Bar-Gera is an expert on large-scale transportation network modeling and algorithms for traffic prediction. Professor Robert Pollin of the Department of Economics and the Political Economy Research Institute at UMass Amherst will be speaking on *Green Economics* on May 8, 2009. Professor Hari Balasubramanian of the Department of Mechanical and Industrial Engineering will also be speaking at a date to be announced. Complete information, as it becomes available, will be posted at: <http://supernet.som.umass.edu/informs/speakernew.html>

Presentations and Seminars

Center Associate, Dr. Stavros Siokos, who is the Managing Director and Vice President of the Piraeus Bank in Athens, Greece, was a featured speaker in London, England, at The Derivative Tech Trader Conference, which took place September 22-24, 2008.

On September 23, 2008, Professor Anna Nagurney gave a talk sponsored by the Center for Women in Mathematics at Smith College in Northampton, MA. The title of her talk was, **Equilibrium Modeling and Vulnerability**

Analysis of Complex Network Systems: Which Nodes and Links Really Matter?

Afterwards, she participated in a discussion with students about Women in Mathematics. Professor Nagurney was hosted by Professor Ruth Haas of Smith College and she enjoyed the audience and discussion tremendously.

October 10-12, 2008, Professor Anna Nagurney took part in the "Workshop on Frontiers in Game Theory and Networked Control Systems" at MIT in Cambridge, MA. This conference was sponsored by the Department of Electrical Engineering and Computer Science at MIT, the Army Research Office, and the National Science Foundation. Her invited talk was entitled, **To Merge or Not to Merge: Multimarket Supply Chain Network Oligopolies, Coalitions, and the Merger Paradox**. Professor Nagurney thanks the organizers and, in particular, Professor Asu Ozdaglar, for such a terrific workshop. The link to the MIT workshop website is: <http://games.lids.mit.edu/>

The Center Associates gave many presentations on topics ranging from humanitarian logistics to electric power supply chains at the INFORMS National Meeting in Washington, DC, October 12-15, 2008. In addition, Professor Anna Nagurney organized two sessions for this meeting as part of the Transportation Science & Logistics Society track. The titles of the sessions were: **Transportation and Climate Change and Transportation Network Vulnerability and Performance Assessment**. The sessions included speakers from Sweden and Turkey. More information on this conference, including the complete program, can be found at: <http://meetings.informs.org/DC08/>



Professors Mehdi Amini, Marla Stafford, Anna Nagurney, Tina Wakolbinger, and Frances Fabian at the Fogelman College

On October 31, 2008, Professor Anna Nagurney was a speaker in the 2008 Fogelman College Distinguished Speaker Series at the University of Memphis. One of her hosts was Center Associate Professor Tina Wakolbinger. The title of Professor Nagurney's Distinguished Lecture was: **Synergies and Vulnerabilities of Supply Chain Networks in a Global Economy**. The day prior she gave the talk, **To Merge or Not**

to Merge: Multimarket Supply Chain Network Oligopolies, Coalitions, and the Merger Paradox, to an academic audience at the University of Memphis. The hospitality extended to Professor Nagurney by the Dean of the School, Dr. Rajiv Grover, by the Provost, Dr. Ralph Faudree, and even by the men's basketball coach, John Calipari, was amazing. More information about the visit can be found at:

<http://supernet.som.umass.edu/media/media.htm>

The 55th Annual North American Meetings of the Regional Science Association International were held November 19-22, 2008, in Brooklyn, New York. Professor Anna Nagurney gave the plenary talk, **Transportation Network Equilibrium – The Formalism for Networks Today from the Internet to Electric Power Supply Chains and Financial Networks: What the World Should Learn from Regional Scientists**, at this conference. The conference website is: <http://narsc.org/conference.html>
The venue for this conference was terrific and the conferees came from around the globe.

Many of the above presentations are available at: <http://supernet.som.umass.edu/visuals.htm>

Kudos and News

Congratulations to the Center Associates for the coverage of their various activities in the *Isenberg School of Management's Annual Report for 2008!* In the *Annual Report* there is an article on the Complex Networks Workshop organized by Center Associate Professor Patrizia Daniele of the University of Catania, along with Professor Anna Nagurney, which took place in March 2008 in Catania, Italy, as part of Professor Nagurney's Senior Fulbright Specialist Award. There is also an article on the Rockefeller Foundation sponsored conference at its Bellagio Center in Italy organized by Professor Nagurney. The conference: Humanitarian Logistics: Networks for Africa took place May 5-9, 2008. Finally, the *Annual Report* highlights the National Award received by the UMass Amherst INFORMS Chapter in 2007. For the complete report, see: <http://www.isenberg.umass.edu/alumni/uploads/listWidget/17815/ISOMAR08.pdf>

On October 7, 2008, the former CEO and Chairman of the Board of General Motors, John F. Smith Jr., UMass '60, visited the Isenberg School of Management and took part in a question and answer session in our beautiful atrium. Students from Professor Anna Nagurney's undergraduate Transportation & Logistics class took part as did the Doctoral Student Center Associates. It was a wonderful occasion and we thank our esteemed alumnus

for taking the time to come and meet with the students!



Professor Anna Nagurney with former ISOM dean, Dr. Tom O'Brien and Jack Smith '60

Congratulations to Center Associate Professor Ding Zhang, who is the MBA Director at the School of Business at SUNY Oswego! His paper, joint with Professor Fan Yang of the Department of Civil Engineering of The City College of New York, entitled: **Day to Day Stationary Link Flow Pattern**, was published in *Transportation Research B* (2009), **43**, pp. 119-126. In the paper, the authors prove that five existing route choice adjustment processes in the transportation literature are all special cases of a so-called rational behavioral route choice adjustment process. These results are a significant theoretical advance with wide practical importance.

Congratulations to Center Associates Professor Jose M. Cruz of the School of Business at the University of Connecticut and Professor Tina Wakolbinger of the Fogelman College of Business and Economics at the University of Memphis Their paper: **Multiperiod Effects of Corporate Social Responsibility on Supply Chain Networks, Transaction Costs, Emissions, and Risk**, was published in the *International Journal of Production Economics* (2008), **116**, pp. 61-74.

Congratulations to Center Associates Professors June Dong and Ding Zhang! Their co-authored paper, with Professor Anna Nagurney, **A Supply Chain Network Equilibrium Model**, published in *Transportation Research E* (2002), **38**, pp. 281-303, is in the top ten most cited papers in the history of the journal, according to the publisher Elsevier.

Professor Anna Nagurney's paper, **A System-Optimization Perspective for Supply Chain Network Integration: The Horizontal Merger Case**, is the lead article in the first issue of 2009 in the journal, *Transportation Research E*. The paper appears in volume **45**, pp. 1-15. The paper initiates a research agenda in exploiting network structure in mergers and acquisitions from a supply chain perspective. It

exploits relationships between transportation networks and supply chains.

Congratulations, again, to Professor Jose Cruz! His paper, **The Effects of Network Relationships on Global Supply Chain Vulnerability**, will appear in the edited book, *Managing Supply Chain Risk and Vulnerability: Tools and Methods for Supply Chain Decision Makers* (2009), T. Wu and J. Blackhurst, Editors, Springer. In addition, the chapter co-authored by Center Associates Professor June Dong and Doctoral Student, Qiang "Patrick" Qiang, entitled, **Modeling of Supply Chain Risk Under Disruptions with Performance Measurement and Robustness Analysis**, and co-authored with Professor Anna Nagurney, will also be appearing in the same volume.

Center Associate Professor Ladimer S. Nagurney of the Department of Electrical and Computer Engineering at the University of Hartford was the subject of a feature article in the October 2008 issue of the magazine *Above Ground Level (agl)*. The article overviewed how Professor Ladimer Nagurney's course, **Engineering Practice**, is educating the next generation of engineers to design and build wireless telecommunications infrastructure. In the course, students learn about feasibility studies, financial viability, environmental impact, and societal concerns regarding cell towers and telecommunications. Professor Ladimer Nagurney is spending the 2008-2009 year on sabbatical at the NSF Engineering Research Center CASA at UMass Amherst. He is working on developing the next generation of weather radars.

Professor Anna Nagurney was deeply honored to be named a "stellar scholar" in Operations Management based on the number of citations to her publications. According to the citation study, published online by the *Journal of Operations Management* and authored by Professor Bin Jiang of DePaul University, Nagurney had an h-index of 13, which tied her for ninth place on the list of scholars. More information can be found at: <http://nebula.bus.msu.edu/jom/osm.asp>

Center Associate Professor Tina Wakolbinger continues to serve as Junior Vice President of Communications of WORMS (Women in Operations Research and the Management Sciences); <http://worms.forum.informs.org/>

Professor Anna Nagurney has been appointed Chair of the 2009 WORMS Award committee and is honored to be serving the Women in Operations Research and the Management Sciences in this capacity.

Center Associate Professor Zugang "Leo" Liu completed his first semester at Penn State Hazleton as an Assistant Professor of Business Administration. On September 24, 2008, he was

one of the faculty participants in the Undergraduate Research Conference there. The conference aims to stimulate undergraduate research and to inform students of the kinds of projects that faculty are engaged in. Dr. Liu's most recent research is on the empirical modeling and analysis of electric power supply chains in New England.

Center Associate, Dr. Ke "Grace" Ke, is enjoying her new position as an Assistant Professor in the Department of Finance and Operations and Supply Chain Management at the School of Business at Central Washington University.

Professor Anna Nagurney is scheduled to give invited presentations in the Spring 2009 term in Dallas, Texas, in Davis, California, and in Northfield, Minnesota, among other locations.

For more information on the talks, conferences, and upcoming events, see: <http://supernet.som.umass.edu/conferences.html>

Recent Center Publications

Copies of these (and other) center articles are at: <http://supernet.som.umass.edu/dart.html>

A System-Optimization Perspective for Supply Chain Network Integration: The Horizontal Merger Case, A. Nagurney, *Transportation Research E* (2009), **45**, pp. 1-15.

Environmental Impact Assessment of Transportation Networks with Degradable Links in an Era of Climate Change, A. Nagurney, Q. Qiang, and L. S. Nagurney, *International Journal of Sustainable Transportation* (2009), in press.

Comment on "Catching the Network Science Bug" by David L. Anderson, A. Nagurney, *Operations Research Online Forum Commentary*, October – November (2008) **56**.

A Relative Total Cost Index for the Evaluation of Transportation Network Robustness in the Presence of Degradable Links and Alternative Travel Behavior, A. Nagurney and Q. Qiang (2008), to appear in the *International Transactions of Operational Research*.

Modeling of Supply Chain Risk Under Disruptions with Performance Measurement and Robustness Analysis, Q. Qiang, A. Nagurney, and J. Dong, *Managing Supply Chain Risk and Vulnerability: Tools and Methods for Supply Chain Decision Makers* (2009), T. Wu and J. Blackhurst, Editors, Springer, in press.

Network Economics, A. Nagurney, invited chapter for the *Handbook of Computational Econometrics*, D. Belsley and E. Kontoghiorghes, Editors, Wiley (2009), in press.

Networks in Finance, A. Nagurney (2008), in the *Handbook on Information Technology and Finance*, D. Seese, C. Weinhardt, F. Schlottmann, Editors, Springer, Berlin, Germany, pp. 383-420.

Spatially Differentiated Trade of Permits for Multipollutant Electric Power Supply Chains, T. Woolley, A. Nagurney, and J. K. Stranlund, in *Optimization in the Energy Industry*, J. Kallrath, P. Pardalos, S. Rebennack, and M. Schei, Editors, Springer, Berlin, Germany (2008).

Identification of Critical Nodes and Links in Financial Networks with Intermediation and Electronic Transactions, A. Nagurney and Q. Qiang, in *Computational Methods in Financial Engineering*, E. J. Kontoghiorghes, B. Rustem, and P. Winker, Editors, Springer, Berlin, Germany (2008), pp. 273-297.

A Unified Network Performance Measure with Importance Identification and the Ranking of Network Components, Q. Qiang and A. Nagurney, *Optimization Letters* (2008), **2**, pp. 127-142.

A Network Equilibrium Framework for Internet Advertising: Models, Qualitative Analysis, and Algorithms, L. Zhao and A. Nagurney, *European Journal of Operational Research* (2008), **187**, pp. 456-472.

Dynamics of Supply Chain Networks with Corporate Social Responsibility Through Integrated Environmental Decision-Making, Jose M. Cruz, *European Journal of Operational Research* (2008), **184**, pp. 1005-1031.

A Network Efficiency Measure with Application to Critical Infrastructure Networks, A. Nagurney and Q. Qiang, *Journal of Global Optimization* (2008), **40**, pp. 261-275.

An Efficiency Measure for Dynamic Networks with Application to the Internet and Vulnerability Analysis, A. Nagurney and Q. Qiang, *Netnomics*, published online by Springer on March 19, 2008.

An Integrated Framework for the Design of Optimal Web Banners, L. Hai, L. Zhao, and A. Nagurney (2008), submitted.

An Integrated Electric Power Supply Chain and Fuel Market Network Framework: Theoretical Modeling with Empirical Analysis for New England, Z. Liu and A. Nagurney (2008), revised and submitted.

Environmental and Cost Synergy in Supply Chain Network Integration in Mergers and Acquisitions, A. Nagurney and T. Woolley (2008), submitted.

The Center Director, Professor Anna Nagurney, and the Center Associates thank you for your support!

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