2013 NNI Strategic Planning Stakeholder Workshop

Ethical, Legal, and Societal Implications

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Washington, DC

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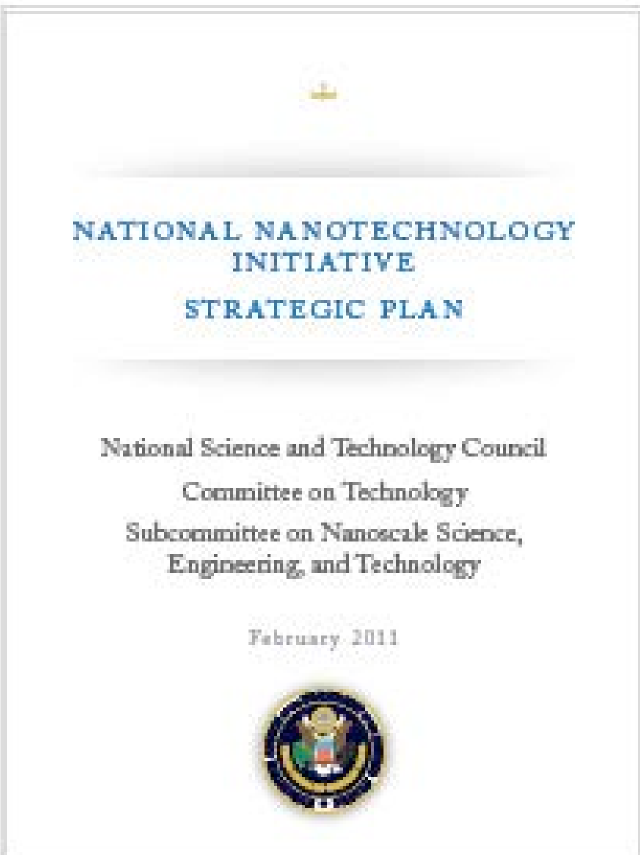
NNI → 4 main strategic goals



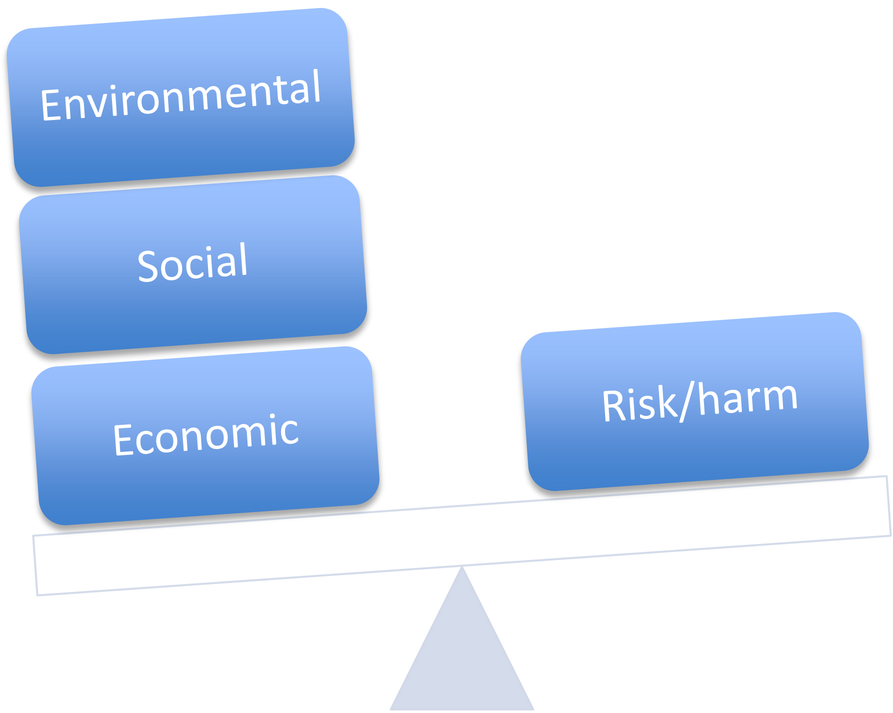
Advance world-class R&D program
Foster transfer of new technologies into products for commercial & public benefit
Develop and sustain educational resources, a skilled workforce, and supporting infrastructure and tools to advance nanotech
Support responsible development of nanotechnology

The National Nanotechnology Initiative Strategic Plan, February 2011,http://www.nano.gov/sites/default/files/pub_resource/2011_strategic_plan.pdf

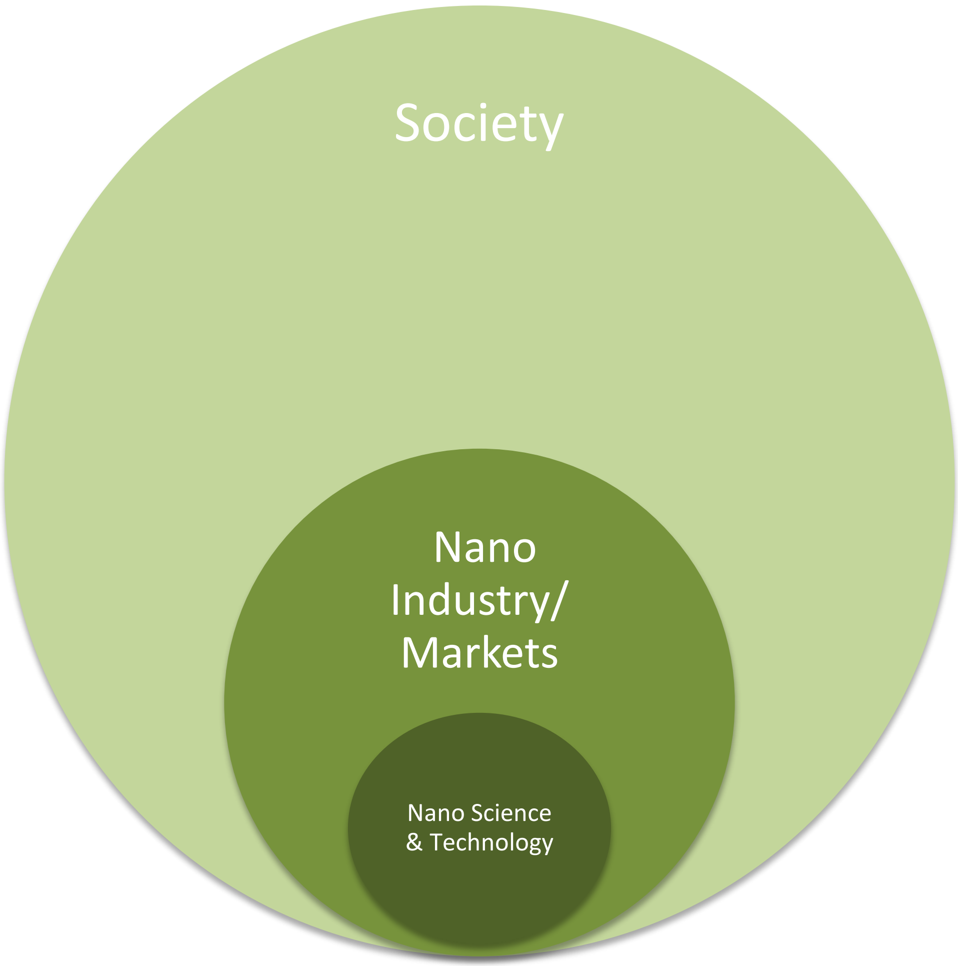
Responsible development

Maximize benefits

Minimize negative consequences



Nanotechnology *in* Society



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Center for Nanotechnology in Society

NSF
SES 0938099

Mission: Nanotechnology Origins, Innovations, and Perceptions in a Global Society

CNS-UCSB challenge: Will nanotechnology mature into a transformative technology, in our rapidly changing international economic, political & cultural environment?

- Social and environmental sustainability, 'responsible development'
- Many methods, disciplines, new approaches

Key factors we focus on:

- Global nano-enterprise (US, Asia, Europe & Latin America)
- Multiple party risk perception
- Modes of dialogue with the public
- Historical contexts for S&T development

http://www.cns.ucsb.edu/

NSEC/Center for Nanotechnology in Society at Arizona State University

- **Research** the societal implications of nanotechnologies
- **Train** a community of scholars with new insight into the societal dimensions of nanoscale science & engineering (NSE)
- **Engage** the public, policy makers, business leaders, and NSE researchers in dialogues about the goals and implications of NSE
- **Partner** with NSE laboratories to introduce greater reflexiveness in the R&D process

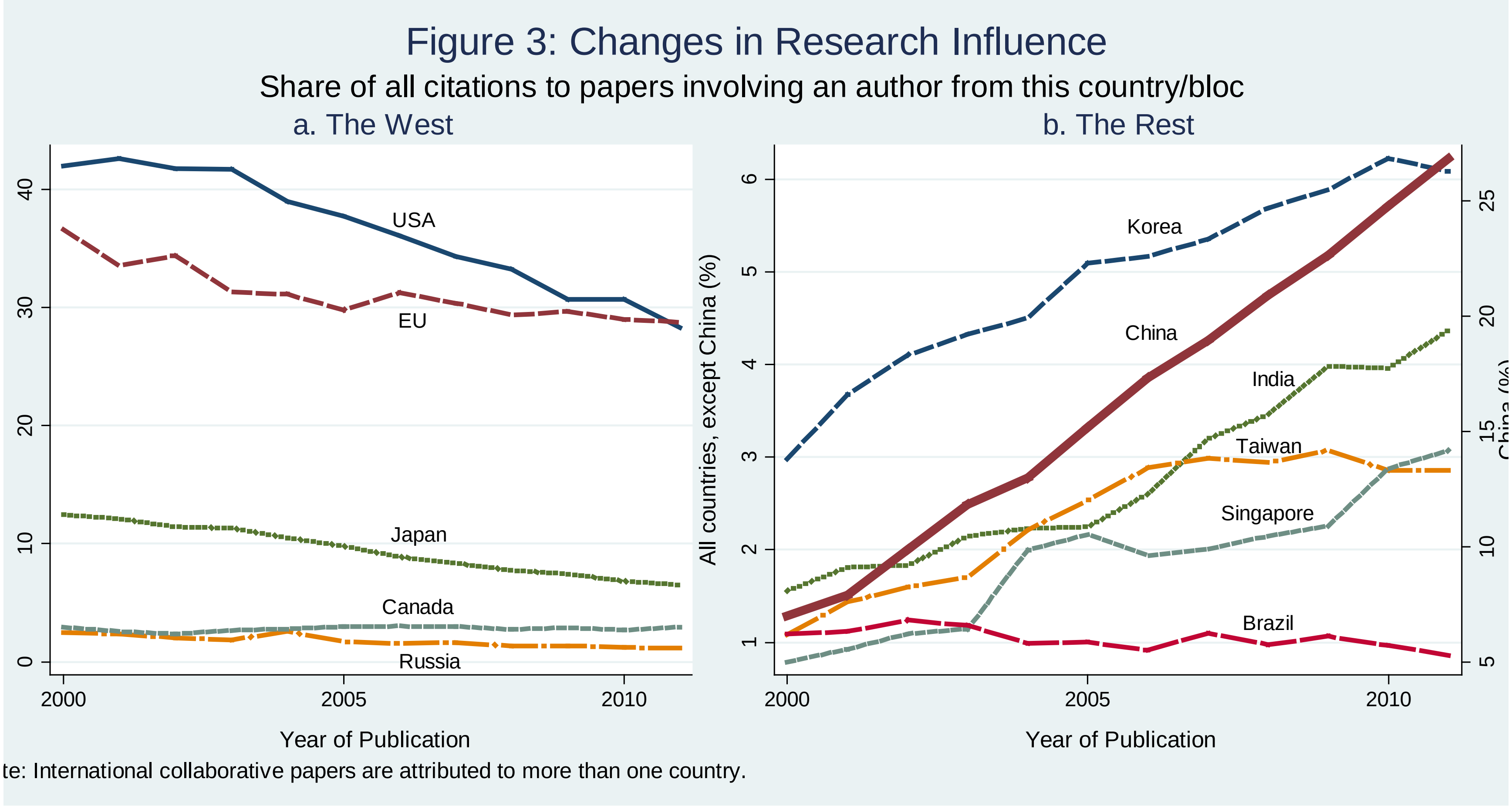
http://cns.asu.edu/

Key Themes of Nano Societal Implications Work

- Global R&D
- Nano workplace
- Risk, benefit, and perception
- Governance
- Engagement

There is a shift in scientific influence

(analysis based on all SCI journals)



Source: Aashish Mehta, with Cong Cao, Shirley Han, Patrick Herron, Timothy Lenoir)

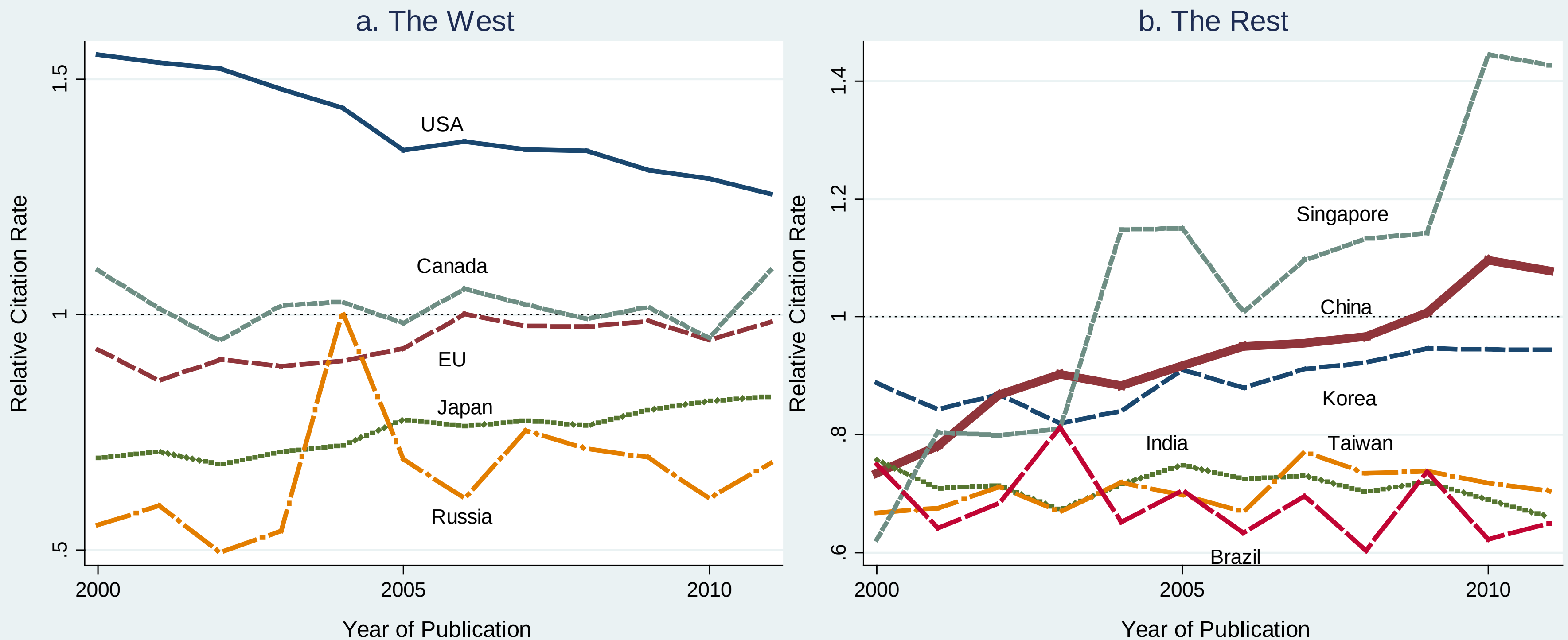
Nanotechnology Research: The Rise of the Rest

(analysis based on top SCI journals)

Western quality dominance less pronounced; China's gains more pronounced.

Figure 2: Changes in Research Quality

Relative citation rate of papers involving an author from this country/bloc



Note: International collaborative papers are attributed to more than one country.

Source: CNS analysis (Mehta, with Cao, Han, Herron, Lenoir)

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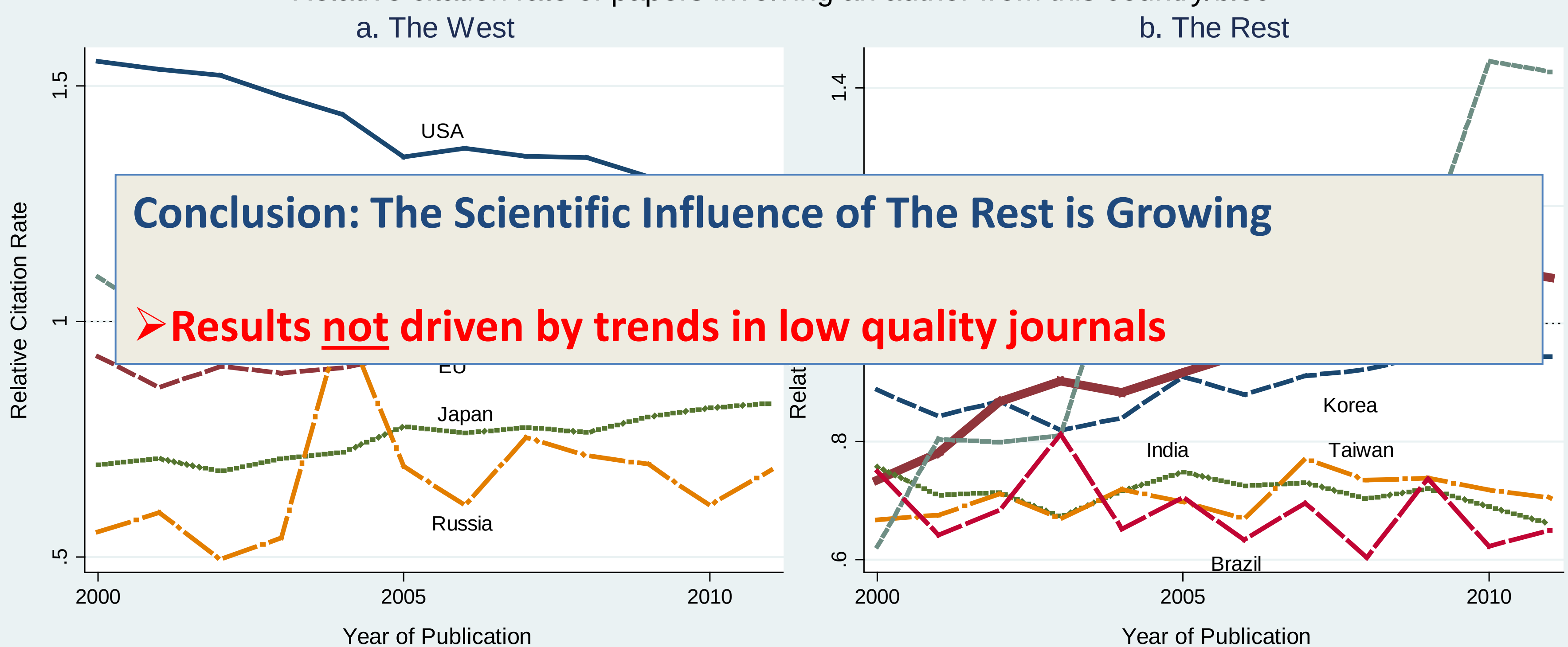


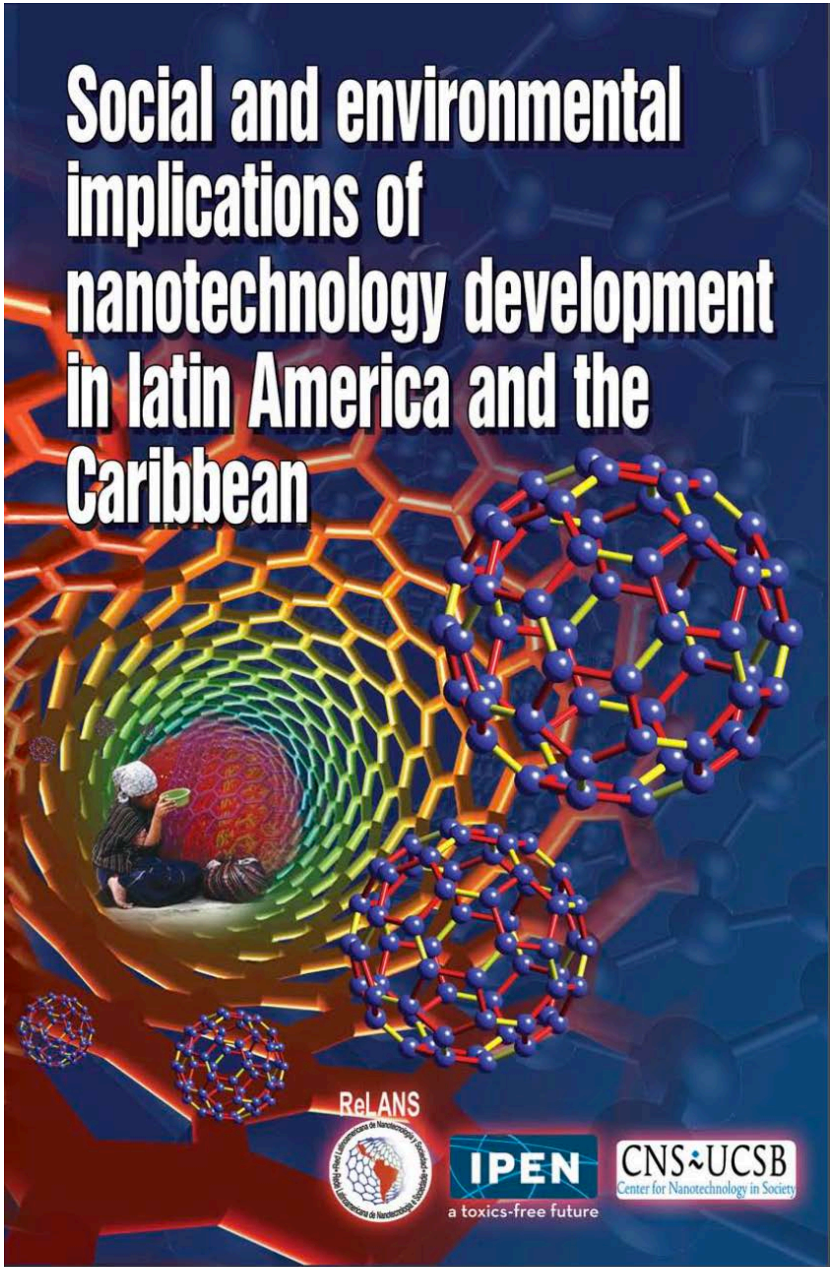
Note: International collaborative papers are attributed to more than one country.

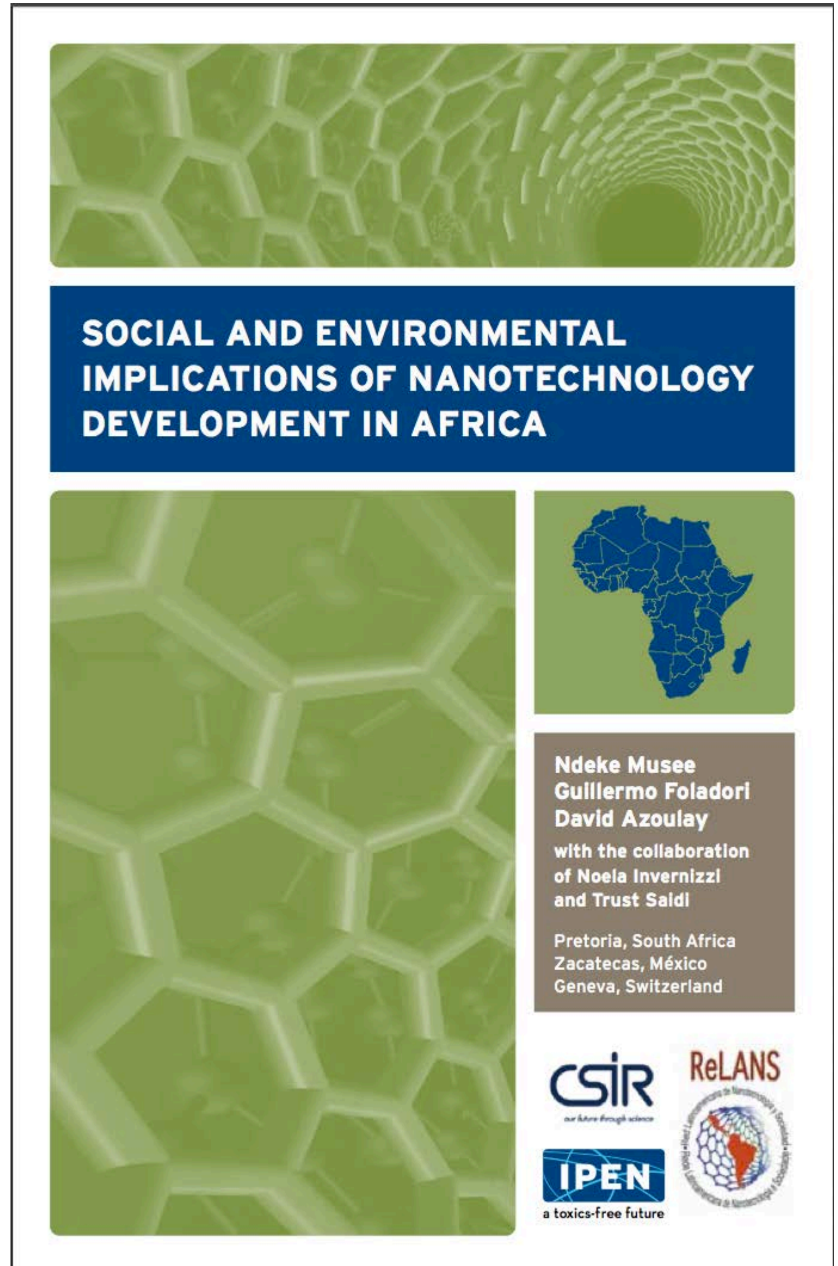
Conclusion: The Scientific Influence of The Rest is Growing

- **Results <u>not</u> driven by trends in low quality journals**

Source: CNS analysis of top SCI journals (Mehta, with Cao, Han, Herron, Lenoir)

Nano in the Global South





California IN THE NanoEconomy

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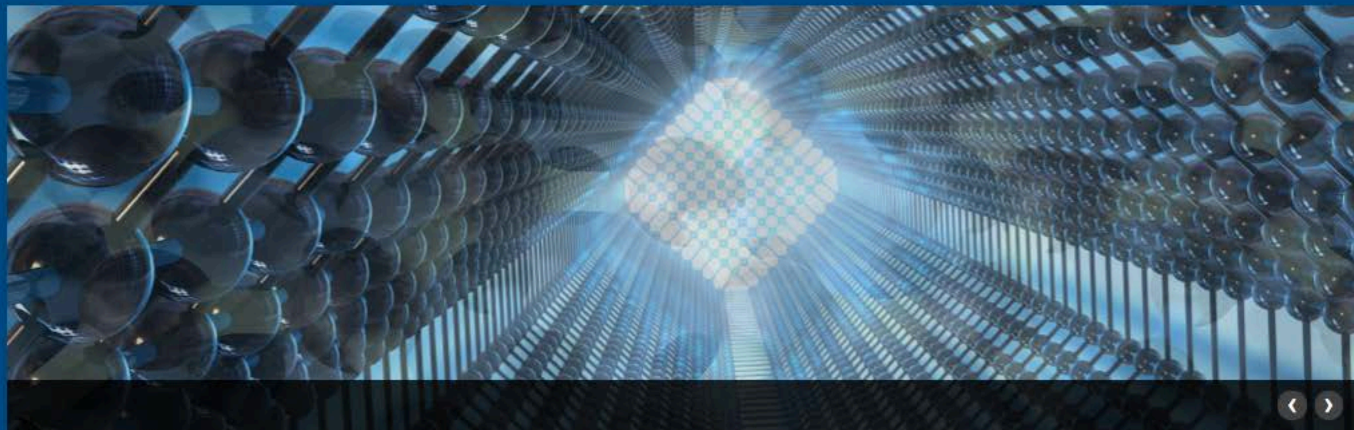

Welcome to California in the Nano Economy, a new industry and education-focused website resource for the nanotechnology community that uses a value chain approach to present California's footprint in nanotechnology.

The purpose of the site is two-fold. The primary focus is to provide a new type of educational resource to enable understanding of the 'nano economy' by using the perspective of the value chain. The approach is illustrated using data for California, and as a result, the site also provides a secondary benefit as a valuable resource for industry in California.

This website is an interactive, web-based version of applying a value chain research approach to a specific location (California) and the parts of a variety of industries that are impacted by a particular technology (nanotechnology). Each of the main sections on the site represent one of the main steps in the research process. For details on the information available on this site and the development process, please see the other overview sections.

Duke
CENTER on GLOBALIZATION, GOVERNANCE & COMPETITIVENESS

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This material is based, in part, upon work supported by the National Science Foundation under Cooperative Agreement No. 0938099. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

http://www.californiananoeconomy.org/

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Home » Value Chain

Value Chain

Value-Adding Activities

Research | Design | Manufacturing | Logistics & Distribution | Marketing & Sales | Service

Nanoscale Materials

- Carbon-Based
- Semi-Metallic
- Metallic
- Ceramic/Inorganic
- Polymers & Chemicals

Nanoscale Intermediates

- Coatings & Ink
- Composites & Catalysts
- Sensors
- Energy Generation & Storage
- Therapeutics & Carriers
- Integrated Circuits

Nano-Enabled Final Products

- Apparel, Sports & Home
- Construction & Industrial
- Transportation
- Electronics & Computers
- Personal Care & Agri-Food
- Medical

Tools, Equipment & Machinery

Analytical Equipment | Software & Modeling | Production: Patterning | Production: Synthesis

Support Stakeholder Groups

Universities & Education | Laboratories & Testing Facilities | Research Centers & Organizations | Industry Associations | Investors & Funding | Service Providers

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Integrated Circuits

This sector includes active electronic components or semiconductors such as integrated circuits (processors, memory, logic), radio frequency (RF) and optoelectronics (LEDs and lasers). Firm types include foundries as well as integrated device manufacturers (IDM) and fabless companies.

California Locations: 48

Employment: 19,078

Tools, Equipment & Machinery

- Analytical Equipment
- Sc
- Production: Patterning
- Production: Synthesis

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The Hierarchy of EHS Practices in the US Nanotechnology Workplace

Government recommended practices

Hierarchical approach to exposure controls:

1. (Elimination or substitution of material)
2. Engineering controls
3. Administrative controls
4. Personal protective equipment (PPE)
   + Respiratory protection

Cleaning practices

Recommend: Wet wiping, absorbent materials
Avoid: Sweeping, use of household vacuum, or compressed air

Monitoring the workplace for nanoparticles

Beyond government recommendations

Product stewardship:

- Advertise /disclose that products contain NMs
- Providing nano-specific guidance to customers regarding product safe use and/or disposal

Waste management:

- Disposing NMs as hazardous waste
- Using separate disposal containers for NMs
- Having a nano-specific waste handling program
- Listing NMs separately on waste manifests

Analysis based on responses of 45 US-based company participants in a 2009-2010 international survey of private companies that use or produce manufactured nanomaterials (MNMs).

- Practices span current government-recommended hierarchical approach to MNM exposure controls
- Practices tailored to current MNM hazard and exposure knowledge reported less frequently than general chemical hygiene practices
- Product stewardship and waste management practices – with influences substantially downstream – reported less frequently
- Smaller companies more frequently identified impediments to implementing nano-protective practices

UCCEIN

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Engeman et al. 2013. Journal of Occupational and Environmental Hygiene (forthcoming)

NSF: DBI-0830117
NSF: 0938099

Divided Labor and Stratified Opportunity in American Nano-manufacturing: The Paradox of the Middle Skilled

- How do community college nanotech programs attempt to fulfill demand for nano-technicians?
- Analyzes the “middle” worker, for whom ingenuity and intellectual ambition are required, but occupational opportunities limited
- Case studies trace educators’ and employers’ ideas of optimized work, including rare instances in which nanotechnicians are treated as innovators and this segmentation challenged

Technicians…workers or innovators?

Drexel UNIVERSITY

CNS-UCSB Center for Nanotechnology in Society

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Amy E. Slaton, Drexel University

OVERALL POSITIVE ATTITUDES, BUT FOR SYN BIO OUTWEIGHED BY RISKS

	How beneficial/risky do you think each of the following is for society as a whole? (1 = “not at all beneficial/risky,” 7 = “very beneficial/risky”)	
	Benefits *Mean (SD)*	Risks *Mean (SD)*
Nuclear Power	4.51 (1.71)	4.67 (1.63)
Nanotechnology	4.20 (1.61)	4.03 (1.54)
Synthetic Biology	3.93 (1.57)	4.40 (1.52)

Public perceptions of benefits & risks of new technology

Benefits predominate thus far—what will constrain (other than EHS)? Views are contingent on:

- Publics' low familiarity/unformed views
- High uncertainty/need for information
- Media coverage low & mixed message
- Inequality/social justice key
- Trust or betrayal by government, industry
- Application-specific views
- Environmental values (resilience); intuitive toxicology
- Gender, race, other social differences
- [Job creation or loss?]

173 Organizations in database
60 "nano engaged" organizations

Preliminary findings based on 20 organizations

Nanotechnology issues?

- Consumer safety
- Environmental protection
- Other issues: development and human health

Specific nano-materials?

- No, nanotechnology, generally
- Nanosilver
- Titanium dioxide

Goals?

- Increased EHS research
- Product labeling
- Government oversight
- Public participation

Tactics?

- Issue reports, public statements, press releases
- Lawsuits and legal petitions
- Industry collaboration, forums

Engeman, Cassandra and Barbara Herr Harthorn (*Research in Progress*)

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Democratizing Technologies: Assessing the roles of NGOs in shaping technological futures

Conference: Spring 2014, UC Santa Barbara

- To what extent, and in what areas, are NGOs attempting to fill the governance roles traditionally provided by nation states – and with what results?
- When are the agendas and policies advocated by NGOs adopted by states or in international agreements? When do industries or companies respond to NGO-advocated standards?
- How are new media changing the landscape for NGO engagement, participation, recruitment and dissemination?

Key aspects of successful public participation

Aims:

- addresses needs and concerns of publics
- reduces mistrust between stakeholders
- results in all participants (including scientists) being better informed about both the issues *and* about one another

Key features:

- Two-way *dialogue*
- "early and often"
- procedural fairness
- well managed process
- implementation that includes breadth, intensity, and integration of scientific expertise

CNS-ASU Nano and the City–

Outreach Summary

Arnim Wiek, Rider Foley

Center for Nanotechnology in Society

Arizona State University

CNS-ASU / Tempe, AZ
June, 2013

Outreach Events

- *Stakeholder workshops*, Arizona State University, 5 events (Jan. 2011 – Dec. 2012) with 100+ nanoscale scientists and engineers, entrepreneurs, investors, science educators, regulators, city and state economic development officers, patent attorneys, county sustainability managers, and business consultants.
- *Walking audits*, Gateway district, Phoenix, 3 events (Nov. 2011) with 25 community organizers, entrepreneurs, health care professionals, scientists and engineers.
- *Science Cafés*, Arizona Science Center, 8 events (Sept. – May, 2013) with over 200+ science educators, citizens, technology enthusiasts.
- *K-12 Education*, Bioscience High School, 6 events (June, 2011 – May, 2013) with 100+ students, teachers and administrators, co-presentations with Maricopa County Sustainability Manager, and Technical Assistant to the Community Involvement Group.

Key Results

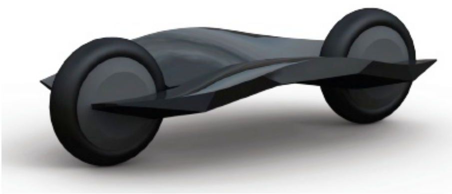
- Change in *network constellations* between network organizations, such as the Arizona Technology Council, Arizona Biotechnology Council, and the Arizona Nanotechnology Cluster.
- Change in *knowledge* about social and technical aspects of urban nanotechnologies was raised in the Community Involvement Group focused on addressing the Motorola 52nd Street Superfund Site (M52 Site) and at Bioscience High School.
- Change in *(professional) practices and activities* → increased willingness by the nano business and entrepreneurial communities to engage with the CNS-ASU researchers in new and different ways (repeated attendance, growing receptivity to CNS-ASU events).

The Strategic Vision

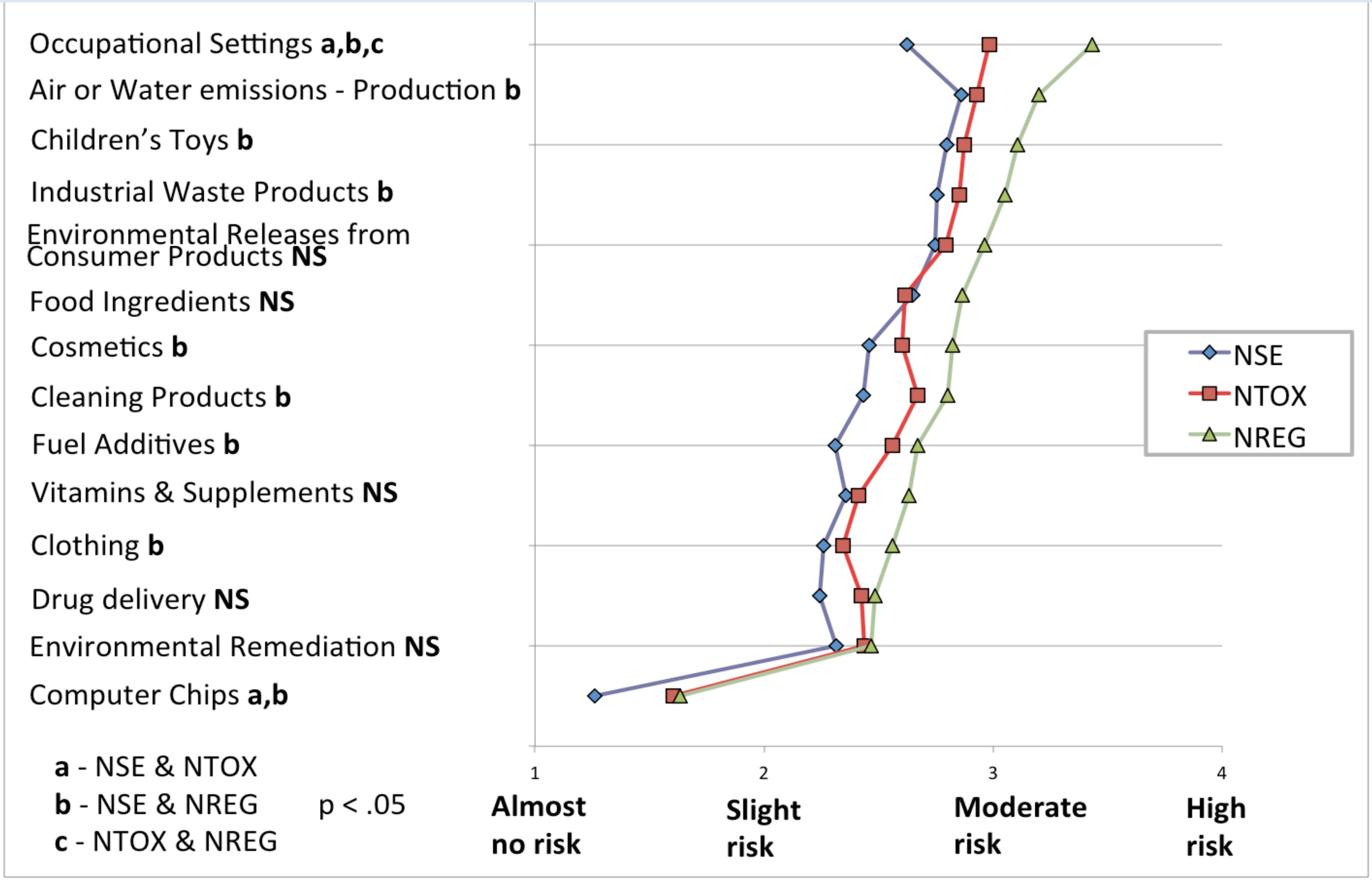
Anticipatory Governance

1. Foresight
   - All governance requires a disposition toward future
2. Engagement
   - Crucial normatively, strategically, pragmatically
3. Integration
   - Scientists know things we don't, and vice versa
4. Ensemble-ization
   - Because none of these works in isolation

CNS-ASU: Guston, *Nature*, 454:940-41 (2008); Barben et al. *STS Handbook* (2008)



Scientists' and Regulators' ENM Risk and Benefit Perceptions—Small but Consistent Differences



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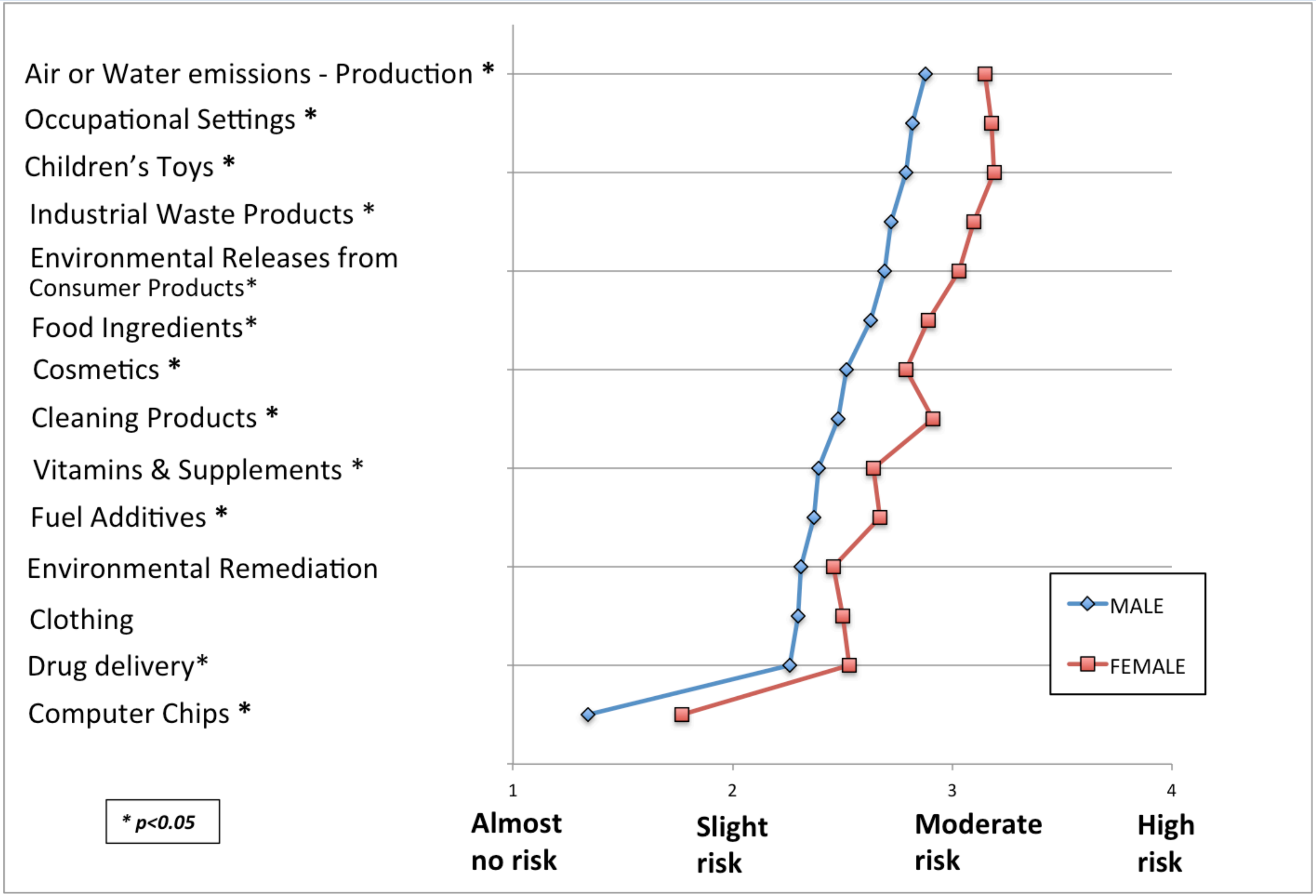
UC CEIN

Beaudrie, Satterfield, Kandlikar, Harthorn. Under review

Experts' risk perceptions differ by gender



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UC CEIN

Beaudrie, Satterfield, Kandlikar, Harthorn. In preparation

Environmental Science & Technology

Policy Analysis

pubs.acs.org/est

From Cradle-to-Grave at the Nanoscale: Gaps in U.S. Regulatory Oversight along the Nanomaterial Life Cycle

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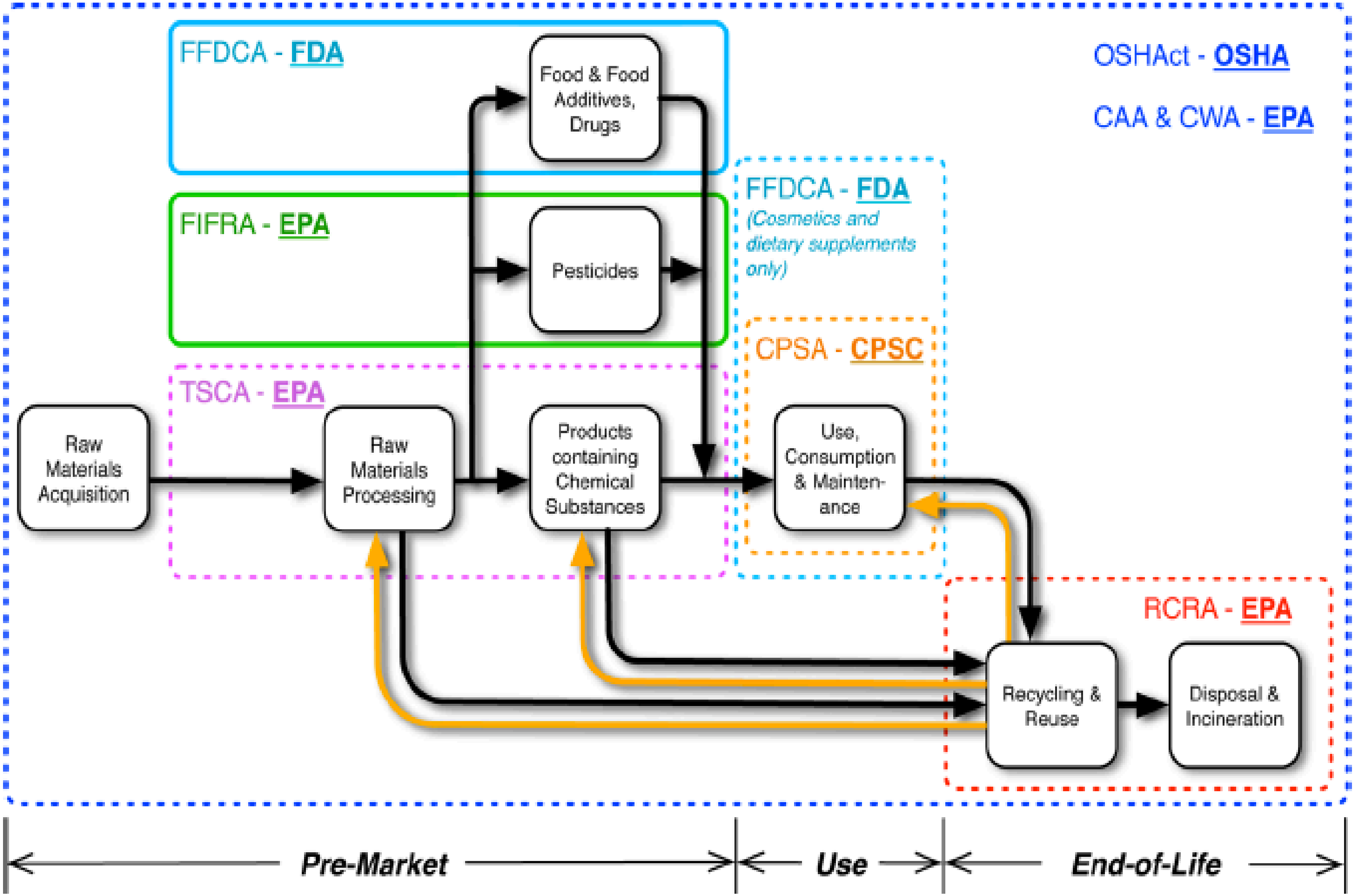
Supporting Information

ABSTRACT: Engineered nanomaterials (ENMs) promise great benefits for society, yet our knowledge of potential risks and best practices for regulation are still in their infancy. Toward the end of better practices, this paper analyzes U.S. federal environmental, health, and safety (EHS) regulations using a life cycle framework. It evaluates their adequacy as applied to ENMs to identify gaps through which emerging nanomaterials may escape regulation from initial production to end-of-life. High scientific uncertainty, a lack of EHS and product data, inappropriately designed exemptions and thresholds, and limited agency resources are a challenge to both the applicability and adequacy of current regulations. The result is that some forms of engineered nanomaterials may escape federal oversight and rigorous risk review at one or more stages along their life cycle, with the largest gaps occurring at the postmarket stages, and at points of ENM release to the environment. Oversight can be improved through pending regulatory reforms, increased research and development for the monitoring, control, and analysis of environmental and end-of-life releases, introduction of periodic re-evaluation of ENM risks, and fostering a "bottom-up" stewardship approach to the responsible management of risks from engineered nanomaterials.



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dx.doi.org/10.1021/es303591x | *Environ. Sci. Technol.* 2013, 47, 5524–5534

Societal implications--challenges and opportunities as we move forward

Opportunities

- Societal implications research program established
- Nano Centers (NSECs) address societal implications
- New knowledge about societal aspects of S&T → evidence based understanding of society
- New partnerships with S&E
- New modes of public input & engagement
- Thriving community of societal implications researchers

Challenges

- Funding base
- Support for workforce development of societal researchers?
- Full integration of societal with nano R&D
- Nano advances → equitable QOL improvements?
- Sustainability—of infrastructure, tools, knowledge, & people?

Thank you!

- NNCO Organizers.
- Colleagues at CNS-UCSB and CNS-ASU
- NSF cooperative agreements #SES 0531184 and # SES 0938099. And NSF & EPA cooperative agreement #DBI 0830117. Views expressed here are those of the author and do not necessarily reflect the views of the NSF or EPA.