

11.17.07
Haas Inside Innovation 2007 Conference

“Nonglobalization” of innovation? The Semiconductor Industry

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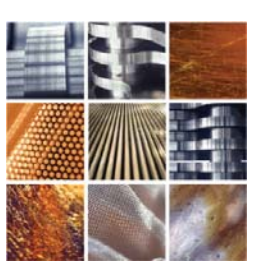
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Part of a National Academy of Sciences project

- Post-1990 trends in globalization of “innovation-related activities” in 10 industries.
 - What is new? What is not new?
 - Volume will be published in early 2008.
- Study of semiconductors builds on 15 years of work at UCB involving Haas, College of Engineering, and Economics.
 - Sloan Foundation Competitive Semiconductor Manufacturing project catalyzed cross-campus collaboration.



Structural change in semiconductors

- Vertical disintegration (separation of product design and manufacturing) has created three segments that compete & collaborate.
 - Fabless firms – mainly in U.S., Canada, Taiwan.
 - Foundries – pure-play foundries are mainly in SE Asia.
 - Integrated Device Manufacturers (IDMs) – many shifting to “asset-light” strategy that relies in part on foundries.
- Change in structure of consumption during 1997-2004
 - Computer share declined from 55% to 41%.
 - Communications applications' share increased from 13% to 25%.
- Shift in geographic distribution of chip consumption during 1987-2004.
 - U.S. consumption share declined from 35% to 18%.
 - SE Asia consumption share increased from 12% to 42%.
- Shift in semiconductor production to non-Japan Asia.
 - Offshoring – Foreign direct investment (FDI) by US, other firms.
 - Outsourcing – Fabless firms rely on SE Asia foundries.
 - Expansion – Investment in SE Asia by foundries and SKorea/Japan IDMs.
- Collaboration is key in a “vertically specialized” industry structure
 - Between product designers (especially in fabless firms) and systems houses (including producers of consumer products based offshore).
 - Between fabless firms and foundries.
- Much of the post-1990 “revival” of U.S. semiconductor industry relies on the growth of US-based fabless firms, viability of which depends on foundries.



Globalization of innovation?:

R&D, alliances, process innovation, patents

- US semiconductor industry offshore R&D investment (NSF data)
 - 1985–2001 “Electronic components” offshore R&D (% of industry-funded R&D) displays little/no trend: 4% in 1985, 2.8% in 2000 (jumps to 5.6% in 2001—a trend?).
- Technology alliances (US & non-US firms)
 - Number appears to have peaked in late 1990s.
 - U.S. firms represent declining percentage of international (home - foreign) and domestic (home - home) alliances.
- Development Fabs (IDMs only)
 - Little/no offshore shift in development fab capacity, despite expanded offshore production capacity.
 - Shrinking # of development fabs within the industry.
- Patents
 - Inventive activity of US, non-US semiconductor firms remains dominated (90%+) by “home country” throughout 1990 – 2004.
 - Patenting of US fabless firms displays a small shift toward offshore invention.
 - US retains a dominant position in offshore patenting of non-US firms.
- *Overall, these indicators reveal little/no offshore shift during 1990 – 2004.*



Caveats & Implications

- “New wave” globalization resembles earlier periods.
 - High-end activities remain “homebound,” reflecting the strong links between domestic (public & private) science, domestic (industrial) inventive activity.
 - Limited evidence of shift offshore is consistent with strength in domestic engineering employment in semiconductors & related fields (US employers’ H1B demand remains strong).
- But our measures are defective in several dimensions:
 - Backward-looking, reflecting consequences of investment, strategic decisions occurring as much as a decade earlier.
 - We have almost no measures of the many other pieces of the overall innovation process that are not captured in R&D investment data, patents, etc.
- One new factor is the importance of new & sophisticated consumer, industrial markets offshore.
 - Users play a central role in driving innovation in IT-related products.
 - An important motive for US firms locating development activities in Asia.
- Restructuring in semiconductor innovation has been greatest “downstream,” in design, device development, rather than in “upstream” scientific activity.
 - Will movement offshore in some activities affect location of others? Evidence is mixed.