



Nanotech Business Models

Giovanni Battista Dagnino

University of Catania



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Academic Experience



- **Professor of Business Economics and Management University of Catania 1996 – present**
- **Faculty Member European Institute for Advanced Studies in Management (EIASM), Brussels**
- **Visiting Positions: Tuck at Dartmouth, Wharton, LBS, IESE, Grenoble Ecole de Mgmt, University of Mannheim**

Journal Editorial Boards

- ***Long Range Planning***
- ***Strategic Management Journal***
- ***International Journal of Strategic Business Alliances***

Journal Special Issues

- ***SMJ, ICC, JMG, ISMO, Man. Res.***

Conferences Organized

- **SMS Rome 2010; SMS Special Conference on Entrepreneurship Catania 2007**



Current Research Interests

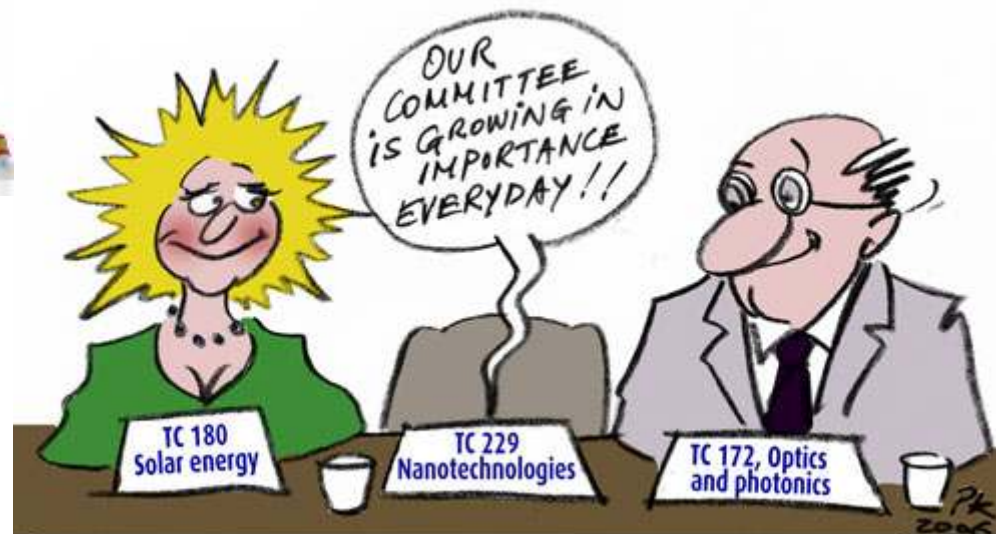
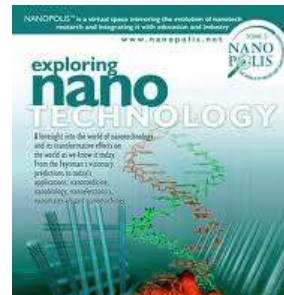


- **The Role of Anchor Firms and Networks in the Development of Nanotech Clusters**
 - **FRIDA Project EU-funded (www.fridaproject.eu)**
- **Coopetition Strategy**
 - **5 EIASM Workshops (2004-2012), 2 Tracks at EURAM (2002, 2007), PDW Academy of Management, Chicago 2009, Showcase Symposium at SMS, Miami 2011**
- **Strategy Paradigms and Research Methods**
- **Dynamic Capabilities and Temporary Advantage**
 - The age of temporary advantage
 - Capability space and opportunity space coevolutionary dynamics
 - Managerial cognition and DCs
 - Combining bibliometric and semiotic analysis of literature on DCs



Nanotech Strategy

- **Real Explosive mix:** engaging the scrutiny of business models in the nanotech setting





Nanotech Models Marshes





Key Questions

- What is a business model?
- What is a nanotech business model?
- What kind(s) of nanotech business models do we know?
- What kind(s) of nanotech business models can we detect?



Outline

- Data Sources
- Nanotech Products and End-Markets
- Business Models Definition(s)
- Nanotech Business Models:
What We Know and What We Do Not Know
- Fab vs. Fabless Business Models... and More
- The Nanotech Business Ecosystem Put into
Context(s): What's Next?
- Research Opportunities for Nanotech Scholars



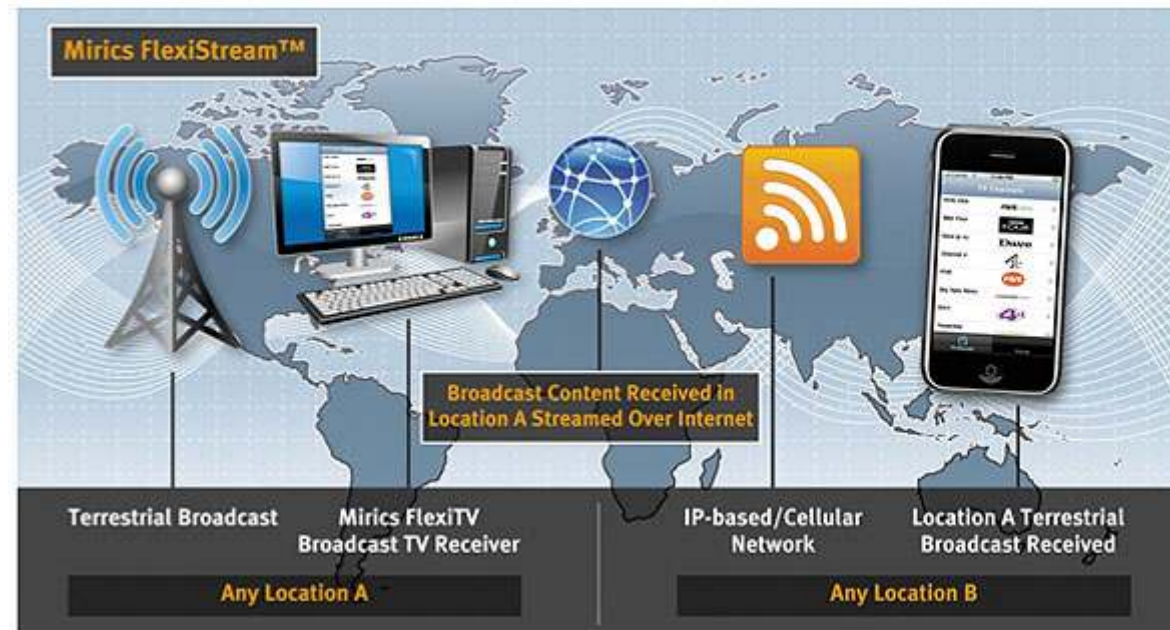
Data Sources

- Background and Literature Review
- Interviews to and Discussion with Researchers, Executives, Academics, and Policy Makers (2009-2011)
- Dissemination Workshops of the **FRIDA** Project
- Web Browsing
- *Triangulation of Data*

Fostering Regional
Innovation and Development
through Anchors and Networks



Nanotech products





Nanotech products

2008E Semiconductor End-Use Markets





Business Models

1. **A *Statement*** (Stewart & Zhao, 2000)
2. **A *Description*** (Applegate, 2000; Weil & Vitale, 2001)
3. **A *Representation*** (Morris, Schindehutte, & Allen, 2005; Shafer, Smith, e Linder, 2005)
4. **An *Architecture*** (Dubosson-Torbay, Osterwarder, Pigneur, 2002; Timmers, 1998)
5. **A *Conceptual Tool or Model*** (Osterwarder 2004; Osterwarder, Pigneur, Tucci 2005; Teece, 2010)
6. **A *Structural Template*** (Amit & Zott, 2001)
7. **A *Method*** (Afuah & Tucci, 2001)
8. **A *Framework*** (Afuah, 2004)
9. **A *Pattern*** (Brousseau & Penard, 2006)
10. **A *Set*** (Seelos & Mair, 2007)



Business Models

Business models articles classification

E-business and Information Technology	Strategy: value creation and value capture thru activities	Innovation and Technology Management
<ul style="list-style-type: none"> •Timmers, 1998 •Mahadevan, 2000 •Steward & Zhao, 2000 •Tapscott et al., 2000 •Applegate, 2001 •Rappa, 2001 •Weill & Vitale, 2001 •Afuah & Tucci, 2001 •Alt & Zimmermann, 2001 •Osterwalder, 2004 •Bonaccorsi e al., 2006 •Brousseau & Penard, 2006 •Casadessus e al., 2010 	<ul style="list-style-type: none"> •Afuah & Tucci, 2001 •Chesbrough et al., 2002 •Magretta, 2002 •Shafer et al., 2005 •Morris et al., 2005 •Makinen et al., 2007 •Seelos & Mair, 2007 •Zott & Amit, 2009 •Osterwalder, 2004; 2010 •Casadessus & Ricart, 2011 	<ul style="list-style-type: none"> •Hedman et al., 2002 •Calia et al., 2007 •Casadessus, 2007 •Chesbrough, 2007 •Teece, 2010



Business Models: Three Definitions

- The story that explains how an enterprise works (Magretta, 2002)
- A business model depicts the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities (Amit & Zott, 2001)
- Business models are made by four interdependent elements that, taken together, create and distribute value. These are: customer value proposition, profit formula, key resources and key processes (Christensen, 2008)
- **Business models are the manners by which an enterprise delivers value to customers, entices customers to pay for value, and convert those payments to profits** (Teece, 2010)





Business Model: Alex Osterwalder 2010

It describes the rationale of how an organization creates, delivers and captures value





Business Model Canvas

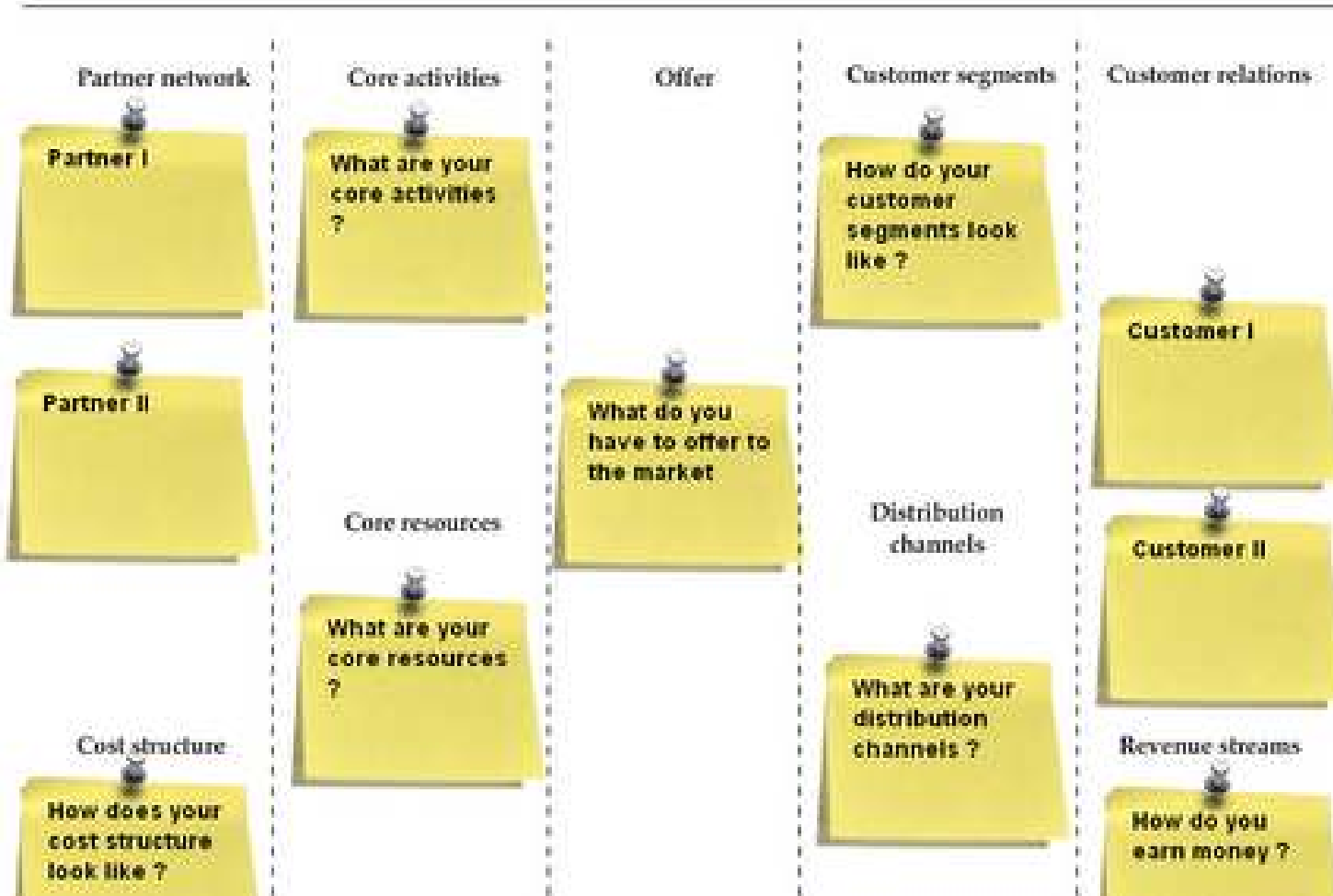


Alex Osterwalder Business Model Canvas





Business Model Canvas





Business Model Canvas

Soccer WC 2010





Characteristics of a Good Business Model

1. Aligned with the firm's goal

2. Self-reinforcing – internal consistency

3. Robust – sustainability of its effectiveness

Threats to sustainability:

a) imitation, b) holdup, c) slack, d) substitution

(Casadessus & Ricart, 2011)



Nanotech Business Models: Key Questions

THE OSTERWALDER-TEECE CONNECTION



**Or... Alex and David:
The Odd Couple!**

- How is it possible to create, deliver and capture value in nanotech settings?
- How is it possible to entice nanotech customers to pay for value and convert their payments to economic profit?



What we don't know

What kind of Business Model(s) for a Nanotech Firm?

- System house?
- System integrator?
- Solution provider?
- Subsystem provider?
- Technological leader?
- IP provider?
- Foundry?



Nanotech Business Models: What we know

A) THE FAB BUSINESS MODEL OR THE “TRADITIONAL” MODEL

The Fab model (FBM) refers to a class of semiconductor/microelectronics firms that owns an **internal silicon fab** or, alternatively, the fabrication of wafers is integrated into its business

B) THE FABLESS BUSINESS MODEL

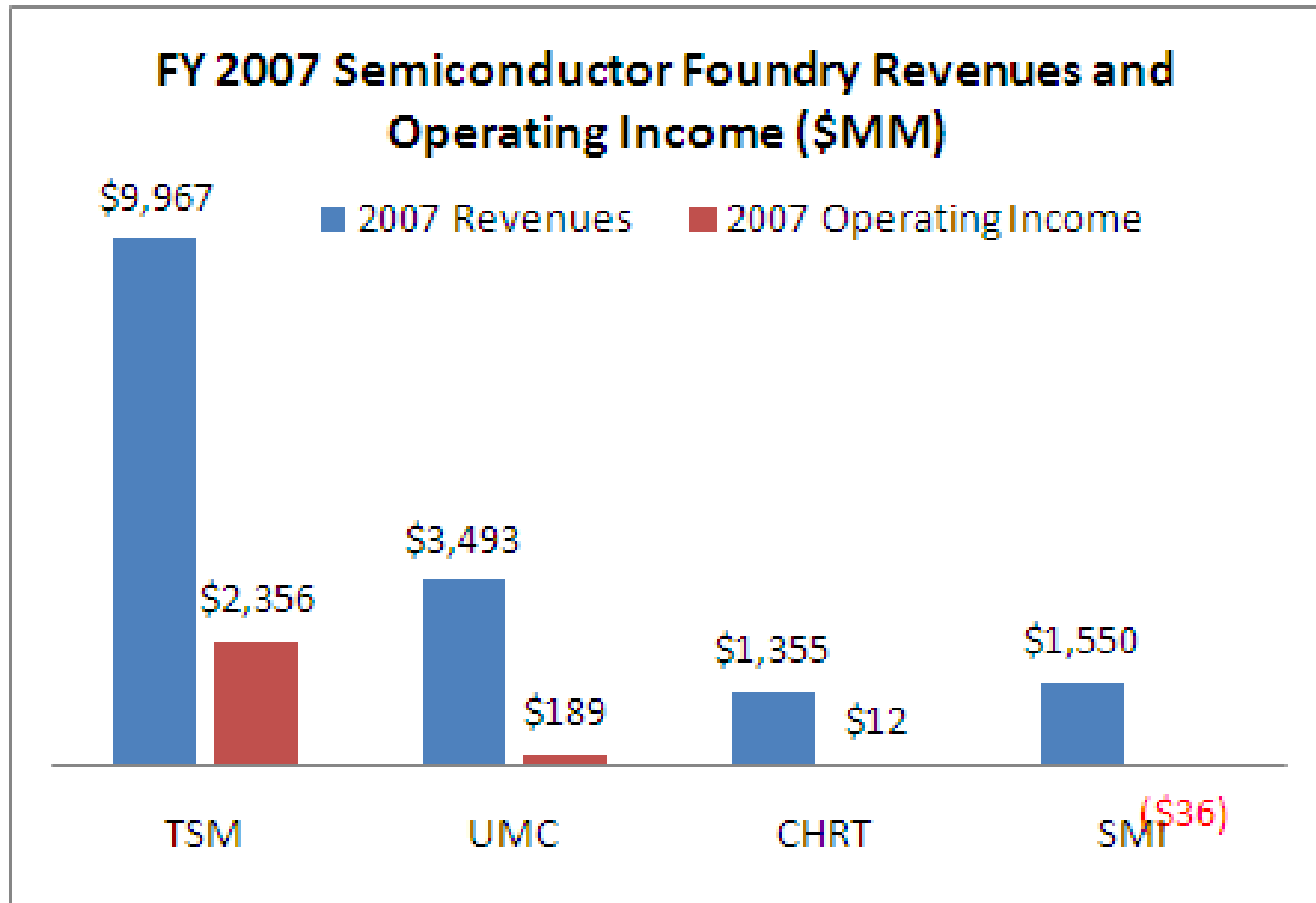
A fabless (FLBM) microelectronics and nanotech firm specializes in the **design and sale** of hardware devices and semiconductor chips, while **outsourcing the fabrication** (or “fab”) of the devices to a specialized manufacturer called a semiconductor foundry

Foundries are typically located in countries with lower cost of labor, since fabless companies can benefit from lower capital costs, while concentrating their research and development resources on the end-market

The pioneers of the fabless concept were **Bernie Vonderschmitt** of **Xilinx** and **Gordon Campbell** of **Chips and Technologies**. The first fabless company was the Western Design Center founded in 1978



Nanotech Business Models: FAB





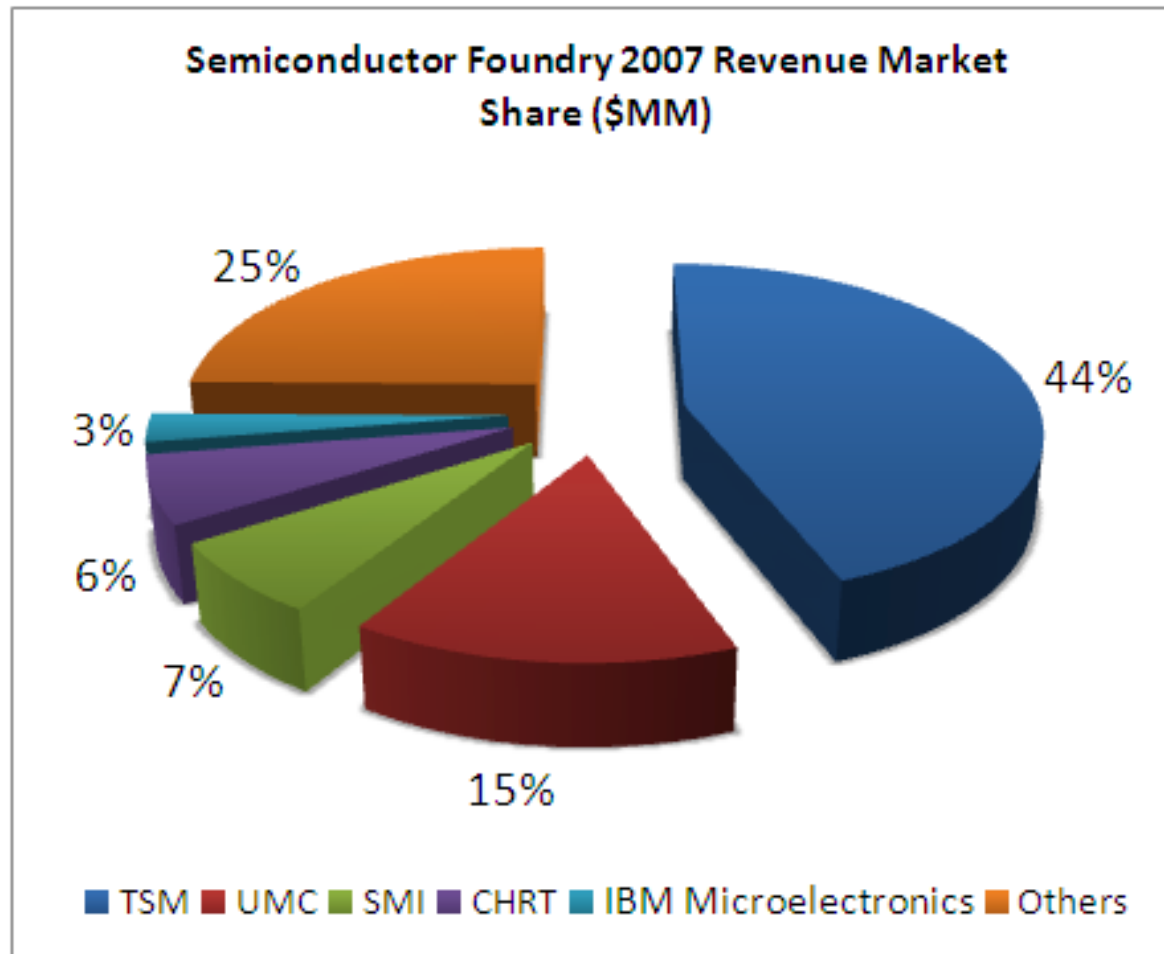
Nanotech Business Models: FAB

The Asia-Pacific region dominates the world for semiconductor manufacturing, due to advantages in cost and government support. Foundries are primarily focused in the East-Asian Pacific rim, with many facilities based in either China or Taiwan

- **Taiwan Semiconductor Manufacturing Company (TSM)** - *Taiwan* - 44.8% share by revenues - The top competitor, TSMC has maintained the largest share of the market due to compelling technology and capability.
- **United Microelectronics (UMC)** - *Taiwan* - 13.1% share by revenues
- **Chartered Semiconductor Manufacturing (CHRT)** - *Singapore* - 7.7% share by revenues - The Singaporean based CHRT manufactures exclusively in Singapore, and is partnered with chip-tester **STATS ChipPAC**. The majority investor of GlobalFoundries, Abu Dhabi's Advanced Technology Investment Co., announced on Sept. 6, 2009, that it has agreed to acquire Singapore-based Chartered Semiconductor Manufacturing Co. Ltd., for a total of \$3.9 billion, with Chartered's operations being folded into GlobalFoundries. The new **GLOBALFOUNDRIES** immediately takes its position as one of the top semiconductor foundries in the world, with 2009 revenues to date for GLOBALFOUNDRIES and Chartered in excess of \$2 billion
- **Semiconductor Manufacturing International (SMI)** - *China* - 7.0% share by revenues



Nanotech Business Models: FAB





Nanotech Business Models: FAB

Foundry 2007 Market Share

Company	Revenue 2007 (\$MM)	2007 Market Share (%)
Taiwan Semiconductor Manufacturing Company (TSM)	\$10,609	47.0
United Microelectronics (UMC)	\$2,957	13.1
Chartered Semiconductor Manufacturing (CHRT)	\$1,743	7.7
GLOBALFOUNDRIES, Inc	NA	NA
Semiconductor Manufacturing International (SMI)	\$1,354	6.0
IBM Microelectronics	\$566	2.5
Vanguard	\$515	2.3
Dongbu HiTek	\$432	1.9
TowerJazz	\$436	1.9
Samsung	\$126	0.6
Others	\$3,850	17.0

NOTE: The global semiconductor foundry market revenues is estimated at \$22.5B by Gartner Dataquest and \$24.5B by IC Insights for the year 2007. The "Top 4" - TSM, UMC, SMI, and CHRT – are estimated to have 72.5% and 68% combined share of the total market by the two data services



Nanotech Business Models: FABLESS



Fabless firms focus on the research, design, development and marketing of their products and form **alliances** with foundries, or silicon wafer manufactures

The affirmation of the fabless model in the 1990s was influenced by firms that had **innovative and ground breaking intellectual property**, bearing the potential to revolutionize the future of the semiconductor industry, but did not have the **financial strength** to invest in building their own manufacturing unit to manufacture chips built on their design

Recently, the business reality is as such that **smaller** firms can afford to pursue the **fabless** business model so that the number of FBM is shrinking



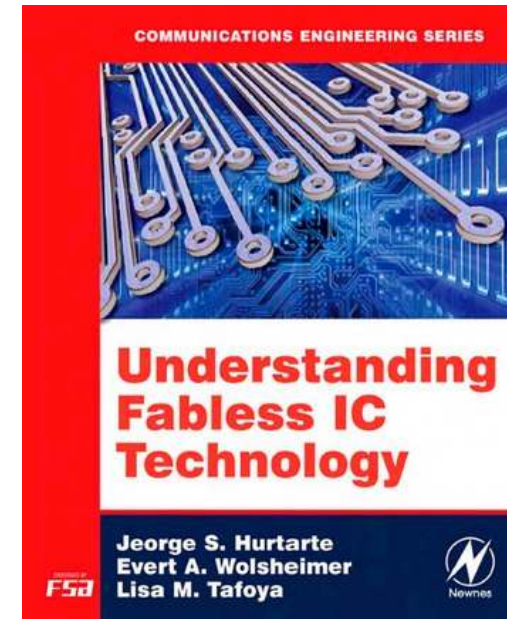
Advantages of the Fabless Business Model

1. Eliminates the huge capital investment associated with building a new fab
2. Eliminates the high operating and maintenance costs of fab and the costs associated with advancing process technologies
3. Fabless companies are shown to benefit from higher profit margins over their counterparts owing in-house fabs
4. The fabless model allows companies to focus on their core competencies - research, design and development
This influences innovations in the semiconductor industry
5. The fabless model supported with a healthy supply chain reduces the product development time significantly and shortens the time-to-market window
6. The fabless model encourages new start-ups with innovative technology to confidently enter the market by partnering with suitable fabs
7. The fabless model allows companies to weather the economic fluctuations that are characteristic of the semiconductor industry



The Top 5 Sales Leaders for Fabless Firms

Rank 2010	Company	Country of origin	Revenue (million \$ <u>USD</u>)	% Change
 1	Qualcomm	USA	7,098	11%
2	Broadcom	USA	6,540	53%
3	AMD	USA	6,460	20%
4	MediaTek	Taiwan	3,610	3%
5	Marvell	USA	3,602	34%



Rank 2003	Company	Country of origin	Revenue (million \$ <u>USD</u>)
1	Qualcomm	USA	2,398
2	NVIDIA	USA	1,716
3	Broadcom	USA	1,610
4	ATI Technologies	Canada	1,401
5	Xilinx	USA	1,300



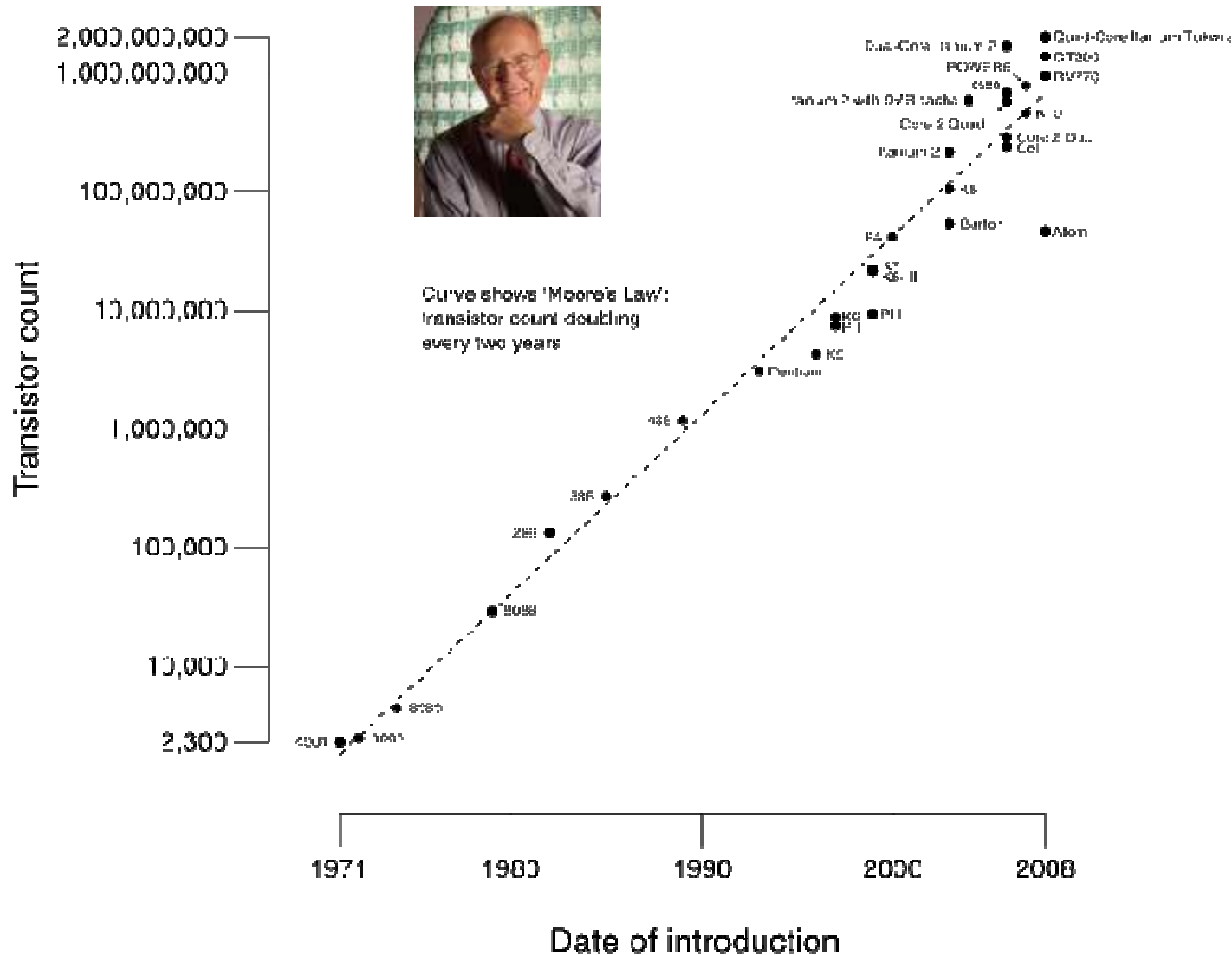
Fabless Business Model: Motivation

- The number of firms embracing the fabless model has increased tremendously in the last decade
- There are more than **750 fabless** companies globally and it is interesting to note that these firms are served by less than **15 independent foundries** globally (data of the year end 2006)
- **Rock's law**, named for Arthur Rock, is the flipside of **Moore's Law**. It says that the cost of a semiconductor chip fabrication plant doubles every four years. As of 2003, the price had reached about 3 billion US dollars



Moore's Law

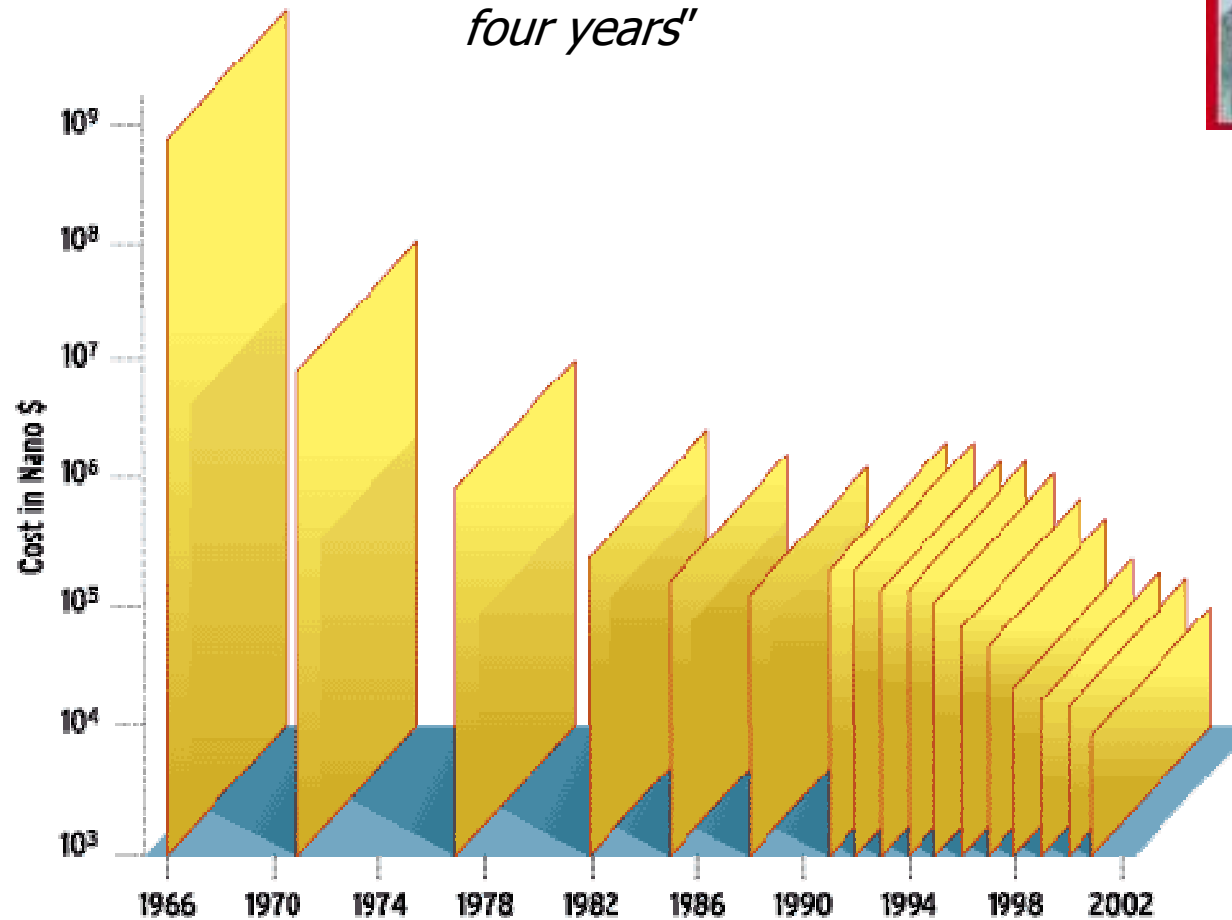
CPU Transistor Counts 1971-2008 & Moore's Law





Rock's Law

"The cost of a semiconductor chip fabrication plant doubles every four years"





Rock's Law: A Critique

- It has been suggested that fabrication plant costs have not increased as quickly as predicted by **Rock's Law**; indeed plateauing in the late 1990s
- And also that the fabrication plant cost *per transistor* (which has shown a pronounced downward trend) may be more relevant as a constraint on Moore's Law



Nanotech Business Models: IDMs

No.3 FABLESS & FOUNDRY: Integrated Device Manufacturers (IDM)

An integrated device manufacturer (IDM) is a semiconductor and nanotech firm which designs, manufactures, and sells integrated circuit (IC) products. Its ability to **manufacture products in house** differentiates it from fabless or "pure play" microelectronics and nanoelectronics companies.

IDMs are motivated to deal with foundries for the purpose of cheaply-expanding capacity without having to invest in new facilities, or to handle manufacturing of older commodity products that are no longer profitably manufactured in-house.

IDMs EXAMPLES:

Texas Instruments, Cypress Semiconductor, Fujitsu Limited, Hitachi, Freescale Semiconductor Inc., Samsung, STMicroelectronics, Infineon, Toshiba, and Intel

Some IDMs, such as **Motorola**, also operate as a foundry or fab, offering excess capacity to manufacture for other companies.





Nanotech Business Models

THE EMERGING BUSINESS MODEL: THREE PIECES IN THE VALUE CHAIN

1. **“Fabless design house”** - competences required are research, design and sales
2. **“Foundry service”** - a service organization that caters to the “fab” or processing and manufacturing of silicon wafers
3. **“Assembly service”**- deals with assembly tests



Small Fabless Firms

 **Nanotech
Semiconductor**

a fabless chip company designing
and supplying ICs



ACCO is a fabless semiconductor company
developing innovative CMOS solutions


Firecomms

a photonics consumer electronics
semiconductor company


**Mirics
semiconductor**

a dynamic fabless semiconductor
company developing innovative
silicon and software solutions to
address nomadic broadcast reception

 **GLONAV**

a fabless chip company
designing and supplying ICs

**Microcosm
Communications Ltd**

a Fabless Chip Company, Microcosm designs
and sells CMOS, BiCMOS and Bipolar Integrated
Circuits (ICs)


**gigle
networks**

a fabless semiconductor company, developing system-
on-chip integrated circuits, firmware and reference
designs that target the rapidly-evolving market for
home multimedia networks



Venture Capital Investors



Pond Venture Partners is Europe's largest early-stage technology venture capital fund, founded in 1997 and with more than \$200 million under management. Pond operates as a cohesive team based in London and Silicon Valley, with strong connections in Asia



Atlantic Bridge Ventures ("Atlantic Bridge") is a Pan European venture capital company with offices in Dublin and London. Atlantic Bridge focuses on making early and mid stage technology investments in semiconductors and software across Europe with a strong focus on a transatlantic business building and investment exit model



Collaborative Nanotech Model



AMD spins off its fabrication business model into another entity and calls it **Global Foundries**. It as well has large interests in Canadian GPU manufacturer ATI and buys out the company for a direct acquisition **Texas Instruments** and **Infineon** said they will outsource some production to Shanghai's SMIC. **Motorola, STMicroelectronics, Philips and Taiwan Semiconductor Manufacturing Co.** are collaborating together. **Sony** teamed up with **IBM** to work together on developing the Cell processor which is used in the PS3 gaming console and future high level server based systems

Note: Collaboration also with public agencies and bodies, universities, and research centers (Triple Helix)



“Virtual Fab”

A foundry works with its customers to create and implement **process roadmaps to support customers’ product planning and leadership** in their markets. These roadmaps look forward through a three-year period for each technology -logic, mixed mode, SRAM, DRAM, non-volatile memory and embedded memories – and allow customers’ new products to be ready as soon as manufacturing capacity is there

The Virtual Fab extends the partnership role by affording customers complete access to their production orders and schedules – The increased flexibility and control over booking procedures provides customers the same level of information that they would have from their own in-house fab



“Virtual Fab”

In support of the Virtual Fab, **TSMC** has implemented a **Total Order Management System** (TOM) to streamline client booking procedures, resulting in shorter delivery time and superior quality of service

With the TOM system, customers are able to track their production and shipping schedules throughout the manufacturing process, and make adjustments as needed to their orders



The Nanotech Business Ecosystem Put into Context(s): What's Next?

- The Dominant Role of the Asia Pacific Rim in FAB
- Smaller firms increasingly engage in the fabless models all over
- A Role for the venture capital investors market in FABLESS
- One fabless model or multiple fabless models?
- Towards a collaborative industry structure?
- From firm-based business models to cluster-centered business models for nanotech?
- Differences and commonalities btw the nanotech and the biotech arena: Heading towards an incoming convergence?
-
-



Plenty of Opportunities for Nanotech Scholars

Call to arms:

A few areas open for research contributions

- Fine-grained comparative analyses of nanotech business models
- Comparative analysis of biotech and nanotech business models
- Detecting evolutionary path(s) to nanotech hybrid business models
- Nanotech business model portfolio
- Governance of nanotech business models
- Nanotech cluster models



Thanks for your patience!
dagnino@unict.it

