



# Semiconductor Cycles:

## What goes up...?

**Scottish  
Enterprise  
Breakfast  
Briefing  
Nov 1, 2004**

**Ron Leckie**  
[ron@infras-advisors.com](mailto:ron@infras-advisors.com)

QuickTime™ and a  
Cinepak decompressor  
are needed to see this picture.

Source: Amkor Technology



## **An Update... New Focus**

- **Independent Analysis & Consulting:**
  - Strategic Marketing
  - Business Development
  - Diligence Studies
  - Start-up Support
  - Expert Witness
  - Public Speaking Engagements



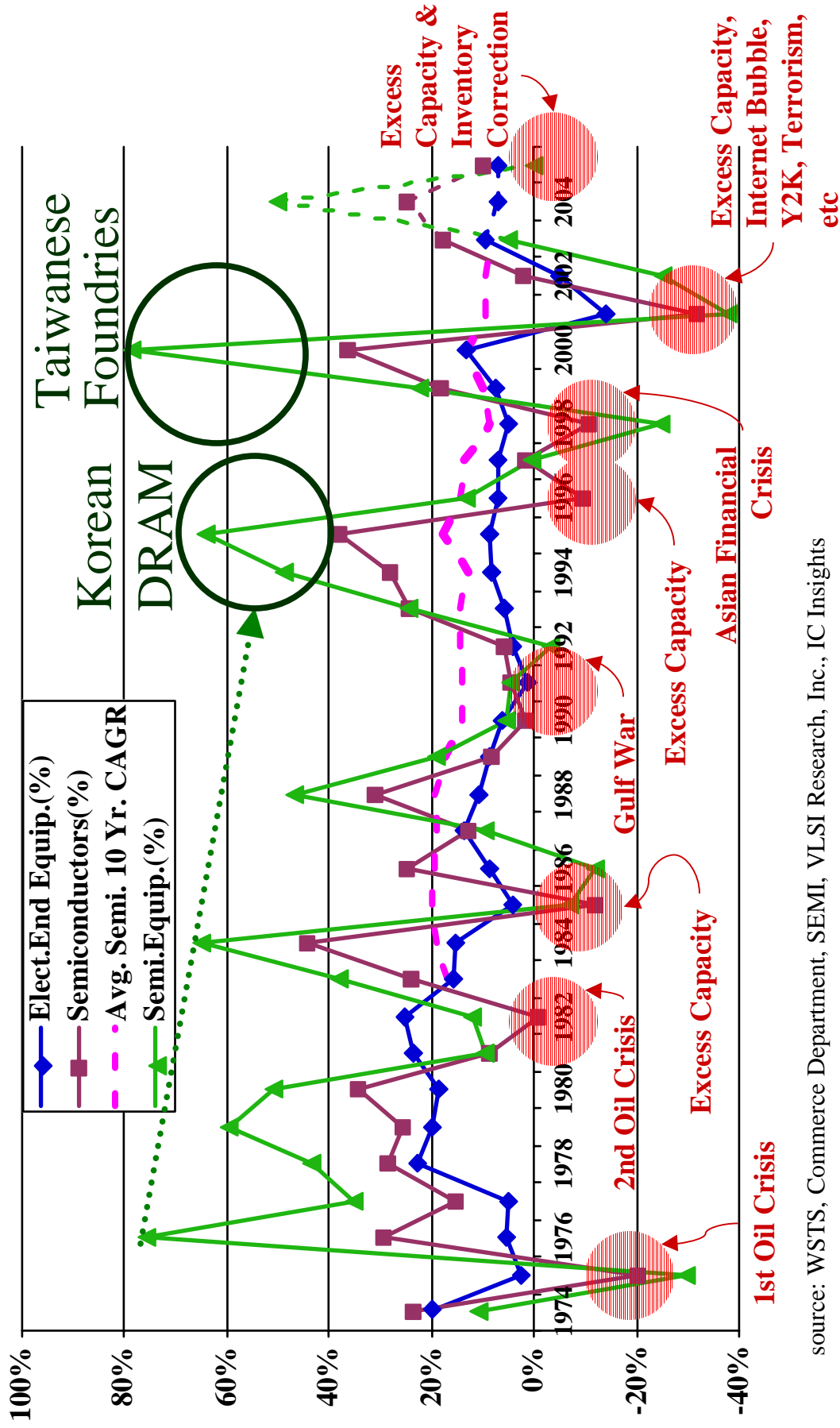
# Sizing Markets - 2003

	Size:	Absolute	Relative
WW GDP		33,243,352,491,025	100.000
US GDP		10,397,500,693,124	31.277
China GDP		1,345,368,050,094	4.047
Electronic Equipment		1,026,150,900,000	3.087
Wal-Mart Stores		258,080,000,000	0.776
Semiconductors		174,017,800,000	0.523
Microsoft Corp		35,270,000,000	0.106
Capital Spending		28,943,071,368	0.087
Capital Equipment		21,741,940,350	0.065

Source: Global Insight, First Call, Gartner Dataquest



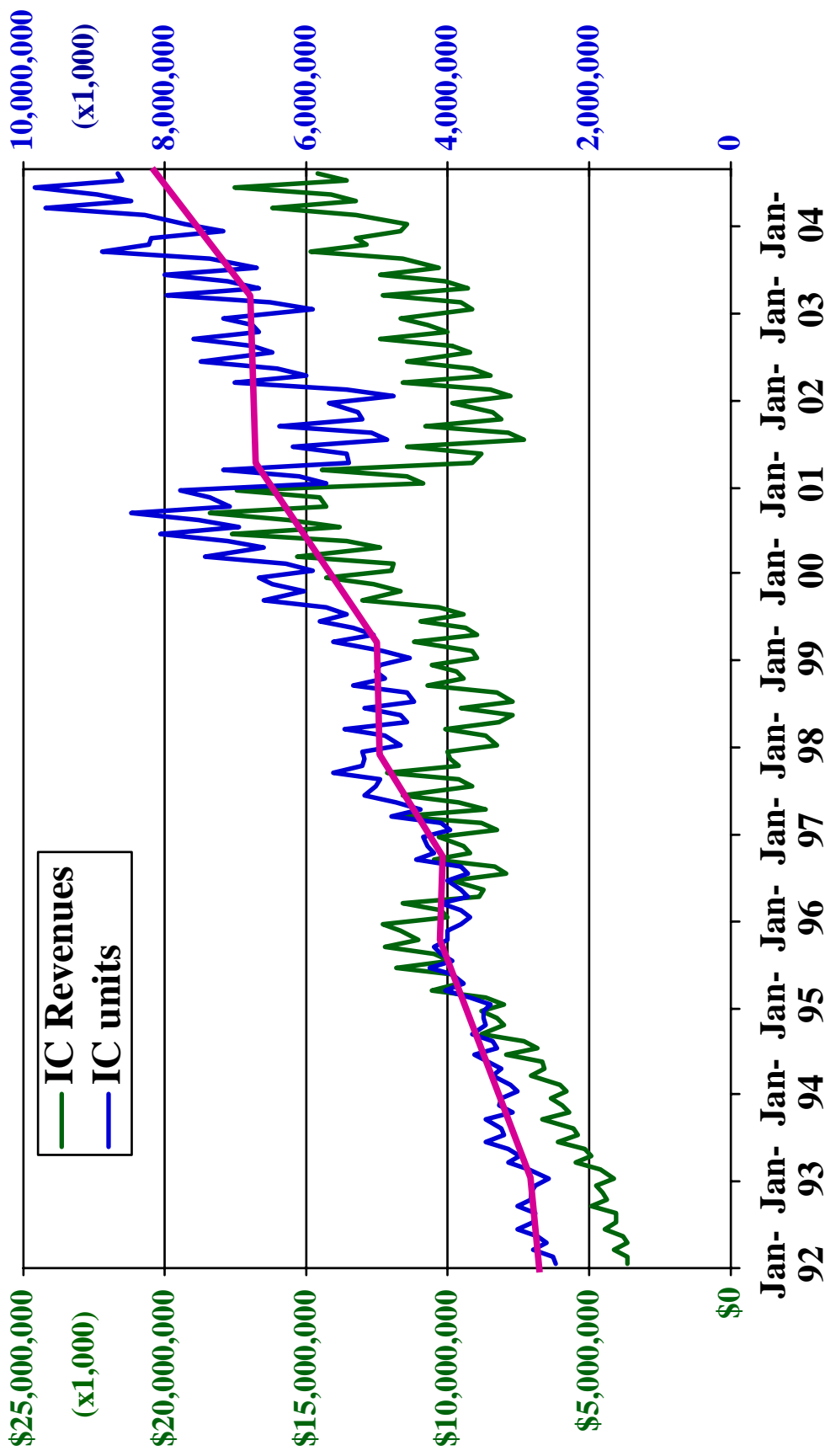
# Electronics Growth



source: WSTS, Commerce Department, SEMI, VLSI Research, Inc., IC Insights



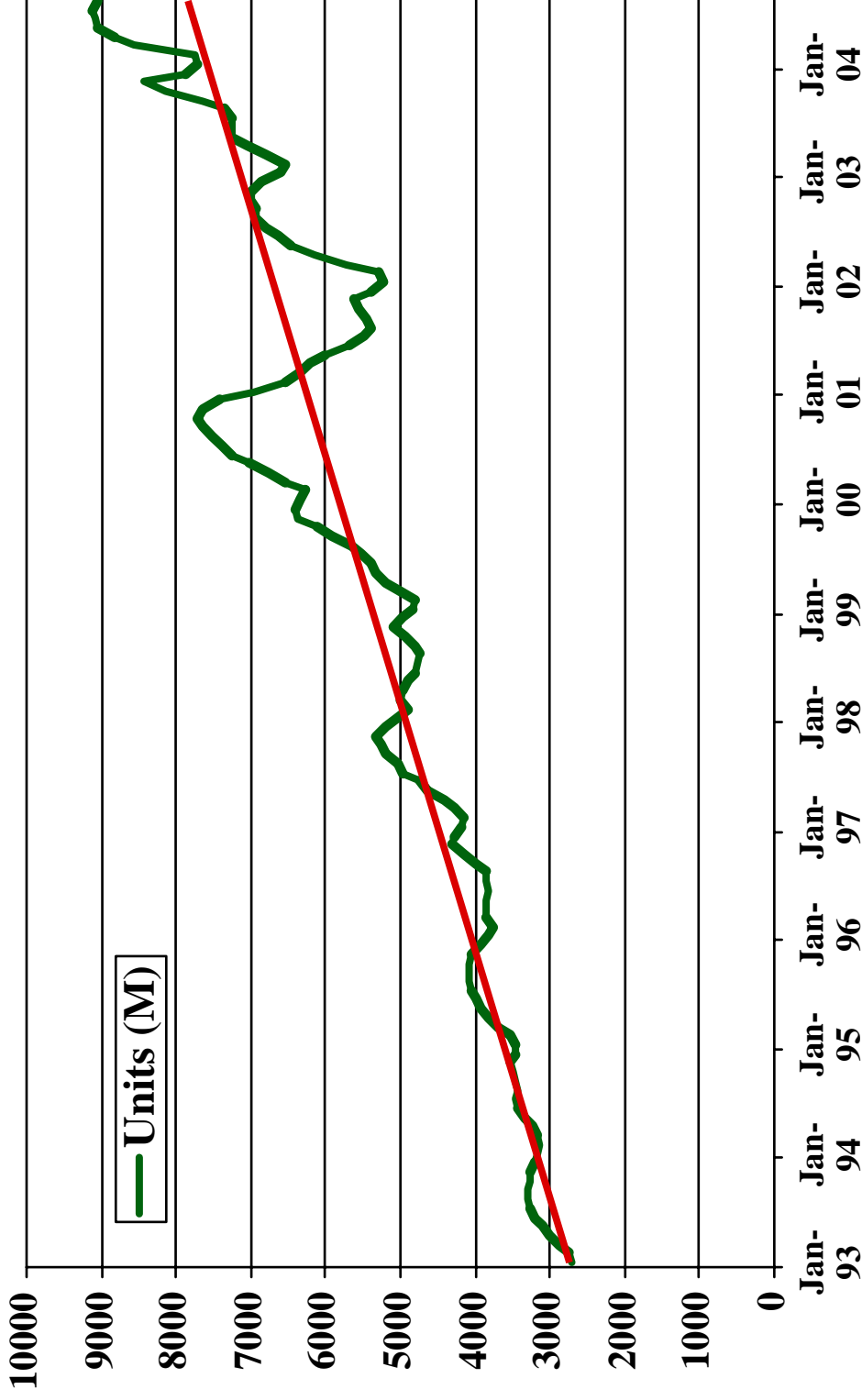
# Monthly IC data



(source: SIA/WSTS)



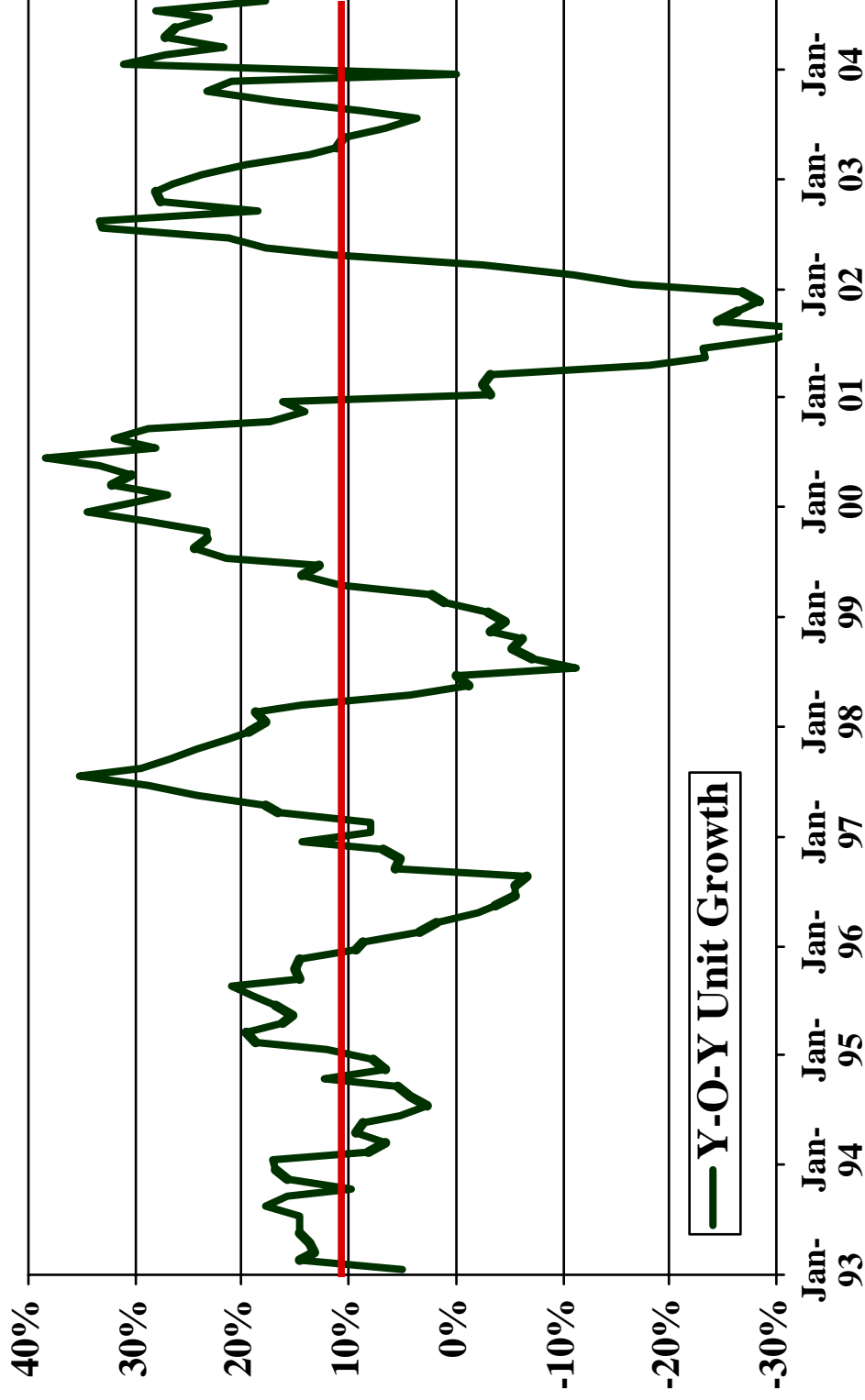
# IC Units - Steady Demand



(source: SIA/WSTS)



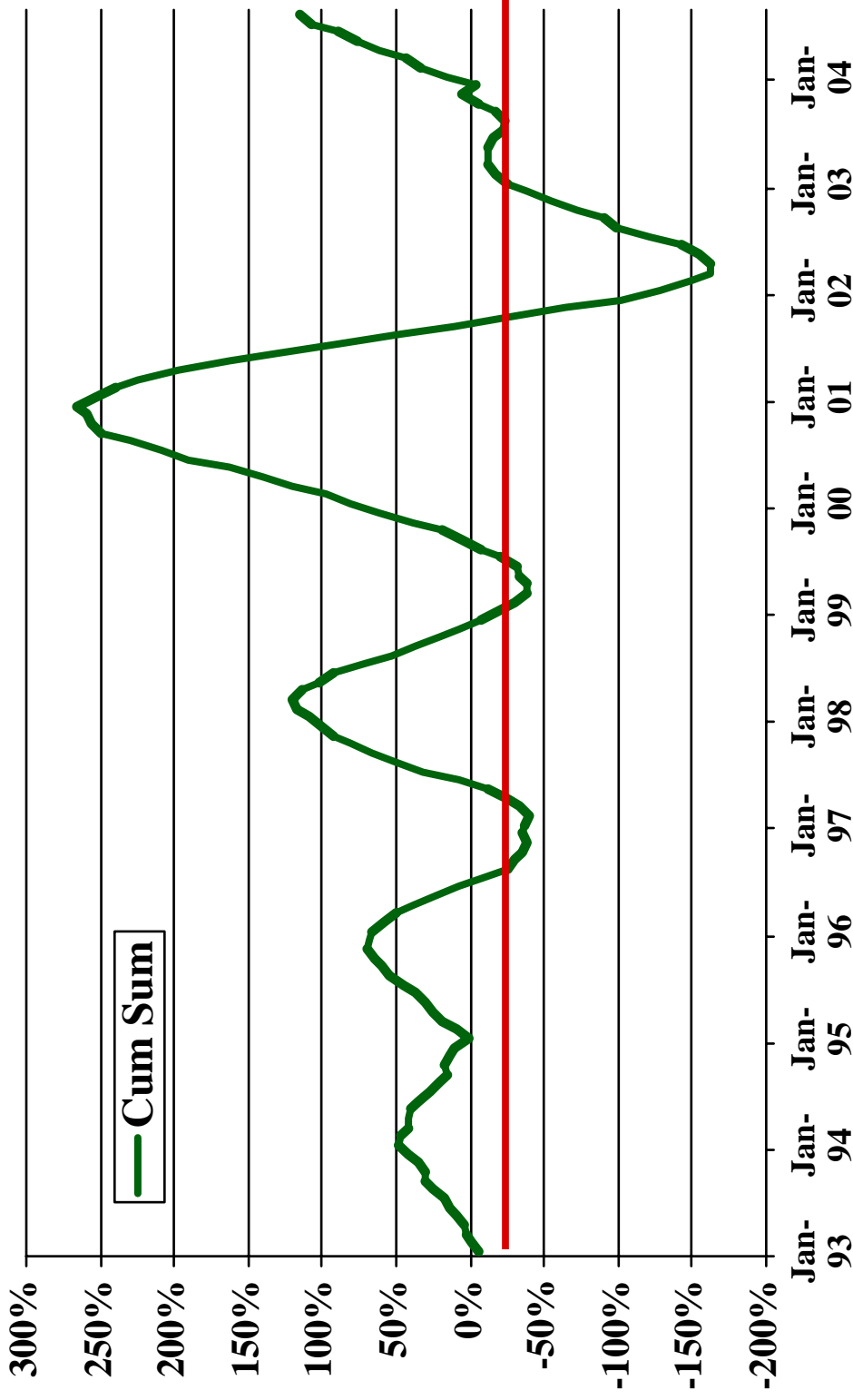
# IC Unit Growth: Year-over-Year



(source: SIA/WSTS)



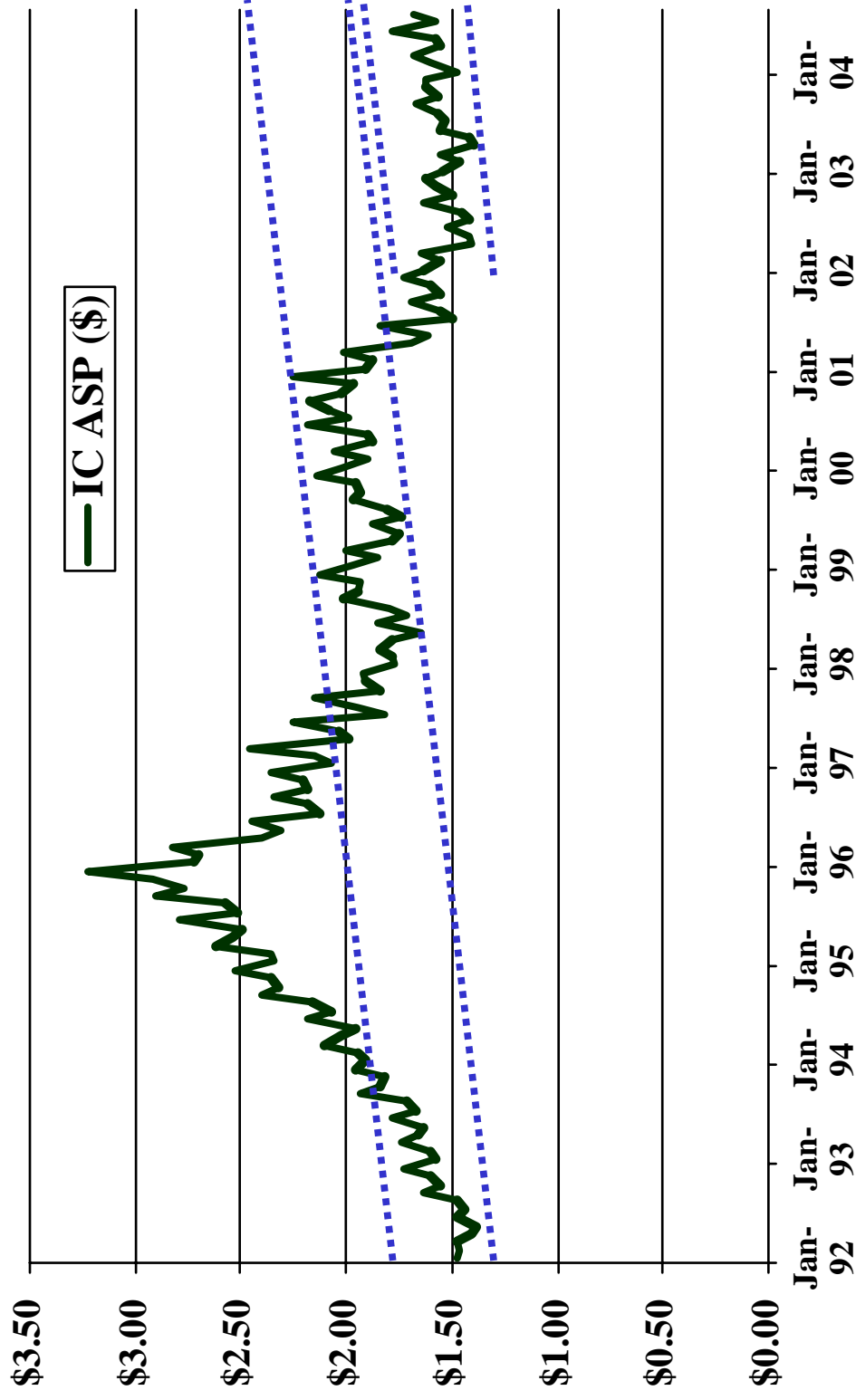
# IC Unit Growth Y-o-Y: Cum Sum



(source: SIA/WSTS)



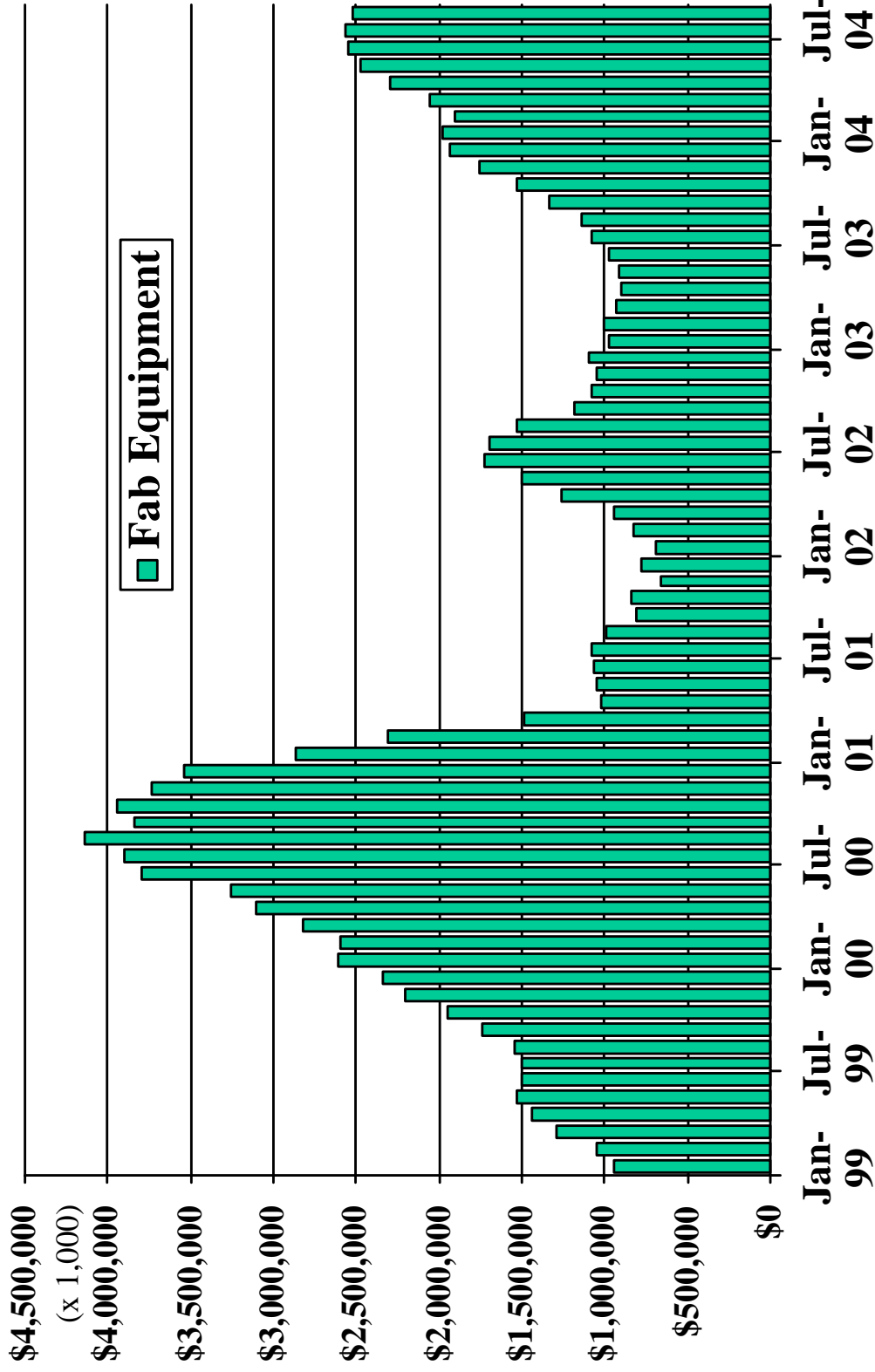
# Chip Average Selling Price



(source: SIA/WSTS)

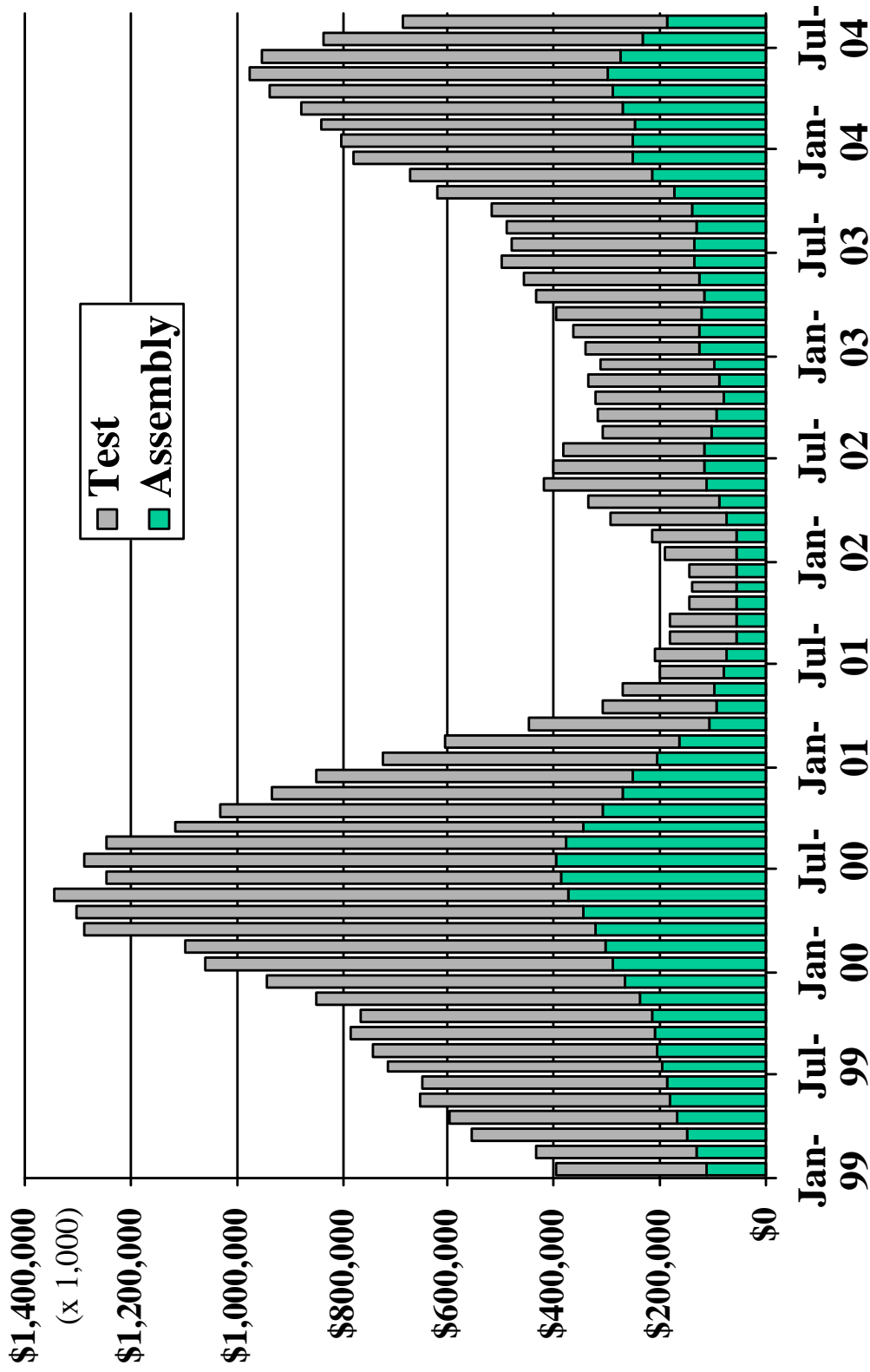


# Wafer Fab Equipment Orders



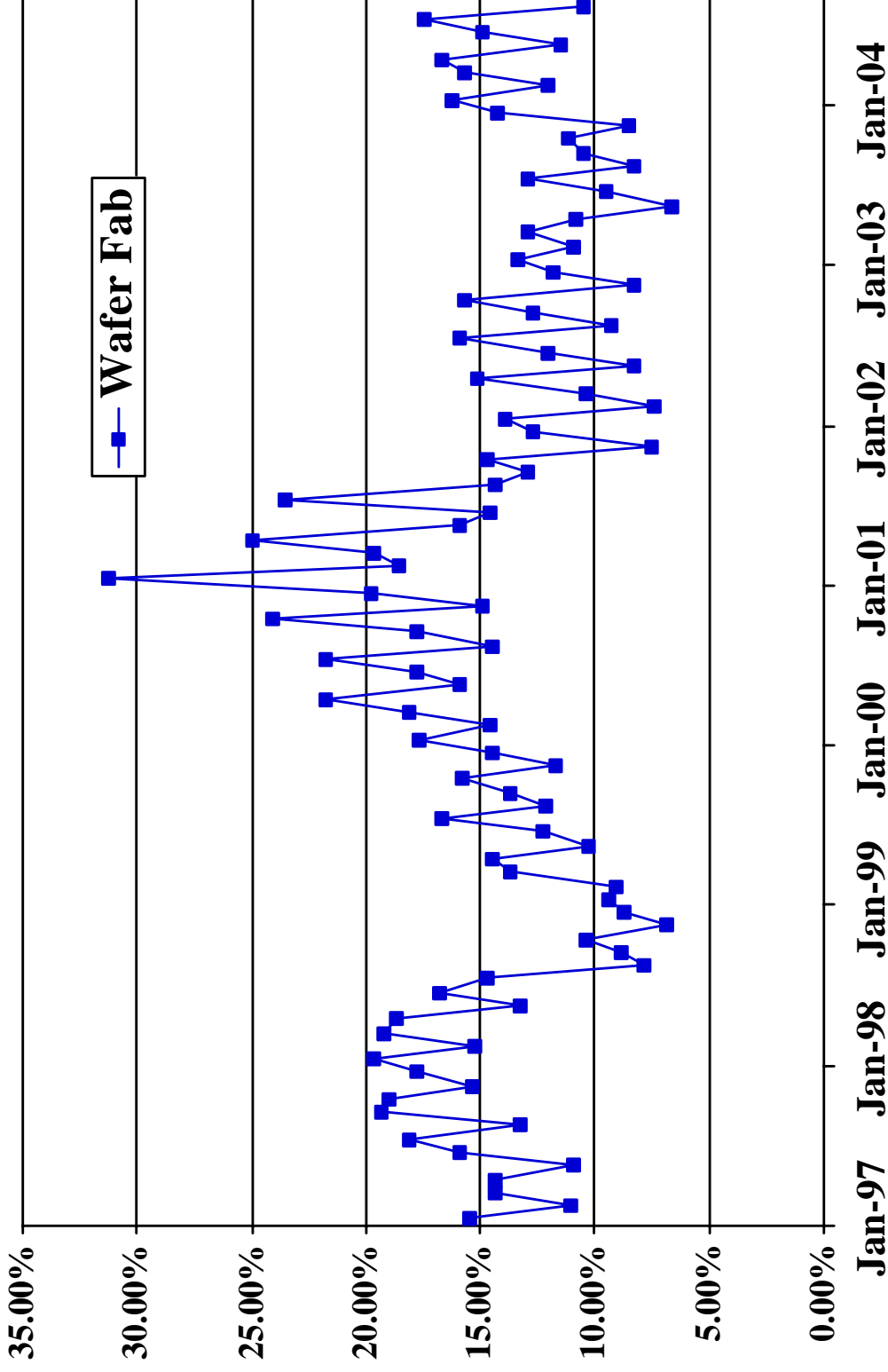


# Test & Assembly Equipment Orders



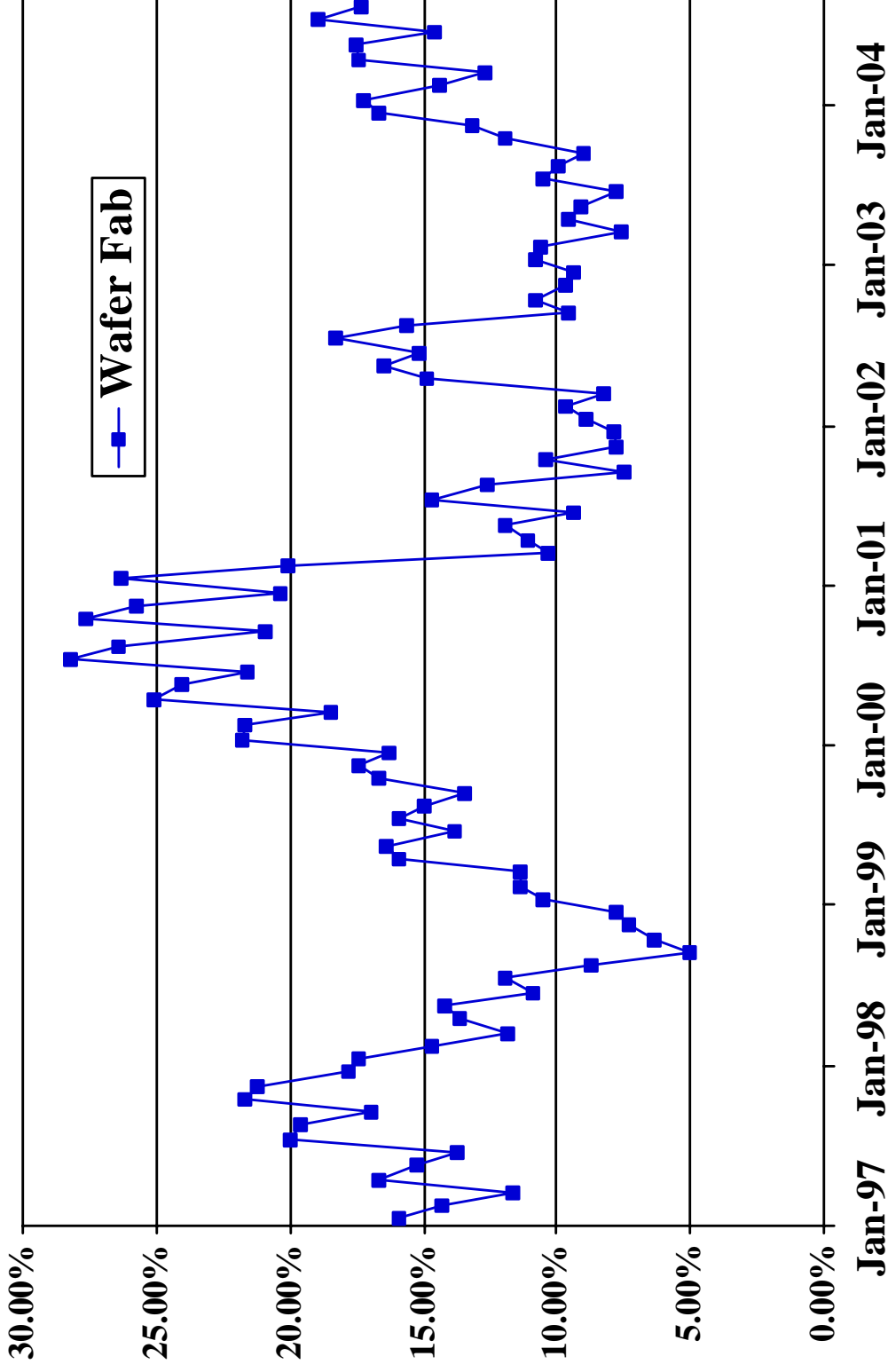


# Wafer Fab Capital Ratio - Revenues



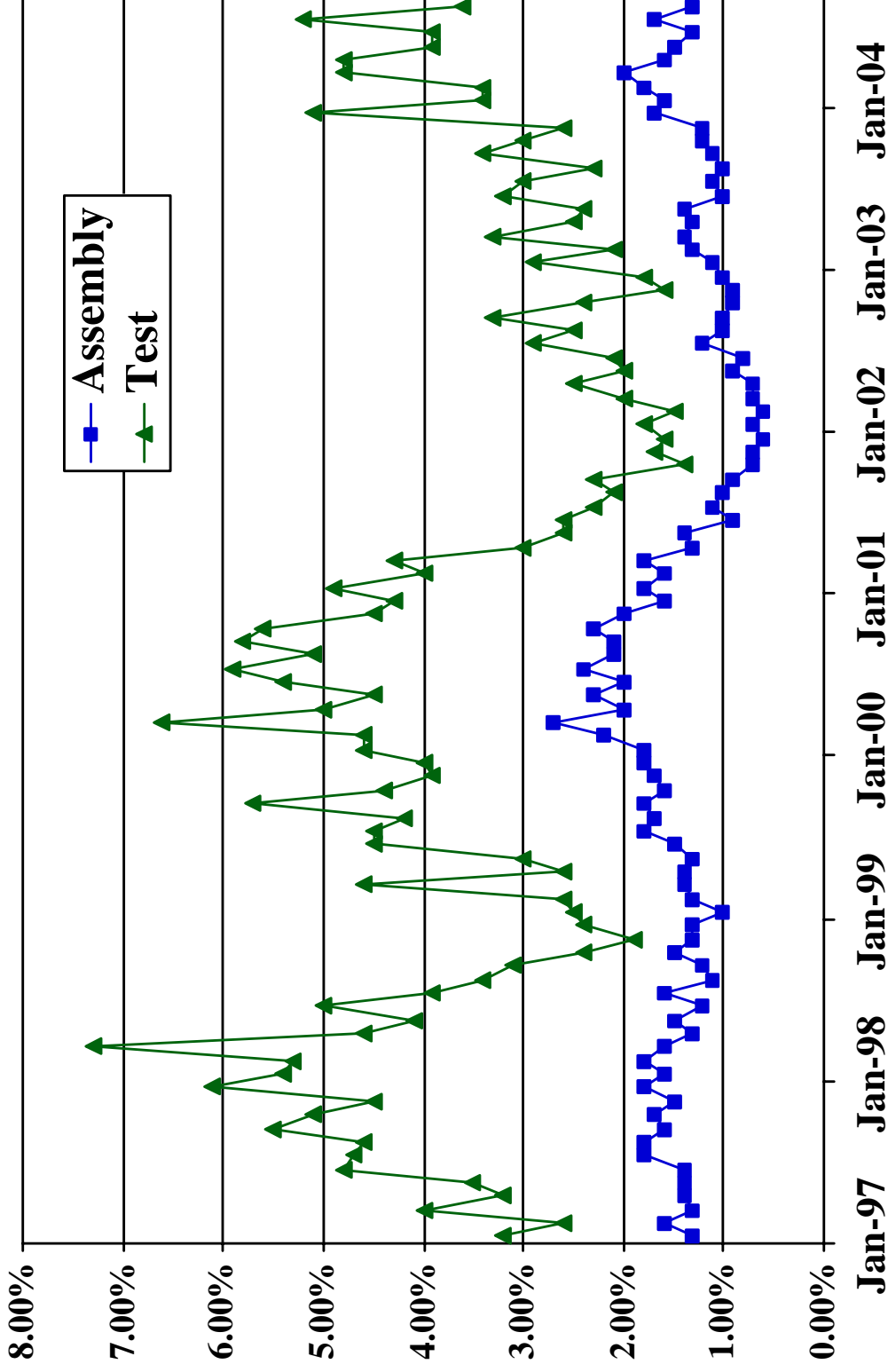


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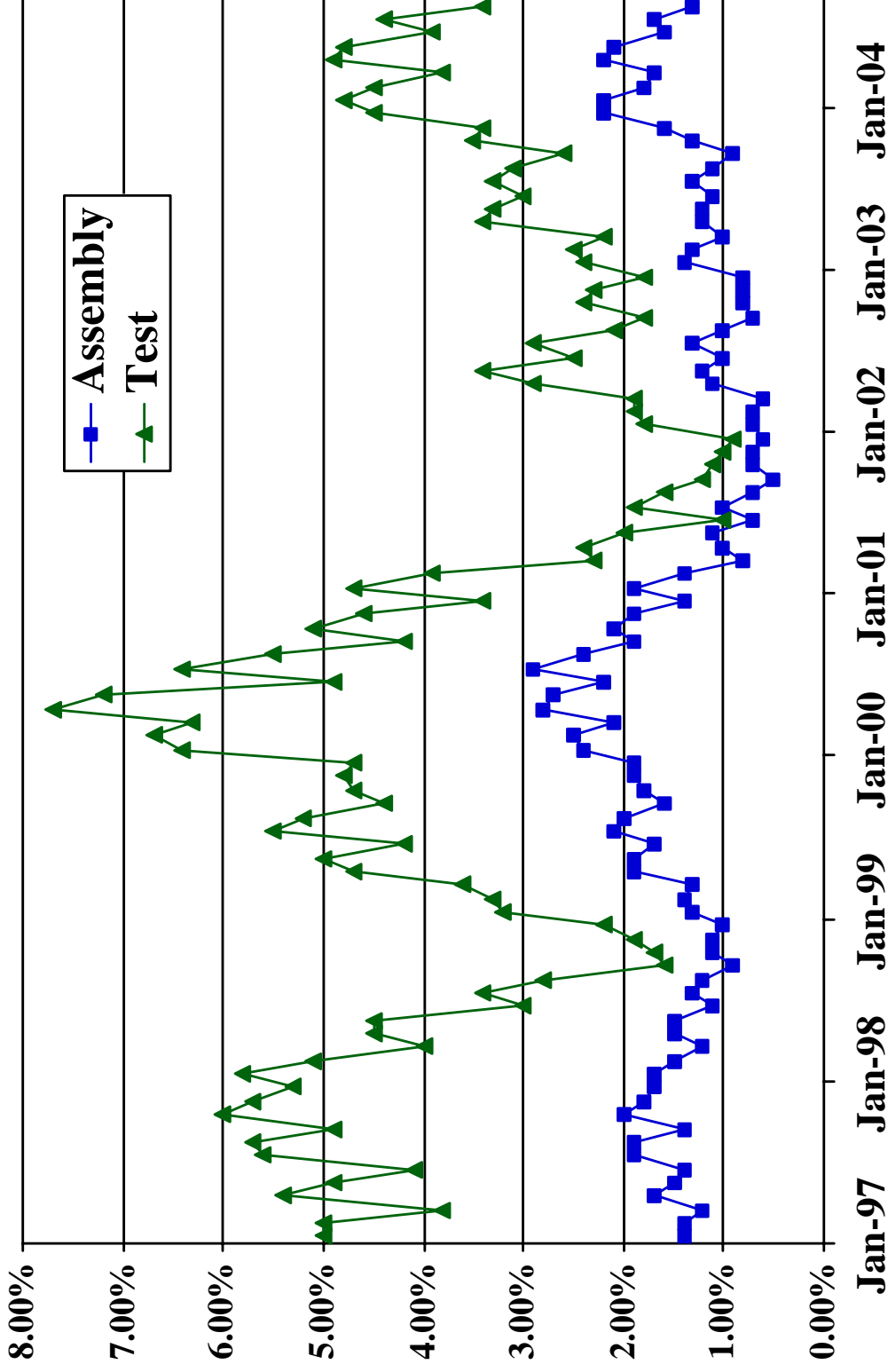


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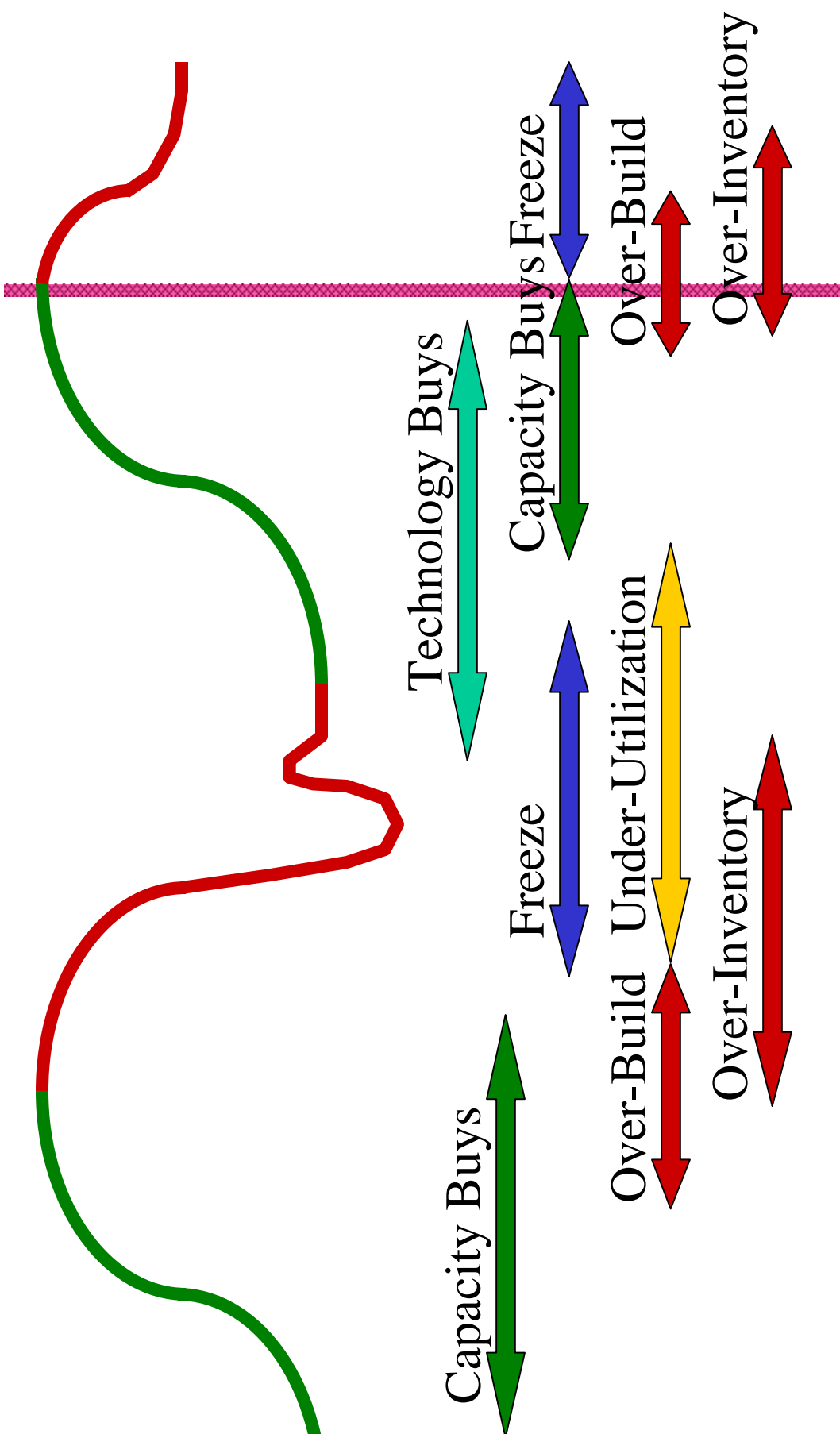


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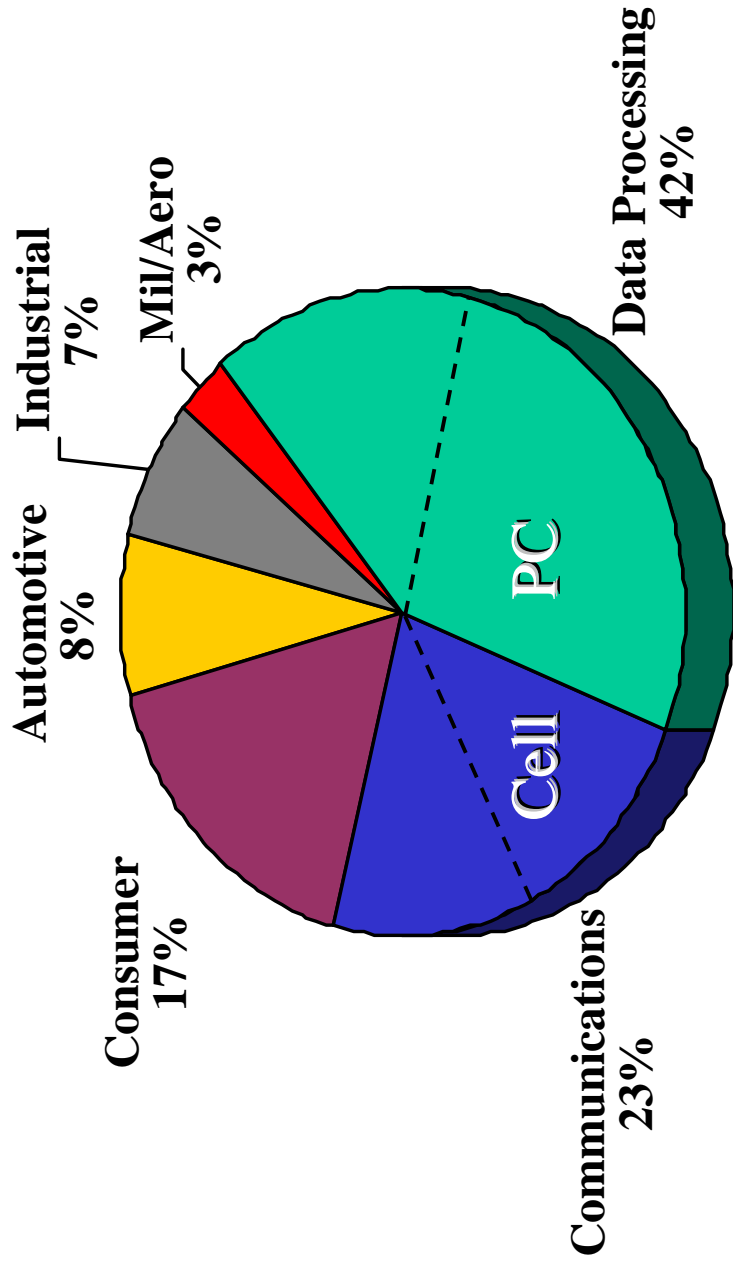


# Where are we in the Chip Cycle?





# Semiconductor Application ‘Pie’



Source: Gartner/Dataquest

**PC + Cell Phones ~ 40% of Semiconductor Market**



# New Applications...

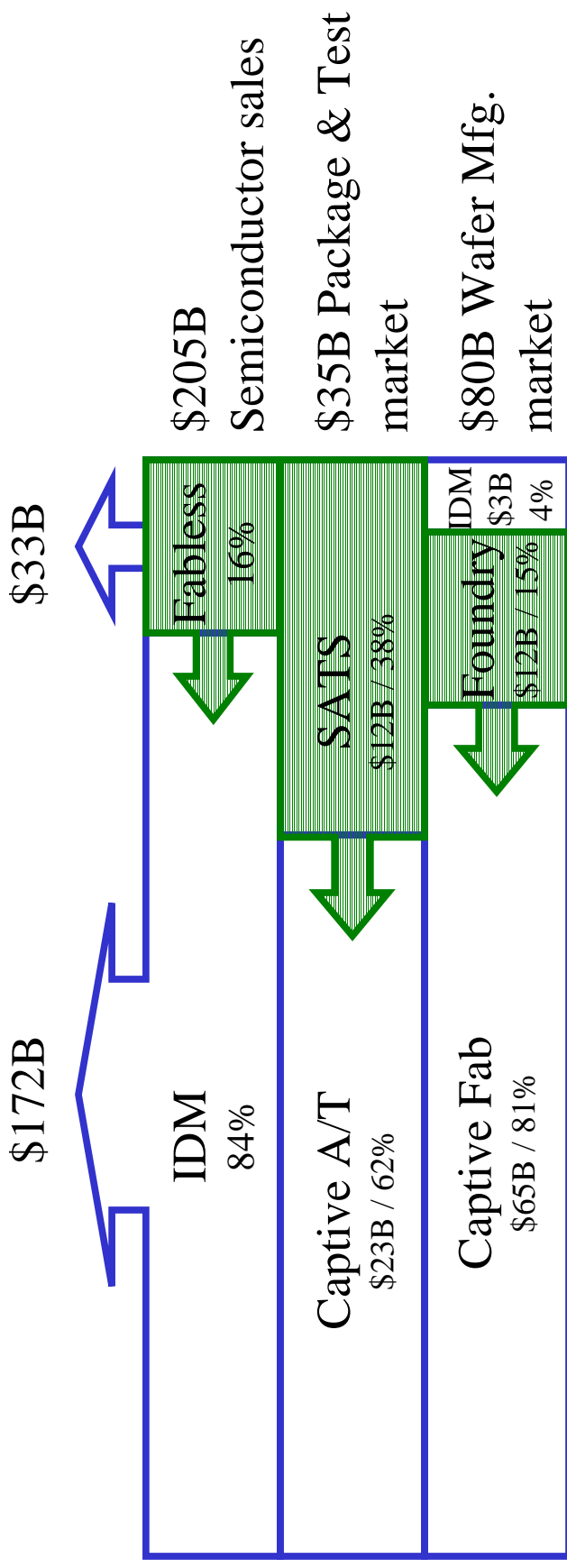
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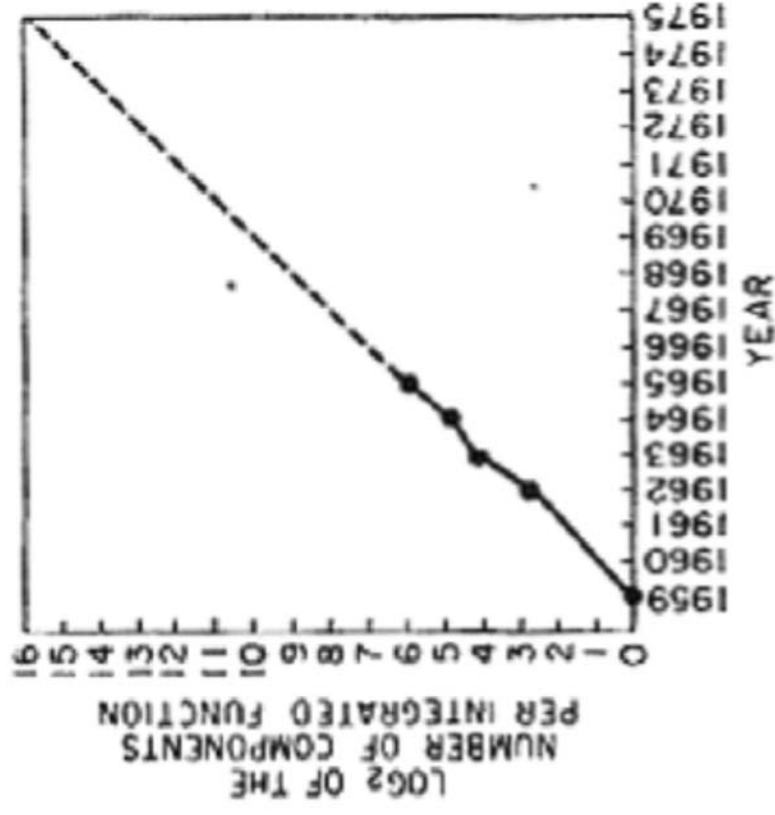
# Chip Making Markets: 2004 est.





# Moore's "Law"

- **Observation:**
  - Exponential growth in the number of transistors per IC
- **Prediction:**
  - This trend will continue

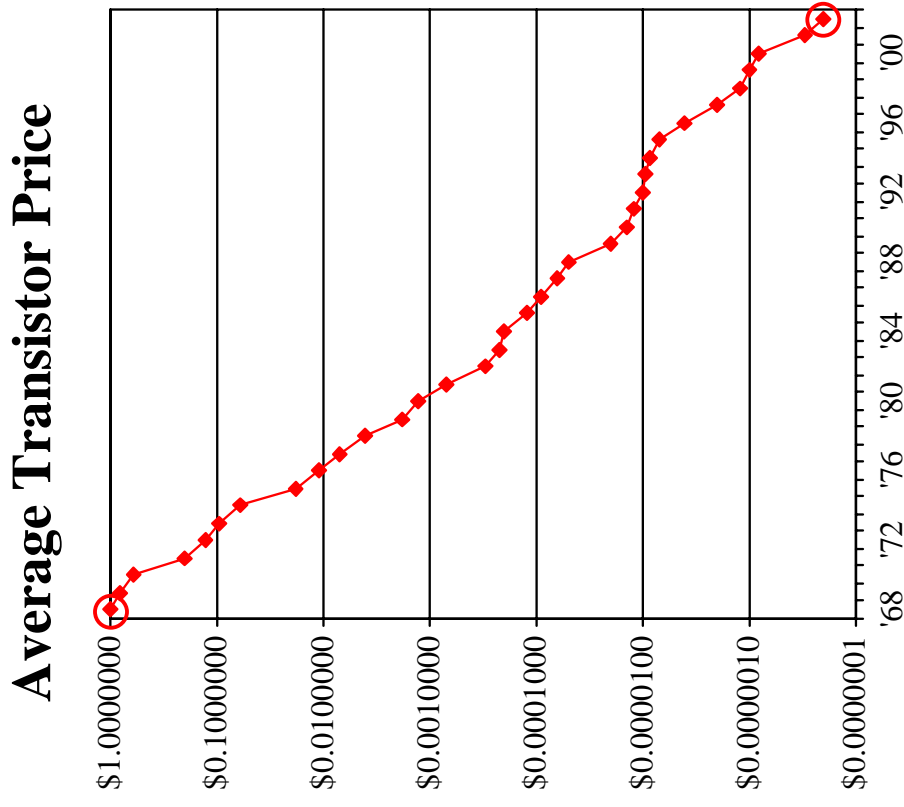


Source: Intel - Moore's original paper



# Moore's "Law"

- **Observation:**
  - Exponential growth in the number of transistors per IC
- **Prediction:**
  - This trend will continue
- **Reality:**
  - Constant Cost Reduction
- **Recent Comment:**
  - “No Exponential is Forever ... but We Can Delay ‘Forever’ ”

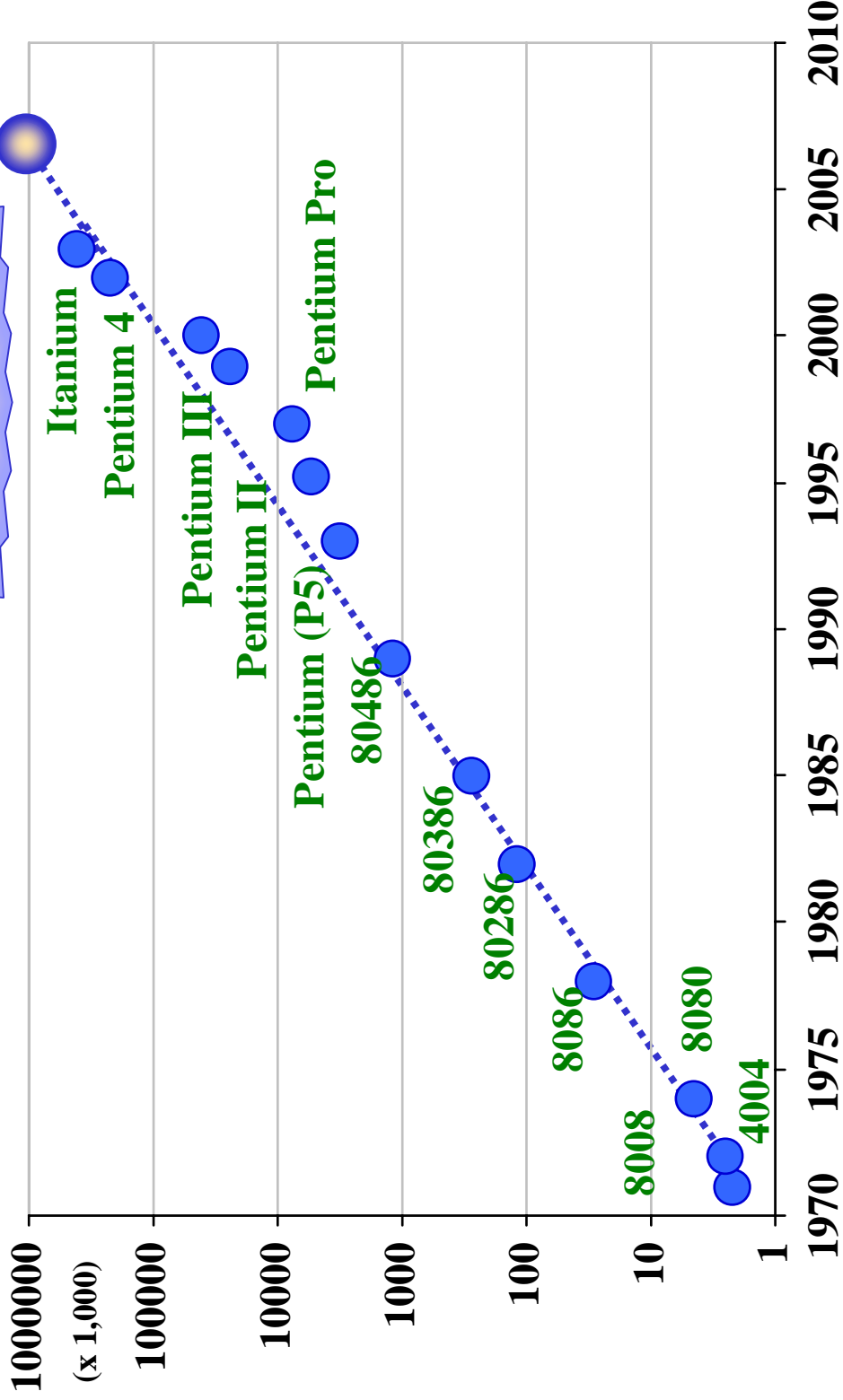


Source: Dataquest / Intel



# Intel Processors: Transistor Count

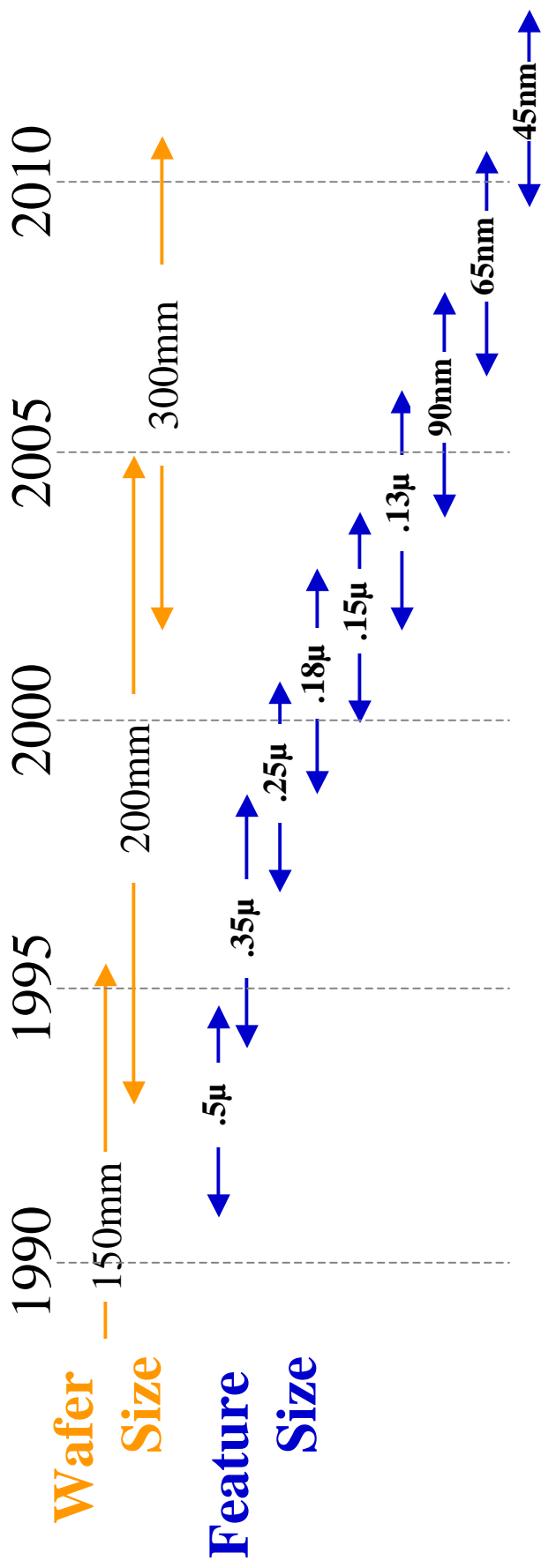
1 Billion Transistors in 2007



(source: Intel)



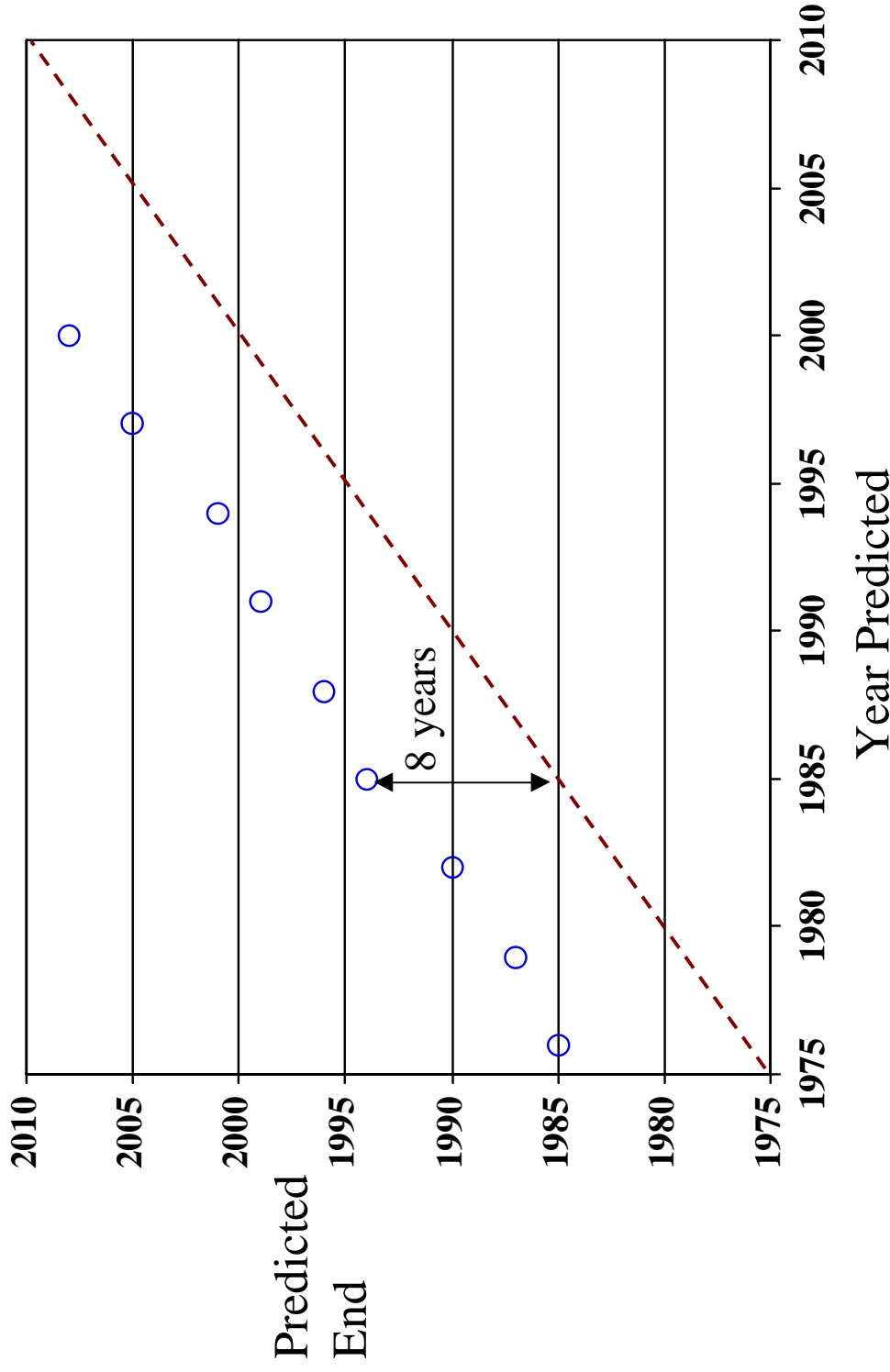
# The (ITRS) Technology Roadmap



- Will the Industry go above 300mm???
- It gets tougher below 130nm
- Yield ramps will take longer
- New Materials, Processes, Structures
- Do the economics support it beyond 2010?

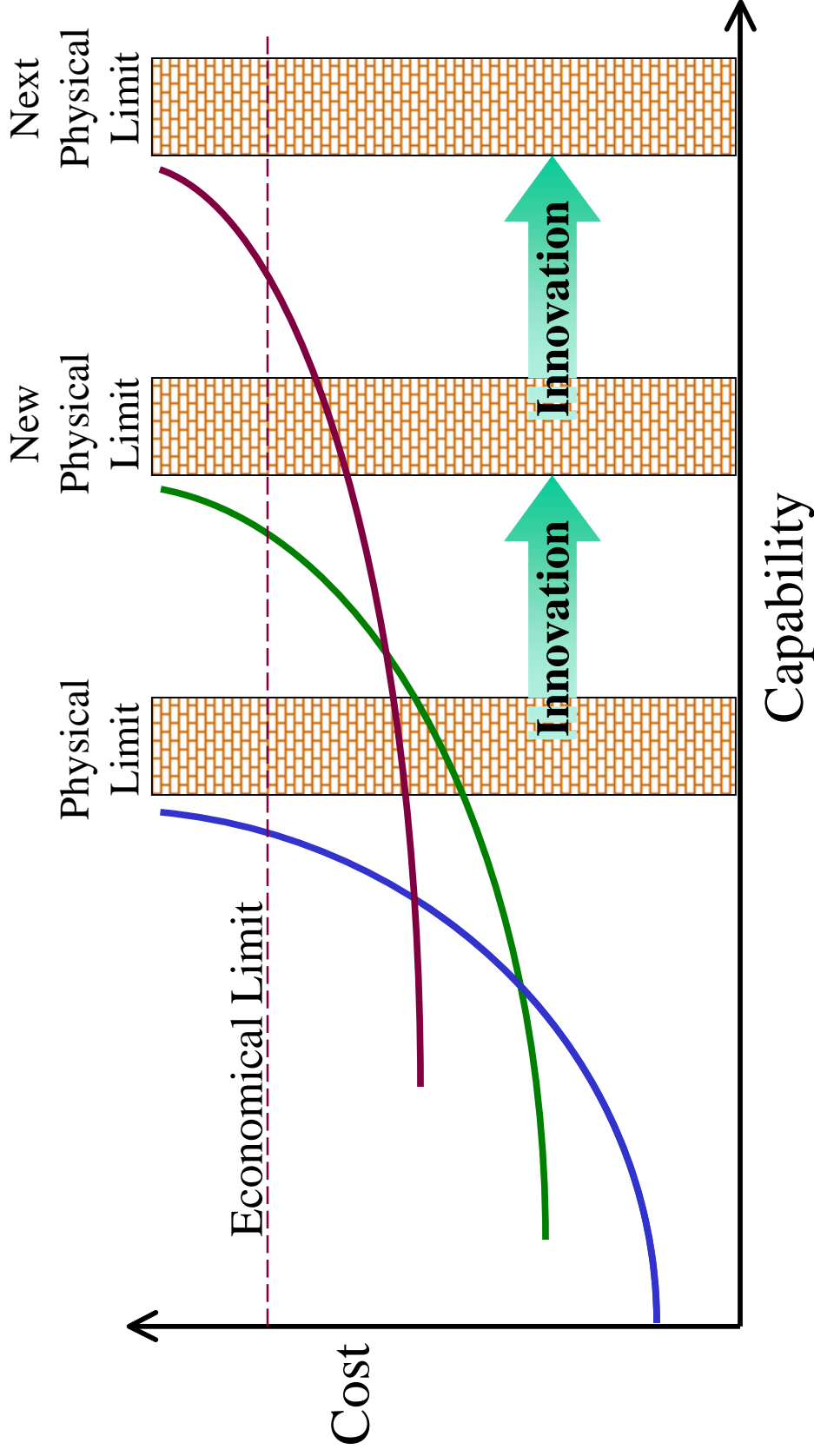


# Predicted end of Optical Lithography



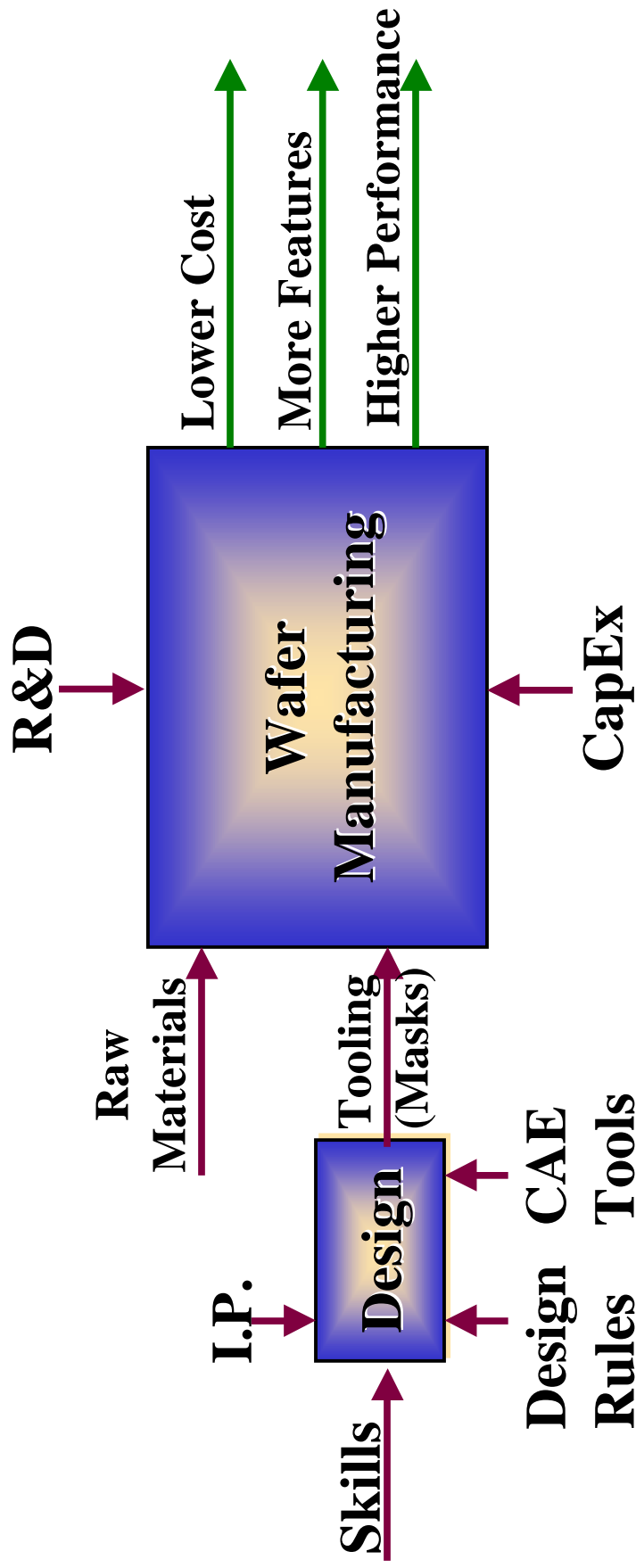


# Innovating Technology





# Macro-Economics





# Manufacturing Technology

- Lithography
- Deposition and Etch
- Materials
- Interconnect
- Structures





# Extending Optical Lithography

- Shorter Wavelengths...
  - 248...193...157?...13nm
- Reticle Enhancement Technologies (RET)
  - Optical Proximity Correction (OPC)
  - Phase Shift Masks (PSM)

Desired Pattern on wafer



Actual Mask Pattern



OPC Optical Proximity Correction

Multilevel Mask



PSM Phase Shift Mask



# Immersion Lithography

QuickTime™ and a  
TIFF (LZW) decompressor  
are needed to see this picture.



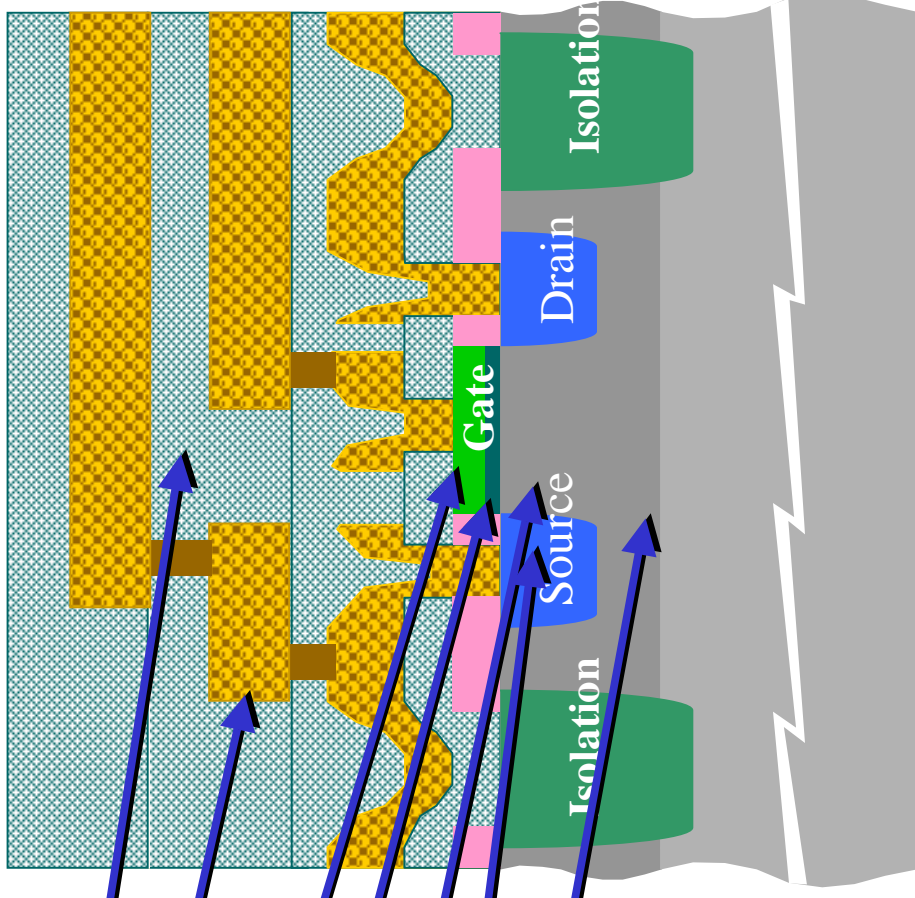
# New Materials

- Escalating Introduction:

- Low-k dielectrics
- Barrier metals
- Metal gates
- High-k dielectrics
- Silicon Germanium
- Strained Silicon
- Silicon on Insulator

- Risks:

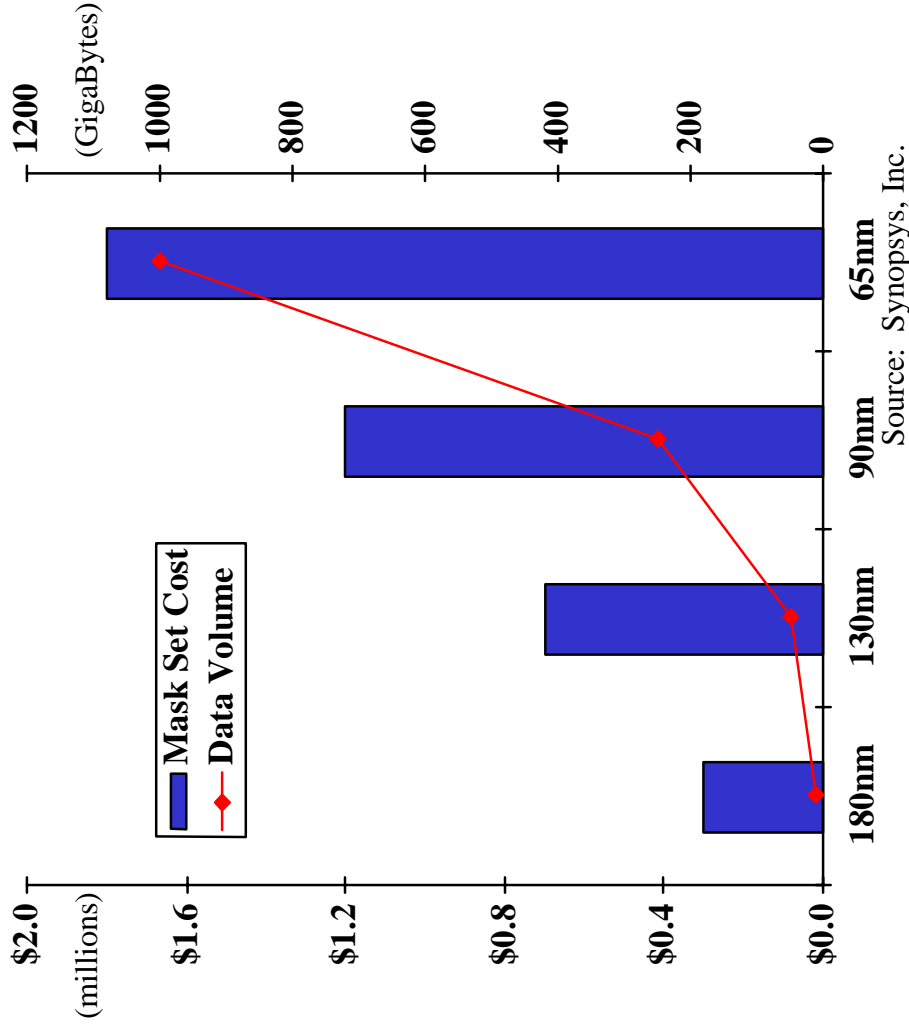
*Yield & Reliability*





# Economic Viability - Design

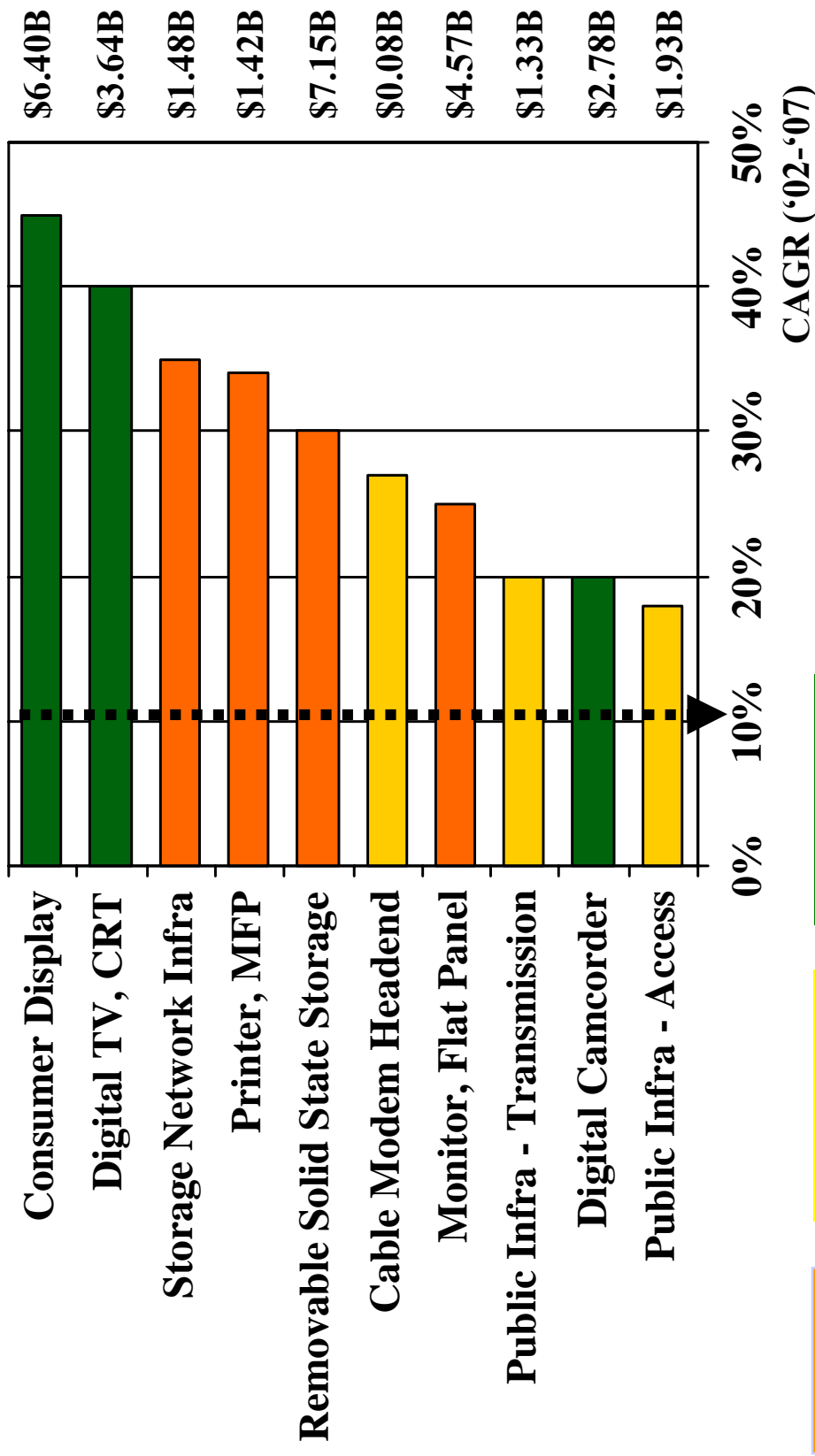
- Escalating Design Cost
  - Labor
  - Masks
- SOC
  - \$10 - 15 million
  - Is there an ROI?
- Is the leading edge really necessary?





# Fastest Growth Applications ('02-'07)

2007 Semiconductor Revenue



Source: Gartner/Dataquest



## Summary

- **The Cycle:**
  - Over-capacity / inventory correction under way
  - Anticipate back on growth track by mid-2005
- **Technology Roadmap:**
  - There is a clear technical path through 2010 to 65nm & 45nm nodes
    - Costs will escalate, but still deliver an ROI
  - Innovation will likely deliver 32nm and 22nm nodes
    - But at slower pace and ROI will diminish and become questionable
  - The Foundry-Fabless model will continue to expand and deliver Moore's Law to those who cannot afford it.



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**Nov 1, 2004**

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*"When one door closes,  
another door opens; but we so  
often look so long and so  
regretfully on the closed  
door that we do not see the  
ones which open for us."*

**by Alexander Graham Bell**

Source: Amkor Technology