450mm and Moore’s Wall: Connecting the Dots for the Semiconductor Industry

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Tendency to view 450mm and scaling as independent

• Both are very connected.
• Key assumption of ‘no need for 450mm’
  – Silicon demand will remain stagnant
  – So new capacity is not needed
  – Capacity not a growth driver because
    • Industry sales growth slowed
    • So, scaling vanquishes demand
At the same time, some say Moore’s Law is about to end or has ended

• They argue that scaling will not drive cost-per-transistor down after 28nm because
  – cost-per-wafer will rise too fast,
  – EUV will not come, and/or
  – multi-patterning will drive costs up.
• Yet they often also argue there’s no need for 450mm?

From an industry economic model basis, these are contradictory beliefs.
These beliefs are contradictory because …

• If growth in transistor consumption continues to stay steady
  – like it has since around 1970 and the rate of scaling slows, then
• the area of silicon consumed has to rise
• It’s simple math.
Moore’s Law and Silicon Demand

- So, assume transistor growth won’t slow if cost-per-transistor rises
- And Moore’s law does not end
- But it extends to a 4 year clock cycle
- *You’re going to need a lot more silicon*
You’ll also be building a lot more fabs

- Even if you don’t believe Moore’s Law is slowing …
  - At a 2 year Moore’s Clock Rate, 2025 is the 1.4nm node production ramp
It’s going to get real expensive

• At a 4 year rate …
• Cap-ex/sales rate
  – will pass 30%
  – In a few years
  – That’s not sustainable
Will transistor growth continue?

- So far, it’s been pretty immune to the business cycle
  - The semiconductor industry has price recessions

- Auto industry as a model:
  - Has grown against significant price increases
When average car prices bottomed …

- 1922: The best unit growth
  - since WW I
- 1918: Prices bottom
  - $242 = $3760 today
  - Average Ford 2013 MSRP:
    - $33,608
- Cars sold
  Ford Worldwide
  - 1920: 0.6M 2.4M
  - 2013: 2.5M 87.4M
  - Growth: 4x 36x
Are chips are here to stay?

• Do you ride a horse to work?
• Do you use a slide rule?
  – Would you buy one because your smart phone is too expensive?
    • I Phone 5s 32GB: $299.99
      – With a $750 2 year contract
  – This Slide Rule costs $4.99
    • Gets a 4.25 rating
    • Based on 18729 reviews
What’s happening to Price-per-Transistor?

- Yes, it’s slowed …
  - To a halving every 2 years
The bottom line:

• Physics will build Moore’s Wall …
  – *if economics doesn’t*

• It won’t be the end of semiconductors
  – It could be a new golden age
  – A basis shift from cost to Value

• 450mm is not needed now

• But it will needed be later …
  – To extract profit from the value
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