TrendMacrolytics

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INTELLECTUAL AMMUNITION

Semiconductors: Down By Law

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Chips aren't just commodities, and it's going to take a lot more than deflation-relief to get the semiconductor industry over the problems created by Moore's Law.

A seasoned Silicon Valley businessman -- an older man of the pre-dotcom generation who's seen his fair share of booms and busts -- once told me that he had discovered the fatal weakness of the technology industry. It is that semiconductors are the most capital-intensive and innovation-intensive industrial products in history, yet everyone wants to pretend that they are commodities. "People have no idea what it takes to make these things," he told me. "They think they're no different than potatoes. They want 'em cheap, and they want 'em in a bin at the grocery store, waiting for whenever they need them."

Now would be a good time for semiconductors if they *were* commodities. With gold solidly back above $300 and the dollar weakening on foreign exchange markets, it looks like we can finally see the end of the monetary deflation that **the Federal Reserve** set in motion in 1997 (see "Twists and Turns on the Road to Reflation" May 21, 2002). That will take some pressure off commodity prices, which in turn will take some pressure off the profits of commodity manufacturers.

But semiconductors are *not* commodities, and a cessation of deflationary pressure won't do anything in particular for the profits of semiconductor manufacturers. At least it won't do anything *special* for them, or anything *more* for them than it will for any other technology companies simply by virtue of generally contributing to economic stabilization and recovery. In fact, if general economic recovery does take hold, those special dynamics of semiconductors that make them *not* commodities will actually make revenue recovery in the semiconductor industry especially challenging.

A true commodity is a good that is highly *stable across time* in its physical attributes, its economics of production: the quality of potatoes and the economics of potato farming improve only gradually through time. A true commodity is highly *substitutable* within a stable end-user community -- one potato is pretty much as good as another, within a standard range of quality, now and across time, for a limited number of end-user purposes.

Because of these attributes of stability and substitutability, commodities are very much like money. In fact, for most of human history, commodities have been used either as money itself or to underpin other forms of money. It is an aberration of our times that money and commodities are entirely detached, at least on an official basis. But whatever the official policies may be, money and commodities remain linked due to their intrinsic similarities -- they can be substituted for each other as a medium of exchange and store of value. That's why the prices of commodities are such sensitive indicators of changes in government monetary policy: commodities prices rise at the first sign of inflation, and fall at the first sign of deflation.

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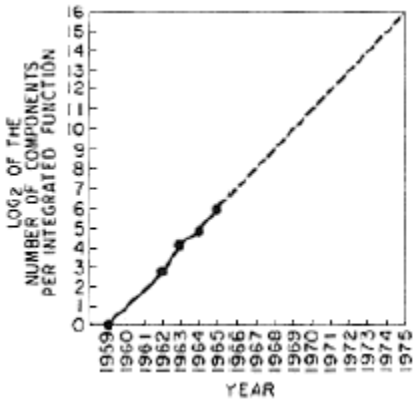
There may be classes of semiconductors -- notably DRAM's -- that are qualitatively stable and substitutable for many end-user purposes, at least within particular windows of time. But over the entire industry and over time, progress in speed, miniaturization, power consumption and functional integration drive constant qualitative change. This same progress also drives steep and sustainable productivity gains that result in relentless price erosion. To use semiconductors for money would be to print dollar bills in vanishing ink. So semiconductors are *not* commodities -- and there is no reason to believe that their prices are importantly influenced by changes in monetary policy.

The distinctly uncommodity-like characteristics of semiconductors are best captured by **Moore's Law**. Moore's Law has entered the common parlance and the conventional wisdom as the underlying technological rationale for the great explosion in technology productivity of the last several decades -- but a closer look at Moore's Law as an *economic* proposition reveals that it has a darker side, as well.

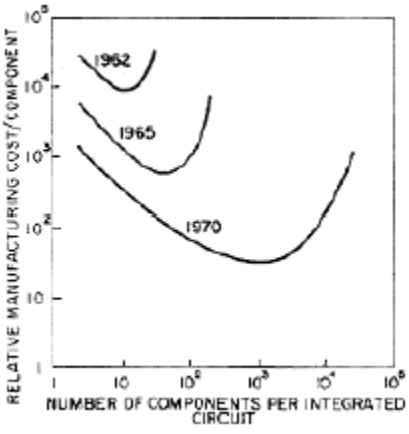
Let's go right to the source. Moore's Law was first suggested 37 years ago by **Intel founder Gordon Moore**. In an April, 1965 article for *Electronics* magazine called "Cramming More Components onto Integrated Circuits" Moore wrote,



"The complexity for minimum component costs has increased at a rate of roughly a factor of two per year (see graph...). Certainly over the short term this rate can be expected to continue, if not increase. Over the longer term, the rate of increase is a little bit more uncertain, although there is no reason not to believe it will remain nearly constant for at least 10 years."

And so it did. Moore revisited this prediction a decade later, in 1975, and revised downward the forecasted rate of doubling from every *year* to every *18 months.* In that form his prediction became known as **Moore's Law**, and it has held remarkably constant ever since, right up through the very latest generation of Intel's Pentium 4 processors. Not bad for line drawn through just five datapoints on a hand-made diagram at the birth of an industry (the first two graphs here are taken from Moore's 1965 article).

What is remarkable about Moore's Law is that it is not just a prediction about engineering, although it is commonly misunderstood as that. Intel's own website incorrectly summarizes Moore's Law as "the number of transistors per integrated circuit would double every couple of years." No, Moore's Law is a prediction about *economics*, linking engineering advances to the cost of implementing those advances. In the same article Moore wrote,

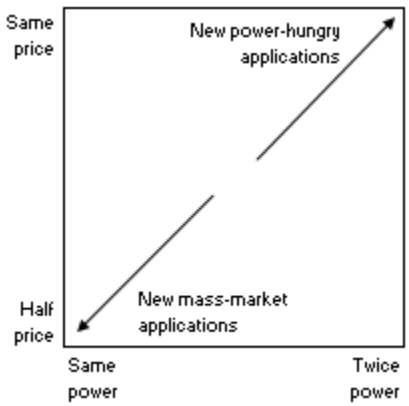


"For simple circuits, the cost per component is nearly inversely proportional to the number of components, the result of the equivalent piece of semiconductor in the equivalent package containing more components. But as components are added, decreased yields more than compensate for the increased complexity, tending to raise the cost per component. Thus there is a minimum cost at any given time in the evolution of the technology."

Perhaps the best way to phrase Moore's Law to capture its economic dimension would be to say that the *cost-effectiveness* of integrated circuits will double every 18

months. In other words, in 18 months you'll get twice the power for the same price, or the same power for half the price, or somewhere in between.

Moore's Law dooms the semiconductor industry to an incurable addiction to growth. Merely keeping revenues unchanged requires getting customers to want twice the power every 18 months, so that they'll keep paying the same old price. If they want the same old power, there have to be twice as many customers -- because they'll only be paying half the price. That's why Intel's revenue growth has imploded, even as they ship record volume. In this deep recession, Intel just can't keep up with the law named after its own founder.



In a rapidly growing innovation-rich economic environment, keeping up is no problem. New high-end applications are developed and demanded -- creating the incentive for customers to upgrade, paying the same price for twice the power. Entirely new customer categories come in at the high end, too, spontaneously created by applications that were unfeasible at lower power. Think how many people bought PC's in order to be able to use word processing software, then desktop publishing, then the Internet. But... *now what?* Same thing with markets for servers, and with routers and switches. But... *now what?*

And at the low-cost end, semiconductors can find their way into an infinite number of uses. Whole new industries can spring into existence when semiconductors hit the right price-point -- cell phones, smart cards, PDAs, digital cameras, MP3 players. But... *now what?*

For the semiconductor industry, Moore's Law is like leverage. It makes the upside better, but it makes the downside worse. It means the industry has to run just to stand still -- and it means that with each new day of this tech recession on which the industry didn't run fast enough, the volume hurdles to get back to peak earnings just get higher and higher.

So why, then, do semiconductor stocks sport a capitalization-weighted average forward price/earnings multiple of 45.1 -- far above the NASDAQ's 33.7, or the S&P 500's 19.5? Perhaps die-hard techstock investors who have gorged on a decade of the upside leverage of Moore's Law don't know what they're up against as they confront the downside. Semiconductors are more than commodities, and it's going to take more than a little deflation relief -- indeed, more than a little cyclical economic recovery -- to justify these unrealistic expectations.

It is perhaps revealing that the cap-weighted average forward p/e for semiconductor equipment stocks is an even more stratospheric 71.5. As good as techstock investors think it's going to be for the chipmakers, apparently they think it will be even better for the arms-merchants who sell the equipment that the chipmakers virtually have to buy to wage competitive war, even in a stagnating market. These companies operate on a law all their own -- **Rock's Law**, propounded by **Arthur Rock**, the legendary venture capitalist who put up the seed money to start Intel: the cost of capital equipment to build semiconductors will double every four years.

I wouldn't want to be a semiconductor company CEO right now -- struggling to come out of a devastating recession with a product regarded as a commodity, the price of which cuts in half every 18 months -- but that is made with equipment the price of which doubles every four years -- *and* with my stock priced at bound-to-disappoint valuations. I wouldn't want to be a semiconductor investor, either. TM