ATREG Thought-Leadership Series

The Inflection Point

Macro Forces & Emerging Trends That Will Reshape The Semiconductor Industry Through 2016

July 2013
Second Edition

> *"It is difficult to make predictions, especially about the future."*
>
> Generally attributed to Niels Henrik David Bohr,
> Danish physicist and Nobel Prize winner (1922)

ATREG

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ATREG

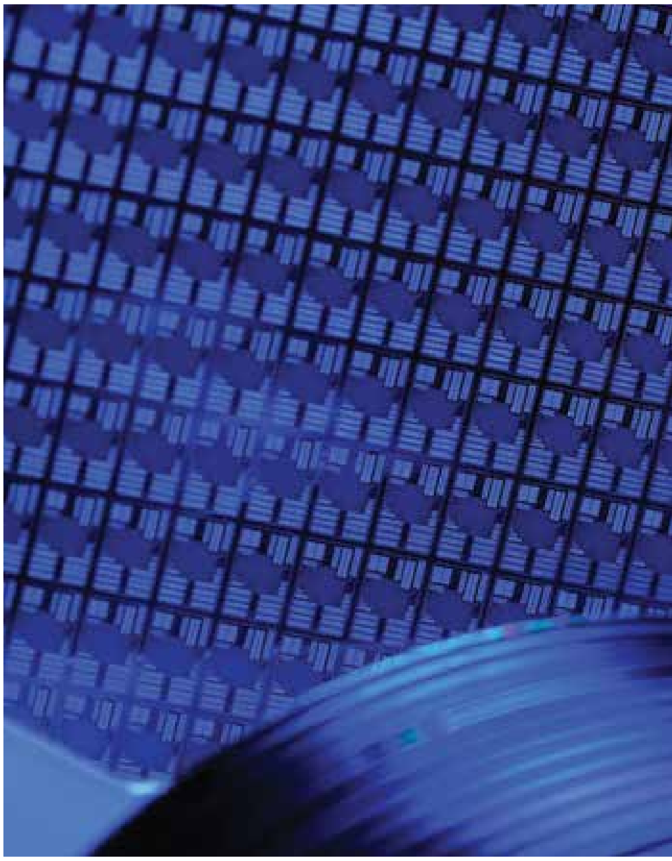
Principal Investigator

This paper authored by ATREG is the first in a series of broad assessments of the semiconductor industry and the predictions for changes to come over the next three years. Our views about the future are unvarnished. We have been rigorous in our analysis by using large data sets to support our conclusions. We have suggested four possible futures that may emerge and have looked at implications for each of these scenarios.

Headquartered in Seattle, USA, ATREG (www.atreg.com) is a global firm that advises the world's largest and most reputable companies in the semiconductor industry and related technology verticals. The industry is subject to volatility, major capital investments, unpredictable market demand, rapidly evolving technologies, fierce global competition, and consolidation. To mitigate these concerns, ATREG provides its clients with unparalleled objective market analysis, advisory services, and transaction expertise.

ACKNOWLEDGEMENTS

ATREG would like to express its thanks and gratitude to the many talented members of the ATREG team who dedicated their time, knowledge, and hard work to the creation of this paper based on unique market data collected by ATREG over the past decade.



Executive Summary

The semiconductor industry is at an inflection point. What was a growth sector for the past 30 years has reached middle age, which has brought unwelcome changes. Cyclicality can mask a gradual maturing of the industry, as can macro-economic shocks. However, the evidence is clear – semiconductor firms are seeing slower revenue growth and a compression of gross margins. As a result, most public semiconductor companies have seen significant drops in their trading multiples as investors no longer see attractive growth returns from the sector.

Given this new landscape, what possible futures might emerge for the semiconductor industry? How should semiconductor firms respond to this ever-changing landscape? This paper examines the macro forces driving change in the industry and explores likely future scenarios that will evolve in the next three years. Companies will react to these changes differently depending on the market segment in which they operate and the respective sub-markets they wish to defend or abandon.

This paper examines a set of four macro themes that are impacting the semiconductor industry:

1. Rising costs of semiconductor production

The cost of developing new processes and building new fabs has gone up exponentially. In 2001, the total costs for process and fab development at 0.13μm amounted to between $1 billion and $2 billion. In 2012, the costs for a new leading fab (22nm) have risen dramatically to approximately $7 billion.

2. Slowing overall growth

Total revenue for the semiconductor industry peaked at $310 billion in 2011. From 1985 to 2005, revenue grew at a compound annual growth rate (CAGR) of 12.8%. However between 2005 and 2012, that rate dropped to 3.4% and current projections show no substantial improvement on the horizon.

3. Concentration in a few large high-growth markets

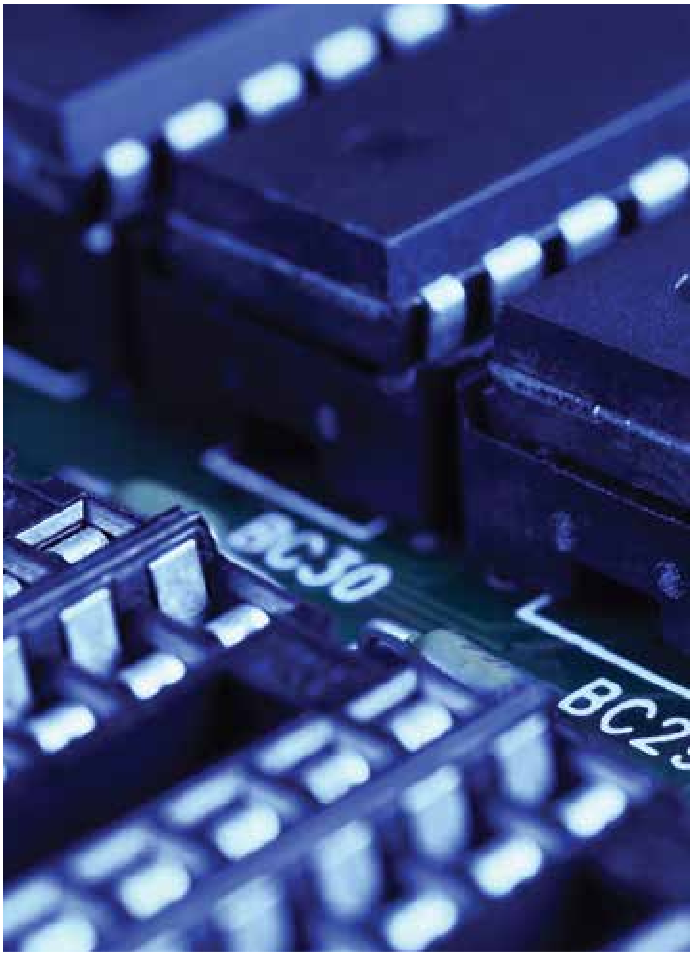
Within the overall semiconductor market, only the tablet and smartphone markets are large (over $10 billion) and fast-growing (over 20% CAGR between 2011 and 2016).

4. Increasing risks associated with today's foundry model

There is a bifurcation in the foundry market. One firm dominates all advanced technology production and achieves high gross margins while the rest of the foundry market is made up of smaller firms that have difficulty loading their factories sufficiently to generate consistent positive profits. We see capital and influence coming from integrated device manufacturers (IDMs), fabless firms, and possibly original equipment manufacturers (OEMs) to support alternatives to a single dominant foundry, thereby ensuring a dynamic and competitive foundry manufacturing ecosystem. This may take the shape of investments in existing foundries, the creation of new foundries, or manufacturing joint-ventures (JVs) between companies.

Given these four macro themes, our research and analysis explore the following three outcomes:

A LESS ATTRACTIVE FABLESS OPERATING MODEL



Fabless semiconductor companies have been viewed by many as the darlings of the industry, given their rapid growth and reduced capital requirements compared to traditional IDMs. Certainly, several fabless semiconductor firms have achieved enormous success. Nonetheless, we anticipate the golden era for fabless firms will fade as many of the fabless ecosystem's economic advantages disappear. Foundries have continued to take margins from fabless firms while the over-reliance on these foundries results in potential capacity constraints as well as geographic and natural disaster risks. Fabless firms do not have the opportunity to benefit from the ***virtuous cycle*** of engineering and design, and research has determined that fabless firms have, in certain instances, a time-to-market disadvantage. The combination of these factors has caused investor sentiment to cool on the fabless ecosystem. This trend does not bode well for complacent firms. We anticipate two things to occur:

- Fabless firms will begin to venture outside of their traditional 100%-outsourced manufacturing reliance. This change does not mean they will necessarily need to build their own fabs, but we anticipate they will begin exploring hybrid capital and operating relationships with partners in order to provide additional supply and strategic security.
- TSMC's growing market dominance will add downward pressure on margins for even the largest fabless companies, particularly at advanced process nodes.

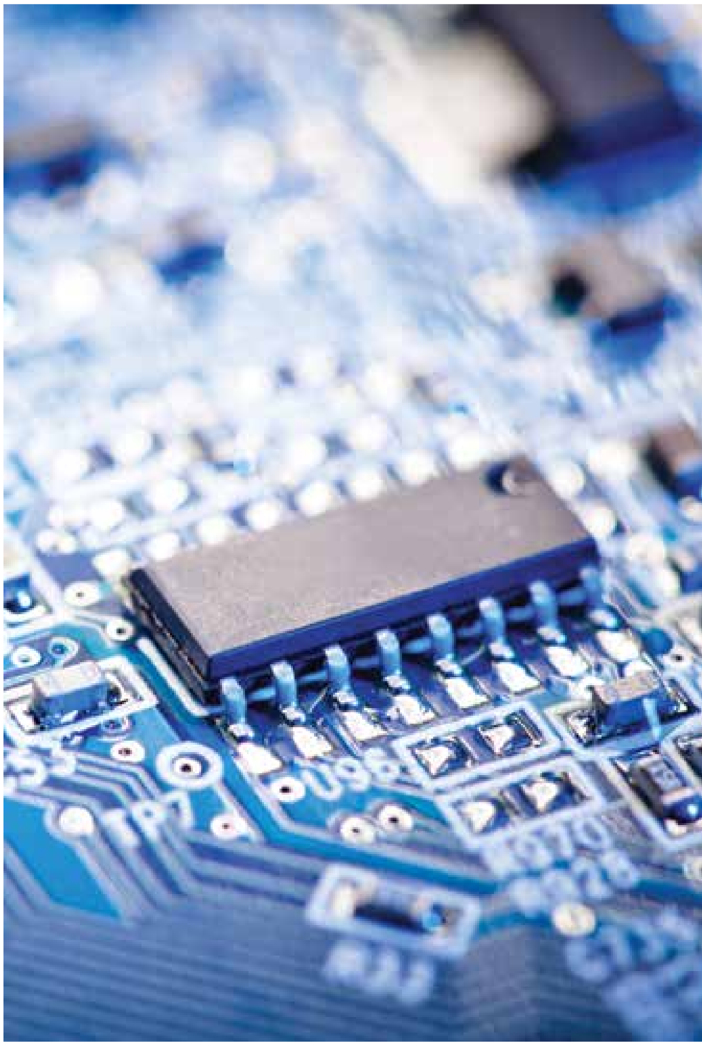
THE RISE OF THE BRANDED OEMS

Large consumer product OEMs (Amazon, Apple, Google, Microsoft, and Samsung) are capturing the dominant share of the tablet and smartphone markets, thereby seizing the most significant portion of this fast-growing semiconductor market segment. This dominance allows these OEMs to capture supernormal profits and amass large cash resources, often at the expense of their semiconductor suppliers. OEM firms have the most to gain and lose if there is a breakdown in the global electronics supply chain. OEMs are taking steps to vertically re-integrate their strategic silicon supply chain and have the cash and the market power to drive significant change. We anticipate OEMs will leverage this power to ensure their needed component supply through any means necessary, including acquiring suppliers.

INCREASING VERTICAL RE-INTEGRATION

Vertical re-integration is already manifesting itself in the market as OEMs, semiconductor firms, and other companies in the supply chain adapt to supply chain pressures. Given the OEMs' market power and access to cash as well as the continued pressure on all participants in the semiconductor supply chain, we expect the trend of vertical re-integration to continue.

Finally, this paper outlines four possible scenarios describing what 2016 might look like for the semiconductor industry and concludes with some thoughts on actions firms might take to ensure the best possible future within the sector.



Background on Semiconductor Manufacturing

In the 1960s, pioneering semiconductor companies such as Fairchild Semiconductor, IBM, Motorola, National Semiconductor, NEC, Sony, and Texas Instruments, not only manufactured semiconductor devices, they also developed the processes, materials, and equipment necessary to build them. Those early-to-market companies were completely vertically integrated and remained this way for much of the first 20 years of the industry.

As the semiconductor sector grew, independent equipment and material suppliers emerged. This allowed semiconductor companies to concentrate on chip design and manufacturing, becoming what we know today as IDMs.

In the late 1970s and early 1980s, the pure IDM model began to change. Companies closed their U.S.-based assembly and test operations in favor of lower-cost off-shore production in their own plants or with independent subcontractors located in Southeast Asia, a region that quickly became a hub of back-end semiconductor manufacturing.

In 1985, the Government of Taiwan recruited Morris Chang, a former Texas Instruments executive and Chairman and President of Taiwan's Industrial Technology Research Institute, to help develop the region's budding semiconductor industry. In 1987, a joint initiative launched with Philips Semiconductor founded the world's first dedicated semiconductor foundry, Taiwan Semiconductor Manufacturing Company (TSMC), setting a precedent for other foundries to emerge in the following years.

TSMC and other foundries supplied low-cost labor and provided IDMs with overflow capacity by duplicating the processes run in the IDMs' internal plants. Initially, the main value provided was production run-off and low labor costs to offset the captive lines of the still mostly integrated IDMs. However, as the foundry industry began to grow, so did the technological expertise of foundries to address an ever-increasing number of requests from IDM customers. It would not be long before TSMC would surpass the technological expertise of most of its customers.

With a foundry ecosystem established by the early 1990s, the option of running a virtual fab by outsourcing production to foundries led to the emergence of fabless chip companies. For emerging small design houses, the major attraction of the fabless model was the avoidance of large capital expenditures required to build, equip, and operate expensive front-end wafer fabs. Successful fabless companies such as Broadcom, NVIDIA, Qualcomm, and others quickly became some of the largest companies in the industry and arguably owe their very existence to the foundries. Figure 1 illustrates the tremendous growth of the fabless model and shows no fabless firms in the top 20 in 2001, two firms in 2006, and four firms, along with three foundries, in 2011.

Figure 1 – Changing composition of the top 20 semiconductor companies (ranking by revenue)

Rank	2001	2006	2011
1	Intel	Intel	Intel
2	Toshiba	Samsung	Samsung
3	STMicroelectronics	Texas Instruments	🟧 TSMC
4	Texas Instruments	Toshiba	Texas Instruments
5	Samsung	STMicroelectronics	Toshiba
6	NEC	🟧 TSMC	Renesas
7	Freescale	Renesas	🟦 Qualcomm
8	Infineon	SK Hynix	STMicroelectronics
9	NXP	AMD	SK Hynix
10	Hitachi	NXP	Micron
11	🟧 TSMC	Freescale	🟦 Broadcom
12	Mitsubishi	NEC	🟦 AMD
13	AMD	Qimonda	Infineon
14	Fujitsu	Micron	Sony
15	IBM	Sony	Freescale
16	Agere	Infineon	Elpida
17	Panasonic	🟦 Qualcomm	NXP
18	Sony	Panasonic	🟧 UMC
19	Micron	🟧 UMC	🟦 NVIDIA
20	SK Hynix	🟦 Broadcom	🟧 GLOBALFOUNDRIES

🟧 **Foundry** 🟦 **Fabless** ☐ **IDM**

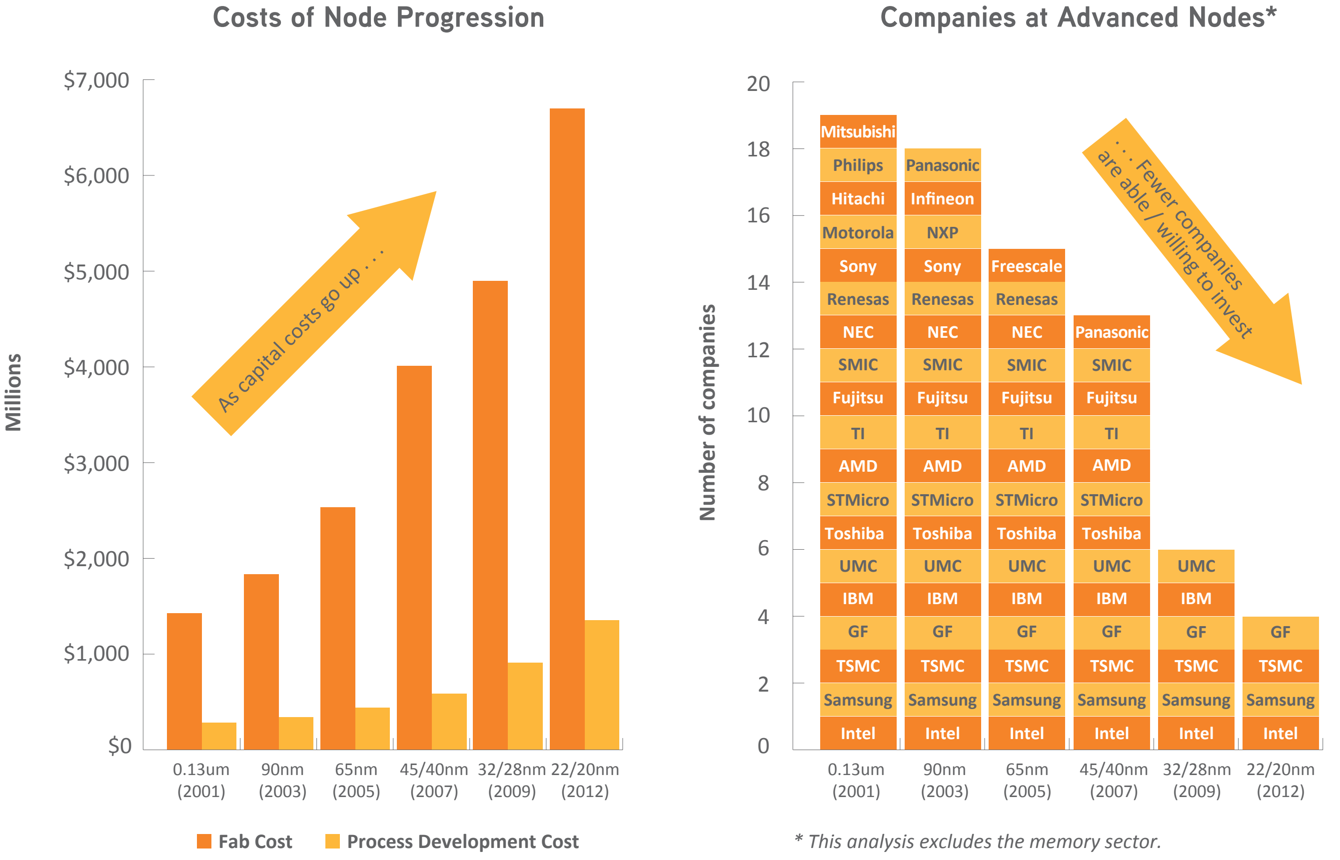
Source: ATREG analysis

Macro Trends Driving Change

RISING COSTS

It is no secret that the cost of remaining at the leading edge is going up exponentially as the industry pursues increasingly small scaling. The implication of rising node progression costs is that in the very near future, only a handful of companies will command the technological and monetary resources required to operate at the leading edge. Figure 2 shows that the total costs for a leading-edge fab increased from $1.5 billion in 2001 to almost $7 billion in 2012.

Figure 2 – Rising node progression costs and declining number of companies at advanced nodes



Costs of Node Progression

Companies at Advanced Nodes*

** This analysis excludes the memory sector.*

Sources: McKinsey & Company, ATREG

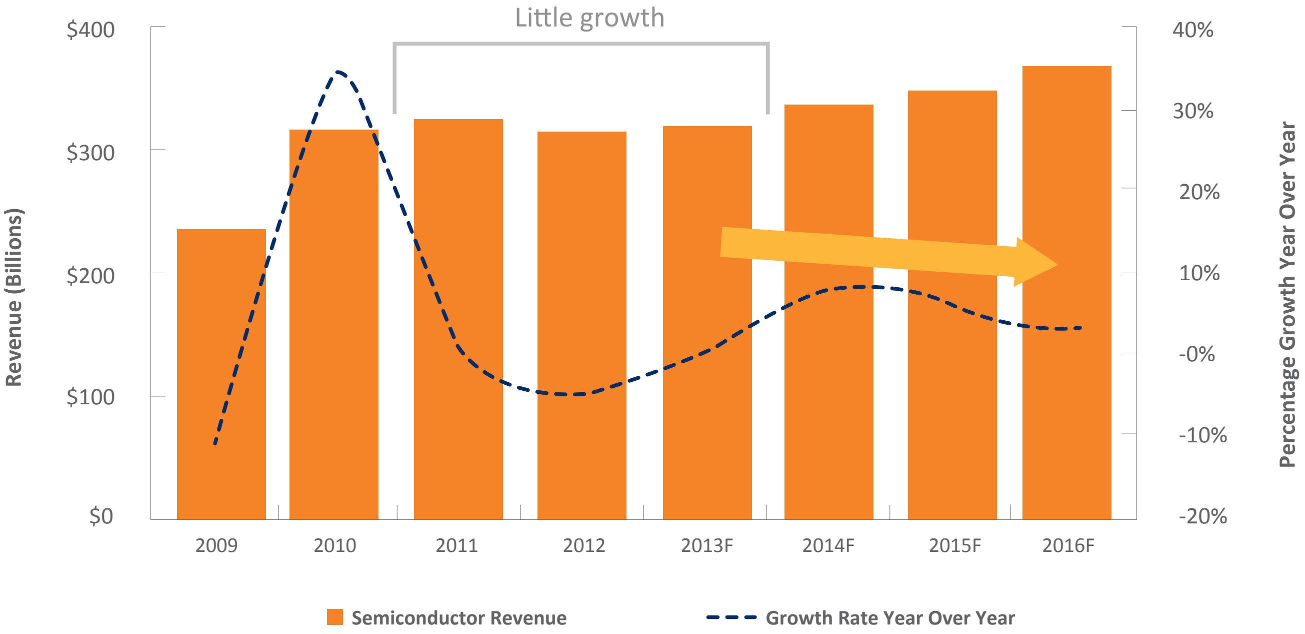
As a result, companies relying on foundry relationships for advanced technology manufacturing are, in effect, tying their fortunes to a shrinking set of suppliers. This reality becomes more pronounced at the bleeding edge because there are even fewer options at these nodes, and two of the four firms capable of 22nm production (Intel and Samsung) are direct competitors to any fabless company looking to them for production capacity.

SLOWING GROWTH

Historically, the semiconductor industry has grown at a respectable rate, reaching a CAGR of 12.8% between 1985 and 2005. However, between 2010 and 2013, that rate is expected to drop to 0.2% and current projections show no substantial improvement on the horizon.

As the industry has matured, semiconductor firms have had to contend with the moderate industry growth outlined in Figure 3. They have done this by entering high-growth markets, particularly the mobile wireless segment.

Figure 3 – Moderate industry growth (2009-2016)

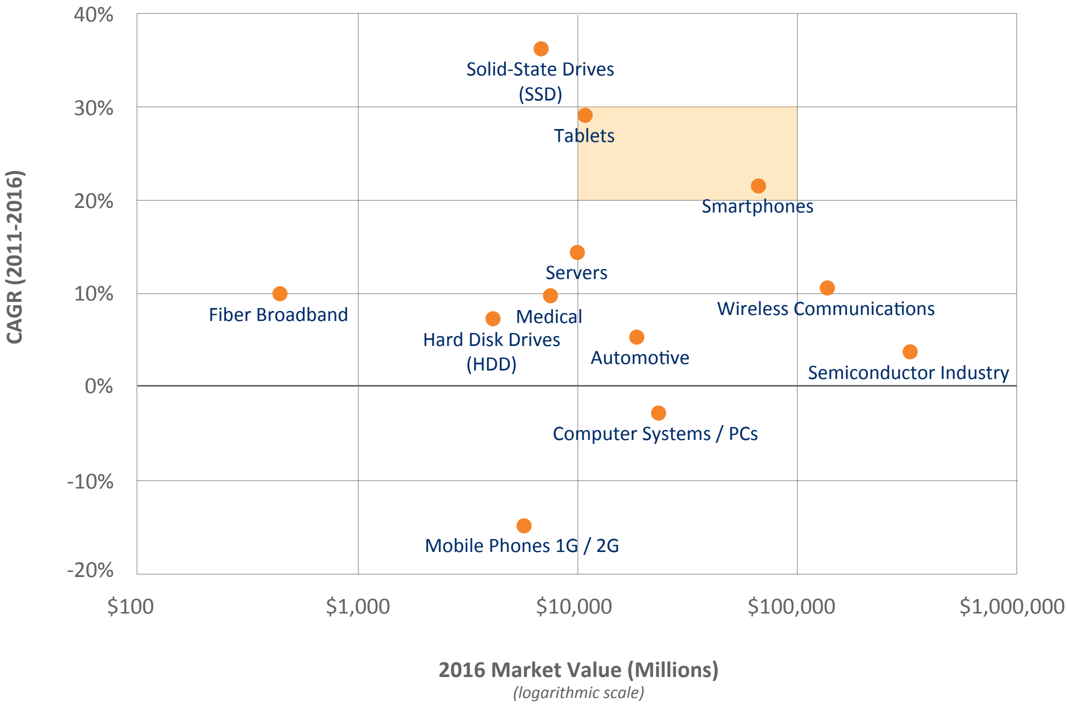


Sources: IHS iSuppli, ATREG

CONCENTRATION IN HIGH-GROWTH MARKETS

As exhibited in Figure 4, consumer markets, particularly wireless mobile devices such as tablets and smartphones, are the primary drivers of semiconductor industry growth. These are the only markets over $10 billion with projected growth exceeding 20%.

Figure 4 – Industry growth drivers by segment



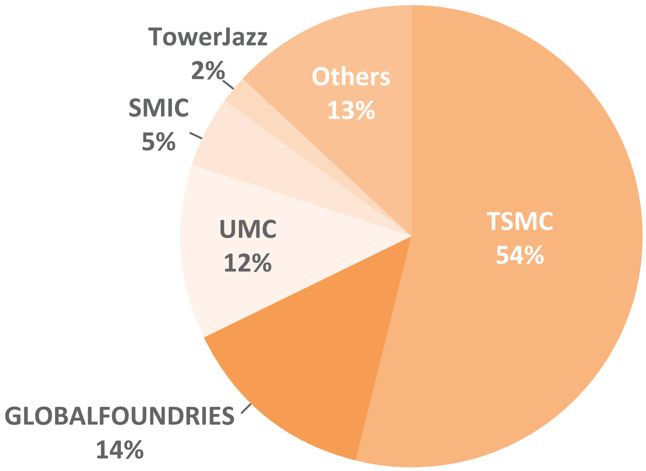
Source: IHS iSuppli

Unlike industrial-focused applications that suffice with incremental changes on a more generous timeline, consumer-focused devices require aggressive scaling and are highly dependent on shorter product life cycles in order to stimulate market demand.

INCREASING RISKS ASSOCIATED WITH TODAY'S FOUNDRY MODEL

As the foundry ecosystem has matured, the foundries' level of sophistication and influence in the market has grown considerably. A handful of companies are able to manufacture at the most advanced nodes, but TSMC unequivocally dominates this space and the foundry market at large. As measured by revenue, TSMC is the leading company, controlling 50% of the market and far exceeding its two nearest competitors – GLOBALFOUNDRIES and UMC – as outlined in Figure 5.

Figure 5 – Estimated pure-play foundry revenue by firm (2012)



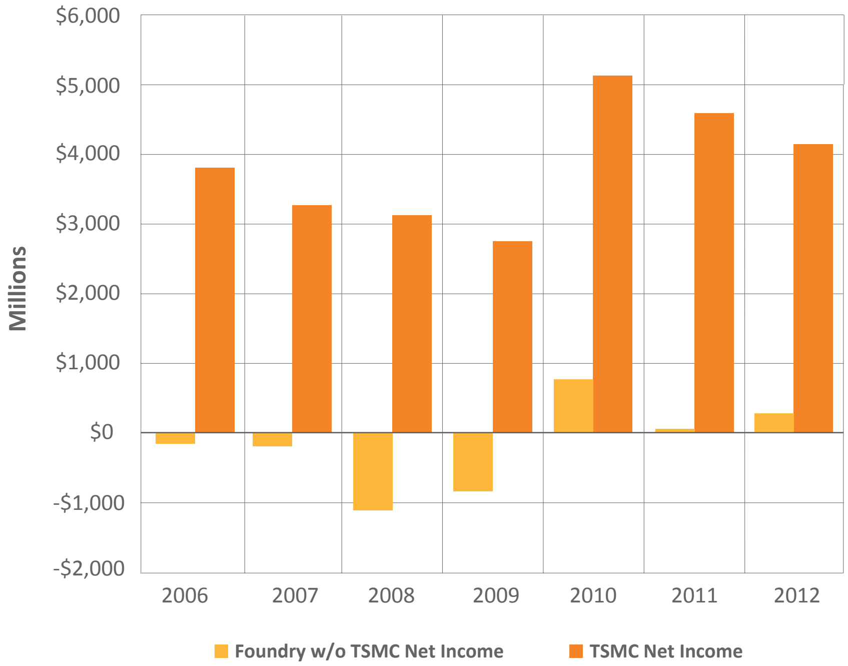
Risks
- Single-source
- Monopolistic supplier

Source: ATREG research

Much to the dismay of the firms relying upon its foundry services, TSMC's dominant market share has allowed it to exert negotiating leverage against fabless companies. In the short term, there is no reason to believe that it will not continue to gain additional market share.

TSMC is the only consistently profitable foundry firm. As other foundries have continued to try catching up, they have not been able to generate consistent profits, and in fact have lost money on a regular basis. Since 2006, TSMC has averaged $3.9 billion per year in net income. The rest of the foundry industry has consistently lost money in aggregate, averaging $160 million in losses per year, as illustrated in Figure 6.

Figure 6 – Evolution of foundry profits

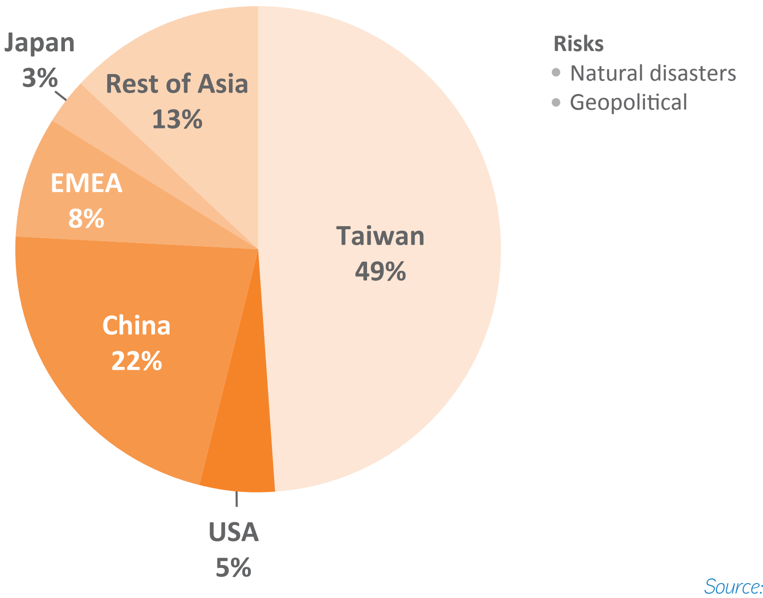


Source: Company financials

TSMC's ability to operationally execute their business model and generate sizeable profits will continue to enable them to develop foundry services in leading-edge manufacturing nodes for the foreseeable future. As the Taiwanese foundry thrives and remains the market leader, the rest of the foundry market will continue to struggle to catch up and gain market traction. The remaining foundry firms have had difficulty creating scale and filling their factories sufficiently to create reasonable profit margins. At this point, based on revenues, profits, available capital for investment, and the prohibitively high cost of building a leading-edge fab, it is hard to believe that any existing pure-play foundry will successfully compete with TSMC without strategic partners and / or outside financial assistance.

As illustrated in Figure 7, 87% of all foundry services are currently provided in Asia, with 49% located in Taiwan alone. TSMC's dominance and concentration in Taiwan also creates enormous geographic risk.

Figure 7 – Installed foundry capacity by geography



Source: ATREG analysis

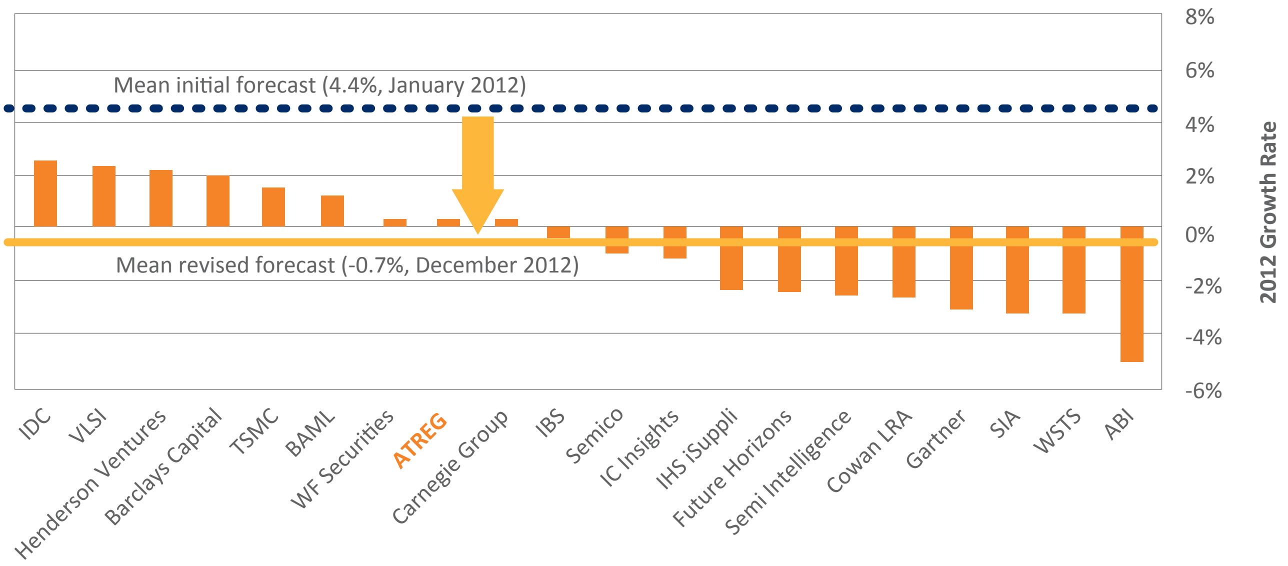
As was painfully learned from the 2011 earthquake and tsunami in Japan, the 2011 floods in Thailand, and the China-Japan dispute in 2012 over the Senkaku / Diaoyu Islands, uncontrollable dynamics pose an elevated level of geopolitical and natural disaster risk for the semiconductor industry. Firms manufacturing at the most advanced nodes today must rely on TSMC and expose themselves to these risks that apply to both fabless firms and IDMs. At the most advanced nodes, essentially all firms are fabless and rely entirely on foundries.

The Inflection Point: Emerging Trends

The semiconductor industry finished 2012 with the same trepidation and uncertainty as it began. While some analysts had optimistic views at the start of 2012, by mid-year the stream of earnings announcements had drained enthusiasm from most market watchers.

Figure 8 outlines the changing market sentiment over the course of the year. The dashed line represents the average growth forecast as of January 2012 and the solid line shows the revised average growth forecast as of December 2012.

Figure 8 – Downward revision in semiconductor growth estimates (2012)



Sources: Publicly available analyst reports and research

ATREG's assessment is that 2012 was a year of indecision and inaction by semiconductor corporate leaders. They deferred important and expensive decisions in the face of dimming market prospects. Yet, the market situation remains unstable and unlikely to improve substantially from the past three years. Pressure is mounting and business leaders cannot postpone decision-making much longer.

A LESS ATTRACTIVE FABLESS OPERATING MODEL

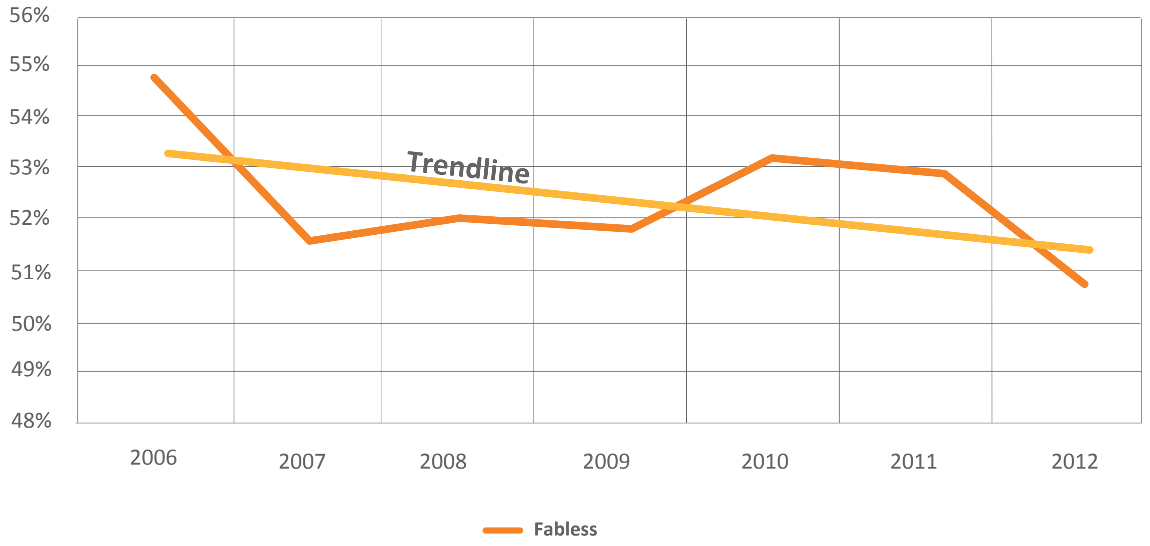
The golden era of fabless companies appears to be fading as the economic advantages of being a fabless firm have deteriorated on multiple fronts. Cracks in the foundation of the fabless model as we know it stem partly from an over-reliance on foundries, resulting in increased risks.

Eroding gross margins

Despite the huge success of a few fabless companies, foundries are successfully passing along higher manufacturing costs to fabless companies, applying pressure to margin growth.

As Figure 9 illustrates, average gross margins for fabless firms have actually declined in recent years. Since 2006, the average gross margin for a fabless firm dropped 70 basis points annually from 54.7% to 50.5%.

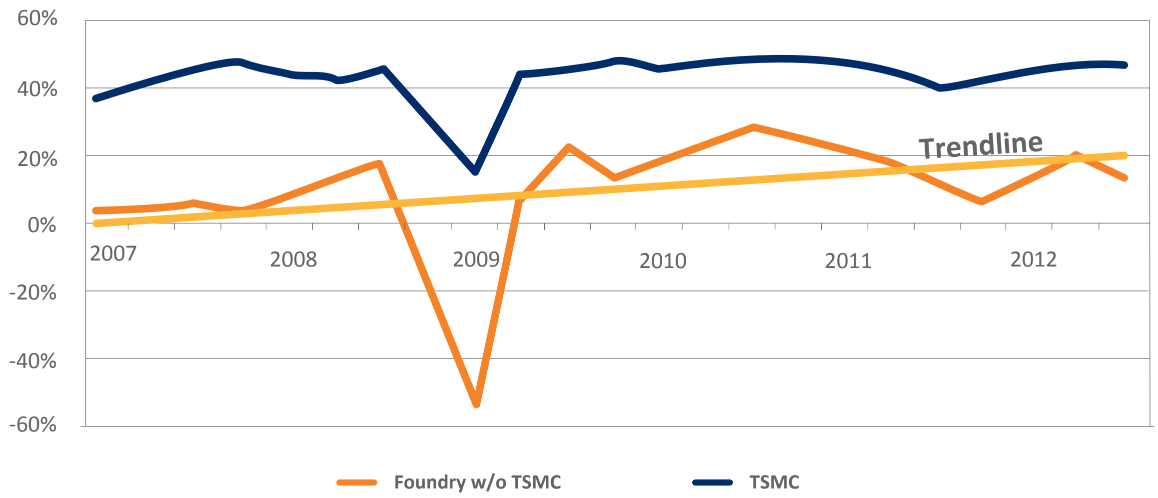
Figure 9 – Evolution of fabless industry gross margin



Source: Company financials

In contrast, as exemplified in Figure 10, gross margins for foundries have been increasing. In recent years, they have increased from 31.6% to 36.9%, an average annual gain of nearly 90 basis points.

Figure 10 – Evolution of foundry industry gross margin



Source: Company financials

Foundries have successfully managed to increase their margins at the expense of fabless customers. The fabless firms' margin compression is magnified at the most advanced nodes given the lack of alternatives.

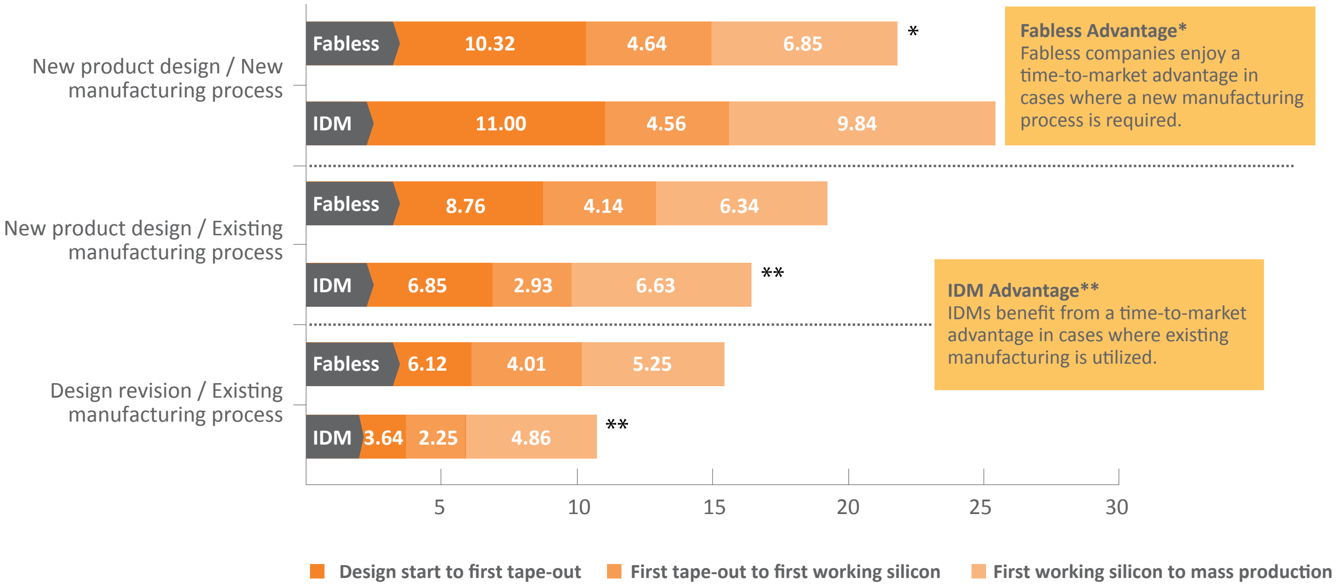
Time-to-market

In November 2012, the Wharton School, University of Pennsylvania, and ATREG jointly conducted a comprehensive industry study entitled *Managing Complexity & Change in the Semiconductor Ecosystem* based on in-depth interviews with more than 20 senior executives from 23 publicly listed IDMs (the full report can be downloaded at www.atreg.com/Wharton).

Based on the study, fabless companies appear to enjoy a time-to-market advantage when a new manufacturing process is required. In these cases, fabless companies have a 3.5 month (16.5%) time-to-market advantage over IDMs. IDM firms take about three additional months to move from first working silicon to mass production. This longer time span may reflect the fact that IDM firms need to develop and scale up new processes whereas fabless firms leverage their foundries' existing manufacturing infrastructure.

However, on average, IDMs seem to be faster by almost three months (17%) in commercializing new product designs using existing manufacturing processes and faster by 4.6 months (43%) for design revisions. As shown in Figure 11, this is mainly attributed to shorter time periods between design start and first tape-out as well as between first tape-out and first working silicon.

Figure 11 – Semiconductor design time-to-market milestones



Fabless Advantage*
Fabless companies enjoy a time-to-market advantage in cases where a new manufacturing process is required.

IDM Advantage**
IDMs benefit from a time-to-market advantage in cases where existing manufacturing is utilized.

Sources: The Wharton School, ATREG

Our research found that fabless firms have a significant time-to-market disadvantage compared to IDMs, except for instances when a new manufacturing process is required. Otherwise, control over manufacturing activities enjoyed by IDMs appears to accelerate time-to-market. This is a significant disadvantage for fabless firms, particularly in the profitable, high-growth consumer markets that are highly dependent on shorter product life cycles and incremental product improvements.

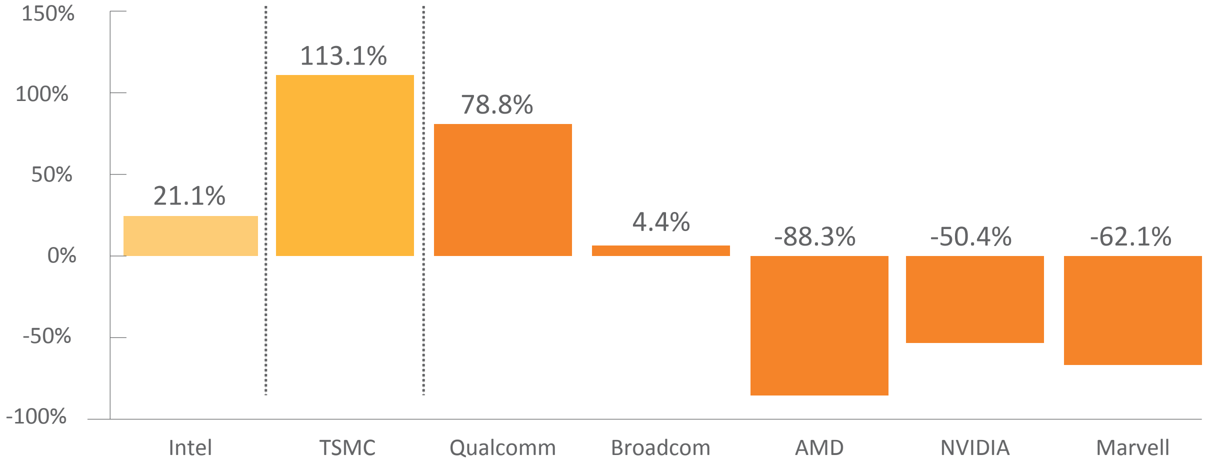
Lack of the 'virtuous cycle'

Without direct control of manufacturing or participation in manufacturing activities, fabless firms do not benefit from the knowledge learned through the ***virtuous cycle*** of design and manufacturing. A certain design and manufacturing synergy is achieved when integrated circuits (IC) designers work closely with the manufacturing and engineering teams. Efficiencies are achieved in both the design and manufacturing processes that otherwise would not be possible. Additionally, design teams are less constrained by the specifications and processes of the foundry provider.

Financials and investor sentiment

From a shareholder's perspective, fabless firms and other foundries have struggled while TSMC has outperformed the entire industry. The Taiwanese company has generated significantly higher total shareholder return (TSR) between 2007 and 2012 than other foundries and fabless companies. Figure 12 shows TSMC's TSR relative to the five largest fabless companies in the industry as well as Intel, the bellwether IDM.

Figure 12 – Total shareholder return over the last six years (2007-2012)

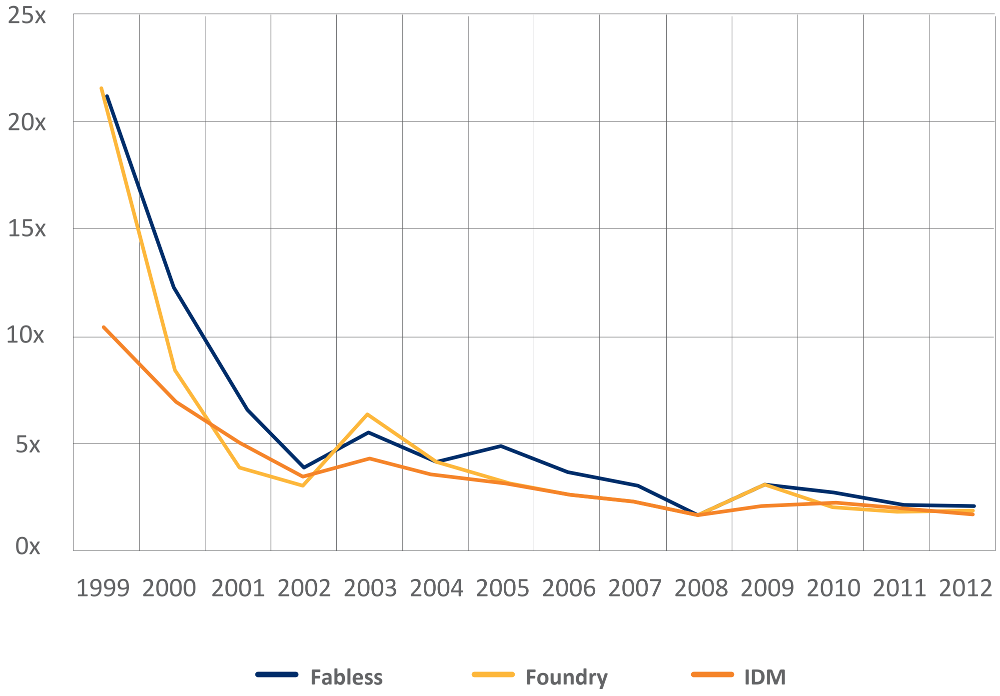


* ***Note:*** *TSR is calculated as equity appreciation with reinvested dividends.*

Source: Company financials

The changing dynamics of the semiconductor market are leading to a shift in investors' perception of the industry, specifically of the fabless semiconductor segment. Declining trading multiples for the sector underline the fact that investors no longer see semiconductors as a growth market. While trading multiple compression in the industry may be well understood, what may be surprising is that investors no longer perceive fabless firms as superior. Valuation multiples for foundries, IDMs, and fabless firms **are converging**, as illustrated in Figure 13.

Figure 13 – Evolution of enterprise value to sales multiples by industry segment



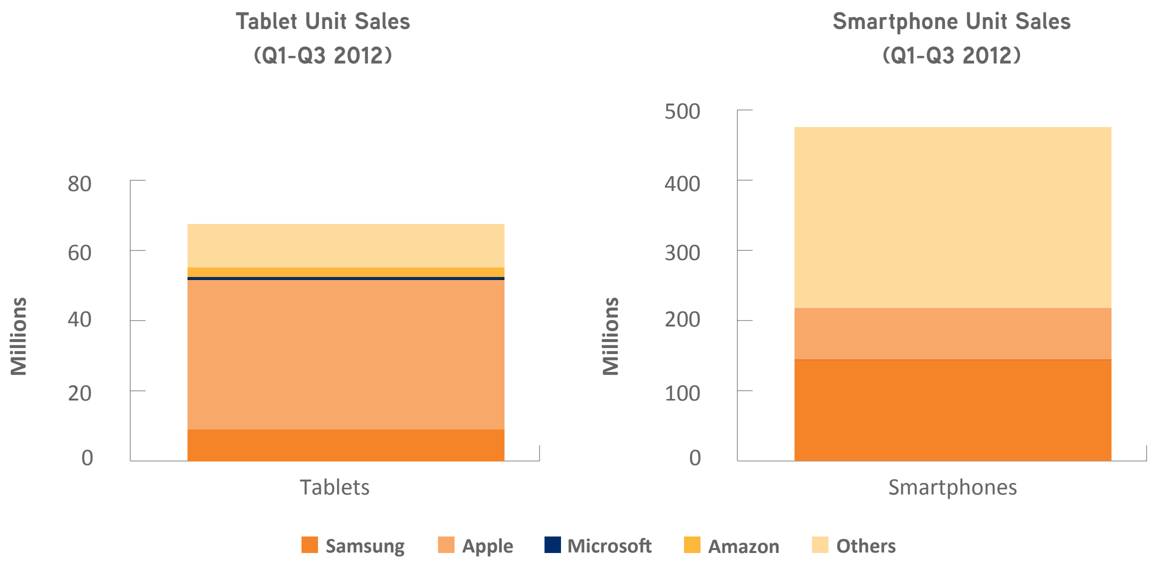
Source: Company financials

As the fabless segment has struggled to consistently grow profit margins over the last decade, investors no longer view fabless companies as a preferred investment over the rest of the semiconductor sector. They are no longer willing to pay a premium to own fabless semiconductor firms, as evidenced by the compression of trading multiples seen over the last 13 years. In 1999, the enterprise value to sales multiple for fabless firms was 21.5x and 10.8x for IDMs. At the end of 2012, the average multiples were 2.0x for fabless firms and 1.8x for IDMs. As the sector growth has slowed, investors see virtually no difference between IDMs, fabless firms, or foundries. In aggregate, the perceived investment advantages once enjoyed by the fabless segment have disappeared.

THE RISE OF THE BRANDED OEMs

We believe large, cash-rich OEMs will drive significant change in the industry over the next three years. As described earlier, a majority of the growth in the semiconductor industry is driven by consumer electronics products such as tablets and smartphones, dominated by Apple and Samsung, as illustrated in Figure 14.

Figure 14 – Tablet and smartphone market dominance



Source: IDC

Along with a few other OEM competitors entering the smart device space (such as Amazon, Google, and Microsoft), these firms have the market power to drive change. As shown in Figure 15, these OEMs look strong on virtually every metric, from market value and margins to cash balances.

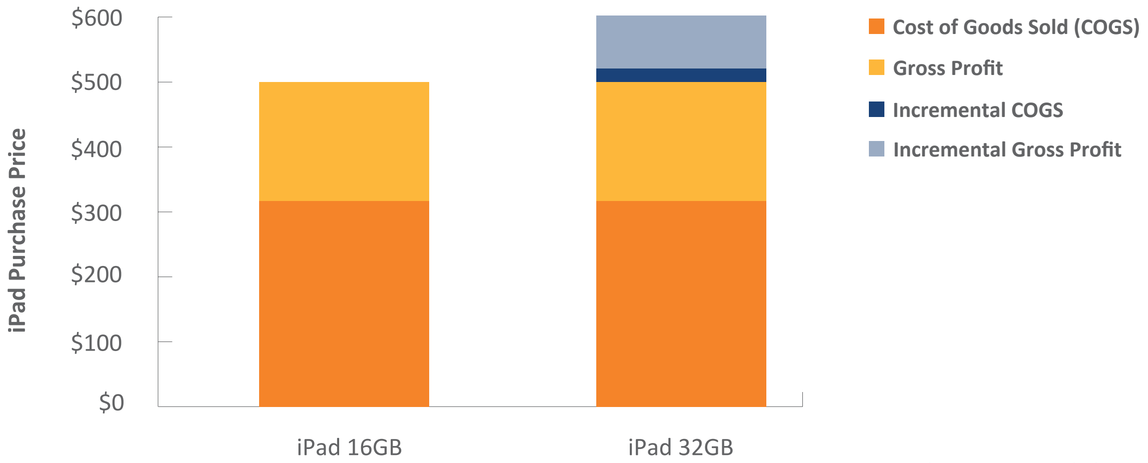
Figure 15 – OEM operating performance (millions)

	Market Cap	Net Income	Cash and Short-Term Investments	Revenue			Gross Margin		
Company	**As of Feb. 14, 2013**	**2012**	**As of Dec. 31, 2012**	**2012**	**2013F**	**2014F**	**2012**	**2013F**	**2014F**
Amazon	$122,488	-$39	$11,448	$61,093	$79,574	$99,607	14.0%	24.3%	24.7%
Apple	$438,549	$41,747	$39,820	$164,346	$188,999	$217,319	43.7%	40.5%	40.9%
Google	$258,080	$10,788	$48,088	$49,958	$48,400	$56,129	59.0%	58.0%	59.7%
Microsoft	$234,786	$15,459	$68,312	$72,764	$79,580	$86,367	75.4%	75.2%	75.0%
Samsung	$178,922	$17,747	$27,295	$168,709	$217,182	$239,879	34.6%	37.7%	38.6%

Source: Company financials

This market strength has enabled OEMs to extract an increasing share of the profits from the semiconductor value chain. For example, Apple derives exorbitant incremental gross income on additional NAND Flash memory in devices with higher storage, as illustrated in Figure 16.

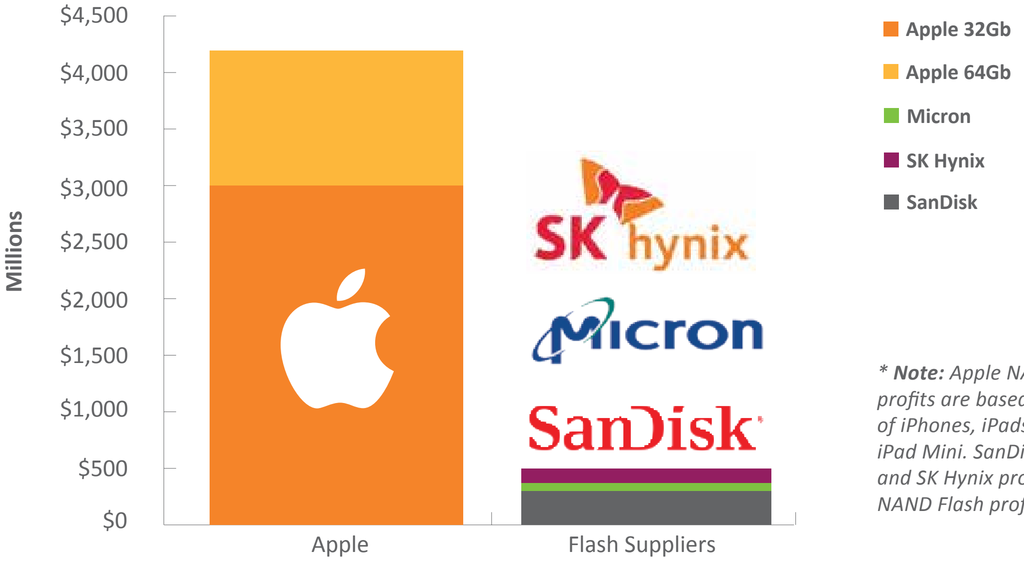
Figure 16 – Apple's incremental iPad revenue derived from NAND Flash memory



Sources: Apple, IHS iSuppli, ATREG analysis

For 32 Gb devices, Apple buys an incremental 16Gb of NAND Flash for $10.40 and sells it for $100. As a result, Apple makes considerably more profit on NAND Flash memory than NAND Flash vendors SK Hynix, Micron, and SanDisk **combined**, as outlined in Figure 17.

Figure 17 – NAND Flash profits (Q4 2012)

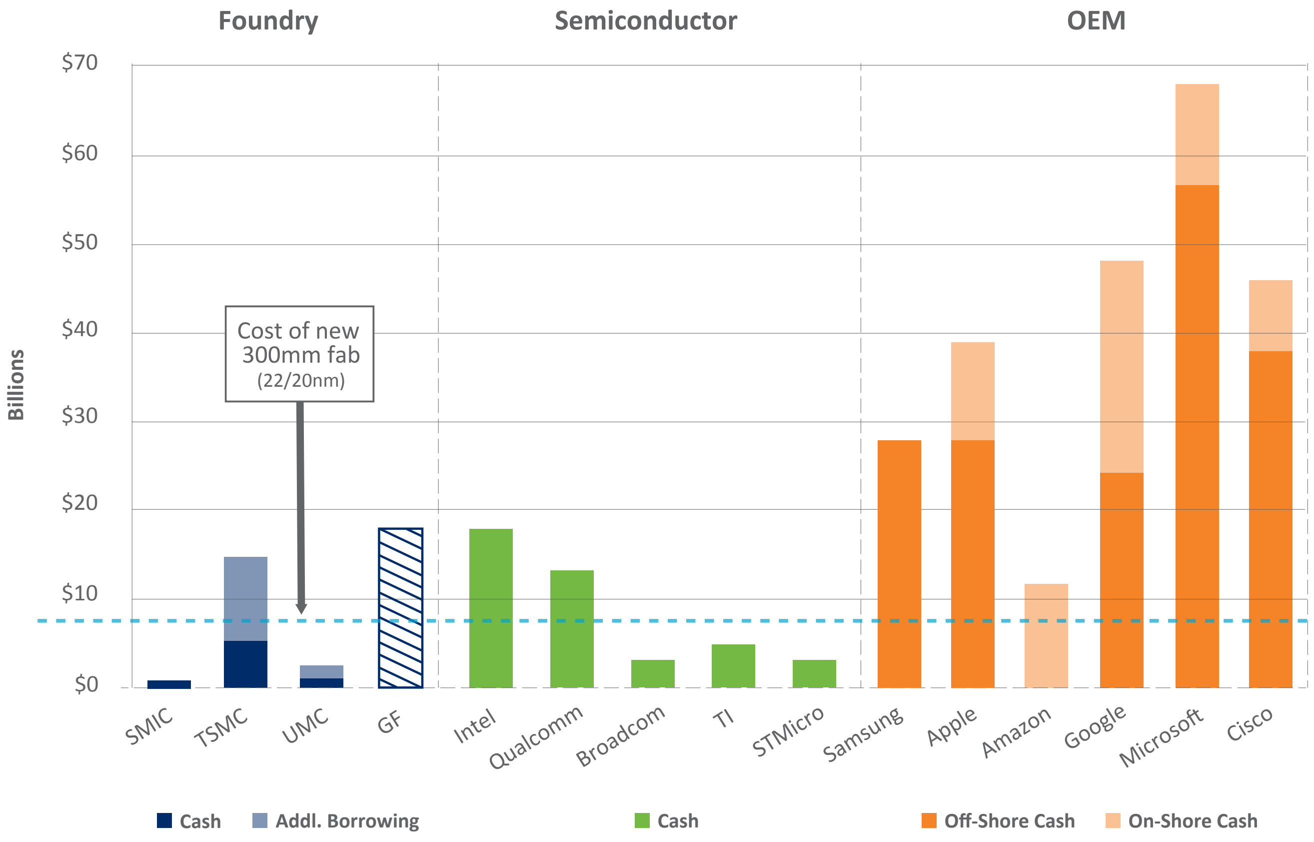


** **Note:** Apple NAND Flash profits are based on sales of iPhones, iPads, and iPad Mini. SanDisk, Micron, and SK Hynix profits are NAND Flash profits only.*

Sources: IHS iSuppli, Apple, company financials

So, while Qualcomm's inability to get sufficient supply of 28nm wafers from TSMC is a problem for Qualcomm, it is a considerably bigger problem for Apple. They, along with their OEM peers, will take the required steps needed to secure their own supply. Unlike semiconductor firms, OEMs have the capital to do so, as illustrated in Figure 18.

Figure 18 – Capital sources by industry segment



Note: *Capital is defined as cash and short-term investments.*

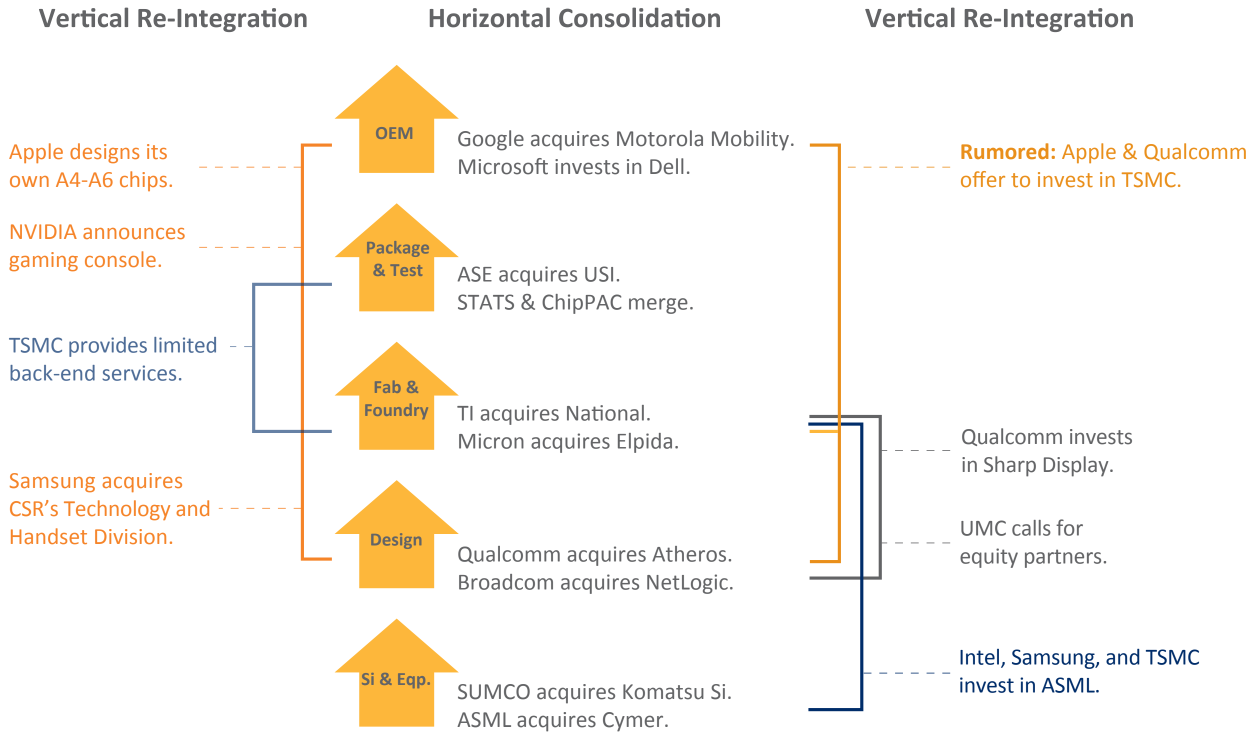
Sources: Company financials, Wells Fargo

If semiconductor firms are unable to provide a stable and diverse product supply, their OEM customers will use their clout to ensure their supply of much needed advanced components will be available from alternative vendors or non-traditional sources.

INCREASING VERTICAL RE-INTEGRATION

While the competitive nature of the semiconductor industry will lead to further consolidation, most of these transactions are likely to be within horizontal market segments. However, in the last 18 months, we have witnessed the emergence of transactions seeking to vertically re-integrate different stages of the value chain. As Figure 19 indicates, vertical re-integration is already manifesting itself in the market as OEMs and semiconductor companies adapt to supply chain pressures.

Figure 19 – Examples of horizontal consolidation and vertical re-integration

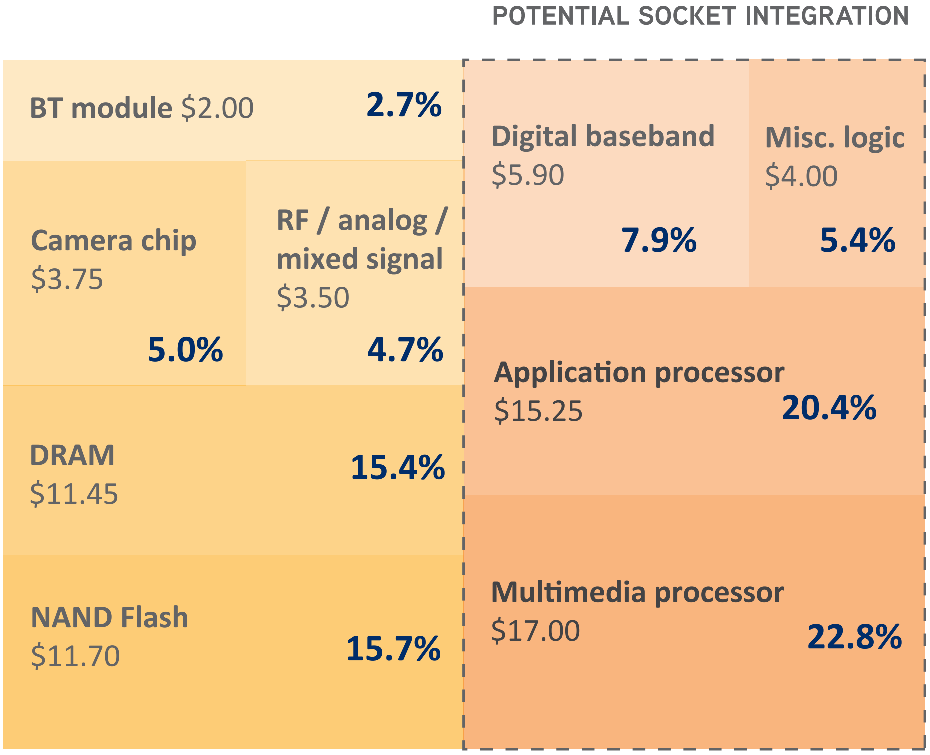


Sources: Company reports

Given their market power and access to cash, we expect that the OEM vertical re-integration trend will continue over the next three years, particularly as OEMs seek to backward-integrate many traditional semiconductor functions. As this happens, there may be fewer markets and fewer sockets over which semiconductor firms can compete.

As outlined in Figure 20, today's smartphone has nine primary semiconductor sockets encompassing a bill of materials totaling $74.55. Of these sockets, it is expected that the digital baseband, application processor, multimedia processor, and some miscellaneous logic functions totaling $42.15 or 56.5% of the overall semiconductor smartphone content will be integrated, resulting in fewer semiconductor sockets and ultimately fewer chips.

Figure 20 – Smartphone IC bill of materials ($74.55)



Sources: Portelligent, EET, Nokia, IC Insights

As OEMs, particularly Apple and Samsung, continue to backward-integrate semiconductor functions and subsume sockets, a large portion of the total addressable market will be carved out. This captive slice will be increasingly unavailable to merchant semiconductor firms and will negatively impact their ability to grow revenue and profitability.

What The Future Might Look Like

The trends described in this paper could lead to several possible future scenarios for the semiconductor industry. We have chosen to look at these along two primary axes.

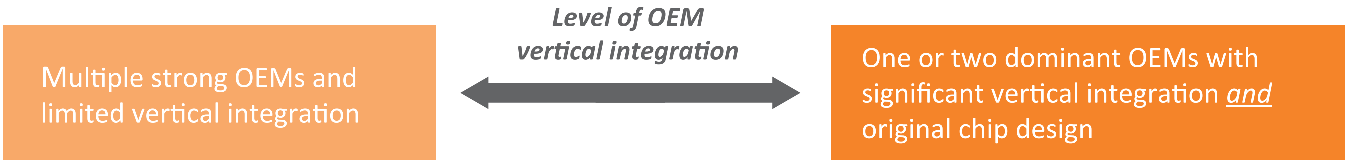
The first axis to consider is TSMC's relative market dominance. As described earlier, the current foundry model is unstable. Therefore, by 2016, we may see a foundry market with viable alternatives to TSMC, including hybrid manufacturing models. However, TSMC is not a company to be underestimated and it is possible that their market position will become even further entrenched.

Monopolistic model
TSMC owns and controls
> 80% of market capacity

Level of TSMC's market dominance

Duopolistic / oligopolistic model
Multiple foundries support
the market capacity

The second axis describes the extent to which the major OEMs further backward-integrate and one or two dominate the market for smart devices.



Multiple strong OEMs and limited vertical integration

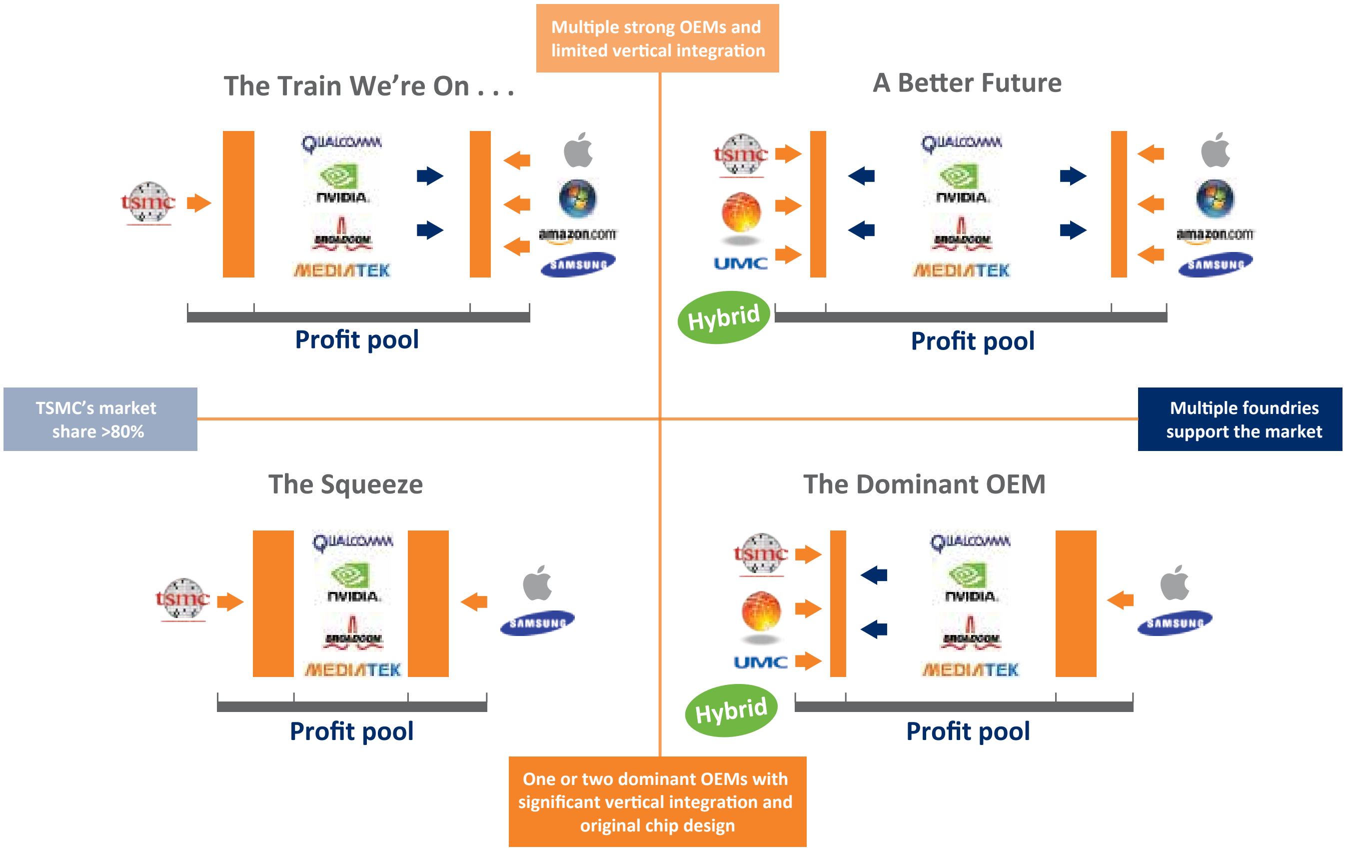
Level of OEM vertical integration

One or two dominant OEMs with significant vertical integration *and* original chip design

A future scenario would be that Apple, or a company like Apple, continues to vertically integrate and captures enormous market share. Alternatively, Apple's market position may erode, allowing the emergence of additional market entrants, all with smaller shares of the smart device market.

As Figure 21 illustrates, looking at possible futures along these two axes lets us examine four scenarios.

Figure 21 – Potential future outcomes



Scenario #1: The train we're on

In this scenario, there are still several viable OEMs in the high-growth markets, but the supply of advanced node wafers is heavily constrained, with only TSMC as a viable volume supplier. The profit pool for fabless semiconductor firms is squeezed, with limited room for fabless semiconductor firms to thrive.

Scenario #2: The squeeze

This is the worst possible scenario for the semiconductor industry whereby TSMC's position becomes entrenched with no viable alternatives, and one or two OEMs dominate the market and subsume many semiconductor functions by vertically re-integrating. The profit pool for semiconductor firms becomes very small and a substantial portion of the semiconductor industry as we know it today gets refocused on the licensing of semiconductor intellectual property (IP) to the vertically integrated OEMs.

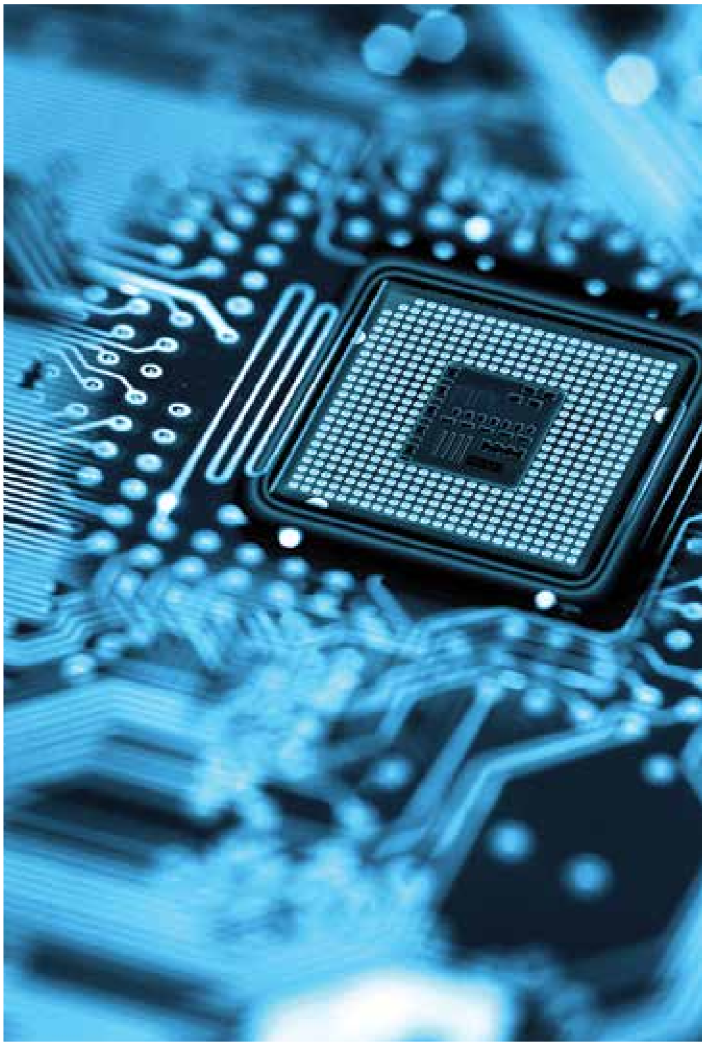
Scenario #3: The dominant OEM

In this potential future, there are still one or two dominant OEMs as in Scenario #2 (*The Squeeze*), but in this case, there are multiple viable foundry and hybrid options available to semiconductor firms. Although this is a significant improvement over Scenario #2, semiconductor firms will still be squeezed due to customer concentration.

Scenario #4: A better future

This is the scenario all semiconductor firms should work toward. In this future, there are both multiple foundry and hybrid options available for IC production as well as multiple successful customers selling smart devices. We expect more manufacturing options to become available through hybrid operating and capital models between existing challenger foundries, major OEMs, and fabless companies. This future maximizes the profit pool available to the semiconductor firms.

Clearly, IDM and fabless companies need to try to influence the future and work to avoid *The Squeeze* whereby many semiconductor firms become irrelevant. We consider this possibility unlikely, but companies cannot remain passive. One key to avoiding *The Squeeze* is to work toward developing alternative manufacturing models that will support an alternative to the single dominant foundry world.



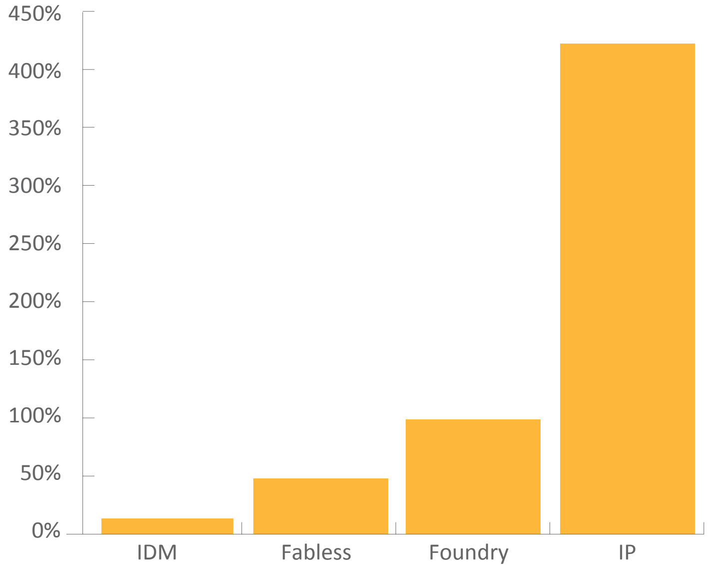
Opportunities For Semiconductor Firms

MAXIMIZE VALUE FROM IP

In many of the future scenarios previously described, semiconductor profits are subsumed by either a dominant foundry, by one or two large vertically integrated OEMs, or by both. Semiconductor firms can prepare for such futures by unlocking the value of their patent portfolios. They can bolster stagnant gross margins and forego the costly infrastructure, high capital requirements, and large levels of risk inherent in manufacturing by licensing their patent portfolios to cash-rich OEMs and infrastructure-ready IDMs reliant on this IP for their advanced components.

As outlined in Figure 22, the IP sector has achieved a significantly higher TSR, weighted by market capitalization, than the foundry, fabless, or IDM sectors.

Figure 22 – Total shareholder return by industry segment



** **Note:** TSR is calculated from 2007 to 2012, captures equity appreciation and reinvested dividends, and is weighted by market capitalization.*

Bellwether companies:	intel	QUALCOMM	tsmc	ARM
	Texas Instruments	BROADCOM	UMC	Imagination Technologies
	Analog Devices	MEDIATEK	SMIC	TESSERA

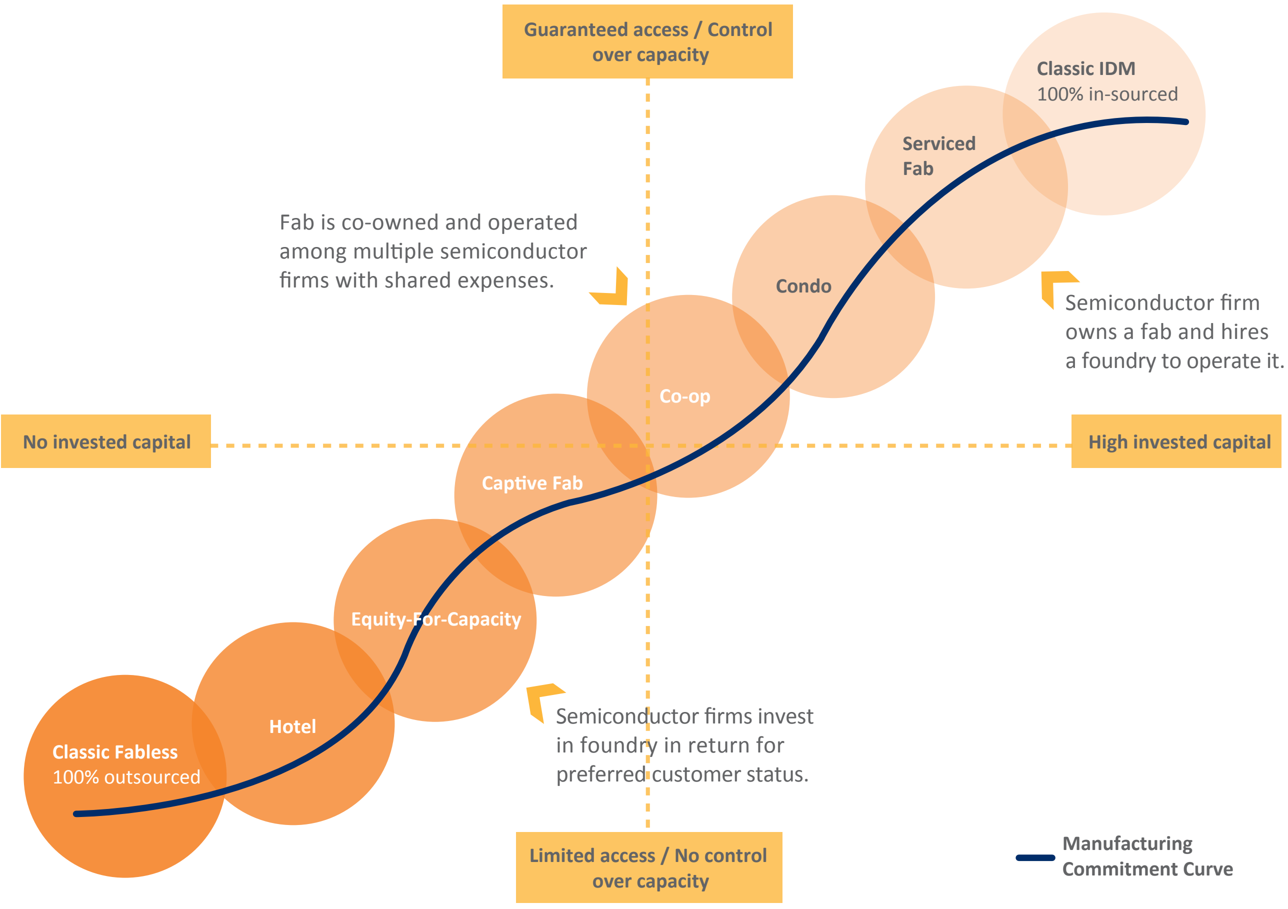
Source: Company financials

HYBRID MANUFACTURING MODELS

Due to the costs associated with new fab development and the fear of TSMC's foundry market dominance, we anticipate that more alternative (or hybrid) semiconductor manufacturing models will develop over the course of the next three years.

As discussed, all semiconductor firms are effectively fabless at advanced nodes, with foundries as their only manufacturing option. Based on our discussions with semiconductor firms around the world, we believe that several hybrid models will emerge along what we refer to as the *Manufacturing Commitment Curve* (MCC), as illustrated in Figure 23. At one end of the MCC is the IDM model where required capital is high, but control and access to capacity is also high. At the other extreme is the fabless model with little required capital and a corresponding lack of control and guaranteed capacity. In-between the two, along the MCC, is a variety of alternative manufacturing models with varying levels of capital and operating responsibility and ownership.

Figure 23 – Emerging models on the manufacturing commitment curve (MCC)



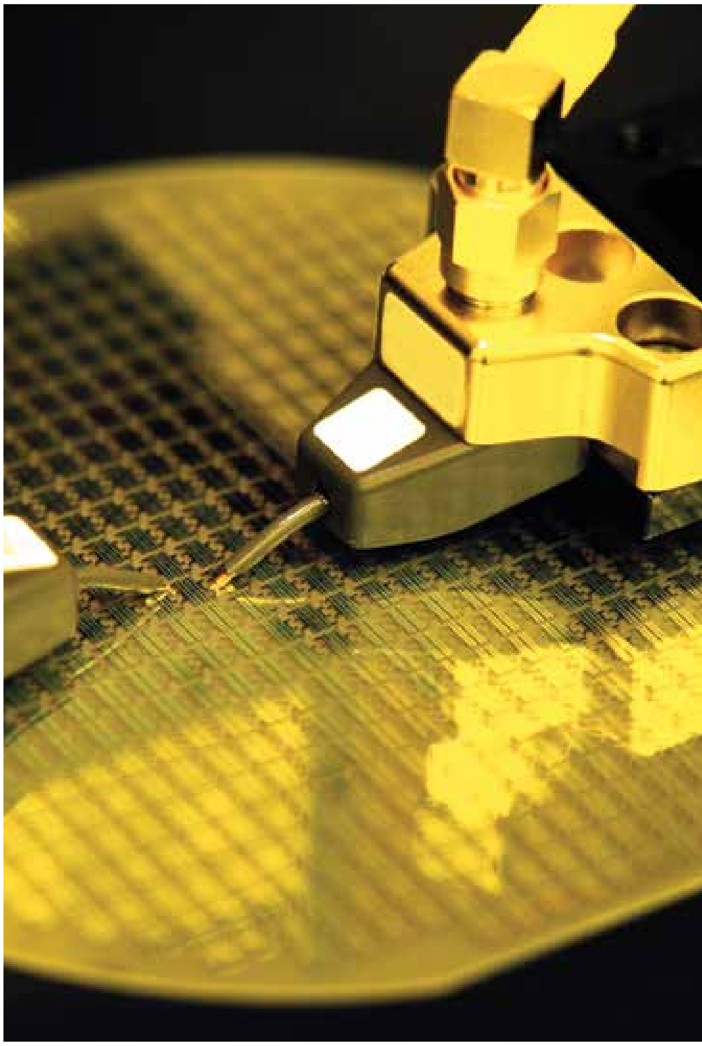
Based on discussions with clients and other firms, we think the following hybrid models are likely to be implemented in at least a few cases before 2016:

Equity for capacity

In this model, a semiconductor firm or OEM makes an equity investment in a foundry or fab operator. This equity investment gives the investor a stake in the overall success of the fab operations (an undivided interest in the entire manufacturing operation), provides insight into the financial state of the fab operator, and ensures guaranteed access to capacity while minimizing the total capital investment. The fab operator gets an infusion of cash and a long-term partner / customer.

Cooperative (co-op)

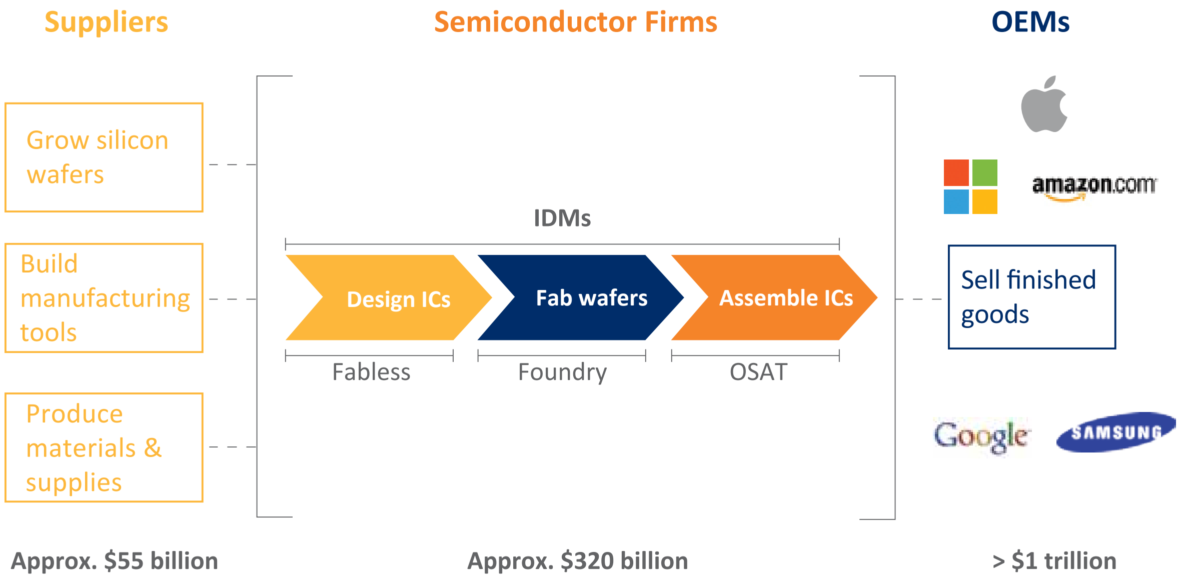
In this model, a fab is co-owned and operated among multiple semiconductor firms. The ownership may be a portion of capacity or module, with expenses shared between partners. While this model has been tried with varying degrees of success around the world, we believe firms have learned to avoid some of the pitfalls of such structures and expect to see additional co-op deals in the next three years.



Conclusion

Beyond paying attention to competitors, smart semiconductor firms will also pay attention to the entire supply chain and ecosystem by working to ensure a better future. One result we expect by the year 2016 is that the current semiconductor supply chain, as outlined in Figure 24, will continue to evolve.

Figure 24 – Current semiconductor value chain



In this new future, the semiconductor supply chain will be reorganized in any number of ways. IDMs may manufacture wafers. IDMs may get more involved in the production of manufacturing tools. Foundries may take on a greater role with respect to back-end IC manufacturing. OEMs may increasingly design their own integrated circuits and participate in front-end wafer fabrication.

The semiconductor industry is entering a new era. Rising costs, slowing growth, increased concentration in high-growth markets, and the unstable foundry model are fundamental forces that will impact the market.

Semiconductor firms will need to carefully consider their strategic options and be ready to address the challenges of ever-powerful foundries and customers (OEMs). We are optimistic about the future and the resourcefulness of the semiconductor industry. Firms will be able to adapt to these pressures, find new operating models and partnerships, and unlock the hidden value in their companies. Above all, semiconductor firms will continue to innovate and help define the 21st century.

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