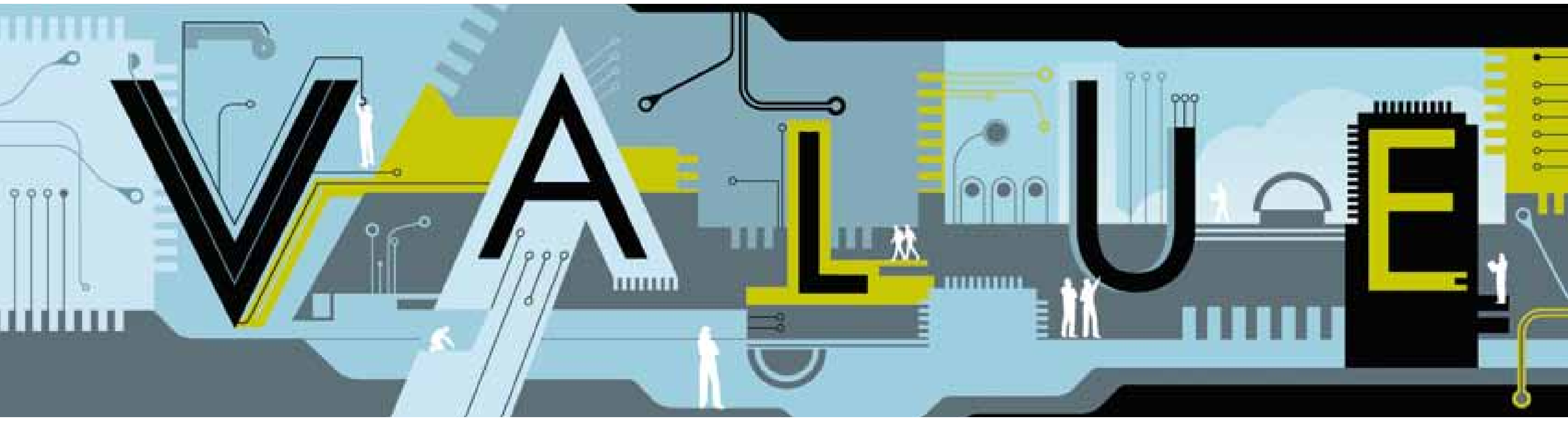


Creating value in the semiconductor industry

In light of increasing consolidation throughout the semiconductor value chain, companies that wish to succeed must move quickly to close capability gaps.

Stefan Heck, Sri Kaza, and Dickon Pinner

Despite its moderate size, the semiconductor industry contributes disproportionately to growth in US labor productivity and delivers tremendous value to consumers. The industry, along with the electronics industry it does so much to power, contributed more than 25 percent of total US productivity growth from 1995 to 1999—more than any other sector. That four-year period outshined overall productivity growth from 1987 to 1995, according to an analysis published by the McKinsey Global Institute.[1]

Much of the tremendous growth seen in the electronics industry over the last three decades comes directly from the increasing power and decreasing price of semiconductors, a function of Moore's Law.[2] This performance improvement enables the electronics industry to continually produce devices and systems that are smaller, more powerful, and richer in features at lower prices. It has famously been noted that if the automotive industry had achieved similar improvements in performance in the last 30 years, a Rolls-Royce would cost only $40 and could circle the globe eight times on one gallon of gas—with a top speed of 2.4 million miles per hour.

However, most chip makers capture only a small percentage of the tremendous value they create; consumers receive the lion's share. Indeed, despite its large positive impact on overall economic growth, the semiconductor industry (excluding

[1] *US productivity growth 1995–2000: Understanding the contributions of information technology relative to other factors*, McKinsey Global Institute, October 2001.

[2] According to Gordon Moore, a founder of Intel, the number of transistors that can be fitted into a single chip doubles roughly every two years, resulting in both faster performance and lower cost.

Intel) destroyed approximately $47 billion in value for shareholders between 1996 and 2009 (Exhibit 1). To put that figure, and the significant disparity seen in the industry, into context, Intel alone created about $57 billion in value during that same time period.

The economic challenges that the semiconductor industry faces can be attributed to a confluence of two factors: cyclicality, and rising costs in R&D and on the capital-investment side of the ledger, due to the increasing costs of upgrading existing fabrication plants and building new ones.

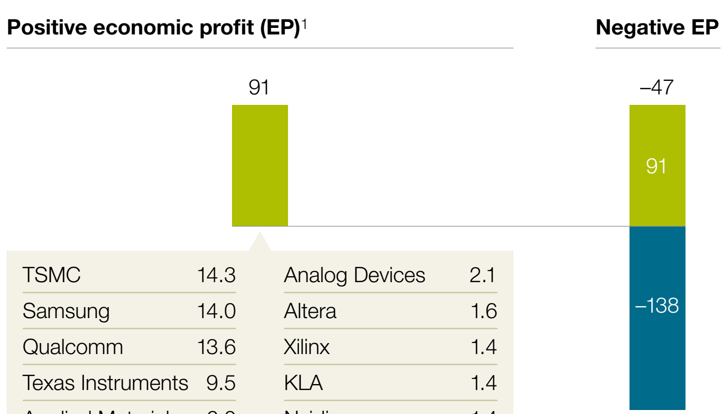
The cycle, while bad for the industry, is in some ways a blessing for underperformers, who have been able to stay in business because the profits they generate during a cyclical upturn enable them to sustain their operations during a downturn and attract funds for capital investments beyond market requirements, which initiates the next cyclical downturn. Government interest in building semiconductor industries—most recently in China and India—accentuates this problem.

As for R&D, chip makers invest heavily, driven to meet the expectations of Moore's Law: costs have

Exhibit 1

The semiconductor industry, excluding Intel, destroyed $47 billion of value from 1996 to 2009.

$ billion



TSMC	14.3	Analog Devices	2.1
Samsung	14.0	Altera	1.6
Qualcomm	13.6	Xilinx	1.4
Texas Instruments	9.5	KLA	1.4
Applied Materials	6.0	Nvidia	1.4
Mediatek	5.1	Microchip	1.2
Linear	3.1	Synopsys	1.2
Maxim	2.4	ASML	1.0
Rohm	2.1	Others	10.0

[1] Positive EP in each year of the time period. In addition, Intel had a positive EP of $57 billion during this period. EP is calculated as net operating profit less adjusted taxes – (capital charge, where capital charge is invested capital at previous year end × weighted average cost of capital).

Source: Corporate Performance Center Semiconductor Database; McKinsey analysis naturally risen along with the ever-increasing complexity of the chips. In addition, the investment hurdle for building a state-of-the-art chip fab continues to rise.

All that said, it is important to remember that the $47 billion of destroyed value is an aggregate figure made up of many losers and several disproportionate successes. Indeed, in many segments, the top performer generates more than 100 percent of the total value. How do the top performers succeed? They implement operational-improvement programs for product lines that can hit acceptable targets for return on invested capital (ROIC), and judiciously divest those that cannot.

Companies that wish to thrive must follow this example. They must optimize for ROIC rather than share or gross margin, a process that entails identifying improvement levers relating to each component of ROIC and designing initiatives targeted to each. Lean operations approaches, including best-practice manufacturing techniques, exert direct impact on ROIC and are therefore key levers in this first step.

The companies that have successfully followed this two-step model have achieved improvements in ROIC in the range of 5 percentage points. Some companies have improved ROIC by as much as 20 to 30 percentage points.

Understanding the sources of value destruction

Although an analysis of income statements shows a number of profitable players in the semiconductor industry, most players are not able to generate economic profit; that is, their ROIC lags behind

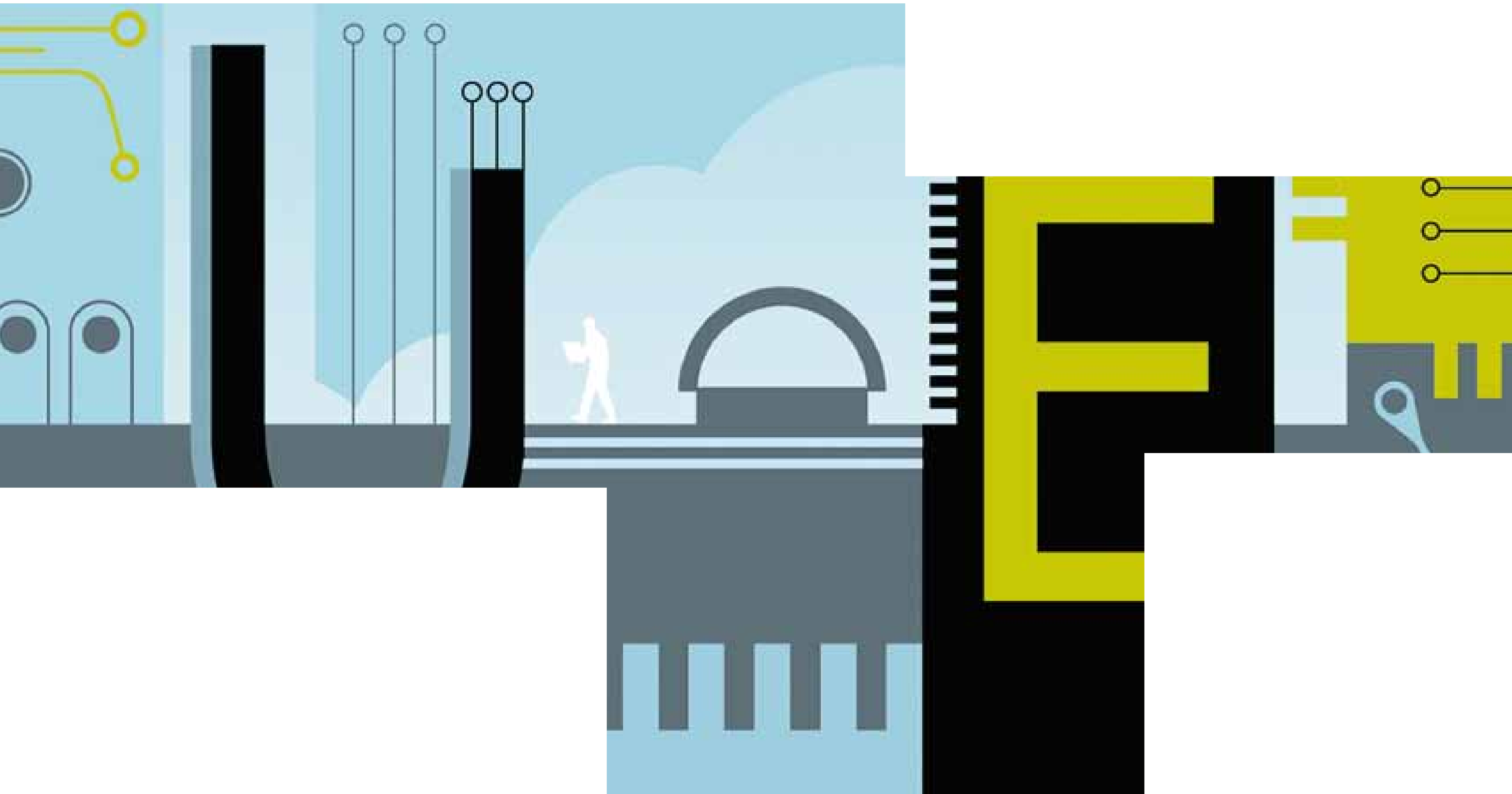
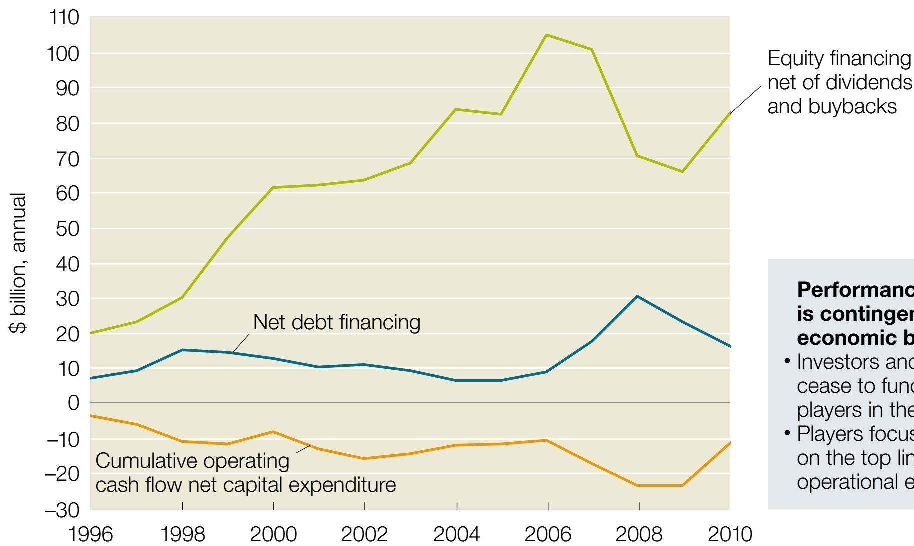


Exhibit 2

Financing continues to flow from private investors and governments as poor performers fail to deliver.

Sources of financing for poor performers[1]



Performance improvement is contingent on change in economic behavior

- Investors and governments cease to fund value-destroying players in the future
- Players focus not only on the top line but also on operational efficiency

[1] This includes the 59 players with the lowest average economic profit/revenue.
Source: Compustat; Corporate Performance Center analysis

their weighted average cost of capital. Indeed, disaggregating the industry by business model and subsegment reveals that in most segments, only one or two players create value.

As we have indicated, the industry as a whole has struggled to generate economic profit because three factors present unique challenges to chip manufacturers.

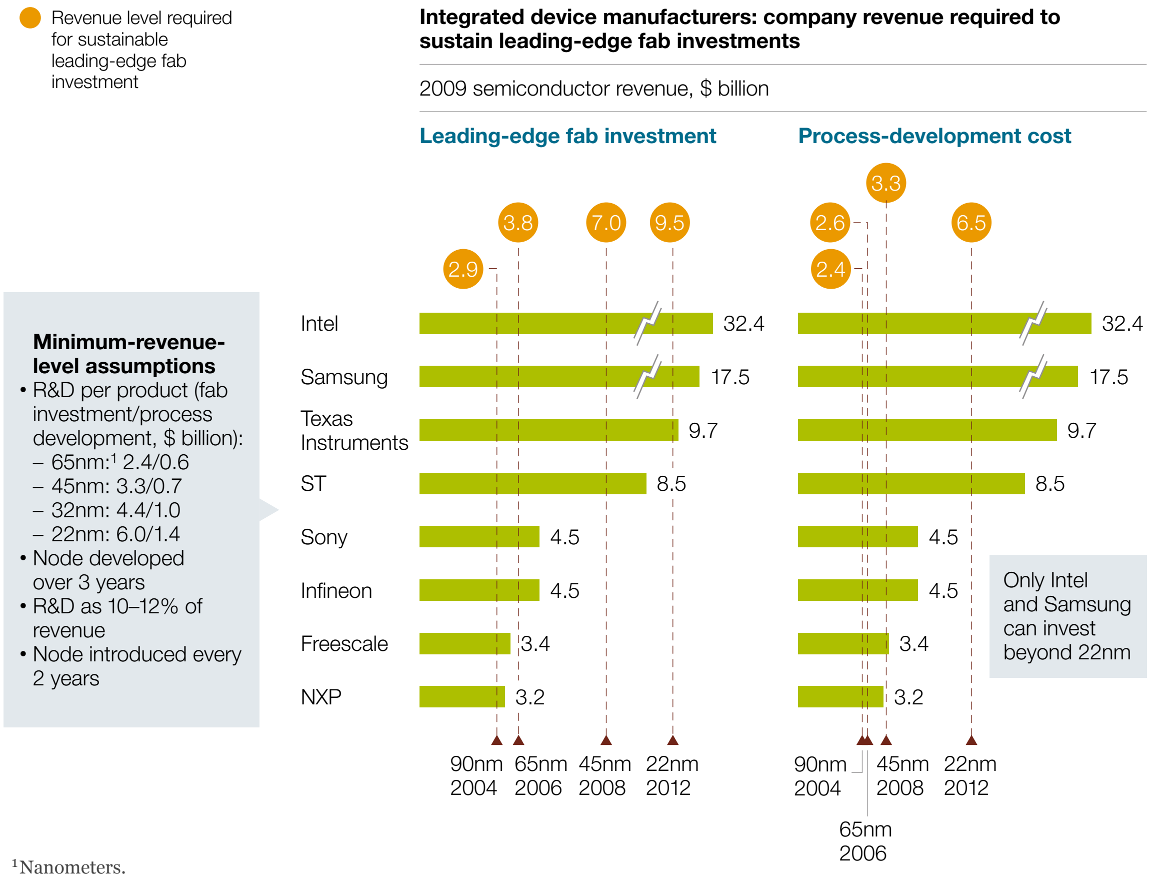
Historically, the semiconductor industry has shown strong cyclical behavior. During a typical upturn of one to two years, most companies generate profits, which they use to sustain their operations during the downturn. In addition, many players use their strong performance during an upturn to entice investors in the public markets or get new loans to fund capital investments; in many cases, governments subsidize these refinancings (Exhibit 2).

But precisely because investment runs ahead of market demand in the upturn, the period is followed by a longer downturn or a very slow growth period, during which poor performers struggle. There is some evidence to suggest that both the amplitude and time frame of the industry's cyclicality is moderating, but it is likely that some degree of cyclicality will remain.

The skyrocketing costs of R&D and the increasing amount of capital required to build a state-of-

Exhibit 3

Fewer logic integrated device manufacturers are able to sustainably invest in leading-edge nodes.



[1]Nanometers.

Source: iSuppli; literature search; McKinsey analysis

the-art fab add to the industry's economic challenges. Chip makers continue to pour money into R&D as new designs and process technologies become increasingly expensive to develop. In 2009, R&D spending amounted to approximately 17 percent of industry revenue for semiconductor companies (up from 14 percent a decade earlier) versus 3 percent for automakers, to take one example. The cost of building leading-edge fabs continues to increase as well; for example, the average 8-inch fab costs $1.6 billion to build, while a state-of-the-art 12-inch fab costs $3 billion to $4 billion. Similarly, the costs for developing process technologies on new nodes is increasing dramatically; for example, the average cost of developing a 90-nanometer logic process technology is approximately $300 million, while the cost of developing a modern 45-nanometer logic process technology is approximately $600 million, representing a doubling of spend in roughly five years (Exhibit 3).

In response to these higher costs, many semiconductor companies have resorted to "fab lite" strategies, outsourcing an increasingly large fraction of their chip production to dedicated manufacturing foundries. Although this has resulted in an overall net reduction of capital expenditures in the industry, from an average of approximately 27 percent of revenues (from 1996 to 2001) to approximately 20 percent of revenues (from 2002 to 2009), it has also led to intense cost pressure on chip makers that continue to handle all their manufacturing in-house (Exhibit 4). The shift of manufacturing to Asia has created additional cost pressures on those that have yet to transfer operations to lower-cost locations.

Prices also remain under pressure in the industry as consumer applications become the main force driving the semiconductor market. The much higher elasticity of demand as prices decline has further accelerated the erosion of average selling prices.

All these pressures are intensified by the shift in the end-user market to Asia. Furthermore, the lack of a "killer app" on the horizon—and the slower growth of traditional large, high-growth markets such as PCs and mobile phones—means that the economic pressures on the industry are not likely to abate anytime soon.

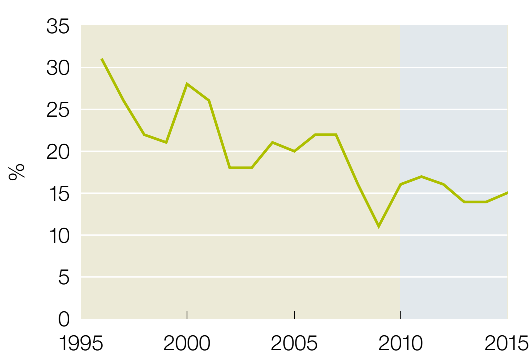
Learning from the top performers

A handful of semiconductor players have consistently generated a disproportionate amount of value in this industry. An analysis of the key attributes of these companies, as well as those of the leading players in other industries, suggests the two major lessons noted earlier for those who seek to capture economic profits in semiconductors: successful players work to improve ROIC where it can be satisfactorily

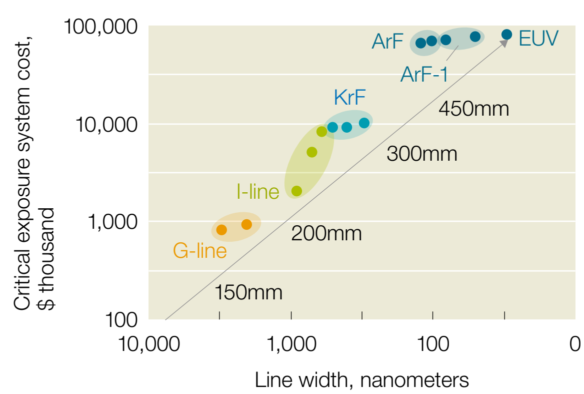
Exhibit 4

'Fab lite' strategies have reduced capital expenditures, and at the same time, overall capital costs are rising sharply.

Capital spending/semiconductor revenue is decreasing . . .



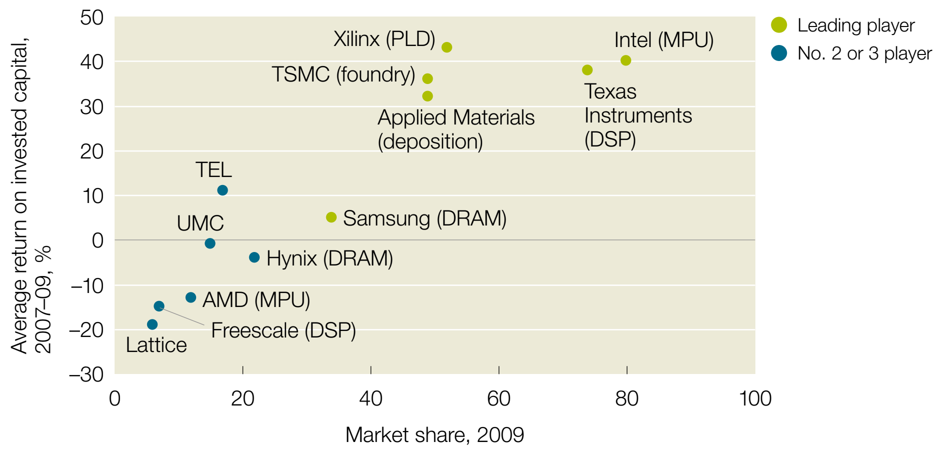
. . . even though capital costs are rising



Source: IC Insights; IC Knowledge

Exhibit 5

A high segment market share enables companies to shape their future and earn higher returns.



Source: Corporate Performance Center Semiconductor Database; iSuppli; Gartner

improved, and they aggressively prune product portfolios of businesses that do not look likely to become sufficiently profitable.

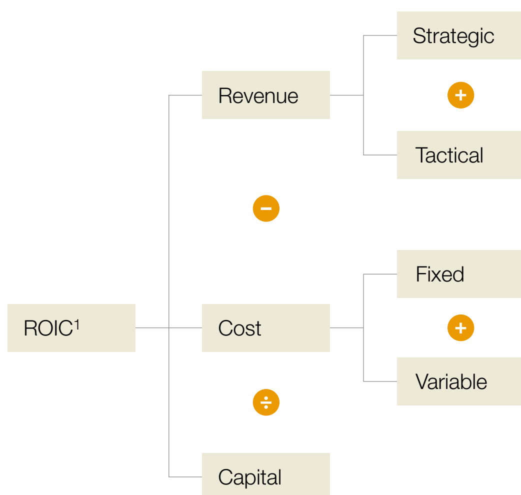
As far as ROIC is concerned, top performers focus on changing the dynamics and structure within a given segment as they seek to build leading positions early on. Acquiring and holding a market share of 40 percent or more within a segment enables companies to drive higher profits (Exhibit 5). Such companies typically have closer relationships with key customers, advanced R&D processes that yield better innovation road maps (which are also more closely aligned with the key value drivers for their segment), deeper insight derived from having a more complete picture of where the market is going, and in many cases, a greater ability to maintain margins through downturns.

To achieve this kind of performance, semiconductor companies must optimize ROIC by executing operational-improvement programs, including but not limited to making lean operational improvements, targeting profitability (rather than other measures), improving asset utilization, and tuning their capital-asset strategy (that is, make versus buy) to further improve return on capital. To target areas for improvement, a detailed ROIC tree can be used to disaggregate the components of revenue, cost, and invested capital and thus identify the main value-creation levers for each component. Exhibit 6 lists examples of value-creation levers and the impact that these levers help companies achieve.

By helping companies implement lean-manufacturing techniques, we have assisted more than 10 semiconductor companies in increasing the throughput of their fabs by 20 to 30 percent (with minimal additional capital expenditure). Naturally, this has been a significant driver of improved ROIC, as well as incremental gross margin. These gains have been achieved by

Exhibit 6

Companies have employed a number of strategies to achieve impact.



Key levers to drive ROIC

- Develop products and drive efficiency and effectiveness in new-product introduction
- Employ a new market-development strategy

- Pricing: improve discipline and value communication
- Sales-force effectiveness: optimize coverage and productivity of field sales force
- Account profitability: realize value from investing in key accounts

- Reduce general and administrative costs, optimize performance
- Optimize R&D spend/portfolio, rationalize products

- Improve fab throughput and drive lean operations
- Employ strategic sourcing focused on total cost of materials
- Optimize consumption to reduce material usage
- Optimize supply chain

- Use fabless/“fab lite” strategy and optimize footprint
- Improve capital-expenditure planning and purchasing strategy

[1] Return on invested capital.

maximizing overall equipment effectiveness, a technique that exposes all the losses attributable to bottleneck machines in a 24-hour period, thereby allowing companies to focus on reducing the largest losses. This technique was as effective in 4-inch, 5-inch, 6-inch, and 8-inch fabs (the older, trailing-edge fabs) as it was when deployed in leading-edge 12-inch fabs.

In trailing-edge fabs, most of the improvements are captured from increasing the uptime of bottleneck machines, for example, by minimizing machine changeovers and setups and optimizing material handling to ensure that a bottleneck machine is never left idle. By contrast, in leading-edge fabs, many of the improvements come from reducing the process time of an individual wafer by tailoring the sequence of tasks of the bottleneck machine to a specific “recipe” (the unique flow of manufacturing process steps required to fabricate the wafer) and eliminating recipe redundancy. For example, dielectric thin-film deposition times can be decreased, with a corresponding increase in the throughput of deposition equipment, by reducing the thickness of excess dielectric material. This has the added benefits of increasing both the throughput of chemical-mechanical-planarization (CMP) machines (because less excess material is removed in the polishing process) and the lifetime of the CMP pads.

Another lever that can help improve ROIC is pricing, and we recommend chip makers use value-based pricing and transactional pricing to drive revenue increases of 2 to 7 percent. Value-based pricing processes enable companies to set prices equivalent to the value perceived by customers by identifying the individual value drivers of a product, interviewing customers to understand the importance of each of these drivers to their purchasing decisions, understanding the degree of differentiation the company possesses with regard to each driver, and translating this value into price. Transactional pricing, by contrast, focuses on minimizing the leakage of value in the final price relative to the list price. This leakage is analyzed with regard to variance (differences in discounting or margin performance), slippage (deviations from established policies, guidelines, or programs), and structure (suboptimal pricing structures, processes, or delegation levels, resulting in unnecessarily low net prices).

Setting aside ROIC, the second main lever involves proactively managing product portfolios: investing in market segments that are growing, either organically or through acquisition, and divesting segments in which growth or margins are low. In reviewing its portfolio, a company may find that it includes some fast-growing businesses with high profit margins as well as other businesses in which the company has achieved limited success despite years of investment. Top-performing companies actively evolve their portfolios as markets mature or become less attractive. Rather than engaging in a price war to increase their share of a stagnating market, for example, they drop out of businesses that offer little hope of profitability (Exhibit 7).

Several top performers have been particularly successful with this approach. Texas Instruments has divested more than 15 lower-growth, lower-

Exhibit 7

It has become even more critical for semiconductor companies to focus on the right markets.

[1]Only positive contributions to growth have been included in the analysis.
[2]AMD, Broadcom, Infineon, Intel, Mediatek, NEC, NXP, Panasonic, Qualcomm, Sony, ST, Texas Instruments, and Toshiba.

Source: Annual reports; McKinsey analysis of granularity of growth margin businesses in the past 15 years (including its DRAM and defense-controls units) to focus on the wireless business, as well as to develop a medical business. Qualcomm focuses on the large, high-growth wireless-handset market and, by controlling intellectual property such as the CDMA and WCDMA chip sets, is able to generate significant profits through licensing arrangements, creating an additional revenue stream that does not entail building chips. Applied Materials' ability to enter key new growth segments (such as rapid thermal processing, copper deposition, and solar) while shifting its mix away from underperforming segments (such as implants) has enabled it to maximize profitability. As these examples illustrate, it is crucial for semiconductor companies to develop solid portfolio strategies and to actively manage their portfolios over time. Put another way, just as the technologies and processes in the fabs evolve, so must the composition of the corporation.

• • •

The inability of many semiconductor companies to create value is one of the key factors driving consolidation throughout the industry's value chain today. Indeed, as private-equity players set their sights on the industry, under-performing companies face a stark choice: they can either follow the lead of top performers and undertake initiatives to improve perfor-mance, thus helping shape the industry's structure, or they can leave it to acquirers to step in and drive a new dynamic of value creation. Those that choose the former course must begin by evaluating whether they have the strategic, organizational, and operational capabil-ities to pursue a performance transformation. If such companies lack these capabilities but still wish to control their future, they must move quickly to close capability gaps before embarking on the journey.

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