

# **Analysis on Changes of Semiconductor Industry Structure Influenced by Business Model Innovations**

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## **Abstract**

Innovative capability is considered inevitable for firms to sustain their competitiveness. In the recent rapidly changing global competition environment, the traditional integrated device manufacturer (IDM) model in semiconductor industry is facing the limitation of sustaining its profitability and competitiveness. IDM's focusing both chip design and manufacturing for various application segments disperse its resources of innovating sustainable competitiveness. The de-integration business model in semiconductor industry has been emerging since late 1980s. The dedicated manufacturing-only model, foundry, has developed process capability and demonstrated cost effectiveness via economies of scale. Chapter 2 develops an analysis framework with incorporating data envelopment analysis (DEA) approach to measure the efficiency through proper input and output variables setting. This framework aims at providing guidelines for developing firm's business and technology strategies. We conducted a DEA analysis by collecting financial data from twenty-six leading semiconductor manufacturing

companies, including twenty IDMs and six foundries. The results reveal that the foundry companies have higher competitive efficiency than those of IDMs. The empirical analysis suggests that adopting the asset-light business model may provide IDMs a better resource allocation and help the increase of relative efficiency scores.

The successful foundries lead technology platforms which enable more value creations through collaborations with their business ecosystem partners. IDM companies in Japan are allergic to this new competition environment, and have still deep attachment to in-house manufacturing. Focusing on fabrication cost reduction efficiency, in chapter 3 we analyzed the defect reduction learning curves of the semiconductor manufacturing. We estimate and compare the cost reduction performances among major Japanese IDM companies and a leading foundry company. Then we discuss the cost advantage brought by demand scales, and the importance of timely cost reduction to the semiconductor technology life cycles. Finally we suggest a collaboration scheme for the IDMs to commit themselves to the developed semiconductor business ecosystem.

The dedicated manufacturing-only business model, foundry, developed process capability and demonstrated cost effective economies of scale by attracting demands from global markets. Starting from design-only chip firms, fabless firms, who outsource the manufacturing to foundries, recently most traditional IDM firms started adopting a fabrication-light approach to streamline their assets for achieving better financial performance. In responding to this trend, foundry firms are expected to prepare sufficient IC (Integrated Circuit) manufacturing capacities. A precise capacity plan for investing in expensive semiconductor process fabrication that exactly meets demand is the ultimate objective of foundry firm planners. Chapter 4 examines the importance of demand forecasting for emerging IC manufacturing new business models. Then,

we propose comprehensive reference architecture for IC manufacturing aggregators to improve forecast accuracy using systematic approaches

With the increasing cost of setting up a semiconductor fabrication facility, coupled with significant costs of developing a leading nanotechnology process, chapter 5 aims to construct a market intelligence framework for developing a wafer demand forecasting model based on long-term trend detection to facilitate decision makers in capacity planning. The proposed framework modifies market variables by employing inventory factors and uses a top-down forecasting approach with nonlinear growth model to estimate the forecast parameters. The nonlinear mathematical approaches could be used to not only examine forecasting performance, but also to anticipate future growth of the semiconductor industry. The results demonstrated the practical viability of this long-term demand forecast framework.

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