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# R&D and firm performance in the semiconductor industry

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## Abstract

While the semiconductor industry is still dominated by large vertically integrated firms, fabless firms, which outsource their manufacturing, are gaining market share. Fabless firms are considered to have an advantage in product innovation, as they can focus their innovation efforts on chip design and can benefit from investments in process innovation made by their manufacturing partners. However, there is little empirical evidence of the performance of fabless firms compared to vertically integrated firms. This research empirically examines the relationship between R&D and the financial performance of fabless and vertically integrated firms from 2000 to 2010. Our results show that fabless firms maintain higher gross and net margins, earn a higher return on assets (ROA) and have greater intangible value (Tobin's q) than vertically integrated firms when controlling for size, capital intensity and R&D ratio (R&D/sales). This supports the argument that fabless firms achieve greater performance by focusing on

one part of the innovation process. The relationship of R&D ratio to net margin is negative for the whole sample, suggesting that the industry may be overinvesting in R&D. Notably, the negative relationship is greater for fabless firms, which spend a higher amount of their sales on R&D. The relationship of R&D ratio to ROA and Tobin's q is negative, and there is no significant difference between fabless and integrated firms. We conclude that fabless firms outperform integrated firms overall, but are somewhat worse in terms of increasing profits and creating value from their R&D investments.

Keywords:

Innovation

firm performance

semiconductor industry

vertical disintegration

fabless firms

vertically integrated firms

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## Notes

<sup>1</sup> The outsourcing of manufacturing is part of a much larger trend of vertical disintegration that occurred in other industries (e.g. electronics manufacturing, aerospace, apparel and footwear, automotive parts and pharmaceutical manufacturing).

<sup>2</sup> ODMs are a specific type of CM that is involved in both the design and manufacturing of a product for OEM.

<sup>3</sup> However, Feng and Lu ([2012](#)) conducted a theoretical analysis and found that as a manufacturer's bargaining power decreases, its profit under outsourcing may increase.

<sup>4</sup> Core silicon refers to the semiconductors that implement specific, individual functionality in an electronic system (iSuppli [2010](#)).

<sup>5</sup> Shin, Kraemer, and Dedrick ([2012](#)) coded EB 300 firms as lead firm, CM and component supplier. Our coding extends the previous coding by further classifying component supplier into a fabless firm and integrated firm. All of the fabless firms and integrated firms coded are operating in the industry of NAICS 3,344. One exception is Qualcomm (fabless firm) operating in NAICS 3,342.

<sup>6</sup> These 21 firms comprised about half of the world market share in 2011. Eleven out of the 21 firms were also listed among the top 25 semiconductor sales leaders of 2011 (IC Insights [2012](#)), and their market share was 40%. The market share of the top 25 semiconductor companies was 76%. Given that the market share of most semiconductor firms in the world is negligible, including about 100 small firms in Taiwan, our study on these 21 firms for 11 years provides some meaningful results. We compared these sample firms (187 observations) with other semiconductor firms in the EB300 data-set (418 observations – all the firms are operating in the industry of NAICS 3,344 except Sony Corporation operating in NAICS 3,343) in terms of total revenue, gross margin, net margin and ROA. By conducting the ANOVA, non-parametric  $\chi^2$  and median tests, we found that other semiconductor firms were not systematically different from the sample firms for most of the measures (total revenue and ROA for the ANOVA test, and total revenue, net margin and ROA for both non-parametric  $\chi^2$  and median tests).

<sup>7</sup> R&D ratios of fabless firms and integrated firms are 25.59 and 17.25%, respectively (Table [1](#)).

<sup>8</sup> The visualisation of the regression model for other performance measures, such as net margin and ROA, shows similar illustrations.

<sup>9</sup> Since the variable of fabless firm is a dichotomous variable, we only use the two ends of the plots for interpretation (integrated firms are coded zero and fabless firms are coded one). It would be interesting if a continuous variable, for example, the outsourcing percentage of chip fabrication, is used instead of a dichotomous variable. However, such data are currently not available from any data sources we are aware of.

<sup>10</sup> Patent data used for the analysis are derived from the COMETS database release 1.0 (Zucker and Darby [2011](#)).

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