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Effects of technical innovation on market value of the U.S. semiconductor industry

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ABSTRACT

This article discusses the effects of technical innovation on the market value (MV) of the American semiconductor industry from the perspective of investors in the securities market. The study quantifies the technical innovations of the semiconductor industry and uses the proportional change of Average Process Technology (APT) as a proxy variable to measure the industrial capability of technical innovations and to act as one of the explanatory variables of a regression model for discussing the connection between technical innovation and MV. The results indicate that: 1) the degree of technical innovation and the proportional change in productivity of the semiconductor industry are the major factors that affect proportional change in the MV of the U.S. semiconductor industry; 2) regardless of the size of a company's MV or the companies' classification in terms of products and services (the Equipment & Material Sector, the Board Line Sector, the IC & Chip Sector and the Fabless & Specialist Sector), the degree of technical innovation shows a significant positive effect on MV.

1. Introduction

The semiconductor industry originated in the U.S. in the 1960s and was dominated by the U.S. until the beginning of the 1980s, when the Japanese semiconductor industry emerged to compete with the U.S. firms (Figs. 1 and 2). From 1986 to 2000, the U.S. and Japanese Integrated Device Manufacturers (IDM) dominated the four major fields of global semiconductor applications: computers, communication, consumption and other fields. When the internet and communication revolution occurred in the mid-1990s, the field of semiconductor applications expanded. The late-industrialization nations–Taiwan, Korea, Singapore and China–began to challenge the high-tech industry of the advanced countries [1], which caused the manufacturing of global semiconductor products to shift to Asian emerging nations. At the end of the 1990s, China and India emerged as competitors in the industry, and their emergence speeded up the eastward industrial transfer. In 2002, the semiconductor sales of Asian emerging nations exceeded those of the U.S., making those nations the largest suppliers in the world. By 2006, the production value of the semiconductor industry in Asian emerging nations had reached USD100.4 billion and accounted for 47% of global sales—and it is still growing (IC Insights, February 2007).

The U.S. semiconductor industry has been severely impacted by the eastward movement of the production and sales markets, and its market share continues to fall (Fig. 1). In 2000, the U.S. lost its lead position in the global semiconductor industry and has not yet regained it. Nevertheless, the U.S. semiconductor industry still maintains a large presence in the industry, and the number

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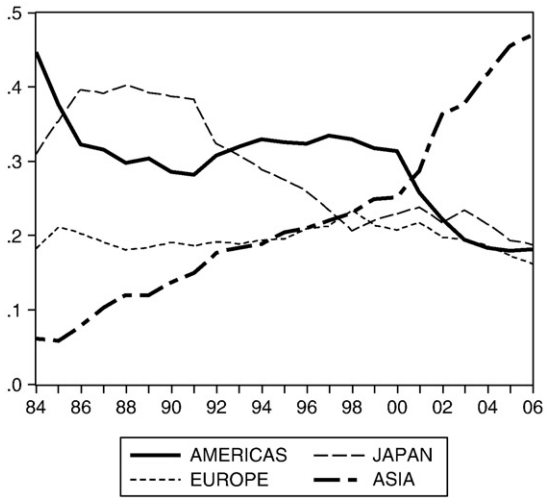

Fig. 1. Trend of global market share of semiconductor products.

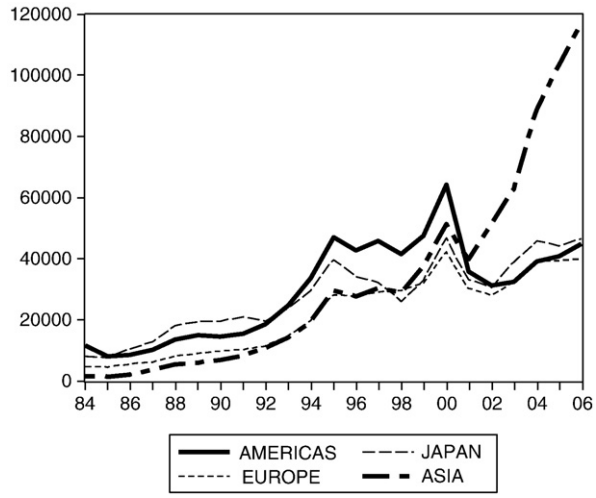

Fig. 2. Trend of global sales volume of semiconductor products (million USD).

and scale of listed semiconductor companies registered in the U.S. stock market for trading are still greater than those of any other country. The U.S. semiconductor industry has a long history and its research institutes are numerous; therefore, its statistical data are thorough and abundant[1] and far beyond the reach of other countries. Hence, this study uses the U.S. semiconductor industry as the target of its research.

At the beginning of the 21st century, process technology of semiconductors moved from the sub-micron generation into the nano-generation and product design underwent revolutionary development, creating a vast market for internet and wireless communication. The technical innovation of the semiconductor industry influenced not only the supply side (production and cost), but also product demand. Technical innovation has become an important variable for semiconductor companies' performance, as well as a point of interest for investors, especially institutional investors. Even so, few valuation studies have been undertaken on the investment value of technical innovation, primarily because the performance (or capability) of technical innovation is difficult to measure.

In early studies, Megna and Klock [2] used R&D intensity and patents to explain variations in Tobin's *Q* in the semiconductor industry, but they pointed out that R&D intensity did not explain the variations completely. R&D intensity is an input-based indicator, and patents are output-based indicators [3], but neither was suitable to act as an indicator of innovation performance for the semiconductor industry. West and Iansiti [4] and Leiblein and Reuer [5] argued that the roadmap of process technology can be

[1] In addition to official institutes such as the Federal Reserve Board (FRB), the Census Bureau, and the Semiconductor International Association (SIA), which provide abundant industrial information, other well known semiconductor technology companies and information sources, such as the World Semiconductor Trade Statistics (WSTS), IC Insights and Garther Dataquest, are all from the U.S.