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Lessons from the global financial crisis for the semiconductor industry

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ABSTRACT

During the global financial crisis in 2008, governments around the world have used a variety of policies to support threatened industries and to stabilize financial systems. In the present study, we empirically compare the patterns of the dynamic change in the financial performance of the semiconductor industry before and after government intervention by using the piecewise linear trajectory model for Japan, South Korea and Taiwan, three major economies for the industry. The empirical results indicate that, during the global financial crisis, the performance of the semiconductor industry can benefit from government support, in spite of the fact that the improvement was somewhat delayed after intervention. Moreover, the change pattern of the performance depends on the performance factor and the economy. Based on the results obtained as well as literature support, we summarize the economic and industrial policies that might have demonstrated usefulness for the industry and discuss some implications.

1. Introduction

The semiconductor industry is a typical technology-concentrated and capital-concentrated high-tech industry. The Asia-Pacific semiconductor market has grown rapidly in the 1990s. The Asia Pacific region continues to be the fastest growing area in the development of the semiconductor industry. In particular, Japan, South Korea, and Taiwan, three major economies for the industry, have demonstrated preponderance in (Brown and Linden, 2009, p. 25-26). The South Korea government has deliberately created and nurtured chaebols (a form of business conglomerate such as Samsung) and used them as locomotives. The chaebols are favored and long-term relationships have been established between them and the South Korea government. The semiconductor industry in Taiwan is mainly composed of small and medium enterprises (Chen, 2010). While South Korea tends to pursue scale-based technological development, Taiwan emphasizes network-based technological development (Wang, 2007; Tseng, 2009). On the other hand, Japanese firms benefit by the vertical and horizontal or upstream and downstream integration of semiconductor divisions and the linkage to banks belonging to a common business group (called keiretsu) (Windrum and Tomlinson, 1999; Brown and Linden, 2009, p. 16). Detailed analysis of the semiconductor industry can be seen in Kozmetsky and Yue (1998) and Brown and Linden (2009).

The global financial crisis in 2008 was caused by the U.S. sub-prime mortgage event, and brought the global financial system to the brink of disaster. The semiconductor industry was inevitably hit by the global financial crisis. The survival and development of the industry were strictly challenged. Under such a severe crisis, governments around the world have used a variety of policies to support threatened industries and to stabilize financial systems. Ding et al. (2013) conduct a comparative study among Asian economies to see how government intervention affected the trajectory of bank performance during the global financial crisis. They concluded that the change pattern of bank performance depends on the evaluative financial indicator, the economy, and whether banks are internationalized. South Korea and Hong Kong have been identified to be the economies with better bank performance after government intervention. Since the semiconductor industry is closely connected with the financial system and its performance reflects both industrial and financial stabilities, it should receive particular attention as well. It is of interest to gain more insight about government intervention. Has the financial performance of the semiconductor industry been successfully stabilized by government policies during the global financial crisis? Specifically, there are two research purposes of this study. First, we empirically evaluate the dynamic changes (change over time) in the financial performance of the semiconductor industry in Japan, South Korea and Taiwan before and after government intervention during the crisis period, and compare the change patterns among the three economies. Second, if it can be confirmed that the performance can improve after government intervention, we summarize useful policies given by the three economies. The remainder of the article is organized as follows. In Section 2, we review the role of government intervention. In Section 3, we introduce financial performance indicators and the piecewise linear trajectory model, and

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describe the data used. We provide empirical results and policy implications in Section 4, and give a brief conclusion in Section 5.

2. Role of government intervention

Government intervention has played important roles in economic development (Guang et al., 2014; Rodrik, 2014) and financial stability (Kawai, 2010; Ding et al., 2013). The Asian economies are characterized by significantly greater degrees of government intervention (Rodrik, 2014). Since the semiconductor industry has faced large business cycle swings and irregular financial crisis, government intervention is needed (Brown and Linden, 2009, p. 37). The semiconductor industry has been receiving much support from the governments. Since the early 1980s, the U.S. government has responded by undertaking policies such as the Semiconductor Chip Protection Act and the National Cooperative Research Act to support their semiconductor producers (Irwin and Klenow, 1996). Government support is a critical factor for the semiconductor industry in newly-industrialized countries (Huang et al., 2009). The semiconductor industry in Japan emerged and developed under the umbrella of the national government (Medina, 2011). The industry is also greatly supported by the governments in South Korea and Taiwan (Chang et al., 2006; Chen, 2010). Taiwanese government has built the Hsinchu Science-based Industrial Park (HSIP) and legislated the "Statute for Encouraging Investment" and the "Statute for Upgrading Industry" (Chen and Huang, 2004; Eriksson, 2005; Wu and Chen, 2006; Chen et al., 2006; Chen and Chen, 2007; Chen, 2010).

For the past three decades, the semiconductor industry has experienced several large fluctuations such as the 1997 Asian crisis, the 2008 global financial crisis, and the 2012 debt crisis in Europe. The government actions and support have been carried out to help faltering firms. As the global economic recession spread in 2008, the Taiwan government proposed loan relief for its semiconductor firms (Brown and Linden, 2009, p. 37). South Korea was severely injured by the Asian financial crisis in 1997. Because firms suffered much from asset liability mismatches and lacked their own financial means, government help became necessary. The South Korea government proposed a variety of policies, bailout funds and financial reforms to mitigate its impact (Kawai, 2010). When encountering later the 2008–2009 global financial crisis, the South Korea government further initiated a number of reforms, giving South Korea a brand-new opportunity to create a competitive economic environment (Lee and Lee, 2008; Kawai, 2010). Historically, the electronics industry has played a leading role in the Japanese economy. Aid was granted to the semiconductor companies such as NEC Electronics Corp., Renesas Technology Corp., and Elpida Memory Inc. by the Japan government. Bailout programs have been reviewed in Evenett et al. (2009).

Based on the review given above, we expect that, during global financial crises, the average trajectory (growth trend) of the financial performance of the semiconductor industry is decreasing before government intervention, but can be improved after intervention. The degree of improvement may depend on the performance indicator and the economy because of different policies used. These will be examined for the semiconductor industries in Japan, South Korea and Taiwan during the 2008 global financial crisis.

3. Methods

3.1. Financial performance indicators for the semiconductor industry

Irwin and Klenow (1996) analyze the high-tech R&D subsidies by examining the effects of Sematech (a U.S. consortium in semiconductor manufacturing) on members' R&D spending, profitability, investment, and productivity, based on the Compustat panel data on all U.S. semiconductor firms. Chen et al. (2001) indicate that a firm's management performance can be evaluated in terms of profitability factor, asset turnover factor, inventory turnover factor, and effective tax ratio factor.

Chen and Chen (2007) evaluate the performance of the semiconductor industry in Taiwan by using the ratio analysis and the balanced scorecard (BSC) method to enhance the validity of the data envelopment analysis (DEA). Twenty-three indices including traditional performance measurement indices such as growth, profitability and value creative indices are used. Huang et al. (2009) use structural equation modeling (SEM) and dynamic analysis to examine the performance of high-tech firms in Taiwan. The ratios used included return on assets (ROA) and return on stockholder equity (ROE). Cheng et al. (2010) use ROA as a criterion variable for analyzing a company's patent quality in the U.S. semiconductor industry. Chao and Chen (2012) analyze the foreign investment ratio in the Taiwan semiconductor industry, by using company financial statistics regarding stock return, system risk-β value and the weight of semiconductor firms in the Morgan Stanley Capital International (MSCI) Taiwan Index. Cheng et al. (2012) use twenty-one financial indicators, categorized as six components, and apply fuzzy integral and order weight average (OWA) method for evaluating financial performance of the semiconductor companies in Taiwan.

Based on the literature review, 15 financial performance indicators are selected for the semiconductor industry in this study. They include gross margin, earnings before interest and tax (EBIT) margin, operating margin, pretax margin, effective tax rate, return on equity, reinvestment rate, average of inventory days, average of account payment days, asset turnover, accounts receivable turnover, fixed asset turnover, pretax return on assets, leverage (assets/equity) and pretax return on equity.

3.2. Data

The data used for this study were obtained from Thomson Reuters database (a comprehensive financial database for individual companies across the world) quarterly reports during the period from the 2nd quarter of 2008 to the 4th quarter of 2009, in which the 2008 financial crisis occurred. To achieve sample representativeness, we selected semiconductor firms that were listed on the Japan, South Korea and Taiwan stock markets. 214 listed semiconductor companies with complete financial data during the period were included, 87 of which were from Japan, 26 from South Korea, and 101 from Taiwan (see Appendix A for the company listing). The semiconductor industry consists of four sub-industries: assembly and test, equipment, fables, and foundry. In our sample, there are 34, 64, 87, and 29 companies for the four sub-industries, respectively. Sample characteristics are presented in Table 1.

The principal component factor analysis with the varimax rotation is used to extract common factors of the 15 initial financial performance indicators. The number of factors extracted is determined by the 'root-greater than one' criterion. To facilitate interpretability, five indicators (average of inventory days, average of account payment days, pretax return on assets, leverage (assets/equity), and pretax return on equity) were removed, and the remaining ten indicators were retained to represent the three common factors, denoted by F_1–F_3. The factor pattern obtained is presented in Table 2. F_1 includes gross margin, EBIT margin, operating margin, pretax margin, and effective tax rate. Since they are all profitability-related indicators, F_1 is named profitability. F_2 includes return on equity and reinvestment rate. Since they can both reflect the capability of reinvestment, F_2 is named reinvestment. F_3 includes asset

Table 1
Sample characteristics.

Sub-industry	Japan	South Korea	Taiwan
Assembly and test	12	4	18
Equipment	45	9	10
Fables	14	12	61
Foundry	16	1	12

The values in the cells are the numbers of companies. The total number of companies is 214. Classifying a company to a sub-industry is based on its main type of products/services.