



The Rise of the Flash Memory Market: Its Impact on Firm Behavior and Global Semiconductor Trade Patterns

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Abstract

This article addresses three questions about the flash memory market. First, will the growth of the flash memory market be a short- or long-term phenomenon? Second, will the growth of the flash memory market prompt changes in firm behavior and industry structure? Third, what are the implications for global semiconductor trade patterns of flash memory market growth? The analysis concludes that flash memory market growth is a long-term phenomenon to which producers have responded in four distinct ways. It also concludes that the rise in flash memory demand has intensified current semiconductor trade patterns but has not shifted them fundamentally.

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Introduction

The past few years have witnessed rapid growth in a particular segment of the semiconductor market known as flash memory.² In each of the past five years, for example, flash memory market growth has either outpaced or equaled that of the total integrated circuit (IC) market³ (McClellan et al 2004-2007, section 5). One observer expects flash memory to have the third-strongest market growth rate over the next six years among all IC product categories (McClellan et al 2007, 5-6). As a result, the flash memory share of the total IC market has increased from 5.5 percent in 2002, to 8.1 percent in 2005. As a share of the memory market segment, flash memory has increased from 28.7 percent to 38.2 percent during the same period. In short, the flash memory market has quickly become a significant part of the overall semiconductor market that cannot be ignored; some predict it will soon compete with the dynamic random access memory (DRAM) market for dominance within the memory sector in the not-too-distant future (McClellan et al 2007, 5-4).⁴

Given its market size and projected growth, flash memory is likely to have an increased impact on the global semiconductor industry, and the decisions that flash memory producers make are likely to have a significant influence on industry evolution. These decisions have already been as dynamic as the recent performance of the flash memory market. Some firms have shifted production from other products to flash memory. In addition, some other firms have partnered to gain flash memory market share. Also, some firms have aggressively moved to lock in long-term deals with certain flash memory consumers.

This article will address three questions about the flash memory market. First, will the growth of the flash memory market be a short- or long-term phenomenon? Second, will the growth of the flash memory market prompt

² Flash memory is a type of nonvolatile memory that can be electrically erased and reprogrammed. Nonvolatile memory is memory that retains data when the power is turned off. Flash memory costs less and includes more functionality than other forms of nonvolatile memory.

³ The semiconductor market is composed of two main subsets, the integrated circuit (IC) market and the optoelectronics, sensors, and discretics (O-S-D) market. The IC segment of the semiconductor market is by far the biggest (85 percent in 2006) and comprises semiconductors that are harder to manufacture, more advanced, and more expensive. Flash memory is a type of IC.

⁴ DRAM is a popular type of volatile memory used mainly in computers. Compared to nonvolatile memory, volatile memory loses data when powered down. DRAM composes the largest share of the memory market, though flash memory has eroded its lead in recent years.

changes in firm behavior and industry structure? Third, what are the implications for global semiconductor trade patterns of flash memory market growth?

The analysis concludes that (1) flash memory market growth is a long-term phenomenon; (2) flash memory producers have responded to flash memory market growth in four distinct ways: choosing to produce flash memory rather than nonvolatile memory, entering into flash memory production, increasing flash memory production and production capacity, and partnering with each other; and (3) increased demand for flash memory and the response of producers to meet this demand have intensified current semiconductor trade patterns but has not shifted them fundamentally.

Flash Memory To Endure

The semiconductor industry has experienced many changes since flash memory first appeared in the early 1980s, one of the most dramatic and long-term of which has been the rise of the consumer electronics market as a demand driver for semiconductors. This rise in the consumer electronics market has fueled flash memory market growth and helped to make flash memory a prominent segment within the semiconductor industry.

Broadly speaking, flash memory ideally suits the consumer electronics market, because it bestows upon electronic devices two qualities that the market demands: mobility and miniaturization. For example, cell phones, a major application for flash memory, require data storage to save and store frequently called numbers and perform other convenient functions for which a traditional hard drive would prove impractical; such information would be erased every time the phone were turned off. Because (1) flash memory is small, reliable, and (2) its memory is nonvolatile, numerous applications not practicable with traditional data storage technology are emerging. Flash memory brings mobility and miniaturization to electronics products, two defining features of most consumer electronics products today.

Given capabilities and attractiveness of flash memory to the consumer market, it is clear why demand for it has rapidly grown. Flash memory allowed existing electronic products to adopt mobile and miniature qualities they did not have before and thus opened them up to new and very large consumer markets. In addition to cell phones, USB flash memory drives function as portable and smaller floppy drives. Flash memory has also prompted the growth of new consumer applications. Flash memory is an important component in popular devices such as DVD players, digital cameras, MP3 players, personal digital assistants (PDAs), and global positioning systems (GPS), all of which could not function without flash memory (McClean et al 2004, 7-2, and 2005, 7-3).

Origins and Early Growth

When flash memory first appeared in the early 1980s, most industry observers hardly took note. The few that did most likely would not have predicted then that the flash memory market would become a major segment of the global semiconductor market (box 1). Once flash memory fully emerged in the early 1990s, the initial industry consensus was that it had growth potential, but certain concerns made its growth trajectory uncertain. First, which markets would drive flash memory market growth? Second, how would flash memory compete against other types of nonvolatile memory technologies? Third, given its high price, how long would sluggish early sales continue?

Box 1 Fujio Masuoka, the Inventor of Flash Memory

The first flash memory device was invented in 1981 by a midlevel factory manager at Toshiba Corp. (Toshiba) named Fujio Masuoka. Masuoka wanted to create a device that would retain its memory after having been powered down. Up until then the main type of memory that existed was volatile memory such as DRAM, which lost its memory when the device was powered down. For example, any data created on a personal computer (PC) using such memory had to be saved to the PC's hard disk drive. Masuoka sought to create a chip that improved upon DRAM and hard disk drives. According to Masuoka,

"Simply put, I wanted to make a chip that would one day replace all other memory technologies on the market. In the 1980s, the market for data storage on PCs was dominated by magnetic tape and disk drives. Going after [the memory storage] market was the obvious thing to do for me..."

The industry was initially slow to recognize Masuoka's invention and realize its potential. It was not until 1985, four years after patent filing, that the industry was introduced to the device at a conference, and some firms realized flash memory potential. Intel asked for a sample of the new chip and in 1987-88 announced mass production of its own version of flash memory. Soon thereafter, Toshiba began mass production of flash memory.

Source: Business Week 2006a and 2006b.

These concerns proved to be unfounded as the flash memory market began to grow in the early 1990s (table 1). First, the most significant factor in flash memory growth was the emergence of the portable and laptop PC market as a growth driver. Flash memory provided the proper benefits of size, power dissipation, reliability, and speed for this expanding market (ICE 1992, 6-48).

The demand for flash memory created by portable and laptop PCs in the early 1990s hinted at a long-term trend within the semiconductor industry that would fuel flash memory market growth: the emergence of the consumer electronics market as the primary driver of end-use demand in the semiconductor industry. Second, within the nonvolatile memory sector, flash memory competed primarily against two other technologies called EPROM and EEPROM. In terms of price and functionality, flash memory fell somewhere in between these two technologies, effectively competing for space at the start of the 1990s (ICE 1992, 6-47). Third, regarding prices, in 1992 flash memory demand received a boost when Intel, the leader in flash memory production at the time, effectively lowered flash memory price-per-megabit ratio (ICE 1992, 6-49). Understanding the future demand for flash memory, Intel decided in 1991 to focus its nonvolatile memory production on flash memory and away from EPROM (ICE 1992, 6-49).

TABLE 1 The Rise of the Flash Memory Market

	Flash memory market (USD Million)	Flash memory market annual percentage growth	Flash memory as percentage of total semiconductor market	Flash memory as percentage of total memory market
1990	35		0.1	0.3
1991	135	286	0.3	1.0
1992	270	130	0.5	1.8
1993	640	106	0.8	3.0
1994	865	35	0.9	2.7
1995	1,860	115	1.3	3.5
1996	2,611	40	2.0	7.2
1997	2,702	3	2.0	9.2
1998	2,493	-8	2.0	10.8
1999	4,561	83	3.1	14.1
2000	10,637	133	5.2	21.6
2001	7,595	-29	5.5	30.5
2002	7,767	2	5.5	28.7
2003	11,739	51	7.1	36.1
2004	15,611	33	7.3	33.1
2005	18,569	19	8.2	38.3
2006	20,275	9	8.1	34.4

Source: WSTS and IC Insights.

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