FRBSF Weekly Letter

October 18, 1985

The Semiconductor Industry

The semiconductor industry is experiencing hard times. Since July of 1984, new orders have fallen by some 30 percent. Employment in Santa Clara County, which includes Silicon Valley and hence a high concentration of electronics firms, fell at an annual rate of 3.6 percent between May and July. This contrasts with average annual employment growth of just under 4 percent through the first half of the decade. In addition, August's 6.0 percent unemployment rate in Santa Clara County was much higher than the 4.3 percent rate that prevailed last December.

Another indicator of hard times in the semiconductor industry is the "book-to-bill" ratio which compares the value of new orders with the value of products shipped. A book-to-bill ratio of 1.1 is required to maintain the industry's average annual 20 percent increase in nominal sales. The ratio has not been above 1.0 since August 1984; it was stagnant at 0.72 from May through July of this year, and rose only to 0.74 in August. While the industry has always followed a boom-bust cycle, the severity and persistence of the current problems are causing some to question the long-run viability of the U.S. semiconductor industry.

Despite its problems, the semiconductor industry continues to show signs of vitality. Even in Santa Clara County, for example, employment in July remained 1.4 percent above its level at the same time last year, and the August unemployment rate of 6.0 percent was well below the national rate of 7.0 percent. Indeed, there are several reasons to expect that the current downturn is a short-run rather than long-run problem. This *Letter* argues that the U.S. semiconductor industry is likely to resume its long-run growth trend. However, the direction in which change seems to be headed suggests that, in the future, domestic jobs in the semiconductor industry will consist almost entirely of positions requiring highly sophisticated technical skills.

Long-run trends

Historically, the semiconductor industry has grown rapidly. New uses for semiconductors and innovations that have reduced the cost of making them have combined to produce average annual growth of 20 percent in nominal sales.

As the chart shows, orders of electronic components (which include but are not limited to semiconductors) have until recently grown more rapidly than orders of other manufactured products. This increase in volume has been accompanied by profound changes in the industry. The most obvious change has been technological. As chips have become more powerful and cheaper to produce, their uses have become more varied, prices have fallen, and sales have risen. The increased variety of products has, in turn, led to greater specialization in production. For example, Japanese producers now dominate the market for 64K and 256K memory chips, while U.S. producers dominate the market for custom chips and those with telecommunications and military applications.

In addition, the industry is becoming more international. More and more, U.S. producers are establishing factories overseas to reduce labor costs and improve access to foreign markets. At the same time, Japanese firms, concerned about possible U.S. retaliatory trade measures, are establishing production facilities in the U.S. Thus, firms and production facilities are increasingly dispersed throughout the world. Moreover, firm headquarters and production facilities are more likely than ever to be located in different countries.

Sources of current weakness

The stage for the current downturn was being set in 1983 when 60 percent growth in the number of personal computers sold left semiconductor producers unable to supply enough chips. Existing U.S. producers responded by investing in plant and equipment to expand their capacity to produce. Meanwhile, overseas producers, particularly from Japan, took advantage of the shortfall in U.S. production capacity by expanding their U.S. market share. Japanese producers, by dominating the memory chip market, expanded their share of the total U.S. market by three percentage points in 1984, to 16 percent.

Shortly after the industry developed the ability to meet chip demand, the fastest growing component of demand, the personal computer market, weakened. There are two main explanations for this slowdown. First, some analysts argue that business users of personal computers are learning how to operate the systems they have before making additional purchases. Although limited uses for *home* computers may prevent that segment of the personal computer market from recovering its previous strength, only a fraction of personal computers — most likely less than 10 percent of sales — are sold for household use. The alternative explanation emphasizes the slowdown in the national economy, which has reduced business investments across the board. By either explanation, the current slowdown is but a temporary deviation from a long-run growth trend and not a secular slowdown.

Even a short-term slowdown can have enormous consequences. Estimates of the 1985 change in the number of personal computers sold range from a decrease of more than 30 percent to an increase of 30 percent. However, even 30 percent growth would present hardship for some firms since some capital investments were based on euphoric projections (made in 1983) of 100 percent annual sales growth.

The consequences for semiconductor manufacturers have been swift and severe. In the middle of 1984, semiconductor orders began falling until, by the end of 1984, chip inventories had built up to as much as $1.5 billion. Enormous price reductions and, ultimately, production slowdowns and losses followed. To the extent that the problem is simply excess inventory accumulation, the current downturn is no different from previous boom-bust cycles in the electronics and semiconductor industries.

However, several other factors have exacerbated what probably would have been a relatively severe bust anyway. In particular, the fast pace of technological innovation, which is the backbone of the industry, ironically compromises the industry's ability to adapt to changing market forces. Costs are especially difficult to cut because research and development as well as capital expenditures must continue to receive priority even during a downturn if firms are to emerge strong in a future upswing. Moreover, increasingly specialized technological innovations limit producers' abilities to switch from the production of one kind of chip to another as demand changes.

Another factor hurting the U.S. industry is Japan's growing prominence as a major competitor. The most recent boom provided an opportunity for Japanese firms to reap the benefits of their heavy investments in producing low-cost chips. By making certain products at lower cost than their American counterparts, the Japanese have forced U.S. firms to establish smaller market niches, reduce costs, or both. The high value of the dollar exacerbates the threat posed by low-cost Japanese firms. As in other U.S. industries that compete with foreign producers, the high value of the dollar makes U.S. products more expensive than foreign products and therefore hurts sales of products made in the U.S.

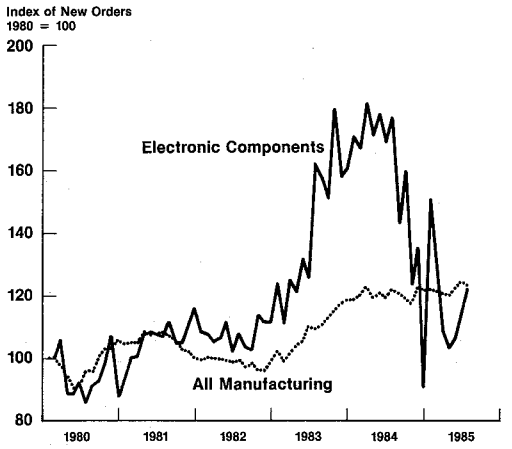
The outlook

The outlook for the U.S. semiconductor industry depends on several factors. The most important are growth in product demand and competitive position relative to other producers. Competitive position in turn depends on technological innovation, costs relative to those of other producers, and the extent and character of market segmentation.

Semiconductor demand will continue to grow as long as the technological innovation that expands uses and reduces costs continues to stimulate increased demand. Household items such as television sets and military uses such as surveillance would be greatly improved by the expanded capacity of smaller chips. Factories could be monitored by robots that can see, and the ability of machines to recognize voices could make offices more efficient. Although the pace of expansion will eventually slow as new uses are exhausted, most agree that the potential for further growth remains substantial.

The pattern of specialization in the industry has actually cushioned U.S. producers somewhat from the current downswing. Since personal computers are a major source of demand for the memory chips in which Japanese producers hold a 70 to 90 percent market share, Japanese firms that export chips to the U.S. were far more devastated than U.S. producers when personal computer demand slowed. One analyst, who in late July anticipated a 20 percent reduction in total U.S. semiconductor

MANUFACTURING ORDERS, 1980 - 1985



sales for 1985, expected a decrease of 65 percent in the sales of memory chips. By concentrating on custom chips and other products with more stable demand, U.S. producers can continue to insulate themselves from the more excessive ups and downs of the industry.

Traditionally, U.S. firms have enjoyed technological superiority over their foreign rivals. Their greater innovativeness is generally attributed to the relatively unstructured environment at many U.S. firms. This environment is claimed to foster creativity while the American cultural and economic system encourages risk-taking. Furthermore, venture capital, which is more readily available in the U.S. than elsewhere, facilitates innovative research and risky investment projects. If this pattern continues, U.S. producers should be able to retain their technological advantage in innovative and custom chips.

As technological advances yield more sophisticated products, the production process is likely to require a more highly skilled work force. For example, "super-chips," which some analysts expect to be mass produced in the 1990s, are extremely small and intricate. The only human workers required are likely to be programmers who instruct the computers how to design and make the chips. To recruit the necessary talent, U.S. firms will probably locate their plants in this country rather than overseas.

The influx of Japanese firms setting up plants in the U.S. (in part to avoid potential retaliatory trade measures) will likely provide a limited additional source of semiconductor jobs. Traditionally, Japanese firms have employed relatively more capital and less labor than U.S. firms because the price of capital in Japan is lower relative to the price of labor than in the U.S. There is even greater incentive for Japanese firms to economize on labor when they invest their low-cost capital in U.S. production since U.S. workers are among the most highly paid in the world.

Conclusions

In spite of the current problems in the semiconductor industry, there appears to be a strong trend toward greater semiconductor use, and toward continued innovation. As long as this innovation continues to produce more powerful chips at lower costs, overall sales should resume their upward climb. While the present situation may cause some firms to fail, the industry as a whole should regain its health in the long-run.

The trends also suggest that the industry will become increasingly multinational, that research and development will continue to be vital, and that production in the U.S. (by both domestic and foreign-based firms) will be increasingly capital intensive and sophisticated. Therefore, a healthy U.S. semiconductor industry in the future will probably require only employees with substantial technical skill, and consequently will not yield abundant low-skilled and semi-skilled jobs.

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Opinions expressed in this newsletter do not necessarily reflect the views of the management of the Federal Reserve Bank of San Francisco, or of the Board of Governors of the Federal Reserve System.
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BANKING DATA—TWELFTH FEDERAL RESERVE DISTRICT

(Dollar amounts in millions)

Selected Assets and Liabilities Large Commercial Banks	Amount Outstanding 9/25/85	Change from 9/18/85	Change from 9/26/84 Dollar	Change from 9/26/84 Percent[7]
Loans, Leases and Investments[1] [2]	194,298	— 272	11,483	6.2
Loans and Leases[1] [6]	175,050	— 392	11,106	6.7
Commercial and Industrial	50,822	— 24	814	1.6
Real estate	64,546	60	3,474	5.6
Loans to Individuals	35,915	111	5,864	19.5
Leases	5,414	— 1	368	7.2
U.S. Treasury and Agency Securities[2]	12,075	111	257	2.1
Other Securities[2]	7,173	9	122	1.7
Total Deposits	196,816	— 1,774	8,952	4.7
Demand Deposits	45,614	— 1,463	2,403	5.5
Demand Deposits Adjusted[3]	31,126	— 539	3,061	10.9
Other Transaction Balances[4]	13,435	— 508	1,532	12.8
Total Non-Transaction Balances[6]	137,766	197	5,015	3.7
Money Market Deposit Accounts—Total	44,973	— 140	7,423	19.7
Time Deposits in Amounts of $100,000 or more	38,636	365	— 2,415	— 5.8
Other Liabilities for Borrowed Money[5]	23,430	1,179	528	2.3

Two Week Averages of Daily Figures	Period ended 9/23/85	Period ended 9/9/85
Reserve Position, All Reporting Banks		
Excess Reserves (+)/Deficiency (−)	61	— 2
Borrowings	39	16
Net free reserves (+)/Net borrowed(−)	23	— 18

1 Includes loss reserves, unearned income, excludes interbank loans
2 Excludes trading account securities
3 Excludes U.S. government and depository institution deposits and cash items
4 ATS, NOW, Super NOW and savings accounts with telephone transfers
5 Includes borrowing via FRB, TT&L notes, Fed Funds, RPs and other sources
6 Includes items not shown separately
7 Annualized percent change