Price Measures for Semiconductor Devices

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ABSTRACT

This note provides quality-adjusted price indexes and nominal shipments data for highly disaggregate classes of selected semiconductor devices. These data may be used to construct indexes under different assumptions from those in currently available indexes. Because the construction of these building blocks require some assumptions, the indexes are compared with similar price measures constructed by Bruce Grimm (1998) and by the Bureau of Labor Statistics.

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INTRODUCTION

This paper provides highly disaggregate measures of constant-quality price change and nominal shipments for selected semiconductor devices that may be used to construct more aggregate measures of price change under a variety of assumptions and methods. An appendix details the data sources and construction of the measures and gives tabulations of the measures. Below, the new measures are aggregated to a level that allows comparisons with existing measures published by statistical agencies. These comparisons are made to highlight the numerical importance of differing assumptions and data sources.

Building on work by Bruce Grimm (1998), quality-adjusted measures for chips in the MOS memories and microprocessor segments are constructed for the period 1992-1999. For the remaining segments, indexes are constructed for as many devices as the existing data allow. All these sub-indexes are chained, matched-model indexes that use either the Fisher or geometric means formula, depending on the available data. The "Matched-model" technique generates a quality-adjusted price index, while the Fisher index formula ensures that the appropriate weights are used to aggregate over goods. Absent revenue data with which to form the Fisher weights, chained geometric means are calculated instead. For the most part, the data are high-frequency data on prices and quantities of chips at a very disaggregate level.

Turning to the top line, the most aggregate index considered here is a price deflator for semiconductors as a whole—most of the products in the old SIC3674.[1] Table 1 compares growth rates for annual averages of this aggregate—labeled "new"[2] to the comparable BEA and BLS measures. Both the new and BEA indexes use chained-Fisher weights, but aggregate over different subindexes; while the new index aggregates over mostly chained-Fisher subindexes, BEA aggregates over the Laspeyres subindexes

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1 Table A1 in the appendix details the individual semiconductor devices covered by this index.
2 Strictly speaking, the annual averages discussed in the text are not properly constructed indexes. As shown in Diewert (2000), annual averages do not weight the high-frequency observations properly. As such, the annual averages in the text should be viewed as a descriptive statistic for the properly-constructed high-frequency indexes in the appendix.

constructed by the BLS. Comparing the two indexes shows the effect that these differences in the underlying subindexes have on the top line: The new index falls 15-20 percentage points faster than the BEA index in 1997 and again in 1998. Similarly, both the BEA and PPI measures aggregate over the same subindexes, but use different aggregation formulas; the BEA uses a chained Fisher formula while the BLS uses a fixed-weight laspeyres. Comparing those two measures shows the effect that different aggregation formulas have on the top line: the BEA index falls 15-30 percent faster than the PPI.

Comparisons at finer levels of disaggregation are discussed below and organized into three coarse market segments: MOS memory chips (like DRAM), MOS logic and microcomponents (including microprocessors like the Pentium III), and everything else (other integrated circuits, opto-electronics, and discrete devices). Of the three segments, the MOS logic and microcomponents segment is the largest in global markets and makes up nearly one-half of the world's production; each of the other two segments make up about one-quarter of world shipments.

MOS MEMORY CHIPS

MOS memory chips are devices intended to store data and are used in a variety of applications, ranging from the personal computer (PC) to digital alarm clocks. In 1999, these devices made up 25 percent of the dollar value of all chips produced in the world and 20 percent of the value of chips produced in the US. This segment of semiconductor markets continues to show rapid rates of product innovation and technological change.

Indexes for five types of MOS memory devices were constructed for the period 1992 to 1999. Table 2 compares the resulting indexes to those constructed by Bruce Grimm (1998). Both indexes tell the same story for MOS memories as a whole: both show small changes for prices in each year between 1993 to 1995 followed by sharp declines in prices in 1996. Measures for some of the underlying segments are also very similar: DRAM, EEPROM, EPROM.

These similarities in the numerical estimates stem from similarities in the methods used and the underlying data. Both the Grimm and new indexes for these devices are matched-model chained Fisher indexes applied to highly detailed data. Both are indexes for the *world* market—they both use worldwide nominal shipments data to form the aggregation weights. Both use data from the same source, but the frequencies are different: data used here are quarterly while the data used by Grimm are annual.

Estimates for the remaining devices differ somewhat, owing to differences in the level of aggregation in the underlying raw data. The Grimm indexes for Flash and SRAM memory are superior to those used here in that they are constructed using (discontinued) data that has a finer level of product detail. For SRAM, table 2 shows the two indexes constructed by Grimm—one for "fast" SRAM and one for "slow" SRAM. Though the differences are nontrivial, the nominal weights for Flash and SRAM are still sufficiently small that the effect on the top line is small.

Chart 1 compares two aggregates of these memory indexes to Producer Price Indexes over the period 1997 to 1999; a comparison for the earlier period is not made because the PPI methodology for these devices was improved beginning in 1997, making the data before 1997 not comparable to the more recent data. The measures labeled "world" are aggregates of the world subindexes shown in table 2, where the aggregation is done using world nominal shipments; the measures labeled "US" are also aggregates of the world subindexes, but the aggregation is done using US nominal shipments data from Census' published *Current Industrial Reports* for semiconductor devices.

In 1997-98, the memory aggregates fall between 45 and 55 percent while the PPI falls less than 30 percent; and in 1999, the new measures fall about 20 percent while the PPI actually rises. These differences reflect the many differences in the construction and data sources of the two measures. As is the case with all PPI measures, the PPI for semiconductors contains some substitution bias—because it uses a Laspeyres formula—and may not introduce goods quickly enough to capture the very steep price declines early in a chip's life. With regard to data sources, though, the subindexes constructed here rely on worldwide shipments for weights and those shipments may not adequately reflect the composition of US production.

Parsing out the differences into the underlying types of memory chips, the differences in the overall indexes stem from gaps in the underlying price indexes for both DRAM—shown in the left, bottom panel—and memory chips other than DRAM—shown at the right. For DRAM, the differences could, in part, reflect the broader coverage of the PPI for DRAM. The PPI covers both contract and spot markets—the latter makes up about 10 percent of the world market—whereas the index used here only covers contract prices. This problem in coverage is not innocuous because contract prices—negotiated in advance—probably respond more sluggishly than spot market prices to changes in the underlying fundamentals. Still, to explain the gap, spot prices would have had to have fallen substantially slower than contract prices and that seems unlikely—transactions in the spot market make up only about 10 percent of the MOS memories market.

MOS LOGIC AND MICROCOMPONENTS

The most widely known and most important type of logic and microcomponent chip is the microprocessor—like Intel's Pentium. In 1999, microprocessors (MPUs) made up 21 percent of the dollar value of all chips produced in the world and 51 percent of the value of chips produced in the US; the weight is heavier in US markets because Intel—the dominant firm in MPU market—produces most of its logic chips in the US.

The remainder of the MOS logic and microcomponent segment is a bucket, covering devices that are very diverse both in terms of technology and uses. These "other logic chips" are also important—taken together, they made up 35 and 14 percent of the world and US markets in 1999, respectively, and are expected to outpace the growth in microprocessor market in coming years. Like microprocessors, these devices show rapid rates of product innovation and technological change.

The first building block for a price index for this segment is the index for microprocessors provided in Aizcorbe, Corrado and Doms (2000). The first two columns of table 3 compare the measure constructed by Grimm to the ACD measure for all Intel microprocessors, including servers. The numerical differences reflect differences in both method and coverage: The Grimm measure is partially based on hedonic techniques and covers all non-embedded chips—those produced by both Intel and its rivals—while the ACD measure is a chained Fisher that only covers Intel's chips—about 90 percent of the dollar value of worldwide sales over this period. Despite the narrower coverage of the ACD measure, one could argue that it is preferable because the quality of data on Intel is superior to that of other firms. Importantly, disaggregate shipments data with which to compute weights are not available for Intel's rivals.

Though these non-embedded chips—typically used in personal computers—have historically dominated the MPU segment, embedded chips are growing rapidly and are expected to continue to increase in importance in the future. While non-embedded chips are fairly standardized and tend to be used in computers, embedded chips tend to be highly diverse and are used in a wide array of applications. As shown in column 3 of table 3, this small, but growing, segment matters: price change for embedded MPUs is substantially slower than that of Intel's chips. And, as shown in column 4, a Fisher of the two types of chips falls perceptively slower than the ACD measure of Intel's prices.

To obtain an index for this MOS micro and logic segment as a whole, the two MPU measures were combined with seven other indexes that were constructed for devices that, taken together, make up about 2/3 of the non-MPU portion of the segment: microcontrollers, digital signal processors, general purpose logic, gate arrays, standard cell chips, and field programmable logic. As detailed in the appendix, the data for these devices were scarce and required some assumptions to fill in the gaps: in some cases, because nominal shipments data were not available, the best one could do is to construct geometric means. In other cases, data to construct Fisher indexes were available but only for some of the years. Care was taken to ensure that the assumptions made to fill in the gaps would err on the side of understating price declines in the aggregate indexes.

The resulting price index is compared to the PPI in chart 2. As was the case with memory devices, the producer price index for this segment shows very small price declines when compared with the new indexes. As seen below, the gap arises in the indexes for "other logic"; the price measures for microprocessors are quite comparable.

OTHER DEVICES

Indexes were also constructed for devices outside of MOS memory and logic. In 1999, these devices, taken together, made up 18 and 15 percent of the world and US markets, in nominal terms. Most of these devices are old, established electronic equipment—like transistors—that are not undergoing a lot of technical change. One exception is analog chips—chips that are heavily used in the production of communications equipment.

The indexes for these devices are chained Fisher indexes that were constructed using the relatively aggregated average sales price and unit data from Semiconductor Industries Association (SIA). There are two things to note about the measured price change for these devices. As shown in chart 3, measured price change for "other integrated circuits rarely fall more than 15 percent—slow price declines when compared with those of other devices. Second, the new price index shows, on balance, slower price declines than either the xxxxxx corresponding PPI.

Although it is hard to tell without higher-quality data, it is probably the case that both the new and PPI indexes have limitations that will tend to understate price declines for these devices. For the new indexes constructed using the SIA data, it is probably safe to say that the data are not sufficiently disaggregated to adequately control for quality changes. Because raw prices typically rise as quality improves, if one doesn't adequately control for quality improvements the price declines in an index will be damped by quality-related price increases. That is, prices probably fall faster than these new indexes show.

In contrast, although the quality of devices are very precisely determined and tracked in the PPI, the use of Laspeyres weights in that index will, all else held equal, yield price declines that are understated. Aggregate prices probably fall faster than these indexes as well.

SUMMARY

This paper provides highly disaggregate measures for semiconductor devices. As is well known, differences in the assumptions used to form aggregate indexes will have a non-trivial impact on the numerical values of the resulting measures. As shown above, this is also true for semiconductor chips. The availability of these data should facilitate the construction of alternative price indexes by other researchers.

APPENDIX

1. CONSTRUCTION OF PRICE INDEXES

Most of the price indexes used to measure price change for semiconductor devices are matched-model, chain-type Fisher indexes of aggregate price change. In a few cases where quantity data were not available, however, it was necessary to construct geometric means.

Matched-Model chained Fisher Indexes

For two adjacent periods, if all goods sold at time t were also sold at time t-1, then a Fisher Index number ($\mathbf{P^F_{t,t-1}}$) that measures aggregate price change from t-1 to t is given by:

(1) $$P^F_{t,t-1} = [\ \Sigma_m\ \omega_{m,t-1}\,(P_{m,t} / P_{m,t-1})\ /\ \Sigma_m\ \omega_{m,t}\,(P_{m,t-1} / P_{m,t})\ ]^{1/2} \quad , \quad m = 1, \ldots, N$$

where the w's are nominal weights

$$\omega_{m,s} = P_{m,s}Q_{m,s} / \Sigma_m (P_{m,s}\, Q_{m,s})$$

and the notation Σ_m refers to summations taken over the matched models—the goods "alive" in both periods. To calculate a matched-model Fisher in the presence of births or deaths, one only includes prices in the index for goods that were alive in both periods. In general, one might be concerned that ignoring new and exiting goods might impart biases on the price index. However, if one has access to *high frequency* data that measures prices and quantities for *technologically distinct products*, then the bias from ignoring product turnover is minimized and hedonic techniques provide little or no advantage over the matched model techniques.[3] This is because the weight on the unobserved price decline is likely very small in the first month or quarter of introduction.

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3 Griliches, Triplett and others have noted that ***if one has the ideal data set***, hedonic techniques do not provide an advantage over matched-model price index techniques. This same point was made in Aizcorbe, Corrado, and Doms (2000) and Silver and Heravi (2000).

While the index formula in (1) measures price change over two adjacent periods (i.e., t and t-1), price change over longer periods of time are measured by multiplying (chaining) these indexes together. Formally, to measure price change from some base period o to time t, the Fisher indexes for all the adjacent periods from o to t are multiplied together:

(2) $$P^*_{o,t-1} = \Pi_{s=o,t} \; P^F_{o,s}$$

This method was used to calculate a price index for all semiconductor products and for three classes of semiconductor chips that make up integrated circuits: memory chips, logic chips, and other integrated circuits.

Matched Model Geometric Means

The formula for a geometric mean of price change from period t-1 to t is given by:

(1') $$P^G_{t-1,t} = \Pi_m \; (P_{m,t} / P_{m,t-1})^{(1/m)}$$

where the notation Π_m refers to products taken over goods that existed in both periods (goods denoted by m). This index of price change over two adjacent periods are chained to obtain price change over longer periods of time:

(2') $$P^*_{o,t-1} = \Pi_{s=o,t} \; P^G_{o,s}$$

2. Data for Price Subindexes

Highly detailed data were obtained to construct matched model indexes for most devices classified in the semiconductor industry (SIC 3674). In table A1, the individual product classes itemized in the 1998 *Current Industrial Reports* (CIR) are listed along with information on whether data were available for the product class, and, if so, on the data source. Descriptions for each of these devices are available on the Semiconductor Industries Association web page at www.semichips.org.

The CIR hierarchy was used as a backbone to facilitate the construction of indexes that use US shipments. Data were available for most product classes: the exceptions were small and were mostly devices outside of "Integrated Circuits"—the type of semiconductors typically measured in previous studies.

The collection of devices in integrated circuits may be thought of in three different classes: MOS memory, MOS logic and microcomponents, and other integrated circuits. In all cases, the data used to construct the sub-indexes were data for the world market—data for US production are not available at the needed level of detail. Because semiconductor markets are highly global, it is probably safe to assume that prices for individual chips do not vary by country. However, to the extent that the distribution of production in the US differs from that in the world as a whole, these price indexes may not provide a precise representation of prices for the US market.

We discuss the data sources and the resulting price measure for each of these in turn.

2A. MOS Memory

As may be seen in table A1 data for the MOS memory indexes (lines 8-24) were obtained from Dataquest, Inc. Dataquest is an international organization that is one of the premier sources of data for high technology goods. Dataquest monitors unit shipments and prices charged by selected companies—making up over 90 percent of the market--at monthly or quarterly frequencies. These data on quarterly prices and quantities are proprietary and reported for 212 distinct devices produced between 1992 and 1999 and are essentially chip-level data.[4] One potential drawback of the data is that they cover only ***contracted*** transactions, and do not capture spot market transactions. Tables A2 and A3 contain quarterly price indexes and world shipments for five types of MOS memory chips: DRAM, SRAM, EEPROM, EPROM, and Flash&ROM. The devices differ by read-write capabilities and the technology used for their production.

4 The index constructed by Bruce Grimm was based on very similar data from DQ and used matched-model techniques. The main difference is that the Grimm data were annual while those used here are quarterly. Surprisingly, the frequency of the data does not appear to make much of a difference.

2B. MOS Logic and Microcomponents

Microprocessors

The construction of a price index for microprocessors (MPUs—shown in lines 25-27 in table A1) required data from several sources. A chained-Fisher price index for non-embedded microprocessors was obtained from ACD (2000). That index—shown in the first column of table A4—is based on data obtained from MicroDesignResources (MDR). The MDR data provide prices and quantities for 43 technologically distinct microprocessors produced by Intel—the dominant firm in the non-embedded market throughout the 1990s. Intel's chips are produced mostly in the US and represented about 80% of the total value of microprocessors produced in the world in 1999.

Columns 2 and 3 provide the nominal value of shipments of Intel's MPUs—as estimated by MDR—and of embedded chips—estimated by multiplying the SIA WSTS nominal value of all MPUs with the SIA Microprocessor Report's estimate for the share of these shipments made up of embedded MPUs.

The data for the embedded microprocessors price index—obtained from DQ—are annual price data that begin in 1996. Because neither nominal shipments nor unit data were available at a sufficient level of detail, geometric means were constructed.

The two price indexes were then combined using nominal world shipments data for embedded and non-embedded microprocessors from Semiconductor Industries Association (SIA) to yield the overall MPU index on table 3 of the text.

Other Microcomponents

Although the microcomponent segment is one of the most dynamic in semiconductor markets, the segment has been largely neglected by statistical agencies and data vendors; these chips are all lumped together with other logic chips as "Other Logic" in the CIRs (line 28), and highly disaggregate data from private vendors is relatively scant. Because the price declines associated with individual chips in this product class are reportedly comparable to those associated with MOS memory and MPU chips, it is very important to use disaggregate data to identify the individual price contours for each chip.

The top panel of table A5 gives information on the sources and construction of indexes for these devices—the corresponding indexes are given in the bottom panel. The source data, and, hence, the indexes are all annual frequencies.

To construct price measures for both types of microcontrollers (MCUs and DSPs), annual data for the period 1996-99 were obtained from DQ and were used to calculate chained Fisher indexes. A measure for Microperipherals (MPRs) could not be constructed owing to lack of data (even SIA does not publish data for these devices).

MOS Logic

The scarcity of data for devices in the MOS Logic category does not allow construction of chained Fisher indexes using highly detailed data—the preferred method. Instead, price change for these devices was measured using matched-model geometric means, indexes that can control for quality change if the data are sufficiently disaggregate but do not use the proper (Fisher) weights.

For two types of MOS logic—general purpose logic and gate arrays—Dataquest publishes disaggregate price data that were used to construct geometric means for the period 1990-1999. For field programmable and standard cell logic devices, the DQ data was discontinued in 1994 and 1995, respectively, and SIA data are not available. The indexes and corresponding worldwide nominal shipments are given in table A6.

Filling in the Gaps for Comparisons

For most devices, when gaps arose, the only available data were the relatively-aggregate SIA data. These monthly-frequency data are slightly more aggregated over products; rather than reporting chip-level data, SIA reports average sales prices and shipments for chips grouped by common attributes. Because these data likely do not hold quality constant, and yield Fisher indexes that likely understate price declines, an alternative measure was constructed: a Fisher index of MOS memories, MPU and MCUs (denoted MMM). The advice of industry analysts about the relative pace of technical change for these devices guided both the construction of the MMM index and the choice of which index to use to measure price change for logic devices—SIA vs. MMM.

Price change for embedded MPUs from 1992-95 was measured using the ACD Fisher index for Intel's MPUs and that of MCUs and DSPs was measured using Fisher indexes based on the SIA data—on the latter, the price change as measured in the SIA data appear reasonable. Price change for the remaining devices—except "other special purpose logic"—was measured using the MMM index. Because data were simply not available, the category for "Other Special Purpose Logic" was simply excluded; this amounts to assuming that overall price change for devices in this category can be represented by an index of price change for all the other devices in the Micro/Other logic category.

2C. Other Devices

Price change for the remaining devices was measured using chained Fisher indexes that were constructed using the relatively-aggregate average sales price and unit data from Semiconductor Industries Association (SIA). All told, we use observations for 84 such aggregates from the SIA data to form price indexes for most of the other devices listed in table 1. The monthly indexes are given in table A7.

3. Nominal Weights for Aggregation

Aggregating from the sub-indexes discussed above to more aggregate indexes requires nominal shipments data. The very disaggregate shipments data are only available for world markets—not US—and are given alongside the price indexes in the appendix tables. Normally, the source for the nominal shipments is the same as the source for the price data. At higher levels of aggregation, SIA data on the dollar value of world shipments are available. The shipments data for the nine coarse classes of integrated circuits and three classes of other semiconductors are given in table A8.

Data on nominal US shipments are available from the *Current Industrial Reports* published by the Census Bureau. There are two potential problems in using these data. First, the global nature of the production process for semiconductor chips makes the value-added for these devices difficult to track. So, for example, the initial assembly of a chip might begin in a US fabrication facility (fab). After the chip is produced, it might be sent to Asia, where the labor-intensive testing and packaging occurs. The measurement problem is that it is not clear exactly what is meant by "US shipments" of these devices—does it include the value-added in Asia? The assumption necessary to use these data for weights is that the index is for *finished* chips and that the reported shipments data include all of the value of the chip. The second problem is that the published data cannot be used without some imputations and judgment calls because the data are often suppressed to avoid violating firms' confidentiality. The public data are available in computer-readable form from the Census Bureau web page at: http://www.census.gov/cir/www/ma36q.html.

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Table 1. Price Indexes for Semiconductors

	1997	1998	1999
New	-42.9	-53.5	-47.7
BEA	-24.25	-37.3	--
PPI	-9.6	-8.1	-4.2

Sources: Authors' calculations based on proprietary data, the price deflator used in BEA's GDP-by industry program, and the BLS PPI for semiconductors.

Table 2. Price Indexes for MOS Memory Chips (percent change)

	1992	1993	1994	1995	1996	1997	1998	1999
MOS Memory								
New	--	-2.1	3.0	-6.1	-41.6	-49.7	-53.9	-17.5
Grimm	-22.4	-6.4	0.3	-7.6	-46.0			
DRAM								
New	-29.8	1.6	2.1	-1.5	-57.2	-64.0	-65.1	-15.7
Grimm	-29.5	-1.5	2.2	-2.6	-59.4			
EEPROM								
New	-19.8	-8.8	-20.9	-17.2	2.3	-44.1	39.3	-62.4
Grimm	-18.7	-8.2	-19.7	-16.2	-4.2			
EPROM								
New	-12.3	-12.9	0.8	-16.9	-1.4	-33.1	-28.6	-19.1
Grimm	-11.2	-12.1	0.7	-16.9	3.4			
Flash and ROM								
New	-11.0	-19.2	-6.2	-20.0	-12.2	-9.1	-63.6	-17.3
Grimm	-16.8	-12.3	-28.3	-39.9	-32.0			
SRAM								
New	-17.4	-9.1	10.0	-10.1	-33.1	-35.3	-35.0	-11.7
Grimm	(-29.4, -9.1)	(-33.6,2.7)	(-6.3,-2.0)	(-36.0,19.0)	(-13.3,-15.5)			

Sources: Authors' calculations based on proprietary data and Grimm(1998).

Note: Figures are percent changes for annual averages.

Table 3. Price Indexes for Microprocessors

	Non-Embedded			
	Grimm	ACD	Embedded	Total
1993	-30.0			
1994	-37.1	-31.6		
1995	-65.9	-58.6		
1996	-60.0	-60.8		
1997		-53.2	-39.6	-52.1
1998		-67.3	-8.9	-63.8
1999		-61.7	15.3	-57.4

Source: Grimm (1998), Aizcorbe, Corrado and Doms (2000)

Table A1. Data Sources and Coverage

	Product Description			DQ	MDR	SIA	No data
1	**IC gallium arsendide**	Memory					■
2		Logic and other.					■
3	**Bipolar memory**	(SRAM)...				■	
4		xSRAM				■	
5	**Bipolar transistors**	Transistor-transistor logic (TTL).				■	
6		Emitter coupled logic (ECL)				■	
7		xECL,xTTL				■	
8	**MOS memory**	DRAM	Not over 80K.	■			
9		DRAM	Over 80k but not over 300k.	■			
10		DRAM	Over 300k but not over 3MB.	■			
11		DRAM	Over 3MB but not over 15MB	■			
12		DRAM	Over 15MB....	■			
13		SRAM	Not over 40K.	■			
14		SRAM	Over 40K but not over 80K..	■			
15		SRAM	Over 80K but not over 300K.	■			
16		SRAM	Over 300K but not over 3MB	■			
17		SRAM	Over 3MB.....	■			
18		EEPROMS	Not over 80K.	■			
19		EEPROMS	Over 80K but not over 900K	■			
20		EEPROMS	Over 900K....	■			
21		EPROMS	Not over 80K.	■			
22		EPROMS	Over 80K but not over 900K.	■			
23		EPROMS	Over 900K....	■			
24		Other nonvolati nec		■			
25	**MOS logic**	MPUs having an internal data bus of 8 bits or less.		■	ACD		
26		MPUs having an internal data bus of 16 bits.		■	ACD		
27		MPUs having an internal data bus of 32 bits or more		■	ACD		
28		Other (microcontrollers, ASICs, PLAs, etc.).....		■			
29	**other**	Complementary BiMOS (BiCMOS)......					■
30		Other complementary BiMOS(BiCMOS), including logic ...					■
31		Other digital silicon ICs..					■
32	**analog**	Radio frequency.....				■	
33		Other, analog				■	
34		Other, including mixed signal (analog/digital), logic .				■	
35		Other, including mixed signal (analog/digital), other..				■	
36	**hybrid**	Radio frequency					■
37		Other...					■
38	**IC**	Other.....					■
39	**Transistors......**	**Signal (less than 1 watt dissipation)**				■	
40		**Power (1 watt or greater dissipation)**				■	
41	**Diodes and rectifiers...**	le .5amps				■	
42		gt.5amps				■	
43		Zener diodes				■	
44		Selenium rectifiers....				■	
45		Microwave diodes				■	
46	**Light-emitting diodes**	Solar cells...				■	
47		Discrete, infrared and laser.....				■	
48		Alpha or numeric displays.				■	
49		Photodiodes, including infrared detectors.				■	
50		Optical coupled isolators, including sensors and emitters......				■	
51		Other light sensitive and light-emitting devices				■	
52	**Thyristors**					■	
53	**Hall effect devices..**						■
54	**All other semiconductor devices**						■
55	**Semiconductor parts:**	**Chips and wafe For integrated circuits (IC's)...**					■
56		**Chips and wafe For discrete semiconductors......**					■
57		All other semiconductor parts					■

Note: Data sources are denoted as follows: Dataquest, Inc. (DQ), MicroDesign Resources (MDR), Semiconductor Industries Association (SIA), Aizcorbe, Corrado and Doms (ACD).

Table A2. Price Indexes for MOS Memory Devices

	DRAM	SRAM	EEPROM	EPROM	Flash & ROM
90q4	1.00000	1.00000	1.00000	1.00000	1.00000
91q1	0.90454	1.27977	0.86309	1.07021	0.87747
91q2	0.86970	0.99324	0.78711	1.01097	0.83481
91q3	0.79076	0.97790	0.72742	0.95661	0.80459
91q4	0.71292	0.89898	0.67095	0.88462	0.77312
92q1	0.64331	0.86549	0.65562	0.93481	0.83244
92q2	0.57623	0.85774	0.62700	0.86130	0.76592
92q3	0.54328	0.84742	0.59484	0.83307	0.69829
92q4	0.53672	0.85848	0.56807	0.80986	0.63116
93q1	0.56565	0.78027	0.59331	0.73551	0.61024
93q2	0.57869	0.76316	0.56853	0.74051	0.59702
93q3	0.58410	0.77220	0.54057	0.75440	0.58679
93q4	0.60846	0.80001	0.52708	0.76529	0.57241
94q1	0.62013	0.85038	0.45824	0.77880	0.59667
94q2	0.59909	0.87190	0.44917	0.76896	0.56673
94q3	0.58617	0.85180	0.43635	0.74136	0.53953
94q4	0.58072	0.85169	0.42008	0.73090	0.51649
95q1	0.58635	0.74758	0.38111	0.63772	0.47000
95q2	0.59570	0.75498	0.36968	0.62689	0.45572
95q3	0.60288	0.78507	0.35811	0.61476	0.42816
95q4	0.56550	0.79341	0.35098	0.62897	0.42177
96q1	0.43951	0.72044	0.42567	0.65056	0.46379
96q2	0.24080	0.55032	0.39267	0.63334	0.39910
96q3	0.17278	0.41731	0.35435	0.63150	0.35861
96q4	0.15308	0.37232	0.32064	0.55828	0.33679
97q1	0.11921	0.35484	0.22782	0.44260	0.40209
97q2	0.10318	0.33767	0.21402	0.41942	0.35328
97q3	0.07707	0.32408	0.20204	0.39700	0.33680
97q4	0.06261	0.31658	0.19095	0.39601	0.32478
98q1	0.04397	0.28819	0.30672	0.30934	0.15173
98q2	0.03173	0.22368	0.29444	0.29751	0.13563
98q3	0.02438	0.18676	0.28388	0.29001	0.11628
98q4	0.02635	0.16806	0.27750	0.28411	0.11256
99q1	0.02944	0.20599	0.11600	0.29738	0.09795
99q2	0.02397	0.19648	0.11200	0.25040	0.09492
99q3	0.02274	0.18663	0.10762	0.21741	0.11193
99q4	0.03040	0.17606	0.10121	0.19038	0.12230

Source: Author's calculations based on proprietary data from DATAQUEST, Inc.

Table A3. Worldwide Nominal Shipments of MOS Memory Devices
(thousands of dollars)

		DRAM	SRAM	EPROM	OTHER
91 q	1	1644725	596927	378601	328027
91 q	2	1617883	604197	372471	379817
91 q	3	1672352	643032	336399	459999
91 q	4	1669989	644864	349036	534781
92 q	1	1949566	696622	292843	451364
92 q	2	2016150	714642	326468	482509
92 q	3	2199226	741738	316658	578184
92 q	4	2358005	737713	311754	661911
93 q	1	2587181	727060	304839	648092
93 q	2	3033703	837952	337744	779764
93 q	3	3567432	882950	353135	979120
93 q	4	3952027	847395	353882	1074591
94 q	1	4431633	822165	373448	925429
94 q	2	5362752	882633	382392	879980
94 q	3	6276922	990620	323870	987375
94 q	4	7345981	1058872	308470	1097784
95 q	1	8014834	1224892	334643	1072318
95 q	2	9544862	1518808	380673	1141456
95 q	3	10805591	1555278	343454	1409723
95 q	4	12467465	1773845	326366	1543702
96 q	1	9968980	1506514	324589	1314932
96 q	2	5945874	1301360	335052	1180001
96 q	3	4570186	1009045	234884	1247309
96 q	4	4647148	928150	208452	1295735
97 q	1	4672817	793342	190516	1183455
97 q	2	5197474	893831	190802	1255868
97 q	3	5504164	1063065	182233	1237759
97 q	4	4423668	1092245	176747	1277109
98 q	1	3592660	1105640	153955	1118726
98 q	2	2850987	957372	136223	1096883
98 q	3	3250753	894800	109652	1062461
98 q	4	4316359	936678	122178	1287674
99 q	1	4676241	1063097	119165	1178048
99 q	2	4292581	1078161	120612	1378512
99 q	3	4914244	1163833	117718	1681730
99 q	4	6830781	1357074	129138	2185195

Source: Author's calculations based on SIA's WSTS survey.

Table A4. Price Index and Nominal Shipments for Microprocessors (thousands of dollars)

	Intel	Worldwide Nominals	
	Price Index	Total	Embedded
93q1	1.0000	2,067,163	116,629
93q2	0.9620	2,116,777	125,791
93q3	0.9080	2,176,177	153,216
93q4	0.8100	2,229,569	153,696
94q1	0.7670	2,591,130	173,502
94q2	0.6900	2,667,331	196,543
94q3	0.5810	2,715,836	191,454
94q4	0.4860	3,021,189	200,507
95q1	0.3790	3,619,841	255,592
95q2	0.2940	3,528,236	349,375
95q3	0.2250	3,412,064	373,525
95q4	0.1750	3,718,451	359,540
96q1	0.1290	4,011,002	416,669
96q2	0.0986	3,881,352	462,456
96q3	0.0806	4,608,572	379,410
96q4	0.0765	6,029,070	507,696
97q1	0.0657	6,299,936	473,183
97q2	0.0512	5,680,634	437,011
97q3	0.0387	5,535,553	502,201
97q4	0.0302	5,950,806	598,598
98q1	0.0213	5,280,009	397,315
98q2	0.0156	5,449,305	441,612
98q3	0.0117	6,552,289	528,012
98q4	0.0098	7,494,042	635,748
99q1	0.0079	6,777,190	465,266
99q2	0.0061	5,902,013	572,748
99q3	0.0047	6,805,851	586,976
99q4	0.0038	7,706,351	713,982

Sources:

Index: Aizcorbe, Corrado and Doms (2000)--col (1), table 12
Worldwide nominals: obtained from SIA's WSTS survey
Embedded: Author's calculation based on data from SIA
(Shares from SIA's Microprocessor Report applied
to WSTS revenues for MPUs)

Table A5. Price Indexes Used for MOS Logic and Microcomponents

	92	93	94	95	96	97	98	99
MOS MICRO								
MPU								
Non-embedded	|---ACD fisher---|							|
Embedded	-	-	-	-	|---DQ geo mean----|			
MCU	-	-	-	-	|------DQ fisher------|			
DSP					|------DQ fisher------|			
MPR	-	-	-	-	-	-	-	-
MOS LOGIC								
GENERAL PURPOSE LOGIC (GPL)	|---DQ geo mean---|							
GATE ARRAY (GA)	|---DQ geo mean---|							
STANDARD CELL (STDCELL)	|-----DQ geo mean-----|				-	-	-	-
FIELD PROGRAMMABLE LOGIC (FPL)	|-DQ geo mean--|			-	-	-	-	-
OTH SPECIAL PURPOSE LOGIC	-	-	-	-	-	-	-	-

Table A6. MOS Microcomponents and Logic Chips

Annual Price Indexes and World Nominal Shipments, 1990-99

	MCU	DSP	GPL	GA	STDCELL	FPL	OTHER
Annual Price Deflators							
1990			1.0000	1.0000	1.0000	1.0000	
1991			0.9763	0.8697	0.8473	0.9525	
1992			0.9328	0.8160	0.7525	0.6764	
1993			1.0178	0.7327	0.7970	0.5667	
1994			1.3652	0.6575	0.6453	0.4730	
1995			1.1903	0.6266	0.6021		
1996	1.0000	1.0000	1.0563	0.5326	0.5118		
1997	0.8370	0.8520	0.9292	0.4961	0.4778		
1998	0.6905	0.7458	0.8390	0.2607	0.3080		
1999	0.6035	0.7309	0.7602	0.2135	0.2540		
Nominal World Shipments							
1991	4514639	337262	1120924	2457948	1485764	463433	3732286
1992	4798589	446571	1075174	2540187	1311666	662455	3742311
1993	5885742	674626	1439934	3117811	1610120	958851	4731000
1994	7275709	1000675	1834927	3874187	2721695	1117529	5980724
1995	9006893	1728902	2255708	4849436	3637455	1646591	7391844
1996	9028803	2406635	1935779	4419165	4688959	1658372	5873549
1997	9408496	3214407	2370346	3960484	6334082	2042644	6339915
1998	8618673	3497151	1903682	3021871	5382377	2174336	6082147
1999	9696421	4386769	2171104	2463899	7332577	2899540	8291347

Source: Indexes: Author's calculations based on proprietary data from DATAQUEST.
Nominal World Shipments are SIA's WSTS shipments series.

Title A7 Price Indexes for Other Integrated Circuits and Discrete Devices

		Other Integrated Circuits		Discrete Devices				
		Bipolar	Analog	Small Trans.	Power Trans	Diodes/Recs	Opto-LEDs	Thyristors
Jan	92	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
Feb	92	1.05495	0.97337	1.00853	1.01468	0.88675	0.97885	0.71093
Mar	92	0.97011	0.99034	0.98080	0.99351	0.89003	0.93849	0.63799
Apr	92	0.99034	0.92281	0.96455	0.97442	0.86476	0.98140	0.65624
May	92	0.94738	0.96109	0.98170	0.95826	0.86933	0.95221	0.64750
Jun	92	0.98724	1.00244	1.01712	0.97248	0.87900	0.96279	0.62889
Jul	92	1.04713	0.99165	1.00401	0.95376	0.88855	1.00377	0.66767
Aug	92	1.00737	1.01341	1.01554	0.94191	0.89225	1.00764	0.68618
Sep	92	1.13236	1.07617	1.07834	0.97668	0.94887	1.07188	0.66760
Oct	92	1.03261	1.08119	1.04872	0.95331	0.95203	1.07839	0.67659
Nov	92	1.00281	1.03626	0.99203	0.93361	0.88486	1.06279	0.66832
Dec	92	0.95200	1.07268	1.01032	0.94684	0.87654	1.01656	0.62504
Jan	93	1.00196	1.08199	0.99896	0.92911	0.87266	1.03665	0.63686
Feb	93	0.95908	1.02670	1.00489	0.92286	0.87273	1.03516	0.66564
Mar	93	0.98323	1.08869	1.04187	0.94882	0.87427	1.05946	0.68187
Apr	93	1.06346	1.09890	1.04561	0.97455	0.90870	1.03747	0.65933
May	93	1.08126	1.05239	1.08575	0.94566	0.89887	0.98605	0.67587
Jun	93	1.10058	1.11894	1.09670	0.97143	0.90513	1.00220	0.64459
Jul	93	1.11570	1.07953	1.03525	0.96936	0.87903	0.98558	0.68067
Aug	93	1.15082	1.08572	1.06708	0.97797	0.89629	1.03859	0.68171
Sep	93	1.14975	1.09359	1.09016	0.99392	0.91278	1.03226	0.78162
Oct	93	1.20928	1.12002	1.05604	0.98704	0.92518	1.00503	0.68317
Nov	93	1.19269	1.07007	1.01185	0.96048	0.90378	1.01311	0.70260
Dec	93	1.14395	1.08931	1.04021	0.97262	0.90274	0.97192	0.59634
Jan	94	1.16727	1.10255	1.00815	0.97383	0.88755	0.98728	0.65786
Feb	94	1.17341	1.10717	1.01749	1.02181	0.90451	1.00372	0.73800
Mar	94	1.08670	1.15051	1.05084	0.97819	0.91394	1.05145	0.64902
Apr	94	1.14634	1.16008	1.02209	0.96256	0.91977	1.01689	0.65725
May	94	1.09138	1.13585	1.04698	0.96086	0.85272	1.01955	0.63319
Jun	94	1.14728	1.14875	1.07136	0.98016	0.91182	1.04370	0.64008
Jul	94	1.12434	1.18426	1.07926	1.01426	0.92101	1.03499	0.73663
Aug	94	1.10781	1.16237	1.08174	1.00259	0.90974	1.01526	0.72678
Sep	94	1.09729	1.21899	1.11989	1.02066	0.94267	1.00515	0.81400
Oct	94	1.14349	1.22298	1.08319	1.04455	0.93518	1.00539	0.71057
Nov	94	1.13206	1.20106	1.07846	1.00934	0.93438	1.00505	0.69059
Dec	94	1.11060	1.21605	1.07958	0.98166	0.93758	0.99969	0.62384
Jan	95	0.99807	1.21540	1.09602	1.00078	1.02593	1.01336	0.65958
Feb	95	1.07518	1.17977	1.06825	1.00892	1.02893	1.01760	0.65816
Mar	95	1.01758	1.24654	1.12111	1.05591	1.06207	1.05977	0.63426
Apr	95	1.05958	1.29439	1.16011	1.10662	1.10321	1.11100	0.67607
May	95	1.13071	1.26904	1.15837	1.05029	1.06105	1.10675	0.66805
Jun	95	1.25339	1.28165	1.11337	1.08396	1.08361	1.07499	0.70975
Jul	95	1.11126	1.28452	1.07550	1.02299	1.08434	1.08279	0.63614
Aug	95	1.12525	1.20299	0.99819	0.98593	0.98355	1.03065	0.59631
Sep	95	1.14202	1.22664	0.99519	0.95519	0.99782	1.05297	0.58785
Oct	95	1.03539	1.26685	1.04218	0.96366	0.99244	0.97894	0.57269
Nov	95	1.01146	1.23645	1.03195	0.93959	0.97001	0.99598	0.61216
Dec	95	1.08294	1.24044	1.05238	0.92503	1.05278	0.97586	0.44491

Title A7 Price Indexes for Other Integrated Circuits and Discrete Devices (cont.)

		Other Integrated Circuits		Discrete Devices				
		Bipolar	Analog	Small Trans.	Power Trans	Diodes/Recs	Opto-LEDs	Thyristors
Jan	96	0.92372	1.26784	1.01557	0.93990	0.93559	0.99087	0.58017
Feb	96	1.01897	1.23321	1.03528	0.88994	0.95650	0.99165	0.62619
Mar	96	1.02567	1.29686	1.06934	0.88972	0.93791	0.98635	0.48753
Apr	96	0.99790	1.33185	1.02589	0.85596	0.91671	1.00918	0.48833
May	96	1.05356	1.25596	1.00226	0.88585	0.87621	0.99158	0.63399
Jun	96	0.96129	1.32733	1.03812	0.87886	0.88568	0.97448	0.46909
Jul	96	0.98798	1.29759	1.01227	0.88846	0.85729	0.94712	0.58040
Aug	96	0.92718	1.24390	0.98745	0.83338	0.83093	0.90964	0.64368
Sep	96	0.88931	1.28224	0.99075	0.82317	0.83704	0.93048	0.46779
Oct	96	0.71720	1.31573	0.99910	0.80900	0.80860	0.88929	0.65669
Nov	96	0.80846	1.23608	1.03701	0.78492	0.84810	0.90053	0.60771
Dec	96	0.96109	1.24722	0.94567	0.78605	0.79244	0.86241	0.45676
Jan	97	0.71999	1.29130	0.92195	0.78073	0.74724	0.85316	0.53956
Feb	97	0.72426	1.20840	0.88380	0.75417	0.73893	0.76539	0.97728
Mar	97	0.67966	1.20698	0.85928	0.73139	0.73678	0.77764	0.56056
Apr	97	0.71670	1.25093	0.81390	0.71171	0.72276	0.73679	0.57301
May	97	0.71847	1.20110	0.82122	0.72308	0.74128	0.74420	0.85632
Jun	97	0.80476	1.20065	0.85531	0.71142	0.75975	0.76310	0.57251
Jul	97	0.74080	1.16867	0.83380	0.70101	0.74188	0.77635	0.68601
Aug	97	0.74455	1.12185	0.80894	0.70512	0.71782	0.75225	0.62733
Sep	97	0.77712	1.17722	0.79351	0.71555	0.73321	0.77882	0.54098
Oct	97	0.73624	1.20861	0.82487	0.70521	0.70099	0.71816	0.79346
Nov	97	0.75697	1.13519	0.78406	0.67865	0.67382	0.70559	0.59996
Dec	97	0.76948	1.15847	0.76501	0.67327	0.68982	0.71788	0.59387
Jan	98	0.77535	1.17388	0.74255	0.66019	0.66311	0.71190	0.73338
Feb	98	0.73028	1.08456	0.76628	0.65476	0.65949	0.71026	0.67817
Mar	98	0.67727	1.13571	0.75323	0.63788	0.70365	0.71768	0.60164
Apr	98	0.70003	1.17066	0.73064	0.65459	0.62092	0.69165	0.61521
May	98	0.69938	1.08686	0.69968	0.66578	0.63287	0.68806	0.52972
Jun	98	0.69229	1.08759	0.67465	0.65335	0.63547	0.69063	0.48334
Jul	98	0.76640	1.09790	0.66165	0.67974	0.60889	0.69545	0.59139
Aug	98	0.73081	1.03350	0.64891	0.62314	0.59910	0.65485	0.50921
Sep	98	0.62886	1.08079	0.68699	0.62269	0.63232	0.67430	0.55737
Oct	98	0.77114	1.11689	0.71430	0.66405	0.67223	0.75574	0.59186
Nov	98	0.74169	1.05008	0.69919	0.60870	0.65861	0.73599	0.55969
Dec	98	0.68570	1.11526	0.73028	0.62315	0.67674	0.72620	0.47665
Jan	99	0.77701	1.08515	0.75480	0.63655	0.67055	0.72561	0.47713
Feb	99	0.70499	1.03405	0.74058	0.67567	0.66292	0.70960	0.47736
Mar	99	0.72604	1.05485	0.69943	0.67503	0.64119	0.69985	0.41321
Apr	99	0.90258	1.04774	0.68240	0.64172	0.62115	0.67383	0.44424
May	99	0.89238	1.04852	0.67943	0.65616	0.58613	0.63565	0.46097
Jun	99	0.97066	1.07268	0.64899	0.64973	0.61070	0.66828	0.38455
Jul	99	1.04170	1.05872	0.64865	0.63555	0.58357	0.62987	0.41292
Aug	99	1.12788	1.05045	0.67668	0.63911	0.59451	0.64753	0.41517
Sep	99	1.13965	1.09584	0.69349	0.66492	0.63512	0.68114	0.38511
Oct	99	1.03753	1.08823	0.71106	0.65595	0.62076	0.67006	0.40564
Nov	99	0.88370	1.06893	0.71103	0.63206	0.61081	0.69550	0.37701
Dec	99	0.96389	1.10499	0.69220	0.65661	0.63553	0.74744	0.38226

Source: Author's calculations based on proprietary data from Semiconductors Industries Association

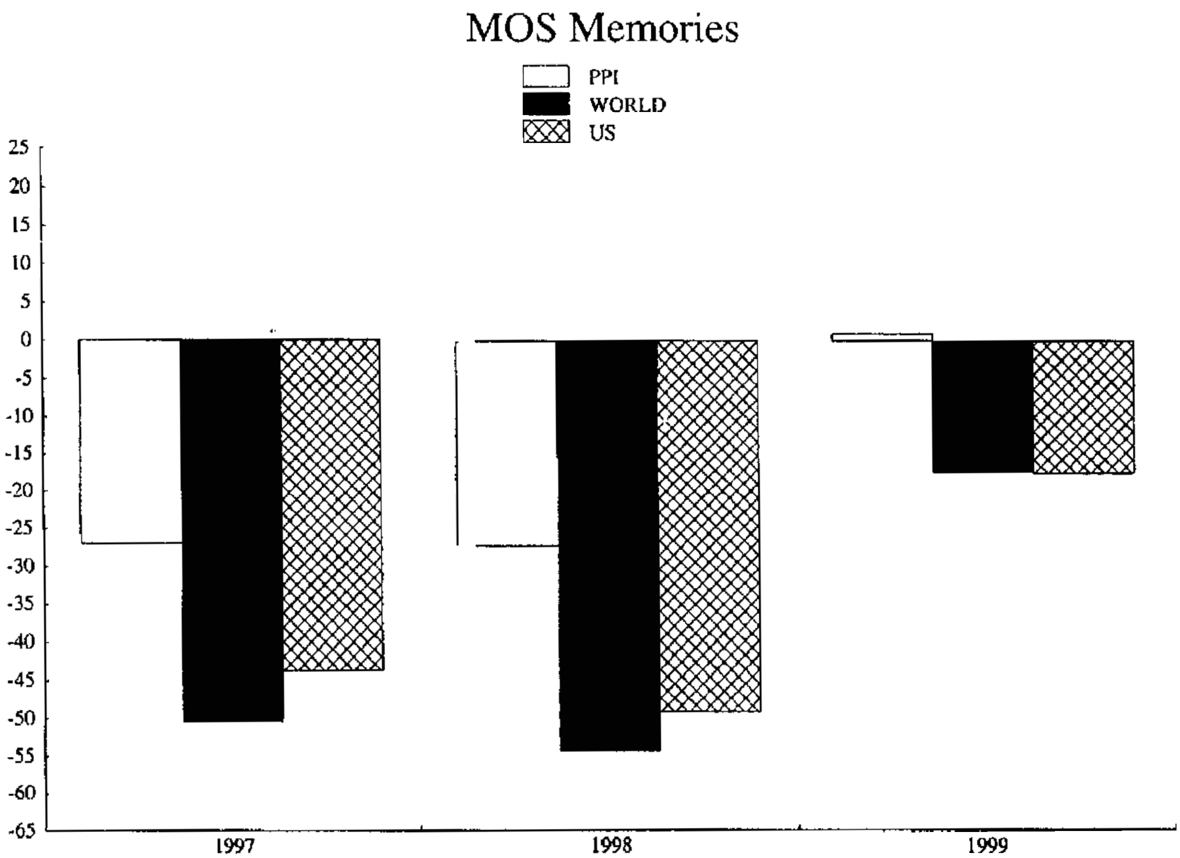
Table A8. WSTS Worldwide Nominal Shipments for Semiconductor Devices (thousands of dollars)

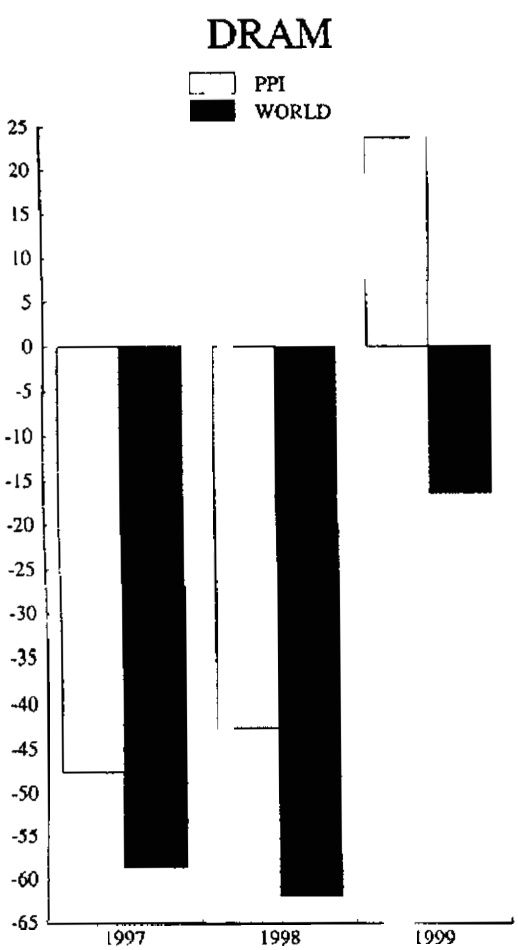
		MOS Memories		MOS Micro/Logic							
	Bipolar	DRAM	MEMxDRAM	MPU	LogicxMPU	Analog	Sm. Trans.	Power Trans	Diodes/Recs	LEDs	Thyristors
92 q 1	780779	1949566	1440829	1117277	4105243	2005724	426469	625752	593510	559222	134319
92 q 2	780485	2016150	1523619	1083794	4321540	2149636	443986	644688	585216	552514	131375
92 q 3	787745	2199226	1636580	1363164	4690261	2303512	470768	687591	616694	614189	134728
92 q 4	798440	2358005	1711378	1896024	4665148	2269815	442097	671788	589219	571453	126720
93 q 1	766626	2587181	1679991	2067163	4782507	2312645	439668	685548	608409	573435	130520
93 q 2	795672	3033703	1955460	2116777	5575626	2726191	505931	761328	670427	662255	146561
93 q 3	813916	3567432	2215205	2176177	6036707	2840058	527645	797427	713364	724894	155746
93 q 4	773638	3952027	2275868	2229569	5944653	2794125	506704	771241	692238	693534	154394
94 q 1	703483	4431633	2379946	2591130	6054821	2974677	520084	797412	708899	712699	163651
94 q 2	727218	5362752	2432209	2667331	6916078	3403248	598422	921351	797282	804671	173698
94 q 3	653139	6276922	2602900	2715836	7465219	3546455	651324	968684	833980	852549	184291
94 q 4	689825	7345981	2752424	3021189	7917529	3660789	662735	1017461	874646	868468	185139
95 q 1	636728	8014834	2928091	3619841	8497652	3811916	737967	1151696	957542	965644	191847
95 q 2	765009	9544862	3369315	3528236	9966339	4392447	926551	1346619	1086498	1153978	219169
95 q 3	712382	10805591	3654945	3412064	10055203	4309055	867781	1359169	1079498	1146573	210629
95 q 4	659759	12467465	4015142	3718451	10379169	4132935	776720	1324084	1031256	1077366	185278
96 q 1	542706	9968980	3424623	4011002	10097856	4112303	731743	1321475	1025579	1058177	192251
96 q 2	469282	5945874	3074815	3881352	10101117	4250916	701681	1306113	982626	1053034	185895
96 q 3	452324	4570186	2758689	4608572	10346549	4218746	729284	1201378	931940	1029084	177261
96 q 4	461348	4647148	2713640	6029070	10877773	4461840	722162	1107102	934769	1006455	182371
97 q 1	414936	4672817	2455578	6299936	10874076	4388187	670669	1168838	926476	1013475	202598
97 q 2	424059	5197474	2658291	5680634	11412864	4863964	704042	1285973	1000611	1104135	225347
97 q 3	388650	5504164	2808223	5535553	11759069	5174105	716575	1331019	1023760	1227580	225941
97 q 4	366374	4423668	2850718	5950806	11301285	5362683	665647	1297789	999219	1160739	251770
98 q 1	338456	3592660	2457640	5280009	10536125	4940026	607527	1181246	962494	1161185	258525
98 q 2	281161	2850987	2190478	5449305	9962080	4763431	596320	1133941	895458	1136880	215718
98 q 3	230900	3250753	2066913	6552289	10059798	4576185	578923	1111481	847380	1127614	194452
98 q 4	249195	4316359	2346530	7494042	10564448	4793313	591530	1190296	903968	1193764	174846
99 q 1	209483	4676241	2360310	6777190	10024142	4767060	620115	1210163	890228	1236013	157814
99 q 2	244098	4292581	2577285	5902013	10606395	5125587	632800	1261647	952438	1308651	163600
99 q 3	289179	4914244	2963281	6805851	11772374	5710442	705609	1403431	1026177	1544362	162583
99 q 4	247540	6830781	3671407	7706351	12995978	6478612	794085	1528925	1146004	1688768	178029

Source: Author's calculations based on SIA's WSTS shipments series.

Chart 1. Price Indexes for MOS Memory Chips

(Percent change, annual rate)





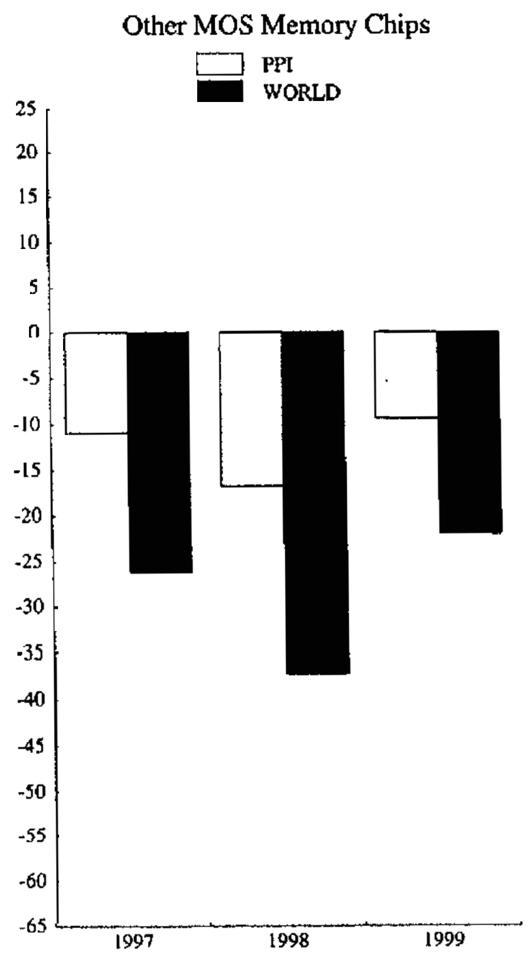
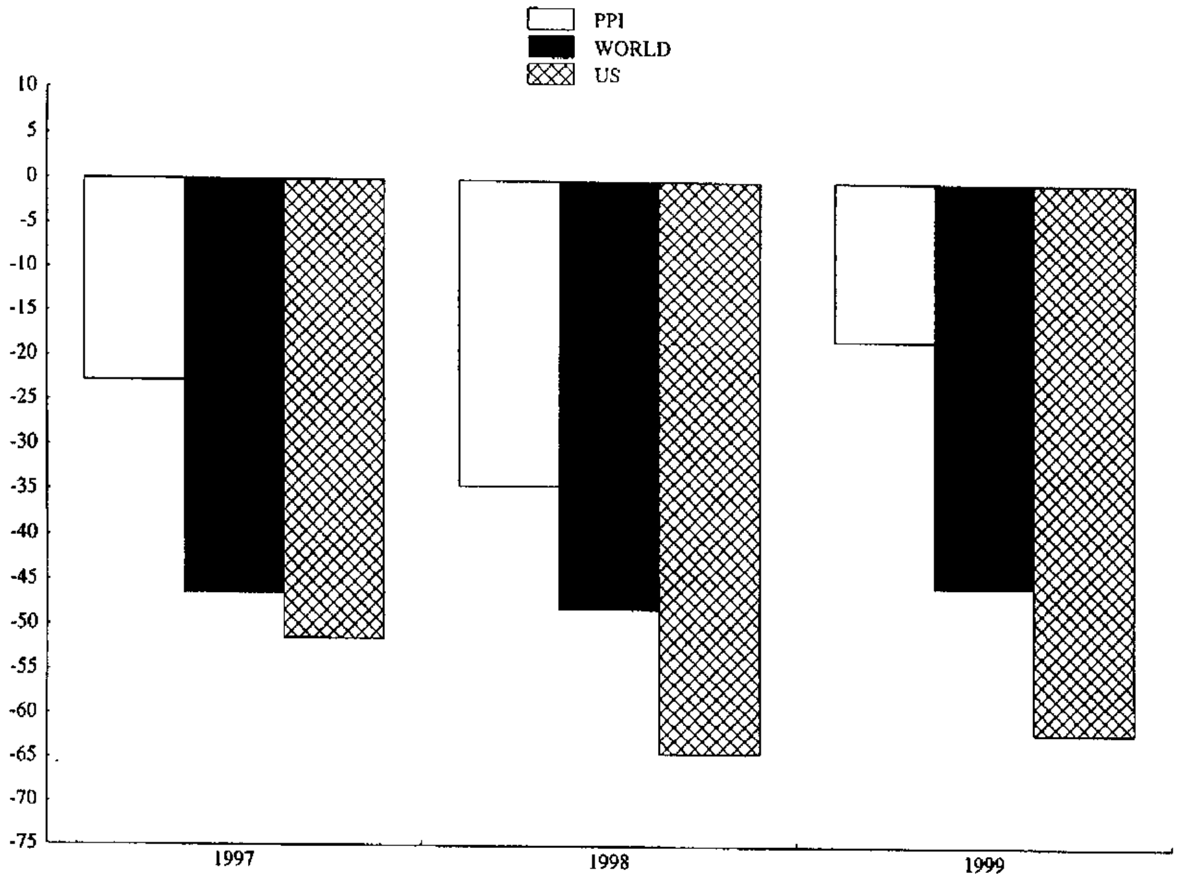
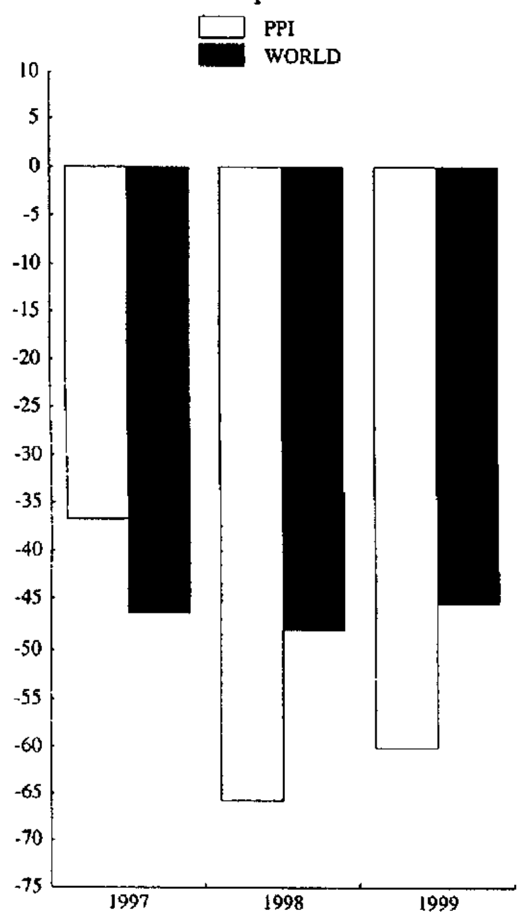


Chart 2. Price Indexes for MOS Logic and Microcomponents

(Percent change, annual rate)



Microprocessors



Other MOS Logic

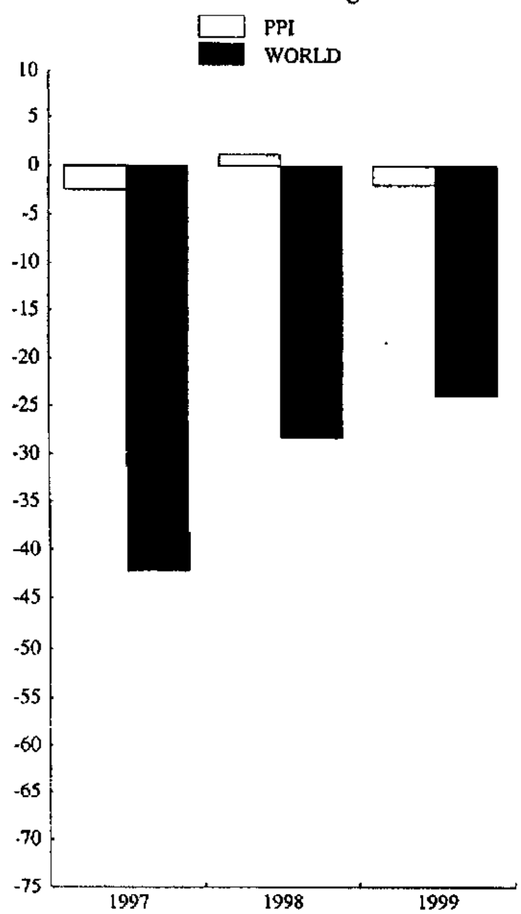


Chart 3. Price Indexes for Other Integrated Circuits

(Percent change, annual rate)