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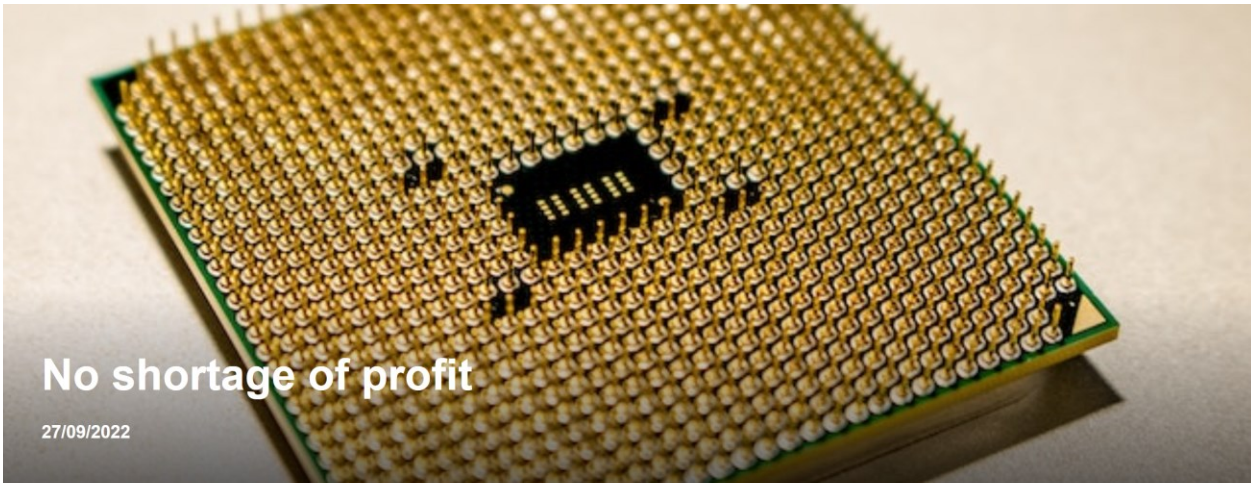
No Shortage of Profit:

Semiconductor firms and the differential effects of chip shortages

by Christopher Mouré



I

Few will argue with the claim that shortages are socially harmful. Shortages, by definition, imply a lack of something – not enough stuff to go around. A shortage of food implies hunger; a shortage of electricity implies darkness. But are shortages harmful to everyone *equally*? And if they are not, does this mean that shortages can also be *good for some*?

As the US government is preparing—via the CHIPS Act—to hand semiconductor firms around 50 billion USD to help solve the ongoing shortage of semiconductors, it seems worth asking how we arrived at this particular shortage, and whether the answers to the above questions can help us avoid such shortages in the future.

Over the past year, I looked into the business of semiconductors. Particularly, I examined the historical relationships between chip production, chip prices, shortages, and profits. I made some surprising findings.

First, there is an inverse correlation between the expansion of chip production and changes in prices in the US. This means that when production growth slows down, so does the rate at which chip prices fall. Second, among the largest semiconductor firms, there is an inverse correlation between the rate of new investment and differential earnings, (that is, earnings relative to those of other large firms). Third, there is a close relationship between the appearance of a semiconductor shortage and the differential profitability of these large firms. This relationship has two salient characteristics. First, shortages tend to appear immediately following a period in which dominant firms trail, rather than beat, average profitability. Second, dominant firms tend to beat average profitability during years in which a shortage appears. In short, chip shortages do not appear to occur by accident.

II

How do large chip producers profit from shortages? The logic is simple. By constraining production, chip producers can increase prices. The following three figures provide evidence of this.

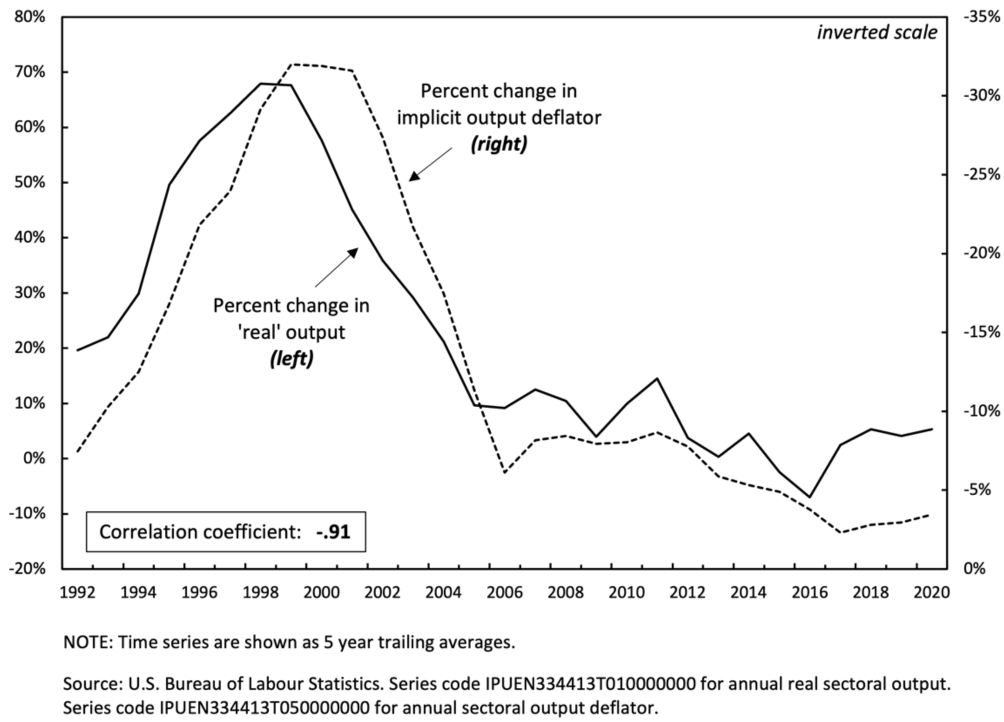


Figure 1. Percent change in 'real' output and percent change in prices, U.S. semiconductor manufacturing

Figure 1 compares the rate of change in US semiconductor production volume and the rate of change of the sector's price deflator.[1] It shows a very tight negative correlation between change in output volume and change in price (-.91, note the inverted right scale). The correlation implies that semiconductor price changes have an inverse relation to changes in production volume. In other words, *the greater the constraints on new chip production, the higher the price of chips can potentially rise*.

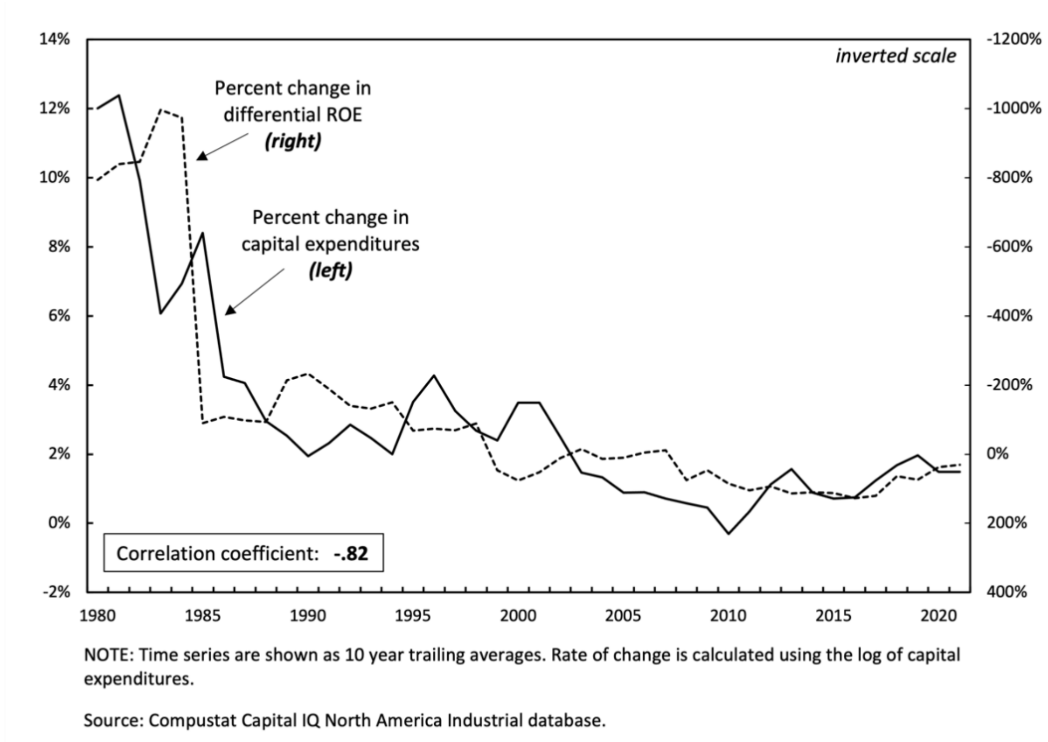


Figure 2. Percent change in differential return on equity and percent change in capital expenditures, Dominant Semiconductor Capital

Where Figure 1 looked at production and prices, Figure 2 compares changes in investment with changes in the rate of profit. To be specific, it compares the rate of change in differential profitability to the rate of change in capital expenditures for the top ten US-listed semiconductor manufacturing firms, a group I label "Dominant Semiconductor Capital." [2]

Rather than measure absolute levels, the figure measures these two factors differentially – relative to the average large US firm. The logic of using a differential measure is that firms tend to judge their own performance relative to the broader business landscape. Thus, differential measures are a more relevant guide to firm behaviour than absolute measures. All firms share a common goal—profit—and investors invest in the firms they think will offer the highest future returns relative to all other available investments. Thus, investors and managers must constantly make comparisons, and a common way they do this is by reference to a benchmark average.

Figure 2 also shows a significant negative correlation (-0.82, again note the inverted right scale). When the rate of new investment slows or decreases, dominant firms tend to increase their differential earnings. This suggests that by strategically limiting production (i.e., by creating more 'scarcity'), dominant semiconductor firms may be able to charge higher prices for their products. Conversely, if production expands too quickly, they are liable to lose control of pricing, resulting in lower relative prices and lower relative profits, and often, lower differential returns. [3]

Interestingly, the fact that the relationship in Figure 2 is negative is counter-intuitive from the perspective of neoclassical economic theory. According to neoclassical economics, profit is a 'cost' of production, and therefore profit should increase faster with a more rapid increase in production, and vice versa when production decelerates. In addition, both profit and production should increase when there is an increase in 'demand'. Thus, according to neoclassical theory, in a perfectly competitive market, the growth of profit and production are likely to move together. However, whereas neoclassical economics focuses on absolute profit growth, in a landscape of shifting prices and antagonistic business relations, what matters is not absolute but relative return on investment.

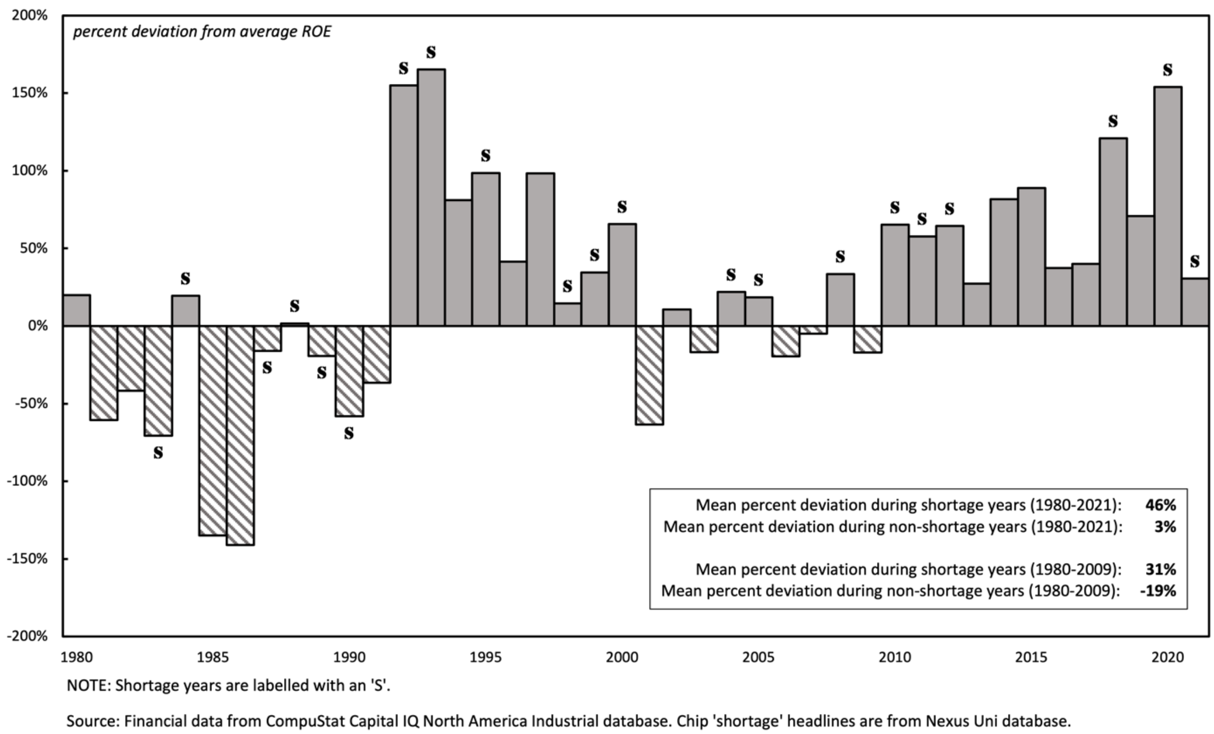


Figure 3. Differential profitability and semiconductor 'shortages', Dominant Semiconductor Capital [4]

Figure 3 compares the differential return on equity of Dominant Semiconductor Capital during shortage and non-shortage years. [5] The shaded areas denote 'danger zones' when Dominant Semiconductor Capital experienced differential decumulation.

A 'danger zone' is an uninterrupted period of a year or more in which Dominant Semiconductor Capital trailed the average return on equity. *All but one* danger zone in the figure ended with a perception of a 'shortage' the following year. In other words, the change in fortune from trailing to beating the average is almost always accompanied by the appearance of a shortage.

In addition, firms are more likely to differentially accumulate during 'shortage' years. Shortages accompanied 61% of years in which Dominant Semiconductor Capital exceeded average profitability, whereas shortages coincided with only 28% of years of below average profitability. There are also large differences in the level of differential profitability. From 1980 to 2021, Dominant Semiconductor Capital exceeded the benchmark by an average of *46%* during shortage years. During non-shortage years, Dominant Semiconductor Capital only just met the benchmark.

The above evidence suggests that there is a structural relationship between the strategic limitation of chip production, differential profitability, and perceptions of a chip 'shortage'. It could be that a shortage is an unintended effect of 'over-shooting' collective constraints on chip production undertaken by Dominant Semiconductor Capital. Yet the periodic regularity of shortages and their correlation with increases in profitability suggest an alternative. Differential prices tend to generate resistance and reaction because they redistribute income. Because of this fact, the creation of an atmosphere of shortage likely plays a crucial role in *justifying* the rise in chip prices from which firms differentially profit.

III

Collusive price cooperation in the semiconductor business has a long history. In the 1980s, US chip producers faced increasing pressure from Japanese firms, who had developed cheaper, more reliable methods of producing the same chips. Unwilling or unable to compete, they turned to the US government. In turn, the US government placed immense pressure on the Japanese to reduce the production and export of chips. The resulting US-Japan Semiconductor Trade Agreement instituted price controls on Japanese semiconductors. Japanese producers cooperated, reducing production, and increasing prices. The immediate effect was a severe global chip shortage in the final years of the 1980s (and large profits for both US and Japanese firms). This was by no means the first chip shortage to occur. However, the outcome of this trade dispute resulted in the creation of a coordinated coalition of global chip producers and national governments, organized around the control of chip production levels in the service of controlling prices.[6] Since the 1980s, this coalition has shifted in both its power and its membership, adding new entrants, and losing others. Currently, concentration in the industry is again at an all-time high.

While semiconductor firm executives complain about the high price of building new production capacity, it is worth measuring these claims against their actions. Firms like Intel currently make record profits. The notion that these firms cannot technically afford new production capacity is obviously false. More importantly, if these firms differentially profit by strategically *limiting* the expansion of productive capacity, then the logic guiding their behaviour runs *counter* to the supposed aim of the CHIPS Act – which is to expand production. Therefore, it is unlikely that subsidizing those profits will solve the problem of periodic semiconductor shortages.

Endnotes

[1] Changes in the price deflator are a rough proxy for overall price change. The price deflator estimates how much of the change in the dollar value of production is a result of 'pure' price changes, as opposed to a change in 'real' output.

[2] I measure differential profitability as the percent deviation of Dominant Semiconductor Capital's return on equity from a benchmark average. I calculate the benchmark as the average return on equity of the 500 largest firms by market capitalization in the Compustat Capital IQ North America database. Return on equity is net income divided by total common equity. The measures for both Dominant Semiconductor Capital and the Compustat 500 are weighted group averages.

[3] The focus on dominant firms and on differential accumulation stems from my engagement with the theory of capital as power, developed by Jonathan Nitzan and Shimshon Bichler. For a greater elaboration of the concept of differential accumulation, see Nitzan, Jonathan. 1998. "Differential Accumulation: Towards a New Political Economy of Capital." *Review of International Political Economy* 5, no. 2: 169-216.

[4] This figure was inspired by the work of Jonathan Nitzan and Shimshon Bichler. They used a similar figure in their study of the differential accumulation of arms and oil producers in relation to Middle East

wars. See Figure 5.8, p.237 in: Nitzan, Jonathan, and Shimshon Bichler. 2002. *The Global Political Economy of Israel*. London: Pluto.

[5] I measure ‘shortage’ years by the appearance of news headlines announcing or commenting on ongoing semiconductor shortages. Information on sources was gathered through the online database Nexis Uni.

[6] A detailed account of this historical sequence can be found in Flamm, Kenneth. 1996. *Mismanaged Trade? Strategic Policy in the Semiconductor Industry*. Washington, DC: Brookings Institution.