

Consider two firms, Chipz and Comps-R-U. Chipz produces memory chips to be used in computers and sells them to Comps-R-U. Comps-R-U then builds the computers and sells them to consumers. The chips produced by Chipz are *specific* to Comps – in other words Chipz only produces chips compatible with the Comps’ computers and Comps can only use Chipz’ chips.

This question addresses whether or not Chipz has the incentive to make cost-reducing investments. There is a *hold-up problem* because the investment is *sunk* – once it is made it cannot be recovered – and because the firms negotiate on the price of chips once the investment is made, so part of the benefits will go to Comps. When they negotiate the sunk costs of investment are ignored and both firms know that Chipz will be willing to produce at any price that covers its production cost, *even if this does not cover the sunk investment cost*).

The demand for computers is very simple. If Chipz produces memory chips for Comps, Comps’ revenues are \$100 million. Comps’ cost is whatever price it agrees to pay Chipz for the memory chips. As usual, profit is revenues minus costs.

Chipz’ revenues are simply the price it gets from Comps and its costs are the production costs for the chips plus investments that Chipz makes to reduce its production costs. Chips can choose to invest \$0, \$5 million, \$10 million or \$15 million dollars streamlining its production of chips for Comps-R-U. Depending on the investment level chosen, the production cost for the chips is given by the following table. Assume that the investment made by Chipz once made, cannot be changed.

Investment	\$0	\$5 million	\$10 million	\$15 million
Production Cost	\$80 million	\$68 million	\$60 million	\$54 million

So, for example, if Chipz and Comps agree on a price of \$75 million for the memory chips, and Chipz invests \$10 million dollars, the profits for Chipz is \$5 million (\$75 million revenues - \$60 million production costs - \$10 million investment) and Comps profits are \$25 million (\$100 million revenues - \$75 million for Chipz).

1. What level of investment maximizes the *joint* profits of Chipz and Comps?

We can see that the marginal benefit to investment always exceeds the marginal costs. With \$0 investment the joint profit is \$20 million. The first \$5 million invested reduces costs by \$12 million, the second reduces costs by another \$8 million, the next by another \$6 million, so each \$5 million produces benefits at the margin and the efficient investment level is \$15 million.

2. Assume that Chipz chooses its investment first and then Chipz and Comps negotiate the price of the memory chips. Assume that when they negotiate, they split the gains from trade (ie. the difference between the chip production cost and the revenues from selling the computers). How much money will Chipz choose to invest (Hint – think of this as a 2-stage game and find the equilibrium. In the first stage the investment is made and in the second stage the price of chips is determined.)

If Chipz invests before negotiations over the price, Chipz will split any cost savings with Comps during the negotiations. As a result, Chipz will only invest \$5 million in cost savings and will negotiate a price of \$84 million. Comps profits will be \$16 million and Chipz profits will be \$11 million.

Thinking of this as a 2-stage game we need to solve for the second stage price and profits for each possible investment level at time 1 – i.e. find the equilibrium of the

second stage negotiation. Once we have this information we can view the game from the perspective of stage 1 and determine the optimal investment choice for Chipz:

Investment	\$0	\$5	\$10	\$15
Production Cost	\$80	\$68	\$60	\$54
Revenue	\$100	\$100	\$100	\$100
Total Profit Stage 2	\$20	\$32	\$40	\$46
Chip Price	\$90	\$84	\$80	\$77
Comps Profit	\$10	\$16	\$20	\$23
Chipz Profit Stage 1 = $\frac{1}{2}(\text{Total Profit}) -$ Investment	\$10	\$11	\$10	\$8

3. Now assume that Chipz and Comps negotiate a price of \$85 million prior to Chipz making the investment to reduce its costs. What investment will Chipz make now? Is the investment level chosen by Chipz sensitive to the negotiated price?

If Chipz and Comps negotiate a price of \$85 million prior to Chipz making the investment, Chipz benefits solely from any cost savings. In such a situation, Chipz would invest \$15 million and obtain profits of $\$85 - \$54 - \$15 = \16 million. The important thing to note is that, so long as Chipz benefits solely from any cost savings, it doesn't matter what the negotiated price is, Chipz will still choose to invest \$15 million. The only exception would be if the price was less than \$69 million, in which case Chipz would rather not make any chips since at this price the company only just breaks even with the most efficient investment level.

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Total Profit Stage 2	\$20	\$32	\$40	\$46
Chip Price	\$85	\$85	\$85	\$85
Comps Profit	\$15	\$15	\$15	\$15
Chipz Profit Stage 1 = $\frac{1}{2}(\text{Total Profit}) -$ Investment	\$5	\$12	\$15	\$16

4. How would part 1 and part 2 change if instead of Chipz making the investment, Comps had to make the investment? Still think of the investment as reducing Chipz production costs, but now the investment is made by Comps. An example of such an investment might be that Comps could design its computer such that it was easier for Chipz to make memory chips for it.

If Comps made the investment instead of Chipz, part 1 would not change. Comps would choose to invest \$5 million and make profits of \$11 million. Since the same surplus occurs in both cases and all that changes is who pays the cost of investment, the roles are just reversed with respect to payoffs, and Comps would choose exactly the same investment as Chips.

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In part 2, though, any cost-reducing investment only benefits Chipz. Thus, Comps has no incentive to reduce the production cost to Chipz unless Comps derives some sort of benefit from it. In the case of a fixed price contract Comps will make no investment because its benefits is fixed and its costs increase with investment. This is the extreme in which the benefits and costs of investment are completely separated and as a consequence, no investment takes place.

Incentives could be corrected by a cost-plus contract (e.g. where Chipz gets revenues equal to their costs plus a profit margin) or by vertical integration/merger. Both these options achieve the goal of making the returns to investment accrue to the agent incurring the costs – with cost-plus Chipz makes a fixed margin, but passes on the cost reduction to Comps with a lower chip price – as above the marginal benefit of investment is positive all the way up to \$15 million so we get the efficient outcome. The merger will also be efficient as we assume the merged firms maximizes the joint profits directly so the hold up problem disappears.