Consider a firm that produces widgets in the US but sells them only in the UK.

How are the profits of the firm affected if the dollar depreciates?

A depreciation of the dollar means $S_t^{\$/£}$ goes up, or $S_t^{£/\$}$ goes down.

Intuitively, how do you think this firm's profits should be affected if the dollar price of sterling rises?

Let's write out equations for the firm's profits.

Profits = Revenues – Costs

Revenues = (Price per unit) X Quantity Sold
Costs = (Cost per unit) X Quantity Sold

The quantity of widgets that our firm can sell depends on the price it charges (in pounds) relative to the overall UK price level:

$Q_t = Q\left(\frac{P_{Wt}^{£}}{P_t^{£}}\right)$. As $\frac{P_{Wt}^{£}}{P_t^{£}}$ rises, Q falls.

Revenue in dollar terms = $\underbrace{\left(P_{Wt}^{£} Q_t\right)}_{\text{Revenue in pounds}} S_t^{\$/£}$

We want to measure our profits not in dollar terms but in real terms, so we divide by the US price level:

Revenue in real terms: $\dfrac{S_t^{\$/£} P_{Wt}^{£} Q_t}{P_t^{\$}}$.

We can rewrite this as: $\underbrace{\left(\dfrac{S_t^{\$/£} P_t^{£}}{P_t^{\$}}\right)}_{\text{Real Exchange Rate}} \dfrac{P_{Wt}^{£}}{P_t^{£}} Q_t$, or simply $RS_t^{\$/£} \dfrac{P_{Wt}^{£}}{P_t^{£}} Q_t$.

The firm's revenue in real terms depends on the relative price it charges in the U.K., $\dfrac{P_{Wt}^{£}}{P_t^{£}}$, and on the real exchange rate, $RS_t^{\$/£}$.

A real depreciation of the dollar is an increase in $RS_t^{\$/£}$.

Let the dollar cost per unit of output be given by $C_t^{\$}$.

The total cost in real terms is given by: $\frac{C_t^{\$}}{P_t^{\$}} Q_t$.

Total profits for the exporting firm are:

$$PROF_t = RS_t^{\$/£} \frac{P_{Wt}^{£}}{P_t^{£}} Q_t - \frac{C_t^{\$}}{P_t^{\$}} Q_t.$$

We want to examine how a firm's profit is influenced by real exchange rate changes. In all of our "cases", let's assume that the real cost per unit, $\frac{C_t^{\$}}{P_t^{\$}}$, is unaffected by changes in $RS_t^{\$/£}$.

Let's also assume $P_t^{\$}$ and $P_t^{£}$ do not change.

Case 1: The firm sets a price in sterling, $P_{Wt}^{£}$. We could say that the firm follows a "local-currency pricing" strategy: It sets its price in the currency of the importer, and does not alter it when the real exchange rate changes.

How are profits affected in this case?

$$PROF_t = RS_t^{\$/£} \frac{P_{Wt}^{£}}{P_t^{£}} Q_t - \frac{C_t^{\$}}{P_t^{\$}} Q_t$$

In this case, $\frac{P_{Wt}^{£}}{P_t^{£}}$, and therefore Q_t are not affected. Since we assumed $\frac{C_t^{\$}}{P_t^{\$}}$ is not affected, then costs are not affected. But revenues rise or fall directly with increases or decreases in $RS_t^{\$/£}$.

Case 2: The firm follows a dollar pricing strategy. It sets a price, $P_{Wt}^{\$}$ in dollar terms. What happens to $\frac{P_{Wt}^{£}}{P_t^{£}}$ as the real exchange rate changes?

$$\frac{P_{Wt}^{£}}{P_t^{£}} = \frac{P_{Wt}^{\$}}{S_t^{\$/£}}\frac{1}{P_t^{£}} = \frac{P_{Wt}^{\$}}{P_t^{\$}}\frac{P_t^{\$}}{S_t^{\$/£}P_t^{£}} = \frac{P_{Wt}^{\$}}{P_t^{\$}}\frac{1}{RS_t^{\$/£}}.$$

That is, $\frac{P_{Wt}^{£}}{P_t^{£}}$ falls as $RS_t^{\$/£}$ rises. Profits are:

$$PROF_t = RS_t^{\$/£}\frac{P_{Wt}^{£}}{P_t^{£}}Q_t - \frac{C_t^{\$}}{P_t^{\$}}Q_t = \frac{P_{Wt}^{\$}}{P_t^{\$}}Q_t - \frac{C_t^{\$}}{P_t^{\$}}Q_t.$$

Are profits for the dollar pricing firm unaffected by real exchange rate fluctuations?

The answer is no.

An increase in $RS_t^{\$/£}$ makes $\frac{P_{Wt}^{£}}{P_t^{£}}$ fall. The firm's relative price in the U.K. falls. So demand for its product increases: Q_t rises.

Both a local-currency-pricing and a dollar-pricing firm should benefit from the real depreciation.

The local-currency-pricing firm has no change in $\frac{P_{Wt}^{£}}{P_t^{£}}$ and therefore no change in Q_t. But the dollar value (and real value) of revenue earned in the U.K. directly rises when $RS_t^{\$/£}$ rises.

The dollar-pricing firm is able to sell a greater quantity and make a greater profit.

We use the term "pass-through" to describe how the consumer's price changes when the exchange rate changes.

There is no pass-through of the exchange rate for a local-currency-pricing firm. $\frac{P_{Wt}^{£}}{P_t^{£}}$ is unaffected by the change in $RS_t^{\$/£}$.

We saw for the dollar pricing firm that $\frac{P_{Wt}^{£}}{P_t^{£}} = \frac{P_{Wt}^{\$}}{P_t^{\$}} \frac{1}{RS_t^{\$/£}}$. Or we could write $\frac{P_{Wt}^{£}}{P_t^{£}} = \frac{P_{Wt}^{\$}}{P_t^{\$}} RS_t^{£/\$}$. There is full 100% pass-through of an increase in $RS_t^{£/\$}$ to $\frac{P_{Wt}^{£}}{P_t^{£}}$.

But are either zero pass-through or 100% pass-through optimal pricing strategies?

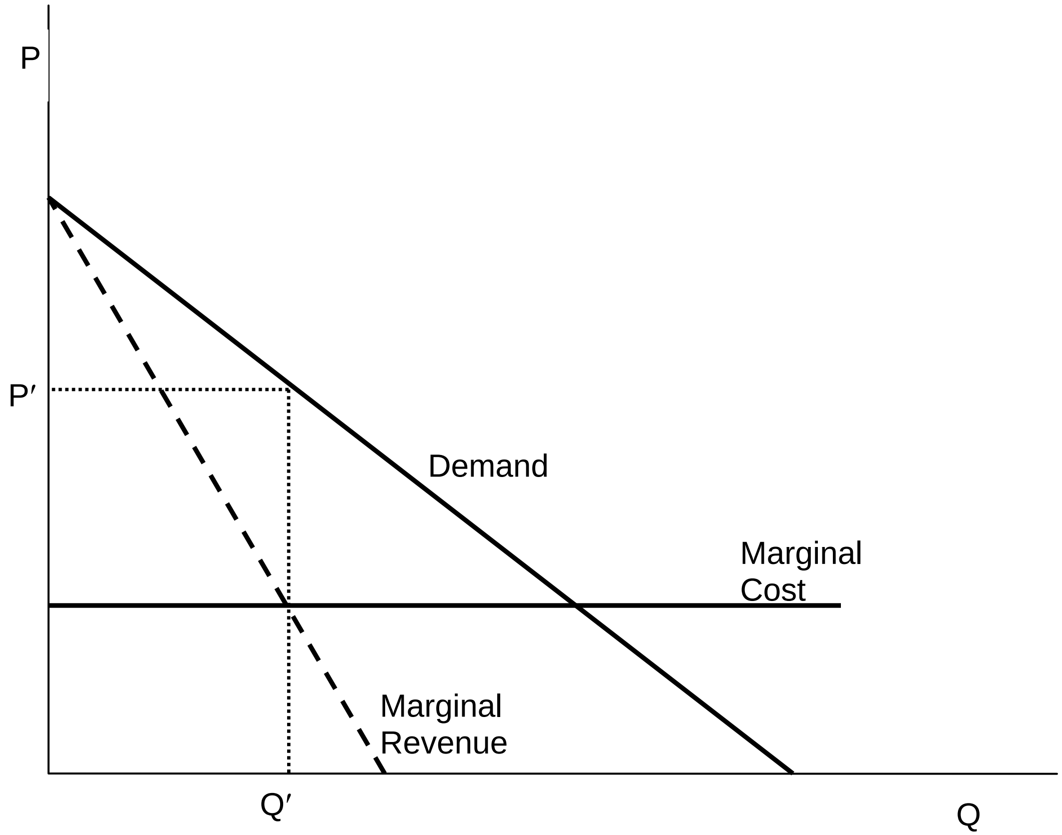
Maybe some intermediate scheme is better.

Case 3: Optimal pricing firm.
Review optimal pricing:

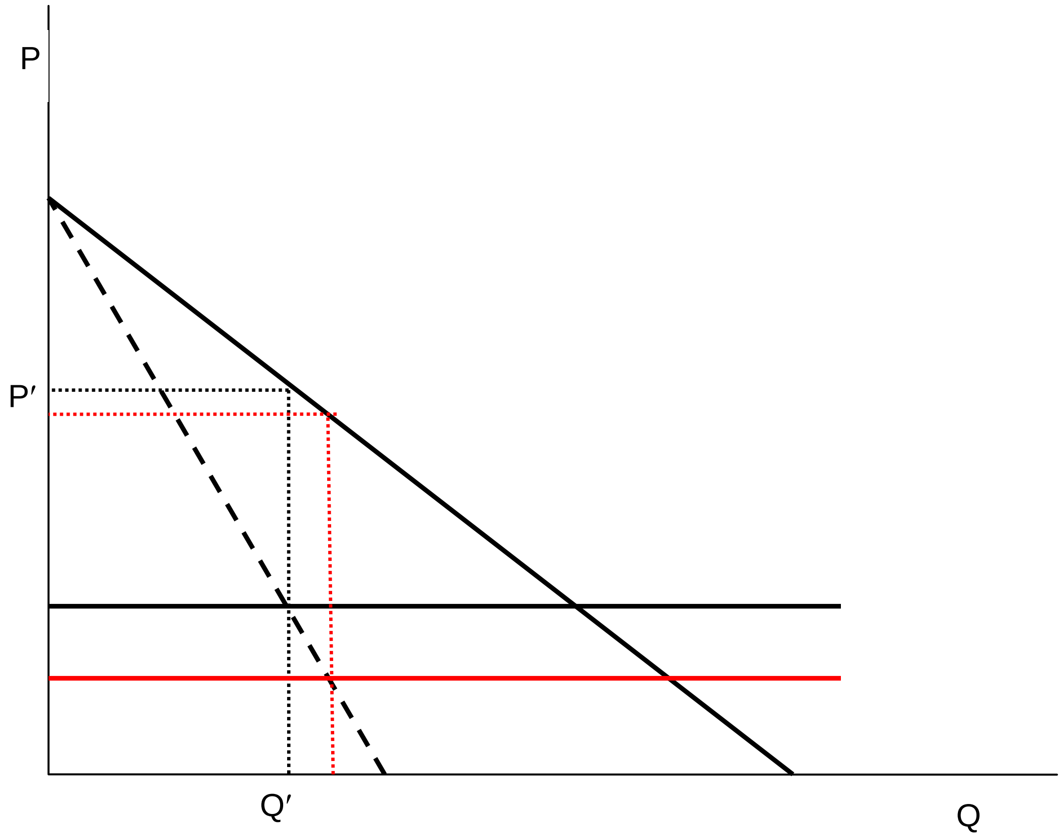
Firm produces up to the point where

marginal revenue = marginal cost.

It charges the appropriate price given by the demand curve:


P
P′
Demand
Marginal
Cost
Marginal
Revenue
Q′
Q

A reduction in marginal cost leads to a less than proportionate reduction in price:



Now let's reconsider the case of the American firm exporting to the U.K. We have been looking at the firm's profits in real U.S. terms:

$$PROF_t = RS_t^{\$/£} \frac{P_{Wt}^{£}}{P_t^{£}} Q_t - \frac{C_t^{\$}}{P_t^{\$}} Q_t$$

We can get the profits in real U.K. terms by dividing through by the real exchange rate:

$$PROF_t^{UK} = \frac{P_{Wt}^{£}}{P_t^{£}} Q_t - \frac{1}{RS_t^{\$/£}} \frac{C_t^{\$}}{P_t^{\$}} Q_t$$

It should not matter what units we express profits in. If the firm maximizes profits in terms of the US consumption basket, it does so in terms of the UK basket as well.

It is easier to look at this problem from the U.K. standpoint. That is, we can think of it as a U.K. subsidiary firm that imports inputs from the U.S.

A real ***depreciation*** of the U.S. dollar is the same as a real ***appreciation*** of the U.K. pound. That is, an increase in $RS_t^{\$/£}$ is the same as a drop in $RS_t^{£/\$}$.

A real appreciation of the pound lowers the cost of imported inputs, and raises profits:

$$PROF_t^{UK} = \frac{P_{Wt}^{£}}{P_t^{£}} Q_t - \frac{1}{RS_t^{\$/£}} \frac{C_t^{\$}}{P_t^{\$}} Q_t = \frac{P_{Wt}^{£}}{P_t^{£}} Q_t - RS_t^{£/\$} \frac{C_t^{\$}}{P_t^{\$}} Q_t .$$

- From the U.S. standpoint, the firm is an exporter and is helped by a real depreciation of the dollar.
- From the U.K. standpoint, the firm is an importer and is helped by a real appreciation of the pound.

How should this firm react to the real exchange rate change – a real depreciation of the dollar ($RS_t^{\$/£}\uparrow$), or a real appreciation of the pound ($RS_t^{£/\$}\downarrow$)?

Approaching this from the standpoint of the U.K. subsidiary, the real appreciation reduces the firm's marginal cost. We see that the firm should lower its price, $\frac{P_{Wt}^{£}}{P_t^{£}}$, but less than proportionately to the drop in $RS_t^{£/\$}$. (See graph.)

We see that optimally, the firm takes an intermediate stance between:

- the local-currency-pricing firm which leaves $\frac{P_{Wt}^{£}}{P_t^{£}}$ unchanged as $RS_t^{£/\$}$ falls, and
- the dollar-pricing firm that lowers $\frac{P_{Wt}^{£}}{P_t^{£}}$ one-for-one with the drop in $RS_t^{£/\$}$.

Note that if the firm is selling in both the U.S. and U.K. market, that this optimal strategy leads to pricing to market.

- The pricing decision in the U.S. is uninfluenced by the real exchange rate change.
- But the real price, in U.S. terms, of the U.K. good goes up (but not by the full amount of the real exchange rate change):

$$\underbrace{RS_t^{\$/£}}_{\text{increases 1 percent}} \quad x \quad \underbrace{\frac{P_{Wt}^{£}}{P_t^{£}}}_{\text{decreases but less than 1 percent}}$$