Lecture #3: More on Exchange Rates

More on the idea that exchange rates move around ‘a lot’.

1. The example at the end of lecture #2 discussed a large movement in the US-Japanese exchange rate that occurred over the period 1986-1987. The example showed how disruptive a move like that could be for business. That swing in the exchange rate was chosen because it was large, and so it was somewhat unusual. This example shows how ‘normal’ exchange rate fluctuations are quite disruptive too. It’s another car maker example.

The example is about an American car maker who sells cars to dealers in Germany. Let $E$ denote the exchange rate, in German Marks per dollar (in the notation of the book, $E$ is $E_{DM/\$}$). Here is the situation of the American car manufacturer. To generate an acceptable return for shareholders, the manufacturer must earn 10 percent over costs. Thus, $m$ from the example of lecture 2 must be $m = 0.10$. Suppose the dollar costs of making a car, $C$, are determined in advance, by contracts with workers and by contracts which specify what price parts suppliers will receive. Also, let $P_{GER}$ denote the price, in German Marks, that the manufacturer receives for each car from German dealers. This too is determined in advance by contract. Now, remember the formula,

$$E \times P_{GER} = (1 + m)C.$$  

This shows how the dollar receipts from a car (the exchange rate times the German Mark receipts) are allocated between costs, $C$, profits, $mC$. Since $P_{GER}$ and $C$ are determined in advance by contract, and $E$ is determined by broader market forces, over which the manufacturer has no control, you can think of this equation as determining $m$. That is,

$$m = E \frac{P_{GER}}{C} - 1.$$  

Suppose $P_{GER}$ and $C$ are determined three months before the American manufacturer actually receives delivery of the dollars, $E \times P_{GER}$. This creates a problem for the manufacturer at the time $P_{GER}$ and $C$ are set in contract negotiations. Since they don’t know what $E$ will be, they in effect don’t know what $m$ will be. If the uncertainty in $E$ were small, this would translate into just a little uncertainty in $m$, and no
one would care. But, let’s see how much uncertainty there is in $E$ in practice.

The attached Figure 1 shows the average value of $E$ during each quarter (a ‘quarter’ is three months) over the period 1971 to the present. Note that, overall, the US dollar has depreciated, with a big exception in the middle 1980s, when the dollar appreciated sharply relative to the German Mark. These longer term trends in the exchange rate are the subject of later lectures. More to the point for present purposes is Figure 2, which displays the quarterly gross rate of change in the exchange rate, that is, if $E_t$ denotes the exchange rate in quarter $t$, then, Figure 2 displays $E_t/E_{t-1}$. Note that this ratio appears to fluctuate between 1.05 and 0.95. This means that it is not unusual for the exchange rate to jump from one quarter to the next by 5 percent, or fall by 5 percent. Let’s see how this translates into uncertainty in the car manufacturer’s profit margin.

Imagine the following timing. Contracts are set in one quarter, and then revenues come in during the following quarter. The amount of uncertainty in next quarter’s exchange rate is captured (somewhat crudely) by the following simple setup. Suppose that next period’s exchange rate could be $E^1$, $E^2$ or $E^3$, where $E^1 = 2.10$, $E^2 = 2.00$, and $E^3 = 1.90$, with probability 1/3 each. Thus, the forecasted value of the exchange rate is $(2.10 + 2.00 + 1.90)/3 = 2$. This is the most recent value of $E$ displayed in Figure 1, rounded up. The example captures the notion that it would not be surprising if the actual exchange rate differed from the forecasted value by 5 percent.

Suppose $P^{GER}$ is set so that, given $C$, $m = 0.10$ if the forecasted value of the exchange rate occurs. Then, what values will $m$ take on if $E^1 = 2.10$, $E^2 = 2.00$, or $E^3 = 1.90$? Denote the values of $m$ corresponding to these three possible values of $E$ by $m^1$, $m^2$, $m^3$, respectively. Then,
it is easy to verify\textsuperscript{1:}

\[
m^1 = \frac{E^1}{E^2} (1 + m^2) - 1 = 0.155
\]
\[
m^2 = .10
\]
\[
m^3 = \frac{E^3}{E^2} (1 + m^2) - 1 = 0.045.
\]

So, the five percent uncertainty in \(E\) translates into uncertainty in profits on the order of 50 percent \(((0.155 \times C)/(0.10 \times C) = 1.55)\)!\textsuperscript{2}

\textsuperscript{1}To see this, note

\[
E^1 \times P^\text{GER} = (1 + m^1)C,
\]
\[
E^2 \times P^\text{GER} = (1 + m^2)C,
\]
\[
E^3 \times P^\text{GER} = (1 + m^3)C.
\]

Divide the first equation by the second, and the third by the second, to obtain:

\[
\frac{E^1}{E^2} = \frac{1 + m^1}{1 + m^2}, \quad \frac{E^3}{E^2} = \frac{1 + m^3}{1 + m^2}.
\]

What appears in the text is a simple transformation on these equations.

\textsuperscript{2}For those who enjoy math, a little calculus uncovers a general principle here. Totally differentiating the expression,

\[
m = E \frac{P^\text{GER}}{C} - 1,
\]

with respect to \(m\) and \(E\), we obtain

\[
dm = dE \frac{P^\text{GER}}{C},
\]

where \(dm\) denotes an infinitesimal change in \(m\). Let the percent change in \(m\) be \(\hat{m}\), so \(\hat{m} = (dm)/m\). Then, the last expression can be written

\[
m\hat{m} = E \hat{E} \left( \frac{P^\text{GER}}{C} \right)
\]
\[
= (1 + m) \hat{E},
\]

since \(EP^\text{GER}/C = 1 + m\). Dividing both sides by \(m\) :

\[
\hat{m} = \frac{1 + m}{m} \hat{E}.
\]

Note that \((1 + m)/m\) is roughly 10. Thus, a one percent change in the exchange rate translates into a \((1 + m)/m\) percent change in profits.
is a lot of uncertainty, and businesses would like to do something to get this uncertainty down.

In reality, the impact of the uncertainty in exchange rates is likely to be even bigger than what the previous example suggests. That’s because contracts are often negotiated much further in advance than just one quarter. For example, most wage agreements extend for a year, and many contracts actually go for three years. The uncertainty in the one-year-ahead forecast of an exchange rate is roughly four times greater than the uncertainty in the one-quarter-ahead forecast. If we widened the spread in \( E \) to \( E^1 = 2.2 \), \( E^2 = 2 \), \( E^3 = 1.8 \), then \( m^1 = 0.21 \), \( m^2 = 0.10 \), \( m^3 = -0.01 \). That is, if the low exchange rate is realized, revenues would fall below costs! The fluctuations in profits in this example are obviously quite large. The point is that this happens with exchange rate fluctuations that are not far from historical experience.

2. The market where traders directly exchange different currencies is called the ‘spot market’. As the previous discussion suggests, business people are likely to be nervous about doing all their currency trading in the spot market when they have to make other decisions in advance. In such cases, they have an incentive to find an alternative to the spot market, which allows them reduce or eliminate the uncertainties in their cash flow arising from spot exchange rate uncertainty. Not surprisingly, the appropriate markets have come into being.

Markets exist where people can commit today to exchanging currencies in the future at a specific rate of exchange. Thus, the manufacturer in the previous example could try and find someone who is willing to commit to giving them dollars in exchange for Marks (i.e., enter into a ‘forward contract’) at some mutually satisfactory rate of exchange three months from now. In this way (for a fee, of course!), the manufacturer can eliminate all exchange rate uncertainty. The exact exchange rate and fees traders are likely to settle on in the forward market will depend in part on how many traders there are on each side of the market and how they feel about the spot market. If one side of the market stands to lose more from the uncertainties of the spot market than the other side, then the laws of bargaining dictate that they are likely to get the worst deal. Pages 339-341 discuss these issues some more.


Financial Asset: A Piece of paper that entitles the holder to a stream of payments in the future. The supplier of the financial asset receives an up-front payment in the form of the purchase price of the asset. In the case of a business, the future stream of payments is paid using the revenues generated by what is purchased using the up-front payment on the asset. For example, if it is a machine that is purchased, the
future stream of payments is paid using the extra receipts earned by
the business as a result of the machine. Businesses issue two types of
financial assets: equity or debt. In the case of debt, the purchaser of
the financial asset is told precisely what the stream of payments will
be in the future (unless the company goes bust!). In the case of equity,
the purchaser does not know what that stream will be, since what it
receives is a cut of the firm’s profits.

One measure of the worth of a financial asset is its expected ‘rate of
return’, which measures how much you get out of it, relative to what
it costs. Below is a discussion of rates of return. It shows that the rate
of return on an asset depends on what units you measure costs and
returns. Units can be in dollars, goods, or some other currency.

(a) Nominal one-period return on a financial asset. This is the amount
of money you get from holding a financial asset for one period and
then selling it next period at the price prevailing then, divided by
the amount of money you paid for it today, $P$:

\[
\text{nominal return} = \frac{D + P'}{P} = 1 + R,
\]

where $D$ is the dollar payment you get from holding the asset,
and $R$ is the (net) nominal return. The asset could be a bond, in
which case $D$ is an interest payment, or a share in a corporation,
in which case $D$ would be a dividend check.

(b) Real return on a financial asset: what you get, in terms of goods,
from holding an asset for one period, divided by what you give up,
in goods, to acquire the asset. The goods value of $\$1$ is just $1/P_c$,
where $P_c$ is the price of a good. In practice, $P_c$ is the price of a
basket of goods. An example is the consumer price index, which is
the price of buying a specific basket of goods (so many apples, so
much bread, so much fuel oil, etc.) that government economists
think resembles the mix of goods Americans actually buy.\(^3\) So, if
the price of a basket is $P_c = \$2$, then with one dollar you can buy
$1/P_c = 1/2$ of one basket. Similarly, if the price of a given asset is
$P$ dollars, then that corresponds to $P/P_c$ baskets of goods. Also,
if the monetary payoff of holding the asset one period and then
selling it is $D + P'$, then that payoff in terms of baskets of goods

\(^3\)The actual level of $P_c$ doesn’t mean much, of course, since we don’t know exactly how
many of each the goods the government economists have in the basket. But, changes in
$P_c$ are of interest, since they indicate that the basket of goods that Americans buy has
changed in cost.
is \((D + P')/P'\), where \(P'\) is next period’s price index. So, now we say what the real return on an asset is:

\[
\text{real return} = \frac{(D + P')/P'}{P'/P} = \frac{(1 + R)}{P'/P} \approx 1 + R - \pi,
\]

where \(R\) is the nominal return defined above and \(\pi\) is the inflation rate, \(1 + \pi = P'/P\). The ‘\(\approx\)’ means ‘almost equals’. You can verify this by plugging in some (not too big!) values for \(R\) and \(\pi\). So, the real rate of return on an asset is the nominal rate of return, minus the inflation rate. You can see here, that even if \(R\) is known at the time an asset is acquired (typically, it is not known - in the case of a bond, \(D\) may be known but \(P'\) is not likely to be known; in the case of equity, neither \(D\) nor \(P'\) are known), there will still be uncertainty in its rate of return stemming from uncertainty there is in \(\pi\).

(c) The return on a foreign currency asset. In thinking about whether to invest in a US dollar asset or a foreign asset, it is important to get the returns in the same units. This is because, as the previous examples indicate, the units matter. So, imagine an American contemplating two assets: a US asset which has a nominal, US dollar rate of return, \(R\), and a German asset, which has a nominal return, in German marks, of \(R_{DM}\). As it stands now, the two assets are in different units. To compare them they have to be put in the same units. So, let’s put them in US dollar units.

To acquire one unit of the foreign asset, the American has to pay \(P_{DM}\) German Marks. In dollar terms, the American has to pay \(E \times P_{DM}\) dollars, where \(E\) denotes the number of Dollars per German Mark in the spot exchange rate market (i.e., this is \(E_{S/DM}\) in the notation of the book). So, the price, to an American, of the German asset, is \(E \times P_{DM}\) dollars. The payoff, next period, in German Marks, is \(D_{DM} + P_{DMI}\), which translates into \((D_{DM} + P_{DMI}) \times E'\) dollars next period. Here, \(E'\) denotes next period’s exchange rate. So, the rate of return, in US dollars, on the German asset is:

\[
1 + R = \frac{(D_{DM} + P_{DMI}) \times E'}{P_{DM} \times E} = (1 + R_{DM}) \frac{E'}{E} \approx 1 + R_{DM} + \frac{E' - E}{E}.
\]

In practice, \(E'\) is not known at the time the asset purchase decision is made, so it makes sense to replace \(E'\) by \(E^e\):

\[
R = R_{DM} + \frac{E^e - E}{E}.
\]
This says that the US dollar return on a German Asset equals the German Mark denominated return on the asset, plus the anticipated rate of appreciation of the Mark (i.e., a rise in $E_{S/DM}$ means a depreciation in the value of the US dollar and an appreciation in the value of the German Mark). The dollar return on a German asset is the sum of the German Mark return and the return on holding German marks.
Figure 1: German Mark per Dollar

Figure 2: Percent Change, over Three Months, in DM Per Dollar