Chapter 18 Measuring and Managing Operating Exposure to the Exchange Rate

Quiz Questions

True-False Questions

_____ 1. A firm that has no operations abroad does not face any operating exposure.

_____ 2. Only firms with exports, or firms that compete against foreign exporters, face operating exposure.

_____ 3. A firm that denominates all of its contracts in home currency, or hedges all of its foreign currency contracts, faces no operating exposure.

_____ 4. Almost every firm faces some operating exposure, although some firms are exposed only indirectly (through the country's general economic activity).

_____ 5. As large economies have a big impact on world economic activity, companies in such a country tend to be very exposed to exchange rates.

_____ 6. Small economies tend to fix their exchange rate relative to the currency of larger economies, or tend to create currency zones (like the EMS). Therefore, companies in small economies tend to be less exposed to exchange rates.

_____ 7. The smaller a country, the more open the economy. Therefore, exposure is relevant for firms.

_____ 8. Everything else being the same, the larger the monopolistic power of a firm, the smaller its exposure because such a firm has more degrees of freedom in adjusting its marketing policy.

_____ 9. Consider an exporting firm that has substantial monopolistic power in its product market. Everything else being the same, the more elastic foreign demand is, the more an exporting firm will profit from a devaluation of its own currency. Similarly, the less elastic foreign demand is, the less an exporting firm will be hurt by an appreciation of its own currency.

_____ 10. Most information needed to measure operating exposure can be inferred from the firm's past export and import contracts.

A. 1. false; 2. false; 3. false; 4. true; 5. false; 6. false: the risk may be lower, but not the exposure; 7. true; 8. true; 9. false: not enough information[1]; 10. false.

Multiple Choice Questions

Choose the correct answer(s).

Q1. In a small, completely open economy,

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[1] Let profits equal $\pi = S \times p^*(x) - c(x)$ where x = exports. Profit maximization means $S \frac{\partial x\, p^*(x)}{\partial x} - \frac{\partial c(x)}{\partial x} = 0$.

Therefore, $\frac{\partial \pi}{\partial S} = x\, p^*(x) + \left[S \frac{\partial x\, p^*(x)}{\partial x} - \frac{c(x)}{\partial x} \right] \frac{\partial x}{\partial S} = x\, p^*(x)$. Without knowing what is held constant, it is

(a) PPP holds relative to the surrounding countries.
(b) A 10 percent devaluation of the host currency will be offset by a 10 percent rise in the host country prices.
(c) The value of a foreign subsidiary, in units of the foreign parent's home currency, is unaffected by exchange rate changes.
(d) The real value of a foreign subsidiary to an investor from the host country is unaffected by exchange rate changes.
(e) In the absence of contracts with a value fixed in host currency, the real value of a foreign subsidiary to an investor from the parent's home country is unaffected by exchange rate changes.
(f) In the absence of contracts with a value that is fixed in foreign currency, the real value of a foreign subsidiary to an investor from the host country is unaffected by exchange rate changes.
(g) There is little or no advantage to using one's own currency: exchange rate policy has virtually no effects.

A1. (a) and (g) are correct. (b) is wrong: the price rise will be 11.11 percent; (c) and (d) overlook contracts fixed in nominal terms; (e) and (f) should read "in the absence of contracts fixed in any currency".

Q2. In a completely closed economy,
(a) PPP holds relative to the surrounding countries.
(b) A 10 percent devaluation of the host currency will be offset by a 10 percent rise in the host country prices.
(c) The value of a foreign subsidiary, in units of the foreign parent's home currency, is unaffected by exchange rate changes.
(d) The real value of a foreign subsidiary to an investor from the host country is unaffected by exchange rate changes.
(e) In the absence of contracts with a value fixed in host currency, the real value of a foreign subsidiary to an investor from the parent's home country is unaffected by exchange rate changes.
(f) In the absence of contracts with a value that is fixed in foreign currency, the real value of a foreign subsidiary to an investor from the host country is unaffected by exchange rate changes.
(g) There is little or no advantage to having an own currency: exchange rate policy has virtually no effects.

A2. (f), (g).

Q3. In an economy that is neither perfectly open nor completely closed:
(a) Consider a company that produces and sells in this economy. Apart from contractual exposure effects, its value in terms of its own (local) currency is positively exposed to the value of other currencies.
(b) The value of an importing firm located in this economy could either go up or go down when the local currency devalues: the effect depends on such factors as the elasticity of local demand and foreign supply.
(c) Consider a company that produces and sells in this economy. Apart from contractual exposure effects, its value in terms of a foreign currency is positively exposed to the value of its currency expressed in terms of other currencies.

A3. (a), (b): when costs increase, the value of the firm cannot; (c): the home currency value could go up, but this effect may be smaller than the effect of a host country devaluation.

Q4. Suppose that the value of the firm, expressed in terms of the owner's currency, is a linear function of the exchange rate up to random noise:
(a) The firm's exposure is the constant $a_{t,T}$ in $V_T(i) = a_{t,T} + b_{t,T}\, S_T(i) + e_{t,T}(i)$
(b) The exposure is hedged by buying forward $b_{t,T}$ units of foreign currency.

A4. (a), (b), and (c) are all false.

Q5. Suppose that the value of the firm, expressed in terms of the owner's currency, is a non-linear function of the exchange rate up to random noise. Suppose you fit a linear regression through this relationship, and you hedge with a forward sale with size equal to the regression coefficient.
(a) All risk will be eliminated.
(b) There is remaining risk, but it is entirely independent of the realized value of the exchange rate.
(c) There is remaining risk, but it is uncorrelated the realized value of the exchange rate.
(d) There is no way to further reduce the variance of the firm's hedged value.
(e) There is no way to further reduce the variance of the firm's hedged value if only exchange rate hedges can be used.
(f) There is no way to further reduce the variance of the firm's hedged value if only *linear* exchange rate hedges can be used.

A5. (c), (f).

Exercises

SynClear, of Seattle, Washington, produces equipment to clean up polluted waters. It has a subsidiary in Canada that imports and markets its parent's products. The value of this subsidiary, in terms of CAD, has recently decreased to CAD 5m due to a depreciation in the CAD relative to the USD (from the traditional level of USD/CAD 0.85 to about 0.75). SynClear's analysts argue that the value in CAD may very well return to its former level if, as seems reasonable, the uncertainty created by Canada's rising government deficit and Quebec's possible secession is resolved. If the CAD recovers, SynClear's products would be less expensive in terms of CAD, and the CAD value of the subsidiary would rise to about 6.5m.

E1. From the parent's (USD) perspective, is the exposure of SynClear Canada to the USD/CAD exchange rate positive or negative? What is the sign of the exposure?

A1. $S_{\text{low}} = 0.75$; the value in USD is $5\text{m} \times 0.75 =$ USD 3.75.
$S_{\text{high}} = 0.85$; the value in USD is $6.5\text{m} \times 0.85 =$ USD 5.525.

Thus, the exposure is strongly positive. This is because SynClear Canada is an importing firm. The stronger the CAD, the more competitive US products are in Canada and, therefore, the more profits SynClear Canada will make.

E2. Determine the exposure, and verify that the corresponding forward hedge eliminates this exposure. Use a forward rate of USD/CAD 0.80, and USD/CAD 0.75 and 0.85 as the possible future spot rates.

A2. $B = \dfrac{5.525\text{m} - 3.75\text{m}}{0.85 - 0.75} = \text{CAD } 17.75\text{m}.$
If $S = 0.75$, the value in USD is $3.75 + 17.75 \times (0.80 - 0.75) = \text{USD } 4.6375$.
If $S = 0.75$, the value in USD is $5.525 + 17.75 \times (0.80 - 0.85) = \text{USD } 4.6375$.

E3. SynClear's chairman argues that, as the exposure is positive and the only possible exchange rate change is an appreciation of the CAD, the only possible change is an increase in the value of the subsidiary. Therefore, he continues, the firm should not hedge: why give away the chance of gain? How do you evaluate this argument?

A3. The chairman overlooks two facts. First, only *part* of the gain from an appreciation is eliminated by the hedge. Second, if the appreciation does not materialize, SynClear will have a gain from the forward contract that alleviates the competitiveness problems associated with a low value of the CAD. In short, the hedge swaps part of the gain from an appreciation for a partial gain in case there is no appreciation.

In the remainder of this series of exercises, SynClear Canada's cash flows and market values are assumed, more realistically, to depend on other factors than just the exchange rate. The Canadian economy can be in a recession, or booming, or somewhere in between, and the state of the economy is a second determinant of the demand for SynClear's products. The table below summarizes the value of the firm in each state and the probability of each state:

State of the economy		Boom	Medium	Recession	Conditional Expectation
S_T = 0.85:	probability	0.075	0.175	0.25	n.a.
	value (USD)	5.25	4.75	4.50	
S_T = 0.75:	probability	0.25	0.175	0.075	n.a.
	value (USD)	4.25	3.857	3.50	

E4. What are the expected cash flows conditional on each value of the exchange rate?

A4. USD 4.70m when S_T = 0.85, and USD 4.00m when S_T = 0.75.

E5. Compute the exposure, the optimal forward hedge, and the value of the hedged firm in each state. The forward rate is still USD/CAD 0.80.

A5. The exposure is:

$$\frac{4.70 - 4.00}{0.85 - 0.75} = \text{CAD 7m.}$$

$$\begin{aligned}(V_{\text{hedged}} \mid S_T = 0.85) &= (V_{\text{unhedged}} \mid \text{S=0.85}) + 7\text{m} \times (0.80 - 0.85) \\ &= 4.7 - 0.35. \\ (V_{\text{hedged}} \mid S_T = 0.75) &= (V_{\text{unhedged}} \mid \text{S=0.75}) + 7\text{m} \times (0.80 - 0.75) \\ &= 4.0 + 0.35.\end{aligned}$$

State of the economy		Boom	Medium	Recession	Conditional Expectation
S_T = 0.85:	probability	0.075	0.175	0.25	n.a.
	value (USD)	4.90	4.40	4.15	4.35
S_T = 0.75:	probability	0.25	0.175	0.075	n.a.
	value (USD)	4.60	4.207	3.85	4.35

The conditional expectations have become independent of the exchange rate, but there still is as much sensitivity to the state of the economy as before, in the sense that the deviation of each possible outcome from its conditional expected value is the same as in the absence of hedging.

Mind-Expanding Exercises

We modify the SynClear Canada example: there are five possible exchange rates, and SynClear Canada's value, in USD is a nonlinear function of the exchange rate. For simplicity, we ignore risk caused by other factors than the exchange rate: from the text, or from Exercises 4 and 5, we already know how to handle other risks. The value V as a function of the exchange rate S is as follows:

S_T	0.750	0.775	0.80	0.825	0.850
Probability	0.10	0.20	0.40	0.20	0.10
$V_T(S_T)$ (in USD)	4.00	4.25	4.45	4.60	4.70

ME1. Suppose SynClear USA wants to use a linear hedge. What is the linear regression of $V_T(S_T)$ on S_T ? (Note that you have to take into account the fact that the outcomes are not equally probable. A correct but computationally simple way to do this is to compute a linear regression on your pocket calculator, as if you had ten equally probably outcomes where the case "S_T = 0.775" occurs two times, the case "S_T = 0.80" four times, and the case "S_T = 0.825" two times.)

A1. The linear regression is $V_T(S_T) = -1.18 + (7 \times S_T) + \text{residual}$.

ME2. (a) If the forward rate is USD/CAD 0.80, what is the value of the firm after this linear hedge?
(b) What is the expected value?
(c) Is the deviation from the mean predictable on the basis of the exchange rate?

A2. (a) Add a forward sale with of CAD 7m.

S_T	0.750	0.775	0.80	0.825	0.850
$V_T(S_T)$ (in USD)	4.00	4.25	4.45	4.60	4.70
$-7\text{m} \times (S_T - 0.8)$	0.35	0.175	0.00	–0.175	–0.35
$V_{T,\text{hedged}}$	4.35	4.425	4.45	4.425	4.35

(b) The expected value, hedged, is USD 4.42m.
(c) Because we know what the deviation from the mean will be for each value of S_T, the residuals are uncorrelated with S_T, but not independent of S_T.

ME3. (a) What portfolio of options would eliminate all uncertainty?
(b) What is the future value of the hedged subsidiary?
(c) The hedge that you engineered in part (b) locks in a rather low value for the subsidiary. Does this mean that hedging using a portfolio of options lowers the value of the participation?

A3. (a) The single linear hedge considered in ME1 and ME2 fails to eliminate all risk because the exposure is not the same everywhere. For example, between the exchange rates 0.75 and 0.775, the exposure is:

$$\frac{4.25 - 4.00}{0.775 - 0.75} = \text{CAD } 10\text{m}.$$

Make similar computations for all other pairs of "adjacent" outcomes:

S_T	0.750	0.775	0.80	0.825	0.850
$V_T(S_T)$ (in USD)	4.00	4.25	4.45	4.60	4.70
Local exposure (CAD)	10m	8m	6m	4m	

The local exposure of the hedge portfolio must be the negative of the local exposure of $V_T(S)_T$. Obtaining an exchange rate exposure equal to of CAD –10m by selling a call on CAD 10m with strike price X_1 = 0.75 is too large, in absolute

value, for exchange rates that exceed 0.775. For S_T > 0.775 we can lower the exposure to CAD –8m by adding a (long) call on CAD 2m with strike price X_2 = 0.775, and so on. The table below summarizes the solution:

		Local exposure of each call				
S_T						
Size	Strike price	0.750	0.775	0.80	0.825	0.850
-10m	X_1=0.75	–10m	-10m	-10m	-10m	
2m	X_2=0.775	0	2m	2m	2m	
2m	X_3=0.8	0	0	2m	2m	
2m	X_2=0.825	0	0	0	2m	
Total exposure of hedge		-10m	-8m	-6m	-4m	

(b) The future value of the hedged subsidiary now always equals USD 4.00.

(c) No. The parent also obtains up-front revenue for writing the (relatively expensive) call on CAD 10m at X = 0.75. The cost of buying the additional calls does not offset this up-front revenue because (1) the higher the strike price, the lower the value of a call option, and (2) the three additional calls are for smaller amounts of CAD than CAD 10m. Thus, the total portfolio of calls surely generates up-front income, which compensates for the lower future value of the hedged firm.

ME4. To value the subsidiary, you could construct a replicating portfolio. How would you construct this portfolio?

A4. First reverse all the signs of the option positions: buy a call on CAD 10m at X_1 = 0.75, sell a call on CAD 2m at X_2 = 0.775, and so on. The payoff from this option portfolio will have the same curvature as the value of the subsidiary, but the option portfolio has a zero value for S_T = 0.75, whereas the subsidiary has a value of USD 4m for S_T = 0.75. That is, the payoff from the options portfolio is too low by USD 4m everywhere. To increase the payoff from the options portfolio by USD 4m everywhere, buy a USD bond with future value equal to 4m. The portfolio of the bond and the four options will perfectly replicate the value of the subsidiary.