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International Finance

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Solutions

1. This question relates to the following three learning objectives,

   - Describe the channels by which central bank intervention can affect the exchange rate and summarize the empirical evidence on these channels. (Questions (a) and (b))
   - Describe the institutional features of the foreign exchange market products (spot, forward, swap and option contracts) and be able to distinguish between speculation and arbitrage. (Questions (c), (d) and (e))
   - Describe the relationships between four prices; spot prices, forward rates and money-market interest rates at home and in the foreign country and be able to predict any single price on the basis of information about the other three. (Question (f))

   (a) True! Sterilized interventions affect the expectations about future movements in fundamentals which feeds back into the current exchange rate. Non–sterilized interventions affect the current money supply and therefore also the current exchange rate according to the signalling approach. The portfolio balance channel does not work in this case.

   (b) True! If foreign and domestic assets are perfect substitutes the portfolio balance model breaks down to the standard monetary model. If so, then the central bank must rely on the signalling approach which cannot work if the intervention is secret.

(c) True! A spot contract is for delivery within 2 business days (1 day for North American currencies). The forward price must, therefore, converge toward the spot price. The price on a forward contract with less than two remaining days until maturity must be equal to the spot price.

(d) False! Triangular (or spatial) arbitrage implies an arbitrage *of the same financial instrument* between two different geographic places, such as arbitrage between two different banks, between two different cities, or between two different markets that trade the same instrument. Triangular arbitrage then implies that it is not possible to make a profit when exchanging the same currencies in, for example, two different geographic places.

(e) False! Maintenance margin is the lower bound for the acceptable level of margin. Touching the maintenance margin level triggers a margin call. Variation margin is the amount needed to restore the initial margin once a margin call has been issued. The variation margin may change depending on how far the margin account has fallen below the maintenance margin level.

(f) False. The price of a forward contract is determined by the cost–of–carry model which relates the forward price to the current spot price and the cost of storage. The forward exchange rate is, according to CIP, determined by the spot exchange rate (current spot price) and the interest differential (cost of storage).

2. This question focuses on the microstructure of the nominal exchange market and relates mainly to the learning objective "describe how the foreign exchange market is organized and how trades take place in the interbank and the retail segments of the market" and to a lesser degree to the objective "describe the institutional features of the foreign exchange market products (spot, forward, swap and option contracts) and be able to distinguish between speculation and arbitrage". The first question is on the main differences between different approaches to exchange rate determination, the second question is on the main model of the market microstructure discussed in the curriculum, and the third question is on whether the predictions of the model are consistent with results obtained in a survey of market participants.

(a) Distinguish between; macromodels: Goods market approach (PPP) and asset market approach (monetary models and portfolio balance model), and micromodels: auction models, sequential trade models and simultaneous trade models.

Main difference between these two approaches is that the details of trading are considered important in the latter approach. These details are, for example, who quotes currency prices and how trade takes place.

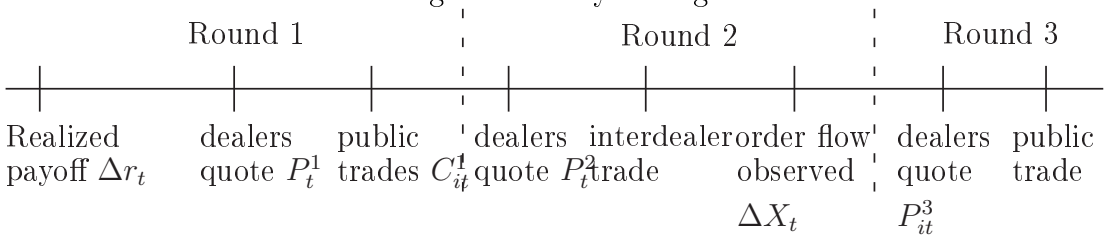
(b) The basic idea is illustrated in the model below. The time line could be thought about as one trading day. The market opens and dealers observe a payoff which represents innovations in macroeconomic variables or interest rate differential. We divide one trading day into three rounds, in round 1 dealers trade with customers, in round 2 dealers trade among themselves to share inventory risk and in round 3, dealers trade again with customers in order to share inventory risk more broadly.

In round 1: Each dealer independently and simultaneously quotes a scalar price to his/her customers, P_{it}^1. (Adding bid–ask spread would not affect the main arguments.) In equilibrium all individual quotes must be the same so that $P_{it}^1 = P_t^1$. The dealer then receives orders from the customer at this price. Note that customer may either buy or sell foreign currency. These orders C_{it}^1 are not publicly observable implying that total demand is not known.

Round 2: Each dealer then simultaneously and independently quotes a price to other dealers, P_{it}^2. By arbitrage reasons, these individual prices must be identical, $P_{it}^2 = P_t^2$. Then dealers trade and this order flow is publicly observable.

Round 3: Dealers share overnight risk with customers. To do this, dealers must quote a new price. The problem is, from the dealers perspective, to set this price. Dealers have only access to the interdealer order flow in round 2. What is assumed is that the necessary order flow in round 3 is proportional to the interdealer order flow in round 2. The price quoted in round 3 is set such that customers willingly absorbs all dealer inventory imbalances so that all dealers end the day with no net position. In other words, the sum of the order flow in rounds 1 and 3 is zero. This implies that the order flow in round 2 (ΔX_t) affects quoted prices, there will be a portfolio balance effect on prices.

Figure 1: Daily timing



In order to be rewarded full points, the answer must also include a discussion of information flows. The order flow between customers and dealers in round 1 incorporates new information relevant for the determination of the spot exchange rate. Customers are assumed to have this information and then it is transmitted to dealers through order flows. Dealers learn about how customers value currencies

through their willingness to sell or buy currencies at quoted prices. Dealers cannot explore this information as it is not publicly known, i.e., known by other dealers.

In the beginning of round 2, new prices are quoted and dealers trade. Through this trade, the new information that dealers obtained from their own customers is transmitted from one dealer to other dealers. The order flow in round 2 is observed by all dealers. The private information that each customer had when the market opened is now public information to all dealers. This is the main explanation as to why order flows affect spot exchange rates.

One important aspect is that new information can reach dealers in two ways, either directly which can be interpreted as common knowledge, or indirectly through order flows. Common knowledge will have an affect on quoted prices in round 1, but private information cannot have an effect. The interdealer order flow, or information aggregation, is essential.

In order to test the predictions of the model one approach is to test for links between order flows and exchange rates. The list below focuses only on four different predictions that can be inferred from the model and in order to obtain full points all these four hypotheses must be mentioned.

- Evans and Lyons (which is included in the curriculum): Empirical evidence suggest that there is indeed a positive link between interdealer order flows and spot exchange rate. The fraction of the spot exchange rate that can be explained increases substantially when also including order flows, over 60% and 40% of the DM/USD and Yen/USD spot rates are explained by interdealer order flows, respectively. Other studies report empirical evidence consistent with these results.
- However, interdealer order flows only tell us that information is transmitted between dealers. But, the model also suggests that private information from customers to dealers through order flows are important. The empirical literature suggests that there is indeed a significant contemporaneous relationship between customer order flows and changes in exchange rates and that the effect is stronger in the medium term (one month horizons).
- Since order flows are assumed to reflect changes in fundamentals it follows that actual spot rates must include forecasts of future fundamentals. Therefore, spot rates should have forecasting power for fundamentals. Empirical evidence is not particularly strong. Spot rates can predict future fundamentals but the forecasting power is limited.

- Following the same type of arguments, there must be a relationship between order flows and future fundamentals. If order flows contain information about fundamentals that is not public information, then order flows should predict future fundamentals beyond what is public information. There is some empirical evidence supporting this hypothesis.

(c) Is this result consistent with results from surveys of traders? The survey by Cheung and Chinn suggests that this is the case. When asking questions regarding the sources of large players' competitive advantage, traders respond that a large customer base and better information about the market are the two main factors. Large players are perceived to have a better customer and market network, which, in turn, gives them better information on order flow and the activity of other trading banks. The importance of a large customer base, thus relates to the importance of order flows illustrated in the model above.

3. This question focuses on foreign currency options and relates to the learning objectives; "list the determinants of put and call options prior to maturity and at maturity", "graph the payoffs of a futures contract as a function of the price of the underlying asset, graph similar payoff profiles or combinations of futures contracts, and be able to show how futures contracts can be used to hedge an open risky position", and "show that a simple option can be replicated by borrowing/lending and holding of a fractional position in the underlying asset and that this replicating portfolio can be used to construct an option, price an option and hedge an option position".

(a) The main difference is that an option provides both a hedge against exchange rate risk but also take advantage of favorable movements in the exchange rate. A futures/forward contract provides a hedge but does not allow the investor to take advantage of favorable movements in the exchange rate.

- Advantages;
  - limited risk,
  - unlimited profit potential, and
  - possibility of taking advantage of favorable changes in the exchange rate.
- Disadvantages
  - more expensive than forward contracts, and
  - premium has to be paid upfront.

(b)
- Option premium = intrinsic value + time value.
- Intrinsic value: The difference between the strike price and the forward rate (or spot rate). Intrinsic value for a call option = spot price - strike price and intrinsic value for a put option = strike price - spot rate. Note that intrinsic value cannot be negative.
- Time value: Represents the additional value of an option due to the opportunity that the intrinsic value will increase.
- If intrinsic value is zero, then for both call and put options: spot price = strike price which is called "at–the–money"
- If intrinsic value is non–zero, we call this "in–the–money". (Call options: Spot price $>$ strike price and for put options: Spot price $<$ strike price.)
- Otherwise we say that the option (both call and put) are "out–of–the–money".

(c)
- Consider, for example a call option on euros (the underlying currency), the buyer (holder) has the right to buy euros (and sell dollars which is the counter currency) at a predetermined rate at a given date in the future. The seller (writer) has agreed to sell euros and buy dollars.
  - Spot exchange rate: higher spot price of euros (pay more dollars per euros) increase the likelihood that the call option is exercised and the price on the call option will be higher.
  - Strike price: Higher strike price reduces the likelihood that the call option is exercised and therefore reduces the price.
  - Time left to expiry: Longer time before expiry increases the likelihood that the call option is exercised implying a higher price.
  - Volatility: Higher volatility of the euro/dollar exchange rate, the more likely it is that the spot rate will exceed the strike price and therefore be exercised. The price on the call will be higher.
  - Domestic interest rate (the underlying currency's interest rate): The buyer is paying dollars for an option to buy euros. The alternative is to hold euros. A higher interest rate in the euro zone makes it more attractive to hold euros and makes the call option less attractive since the investor is foregoing the euro interest rate. This tends to reduce the price on the call option.
  - Foreign interest rate (the counter currency's interest rate): A rise in the foreign interest rate makes it more attractive to hold this currency and the premium should increase on the call option.

(d) The delta of an option is the change in the price of the option conditional on the change in the price of the underlying asset, assuming that all other variables are held constant. The calculation of delta assumes that (1) all other variables are held constant, (2) the theoretical model for option pricing (and used to calculate the price change) is the correct model, and (3) the contemplated price change in the underlying asset is differentially (very) small. Gamma is the change in the option delta conditional on the change in the price of the underlying asset.

(e) The delta indicates the number of calls or puts a trader needs to buy or sell to result in a delta of zero for his overall portfolio. A delta of zero, or "delta neutral" position is one where the change in the value of the position conditional on a change in the price of the underlying asset is zero. In other words, a delta-neutral position is hedged against price changes in the underlying asset. A delta-neutral position is still exposed to the risk of loss from large price changes in the underlying asset.

(f) Several of the assumptions in the Garman–Kohlhagen model are not satisfied in the real world. In particular, transaction costs exist and interest rates vary over the life of the option. The distribution of price changes in the underlying asset may not be log–normally distributed. In the case of currencies, jump processes or fat–tailed distributions may be more appropriate.