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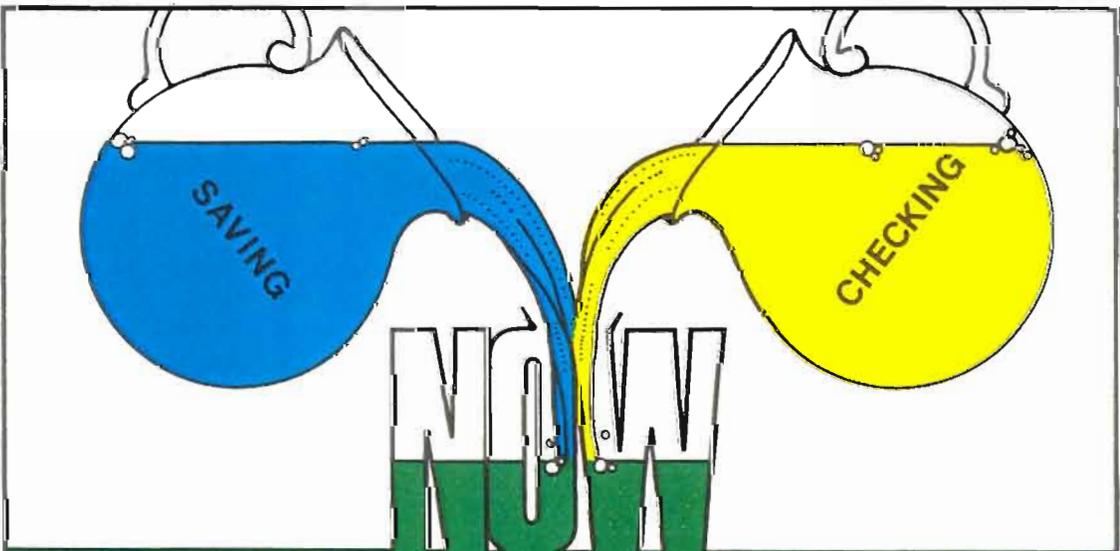
Federal Reserve Bank of Philadelphia

JULY · AUGUST 1984

...New Markets in Foreign Currency Options

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The Return Banks Have Paid on NOW Accounts

Herb Taylor

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Ten Independence Mall
Philadelphia, Pennsylvania 19106

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Brian Gendreau

In late 1982, exchanges in Amsterdam, Montreal and Philadelphia opened trading in foreign currency options. These financial instruments emerged in response to expanding foreign trade and increased exchange rate volatility. Options add a new dimension to foreign currency markets by limiting the risks associated with unpredictable exchange rate movements. And so long as foreign trade continues to grow and exchange rates remain volatile, foreign currency options should thrive.

THE RETURN BANKS HAVE PAID ON NOW ACCOUNTS 13

Herb Taylor

Despite the differences among NOWs, regular checking, and savings accounts, an analysis of FCA data reveals that all three pay about the same total rate of return. Why should this be true when the legal ceilings on interest rates differ for each account? The answer lies in analyzing the behavior of the "implicit" interest rate banks pay depositors.

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New Markets in Foreign Currency Options

Brian Gendreau*

INTRODUCTION

In recent years, exchanges and banks have developed a variety of new financial instruments designed to give customers the option to buy or sell foreign currencies. Exchanges in Amsterdam, Montreal, and Philadelphia opened trading in standardized options on foreign currencies in late

1982. Banks responded by resurrecting an old practice of writing tailor-made foreign currency options for their customers. And in January, 1984 the Chicago Mercantile Exchange opened trading in the newest instrument, an option on its Deutsche mark *futures* contract.

How do these new currency options work? What do options allow traders to do that they cannot do already in foreign currency markets? Under what circumstances will they do well in the marketplace? As a first step toward examining these issues, it is important to understand exactly what options are.

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WHAT ARE OPTIONS?

An option is a contract that gives its holder the

right, but not the obligation, to buy or sell an asset on or before a future date at a specified price. In this regard options differ crucially from forward and futures contracts, which are firm commitments to buy or sell an asset at a fixed price on a future date. Once forward and futures contracts are made, they must be fulfilled whether prices have moved favorably or not.¹

An option that can be exercised only on its expiration date is called a European option; one that can be exercised anytime up to expiration is called an American option. Theoretically, options can be written on any asset or commodity, be it a crop, real estate, a security, or a futures contract. With foreign currency options, the underlying asset is a specified quantity of a foreign currency, say, 12,500 British pounds or 62,500 Swiss francs.

Foreign currency options, like all other options, involve two transactions. The first transaction is the purchase or sale of the *option* itself: one party buys from the other the right to exchange dollars for foreign currency in the future at a set price, known as the exercise or striking price. The person obtaining the right to make the future exchange is known as the option buyer or holder, and the person granting the right is known as the option seller or writer. To have the privilege of exchanging the currency at the price specified in the option contract, the buyer must pay the seller a fee, called a premium.

The second transaction in an option is the future exchange of the underlying *asset*: the foreign currency. This exchange may be one of two kinds. In a *call* option, dollars may be exchanged for a specified quantity of the foreign currency; a call is thus a contract for the right to buy the foreign currency. In a *put* option, a specified quantity of the foreign currency may be exchanged for dollars; it is a contract for the right to sell the foreign cur-

rency. Because options may be bought or sold for the right to buy or sell foreign currency, four basic trading positions are possible. A market participant can:

1. buy a call, obtaining the right to purchase the foreign currency;
2. sell a call, standing ready to sell the foreign currency at the option buyer's discretion;
3. buy a put, obtaining the right to sell the foreign currency; or
4. sell a put, standing ready to buy the foreign currency at the option buyer's discretion.

Each of these four positions exposes the trader to different risks and returns. Why a trader would choose to take on any of these positions may be best explained with examples, beginning with foreign currency calls.

RISKS AND REWARDS IN TRADING CURRENCY OPTIONS

Call Options. Suppose a trader has good reason to think that the Swiss franc will rise relative to the dollar by more than the market expects. One way to profit from that information is to buy a call option on francs. The trader could, for example, buy a call in March giving him the right to purchase 62,500 francs at a price of \$.46 apiece in June, paying (for example) a \$560 premium for the option. If the trader is correct and by March the franc rises—say to \$.48—the trader can exercise the option, buy the francs from the option writer at the exercise price, \$.46, then sell them in the spot market at \$.48 for a profit of \$1,250—more than enough to cover the premium. If, instead, the franc does not rise above the option's exercise price, the trader will let the option lapse and lose the premium. In no event, however, will the buyer lose more than the \$560 paid for the premium.

Put Options. In contrast to calls, in which buyers gain from unexpected rises in the spot price, puts enable buyers to gain from unexpected declines in the spot price. Specifically, the buyer of a put held to expiration will profit if the price of the underlying currency falls below the exercise price by more than enough to cover the cost of the premium. If the currency price does not fall below the option's exercise price, the buyer will lose the premium.

To see how puts can be used to profit from exchange rate declines, imagine a trader who be-

¹Forward and futures contracts can be fulfilled either by delivering the currency specified in the contract or by making a second, offsetting contract. Forward contracts for foreign exchange are generally made with commercial banks and can be tailored to specific customer needs. Futures contracts are similar to forward contracts, but are traded in standardized quantities with regular maturities on organized exchanges, are guaranteed by the exchanges, and generally require a security deposit (called a "margin"). See K. Alec Chrystal, "A Guide to Foreign Exchange Markets," Federal Reserve Bank of St. Louis Review, Vol. 66, No. 3 (March 1984) pp. 5-18.

believes that the Japanese yen will drop relative to the dollar by more than the rest of the market expects. The trader could bet on the extra decline by paying, say, a \$225 premium for a June put on 6,250,000 yen with an exercise price of \$.0042. If by June the yen falls unexpectedly, say to \$.0040, the trader will find it profitable to exercise the put and sell the yen purchased in the spot market at \$.0040 to the option seller at the exercise price of \$.0042 for a gain of \$1,250, an amount that more than offsets the cost of the premium.

These examples illustrate two important features of option trading. First, the amount the option buyer stands to gain depends on the movement of the spot price of the underlying currency relative to the option's exercise price. Second, the risks in option trading are asymmetric. The most the option buyer stands to lose is the premium, while his potential gains are limited only by the subsequent movement of the underlying currency's exchange rates. By the same token, the most the option seller can gain is the premium, though his potential losses are bounded only by the range of future exchange rate movements.² In effect, the option buyer is paying the seller to take on his risk, and the premium will rise to a value that compensates the seller for assuming that risk.

In contrast to options, the upside and downside risks in trading forward and futures contracts are symmetric. The buyer of a forward contract held to maturity will lose, dollar for dollar, as much when the spot price falls below the contract price as he will gain when the spot price rises above the contract price. Options are thus likely to attract traders who wish to profit from movements of prices in one direction while limiting their losses from adverse price movements. In addition, options are likely to attract traders who wish to profit from misalignments between prices on forward or futures contracts and prices on options. Option and forward foreign exchange prices, therefore, are not independent. (See the APPENDIX: PUT-CALL PARITY).

²Puts and calls can also be combined in a number of complex strategies to bet on price volatility, rather than on the direction of a price movement. For a discussion of these strategies in currency option markets, see Ian H. Giddy, "Foreign Exchange Options," *The Journal of Futures Markets*, Vol. 3, No. 2 (1983) pp. 143-166.

USING OPTIONS TO HEDGE CONTINGENCIES

The asymmetries between potential gains and losses in options allow them to be used—in ways that forwards and futures cannot—to hedge *contingencies*: transactions that are not certain to materialize. Consider, for example, a U.S. firm that has submitted a competitive bid in pounds to supply communications equipment in Britain. If it wins the bid, it will receive pounds, which it will then want to convert into dollars. Until the bids are awarded, the firm is exposed to the risk of a decline in the value of the pound, which would reduce the value of the contract award if it wins the bid. The firm would like to hedge against this risk. Forward or futures contracts are not the right hedging instruments in this case because it is not certain that the firm will actually be awarded the bid. If the firm tries to hedge the bid by selling pounds under a forward contract, and then fails to win the bid, it will be left with a forward contract but no matching business transaction in the foreign currency. The firm will have started out trying to reduce its foreign exchange risk, only to wind up with a foreign currency exposure after all.

To hedge a contingent transaction like a competitive bid a firm should use an option; in this case it should buy a put. If the anticipated transaction does occur, the firm can exercise the option and sell the foreign currency it receives at a set price. If, instead, the transaction falls through, the firm can simply let the option expire. From the firm's perspective, buying an option is like buying insurance against foreign exchange risk by paying the option seller a premium to cover its risk.

Contingent transactions are not uncommon in international finance. The terms of an investment in a foreign firm, for example, may include the acquisition of warrants to buy the firm's shares at a fixed price in the future, with payment in the foreign currency. In another case, a firm's future foreign currency requirements may hinge upon whether it decides to take advantage of an option it has obtained to purchase a foreign asset—say, the right to purchase a hotel in Bavaria. Or a firm may anticipate receiving a future award in a foreign currency depending upon the outcome of a lawsuit in a foreign court. Each of these possible, but not certain, future claims or liabilities in a foreign currency can be hedged with options. The warrants and hotel option can be covered by buying calls,

and the potential receipt of a lawsuit award covered by buying a put.

THE DEMAND FOR CURRENCY OPTIONS

Despite the advantages currency options have over forward and futures contracts in some situations, no markets existed for these options until recently. An unsuccessful effort had been made to start a market for puts and calls on foreign currencies in New York in the 1920s, and U.S. banks have occasionally arranged currency options privately for customers since the 1940s. But by and large, the market for currency options was dormant until the European Options Exchange (Amsterdam), the Montreal Exchange, and the Philadelphia Stock Exchange opened trading in currency options in late 1982. Once currency option trading was established on these exchanges, banks began writing substantial quantities of currency options for customers, creating an over-the-counter market parallel to the exchange markets.

The recent demand for currency options can be attributed to two factors: increased exchange rate volatility and the growth of international trade. Prior to 1971, exchange rates were not as variable as they are now. At the Bretton Woods conference in 1944, the industrial nations agreed to have their central banks buy and sell dollars to keep exchange rate movements within fairly narrow bounds. As a result, traders expected little variability in exchange rates. Under these circumstances, few market participants were willing to pay for option contracts to provide protection against adverse exchange rate movements: the costs to maintaining uncovered foreign currency positions were small, as were the fees writers could have earned by producing option coverage.

After this system of nearly-fixed exchange rates collapsed in 1971, most major currencies began to float with market forces and exchange rates became more volatile. The average monthly range of fluctuations of the Deutsche mark to the dollar, for example, widened from .44 cents over the 1959 to 1971 period to 5.66 cents between 1971 and 1982—a more than twelvefold increase. At the same time that exchange rates were becoming more variable, the volume of trade in goods and services and financial flows between nations continued to grow. The sum of exports and imports in the U.S. alone grew from \$135.9 billion in 1971 to \$265.7 billion

in 1982 in constant (inflation-adjusted) dollars. Forward and futures contracts could have been used to hedge the lion's share of these international transactions. Some portion of foreign trade, however, is carried out under contingent contracts, for which options are the desired hedging tool. Assuming that the proportion of contingencies in international trade is constant, the combination of volatile exchange rates and growing trade meant inevitably that a market for foreign currency options to hedge those contingencies would also grow. It was to meet this expanding market that exchanges and banks began to offer options.

CREATORS OF CURRENCY OPTION MARKETS

The existence of markets is often taken for granted, but creating a market can be a costly and risky venture. Before trading can advance beyond the crudest type of barter, several obstacles must be overcome. First, someone must provide the physical facilities for bringing buyers and sellers together, whether they are open-air booths, a bank of telephones, or an elaborate computerized trading floor. Next, someone has to provide a mechanism for matching buyers' and sellers' orders at a common price. Small markets sometimes employ an auctioneer, but most markets rely on dealers or market-makers: firms that stand ready to trade with customers, buying and selling for their own account. Standing ready to trade with customers immediately, however, is risky: the danger always exists that the next customer may be willing to buy only at a price that is less than the price the last seller received. Markets for assets that are not physically present when agreements are made to exchange must overcome yet another problem, the risk that the other party to the transaction will default. Agreements made under these circumstances are promises to trade, and trading will falter unless there is some assurance that the promises will be kept.³ Exchanges and banks have taken different approaches to overcoming these obstacles, producing different kinds of option contracts and trading procedures.

³Sir John Hicks has called trading in markets where the goods are not present "trading in promises." See his book *A Theory of Economic History* (Oxford: Oxford University Press, 1969) for a discussion of the crucial role of market-makers and contract protection in the development of markets.

Exchange Options. The Amsterdam, Montreal, and Philadelphia exchanges have devoted resources to providing centralized trading floors, and have adopted the open outcry system for matching option buyers to sellers (See EXECUTING CURRENCY OPTION TRADES). To open trading in currency options to a wide range of participants, the exchanges have adopted contract designs and trading safeguards that have proven successful on futures exchanges and common stock option exchanges. To begin with, currency options on all three exchanges were designed as American options with standardized trading units and expiration dates. (See CONTRACT SPECIFICATIONS ON THE AMSTERDAM, MONTREAL, AND PHILADELPHIA EXCHANGES). Contract standardization helps to reduce the number of dimensions over which buyers and sellers must agree. Some flexibility is lost as a result, but standardization is probably necessary for contract trading in a central market-

place: matching customers with a wide range of quantity and maturity preferences would be an administrative nightmare.⁴ By standardizing the contract terms the exchanges have made it possible to trade options in a secondary market—a market in which options can be bought and sold many times before expiration. Indeed, exchange options are so readily accepted by traders that no distinction exists between new and resold options: all are traded interchangeably on the exchange floor.⁵

⁴Just imagine the difficulties involved in trying to negotiate a match between a buyer's order for a June 17th option on 145,000 Deutsche marks with a striking price of .366 to a seller's order for an option on 112,500 marks, to expire July 2nd, with a striking price of .373.

⁵Once a secondary market exists, buyers may find it easier to sell the option to a new buyer rather than to exercise the option and actually take delivery of (or deliver) the underlying currency. The premium on the option will always rise to reflect a difference between the spot price and the option's exercise

EXECUTING CURRENCY OPTION TRADES

The way currency option trades are made is perhaps best illustrated by following a typical trade through the Philadelphia Stock Exchange; the other exchanges follow essentially similar procedures. Suppose a customer wants to buy a British pound option with a \$1.45 exercise price and June expiration date at the best price available on the market. The trading process begins when the customer calls a broker who is a member of the exchange and places the order. The broker books and clocks the order, then relays it electronically to the broker's booth on the exchange trading floor. The broker's floor trader then walks over to the other pound contract traders standing near the screens on which trades are reported, and shouts out his bid of, say, 1¢. Option price bids are quoted at cents per unit of the underlying currency, and a bid of 1¢ on a 12,500 British pound contract is equal to a premium of \$125.

The floor trader's bid would be answered by offers to sell from other traders, at (say) 1.25¢, 1.20¢, and 1.15¢. The offers may be coming from three kinds of traders: specialists, market-makers, or floor brokers acting as agents for other customers. *Specialists* are firms designated by the exchange to maintain orderly trading and manage the limit orders for each currency. Some customers give their brokers orders to buy or sell only when prices reach a certain limit (say, "buy at \$130.00" or "sell at \$150.00"), and the specialist coordinates these orders. *Market-makers* are member firms who buy and sell for their own account, and who must make a bid or offer on a customer's order if called upon to do so by the specialist. In return for standing ready to trade even when it is not always in their interest to do so, market-makers enjoy reduced margin requirements, and are able to execute trades for their own account faster than traders who must use a broker.

The floor trader takes the lowest offer—in this case 1.15¢, implying a premium of \$143.75—and "matches tickets" with the selling trader, confirming the trade in pencil on printed paper slips. The buying trader hands the slips to the specialist, who staples them and gives them to an exchange employee who puts the information into the exchange's computerized reporting system. As soon as the trade is in the exchange's reporting system it is flashed onto the trading floor screens and private wire service screens. By SEC rules, the trade must be reported on the system within 90 seconds of when it occurred. The broker's floor trader then wires confirmation of the trade back to the broker, who advises his customer that the trade has been completed. If the option seller is another customer rather than a market-maker, the seller's order will have followed a similar path through the customer's broker to the exchange floor, with one difference: the seller's broker will have required a margin deposit from its customer to protect the broker, the exchange's clearing corporation, and the option buyer from default.

The greatest obstacle to achieving widespread participation in option trading is credit risk: option buyers are at risk that sellers will default when the options are exercised. To assure buyers that sellers will fulfill their contracts, the exchanges restrict trading privileges to members and provide clearing corporation guarantees for their options. Exchange

price, and will generally exceed this amount, reflecting the probability that the spot price might deviate even further from the exercise price before the option expires. See Robert A. Jarrow and Andrew Rudd, *Option Pricing* (Homewood, Ill.: Irwin, Inc., 1983) for a discussion of the determinants of option prices.

rules require the public to trade currency options through exchange member firms, who are liable to other members for their customers' traders. In the event that an option seller defaults, then, the seller's member firm is responsible for completing the contract with the buyer's member firm. As a result, members have an incentive to execute trades only for customers they believe are willing and able to honor their contracts. The clearing corporation guarantees, however, provide an even stronger safeguard for traders. All organized options exchanges are affiliated with a clearing corporation, a non-profit organization of member firms that clears trades on the exchange.⁶ Though

CONTRACT SPECIFICATIONS ON THE AMSTERDAM, MONTREAL, AND PHILADELPHIA EXCHANGES

The European Options Exchange (Amsterdam), the Montreal Exchange, and the Philadelphia Stock Exchange all offer trading in standardized puts and calls on foreign currencies. The following table gives the number of foreign currency units underlying each option contract offered on the three exchanges:

Currency	Trading Units		
	European Options Exchange (Amsterdam)	Montreal Exchange	Philadelphia Stock Exchange
British pounds	£5,000	£5,000	£12,500
Canadian dollars	—	CD 50,000	CD 50,000
Deutsche marks	\$10,000	DM 25,000	DM 62,500
Japanese yen	—	¥ 2,500,000	¥ 6,250,000
Swiss francs	—	SF 25,000	SF 62,500
Dutch guilders	\$10,000	—	—

— Indicates that the contract is not offered on that exchange.

Payment for all options on the Montreal and Philadelphia exchanges is in U.S. dollars. Payment for each of the options offered on the Amsterdam exchange, however, is in a different currency. The Amsterdam exchange offers an option on British pounds with payment in U.S. dollars, an option on U.S. dollars with payment in Dutch guilders, and an option on U.S. dollars with payment in Deutsche marks. Contracts on all three exchanges are issued with maturities of 3, 6, and 9 months, with expiration dates set in March, June, September, and December to coincide with the maturity dates of the CME's International Monetary Market's foreign currency futures contracts. Option contract sizes are also compatible with the IMM's futures contracts; the Philadelphia exchange's options, for example, are exactly one half the size of the corresponding IMM futures contracts. Making currency option contracts compatible with futures contracts facilitates cross-trading between the two kinds of instruments, encouraging trading volume growth in both markets.

customers trade options with each other through member firms on the exchange, options are legally contracts with the clearing corporation, not other customers. In effect, the clearing corporation inserts itself between the buyer and seller of every option, giving each party a contract with the clearing corporation. The clearing corporation guarantees all trades, and stands ready to assess its member firms to cover losses resulting from a default by a member firm. To protect itself from losses, the clearing corporation requires that a security deposit known as a margin be posted by exchange members that have sold options; the members in turn generally require their customers to make margin deposits with them. By providing for clearing corporation guarantees, the exchanges have created an option instrument that people can trade without worrying about each other's creditworthiness.

Options on Currency Futures. Recently, the Chicago Mercantile Exchange (CME) introduced a new option instrument to compete with the currency options offered by exchanges and banks: an option on a foreign currency futures contract. This option contract gives the holder the right to buy or sell a futures contract for Deutsche marks, rather than the marks themselves. When a buyer exercises this option, he or she receives a futures contract to buy or sell 125,000 Deutsche marks on the CME's International Monetary Market at a set price. The futures contract can either be offset immediately to take the gain, or can be held to maturity. Like the currency options offered on other exchanges, the CME's option has standardized delivery dates and is guaranteed by a clearing corporation.

At first glance, an option on a futures contract rather than on the underlying currency appears to be an unnecessarily cumbersome instrument. For a number of reasons, however, options on futures

and currency options may be close substitutes. Futures prices and spot currency prices are closely correlated, so that an option on a futures contract is for most purposes as effective a hedging instrument as an option on the currency itself. Moreover, currency futures markets are more accessible to small traders seeking to make large trades than are spot or forward foreign currency markets. In trading spot currencies with a bank, small traders typically would have to pay retail prices that are higher than the wholesale prices charged on large trades. In addition, banks are reluctant to make forward contracts that are large relative to the resources of small traders. In contrast, arranging for a large futures contract to make delivery under an option is no problem for small traders. Also, an option on a futures contract makes it easy for traders to shift between options and futures to take advantage of temporary price misalignments between the two markets. The CME hopes that its option on a futures contract will be attractive to the kinds of traders who currently trade currency options and will appeal to new groups of traders as well.

Bank Options. The bank market for foreign currency options is composed of large U.S. banks which write options for their corporate customers. When banks write puts and calls, they are creating a market individually by buying and selling for their own account. Banks provide no trading floors for the exchange of orders; instead, they quote prices directly to customers, often by telephone. Usually, banks only sell options, and write the contracts as European options. Because the option seller is commonly a bank with whom the customer has had a long-standing relationship, the customer generally has little concern that the bank will default on the option.

Banks write currency options on an individual basis, tailoring the contracts to the specific currency, quantity, and maturity needs of each customer. Not surprisingly, no secondary market yet exists for bank options: creating a secondary market would require banks to agree to some minimal contract standardization conventions, and reaching such an agreement is likely to take some time. Banks sometimes reduce the risks they have taken in selling options, however, by buying currency options on an exchange. When banks completely offset their option sales in this way, they are acting as middlemen between their customer and the

⁶Options on the Philadelphia Stock Exchange are cleared and guaranteed by the Options Clearing Corporation, which also clears and guarantees equity and debt options traded on the American Options Exchange, the Chicago Board Options Exchange, the Pacific Stock Exchange, and the New York Stock Exchange. Currency options on the European Options Exchange and the Montreal Exchange are cleared and guaranteed by the International Options Clearing Corporation, which is operated as a joint venture with the Vancouver Stock Exchange and Sydney Stock Exchange.

ultimate sellers of the contract. When banks choose instead not to offset options written for customers, they are acting as insurers, bearing their customers' exchange risk in return for fee income.

WHICH OPTION MARKETS WILL PROSPER?

Is the market for currency options large enough to accommodate the growing number of competitors seeking to provide traders with options? Will customers prefer some types of currency option markets to others? To the extent that differences among the option contracts offered in various markets are small, traders are likely to gravitate to the market that promises the highest trading volume. Studies of futures markets have shown that trading costs decline with volume, so that a single market for any contract will provide lower cost trading than two markets that each have half as much volume.⁷ This explains why each contract traded in financial futures markets has come to be traded on a single exchange, unless the exchanges have been located on different continents (with different trading hours), and there is little reason to believe that the experience with trading in foreign currency options will be different. If, on the other hand, the differences in option contracts offered in various markets are large, each contract may appeal to traders with different needs, and all market-makers may coexist.

Differences among exchanges' options are small: the currency options traded on the Amsterdam, Montreal, and Philadelphia exchanges are fundamentally the same instruments, and it is clear that the three exchanges are competing head to head for the same kind of customers. So far, the Philadelphia Stock Exchange has generated by far the greatest trading volume: trading has expanded rapidly from an average of 394 puts and calls per day in January 1983 to over 5,778 per day in March 1984. The Philadelphia Stock Exchange has generated more trading in each of its contracts than the other two exchanges, with the exception of the Canadian dollar option, which traded in greater volume in Montreal than in Philadelphia in every month but one in 1983. Volume on all three exchanges has picked up sharply in early 1984, re-

flecting in part an increase in exchange rate volatility in the first three months of the year.

Options based on currencies and the CME's option on a currency futures contract are similar enough to suggest that the CME will also be competing directly with the other exchanges. The CME's Deutsche mark futures option has done well since its introduction on January 24, 1984: an average of 1,954 calls and puts were traded per day in February, 2,756 in March, and 2,332 in April 1984. Nevertheless, trading volume in Philadelphia's mark contract is still growing, indicating that for the time being both exchanges are sharing an expanding market.

While the differences among the exchanges' options are small, differences between the kinds of options offered by the exchanges and those offered by banks are large enough to suggest that they may attract different customers. The standardized and guaranteed options available on exchanges are likely to attract buyers who need options on major currencies and buyers who do not wish to incur the costs of searching out and evaluating the credit of sellers. In addition, the exchanges are likely to attract small investors: trading on exchanges is open to virtually all buyers, and to any sellers able to meet their brokers' margin requirements. The tailor-made options written by banks, on the other hand, are likely to be attractive to customers who need options in less frequently traded currencies, or who need options for maturities that differ substantially from those offered by exchanges. Bank options are also likely to attract customers who have an infrequent need for options, but make forward contracts with banks regularly.

To date, trading on the Philadelphia exchange has attracted a large number of foreign firms and individual investors, as well as U.S. and foreign banks.⁸ Banks, in contrast, appear to have written options mostly for large U.S. and multinational corporations, many of whom already use the

⁷See Lester G. Telser, "Why Are There Organized Futures Exchanges?" *Journal of Law and Economics*, Vol. 24, No. 1 (April 1981).

⁸Subsidiaries of two bank holding companies, Bank of America and Citicorp, began serving as specialists on the floor of the Philadelphia Stock Exchange in 1984. In addition, in April 1984 the Federal Reserve Board approved an application of Fidelcor, Inc., a Pennsylvania bank holding company, to trade foreign currency options for its customers through a subsidiary.

banks for their forward foreign exchange trading. These differences in customers indicate that exchange and bank options may exist side by side for some time, much as futures and forward markets for foreign exchange have coexisted during the past decade.

CONCLUSION

Since late 1982, traders have been able to use options on foreign currencies in addition to forward and futures contracts to manage their exchange rate risk. These options allow traders to profit from favorable exchange rate changes while avoiding the risks of adverse movements. Because they convey the right, but not the obligation, to buy or sell a foreign currency, options can be used

to hedge transactions that are not certain to occur, a task for which forward and futures contracts are not well suited.

Continued volatility in exchange rates and growth in international trade will ensure a demand for currency options. Exchange options and over-the-counter bank options are likely to coexist for some time because they are different instruments and appeal to different customers. Many exchange options, however, are close substitutes for each other. The experience with futures markets suggests that not all exchanges' options will prosper, and that traders will increasingly give their business to the market able to offer the greatest volume and lowest cost trades.

APPENDIX

Put-Call Parity

Though options and forward contracts are distinct instruments, their prices are linked together by the actions of traders who buy and sell both instruments in search of profits. The basic trading strategy for profiting from a price difference between option and forward markets is called a *reversal*. With this strategy, a trader simultaneously buys a call and sells a put, both for the same expiration date and exercise price E . This strategy will give the trader a pattern of gains and losses that duplicates that on a forward contract to purchase the currency on that expiration date at the exercise price E . The trader will, by maturity, gain dollar-for-dollar on the call by the amount the spot price rises above E , or lose dollar-for-dollar on the put by the amount the spot price falls below E , just as he would on a forward contract. The price at which the trader has effectively purchased currency forward, however, should take into account the interest cost of borrowing the difference between the premium C paid for the call and the premium P received for the put (if C is greater than P) over the life of the contracts. Assuming the trader can borrow at an interest rate i , the price at which the trader is buying the currency forward under the reversal will be:

$$(1) \quad E + (C - P)(1 + i)$$

where C and P are measured per quantity of currency traded.

If the cost of obtaining the currency using this strategy is cheaper than buying it under a forward contract at the going forward rate F , the trader will, by coupling the reversal with a forward sale, earn a profit of π_r :

$$(2) \quad \pi_r = F - E - (C - P)(1 + i)$$

Alternatively, if the cost of buying currency under a forward contract is cheaper than obtaining it by combining puts and calls, the trader could profit by executing the mirror image trade of the reversal called a *conversion*. Here the trader would create an artificial contract to sell the currency forward by buying a put, selling a call, and investing the difference (if it is positive) between the two premiums in a money market instrument paying a rate of interest i . This strategy will, coupled with a forward purchase, produce a profit of π_c :

$$(3) \quad \pi_c = E + (C - P)(1 + i) - F$$

As many traders try to take advantage of price differentials between the forward and options markets, they will drive the call prices up and put prices down when executing reversals (and drive call prices down and put prices up in executing conversions) until no more profits can be made with these strategies ($\pi_r = \pi_c = 0$). This implies that in equilibrium the difference between the call and put premiums for an option at an exercise price E will be equal to the difference between the forward exchange rate F and E , discounted to the market interest rate or:

$$(4) \quad C - P = (F - E)/(1 + i)$$

This relationship is called *put-call parity*. How close does it come to describing the relationship we see in reported option and forward prices? A complete answer requires a careful statistical study, but a rough idea can be obtained by seeing how close the put-call parity theory comes to predicting the actual price differences between puts and calls on one of the Philadelphia Stock Exchange's most active contracts on a recent date. On July 17, 1984, at 10:11 a.m., calls on the Deutsche mark contract with a \$.36 striking price and September expiration were trading for \$318.75, while puts on that contract were trading for \$631.25. These prices are the average bid-offer prices on recent trades, kindly provided by the Financial Options Group, Inc. A 2-month forward contract made on July 17th would be settled on the same date the options expired, and the average bid-offer rate on this contract posted by Citibank's New York office was \$.3555. The 2-month CD rate, taken here to be a representative interest rate, was 11.63 percent, or 1.85 percent for 2 months.

Inserting the figures for the forward rate, the exercise price, and the interest rate into the put-call parity formula gives a predicted difference between the call and put premiums of $-\$276.14$:

$$\begin{aligned} \text{Predicted } (C - P) &= [(F - E) \times 62,500]/(1 + i) \\ &= [(.3555 - .36) \times 62,500]/(1.0185) \\ &= -\$276.14 \end{aligned}$$

The difference between the forward price and the exercise price ($F - E$) was multiplied by the number of Deutsche marks in the Philadelphia Stock Exchange's contract to put these prices in the same units as the premium.

The actual difference between the call and put options on July 17th was $-\$312.50$. So the parity formula used with market data gives a close prediction of what the relationship among call, put, and forward prices was on the date. Could traders have executed reversals and conversions at the time the market data were taken to profit from the price difference? The answer is no: inserting the appropriate bid and offer prices into the reversal condition formulas (equations (2) and (3)) revealed no profit opportunities. In addition, the formulas do not take brokerage costs—which are on the order of \$13 to \$16 per option—into account. At the time the market data were collected, the September Deutsche mark option with a \$.36 striking price was not mispriced relative to the forward market.