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The Impact of Backwardation on Hedgers' Demand for Currency Futures Contracts: Theory versus Empirical Evidence

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The Impact of Backwardation on Hedgers' Demand for Currency Futures Contracts: Theory versus Empirical Evidence*

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Abstract

This study compares the relation between backwardation and optimal hedging demand as suggested by economic theory to empirical findings concerning the impact of weak and strong backwardation on hedgers' trading volume in six long and short currency futures contracts. First, the optimal hedging demand of a representative importer, with and without hedging costs, is derived. Then hedgers' position data from the Commitments of Traders (COT) report are regressed on weak and strong backwardation. The empirical results offer little support for the hypotheses suggested by economic theory.

Keywords: Backwardation, hedging, currency futures.

JEL Classification: **C20, D81, G15.**

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1 Introduction

Most recent models on optimal hedging deal with exporting firms facing price or exchange rate risk. In order to hedge the spot commitment, firms go short in futures contracts.[1] This hedging literature, dealing with exporting firms hedging short, unequivocally suggests a negative relation between backwardation and the size of the optimal short hedging position.[2] In sum, the literature suggests that if the futures market is characterized by backwardation [contango] it is optimal for the short hedger to underhedge [overhedge] where underhedging [overhedging] means choosing a futures position smaller [larger] than the initial spot commitment. In the absence of backwardation or contango, the firm hedges fully, and therefore chooses the futures position to be the same size as the spot position.[3] Hence, an increase in backwardation should ceteris paribus reduce the trading volume of hedgers in short futures contracts.

This paper studies the impact of backwardation on hedging activity in short and long currency futures contracts. First, the optimal hedging strategy of a representative importer is derived. The importing firm expects delivery of a certain amount of a good at a futures date at the then prevailing random exchange rate. To hedge the spot exposure the importer can go long in currency futures markets. Second,

[1] See e.g. Briys, Crouhy and Schlesinger (1993), Briys and de Varenne (1998), Briys and Schlesinger (1993), Friberg (1998), Adam-Müller (1997, 2000) and Lien and Wang (2002). For more information on the role of unbiasedness in futures markets and hedging see e.g. Benninga, Eldor and Zilcha (1984, 1985), Broll and Eckwert (1996, 2000), Broll, Wahl and Zilcha (1995) and Zilcha and Broll (1992).

[2] In the literature, the term backwardation is used in a variety of ways relating current and expected spot prices to futures and forward prices. Following Holthausen (1979), Briys and Schlesinger (1993) and Adam-Müller (2000), in this study, backwardation is defined as the futures price being less than the expected spot price. The futures market is said to exhibit contango if the futures price exceeds the expected spot price. The literature on backwardation and contango dates back to Keynes (1930), Hicks (1939) and Kaldor (1940). There is a large literature dealing with the controversy about the Keynesian "normal backwardation" hypothesis. Some studies find backwardation to be normal while others reject the hypothesis. For a survey on the controversy, see e.g. Ehrhardt, Jordan and Walkling (1987), Kolb (1992) and Miffre (2000). This paper does not add to this controversy but rather investigates the impact of backwardation on hedgers' demand for currency futures contracts.

[3] See e.g. Briys, Crouhy and Schlesinger (1990, 1993), Briys and de Varenne (1998), and Broll and Wong (2002).

hedging costs are introduced into the model. Third, the impact of backwardation on long and short hedging activity in six currency futures markets is investigated empirically. To the best of our knowledge, there is rarely any literature dealing with importers hedging long. Among the few exceptions are Haigh and Holt (2000) and Jin and Koo (2006). Haigh and Holt (2000) use a model in which hedgers are simultaneously long and short in different futures markets. Jin and Koo (2006) examine the hedging problem of a Japanese grain importer facing multiple risks. However Haigh and Holt (2000) and Jin and Koo (2006) do not investigate the role of backwardation and contango on optimal hedging. In addition the model in this paper is related to the expected utility framework laid out by Holthausen (1979) and Briys and Schlesinger (1993), whereas Haigh and Holt (2000) and Jin and Koo (2006) both employ the mean-variance concept. Holthausen (1979) and Briys and Schlesinger (1993) investigate the impact of backwardation on the optimal hedging decisions of exporting firms. The model presented in this paper extends these investigations to importers. In addition, this paper investigates the impact of hedging costs on the importer's optimal hedging strategy.

The model of the importer's hedging problem introduced in this paper leads to the conclusion that it is optimal for long hedgers to overhedge [underhedge] if the futures market is characterized by backwardation [contango]. The firm hedges fully in the absence of backwardation or contango. However, this result is altered by introducing hedging costs. In fact, the existence of hedging costs provides a rationale for backwardation to be normal. In the presence of hedging costs, the importing firm hedges fully if, and only if, the futures market exhibits backwardation. The firm tends to overhedge if the amount of backwardation exceeds hedging costs. The firm hedges fully if the extent of backwardation equals hedging costs. If hedging costs exceed the amount of backwardation, or, if the futures market is unbiased or exhibits contango, the optimal hedge is a partial hedge. However, irrespective of the existence of hedging costs, an increase in backwardation should ceteris paribus increase the trading volume of hedgers in long futures contracts.

Although there is a large literature dealing with backwardation and firms' optimal hedging strategies in the theory of the firm, few attempts have been made to approach the impact of backwardation on hedgers' demand for futures contracts empirically. The empirical part of this study analyzes the impact of backwardation on hedgers' demand for short and long currency futures contracts in six currency futures markets. Following Litzenberger and Rabinowitz (1995) and Pindyck (2001), two measures for backwardation (i.e., weak and strong backwardation) are employed. Using simple OLS regression analysis the results of this study show that backwardation has a significant impact on hedgers' trading volume in currency futures markets. However, the sign of the impact does not correspond to economic theory for all currencies. The results therefore offer very little support for the hypothesis that short [long] hedging activity depends negatively [positively] on backwardation.

In Section 2 the model is presented and the firm's optimal hedging strategy is derived. The impact of backwardation and contango on the optimal hedge are analyzed and hedging costs are introduced into the model. Section 3 presents the empirical results based on OLS regressions. Section 4 concludes.

2 The Expected Utility Hedging Model

2.1 *Optimal Long Hedging*

Suppose there is a representative importer in country A who is obliged to buy a known quantity x of a good from country B at period $t = 1$ at a certain price level p.[4] Having made the decision to import the quantity x, the firm faces exchange rate

[4] It is important to stress that the quantity x of imports is given. Since the firm in this model is not deciding about the optimal production level, and therefore not choosing the optimal amount of imports, this model can be interpreted as concerned with the short run. Moreover, the price level p is fixed, also pointing to a short run model. According to Sandmo (1971) this approach may be considered a weakness but also a strength. The weakness concerns the separation of production policy and strategies for financing and investment. A strength of dealing with short run profits is that the model stays relatively simple and is not based on too many assumptions. Moreover it is more realistic and applicable since hedging is generally concerned with single cash flows, and hedging vehicles like futures are generally available only for the short run.

risk between the period the decision is made (i.e., $t = 0$) and the spot commitment date $t = 1$. The expected return of the spot position depends on the random exchange rate $\tilde{e}_1$ as follows:

$$E(R_S) = -\tilde{e}_1 px \tag{1}$$

Since the price level p is non-stochastic and known at period $t = 0$, p is set equal to one for simplicity. In addition to the spot commitment, the importer can trade long futures contracts in the currency futures market. Let f_0 be the futures price at time $t = 0$ for delivery of a certain amount of foreign currency in $t = 1$. In this model the importer holds the futures position until delivery at period $t = 1$, that is, until the spot commitment date. At futures delivery date, the random futures delivery price is $\tilde{f}_1$. Suppose that, due to arbitrage relations, the random spot price and the random futures price coincide at spot commitment date (futures delivery date, respectively). Then, since basis risk is absent, the expected return of the long futures position $\tilde{f}_1 - f_0$ equals $\tilde{e}_1 - f_0$ per contract h.[5] If the term $\tilde{e}_1 - f_0$ is zero [not zero], the futures market is said to be unbiased [biased]. If the futures price is less than the expected spot price (i.e., $\tilde{e}_1 - f_0 > 0$), the futures market exhibits backwardation. The futures market exhibits contango if the futures price exceeds the expected spot price (i.e., $\tilde{e}_1 - f_0 < 0$). The expected profit of the hedged portfolio is the sum of the expected return of the spot position plus the long futures position:

$$E(\Pi) = -\tilde{e}_1 x + (\tilde{e}_1 - f_0)h \tag{2}$$

It can be easily seen that the long futures position can be used to offset (i.e., to hedge) the existing spot exchange rate exposure. If the importer chooses the amount

[5] The difference between the random variables $\tilde{e}_1$ and $\tilde{f}_1$ in the delivery period is known as the basis (or, basis risk, respectively). See e.g. Peck (1975) and Lapan and Moschini (1994).

of futures contracts traded h to equal the spot commitment x, then the expected profit of the hedged portfolio is non-stochastic. This hedging strategy is widely known as the "equal and opposite" or "one to one" hedge. However, although potential losses in the spot position are offset by the futures position, potential gains in the spot position due to a decrease in the exchange rate are offset as well by losses in the futures position.

The importer's decision problem is to choose a futures position h to maximize expected utility. The importing firm maximizes its expected utility of profit at date $t = 1$ where U is a concave, continuous and differentiable utility function defined over profit Π.

$$\underset{h}{Max}\, EU[\Pi] = U[-\tilde{e}_1 x + (\tilde{e}_1 - f_0)h] \tag{3}$$

The firm is assumed to be risk averse, so that $U'[\Pi] > 0$, $U''[\Pi] < 0$.[6] Following Briys and Schlesinger (1993) the first-order condition is calculated:

$$\frac{\delta EU[\Pi]}{\delta h} = EU'[-\tilde{e}_1 x + (\tilde{e}_1 - f_0)h](\tilde{e}_1 - f_0) = 0 \tag{4}$$

Using the representation of profit presented in equation (2) the first-order condition can be rewritten as

$$\frac{\delta EU[\Pi]}{\delta h} = EU'[\Pi](\tilde{e}_1 - f_0) = 0 \tag{5}$$

The second-order condition for a maximum are assumed to hold given risk aversion.[7]

[6] For more information on similar utility functions and risk aversion see e.g. Pratt (1964), Baron (1970), Rothschild and Stiglitz (1970), Sandmo (1971), Diamond and Stiglitz (1974), Ishii (1977), and Kimball (1990, 1993).

[7] The second partial derivative of the utility function with respect to h is

Using the covariance operator Cov, equation (5) can be written as[8]

$$\frac{dEU[\Pi]}{dh} = EU'[\Pi]E(\tilde{e}_1 - f_0) + Cov[U'[\Pi], \tilde{e}_1] = 0 \tag{6}$$

The covariance term $Cov[U'[\Pi], \tilde{e}_1]$ is crucial in the subsequent analysis of the relationship between hedging activity and backwardation. Equation (6) can be used to determine the conditions under which the risk-averse firm hedges fully (i.e., $h = x$), hedges partially (i.e., $0 < h < x$), or overhedges (i.e., $h > x$). Note that equation (6) consists of three terms. $U'[\Pi]$ is positive for any Π by definition. The second term, $E(\tilde{e}_1 - f_0)$, is zero if the futures market is unbiased (i.e., $\tilde{e}_1 = f_0$). Suppose the second term is zero, then equation (6) reduces to $Cov[U'[\Pi], \tilde{e}_1] = 0$.

In order to analyze the covariance term in more detail, recall that profit at date 1 is given by $E[\Pi] = -\tilde{e}_1 x + (\tilde{e}_1 - f_0)h$. As already mentioned, profit is independent of the exchange rate if $h = x$, and hence the covariance is zero. If the firm hedges less than full (i.e., $h < x$) the covariance is positive and if the firm overhedges (i.e., $h > x$) the covariance is negative.[9]

$$\frac{\delta^2 EU[\Pi]}{\delta h^2} = EU''[\Pi](\tilde{e}_1 - f_0)^2.$$

The equation is negative since $U'[\Pi] > 0$, $U''[\Pi] < 0$ by definition. Therefore an interior maximum exists. However, as Holthausen (1979, p. 989) points out, this is not the case for risk-neutral ($U''[\Pi] = 0$) or risk-loving firms ($U''[\Pi] > 0$).

[8] To see this, recall that $E(XY) = E(X)E(Y) + Cov(X, Y)$ (see e.g. Cochrane, 2001, p. 15). Equation (5) can therefore be rewritten as

$$EU'[\Pi](\tilde{e}_1 - f_0) = EU'[\Pi]E(\tilde{e}_1 - f_0) + Cov[U'[\Pi], (\tilde{e}_1 - f_0)] = 0$$

which in turn, using $Cov(X + Y, Z) = Cov(X, Z) + Cov(Y, Z)$, can be formulated as

$$EU'[\Pi]E(\tilde{e}_1 - f_0) + Cov[U'[\Pi], \tilde{e}_1] + Cov[U'[\Pi], -f_0] = 0$$

Since f_0 is non-stochastic, and using $Cov(1, X) = 0$, the equation can be simplified to

$$EU'[\Pi]E(\tilde{e}_1 - f_0) + Cov[U'[\Pi], \tilde{e}_1] = 0$$

[9] Note that the covariance is defined as

$$Cov(X, Y) = E((X - E(X))(Y - E(Y)))$$

Now, if the futures market is unbiased, the term $\tilde{e}_1 - f_0$ in equation (6) is zero. Therefore, the covariance must be zero as well for equation (6) to hold. For the covariance to be zero, which is achieved if profit is independent of exchange rate changes, the firm must hedge fully. Hence, firms hedge fully when the futures market is unbiased. If the futures market exhibits backwardation (i.e., $\tilde{e}_1 > f_0$) the second term in equation (6) is positive. The covariance in equation (6) therefore must be negative for the condition that the first-order-condition equals zero to hold. This implies that $h > x$. The resulting futures position is an overhedge. Now suppose that the futures market exhibits contango (i.e. $\tilde{e}_1 < f_0$). In this case, the covariance in equation (6) must be positive, since the first term in the equation is negative, for the condition that the first-order-condition equals zero to hold. This implies that $h < x$. The resulting futures position is a partial hedge.

2.2 *Hedging Costs and Optimal Hedging*

In this section hedging costs are introduced into the model. The expected utility of profit with hedging costs is

$$EU[\Pi] = U[-\tilde{e}_1 x + (\tilde{e}_1 - f_0 - c)h] \tag{7}$$

Again, profit is independent of the exchange rate if the firm hedges fully (i.e., $h = x$). In this case, spot exposure is completely offset and therefore perfectly hedged by the futures position. Maximizing expected utility of profit with respect to h yields

Suppose that $X = U'[\Pi]$ and $Y = \tilde{e}_1$. If the firm underhedges (i.e., $h < x$), the futures position is smaller than the spot position and profit therefore depends negatively on the random exchange rate. An increase in $\tilde{e}_1$ decreases Π and, due to concavity, increases $U'[\Pi]$. Hence, $(X - E(X)) > 0$. In addition, an increase in $\tilde{e}_1$ leads to $(Y - E(Y)) > 0$. The covariance is therefore positive. However, if the firm overhedges (i.e., $h > x$), the futures position is larger than the spot position. Since the futures position yields profits when $\tilde{e}_1$ increases, profit depends positively on the exchange rate. Hence, an increase in $\tilde{e}_1$ increases Π and decreases $U'[\Pi]$, again, due to concavity. Therefore $(X - E(X)) < 0$. Since, everything else is equal, the covariance is negative.

$$\frac{dEU[\Pi]}{dh} = EU'[-\tilde{e}_1 x + (\tilde{e}_1 - f_0 - c)h](\tilde{e}_1 - f_0 - c) = 0 \tag{8}$$

Using covariances, the first-order condition can be rewritten as

$$\frac{dEU[\Pi]}{dh} = EU'[\Pi]E(\tilde{e}_1 - f_0 - c) + Cov[U'[\Pi], \tilde{e}_1] = 0 \tag{9}$$

Equation (9) consists of three terms. Again, $U'[\Pi]$ is positive for any Π by definition. The second term, $E(\tilde{e}_1 - f_0 - c)$ is zero if hedging costs equal the amount of backwardation (i.e., $c = \tilde{e}_1 - f_0$). Suppose, the second term is zero, then equation (9) reduces to $Cov[U'[\Pi], \tilde{e}_1] = 0$, which holds true if firms hedge fully. If $c > 0$, the term $E(\tilde{e}_1 - f_0 - c)$ in equation (9) is zero if $E(\tilde{e}_1 - f_0) > 0$, or more precisely if $E(\tilde{e}_1 - f_0) = c$. Hence, firms hedge fully if, and only if, futures markets are biased, i.e. exhibit backwardation ($E(\tilde{e}_1) > f_0$). If the amount of backwardation exceeds trading costs c (i.e., $E(\tilde{e}_1 - f_0) > c$), the second term in equation (9) is positive. The covariance in equation (9) therefore must be negative for the condition that the first-order-condition equals zero to hold. This implies that $h > x$. The resulting futures position is an overhedge. In the case of an unbiased futures market (i.e., $E(\tilde{e}_1) = f_0$), or if the futures market exhibits contango (i.e., $E(\tilde{e}_1) < f_0$), the covariance in equation (9) therefore must be positive for the condition that the first-order-condition equals zero to hold. This implies that $h < x$. The resulting futures position is a partial hedge.

3 Empirical Investigation

In this section the impact of backwardation on short and long hedging activity is empirically investigated. Regarding short hedging, again, the hedging literature suggests that in the case of backwardation [contango] it is optimal to underhedge [overhedge]. The theoretical model in this study dealing with a representative importer's long hedging problem suggests that it is optimal to overhedge [underhedge] if the futures market is characterized by backwardation [contango]. Hence, ceteris paribus, the hedging models predict a negative effect of backwardation on short hedging activity and a positive effect on long hedging activity.

3.0.1 *Data and Summary Statistics*

The empirical investigation uses weekly data on spot and futures prices and hedgers' positions for six currency futures contracts traded at the Chicago Mercantile Exchange. Australian Dollar (AUD), Canadian Dollar (CAD), Swiss Francs (CHF), Euro (EUR), Japanese Yen (JPY), and Mexican Peso (MXP) futures contracts are investigated. The hedgers' position data come from the Commodity Futures Trading Commission's (CFTC) Commitments of Traders (COT) report and the price data come from Datastream.[10]

Following Litzenberger and Rabinowitz (1995) and Pindyck (2001), two measures for backwardation are employed. Futures markets exhibit strong backwardation if futures prices are below spot prices (i.e., $\tilde{e}_t > \tilde{f}_t$). Weak backwardation is defined as a situation where discounted futures prices are below spot prices (i.e., $\tilde{e}_t > exp(-r_t * (3/12))\tilde{f}_t$ where r_t is the three month LIBOR rate).

[10]For more information on the COT report, see e.g. Chatrath, Song and Adrangi (2003) and Röthig and Chiarella (2007).

Table 1: Summary statistics for backwardation and hedging activity

Futures contract	AUD		CAD		CHF		EUR		JPY		MXP	
Sample	02 Jan 2001 to 31 Jan 2006		06 Oct 1992 to 31 Jan 2006		06 Oct 1992 to 31 Jan 2006		12 Jan 1999 to 31 Jan 2006		06 Oct 1992 to 31 Jan 2006		26 Mar 1996 31 Jan 2006	
Observations	252		696		694		369		696		515	
Panel A: Weak and strong backwardation												
	BW	BS	BW	BS	BW	BS	BW	BS	BW	BS	BW	BS
Mean	0.0101	0.0030	0.0101	0.0001	0.0075	-0.0023	0.0121	-0.0004	0.0000	-0.0000	0.0032	0.0018
Minimum	0.0027	-0.0040	0.0048	-0.0056	-0.0004	-0.0094	-0.0039	-0.0180	-0.0000	-0.0001	-0.0017	-0.0028
Maximum	0.0178	0.0106	0.0245	0.0091	0.0230	0.0129	0.0224	0.0115	0.0002	0.0000	0.0119	0.0101
Standard error	0.0028	0.0024	0.0026	0.0019	0.0030	0.0030	0.0030	0.0037	0.0000	0.0000	0.0023	0.0020
% in backwardation	100	92.46	100	53.01	99.85	21.32	99.72	50.13	96.40	6.75	99.61	98.83
Panel B: Short hedging activity												
	Short		Short		Short		Short		Short		Short	
Mean	35539.88		39196.21		22124.58		65122.91		47972.39		27602.20	
Minimum	4910.00		4945.00		1932.00		2984.00		7440.00		1306.00	
Maximum	114073.00		111552.00		86565.00		148495.00		184367.00		127620.00	
Standard error	19312.65		21500.59		14244.79		28653.69		30963.11		23741.40	
Panel C: Long hedging activity												
	Long		Long		Long		Long		Long		Long	
Mean	12569.76		27201.43		28371.87		39115.23		62162.80		17977.66	
Minimum	1294.00		1360.00		1558.00		1647.00		10111.00		1752.00	
Maximum	51749.00		63398.00		87271.00		125244.00		188591.00		54741.00	
Standard error	9973.88		13125.70		17377.14		20266.04		28854.10		9804.78	

Note: The summary statistics are computed using weekly data. The price data are obtained from Datastream. Strong backwardation is defined by $BS_t = \tilde{e}_t - \tilde{f}_t$ where $\tilde{e}_t$ is the spot price and $\tilde{f}_t$ is the futures price in t. Weak backwardation is defined by $BW_t = \tilde{e}_t - exp(-r_t * (3/12))\tilde{f}_t$ where r_t is the three month LIBOR rate. Data on hedging activity are obtained by the Commodity Futures Trading Commission's (CFTC) Commitments of Traders (COT) report. Short hedging activity is defined by $Short_t = Comm\_Positions\_Short\_All_t$, and long hedging activity is defined by $Long_t = Comm\_Positions\_Long\_All_t$.

The summary statistics are presented in Table 1. With regard to the measure of weak backwardation, backwardation appears to be normal as proposed by Keynes (1930). All currency futures markets investigated exhibit weak backwardation at least 95 percent of the time. The results for strong backwardation are mixed. While some currency futures prices were on average strongly backwarded (i.e., the AUD and MXP series over 90 percent of the time) some exhibit backwardation and contango from time to time (i.e., CAD and EUR), and some exhibit contango most of the time (i.e., CHF and JPY). Interestingly, with regard to the measure of strong backwardation, in the markets where futures prices exhibit contango hedgers are on average net long (i.e., the mean of long hedging activity exceeds the mean of short hedging activity in Table 1). Miffre (2000) points out that the idea that backwardation and contango depend on hedgers' net positions is consistent with the Keynesian hypothesis. According to this hypothesis, futures prices should be backwarded if hedgers are net short, and futures prices should exhibit contango if hedgers are net long. The inequality between hedgers' long and short positions requires the existence of speculators to fill the gap and restore equilibrium.[11] Since backwardation and contango can be regarded a risk premium earned by speculators, backwardation [contango] attracts speculators to go long [short]. However, with regard to the hedging literature and in line with the model in the previous section, in addition to speculators, hedgers are motivated to hedge long [short], if futures prices exhibit backwardation [contango], as well.

3.1 *Estimation Results*

The impact of backwardation on short and long hedgers' volume of trading is investigated using OLS regressions. Theory suggests that, with growing backwardation, hedgers' demand for short futures contracts should be reduced and hedgers' demand

[11] Samuelson (1957, p. 194) points out that "[...] the total long position (of hedgers and speculators) must be exactly matched, at the equilibrium pattern, by the total short position (of hedgers and speculators)." See also Danthine (1978), Anderson and Danthine (1983) and Fort and Quirk (1988) for more information on backwardation and speculation.

Table 2: Short hedging and backwardation

Panel A: Short hedging and weak backwardation: $Short_t = \alpha_t + \beta_t BW_t + \varepsilon_t$						
	AUD		CAD		CHF	
	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$
Estimate	8374.65	2681316.81	75524.43	-3590257.59	25298.81	-419001.60
t-stat	2.0375	6.8684	26.0117	-12.9298	17.7391	-2.4039
p-value	0.0426	0.0000	0.0000	0.0000	0.0000	0.0164
	EUR		JPY		MXP	
	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$
Estimate	26469.23	3178129.72	52957.23	-69498562.11	36688.42	-2757165.72
t-stat	4.5113	6.7863	21.9728	-2.3656	20.8088	-6.2845
p-value	0.0000	0.0000	0.0000	0.0182	0.0000	0.0000
Panel B: Short hedging and strong backwardation: $Short_t = \alpha_t + \beta_t BS_t + \varepsilon_t$						
	AUD		CAD		CHF	
	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$
Estimate	32177.15	1109025.20	39483.96	-1449165.19	23329.78	513526.53
t-stat	16.7385	2.2473	48.6098	-3.5579	34.2664	2.8874
p-value	0.0000	0.0254	0.0000	0.0003	0.0000	0.0040
	EUR		JPY		MXP	
	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$
Estimate	66595.54	3488933.76	57072.55	174404335.43	33480.15	-3097865.11
t-stat	49.6444	9.6920	31.3663	6.4209	24.1169	-6.1738
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

for long futures contracts should increase. The empirical investigation in this study approaches this suggestion on an aggregate level by regressing hedgers' trading volume in short and long currency futures contracts on weak and strong backwardation. Table 2 reports the short hedging regression results for weak (Panel A) and strong (Panel B) backwardation. The results point to a significant impact of both weak and short backwardation on short hedging activity. However, this impact is not negative for all currency futures markets. Regarding the effect of weak backwardation presented in Panel A of Table 2, the estimates for the AUD and EUR series are significantly positive. Moreover, the results for strong backwardation shown in Panel B of Table 2 point only twice (i.e., for the CAD and MXP series) to a negative impact of backwardation on short hedging activity. Hence, the estimates do not unambiguously support the findings of a negative relation between backwardation and

Table 3: Long hedging and backwardation

Panel A: Long hedging and weak backwardation: $Long_t = \alpha_t + \beta_t BW_t + \varepsilon_t$						
	AUD		CAD		CHF	
	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$
Estimate	9646.06	288580.74	41389.99	-1402231.94	36792.97	-1111593.50
t-stat	4.1825	1.3174	21.8482	-7.7397	21.4854	-5.3112
p-value	0.0000	0.1889	0.0000	0.0000	0.0000	0.0000
	EUR		JPY		MXP	
	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$
Estimate	29186.73	816327.22	77025.10	-207209877.40	18794.19	-247771.17
t-stat	6.6789	2.3403	35.6481	-7.8672	24.9139	-1.3199
p-value	0.0000	0.0197	0.0000	0.0000	0.0000	0.1874
Panel B: Long hedging and strong backwardation: $Long_t = \alpha_t + \beta_t BS_t + \varepsilon_t$						
	AUD		CAD		CHF	
	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$
Estimate	15579.59	-992639.44	27547.95	-1745129.81	25325.67	-1297957.30
t-stat	16.0204	-3.9763	57.0800	-7.2110	31.1162	-6.1049
p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	EUR		JPY		MXP	
	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\alpha}$	$\hat{\beta}$
Estimate	39097.79	-41323.75	58951.70	-61540778.01	18564.30	-309176.63
t-stat	36.7717	-0.1448	33.9150	-2.3717	31.3038	-1.4423
p-value	0.0000	0.8849	0.0000	0.0179	0.0000	0.1498

trading volume of hedgers in short futures contracts as discussed in the theoretical hedging literature.

Table 3 presents the regression results for long hedging. Again, there appears to be a significant impact of backwardation on long hedgers' trading volume for all currencies except the MXP series, the AUD series and weak backwardation, and the EUR series and strong backwardation. However the sign of the impact does not correspond to the theoretical findings. The impact of backwardation on long hedging is negative for all currencies except the AUD series and weak backwardation, and the EUR series and weak backwardation reported in Panel A of Table 3. Hence, the regression results offer very little support for the hypothesis that hedging activity in long futures contracts depends positively on backwardation.

The graphical representations of the regression results confirm this finding. Figures

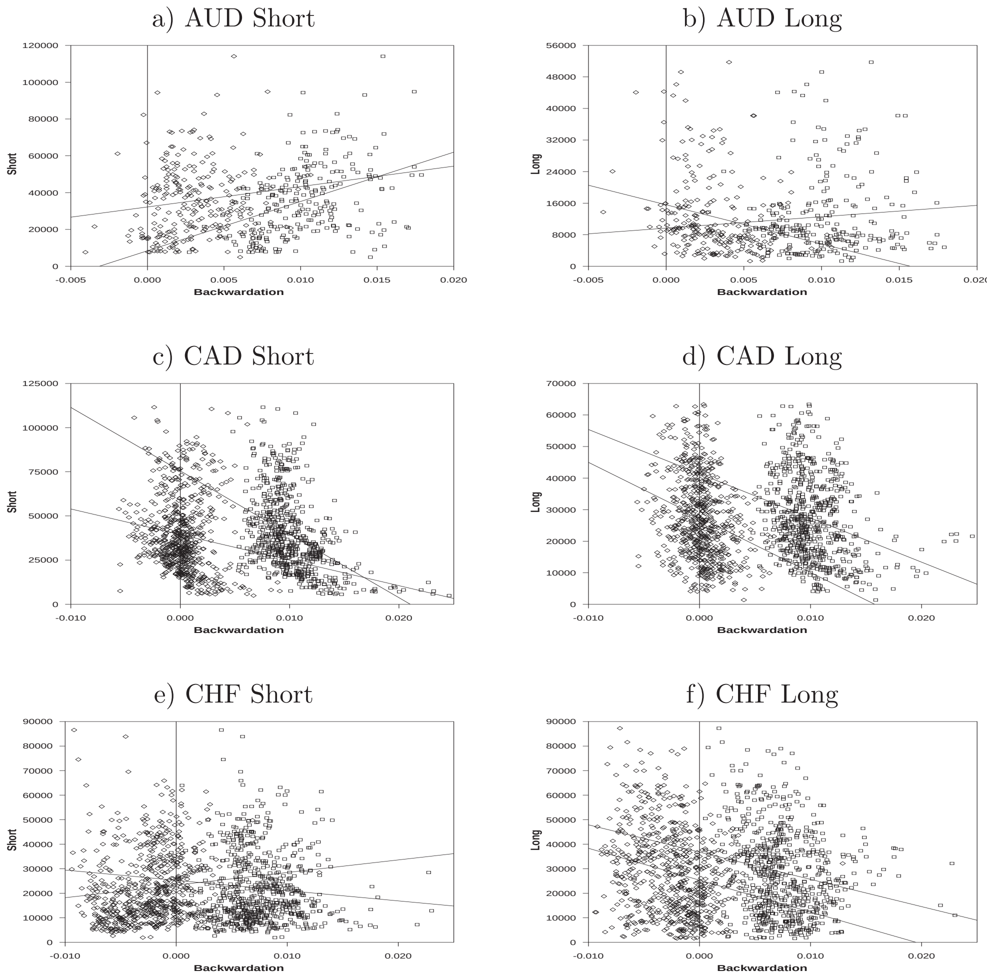

Figure 1: Short and long hedging and backwardation: Strong backwardation is represented by 'diamonds' (◊) and weak backwardation is represented by 'boxes' (□).

1 and 2 present scatterplots with regression lines for weak and strong backwardation and short and long hedging activity. Regarding short hedging activity only the results for the CAD and MXP series show consistently a negative effect of backwardation on short hedgers' trading activity. The slopes of the four regression lines shown in Figures 1c) and 2e) are all negative. The results for the AUD and EUR series suggest a positive relationship (i.e., the slopes are all positive) and the results for the CHF and JPY series are mixed. The results for long hedging activity are even worse. None of the regression results point unambiguously to a positive effect of backwardation on long hedging volume. The regression results for the CAD,

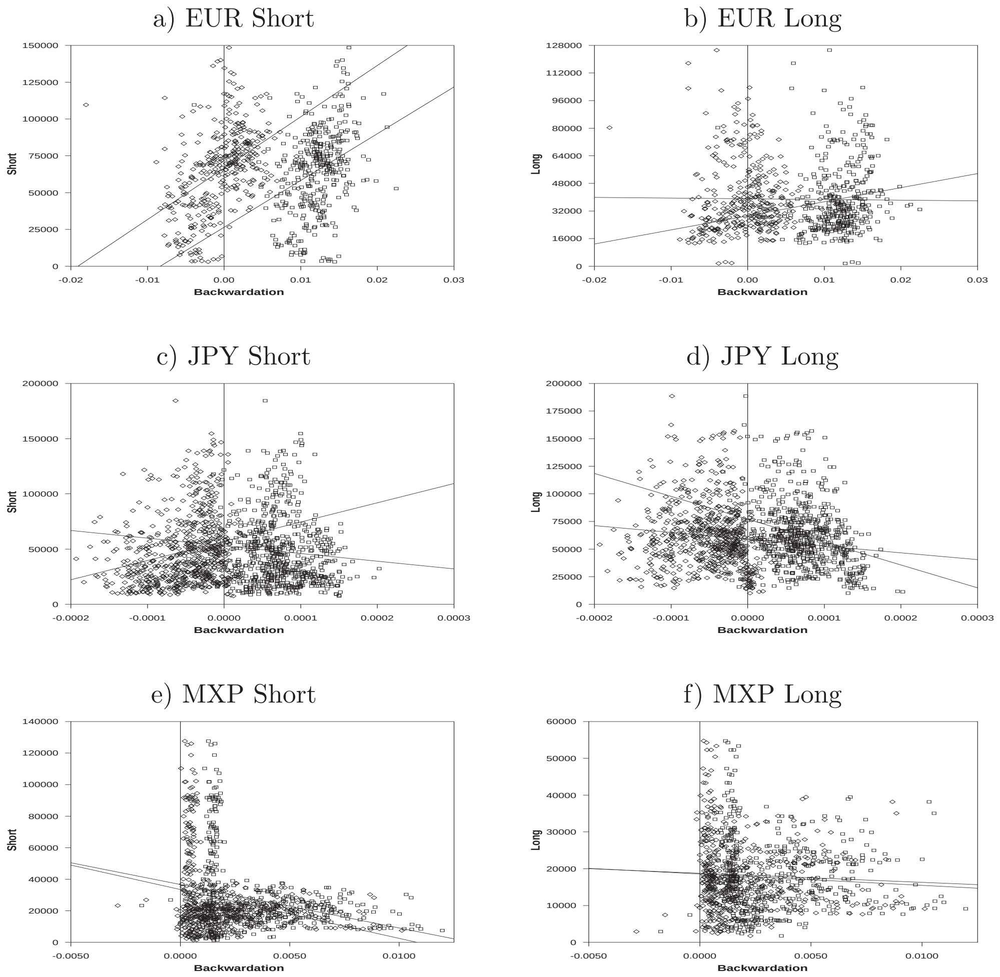

Figure 2: Short and long hedging and backwardation (continued): Strong backwardation is represented by 'diamonds' (◊) and weak backwardation is represented by 'boxes' (□).

CHF, JPY, and MXP series presented in Figures 1d), 1f), 2d), 2f) consistently point to a negative impact. The remaining results for the AUD and EUR series are mixed.

4 Conclusions

This study investigates the impact of backwardation on long and short hedging activity in currency futures markets. First, the optimal long hedging strategy of an importer exposed to currency risk is derived in an expected utility framework with and without hedging costs. The model suggests that it is optimal for the long hedging importer to overhedge [underhedge] if the futures market exhibits backwardation [contango]. The importing firm hedges fully if the futures market is unbiased. However, in the presence of hedging costs, the firm hedges fully if the futures market is characterized by backwardation. Therefore, hedging costs provide a rationale for backwardation to exist. Irrespective of whether hedging costs are introduced into the model, backwardation has a positive impact on the size of the firm's optimal hedging position.

The empirical part of this paper investigates the relationship between backwardation and hedgers' demand for six currency futures contracts. Hedgers' short and long trading activity are regressed on weak and strong backwardation. The summary statistics suggest that backwardation and contango are indeed normal in currency futures markets as proposed by Keynes (1930). However, the hypothesis of a negative [positive] impact of backwardation on short [long] hedging activity cannot be supported.

The contribution of this study is threefold. First, the hedging problem of the representative exporter examined by Holthausen (1979) and Briys and Schlesinger (1993) is extended to the hedging problem of an importer. Second, hedging costs are found to provide a rationale for backwardation to be normal. Finally, the impact of backwardation on long and short hedgers' trading volume in currency futures markets is investigated empirically. To the best of our knowledge, this is the first study to directly regress hedgers' position data from the Commitments of Traders (COT) report on two measures for backwardation. However, the results offer very little support for the hypotheses suggested by economic theory. Further research aimed at clarifying the determinants of hedgers' demand for currency futures contracts may be fruitful.

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