Normal Backwardation Is Normal

JOËLLE MIFFRE

Traditionally, constant expected return asset pricing models are used to assess the presence of a futures risk premium and the validity of the normal backwardation theory. In the light of recent evidence regarding the presence of time variation in expected futures returns, such an approach may lead to incorrect inferences on the applicability of the Keynesian hypothesis. This article therefore allows for variation through time in expected futures returns and offers some strong evidence in favor of the normal backwardation and contango theories. © 2000 John Wiley & Sons, Inc. Jrl Fut Mark 20:803–821, 2000

INTRODUCTION

Keynes formulated the normal backwardation theory in 1930. Ever since there has been a controversy in the literature over the presence of a futures risk premium that compensates speculators for bearing hedgers' price risk. Consistent with the Keynesian hypothesis is the idea that futures prices depend on hedgers' net positions and their degree of risk aversion. Whenever the supply and demand of futures contracts by equally risk averse short and long hedgers are balanced, hedgers transfer their risks to one another at no cost. Thus, they are not willing to pay a

The author would like to thank two anonymous referees for helpful comments, Paul Cashin and John McDermott for computer assistance, and James Chong for providing the data. The usual disclaimer applies.
Correspondence to, ISMA Centre, the University of Reading, Reading, Berks., RG6 6BA, United Kingdom.

Received October, 1999; Accepted March, 2000

■ *J. Miffre is a Lecturer in Finance at the ISMA Centre, the University of Reading, Reading, Berks., UK.*

The Journal of Futures Markets, Vol. 20, No. 9, 803–821 (2000)

premium to induce speculators to enter the futures market. In this scenario, the futures price is an unbiased estimate of the spot price expected at maturity. Conversely, if hedgers are net short, or if short hedgers are more risk-averse than long hedgers, the futures price will be a downward biased estimate of the expected spot price in order to entice speculators to open long futures positions. The increase in the futures price relative to the expected spot price as maturity approaches is referred to as normal backwardation. Similarly, if hedgers are net long, or if long hedgers are more risk-averse than short hedgers, the futures price will exceed the expected spot price. The decrease in the futures price relative to the expected cash price that results is traditionally called contango. Thus, normal backwardation and contango arise as a result of the inequality between long and short hedging positions, which requires the existence of speculators to restore equilibrium (Anderson & Danthine, 1983). That is why, in spite of a continuing debate, it is generally accepted that futures markets provide an insurance to hedgers by ensuring the transfer of price risk to speculators. The insurance that net hedgers are willing to pay equals the premium earned by speculators for this risk bearing.

Studies of the normal backwardation theory in an asset pricing framework traditionally search for the presence of a futures risk premium. This premium ideally should compensate speculators for undertaking the risk of price fluctuations that hedgers are unable to transfer to one another at no cost. This article offers a possible explanation as to why the evidence presented thus far may have failed to provide unambiguous inferences on the validity of the normal backwardation theory. Most of the tests implemented in the literature are joint tests of the absence of a futures risk premium and of a constant expected return asset pricing model (such as the capital asset pricing model (CAPM) or the arbitrage pricing theory (APT)). The presence of time variation in expected futures returns (Bessembinder & Chan, 1992; Miffre, 2000) rules out the possibility that a constant expected return asset pricing model accurately tests the normal backwardation theory. This article therefore allows for variation through time in expected futures returns and uses conditional versions of the CAPM and APT to investigate the presence of a futures risk premium and, ultimately, the applicability, or otherwise, of the normal backwardation theory.

The results indicate that the Keynesian hypothesis has some merit in describing the pricing of futures contracts. Hedgers are willing to pay a premium to induce speculators to take a position in futures markets. This premium is found to be positive in commodity and stock index futures markets and negative in currency futures markets. This article therefore offers some strong evidence in favor of the normal backwardation and contango theories and offers very little support for the hypothesis that the futures price is an unbiased estimate of the maturity spot price.

The remainder of this article is organized as follows. The second section presents a brief review of the existing literature. The third section introduces the methodology. The fourth section describes the data set. The fifth section investigates the validity of the normal backwardation theory within conditional versions of the CAPM and the APT. Finally the last section concludes.

THE CROSS SECTION OF EXPECTED FUTURES RETURNS: A REVIEW

In recent years, tests of normal backwardation focused on the presence of a risk premium in futures markets. In the main, these studies related expected futures returns to the covariances between futures returns and (1) the market portfolio returns; (2) the factors extracted from the covariance matrix of returns; (3) some prespecified factors; and (4) the variation through time in the market returns.

The studies that investigated the normal backwardation theory within the CAPM produced conflicting evidence. Dusak (1973) concluded that there is no risk transfer between hedgers and speculators in wheat, corn, and soybeans futures markets. However Carter, Rausser, and Schmitz (1983) allowed for changing speculative position within the CAPM and supported systematic risk and hedging pressure as determinants of commodity futures prices. There has been some debate also with regards to the nature of the market portfolio. It has been argued that the proxy used in the tests should account for the degree of systematic risk present in commodity markets.[1] The results then indicate that, while the normal backwardation theory fails to describe the pricing of commodity futures (Baxter, Conine, & Tamarkin, 1985), it has some merits in explaining the relationship between risk and expected return in metal futures markets (Chang, Chen, & Chen, 1990).

More recently, studies of the normal backwardation theory have centered on the search for risk premia using multifactor models emanating from the APT. The interest in these models stems from the failure of the

[1]The weight given to commodities in the proxy of the market portfolio should not exceed the market value of commodities as expressed by their percentage of total wealth; approximately, 10 percent (Marcus, 1984).

single factor CAPM to price futures contracts[2] and from the controversy over the nature of the market portfolio. The rationale for the use of multifactor models in this context is that a more dissaggregated risk structure may be useful for explaining the cross section of expected futures returns.

Ehrhardt, Jordan, and Walkling (1987) used factor analysis in commodity futures markets and did not claim support to the Keynesian hypothesis. Park, Wei, and Frecka (1988) used principal components analysis and also failed to support the predictions of the normal backwardation theory in commodity futures markets. The success of multifactor models using prespecified risk factors in the stock market (see, for example, Chen, Roll, & Ross, 1986) has led to this approach being adopted in futures markets. Young (1991), for example, found that soybeans and wheat futures do not exhibit any significant risk premium. Finally Bessembinder (1992) showed that, while normal backwardation does not prevail in financial and metal futures markets, residual risk conditioned on net hedging is priced in agricultural and foreign currency futures. This result suggests that the normal backwardation theory has some merit in describing agricultural commodity and currency futures prices.

These studies uniformly assume constant expected futures returns and make use of traditional asset pricing models to test for the presence of a futures risk premium. It is therefore assumed that the sensitivities of futures returns to some systematic sources of risk, as well as the prices of risk present in the market, are constant. These assumptions however do not seem to be valid in the light of recent evidence regarding the presence of time variation in expected futures returns (see Bessembinder & Chan, 1992; Miffre, 2000). It follows that the applicability of the normal backwardation theory should be tested within a model that allows for time variation in expected futures returns. McCurdy and Morgan (1991, 1992) estimated a conditional CAPM in currency futures markets. They found evidence of risk premia when the model allows for change in the prices of covariance risk and for shifts in the covariances between currency futures returns and the benchmark portfolios.

METHODOLOGY

The presence of a futures risk premium is investigated using a conditional asset pricing model that allows for variation in the systematic risk of the futures contract and in the prices of risk associated with the risk factors

[2]The evidence in Bodie and Rosansky (1980), Park et al. (1988), and Kolb (1996) suggests that the relationship between beta and realized return is either flat or negative.

(see, for example, Ferson & Harvey, 1993; Harvey, 1995; Eckbo & Smith, 1998)

$$ul_t = F_t - \gamma' Z_{t-1} \quad (1a)$$

$$u2_t = (ul_t ul_t')(\kappa' Z_{t-1}) - (ul_t R_t) \quad (1b)$$

$$u3_t = R_t - \alpha - (\gamma' Z_{t-1})'(\kappa' Z_{t-1}) \quad (1c)$$

Here, $u1_t$, $u2_t$, and $u3_t$ are error terms that are orthogonal to the L instruments Z_{t-1}, R_t represents the futures return, and F_t is a K-vector of excess returns on mimicking portfolios, where the portfolios mimic K systematic risk factors. The parameters to estimate are $\{\gamma, \kappa, \alpha\}$, where γ is (L^*K), κ is (L^*K), and α is a scalar. α is the conditional counterpart of the Jensen (1968) measure of abnormal performance. The model implies the following orthogonality conditions

$$E(u1_t Z_{t-1}', u2_t Z_{t-1}', u3_t) = 0$$

for each contract. System (1) is estimated through the generalized method of moments (GMM) introduced by Hansen (1982). With K risk factors and L instruments, there are $2KL + 1$ orthogonality conditions and $2KL + 1$ parameters to estimate, leaving the model perfectly identified.

(1a) is a system of K equations that defines the conditional factor risk premia as the fitted returns from a regression of the excess returns on the factor mimicking portfolios on the instruments. Equation (1b) determines the conditional betas ($\kappa' Z_{t-1}$) as the ratio of the conditional covariances ($u1_t R_t$) over the conditional variances ($u1_t u1_t'$) (see Harvey, 1989 for more details). The conditional sensitivities are used along with the conditional factor risk premia to measure $(\gamma' Z_{t-1})'(\kappa' Z_{t-1})$, the time varying futures risk premium in (1c). Literally speaking, equation (1c) defines $u3_t$ as the residuals from the conditional asset pricing model with time-varying risk ($\kappa' Z_{t-1}$) and time-varying prices of risk ($\gamma' Z_{t-1}$). (1c) is derived from the following relationship

$$E(R_t|Z_{t-1}) = E\left[\sum_{j=1}^{K} \beta_{jt} F_{jt} | Z_{t-1}\right] = (\gamma' Z_{t-1})'(\kappa' Z_{t-1}) \quad (2)$$

where β_{jt} measures the time t sensitivity of futures returns to the excess returns on the jth factor mimicking portfolio.

The system of equations outlined in expression (1) does not impose any constraint on the parameters of the conditional asset pricing model.

It assumes that the change in the sensitivities of futures returns to the factor mimicking portfolios, along with the shift in the factor risk premia, capture the time varying risk premia present in futures markets. Valid inferences regarding the validity of the normal backwardation theory can only be drawn within well-specified conditional asset pricing models. To ensure that this condition is met, the following two tests of model adequacy are implemented.

First, Andrews' (1993) recursive test of structural change with unknown break point is used as a test of the hypothesis that the vector β_t in (2) is time varying. The procedure is as follows. The unrestricted model

$$u_t = R_t - (\alpha + \beta F_t + \delta F_t d) \tag{3}$$

is estimated through GMM. u_t is an error term, R_t represents the futures return, α is a scalar, β and δ are (1^*K) vectors of sensitivities, F_t is a K-vector of excess returns on the factor mimicking portfolios, d is a K-vector of dummy variables set to 1 over the sample June 1982 $-$ t (where t is the break point) and equal to 0 otherwise. The test of structural stability consists in testing the restriction that the dummy variables in (3) are jointly insignificant. The procedure is repeated recursively changing the break point over the sample August 1984—August 1994.[3] Andrews (1993) showed that the maximum of the resulting χ^2 statistics could be used as a test of the stability of the β_t estimates in (2).

System (1) also assumes time variation in the excess returns on the factor mimicking portfolios. As a further test of model accuracy, the prices of systematic risk are regressed onto the set of lagged instruments and the hypothesis of constant factor risk premia is tested. The following model is estimated

$$F_t = \alpha_0 + \alpha Z_{t-1} + \varepsilon_t \tag{4}$$

α_0 and α are the estimated parameters and ε_t is an error term. Since the omission of some information variables from the actual information set used by investors could result in serial correlation and heteroscedasticity in the regression errors, the standard errors in (4) are adjusted for serial correlation and heteroscedasticity using Newey and West (1987) correction with Parzen weights.[4]

[3]Andrews (1993) suggests changing the break point over an interval [0.15, 0.85]. This covers the period August 1984—August 1994 for most of the contracts considered in this study. There is one exception. Because the data set for palladium futures starts in March 1983, the test for recursive stability for this futures is rolled over the period February 1985—August 1994.
[4]The bandwidth is set equal to one-third of the sample size (see Andrews, 1991).

The applicability of the normal backwardation theory is tested with respect to the hypothesis that the conditional risk premium $(\gamma' Z_{t-1})'(\kappa' Z_{t-1})$ in (1c) is positive. In this scenario, long speculators require a risk premium for underwriting the risk of price fluctuation short hedgers are willing to avoid. On the other hand, a finding that $(\gamma' Z_{t-1})'(\kappa' Z_{t-1})$ is negative will indicate that the imbalance between long and short hedging is eliminated by short speculators who require a negative premium for undertaking that part of long hedgers' risk that is not covered at no cost by short hedgers. In this case, the contango theory will be supported. The absence of a risk premium in (1c) is considered as evidence in favor of the unbiasedness hypothesis: long and short hedgers transfer their risk to one another at no cost, leaving no incentive for speculators to enter futures markets. The futures price is then an unbiased estimate of the maturity spot price. In sum, a significant risk premium is evidence in favor of the presence of a risk transfer in futures markets. The sign of the expected return in turn indicates whether the premium supports the normal backwardation or contango theory.

DATA

The data consist of end-of-month closing prices on 19 futures contracts traded in the US over the period May 1982 to October 1996.[5] The futures contracts include 8 agricultural commodities, 5 metals commodities, and 6 financial futures. The choice of the particular contracts is governed by both the need to have a sufficiently long time series such that asymptotic theory can be applied to the test statistics and the requirement that a wide cross section of futures be used. As in most studies on multifactor models, the frequency of the data is monthly.

The article tests the sensitivity of the results to the technique employed to compute futures returns. Two approaches are used to compile the time series of futures prices. First, the closing prices on the nearest maturity futures contract is used, except in the maturity month when the price on the second nearest futures is collected. Futures returns are then computed as the percentage change in these closing prices (see, for example, Bessembinder, 1992; Dusak, 1973).[6] Second, time series of end-of-month closing prices are collected over the life of the futures contract,

[5]The data set for palladium futures covers the period March 1983—October 1996.

[6]Apart from the initial margin there is no cash payment at the time the contract is traded. It follows that a definition of returns that implicitly assumes that investors purchase the futures contract at the settlement price is inaccurate. A definition that considers the initial margin as an investment is also incorrect since the initial margin is just a good faith deposit and not an investment.

except within the delivery month when the closing price on the contract whose maturity is the farthest is used. Futures returns are then computed as the change in these closing prices.

Table I presents a list of the contracts used in this study and some summary statistics of returns (returns are then computed as the percentage change in the futures prices on the nearest or next nearest to maturity contract). In all cases, the mean return is positive. In common with the ideas of modern portfolio theory, the contracts with the highest mean returns tend, on average, to have higher standard deviations and higher absolute maximum and minimum values.

The set of instruments used in the GMM estimation follows from Fama and French (1989). Bessembinder and Chan (1992) used similar instruments for the US futures markets. In addition to stock and commodity index returns, the instruments include dividend yield, the term structure of interest rates, and the spread between low and high grade bond yields. Table II reports their definitions.

A proxy for the market portfolio constructed with 90 percent of the Standard and Poor's returns and 10 percent of the Dow-Jones cash commodity index returns is used to estimate the conditional CAPM (Marcus, 1984). Along with the market proxy, the set of risk factors that enter into the conditional multifactor model include unexpected inflation, the change in expected inflation, unexpected change in industrial production, shocks to the term structure of interest rates, and shocks to default risk (Chen et al., 1986). Young (1991) and Bessembinder (1992) used similar factors in their analyses of the US futures markets. Table III, panel A defines the risk factors.

The methodology proposed by Fama and French (1993) is employed to construct portfolios that mimic the realization of the macroeconomic and financial variables (see also Chan, Karceski, & Lakonishok, 1998). To do so, the excess returns on the individual companies of the Russell 2,000 index that have been continuously listed over the period May 1977—October 1996 are considered.[7] The approach is as follows. First the stocks' loadings on the factor that is being mimicked are estimated over a 60 month period through OLS regressions of individual excess returns on (1) the factor unexpected component[8] and (2) the excess return on the Standard and Poor's composite index. Second, the stocks are

[7]Securities with missing values are excluded because of the inability of SAS-IML to handle, for example, multiplication of such matrices. This consideration restricts the sample to 773 companies. The resulting cross section is considered to be large enough for the orthogonal portfolios to contain negligible idiosyncratic risk.

[8]The Kalman filter approach is used to generate white-noise unexpected components in the macroeconomic and financial variables. The results are available upon request.

TABLE I

Summary Statistics of Futures Returns

Futures Contracts	*Exchange*	*Mean*	*Standard Deviation*	*Minimum*	*Maximum*
	A: Agricultural Commodities				
Corn	Chicago Board of Trade	0.0027	0.0760	−0.3138	0.4582
Cotton	New York Cotton Exchange	0.0045	0.0827	−0.5327	0.3053
Live hogs	Chicago Mercantile Exchange	0.0027	0.0836	−0.2110	0.2830
Oats	Chicago Board of Trade	0.0042	0.1102	−0.2309	0.9342
Orange juice	New York Cotton Exchange	0.0029	0.0843	−0.1795	0.3415
Soybeans	Chicago Board of Trade	0.0021	0.0611	−0.2130	0.3049
Sugar	Coffee, Sugar, and Cocoa Exchange	0.0079	0.1188	−0.2078	0.6742
Wheat	Chicago Board of Trade	0.0027	0.0694	−0.2424	0.2849
	B: Metal Commodities				
Copper	Commodity Exchange	0.0048	0.0754	−0.2484	0.3974
Gold	Commodity Exchange	0.0019	0.0431	−0.1694	0.2016
Palladium	New York Mercantile Exchange	0.0029	0.0646	−0.1597	0.2399
Platinum	New York Mercantile Exchange	0.0042	0.0723	−0.2053	0.3403
Silver	Commodity Exchange	0.0014	0.0775	−0.2752	0.2836
	C: Financial				
SP500	Chicago Mercantile Exchange	0.0117	0.0415	−0.2041	0.1322
British pound	Chicago Mercantile Exchange	0.0001	0.0353	−0.1179	0.1482
Canadian dollar	Chicago Mercantile Exchange	0.0001	0.0126	−0.0493	0.0356
Deutsche mark	Chicago Mercantile Exchange	0.0031	0.0348	−0.1101	0.1008
Japanese yen	Chicago Mercantile Exchange	0.0050	0.0348	−0.0970	0.1257
Swiss franc	Chicago Mercantile Exchange	0.0033	0.0375	−0.0967	0.1128

TABLE II

The Information Set

Information Variable	*Definition*
Dividend yield	Dividend yield on the Standard and Poor's composite index
Default spread	Spread between the yield on U.S. domestic corporate AAA-rated bond and the yield on U.S. over 10-year Treasury bond
Term spread	Spread between the yield on U.S. over 10-year Treasury bond and the U.S. 3-month bill auction discount rate
Standard and Poor's return	Percentage change in the Standard and Poor's composite index
Dow-Jones commodity return	Percentage change in the Dow-Jones Commodity Index

TABLE III

The Factor Risk Premia

A: Macroeconomic and Financial Variables

Factor	*Definition*
Proxy of the market portfolio	90% of the Standard and Poor's returns and 10% of the Dow-Jones cash commodity index returns
Term spread	Spread between the yield on U.S. over 10-year Treasury bond and the U.S. 3-month bill auction discount rate
Inflation	Percentage change in the consumer price index
Change in expected inflation	$E_t[I(t+1)] - E_{t-1}[I(t)]$, where $I(t)$ is the inflation rate at time t
Default spread	Spread between the yield on U.S. domestic corporate AAA-rated bond and the yield on U.S. over 10-year Treasury bond
Industrial production	First difference in the log of industrial production

		Mimicking Portfolio Associated with				
	Excess Return on the Market Portfolio	*Shocks to the Term Structure*	*Unexpected Inflation*	*Change in Expected Inflation*	*Shocks to Default Spread*	*Unexpected Industrial Production*
B: Summary Statistics of the Factor Risk Premia						
Mean	0.005	0.001	0.002	0.004	−0.003	0.001
Standard deviation	0.037	0.035	0.024	0.018	0.036	0.026
Minimum	−0.201	−0.249	−0.222	−0.042	−0.126	−0.109
Maximum	0.114	0.106	0.050	0.066	0.244	0.207
C: Correlation Matrix in the Factor Risk Premia						
Excess returns on the market portfolio	1					
Shocks to the term structure	0.42	1				
Unexpected inflation	−0.04	0.51	1			
Change in expected inflation	−0.27	0.04	0.43	1		
Shocks to default spread	−0.36	−0.92	−0.46	−0.17	1	
Unexpected industrial production	0.15	0.12	−0.35	0.06	−0.10	1

ranked into five portfolios according to their beta estimates. In each of the subsequent 12 months, the differences in the average returns on the highest-ranked and the lowest-ranked portfolios represent the excess returns on the factor mimicking portfolio. The procedure is rolled over using the most recent 60 months of data prior to the portfolio formation date. Given the sample, this procedure produces 173 estimates of the excess return on the factor which is being mimicked.

Summary statistics of the factor risk premia are presented in Table III, panel B. Panel C reports the correlation matrix in the excess returns on the factor mimicking portfolios. The correlation between the derived series for term and default spreads equals 0.92 in absolute terms. Because term spread is likely to pick up similar influences as default spread, it can be removed from the set of mimicking portfolios without losing much information.

EMPIRICAL RESULTS

Valid conclusions regarding the applicability, or otherwise, of the Keynesian hypothesis can only be inferred from well-specified conditional asset pricing models. System (1) assumes variation through time in the sensitivities of futures returns to the factors and in the factor risk premia. Table IV reports results from Andrews' recursive test of structural stability with unknown break point for the conditional CAPM and the conditional multifactor model. Table V presents the results of tests of the hypothesis of constant prices of systematic risk.

Andrews' (1993) test of structural change with unknown break point in Table IV suggests rejection of the hypothesis of constant β_t in (2). Hence it is legitimate to assume some time variation in the conditional CAPM betas and in the sensitivities of futures returns to the excess returns on the factor mimicking portfolios. The results in Table V indicate that the hypothesis of constant prices of systematic risk is constantly rejected at the 1 percent level of statistical significance. Therefore the factor risk premia and the price of market risk are also time varying. It follows that the conditional asset pricing model (1) is correctly specified and can be used to address the issue of the validity of the normal backwardation theory.

The conditional futures risk premia are measured as the cross product of the time varying prices of systematic risk and the time varying betas in (1c); namely $E(R_t|Z_{t-1}) = (\gamma' Z_{t-1})'(\kappa' Z_{t-1})$. The significance of the risk premium indicates the presence of a risk transfer in futures markets. The sign of the risk premium in turn reveals whether the premium sup-

TABLE IV

Andrews' Recursive Test of Structural Stability in the Sensitivities*

	Conditional CAPM	*Conditional APT*
	A: Agricultural Commodities	
Corn	148.64	634.32
Cotton	19.66	487.35
Live hogs	77.96	675.13
Oats	174.04	48.30
Orange juice	57.80	583.12
Soybeans	162.38	522.49
Sugar	110.12	296.78
Wheat	178.88	408.62
	B: Metal Commodities	
Copper	209.16	530.89
Gold	146.76	657.85
Palladium	256.30	969.58
Platinum	369.95	651.75
Silver	147.37	442.89
	C: Financial	
SP500	445.25	585.42
British pound	168.56	742.90
Canadian dollar	106.41	804.70
Deutsche mark	96.03	536.54
Japanese yen	187.93	148.27
Swiss franc	114.28	488.92

CAPM, capital asset pricing model; APT, arbitrage pricing theory.
*Andrews's (1993) recursive test of structural change with unknown break point in the vector β_t in eq. (2). The test is distributed as $\chi^2(1)$ for the conditional CAPM and as $\chi^2(5)$ for the conditional multifactor model. The critical values at the 5% level of statistical significance, 8.85 for the conditional CAPM, and 18.35 for the conditional multifactor model, are given in Andrews (1993, page 840).

ports the normal backwardation or contango theory. System (1) is estimated under different assumptions regarding the technique to construct futures returns. Table VI reports the results when the futures prices on the nearest or next nearest to maturity contract are linked together. Table VII presents the results when the futures prices over the life of the contract are considered.

The results in Table VI overwhelmingly support the conclusion that there is some risk transfer that takes place in futures markets. The normal backwardation hypothesis is supported in most agricultural and metal futures markets and in the stock index futures market. Within the conditional multifactor model, 12 (11) out of 19 futures markets exhibit a positive risk premium that is significant at the 10 (1) percent level. The results from the conditional CAPM produce similar, although weaker, inferences: the normal backwardation is supported in 8 futures markets.

TABLE V

Evidence of Predictable Movements in the Factor Risk Premia*

	Excess Return on the Market Portfolio		Excess Return on the Mimicking Portfolio Associated with: Unexpected Inflation		Change in Expected Inflation		Default Spread		Unexpected Industrial Production	
	Coefficient	*p-value*	*Coefficient*	*p-value*	*Coefficient*	*p-value*	*Coefficient*	*p-value*	*Coefficient*	*p-value*
Constant	0.004	0.73	−0.003	0.76	0.003	0.61	0.013	0.20	0.007	0.19
Dividend yield	−0.831	0.22	−1.120	0.29	−0.175	0.79	0.916	0.60	−3.723	<0.01
Term structure	−0.177	0.35	−0.005	0.97	−0.117	0.41	−0.165	0.33	0.253	<0.01
Default spread	1.456	0.26	1.389	0.05	0.785	0.21	−2.282	<0.01	−0.448	0.53
S&P returns	−0.028	0.51	0.024	0.27	0.013	0.71	−0.084	0.08	0.003	0.86
Dow-Jones returns	0.212	0.02	0.058	0.37	0.050	0.24	−0.215	<0.01	0.024	0.76
$\bar{R}^2$	0.04	—	0.04	—	0.04	—	0.07	—	0.07	—
$\chi^2(5)$	144.06	<0.01	90.62	<0.01	43.18	<0.01	55.88	<0.01	69.34	<0.01

*Coefficient estimates of a regression of the factor risk premia on the information set lagged once and tests of the hypothesis of constant prices of systematic risk. χ^2 is a heteroscedasticity and serial correlation consistent test of the hypothesis of constant factor risk premia. $\bar{R}^2$ is the adjusted R^2 of the regression; p-values are the associated probability values.

TABLE VI

Evidence of Time-Varying Risk Premia in Futures Markets When Futures Returns Are Computed as the Percentage Change in the Nearest or Next-Nearest to Maturity Contract*

		Conditional CAPM				Conditional APT			
Futures	*Unit of Quotation*	*Estimate*	*t-ratio*	*Average Cost*	*Standardized Cost*	*Estimate*	*t-ratio*	*Average Cost*	*Standardized Cost*
		A: Agricultural Commodities							
Corn	US cents per bushel	0.0021	5.11	0.6779	0.0026	0.0080	9.50	4.4717	0.0172
Cotton	US cents per pound	0.0037	10.35	0.3484	0.0050	0.0109	7.34	2.0887	0.0301
Live hogs	US cents per pound	−0.0002	−0.56	−0.0118	−0.0002	0.0056	4.09	0.5325	0.0110
Oats	US cents per bushel	0.0054	6.76	1.6852	0.0108	0.0088	8.81	3.8458	0.0246
Orange juice	US cents per pound	0.0002	0.80	0.0223	0.0002	−0.0039	−5.37	−0.3438	−0.0026
Soybeans	US cents per bushel	−0.0002	−0.44	−0.1293	−0.0002	0.0036	7.05	3.0435	0.0049
Sugar	US cents per pound	−0.0028	−4.61	−0.0178	−0.0019	−0.0031	−1.80	−0.0202	−0.0022
Wheat	US cents per bushel	0.0020	6.82	0.8114	0.0023	0.0041	4.92	2.0028	0.0057
		B: Metal Commodities							
Copper	US cents per pound	0.0006	0.94	0.0353	0.0004	0.0029	3.13	0.2197	0.0024
Gold	US dollars per Troy ounce	0.0004	1.78	0.1421	0.0004	0.0031	8.32	1.2960	0.0034
Palladium	US dollars per Troy ounce	−0.0010	−3.33	−0.0886	−0.0007	0.0026	2.98	0.3136	0.0025
Platinum	US dollars per Troy ounce	0.0014	5.60	0.4219	0.0010	0.0034	5.24	1.2629	0.0030
Silver	US cents per Troy ounce	0.0014	5.23	0.9831	0.0016	0.0106	8.88	17.6550	0.0293
		C: Financial							
SP500	Index Points	0.0063	10.35	1.2581	0.0037	0.0014	1.91	0.1738	0.0005
British pound	US cents per British pound	−0.0006	−6.73	−0.1020	−0.0006	−0.0018	−4.96	−0.2672	−0.0017
Canadian dollar	US cents per Canadian dollar	−0.0001	−0.99	−0.0042	−0.0001	−0.0007	−4.69	−0.0509	−0.0007
Deutsche mark	US cents per Deutsche mark	−0.0008	−8.77	−0.0320	−0.0006	−0.0043	−8.68	−0.1249	−0.0023
Japanese yen	US cents per Japanese yen	−0.0008	−8.17	−0.0286	−0.0004	−0.0035	−7.86	−0.1041	−0.0015
Swiss franc	US cents per Swiss franc	−0.0010	−8.34	−0.0449	−0.0007	−0.0040	−7.66	−0.1421	−0.0022

*Tests of the significance of the time-varying risk premia estimated from the conditional asset pricing models (1) when the closing prices on the nearest or next-nearest maturity contract are used to compute futures returns; also reported are estimates of the monthly cost of the hedge expressed in unit of quotation. Finally, the standardized cost of the hedge is reported, where the standardized cost is measured as the ratio of the average monthly cost divided by the average futures price over the period June 1982–October 1996.

TABLE VII

Evidence of Time-Varying Risk Premia in Futures Markets: Sensitivity of the Results to the Technique Employed to Construct Futures Returns*

	Conditional CAPM			*Conditional APT*		
Futures	*Monthly Risk Premium*	*t-ratio*	*p-value*	*Monthly Risk Premium*	*t-ratio*	*p-value*
		A: Agricultural Commodities				
Corn	0.2590	2.77	0.01	1.7515	9.90	<0.01
Cotton	−0.1027	−5.34	<0.01	0.3518	9.10	<0.01
Live hogs	−0.0319	−2.60	0.01	0.3067	5.57	<0.01
Oats	0.8365	7.79	<0.01	1.5496	10.41	<0.01
Orange juice	−0.0437	−1.28	0.20	−0.3893	−3.26	<0.01
Soybeans	0.5235	1.86	0.06	3.3516	10.30	<0.01
Sugar	−0.0220	−4.08	<0.01	0.0268	2.71	0.01
Wheat	0.6045	6.10	<0.01	1.4957	5.60	<0.01
		B: Metal Commodities				
Copper	−0.0606	−1.74	0.08	−0.0180	−0.39	0.70
Gold	0.3490	3.35	<0.01	2.0151	10.62	<0.01
Palladium	−0.1522	−3.87	<0.01	0.3187	3.26	<0.01
Platinum	0.5724	6.01	<0.01	2.2010	7.25	<0.01
Silver	1.9192	7.69	<0.01	7.6682	9.51	<0.01
		C: Financial				
SP500	1.8818	10.19	<0.01	0.9020	3.94	<0.01
British pound	−0.1402	−7.72	<0.01	−0.1767	−3.32	<0.01
Canadian dollar	−0.0104	−2.31	0.02	−0.0606	−4.69	<0.01
Deutsche mark	−0.0593	−10.23	<0.01	−0.2375	−9.42	<0.01
Japanese Yen	−0.0785	−8.25	<0.01	−0.1889	−6.84	<0.01
Swiss Franc	−0.1006	−9.83	<0.01	−0.2841	−8.70	<0.01

*Estimates of the time-varying futures risk premia estimated from the conditional asset pricing models (1) when returns are computed as the change in the futures prices over the life of the contract, except in the maturity month where the price on the farthest contract is used. t-ratios are tests of the significance of $(\gamma' Z_{t-1})'$ $(\kappa' Z_{t-1})$; p-values are the associated probability values.

The results in Table VI also suggest that speculators require a negative risk premium for holding orange juice, sugar, and currency futures. Such a result suggests that the contango theory has some merit in describing the way these contracts are priced. Finally, the findings offer only weak support for the hypothesis that the futures price is an unbiased estimate of the maturity spot price. The conditional CAPM supports the unbiased hypothesis in 5 futures markets only; the risk premia identified by the conditional multifactor model are always statistically significant. These results are quite surprising in the light of recent evidence that failed to detect any trend in futures prices (Kolb, 1992).

Table VI also reports an order of magnitude for the average monthly cost of the hedge per unit of quotation over the period June 1982—

October 1996. For example the result from the conditional multifactor model indicates that hedgers paid an average of 4.47 cents a month to hedge a bushel of corn over the period June 1982—October 1996. The table also reports the standardized costs (measured as the ratio of the average monthly cost relative to the average futures price over the sample period), which suggests that hedging corn, cotton, oats, and silver was relatively more expensive.

As a further robustness check, the article tests whether the bias identified in Table VI occurs only over the last few months before maturity or reflects a mispricing that arises consistently over the life of the contracts. Table VII reports estimates of the monthly premium paid by hedgers to speculators to eliminate the risk of price fluctuation when returns are computed as the change in the futures prices over the life of the contract. The conclusions regarding the applicability of the Keynesian hypothesis do not seem to be sensitive to the technique employed to link together the futures prices. A comparison of the results in Tables VI and VII suggests that normal backwardation is normal in the corn, oats, soybeans, wheat, gold, platinum, silver, and Standard and Poor's 500 futures markets and that the contango theory has some merits in explaining the pricing of orange juice and currency futures. The evidence however is not as clear-cut in the futures markets for cotton and copper, where the risk premia change signs between Tables VI and VII. This suggests that the initially upward biased estimate of the maturity spot price moves to a downward bias as maturity approaches.

The normal backwardation (contango) theory also predicts that the farther the maturity, the lower (higher) the futures price relative to the maturity spot price and, hence, the higher (lower) the premium. The tests implemented in this study only offer weak support for this hypothesis. A comparison of the monthly risk premia in Tables VI and VII suggests that the longer the hedge in the financial and metal futures markets, the higher its average cost. However this conclusion does not seem to apply to the agricultural commodity futures markets and in particular to the corn, cotton, oats, wheat, and copper contracts. This result suggests either that the increase in the futures prices as maturity approaches is non linear in these markets or that the risk premia change signs from negative to positive over the life of these contracts.

Growers of agricultural and metal commodities have a short hedging incentive and promote a downward bias. On the other hand processors have a long hedging incentive and promote an upward bias. The positive risk premia identified in commodity futures markets suggest that the supply for hedging by producers exceeds the demand by processors, resulting in hedgers being on average net short. This imbalance requires the intervention of long speculators to restore equilibrium. A possible explanation for this result might be that short hedgers who are long the spot commodity are willing to pay a premium that depends on the interests foregone and the warehousing costs involved in holding the commodity spot. Although this explanation cannot account for a finding of a negative risk premium in currency futures, the absence of storage costs in the foreign exchange futures markets might explain failure to identify a positive risk premium in currency futures markets.

CONCLUSIONS

The search for a risk premium in futures markets has been the subject of a long debate. Unfortunately, most authors assume constant expected futures returns and test the normal backwardation theory within the context of a constant expected return asset pricing model. In the light of recent evidence regarding the variation through time in expected futures returns, such an assumption may potentially lead to incorrect inferences regarding the presence of a futures risk premium. The purpose of this article therefore is to test the validity of the normal backwardation theory within an asset pricing model that allows for variation in the sensitivities of futures returns to the factors and for shifts in the factor risk premia.

The main conclusion from this study is that hedgers are willing to pay a premium to motivate speculators to take a position in futures markets. This premium is proportional to the time varying risk of the futures contract and to the time-varying risk premia present in futures markets. It is positive in the commodity and stock index futures markets. At least for these futures, the theory of normal backwardation first proposed by Keynes in 1930 seems to apply. In particular, the results for the corn, soybeans, and wheat contracts that inspired a wide literature (Baxter et al., 1985; Carter et al., 1983; Dusak, 1973; Ehrhardt et al., 1987; Park et al., 1988; Young, 1991) strongly support the predictions of the normal backwardation theory. The premium for holding currency futures is negative, suggesting that the contango theory is valid in the foreign exchange futures market. On the whole, the findings offer very little support for the hypothesis that the futures price is an unbiased estimate of the maturity spot price. When one allows for time variation in expected futures returns, there is strong evidence in favor of a risk transfer between hedgers and speculators in futures markets. Normal backwardation and contango are normal.

BIBLIOGRAPHY

Anderson, R., & Danthine, J. P. (1983). Hedger diversity in futures markets. Economic Journal, 93, 370–389.

Andrews, D. W. K. (1991). Heteroscedasticity and autocorrelation consistent covariance matrix estimation. Econometrica, 59, 817–858.

Andrews, D. W. K. (1993). Tests for parameter instability and structural change with unknown change point. Econometrica, 61, 821–856.

Baxter, J., Conine, T. E., & Tamarkin, Jr. M. (1985). On commodity market risk premiums: Additional evidence. The Journal of Futures Markets, 5, 121–125.

Bessembinder, H. (1992). Systematic risk, hedging pressure, and risk premiums in futures markets. Review of Financial Studies, 5, 637–667.

Bessembinder, H., & Chan, K. (1992). Time varying risk premia and forecastable returns in futures markets. Journal of Financial Economics, 32, 169–193.

Bodie, Z., & Rosansky, V. I. (1980). Risk and return in commodity futures. Financial Analysts Journal, 27–39.

Carter, C. A., Rausser, G. C., & Schmitz, A. (1983). Efficient asset portfolios and the theory of normal backwardation. Journal of Political Economy, 91, 319–331.

Chan, L. K. C., Karceski, J., & Lakonishok, J. (1998). The risk and return from factors. Journal of Financial and Quantitative Analysis, 33, 159–188.

Chang, E., Chen, C., & Chen, S. (1990). Risk and return in copper, platinum, and silver futures. The Journal of Futures Markets, 10, 29–39.

Chen, N., Roll, R., & Ross, S. A. (1986). Economic forces and the stock market. Journal of Business, 59, 383–403.

Dusak, C. (1973). Futures trading and investor returns: An investigation of commodity market risk premium. Journal of Political Economy, 81, 1387–1406.

Ehrhardt, M. C., Jordan, J. V., & Walkling, R. A. (1987). An application of arbitrage pricing theory to futures markets: Tests of normal backwardation. The Journal of Futures Markets, 7, 21–34.

Eckbo, B., & Smith, D. (1998). The conditional performance of insider trades. Journal of Finance, 53, 467–498.

Fama, E. F., & French, K. R. (1989). Business conditions and expected returns on stocks and bonds. Journal of Financial Economics, 25, 23–49.

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. Journal of Financial Economics, 33, 3–56.

Ferson, W. E., & Harvey, C. (1993). The risk and predictability of international equity returns. Review of Financial Studies, 6, 527–566.

Harvey, C. (1989). Time-varying conditional covariances in tests of asset pricing models. Journal of Financial Economics, 24, 289–317.

Harvey, C. (1995). Predictable risk and returns in emerging markets. Review of Financial Studies, 8, 773–816.

Hansen, L. (1982). Large sample properties of generalized method of moments estimators. Econometrica, 50, 1029–1054.

Jensen, M. C. (1968). The performance of mutual funds in the period 1945—1964. Journal of Finance, 23, 389–416.

Keynes, M. (1930). A treatise on money, II: The applied theory of money, Edition Macmillan and Co.

Kolb, R. (1992). Is normal backwardation normal? The Journal of Futures Markets, 12, 75–91.

Kolb, R. (1996). The systematic risk of futures contracts. The Journal of Futures Markets, 16, 631–654.

Marcus, A. (1984). Efficient asset portfolios and the theory of normal backwardation: A comment. Journal of Political Economy, 92, 162–164.

McCurdy, T., & Morgan, I. (1991). Single beta models and currency futures prices. Economic Record, 117–129.

McCurdy, T., & Morgan, I. (1992). Evidence of risk premiums in foreign currency futures markets. Review of Financial Studies, 5, 65–83.

Miffre, J. (2000). Efficiency in the pricing of the FTSE 100 futures contract. European Financial Management (forthcoming).

Newey, W. K., & West, K. D. (1987). Hypothesis testing with efficient method of moments estimation. International Economic Review, 28, 777–787.

Park, H., Wei, J., & Frecka, T. (1988). A further investigation of the risk-return relation for commodity futures. Advances in Futures and Option Research, 3, 357–377.

Young, D. (1991). Macroeconomic forces and risk premiums on commodity futures. Advances in Futures and Options Research, 5, 241–254.