A Comprehensive Study on Normal Backwardations in Futures Markets

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This article examines the theory of the normal backwardation (or contango) and forecasting theory in futures markets. This study finds evidence on the extent to which these two seemingly opposing theories have been operative in futures markets for last 24 years. The study shows that normal backwardation (or even contango) is not general characteristic of futures markets. Each market is unique. Behaviors of some futures prices are quite consistent with a priori expectations. Surprises, however, come from financial futures contracts in that extreme forms of backwardation and contango are very evident here, whereas many may believe that forecasting skills are most needed in these markets.

INTRODUCTION

There are two seemingly opposing theories proposed to explain the returns of traders in futures markets. The first one is the "theory of normal backwardation" (or "contango" in the opposite) which views speculative returns as directly linked to the bearing of risk. The other is so-called "forecasting theory" which considers returns to be determined by the ability of traders (in this case speculators) to forecast prices accurately. At closer examination, we find that these theories may not be mutually exclusive even though they can be competitive. In this study, we will present evidence on the extent to which each of these competing explanations may have been operative in futures markets from June 1987 to June 2011.

For our study, we will make use of over 16,700 semimonthly observations covering 29 markets for 24 years since 1987. This broader coverage makes possible much more conclusive inferences about mechanism which determines the returns to traders and the futures costs of hedging. In the earlier part of study we will define the theory of normal backwardation and examine the different assumptions which are made concerning the forecasting ability of speculators. In its simplest form, the theory assumes that speculators: 1) are net long; 2) require positive profits; and 3) are unable to forecast prices. Thus the theory predicts that futures prices rise on the average during the lives of each contract. Conversely, in contango case, the hedgers are net long and the futures price would lie above the expected future spot price, and the price of the futures contract would fall over its life. If speculators are assumed to be unable to forecast prices, it is appropriate to consider all of their profits to be a reward for risk-bearing and none to be a reward for forecasting. Therefore, the profit flow between hedgers and speculators is analogous to the flow of insurance premiums between insured and insurer.

In the meantime, the failure to find any consistent evidence of normal backwardation (or contango) implies the acceptance of the extreme alternative hypothesis that all important profit flows are to be explained in terms of forecasting ability. The existence of a subset of speculators who can forecast price changes causes futures prices on the average to be an unbiased estimate of the ultimate spot price. The assertion that all important profit flows are to be explained in terms of forecasting ability implies the

proportion of profits attributed to normal backwardation (or contango) is zero. However, it is possible to define two levels of forecasting skill: first, an elementary ability which is called basic forecasting skill; and the second, a more sophisticated ability which can be dubbed as special forecasting skill. Basic skill measures the ability of a group to be long in markets where prices rise over the total period of observation and short in markets where prices fall over the total period of observation. Special skill, therefore, measures a trader's ability to forecast price movements whose duration is shorter than the total period of observation. An examination of the results of this division of profit confirms the conclusion that it is the degree of forecasting ability which controls the flow of profits.

The evidence presented in this paper indicates that in majority of markets, it is forecasting ability and not the bearing of risk that determines the profits of speculators. While the theory of normal backwardation may be valid for particular markets under special conditions, it is not adequate as a general explanation of the flow of profits in commodity markets.

The fact that the gross profits of all small traders are zero means that they make substantial losses after commissions. Firstly, small speculators are either risk seekers and are consequently willing to lose money for the privilege of speculating. Secondly, they comprise a stable population of risk averters who are unable to forecast prices, but do not realize this. Or finally, they constitute a changing population of risk averters, in which the successful forecasters rise to become large speculators while the unsuccessful withdraw from the market and are replaced with new blood.

The existence of a subset of speculators who are able to forecast price changes causes futures price on the average to be an unbiased estimate of the ultimate spot price. This conclusion in a modified version readmits a question which the theory of normal backwardation was thought to answer: why are large speculators consistently net long, even when we consider sets of markets where there is clearly no tendency for prices to rise? Since large speculators own only a small fraction of all commitments, it is possible for them to be either net short or net long quite independently of the sign of net hedging commitments. The answer to this may be that even the more sophisticated speculators have an irrational preference for the long side. On the other hand, it may well be equally true that the distribution of price changes is asymmetric so that skewness and moments other than the mean influence the decision of speculators to be net long.

That futures prices on the average, are unbiased estimates of ultimate spot prices need not imply that the result holds either for all markets or for all time periods within a market. As an example of the former, livestock futures prices have exhibited a strong upward tendency in the last 24 years which is quite consistent with the theory of normal backwardation. As an example of the latter, it can be shown that if hedgers are net long, futures prices tend to rise. Of course, the results suggest that this evidence of bias is critically dependent both upon the markets which are selected and upon the special structural characteristics which determine any conditional price forecasts. In the meantime, the overall generalization from the date investigated here is that the futures price is an unbiased estimate of the ultimate spot price. In the next section, we compare the forecasting theory and backwardation. Then specific aspects of forecasting are considered. Next, the price structures of 29 futures markets for last 16 and half years are delved into. Conclusions will follow last.

FORECASTING THEORY VS BACKWARDATION (OR CONTANGO)

The theory of normal backwardation predicts that under certain assumption it is necessary on the average for the price of futures contracts to rise. Two of the assumptions of the theory as originally stated by Keynes (1923) are that speculators be net long and be risk averters (that is, they require a positive history of profits if they are to continue trading). Under these circumstances, a rising trend in prices is the mechanism that rewards long speculators for the risks they bear. To Keynes, the possibility that speculators may be better forecasters than hedgers is a "dubious proposition". This contention appears to be reversed in later formulations of the theory of normal backwardation by Hicks (1953), and Houthakker (1957). Since forecasting ability, or its absence, can be a central theme of the argument. In Keynes' version of the theory, it is the speculators' inability to forecast accurately that makes them dependent upon

the incidental, and probably unanticipated, rising price level to provide a positive history of profits. The unambiguous to interpret whatever profits they receive as a risk premium paid to them by hedgers and not as a reward for forecasting. The postulation of "no forecasting" ability, however, raises problems concerning the prediction that prices must rise (or fall). If the level of the net short position of hedgers is subject to variations, it is possible for speculators to have a positive history of profits without prices rising on the average. Note that the assumptions of the theory of normal backwardation (contango) are neither necessary nor sufficient for the prediction that prices rise (fall). The principal modification of the theory of normal backwardation made by Hicks and Houthakker is to assume that speculators are able to forecast prices. This distinction may be seen by contrasting the position of Keynes as stated above with that of Hicks in "Value and Capital" (1953).

One consequence of granting speculators even a modest amount of predictive ability is that it frees the backwardation hypothesis from counter example that involve speculators being net long during periods when prices fall in a "predictable" manner. For example, "hedging pressure" theories, where the direction of price change is directly related to the magnitude of short hedges, imply a lack of foresight by speculators who take positions early in the season that are inconsistent within the assumption of forecasting ability. Thus, the assumptions of the Hicks-Houthakker version of the theory necessarily imply that prices must rise on the average. However, this improvement in the logic of theory is gained at a cost. That is the returns of speculators may no longer be viewed unambiguously as a reward for bearing risk. Rather they represent a mixed payment for forecasting and risk bearing, the proportions of the mixture being determinable only by empirical investigation. The view held by Keynes that the returns of speculators may be interpreted as an insurance premium, will be valid only if the forecasting component of profits is relatively small.

So it would be interesting to measure a normal backwardation component of profits and then define the difference between this amount and the actual returns as the forecasting component. Now note a couple of problems which arise in defining an empirical estimate of normal backwardation. The first problem is the case of a contango when hedgers are net long rather than net short. The Keynes and Hicks formulations clearly assume hedgers to be net short. The second problem concerns with weights would be used in aggregating over individual contracts and commodities. There are at least three possibilities: 1) each contract may be given a weight of one; 2) each contract may be given a weight equal to the average value of the open interest in that contract; and 3) each contract may be weighted by the actual open interest existing on that date. The first alternative, unity weights, gives undue importance to inactive contracts and commodities and need not be considered. The choice between options two and three is more difficult. Numerous arguments can be made for either side. The most important consideration would be protection against misleading results caused by changing market structure. We measure normal backwardation as the sum of the return on the total long open interest when hedgers are net short. We measure contango as the sum of the return on the total short open interest when hedgers are net long.

If this measure is to be used, what is its relation to the existing theories of normal backwardation? Normal backwardation describes the profits of marginal speculators who possess no forecasting ability. We may therefore conceive of normal backwardation (contango) as the return earned by a hypothetical speculator who follows a naive strategy of being constantly long when hedgers are net short (constantly short when hedgers are net long). The naive strategy may assume that the hypothetical trader adjusts the size of his positions to maintain them as a constant proportion of the total open interest. If normal backwardation is defined as the returns which a naive speculator earns by keeping his commitments long, in proportion to the total open interest when hedgers are net shot, then the rate of return on the total long open interest is closely related to the rate of normal backwardation. Likewise, the same can be said in case of contango when hedgers are net long.

FORECASTING SKILLS

The rates of return of net trading groups can be divided into two categories. One is a reward defined as the basic forecasting skill, the other is a residual component defined as the special forecasting skill.

Now let $V_m^{\ L}$ and $V_m^{\ S}$ be total value of trading group's long and short commitments, in a single market m, aggregated over time periods, let $R_m^{\ B}$ be the rate of return on the long open interest in that market. Then, any net trading group's rate of profit attributable to the basic forecasting skill is given by

$$R_m^{\ B} = \frac{R_m\left(V_m^{\ L} - V_m^{\ S}\right)}{V_m^{\ L} + V_m^{\ S}}$$

Denoting the groups actual rate of return by $R_m^{\ A}$, we then obtain the measure of the special forecasting skill as residual of $R_m^{\ F} = R_m^{\ A} - R_m^{\ B}$.

In the aggregate, we have

$$R^B = \frac{\sum_m R_m\left(V_m^{\ L} - V_m^{\ S}\right)}{\sum_m \left(V_m^{\ L} + V_m^{\ S}\right)}$$

And $R^F = R^A - R^B$.

The measure $R_m^{\ B}$ will be positive when R_m is positive and the group is net long on the average $(V_m^{\ L} - V_m^{\ S} > 0)$ or when R_m is negative and the group is net short on the average $\left(V_m^{\ L} - V_m^{\ S} < 0\right)$. So the measure discussed here defines the basic skill as the ability to be net long on the average in markets where prices rise on the average, and to be net short on the average in markets where prices fall on the average. This measures the long term ability of a trading group to stay on the profitable side of the market. In the mean time, the special forecasting skill measures the success with which a trading group varies its position, from period to period to profit from short run price trends. These forecasting skills should be necessary especially when backwardations or contangos are not evident in the price structures.

FUTURES PRICE STRUCTURES

Data

All futures settlement prices from June 16, 1986 through June 30, 2011 were collected from Futures section in the Wall Street Journal (WSJ) and Investor's Business Daily (IBD). In order to make semimonthly data, we grouped data from the first day to 15th day of the month as one set and 16th day of the month to last day of the month as the other set. If 15th day fell on holidays we used the closest day which gave two sets as equal as possible. Accordingly, for each futures contract, we had 577 data points. The first one was the settlement price of June 30, 1986, and the last one was the settlement price of June 30, 2011. Then the number of periods where the price was increased during that semimonthly period was counted.

Table I contains futures contracts and markets, period of observation, numbers of semimonthly observations, change in price level during the period, annual percentage change, and number of semimonthly periods with price increases. Price changes are based on the most actively trading months. The average annual percentage price change of the contract during the period can be obtained by

$$\frac{\left(P_{end} - P_{start}\right)/P_{start}}{\text{Number of Years}}$$

The last column shows the number of the semiannual periods where there have been price increases.

This indicates that the backwardation has happened and long positions were actually profitable during those periods.

Severe Backwardations (and Contangos) in Financial Futures

The findings are rather surprising in that the most severe forms of backwardations and contangos have appeared mostly in the financial instruments. Quite contrary to *a priori* belief that the grain markets may show sellers hedging (farmer's incentive to hedge), we find almost none such thing during last 24 years. Prices increased almost half of the periods (50% - 52 %) in overall grain markets. Only wheat market shows a mild form of the consumer hedge (47% of price increase). In this case, the traders forecasting ability may determine their profits (Forecasting Theory). Live cattle markets indicate decent amount of producer's incentive to hedge with 55% of periods prices increase. The most acute form of contangos in commodities can be found in the cocoa and lumber markets. For some reason, the buyers (e. g., chocolate makers, and lumber users like home builders) have lots of incentive to buy in this market to hedge their risk. In precious metals, copper and platinum exhibit the noticeable backwardations (with 54% of increase each). This implies last 24 years or so buying in the futures contracts on the average may have given us higher probability of making profits in these futures markets. Energy markets also show strong backwardations (55% to 58% price increases during the period). It looks like oil producing countries (e.g., OPEC members) and refiners are willing to pay premium to hedge their risks.

Foreign exchange markets are split. Canadian dollars market is backwardated, but Japanese yen contract is the opposite. Japanese yen is rather interesting. Even though the Japanese yen is in the record high territories against US dollars nowadays and yen generally has been appreciated against dollar during last 24 years, the right strategy might have been selling yen in the futures markets, since it has shown severe contango with only 44% price increases in last two decades and four years. Interest futures markets (Eurodollars and Tbonds) show a good deal of backwardations (56% increase each), i.e., high level of premiums to be paid to buyers from sellers. For example, the U.S. Treasury department has a strong incentive to pay insurance premium to sell government securities. Why is that? Note that last two and half decades, we have witnessed that the general interest level has been falling. Falling interest rates (or increasing bonds prices) seem to be related with the normal backwardation in these markets. As for the stock markets, buy and hold strategy still seems to work. Even with market turmoil during financial crisis in 2008-2009, so-called a Great Recession, and stagnant stock prices last 10 years, S & P 500 shows one of the highest levels of backwardation (with 58% price increase) among studied markets.

CONCLUSIONS

This study finds that normal backwardation (or even contango) is not general characteristic of futures markets. Each market is unique. The claim that futures prices are on the average unbiased estimates of ultimate spot prices need not imply that this result holds either for all markets or for all time periods within a market. For example, it's quiet astonishing that we cannot find any farmers' incentive to hedge their risk in the form of backwardation in grain markets. These markets do not show a strong upward tendency during the period that is quite consistent with the theory of normal backwardation. Speculators who employed naive trading strategy of long positions believing that the risk premiums were paid to them might have been failed in these markets at least last 24 years. Of course, behaviors of some futures prices are quite consistent with *a priori* expectation.

Another surprise comes from financial futures contracts in that extreme forms of backwardation and contango are very evident here, whereas many may believe that forecasting skills are most needed in these markets. Why financial futures markets exhibit strong form of backwardation or contango? Why interest instrument contracts show sellers incentive to hedge? Why stock index futures prices are backwardated? Further research should shed more light on these issues.

TABLE 1
DESCRIPTION AND PRICE LEVEL

Commodity and Markets	Period of Observation		# of semi-monthly observations	Price change		Annual Percentage Price Change	# of Obs Price was up (%)
	From	To		Start	End		
Com, CBOT	6/87	6/11	577	186.5	620.5	+ 9.70	298 (52%)
Beans, CBOT	6/87	6/11	577	543.25	1294.0	+ 5.76	297 (51%)
Meal, CBOT	6/87	6/11	577	166.2	330.9	+ 4.13	291 (50%)
S-Oil, CBOT	6/87	6/11	577	17.53	56.15	+ 9.18	291 (50%)
Wheat, CBOT	6/87	6/11	577	263.25	660.0	+ 6.28	274 (47%)
F-Cattle, CME	6/87	6/11	577	70.92	138.07	+ 3.95	295 (51%)
L-Cattle, CME	6/87	6/11	577	63.30	110.87	+ 3.13	318 (55%)
Hogs* CME	6/87	6/11	577	71.75*	91.67	+ 1.16	299 (52%)
P-Bellies, CME	6/87	6/11	577	69.32	121.0**	+ 3.11	282 (49%)
Cocoa, CSCE	6/87	6/11	577	1997	3151	+ 2.41	258 (45%)
Coffee CSCE	6/87	6/11	577	105.75	265.60	+ 6.30	273 (47%)
Sugar CSCE	6/87	6/11	577	6.97	26.34	+ 11.58	301 (52%)
Cotton NYCE	6/87	6/11	577	72.80	118.59	+ 2.62	281 (49%)
OJ NYCE	6/87	6/11	577	125.3	187.10	+ 2.06	279 (48%)
Copper CMX	6/87	6/11	577	71.45	428.25	+ 20.81	314 (54%)
Gold CMX	6/87	6/11	577	452.2	1505.0	+ 9.70	284 (49%)
Platinum NYM	6/87	6/11	577	560.3	1726.1	+ 8.67	310 (54%)
Silver CMX	6/87	6/11	577	7.41	34.85	+ 15.43	291 (50%)
Crude Oil NYM	6/87	6/11	577	20.05	96.50	+ 15.88	321 (56%)
Heating Oil NYM	6/87	6/11	577	.5537	2.9562	+ 18.08	318 (55%)
Unleaded Gasoline (RBOB)	6/87	6/11	577	.5435	2.7418	+ 16.85	335 (58%)
Lumber 1 CME	6/87	6/11	577	183.8	244.9	+ 1.39	260 (45%)
Japanese Yen CME	6/87	6/11	577	6863	1.2433	+ 2.75	256 (44%)
Canadian Dollar CME	6/87	6/11	577	.7492	1.0358	+ 1.59	330 (57%)
British Pound CME	6/87	6/11	577	1.6100	1.6051	+ 0.00	302 (52%)
Swiss Franc CME	6/87	6/11	577	.6658	1.1907	+ 3.28	283 (49%)
Eurodollars CME	6/87	6/11	577	92.58	99.66	+ 0.32	321 (56%)
T-Bonds CBOT	6/87	6/11	577	91.16	123.01	+ 1.46	321 (56%)
S & P 500 CME	6/87	6/11	577	503.55	1315.5	+ 6.72	334 (58%)

* Live Hogs (Prior to Dec 1996) were based on conversion factor of .74 of lean hogs.
** Delisted as of 7/18/11.

REFERENCES

Anderson, R. W. & Danthine, J. P. (1983). The Time Pattern of Hedging and the Volatility of Futures Prices. *Review of Economic Studies,* 50, (2), April, 249-266.

Cornell, B. & Reinganum, M. R. (1981). Forward and Futures Prices: Evidence from Foreign Exchange Markets. *Journal of Finance,* 36, (5), December, 1035-1045.

Cox, J., Ingersoll, J. & Ross, S. (1981). The Relation between Forward Prices and Futures Prices. *Journal of Financial Economics,* 9, (4), December**,** 321-346.

Furguson, R. & Leistikow, D. (1998). Are Regression Approach Futures Hege Ratios Stationary? *Journal of Futures Markets,* 18, (7), October, 851-866.

Grinblatt, M. & Jagadeesh, N. (1996). Relative Pricing of Eurodollar Futures and Forward Contracts. *Journal of Finance,* 51, (4), September, 1499-1522.

Houthakker, A. H. S. (1957). Can Speculations Forecast Prices? *The Review of Economics and Statistics*, May, 145-150.

Kamara, A. (1984). The Behavior of Futures Prices: A Review of Theory and Evidence. *Financial Analysts Journal,* 40*,* (4), July-August, 68-75.

Krehbiel, T. & Collier, R. (1996). Normal Backwardation in Short-Term Interest Rate Markets. *Journal of Futures Markets,* 16, (8), December, 899-913.

Keynes, J. M. (1923). Some Aspects of Commodity Markets. *Manchester Guardian Commercial: European Reconstruction Series*, Section 13, March 29.

Lee, J. W. & Zhang, Y. (2009). Evidence on Normal Backwardation and Forecasting Theory in Futures Markets. *Journal of Derivatives & Hedge Funds,* 15, (2), August, 159-170.

Movassagh, N. &and Modjtahedi, B. (2005). Bias and Backwardation in Natural Gas Futures Prices. *Journal of Futures Markets,* 23, (3), 281-308.

Park, H. Y. & Chen, A. H. (1985). Differences between Forward and Futures Prices: Further Investigation of Marking to Market Effects. *Journal of Futures Markets,* 5, (7), February, 77-88.

Wright, B. & and Williams, J. (1989). A Theory of Negative Prices for Storage. *The Journal of Futures Markets,* 9, (1), February, 1-13.