Rolling Over Futures Contracts: A Note

Christopher K. Ma
Jeffrey M. Mercer
Matthew A. Walker

INTRODUCTION

The limited life span of individual futures contracts complicates the testing of academic hypotheses as well as the implementation of trading rules in futures markets. Avoiding the problems associated with the limited life span usually involves linking the price series of individual futures contracts through time so that a longer artificial price history can be created. By doing so, however, the heterogeneity between consecutive contracts, as well as the unusual market activities often observed near maturity, can generate significant biases in the various time-series properties of the artificial price series depending upon the rollover method chosen.[1]

Though the concern for possible bias is implicitly shared by a number of researchers of futures markets, there does not appear to be a consensus regarding the procedure to construct these artificial series. In estimating the parameters of return distributions for 18 different futures contracts, Cornew, Town, and Crowson (1984) construct each artificial time series using the closing prices of the futures contract nearest to delivery from approximately ten weeks before the beginning of the delivery period until approximately two weeks before first notice day, and then roll into the next contract closest to delivery. At the rollover date, the closing price of the new contract on the day prior to the rollover is used to compute the relative price change so that it is not sensitive to price discontinuities. In an investigation of the daily effect in stock index future markets, Junkus (1986) excludes prices in the delivery month to avoid any nonstationarity in the return series due to any increase in variance associated with decreasing time-to-maturity. In contrast, Dyl and Maberly

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[1]The term "biases" is used loosely in this article. Since it is not known what the true underlying parameters are, any differences in estimates between various time series produced by different rollover methods are referred to as biases. Therefore, throughout the article, the term "biases" and "differences" are used interchangeably.

Christopher K. Ma is an Associate Professor of Finance, Texas Tech University.

Jeffrey M. Mercer is an Assistant Professor of Finance, Northern Illinois University.

Matthew A. Walker is an Assistant Professor of Finance, North Dakota State University.

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(1986), when testing for the weekend effect in the S&P 500 futures index, set the rollover date at the third Wednesday of the current contract month—two days prior to the actual delivery day of the S&P 500 futures contracts, while no adjustment is made in the price series at the time of the switch from one contract to the next. Similarly, Herbst, Kare, and Caples (1989) create a "perpetual contract" with the daily price computed as a weighted average of prices on outstanding contracts, where the weights represent each contract's number of days from the present. Grammatikos and Saunders (1986), in testing the price–volume relationship in futures markets, use market data gathered for each contract beginning six months before maturity, and ending at the beginning of the delivery month. The delivery month is excluded to control for what they call "delivery complications." While testing the same issue, Karpoff (1988) uses the price of the most actively traded contract that day, which usually is the nearest-to-deliver contract, but not within one month of delivery. He further notes that the resulting return series is nearly identical to a buy-and-hold strategy of holding the single nearest-to-deliver contract and rolling into the next nearest-to-deliver contract one month before delivery.

The studies cited above, along with numerous others, indicate there are many different rollover methods being utilized. The two factors that appear to vary among these studies are: (i) the point in time at which the current contract is rolled to the next; and (ii) whether to adjust the price level of the contract being rolled into upon rollover. Therefore, this note seeks to demonstrate the differences that result from the use of alternative conventional methods of rolling over futures contracts. It is shown that the conclusions drawn from three common empirical tests of futures markets are not robust to the choice of method for rolling over futures contracts.

The conclusions of this study go beyond mere academic refinement in hypothesis testing. Traders often need to rely on time series of futures prices that resemble trading in consecutive contracts to test the effectiveness of trading rules. Changes in trading positions are usually activated by the triggering of the trading rule. However, a trader can be forced to roll over from the maturing contract to the next-out contract if the trading rule is not activated before maturity. This occurrence complicates the measurement of the risk-return performance of the trading rule. Thus, it is important to traders to know whether their positions are affected by a rollover date other than the date decided upon by a trading rule. Moreover, if the time series properties of the price series depends upon the rollover date, so too does the efficacy of a trading rule depend upon the rollover date.

This note describes several popular methods of rolling over contracts that are used in academic research and by practitioners. Differences in time-series properties associated with each method are discussed. Results from three typical empirical tests on time series that are constructed using common rollover methods are presented. The relevance of the choice of rollover method is demonstrated by the significantly different conclusions reached from the various empirical tests.

METHODS OF ROLLING OVER CONTRACTS

Selecting Rollover Dates

In choosing a method of rolling over contracts, the first decision to be made is the selection of a point in time to "roll over," i.e., when to switch from the maturing contract to the next-out contract. From the various choices in the cited studies, it appears that there is not a unique date for all purposes. However, the most common methods include switching at the delivery date, the first notice date, or some arbitrary length of time before the delivery date. For most purposes, the use of first notice day seems to be a logical choice. This is often a popular choice for trading purposes, because some exchanges require extra margin in specific markets after the first notice day. Thus, traders roll forward to the next contract prior to the first notice day if they do not intend to post additional margin.

As for the rationale to roll over at dates distant from the actual delivery date, the open interest begins to decline as the delivery day for a contract nears. Traders begin switching out of the nearby contract and into the next nearby contract to avoid problems associated with illiquid trading. Therefore, if liquidity of the current contract is deemed to be an important concern, futures contracts are rolled over at some arbitrary time before the delivery date, e.g., the first of the delivery month or the last trading day of the previous month. On the other hand, if the liquidity in the next nearby contract is not at a sufficient level, the actual timing of rollover may be delayed until the liquidity of that contract increases.

Alternatively, the use of the actual delivery date as the rollover date is motivated by the fact that traders are able to follow the entire life of each individual contract. However, it is well known that the price volatility, the trading volume, and open interest in the delivery month are often so erratic that the data can be meaningless. The source of the abnormal market movements in the delivery month is often attributed to the thin trading and illiquidity of the maturing contract. This may result in discrete price movements. Furthermore, speculative activities prevalent in the last week of the life of the contract can cause excessive volatility which can significantly bias the testing.[2]

The Adjustment on the Price Levels at the Rollover Date

An equally important dimension to consider when rolling over contracts is the difference in the price levels between the two contracts, which is often observed at the rollover dates. One immediate implication is that there are some "artificial jumps" in the entire time series because of the rollovers. The jumps may generate seemingly excessive volatility and extremely large price changes (returns) which may distort the parameter estimates of the true underlying distributions which, therefore, bring into question the validity of the test statistics. On the other hand, traders argue that no *ex post* adjustment should be made, since only real transaction prices can be used in practice. This commitment should be followed even when it is known that an explicit bias will be present. Therefore, a decision needs to be made regarding whether a series of prices is adjusted to remove the price jumps that occur at the rollover date, or is left unadjusted with the price jumps intact.

If a price adjustment at the rollover date is deemed necessary, both the magnitude and the extent of the adjustment become relevant considerations. One typical method of adjustment is to subtract the difference in the price levels between the new contract and the old contract, at each rollover date, from all new prices, or add the difference to the previous prices. This way, by adjusting price levels backward

[2]Of course, the decision whether to include in the sample the price history in the last few weeks of the maturing contract depends on the issue under investigation. It should be noted that a later rollover date may introduce significantly higher variances and price discreteness.

or forward, the price gaps resulting from contract rollover are eliminated.[3] Furthermore, since there is an adjustment on all prior prices at each rollover date, most prices have a number of price gaps subtracted from them. A "negative price syndrome" may result from the fact that earlier (or later) futures prices may turn negative as they are altered by accumulation of all price gaps over the entire time period.[4]

A measurement error is introduced also if the return is computed using a percentage form. Once the price level is adjusted several times, the daily price can be artificially low or negative, thereby causing the percentage return to be significantly amplified. This is due to the reduction in the base price in computing returns with the same daily price changes. To demonstrate this point, an example is presented in Appendix A. For the original price series, both the price changes and returns are at reasonable levels. However, once the level adjustment of 100 is subtracted from the price level, the daily price changes remain the same, but the daily returns are drastically distorted. It is clear that the bias is attributable to the reduction in price levels given the same price changes. Apparently, the net impact of this change in absolute price levels is a significant increase in the volatility measures which produces totally unpredictable changes on other parameter estimates.

EMPIRICAL EXAMPLES

To demonstrate both the economic and statistical differences associated with commonly used rollover methods, three tests which are commonly used in the futures literature are conducted: (i) risk-return combinations of a buy-and-hold trading strategy; (ii) serial dependence between successive price changes (returns); and (iii) daily effects in the payoff distributions. The purpose of replicating these tests is to see if the conclusions are robust to which rollover method is used. Therefore, the same empirical estimation processes are repeated for each of the six time series that are created using the six methods discussed above. The choices of six possible combinations of rollover dates and whether or not to adjust the price level at the rollover date are summarized in Table I.[5]

Table I

Method	Rollover Date	Adjustment at Rollover
A	First day of the contract month	Yes
B	First day of the contract month	No
C	Delivery day	Yes
D	Delivery day	No
E	First notice day	Yes
F	First notice day	No

[3]One apparent side effect of this method, as argued by its critics, is that most of the price history does not represent actual transactions prices, which may pose a serious problem for traders who wish to test trading strategies and need to use actual prices.

[4]The occurrence of negative prices should depend on the range of the time period and the price variation of the futures prices. Futures contracts like Corn, Feeder Cattle, Gold, Pork Bellies, Platinum, Sugar, Swiss Franc, Silver, Soybeans, Soybean Meal, and Wheat are known to generate negative prices after adjustments. For details, see Technical Tools (1989).

[5]Obviously, there are numerous other *ad hoc* methods in both selecting rollover dates and adjusting price levels of different contracts. Six of the most commonly used methods are simulated here.

To further show that the impact may be universal, one representative futures contract is selected from each of the five different categories of futures markets, i.e., Gold (precious metal), S&P 500 (equity), T-bond (financial), Japanese Yen (currency), and Soybeans (agri-commodity). The relevant institutional contract specifications are outlined in Appendix B.

The Payoff Distributions

The parameters of the payoff distribution based on the six time series generated from each futures contract are estimated first. In Table II, the comparative results are presented. The mean and standard deviation of the daily price changes for each of the six time series is computed. As predicted in the previous section, the standard deviation of the price changes decreases if the price level is adjusted to eliminate the price gap. This is true regardless of which rollover date is used. In most of the cases, the volatility measures are higher if the rollover date is the contract delivery date. However, the net impact on the volatility measures from the tradeoff between rolling over at days different from the delivery dates and whether to adjust the price levels at the rollover dates is not clear.

The comparisons of the return distributions in Table III, however, show sharp differences. The Gold futures returns, for example, exhibit tremendously large variations between the adjusted series and the unadjusted series in both the estimates of the mean and the standard deviation. This appears to be attributable to the measurement error problem discussed in the previous section. Gold futures prices are known to have the negative price syndrome. A more serious issue, however, is that, because the magnitude of the measurement error is so large, on the order of more than 1000 times, proper comparisons of the bias from different rollover methods become meaningless. Aside from the fact that the return measure after adjustment is distorted, the bias on the mean of the price change (return) of the buy-and-hold trading strategy is not absolutely clear. However, the bias of either higher or lower return measures resulting from the adjustment decision at rollover dates is, at least, consistent across all selections of the rollover dates.[6]

Serial Dependence

One standard test of market efficiency is based on the predictive power of past payoffs on current payoffs. The statistical significance of serial correlation between successive daily price changes (returns) is often used for that purpose. The serial correlation for each of the six series is computed in both return and price change forms. In Table IV, the comparative results are presented. Again, there seems to be no consistent pattern with respect to the direction of the effects on serial correlation from one series to another. The different combinations of adjustment decision and rollover date do not render any predictable impact on the magnitude of the correlation. A further disturbing finding is that both the statistical significance and the direction (sign) of the serial correlation may be altered depending upon which time

[6]The practical relevance of the evidence in Tables II and III is indicated by a different risk-return tradeoff if traders use different time series to execute their trading rules. For example, if traders follow naive daily buy and hold strategies, the return can vary between 0.26% and 0.89% and the risk can vary between 0.83% and 0.88%. In some cases, the conclusion of whether the profit is actually achieved can be altered, as demonstrated by the changing signs of the mean price changes among the six different series.

Table II
DISTRIBUTIONS OF DAILY PRICE CHANGES

	Rollover Date											
	Contract Month (Yes)[a]		Contract Month (No)[b]		Delivery Day (Yes)[a]		Delivery Day (No)[b]		First Notice Day (Yes)[a]		First Notice Day (No)[b]	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Gold	−0.0779	6.574	0.051	6.66	−0.0172	6.6228	0.0504	6.6312	−0.0817	6.5755	0.0401	6.6858
S&P 500 Index	0.0821	3.3386	0.1129	3.3488	0.0787	3.3294	0.1163	3.3574	0.078	3.3289	0.1163	3.351
U.S. T-bond	0.0042	0.6689	−0.0002	0.6717	0.006	0.6685	−0.0009	0.6737	0.0042	0.6689	−0.0002	0.6717
Live Hog	0.0106	0.6746	0.0104	0.7301	0.0425	0.6522	0.0101	0.8515	0.0116	0.6746	0.0043	0.8231
Soybean	−0.0258	11.2016	0.0377	11.5811	0.0911	11.876	0.0871	12.275	−0.0258	11.201	0.0377	11.5811
Japanese Yen	0.004	0.367	0.0115	0.3716	0.0031	0.3645	0.0122	0.3746	0.0032	0.365	0.0122	0.3757

[a] Adjustment rollover.
[b] No adjustment rollover.

Table III
DISTRIBUTION OF PERCENTAGE RETURNS

	Rollover Date											
	Contract Month (Yes)[a]		Contract Month (No)[b]		Delivery Day (Yes)[a]		Delivery Day (No)[b]		First Notice Day (Yes)[a]		First Notice Day (No)[b]	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Gold	−61.336	1085.55	0.0297	1.5233	0.016	2.2568	0.03	1.5219	−172.68	3020.36	0.0269	1.5287
S&P 500 Index	0.0616	1.6409	0.0678	1.4249	0.0597	1.6327	0.0696	1.4271	0.0597	1.6334	0.0696	1.4249
U.S. T-bond	0.0071	0.8624	0.0035	0.8721	0.0089	0.835	0.0026	0.8761	0.0071	0.8624	0.0035	0.8721
Live Hog	0.0377	1.3859	0.0325	1.3573	0.053	0.8058	0.0473	1.9273	0.0377	1.3859	0.0307	1.8951
Soybean	0.0776	3.9624	0.0246	1.5828	0.0292	1.3354	0.0339	1.6685	0.0776	3.9624	0.0249	1.5828
Japanese Yen	0.0164	0.9282	0.0256	0.7008	0.0152	0.9781	0.0274	0.7106	0.0155	0.9749	0.0274	0.7111

[a]Adjustment rollover.
[b]No adjustment rollover.

Table IV
SERIAL CORRELATIONS

	Rollover Date											
	Contract Month (Yes)[a]		Contract Month (No)[b]		Delivery Day (Yes)[a]		Delivery Day (No)[b]		First Notice Day (Yes)[a]		First Notice Day (No)[b]	
	Price Chg.	%Chg.	Price Chg.	% Chg.	Price Chg.	% Chg.	Price Chg.	% Chg.	Price Chg.	% Chg.	Price Chg.	% Chg.
Gold	0.0237	0.0720[c]	0.0236	−0.0293[c]	0.0069	−0.0617[d]	0.0093	−0.0432[d]	0.0247	−0.0065[c]	0.0203	−0.0314
S&P 500 Index	0.0014	−0.0229	0.004	−0.0223	0.0009	−0.0223	−0.0029	−0.029	0.0017	−0.0222	0.0019	0.0237
U.S. T-bond	0.0087	−0.0018	0.0091	0.0024	0.0065	−0.0045	0.0103	0.0038	0.0087	−0.0018	0.0091	0.0024
Live Hog	−0.0006	0.0113	0.0391[c]	0.0489	0.0225	0.0303[c]	−0.0129	−0.0046	−0.0006	0.0113[d]	−0.0073	−0.003
Soybean	0.1395[c]	−0.0368[c]	0.1349[c]	0.0816[c]	0.1504[c]	0.0953	0.1065[c]	0.0661[c]	0.1395[c]	−0.0368[c]	0.1349	0.0816[c]
Japanese Yen	−0.0056	−0.003	−0.0003	−0.001	−0.0047	−0.0001	−0.0021	−0.0041	−0.0045	−0.0005	−0.008	−0.009

[a]Adjustment rollover.
[b]No adjustment rollover.
[c]Significant at 5% level.
[d]Significant at 10% level.

series is used. The sharp contrast can best be demonstrated by the six different serial correlations computed for the daily Soybean futures returns. Two of the six series exhibit significantly negative serial correlation, while the other four have significantly positive serial correlation.

Day-of-the-Week Effect

The standard test procedure to investigate whether or not the typical negative (positive) Monday (Friday) effect exists is performed by estimating the following equation:

$$R_{it} = a + b_2D_2 + b_3D_3 + b_4D_4 + b_5D_5 + e_t \qquad (1)$$

where R_i is the ith time series of the daily return or the daily price change series. D_i represents the daily dummy, and its coefficient measures the difference between the Monday return (price change) and another weekday return (price change). The estimate of a is the mean return (price change) for Monday. In Tables V and VI, eq. (1) is estimated for all six series ($i = 1,\ldots,6$). Both the magnitude and the statistical significance of the Monday return and the differences of other weekday returns vary significantly across the six series. For instance, in the gold futures market, there is a significant (negative) Monday effect only for the first and the sixth series. For the live hog futures market, the third series has a positive Monday effect. Furthermore, the statistical significance of the return difference on other-than-Monday weekdays also varies widely from one series to the next. Thus, it appears that different conclusions can be drawn from the empirical results estimated from time series generated from different contract rollover methods.

In summary, the collective evidence suggests that there are wide variations in terms of both quantitative and qualitative conclusions one can draw from the evidence estimated from the six time series. The disturbing aspect of this finding is that most of the differences in results cannot be predicted. It is important to know that the results of these three common empirical tests are not robust to the rollover method used in the analysis.

IMPLICATIONS AND CONCLUSIONS

This note demonstrates that biases are generated from the selection of different methods to roll over futures contracts. This issue is particularly relevant since much academic research and many practical trading rules rely on historical time series that last beyond the limited life span of individual contracts. A review of the literature reveals that several methods of rolling over futures contracts are commonly used. The necessary decisions involved in rolling over contracts include the selection of a rollover date and the adjustment on the price level when the contract is rolled over.

Any differences resulting from alternative sample selection procedures should not pose serious problems to users so long as the direction and the magnitude of the difference can be ascertained *ex ante*. However, most of the effects discussed cannot be predicted beforehand. For instance, if the new contract price at the rollover date is higher (lower) than the price of the old contract, and if the futures price follows a submartingale, removing the price gap imparts negative (positive) serial correlation into the series. The impact on total variance, however, is less straightforward. The total volatility can increase, depending on the interaction be-

Table V
DAILY EFFECTS FOR PRICE CHANGES

	Gold Futures						S&P 500 Index Futures					
	Rollover Date											
	Contract Month		Delivery Day		First Notice Day		Contract Month		Delivery Day		First Notice Day	
	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]
Intercept	−0.5096[c]	−0.1983	−0.4131	−3473	−0.5089[c]	−0.4414[c]	−0.0869	−0.0334	−0.092	0.3606	−0.0921	0.0103
D2	0.8537[c]	0.617[d]	0.8100[c]	0.7809[c]	0.8480[c]	0.8864[c]	0.2505	0.2161	0.2541	0.126	0.2565	0.154
D3	0.5184	0.3171	0.4954	0.548	0.514	0.5186	0.3658	0.0336	0.3765	0.2483	0.3753	0.2922
D4	0.3005	0.0588	0.2641	0.2842	0.2966	0.3345	0.1679	0.1567	0.1682	0.0401	0.1696	0.0671
D5	0.4206	0.2509	0.3938	0.3579	0.4619	0.0522[d]	0.0445	0.0101	0.03532	−0.0229	0.0347	0.0045
	U.S. T-Bond Futures						Live Hog Futures					
	Rollover Date											
	Contract Month		Delivery Day		First Notice Day		Contract Month		Delivery Day		First Notice Day	
	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]
Intercept	−0.0750[c]	−0.0789[c]	−0.0728[c]	−0.0799[c]	−0.0750[c]	−0.0789[c]	−0.0018	−0.0178	0.0357[d]	−0.035	−0.0018	−0.0168
D2	0.1487[c]	0.1480[c]	0.1468	0.1500[c]	0.1487[c]	0.1480[c]	−0.0003	−0.0239	−0.0066	0.0365	−0.0003	0.0163

D3	0.0459	0.045	0.0472	0.0469	0.0459	0.045	0.0481	0.0169	0.0421	0.0931[c]	0.0481	0.0528
D4	0.0827[c]	0.0805	0.0826[c]	0.0744[c]	0.0827[c]	0.0805[c]	0.0218	0.052	0.0333	0.0744[d]	0.0218	0.037
D5	0.119[d]	0.1195[c]	0.1224[c]	0.1182[c]	0.1191[c]	−0.0053	0.0939	−0.0394	0.0164	−0.0053	−0.0037	

	Soybean Futures						Japanese Yen Futures					
	Rollover Date											
	Contract Month		Delivery Day		First Notice Day		Contract Month		Delivery Day		First Notice Day	
	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]
Intercept	−0.9901[c]	−0.7434[c]	−0.9177[c]	−1.075[c]	−0.9901[c]	−0.7432[c]	0.0114	0.0234	0.0068	0.0068	0.0078	0.0196
D2	0.7951	0.5411	0.8081	0.9159[d]	0.7951	0.5411	−0.0002	−0.006	0.003	0.0497[c]	0.0021	0.0198
D3	1.5041[c]	1.2187[c]	1.4268[c]	1.6757[c]	1.5041[c]	1.2187[c]	0.0054	−0.001	0.0104	0.0104	0.0095	−0.0022
D4	0.901[d]	0.7342	1.030[d]	1.236[d]	0.9013[d]	0.7342	−0.0095	−0.0133	−0.005	−0.005	−0.006	−0.0178
D5	1.5451[c]	1.3482[c]	1.7046[c]	1.8938[c]	1.5451[c]	1.3482[c]	−0.0327	−0.0391[d]	−0.0275	−0.275	−0.0288	−0.035[d]

[a]Adjustment rollover.
[b]No adjustment rollover.
[c]Significant at the 5% level.
[d]Significant at the 10% level.

Table VI
DAILY EFFECTS IN PERCENTAGE RETURNS

	Gold Futures						S&P 500 Index Futures					
	Rollover Date											
	Contract Month		Delivery Day		First Notice Day		Contract Month		Delivery Day		First Notice Day	
	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]
Intercept	−0.4361	−0.0005	−0.0014	−0.0009	−2.5221	−0.0012[c]	0	0.0002	0	0.0006	0	0.0005
D2	−0.6807	0.0014[d]	0.0026[c]	0.0019[c]	1.8014	0.0022	0.001	0.0006	0.0011	0.0002	0.0011	0.0003
D3	0.2879	0.0014[d]	0.0025[c]	0.0020[c]	1.3453	0.002	0.0014	0.001	0.0015	0.0006	0.0015	0.0007
D4	−0.2172	0.0001	0.0007	0.0006	1.9197	0.0007	0.0006	0.0005	0.0006	0	0.0006	0.0001
D5	−0.3	0.0011	0.0017	0.0015	−1.1699	0.0023[c]	0	−0.0003	−0.0001	−0.0005	−0.0001	−0.0004

	U.S. T-Bond Futures						Live Hog Futures					
	Rollover Date											
	Contract Month		Delivery Day		First Notice Day		Contract Month		Delivery Day		First Notice Day	
	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]
Intercept	−0.0010[c]	−0.001	−0.0009[c]	−0.0010[c]	−0.0010[c]	−0.0010[c]	0.0004	0	−0.0009[c]	0	0.0004	0
D2	0.0019[c]	0.0019	0.0018[c]	0.0019[c]	0.0019[c]	0.0019	−0.0003	−0.0006	−0.0007[c]	0.0003	−0.0003	0.0001

D3	0.0006[c]	0.0005[c]	0.0006[c]	0.0006[c]	0.0006	0.0005	0.0004	0.0001	−0.0001	0.0015	0.0004	0.001
D4	0.0012[c]	0.0011[c]	0.0012[c]	0.0011[c]	0.0012[c]	0.0011[c]	0.0002	0.0008	0	0.0011	0.0002	0.0006
D5	0.0016[c]	0.0016	0.0016[c]	0.0017	0.0016[c]	0.0016[c]	−0.0006	0.0014[c]	−0.0010[c]	−0.0004	−0.0006	−0.0005

	Soybean Futures						Japanese Yen Futures					
	Rollover Date											
	Contract Month		Delivery Day		First Notice Day		Contract Month		Delivery Day		First Notice Day	
	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]	Yes[a]	No[b]
Intercept	−0.0025	−0.0011	−0.0011	−0.0016	−0.0025	−0.0011	0.0001	0.0004[d]	0	0.0001	0	0.0003
D2	0.0036	0.0009	0.0012	0.0015	0.0036	0.0009	0.0003	0	0.0004	0.0011	0.0004	0.0005
D3	0.0053	0.0023	0.0021	0.003	0.0053	0.0023	0.0003	0	0.0005	0.0002	0.0004	0
D4	0.0037	0.0014	0.0016	0.0022	0.0037	0.0014	0	−0.0004	0	−0.0002	0	−0.0004
D5	0.0034	0.0019	0.0021	0.0028	0.0034	0.0019	−0.0005	−0.0006	−0.0003	−0.0004	−0.0004	−0.0005

[a]Adjustment rollover.
[b]No adjustment rollover.
[c]Significant at the 5% level.
[d]Significant at the 10% level.

tween the removal of price gaps and the additional serial correlation. It also appears to be difficult to estimate the relationship between old and new contract prices at rollover dates. Since the futures price of the current contract is equal to the actual spot price at the delivery date, the new contract price could be at a premium or a discount, depending on the cost of carry to next delivery and the expectation of the future spot price. This ambiguity presents similar unpredictability on the magnitude and the direction of the effect.

In general, the evidence suggests that the choice of rolling over at the delivery date should be avoided since it almost always generates excessive volatility. While adjusting the differential price levels at rollover dates reduces volatility, some artificial but drastic measurement errors are created if returns are computed using the adjusted price series. Furthermore, the magnitude of the measurement error is so large that the direction and size of the biases from the different rollover methods is lost. It may appear that as long as the issue under investigation does not rely on the absolute price levels, the "negative price" from the adjustment should not alter any conclusions. However, a subtle problem arises when the price levels are differenced multiple times over different ranges of the time series. The level adjustment procedure effectively replaces the large (positive or negative) daily price changes at the rollover dates with zero price changes. Consequently, the average return, the variance and serial correlation estimates may be biased.

An important implication of the evidence presented here is that anytime it becomes necessary to link individual futures contracts' price series, be it for the development of trading rules or for hypothesis testing, the results achieved and the conclusions reached are likely to depend upon the procedure with which the contracts are linked. Unfortunately, the evidence presented here does not allow one to choose a "best" method. In fact, it appears likely that the selection of the "best" method may be contract specific. This issue is left to further research.

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Appendix A

AN EXAMPLE OF THE MEASUREMENT BIAS ON RETURNS FROM ADJUSTING PRICES AT THE ROLLOVER DATE

Day	Unadjusted Price	Unadjusted Return	Unadjusted Price Change	Adjusted Price[a]	Adjusted Return	Adjusted Price Change
$t-3$	99	—	—	−1	—	—
$t-2$	102	3.03%	3	2	300%	3
$t-1$	105	2.94%	3	5	150%	3
t	102	−2.86%	−3	2	−60%	−3
$t+1$	106	3.77%	4	6	200%	4
$t+2$	109	2.83%	3	9	50%	3
$t+3$	105	−3.67%	−4	5	−44.4%	−4

[a]The adjustment level of 100 is subtracted from the original price level.

Appendix B

CONTRACT SPECIFICATIONS OF SIX FUTURES CONTRACTS

Contract	Delivery Date	First Notice Date	Sample Period
T-bond	8th last business day of the contract month	Last business day of previous month	9/77–6/89
S&P 500	3rd Thursday of the contract month	N/A	4/82–6/89
Gold	4th last business day of of the contract month	2nd last business day of previous month	12/82–6/89
Japanese Yen	2nd business day before 3rd Wednesday	N/A	11/76–6/89
Live Hog	20th or prior business day	Last business day of previous month	2/68–6/89
Soybean	8th last business day of the contract month	Last business day of previous month	6/89–6/89

N/A: Cash clearing at delivery dates (a week prior to the delivery date is then used).

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