Predictable and profitable price patterns: Evidence from US interest rates

Vivek Moorthy

Indian Institute of Management, Bannerghatta Road, Bangalore-560 076, India

Abstract

This paper detects a predictable response of short-term (Eurodollar) interest rate futures to US employment data during 1988–1993. A simulation with a trading rule derived from this predictable response generates systematic profits, thus violating the efficient markets hypothesis.

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1. Introduction

A growing number of studies have called into question the validity of the random walk and the efficient markets hypothesis. The occurrence of seasonal anomalies such as the January, Monday and holiday effects, the observation that specific mutual funds continue to outperform or underperform a market index, and the finding that technical trading rules can predict price movements, all constitute violations of the random walk and/or the efficient markets hypothesis. Many of these studies assess whether, after adjusting for transactions costs the possibility risk factors, systematic profits can be made. The results on profitability are mixed, with some studies concluding that profits can be made.[1]

This paper provides evidence from the Eurodollar interest rate futures contract of predictable price movements that generate profits.[2] There are two noteworthy features of this

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[1] Froot and Thaler (1990) and *The Economist* (1992) provide useful summaries of the evidence on inefficiencies, particularly with regard to technical trading rules. Hendricks (1993) unearth trends in mutual fund performance, while Agrawal and Tandon (1994) document the evidence on calendar-day anomalies for stock markets in 18 countries.

[2] The Eurodollar future on three-month LIBOR is the most widely traded futures contract in the world. Trading volume and the number of outstanding contracts usually exceeds that on the 30-year US Treasury bond, the Euromark and S&P 500 futures contracts.

paper. First, the evidence provided here regarding the profitability of a trading rule based on a predictable price pattern is quite strong. Second, the trading rule used here to generate profits is linked to a *fundamental* reaction to economic news, unlike the technical trading rules or rules based on calendar-day anomalies that have been used in previous studies.

The paper is organized as follows: Section 2 outlines and interprets the evidence regarding the predictable reaction after the news, while section 3 presents the results of the simulation that generates statistically significant profits. Section 4 shows that the trading rule continues to be profitable *well after* the market has reacted to the initial surprise, thus suggesting that the delayed response cannot be explained by the slow learning process of market participants.

2. The delayed response

2.1. The employment survey data

In recent years, the most important release for the US financial and foreign exchange market has been the monthly employment report. The monthly employment report, usually released on the first Friday of the month, contains a wealth of data: the unemployment rate; the number of payroll jobs; average hourly earnings; and the average workweek, etc. While the markets pay attention to all these variables, the statistic of greatest import is the *change in payroll employment*.[3] As is the case with other data, such as money supply or the trade balance, the markets react only to the surprise in employment, henceforth labelled *EMPGAP*. This surprise *EMPGAP*, measured in thousands (K), is the discrepancy between the actual value and the expected (MMS) survey value. Since the MMS survey for payroll employment started in January 1985, *EMPGAP* is available from then onwards.

2.2. Evidence of delay

The tests in the top part of Table 1 document both the contemporaneous response (*DELNEWS*) and the subsequent response (*DELAFTER*) of the Eurodollar interest rate to *EMPGAP* over the period January 1988–December 1993. The first regression indicates that an employment surprise of 100 K raises interest rates by about 8.3 basis points during that day. The second regression indicates the subsequent response: *after* the news, by the end of the month interest rates again rise by about 4.4 basis points in response to *EMPGAP*. Although the response of *DELAFTER* is considerably weaker than that of *DELNEWS*, it is still statistically significant at the 10% level. The last regression looks at the link between *DELAFTER* and *DELNEWS*: a one basis point contemporaneous rise in rates leads to a 0.43 basis point rise by the end of the month, significant at the 5%, and almost significant at the

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[3] The payroll employment data based on a large sample of firms have less sampling error than does the more widely known unemployment rate statistic. Hence markets 'efficiently' pay more attention to the former. Evidence documenting this phenomenon and further details about the Bureau of Labor Statistics employment data, as well as the corresponding Money Market Services (MMS) survey of market participants data is provided in Moorthy (1994).

Table 1
Responses to the surprise in payroll employment sample period January 1988–December 1993

Dependent variable: Change in Eurodollar rate, basis points	Adj. R^2	Explanatory variable	D – W
		EMPGAP	
Thursday to Friday (DELNEWS)	0.41	8.36 (7.06)***	1.99
Friday to to end month (DELAFTER)	0.04	4.37 (1.86)*	1.68
		DELNEWS	
Friday to end month (DELAFTER)	0.07	0.43 (2.37)**	1.73
Sample period January 1985–December 1987			
		EMPGAP	
Thursday to Friday (DELNEWS)	0.28	7.51 (3.85)***	2.38
Friday to end month (DELAFTER)	−0.02	2.87 (0.486)	2.25
		DELNEWS	
Friday to end month (DELAFTER)	−0.03	0.111 (0.250)	2.19

Notes: (1) t-values are in parentheses. *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively. (2) Closing Eurodollar futures rate (Source: Knight–Ridder). The Eurodollar interest rate is 100 minus the Eurodollar price.

1%, level. Taken in isolation, the responses of DELAFTER to EMPGAP and to DELNEWS are not very strong. However, the joint probability that the null hypothesis of no response is true and that both these responses could occur randomly is about 1 in 900, given the statistical significance of the individual regressions.

Two possible channels of influence that lead to this delayed response suggest themselves. First, the employment report is followed later in the month by industrial production, retail sales, housing starts and permits, the index of leasing indicators and other reports for that (previous) month. All these variables are affected by employment. Thus, a strong and/or stronger than expected employment report would imply strength in these later data as well and vice versa.[4] However, if the market does not fully discount the subsequent data immediately, then interest rates later in the month will be bid up or down in anticipation of the upcoming strong or weak reports, respectively. More generally, the initial surprise could create a wave

[4] In particular, industrial production is directly related to manufacturing employment and hours worked, information on which is also provided in the employment report.

of optimism or pessimism that carries through to the end of the month. A second possible channel of influence is that a strong report in one month could lead market participants to expect a strong report in future month(s) as well, which would push interest rates higher towards the end of the month when market participants turn their attention to the next month' data.[5]

In the existing literature, the use of very short intervals after the news to test for a delayed response is meant to increase the 'power' of the test: since information is disseminated very rapidly in an efficient market, the lack of the response in the *immediate* aftermath is taken to imply an extremely efficient market that was reacted very quickly.[6] However, if the autocorrelated response gradually gets built into prices, the standard test procedures will not be able to detect the delayed impact.

3. The trading rule

The delayed response implies a trading rule that generates profits. If employment is higher than expected ($EMPGAP > 0$), a short position in one contract should be established at Friday's closing price and vice versa. (Since the Eurodollar price equals 100 minus the Eurodollar rate, a rise in rates/fall in price should lead one to establish a short position.) This position should be closed out on the last trading day of the month with an offsetting position. Using this '*EMPGAP* rule' generates about 8.21 basis points of average *gross* profit and 6.21 basis points of average *net* profit over 1988–1993.[7]

An alternative trading rule is to follow through solely with the direction of *DELNEWS*, irrespective of the value of *EMPGAP*. This alternative rule yields slightly lower profits than the *EMPGAP* rule; so does a qualified *EMPGAP* trading rule based on omitting those months in which *DELNEWS* does not respond in the appropriate direction to *EMPGAP*.

The efficacy of the *EMPGAP* rule can be ascertained by comparing it with the alternative of randomly choosing a long or short position and closing it out accordingly.[8] The random strategy was conducted 500 times, i.e. the sequence of random trades over the sample period 1988–1993 was repeated 500 times and the *average* gross profits for each sequence was computed. The number of trades corresponding to different values of (average) gross profits is depicted in the histogram of Fig. 1. The bar over 1, for instance, denotes average gross profits

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[5] The response of *DELAFTER* ws broken down into the first week, second week, third week and end month responses. Tests did not reveal the response to *EMPGAP* to be significant over any of these sub-periods, although the coefficients on *EMPGAP* for all the sub-periods are of the right sign. Hence, one can conclude that the delayed response to *EMPGAP* occurs during the entire month and tends to support the first explanation.

[6] See, for instance, the tests in Hakkio and Pearce (1985).

[7] The net profit is 6.21 basis points after allowing for the 2 basis points transactions costs of the buy and sell trades. Since 1 basis point is $25 on one contract, this amounts to $155 of net profit per monthly trade. This calculation ignores the interest income that may be foregone on the funds deposited in the margin account and/or ignores the losses from liquidating a position due to the inability to meet margin calls.

[8] All the results in this paper were obtained using Microtsp. The random numbers generated by the random number generator command were converted into a binary decision rule ($+1$ short sell/-1 buy now, reverse the position at end month).
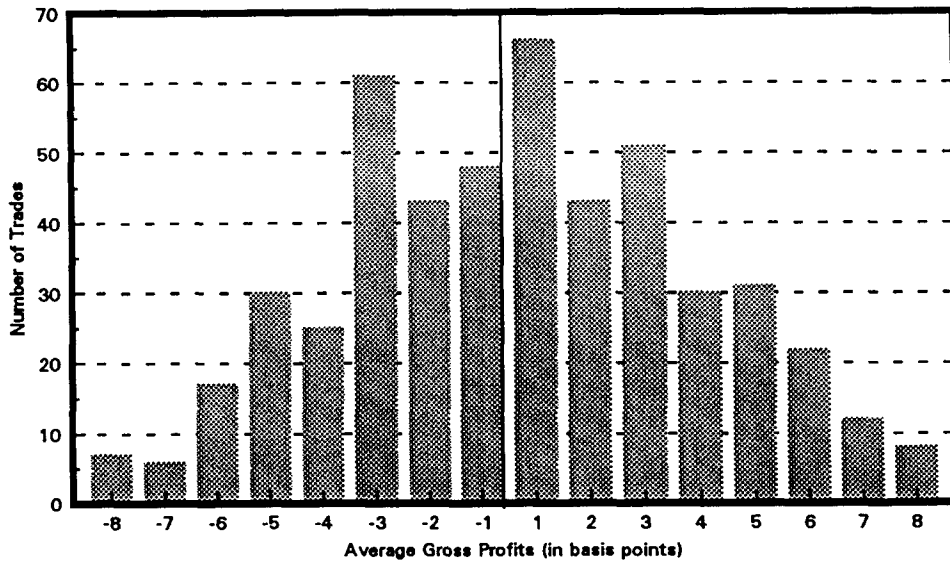
Fig. 1. Average gross profits from 500 random trades.

in the 0–1 basis point range. The standard deviation of profits with the random strategy is 2.90 basis points and the mean gross profit of 0.20 basis points is not significantly different from zero. So, compared with the random strategy, the trading rule does better in over 95%, but under 99% (2.90 times 3), of the cases.[9]

4. A learning process?

Previous studies have found that ostensible violations of market efficiency may be due to the excess profits earned during the initial learning period, and which get competed away over time.[10] However, the evidence suggests that such a learning process does not apply here. The bottom half of Table 1 repeats the regressions over the first three years of the survey. As can be seen, a 100 K surprise raises *DELNEWS* by 6.48 basis points and the coefficient is significant at the 1% level. Nevertheless, there is no delayed response of *DELAFTER* to either *EMPGAP* or *DELNEWS*. In contrast to the delayed response during 1988–1993, there

[9] For the random strategy, gross profit is not significantly different from zero and net profit is close to −2 basis points. Transactions costs are the same for both strategies and so the comparison should be done either for gross or net profit from both strategies.

[10] Lewis (1989) prevents evidence that investors' learning process about the unobservable change in the money supply process can explain part of the error implicit in the forward exchange rate. A pure 'peso problem' explanation – where a discrete change is correctly anticipated and ultimately occurs, but is not reflected in the price outcomes of the early part of the sample – does not seem to be germane to the situation being analyzed here.
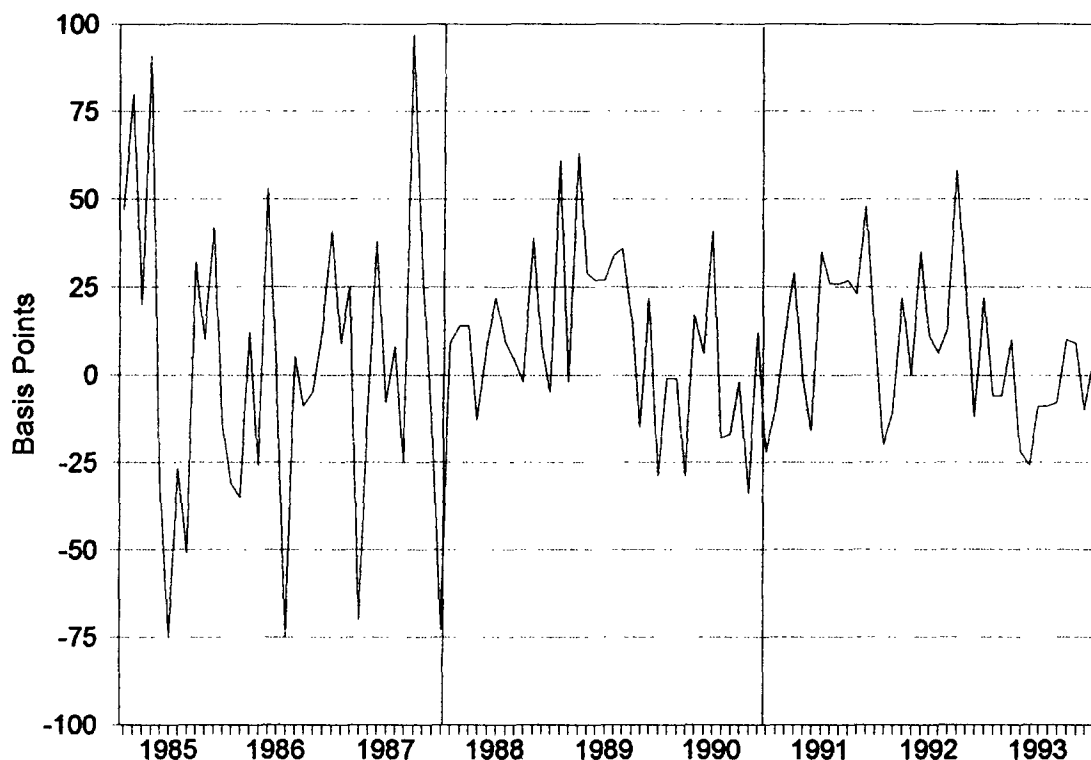
Fig. 2. Profits from EMPGAP trading rule. Note that average gross profits for the subperiods are 2.22, 8.83 and 7.78 basis points respectively.

is a lack of delayed response during this *early* period, 1985–1988, which is precisely the opposite of what one would expect under the learning process scenario.[11]

Further decomposing the main 1988–1993 period into two equal subperiods 1988–1990 and 1991–1993 indicates that the delayed profitable response *continues* into the second subperiod. Between January 1988 and December 1990, the response of *DELAFTER* to both *EMPGAP* and *DELNEWS* is just about significant at the 10% level. For the second subperiod, January 1991–December 1993, the coefficients of *DELNEWS* on *EMPGAP* and *DELNEWS* are of the right sign although not significant. However, the joint probability of both these responses occurring randomly is about 1 in 10.

The behavior of profits during the subperiods, which is more crucial than the significance of the regressions, is plotted in Fig. 2. As can be seen, gross profits are very small during 1985–1987, the early period, with net profits close to zero. However, during the subperiods 1988–1990 and 1990–1993 the trading rule provides gross profits of 8.63 and 7.78 basis points,

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[11] In the course of the 1980s, domestic real-side data (as opposed to money supply data) played an increasingly larger role in determining monetary policy and anticipations thereof. Slow learning or a lack of knowledge about this 'monetary regime shift' should have implied a lack of response of *DELNEWS* to the real surprise, *EMPGAP*, during the early period as well.

respectively, better than the random strategy in over 95% of the cases for both subperiods.[12] The response during 1991–1993 can be considered the equivalent of an out-of-sample test of the trading rule developed with data during 1988–1990. In brief, the evidence constitutes a noteworthy violation of the efficient markets hypothesis.

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[12] The difference between mean profits in the two sub-periods 1988–1990 and 1991–1993 is not significant at the 5% level.