

Support for Resistance: Technical Analysis and Intraday Exchange Rates

- Among the technical trading signals supplied to customers by foreign exchange trading firms are “support” and “resistance” levels. These levels indicate points at which an exchange rate trend is likely to be interrupted or reversed.
- A rigorous test of the levels specified by six trading firms during the 1996-98 period reveals that these signals were quite successful in predicting intraday trend interruptions.
- Although all six firms were able to identify turning points in exchange rate trends, some firms performed markedly better than others. As a group, the firms predicted turning points in the dollar-yen and dollar-pound exchange rates more accurately than turning points in the dollar-mark exchange rate.
- In addition, the predictive power of the support and resistance levels appeared to last at least five business days after they were first communicated to customers.

Early in the morning of each business day, the major foreign exchange trading firms send their customers lists of technical trading signals for that day. Timely technical signals are also supplied by major real-time information providers. These signals, which are based primarily on prior price and volume movements, are widely used by active foreign exchange market participants for speculation and for timing their non-speculative currency transactions. In fact, 25 to 30 percent of foreign exchange traders base most of their trades on technical trading signals (Cheung and Chinn 1999; Cheung and Wong 1999). More broadly, technical analysis is used as either a primary or secondary source of trading information by more than 90 percent of foreign exchange market participants in London (Allen and Taylor 1992) and Hong Kong (Lui and Mole 1998).

The technical trading signals provided to customers vary over time and across technical analysts, but the vast majority of the daily technical reports include “support” and “resistance” levels. According to technical analysts, support and resistance levels are points at which an exchange rate trend is likely to stop and may be reversed. For example, a firm publishing a support level of \$1.50/£ would claim that the dollar-pound exchange rate is likely to stop falling if it reaches \$1.50/£. If the firm also provided another support level of \$1.45/£, the firm would claim that if the exchange rate passes through \$1.50/£, it is likely to stop falling at \$1.45/£.

Carol Osler is a senior economist at the Federal Reserve Bank of New York.

The author thanks Franklin Allen, Alain Chaboud, and Charles Jordan for thoughtful comments, Gijoon Hong for excellent research assistance, and two anonymous referees. The views expressed are those of the author and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.

Despite the almost universal use of support and resistance levels in short-term exchange rate forecasting, the ability of these trading signals to predict intraday trend interruptions has never been rigorously evaluated. This article undertakes such a test, using actual support and resistance levels published daily by six firms from January 1996 through March 1998. The firms include commercial banks, investment banks, and real-time information providers based in the United States and abroad. I examine the value of three currencies relative to the U.S. dollar: the German mark, the Japanese yen, and the British pound. Support and resistance levels for these exchange rates are tested against indicative exchange rate quotes sampled at one-minute intervals between 9 a.m. and 4 p.m. New York time.

These tests strongly support the claim that support and resistance levels help predict intraday trend interruptions for exchange rates. All six of the firms studied were able to identify

Despite the almost universal use of support and resistance levels in short-term exchange rate forecasting, the ability of these trading signals to predict intraday trend interruptions has never been rigorously evaluated.

points where intraday trends were likely to end. However, some firms were better than others at identifying such points.

For most firms, the predictive power of support and resistance levels lasted at least five business days beyond the levels' publication date. Despite their overall success at identifying points of trend interruptions, none of the firms correctly assessed the relative likelihood of trend interruptions at the different levels. These results are consistent across firms and are sustained over a number of sensitivity analyses.

The statistical tests are based on the bootstrap technique (Efron 1979, 1982), a nonparametric method frequently used to evaluate technical trading strategies (Brock et al. 1992; Levich and Thomas 1993). To implement the tests, I compare the behavior of exchange rates upon reaching published support and resistance levels with the behavior upon reaching 10,000 sets of arbitrarily chosen support and resistance levels. If the outcome associated with the actual levels exceeds the average outcome for the arbitrary levels in a high proportion of months, I conclude that the published levels have significant predictive power.

To complement the analysis of these signals' predictive power, I also analyze the signals themselves. I show that support and resistance levels provided by individual firms tend to be fairly stable from day to day. Their range varies very little over time. Firms do not agree extensively with each other on the relevant signals.

The specific conclusion that exchange rates tend to stop trending at support and resistance levels has no precedent in the academic literature. The closest point of comparison is a study by Lo et al. (2000), which finds that the conditional distribution of financial prices is sensitive to the presence of a broad variety of technical trading signals, consistent with the results presented here.

The finding that support and resistance levels are able to predict trend interruptions is consistent with other studies of the usefulness of technical trading rules when applied to currencies. Filter rules were found to be profitable as early as 1984 (Dooley and Shafer 1984), less than a decade into the floating rate period, and this finding has been confirmed repeatedly (Sweeney 1986; Levich and Thomas 1993). Moving-average crossover rules have also been tested frequently on exchange rates, with similar results (Levich and Thomas 1993; Menkhoff and Schlumberger 1995). More recently, Chang and Osler (1998) find that a trading strategy based on the head-and-shoulders chart pattern is profitable for dollar exchange rates vis-à-vis the mark and the yen, although not for four other dollar exchange rates.

This study differs from those earlier studies in four notable ways. First, the technical trading signals used here are intended to anticipate trend reversals, rather than trend continuations. Second, this study uses a type of trading signal that is actively used by market participants. Third, it uses trading signals that were produced by market participants. Other academic studies of technical analysis have typically constructed technical trading signals of their own. Finally, this study uses data sampled at one-minute intervals throughout the New York trading day, while most earlier studies have used data sampled at daily or lower frequencies.

The two existing studies of support and resistance levels—Curcio et al. (1997) and Brock et al. (1992)—test the hypothesis that prices tend to move rapidly once the levels are breached. Curcio et al. find that the hypothesis is not true on average for currencies, but may hold true during periods of strong trending. Brock et al. find that the hypothesis is true for daily movements of the S&P 500 stock index, but the profits may not be sufficient to offset transaction costs. The hypothesis that prices will trend once a trading signal is breached is not unique to support and resistance levels and is not examined here.

Technical Analysis

Technical analysts claim that they can predict financial price movements using an information set limited to a few variables, such as past prices. Many of the major technical indicators were described as early as 1930 by Shabacker, who based his conclusions on observations of U.S. stock prices. By now, technical indicators are widely used in major financial markets around the world, including foreign exchange and futures markets. There are two magazines devoted exclusively to the topic, each of which has more than 40,000 subscribers. To learn about technical analysis, one can consult myriad manuals, software, and on-line sources. Alternatively, one can take courses on technical analysis.

Casual observation and conversations with market participants indicate that support and resistance levels are the most widely used technical indicators in the foreign exchange market. This conclusion is also suggested by the fact that support and resistance levels are the only indicators provided by all six of the technical services covered in this research. In fact, some services provide no technical indicators at all other than support and resistance levels.

Support and Resistance Levels Defined

Before delving further into the analysis, it is important to explore the definition of support and resistance levels provided by technical analysts themselves. According to one major technical analysis manual, “support is a level or area on the chart under the market where buying interest is sufficiently strong to overcome selling pressure. As a result, a decline is halted and prices turn back again. . . . Resistance is the opposite of support” (Murphy 1986, p. 59).

A review of technical analysis manuals reveals that there is little disagreement among analysts on this definition (Arnold 1993; Edwards and Magee 1997; Hardy 1978; Kaufman 1978; Murphy 1986; Pring 1991; Sklarew 1980). For example, Pring states: “Support and resistance represent a concentration of demand and supply sufficient to halt a price move at least temporarily” (p. 199). Likewise, Arnold (1993) observes: “A support level is a price level at which sufficient demand exists to at least temporarily halt a downward movement in prices” (p. 67).¹

To identify the support and resistance levels relevant for the coming day, practicing technical analysts consult a variety of information inputs. These include visual assessments of recent price performance, simple numerical rules based on recent

price performance, inference based on knowledge about order flow, and market psychology.

The simplest approach to visual assessment is to look at recent minima and maxima: “Usually, a support level is identified beforehand by a previous reaction low,” and “a resistance level is identified by a previous peak” (Murphy 1986, p. 59). According to Pring (1991), one could also identify support and resistance levels by drawing a trendline,

To identify the support and resistance levels relevant for the coming day, practicing technical analysts consult a variety of information inputs.

or “channel,” in which recent peaks are connected by one line and recent troughs are connected by another: “A good trendline represents an important support and resistance zone” (p. 105).

One numerical rule used to infer support and resistance levels is the “50 percent rule,” which asserts that a major market move will often be reversed by about 50 percent in the first major correction (Pring, p. 187). Fibonacci series, which are widely used, suggest that 38.2 percent and 61.8 percent retracements of recent rises or declines are common.

Market insiders sometimes identify support and resistance levels using private information or information circulated informally in the market about certain market participants. For example, if a technical analyst learned in conversation that Japanese exporters are selling at 100, he or she would report a resistance level at ¥100.00/\$. Similarly, if a trader knew that his or her own firm had a large order at DM1.50/\$, he or she might expect unusual price behavior at that point.

Simple market psychology is also used to help identify support and resistance levels. According to Murphy (1986): “Traders tend to think in terms of important round numbers . . . as price objectives and act accordingly. These round numbers, therefore, will often act as psychological support or resistance levels.” As I will demonstrate later, published support and resistance levels are round numbers that end in 0 or 5 much more often than they would if they were chosen at random.

Some of the firms in the sample provided explanations for their chosen support and resistance levels. All of the approaches listed above are well represented among those explanations.

Properties of the Support and Resistance Database

The data examined here include support and resistance levels for the mark, yen, and pound in relation to the U.S. dollar, published daily by six firms from January 1996 through March 1998. Two of the firms did not report support and resistance levels for the pound. In total, there are approximately 23,700 support and resistance values (combined) for the mark, 22,800 for the yen, and 17,700 for the pound.

The six providers of technical analysis include commercial banks, investment banks, and news services. Some operate in the United States and others operate abroad. The commercial and investment banks provide the information free of charge to

The data examined here include support and resistance levels for the mark, yen, and pound in relation to the U.S. dollar, published daily by six firms from January 1996 through March 1998.

their customers, hoping that customers will be encouraged to direct more business toward them. Some news services charge for the information. Since all the providers hope that the usefulness of their signals will generate additional business, they have every incentive to maximize accuracy. In the analysis that follows, the firms are assigned numbers to preserve anonymity.

Table 1
Average Total of Support and Resistance Levels per Reporting Day

Firm	Overall	German Mark	Japanese Yen	British Pound
1	10.0	10.0	10.0	10.0
2	6.0	6.0	6.0	6.0
3	17.8	18.1	18.0	17.5
4	9.0	9.2	8.8	—
5	4.2	4.8	3.8	4.0
6	2.5	2.7	2.3	—

Source: Author's calculations.

Table 2
Average Distance between Support and Resistance Levels

Firm	Overall	German Mark	Japanese Yen	British Pound
1	30	36	29	26
2	61	75	52	55
3	54	58	49	54
4	57	64	49	—
5	162	156	184	144
6	42	47	36	—

Source: Author's calculations.

Note: Distances are measured in points, or 0.0001 marks/dollar, 0.01 yen/dollar, and 0.0001 dollars/pound.

On any given day, technical indicators were likely to be received from about five of the six firms. Firms failed to report for reasons such as vacations, sickness, and equipment problems. For individual firms, the average number of support and resistance levels (combined) that were listed per reporting day per currency ranges from two to eighteen (Table 1).

The support and resistance levels were quite close together for some firms and quite far apart for others. As shown in Table 2, the average distance between levels varied from 30 to 162 points on average (where a point is the smallest unit used in quoting an exchange rate).

Table 3
Average Gap between Current Spot Rates and Outermost Support and Resistance Levels

Firm	German Mark	Japanese Yen	British Pound
1	3.45	2.56	2.38
2	3.71	2.38	2.63
3	8.32	6.73	7.15
4	5.52	3.79	—
5	4.96	5.13	4.52
6	1.24	0.74	—
Daily ranges			
Average	0.45	0.33	0.37
Maximum	3.23	3.88	3.28

Source: Author's calculations.

Note: Distances are measured in units of 100 points, or 0.01 marks/dollar, 1.0 yen/dollar, and 0.01 dollars/pound.

Firms also varied dramatically in the range over which they chose to present support and resistance levels applicable to a given day (Table 3). For Firm 6, the outermost support and resistance levels were typically only about 100 points away from current spot rates, while for Firm 3 the outermost support and resistance levels were typically more than 700 points away. The final two rows of the table show the average and maximum daily exchange rate moves away from their opening rates over the period. For all firms, the outermost support and resistance levels were substantially farther away from the opening rates than this average move. The correlation between daily exchange rate ranges and the gap between opening rates and outermost support and resistance levels was not statistically significant for any firm-currency pair.

Use of Round Numbers

More than 70 percent of the support and resistance levels in the sample end in 0, and a full 96 percent end in either 0 or 5 (Table 4). These proportions greatly exceed the proportions we would observe if levels were chosen randomly, which would be 10 or 20 percent, respectively. Levels ending in 00 or 50 were also disproportionately represented. This may be a manifestation of the psychological interpretation of support and resistance levels mentioned earlier. It is interesting to note that

Table 4
Support and Resistance Levels Ending
in Round Numbers
Percent

	Support and Resistance Levels Ending in			
	00	00 or 50	0	0 or 5
Natural frequency	1.0	2.0	10.0	20.0
Firm 1	12.1	17.9	65.8	96.3
Firm 2	13.2	22.4	58.1	84.4
Firm 3	12.5	16.8	82.4	96.6
Firm 4	7.8	15.7	52.9	92.2
Firm 5	49.4	66.4	97.1	99.4
Firm 6	22.9	42.9	74.3	100.0
All firms	13.5	19.6	70.1	95.5

Source: Author's calculations.

Goodhart and Figliuoli (1991) observed that round numbers were also disproportionately represented in bid-ask spreads for major currencies.

Continuity

To analyze the extent to which support and resistance levels published by a given firm vary from day to day, I counted the number of support and resistance levels shared across days for a given firm, and compared it with the maximum number of levels that could have been shared. That maximum depends on the number of support and resistance levels provided on the two days: if the firm provided three support levels on the first day and four on the second day, the number of shared support levels, or matches, could not possibly exceed three. The maximum number also depends on the size of the exchange rate move from the first to the second day: if the exchange rate falls substantially between days one and two, then some of the support levels provided on day one might be irrelevant on day two. A shared level, or "match," was defined as a pair of support and resistance levels on contiguous days that differed by less than 5 points.

On average, about three-quarters of the still-applicable support and resistance levels from one day would be used again the next day (Table 5). This average masks a clear division of

Table 5
Continuity in Support and Resistance Levels

Firm	Overall	German Mark	Japanese Yen	British Pound
1	64.4	62.4	62.9	67.9
2	54.0	51.0	56.2	54.5
3	<i>91.4</i>	<i>89.8</i>	<i>91.7</i>	<i>92.6</i>
4	<i>81.9</i>	<i>81.2</i>	<i>82.7</i>	—
5	<i>80.8</i>	<i>77.5</i>	<i>85.0</i>	<i>81.3</i>
6	56.5	56.0	57.4	—
All firms	77.8	76.5	78.2	79.1

Source: Author's calculations.

Notes: The table shows the percentage of support and resistance levels shared across adjacent days. A pair of levels on adjacent days is defined as shared if the levels differ by at most 5 points. Numbers for firms showing particularly high continuity are italicized.

the firms into two groups. Firms 3, 4, and 5 showed the strongest continuity: more than three-quarters of their still-applicable support and resistance levels were used again the next day. For the remaining three firms, the corresponding proportions were lower, ranging from about one-half to two-thirds. These results do not change qualitatively if a match is defined as two levels within 2 points of each other.

Agreement across Firms

Firms do not agree extensively on the relevant support and resistance levels for a given day. To examine the extent of agreement across firms, I first counted the number of matches across each of the fifteen pairs of firms. For each day, the number of actual matches was then compared with the number of possible matches for that day. For a given day, the number of possible matches among support (resistance) levels was taken to be the minimum number of support (resistance) levels provided across the two firms.

On average, roughly 30 percent of all possible matches were realized as actual matches under the basic definition of a match (a maximum difference of 5 points), as shown in Table 6. Across firm pairs, the frequency of agreement varied from 13 to 38 percent (Table 7). Firm 5 stands out as the least likely to agree with its peers. Firms 1 and 2 stand out as agreeing particularly frequently with each other. Among the other firms, no strong patterns are distinguishable.

Table 6
Overall Agreement on Support and Resistance Levels across Firms

	Overall	German Mark	Japanese Yen	British Pound
Average possible matches per day	112.0	47.9	43.0	21.1
Average actual matches per day	33.5	14.3	12.3	6.9
Average actual matches per day as a percentage of possible matches	29.9	29.9	28.6	32.7

Source: Author's calculations.

Notes: The table shows the number of times all firms' support and resistance levels actually match as a percentage of the total number of possible matches. A match is defined as a pair of support and resistance levels that differ by at most 5 points.

Table 7
Pairwise Agreement across Firms on Support and Resistance Levels
All Currencies

Firm	Firm			
	2	3	4	5
1	38	33	27	17
2		35	31	13
3			32	25
4				23
5				

Source: Author's calculations.

Notes: The table shows the number of times a pair of firms' support and resistance levels actually match as a percentage of the number of possible matches. A match is defined as a pair of support and resistance levels that differ by at most 5 points. Numbers representing firm pairs for which agreement falls at or below 23 percent (mean overall agreement of 30 percent minus one standard deviation) are in bold. The italicized number represents firm pairs for which agreement falls at or above 37 percent (mean overall agreement of 30 percent plus one standard deviation).

If a match is defined as two levels within 2 points of each other, then roughly 18 percent of possible matches are actually realized. The same Firm 5 still stands out as the least likely to agree with its peers; the only strong agreement appears to be between Firms 3 and 6.²

Exchange Rate Data and Methodology

This section presents the exchange rate data, some important definitions, and the statistical methodology used to test the ability of support and resistance levels to predict intraday trend interruptions.

Exchange Rate Data

The exchange rate data comprise indicative bid-ask rates posted on Reuters, captured at one-minute intervals from 9 a.m. to 4 p.m. New York time. The prices for a given minute were taken to be the last quote made prior to that minute.

The analysis in Goodhart, Ito, and Payne (1996) suggests that these indicative quotes are likely to correspond closely to actual transaction prices. The major divergences between quotes and actual prices seem most likely to occur at times of large, rapid price movements. During the sample period, these divergences often occurred at times of macroeconomic data announcements from the United States, which tended to happen at 8:30 a.m., before the exchange rate data used here begin. Recent research by Danielsson and Payne (1999) finds that quotes may differ from actual transaction prices in other, potentially important ways. This point is discussed in greater detail below.

The construction of the exchange rate data set was driven primarily by the need to capture as closely as possible the price sequence that would be observed by traders operating in the market. This explains why an interval of one minute was

The construction of the exchange rate data set was driven primarily by the need to capture as closely as possible the price sequence that would be observed by traders operating in the market.

selected, rather than the more common interval of five minutes (for example, see Andersen and Bollerslev [1998]). It also explains why prices were not taken as an average of the immediately preceding and following quotes, another common technique in the literature (for example, see Andersen and Bollerslev [1998]): traders operating in real time could not know the immediately following quote.

The starting time for the data was chosen as 9 a.m. New York time for two reasons. First, by 9 a.m., the support and resistance levels in the data set have been transmitted to customers, including those from New York firms. Second, by 9 a.m., the reaction to macroeconomic data announcements from all the countries involved—including the United States, where, as noted, major announcements generally occurred at 8:30 a.m. New York time—would largely be over (see Andersen and Bollerslev [1998]).

The data end at 4 p.m. because very little trading takes place between then and the beginning of the next trading day in Asia. The 4 p.m. cutoff was also chosen because, in the underlying tick-by-tick exchange rate data set, quotes are not captured after 4 p.m. on Fridays.

Some Definitions

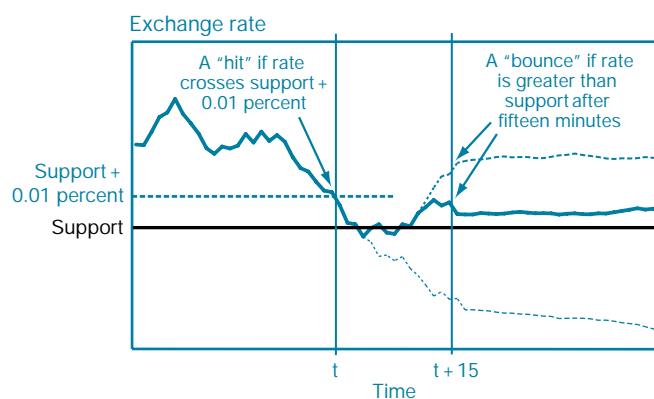
The exchange rate was defined as hitting a support (resistance) level if the bid (ask) price fell (rose) to within 0.01 percent of that level (see the chart for an illustration). Because the 0.01 percent figure is somewhat arbitrary, more than one definition was tried: the gap was also set at 0.00 percent and 0.02 percent in alternative tests. A trend interruption was defined as follows: once the exchange rate hit a support (resistance) level, the trend was interrupted if the bid (ask) price exceeded (fell short of) the support (resistance) level fifteen minutes later. Since the cutoff at fifteen minutes is also somewhat arbitrary, an alternative of thirty minutes was examined as well.

For brevity, a trend interruption will be referred to frequently as a “bounce,” and the ratio of times the exchange rate bounces to the number of actual hits will be referred to as the “bounce frequency.” In formal terms, the goal of the test described below is to ascertain statistically whether the bounce frequencies for the published support and resistance levels are high, as claimed by technical analysts.

Statistical Methodology

The statistical test evaluates whether or not published support and resistance levels are able to identify points of likely trend interruptions, as claimed by technical analysts. The central or “null” hypothesis is that the published levels have no special ability to identify such points. I begin with a summary of the methodology and then present details.

Hypothetical Exchange Rate Paths



Source: Author's calculations.

Summary

The statistical methodology used to test this null hypothesis is a specific application of the bootstrap technique (Efron 1979, 1982). To apply this technique, I first calculate bounce frequencies for each firm for each month in the sample. I then build a statistical representation of what bounce frequencies for the published support and resistance levels would look like if the null hypothesis were true. In the present context, this representation is constructed by first creating 10,000 sets of artificial support and resistance levels for each day. For each of these artificial sets of support and resistance levels, I then calculate bounce frequencies for each month, using the criteria for hits and bounces listed above.

At this point, I have twenty-eight bounce frequencies for each firm, one for each month of the sample, and twenty-eight average bounce frequencies for the artificial support and resistance levels. In the final step of the test, I determine the number of months in which the bounce frequency for a given firm exceeds the average bounce frequency for artificial levels. If this number of months is quite high, I conclude that the published support and resistance levels have some ability to predict intraday trend interruptions. Additional details on this methodology are presented below.

Calculating Artificial Support and Resistance Levels

For each day, the artificial support and resistance levels are chosen at random from exchange rates within a certain range of the day's opening rate. The range for each month is based on the exchange rate's actual behavior, as follows: for a given month, I calculate the gap between the opening rate and intraday highs and lows for each day. The absolute value of the largest of these gaps is used as the range for calculating artificial support and resistance levels for that month.

For each day, twenty artificial support and twenty artificial resistance levels are calculated using the following algorithm:

$$R_{it} = O_t + b_{it} \text{range} ,$$

$$S_{it} = O_t - a_{it} \text{range} .$$

Here, t represents time, $S_{it}(R_{it})$ is the i th artificial support (resistance) level, O_t is the day's opening rate, a_{it} and b_{it} are random numbers generated from a uniform distribution over $[0,1]$, and range is the range for that month. These levels are then rounded off so that they have the same number of significant digits to the right of the decimal point as actual quoted exchange rates.³

The Statistical Test

The statistical test is based on comparing the bounce frequencies for the published support and resistance levels (B^P) with the average bounce frequencies for the artificial levels (B^A), month by month. To understand the test intuitively, suppose published support and resistance levels provide no more information than arbitrary levels. In this case, B^P should not consistently be higher or lower than B^A . However, if published support and resistance levels can predict points of likely trend interruptions, as claimed by technical analysts, then B^P should usually be higher than B^A .

This idea can be formalized into a rigorous statistical test. The comparison for each month can be viewed as a "Bernoulli trial," in which a random event occurs with a certain proba-

Consistent with the market's conventional wisdom, exchange rates bounced quite a bit more frequently after hitting published support and resistance levels than they would have by chance.

bility. The random event here would be $B^P > B^A$. Under the null hypothesis that published levels have no special predictive power, the likelihood of that event is 50 percent. Over the entire twenty-eight-month sample, if it is true that published levels are not informative, the chance that $B^P > B^A$ for any given number of months will conform to the binomial distribution. This distribution is symmetrical around a single peak at fourteen months, where the probability is about 15 percent.

To understand how to use this distribution, suppose we find that $B^P > B^A$ in twenty of the twenty-eight months of the sample. We might naturally ask: Would it be unusual to get such an extreme outcome if the published levels are truly not informative? More concretely, what is the likelihood, if the published levels are not informative, of finding $B^P > B^A$ in twenty or more of the twenty-eight months of the sample? This likelihood is the area under the tail of the distribution to the right of the number 20. This is a very small number: in fact, it is 1.8 percent.

The likelihood of finding $B^P > B^A$ in twenty or more of the twenty-eight months, under the assumption that published levels are not informative, is called the "marginal significance level" associated with the number 20.⁴ If the marginal significance level of some result is smaller than 5 percent, it is consistent with standard practice in the literature to conclude

that the published numbers are better than arbitrary numbers at predicting trend interruptions. Such a result is said to be “statistically significant.”

To summarize our example: it would be extremely unusual to find that $B^P > B^A$ in twenty or more of the twenty-eight months if the published support and resistance levels were truly not informative. In fact, we would realize such an outcome only 1.8 percent of the time. Since 1.8 percent falls below the common critical value of 5 percent, we would conclude that the predictive power of the published levels exceeds that of the arbitrary levels to a statistically significant degree.

Results

Consistent with the market’s conventional wisdom, exchange rates bounced quite a bit more frequently after hitting published support and resistance levels than they would have by chance. Exchange rates bounced off arbitrary support and resistance levels 56.2 percent of the time on average.⁵ By contrast, they bounced off the published levels 60.8 percent of the time on average (Table 8). Looking more closely, we find that in all sixteen firm-currency pairs, average bounce frequencies for published levels (across the entire sample period) exceeded average bounce frequencies for artificial levels.

The month-by-month breakdown shows that for most firm-currency pairs bounce frequencies for the published levels exceeded average bounce frequencies for artificial levels in twenty or more months. As noted above, these outcomes would be extremely unlikely if the support and resistance levels were truly not informative. More rigorously, the marginal significance levels indicate that the results are statistically significant at the 5 percent level for all but three firm-currency pairs.

The firms’ ability to predict turning points in intraday trends seems to have been stronger for the yen and weaker for the mark and the pound. On average, bounce frequencies for published support and resistance levels exceeded those for arbitrary levels by 4.2 percentage points for the mark, 5.6 percentage points for the yen, and 4.0 percentage points for the pound. This relative ranking was maintained fairly consistently for individual firms.

Although all six firms seem to have the ability to predict exchange rate bounces, their performance varied considerably. The bounce frequencies of the best and worst firms differ by 4.0 percentage points on average. At one extreme, Firm 1’s support and resistance levels for the yen had a bounce frequency 9.2 percentage points higher than that of the arbitrary levels.

Differences across firms are evaluated statistically in Table 9. Firm 1 is clearly the best overall: it had the highest bounce frequency for two of the three currencies and the second-highest bounce frequency for the third currency. Furthermore, the differences between Firm 1 and the other firms are statistically significant at the 5 percent level in seven of the thirteen possible firm-to-firm comparisons and are statistically significant at the 10 percent level in another comparison. Firm 5 did quite well for the mark, but did not do noticeably well for the other two currencies. No firm was consistently worst.

Table 8
Ability of Support and Resistance Levels to Predict Interruptions of Intraday Exchange Rate Trends

	Artificial Levels	Levels Published by Firm					
		1	2	3	4	5	6
		Bounce Frequency (Number of Hits)					
German mark	54.9 (6,291)	60.1 (4,102)	56.6 (8,111)	58.0 (3,570)	58.5 (1,262)	62.0 (2,296)	59.3 (2,296)
Japanese yen	57.3 (4,558)	66.5 (3,874)	63.6 (6,271)	62.3 (2,679)	60.7 (859)	61.6 (1,396)	62.6 (1,396)
British pound	56.3 (5,409)	63.0 (3,920)	58.8 (6,056)	59.6 (6,056)		60.0 (1,039)	
		Months $B^P > B^A$ /Total Months (Marginal Significance)					
German mark		24/28 (0.000)	17/28 (0.172)	21/28 (0.006)	20/27 (0.010)	20/26 (0.005)	19/28 (0.044)
Japanese yen		26/28 (0.000)	24/27 (0.000)	22/28 (0.002)	23/27 (0.000)	15/23 (0.105)	20/27 (0.010)
British pound		27/28 (0.000)	19/28 (0.044)	24/28 (0.000)		16/26 (0.163)	

Source: Author’s calculations.

Notes: The table compares the ability of published support and resistance levels to predict intraday trend interruptions with the distribution of predictive ability for 10,000 sets of arbitrary support and resistance levels. The measure of predictive ability is based on the “bounce frequency,” or the number of times the exchange rate stopped trending after reaching support or resistance levels compared with the total number of times the rate actually reached such levels.

The table shows the bounce frequency for published and artificial support and resistance levels, the number of hits, the number of months in which the bounce frequency for published levels (B^P) exceeds the bounce frequency for artificial levels (B^A), and the marginal significance of this number of months under the null hypothesis that published support and resistance levels are not informative. “Total months” varies across firms and currencies because occasionally a firm contributed too few support and resistance levels to have any hits at all.

Table 9
Differences in Firms' Ability to Predict
Exchange Rate Bounces

Firm B	Firm A				
	1	2	3	4	5
German mark					
2	3.5**				
3	2.1**	-1.4			
4	1.5	-2.0	-0.6***		
5	-2.0**	-5.5**	-4.1***	-3.5	
6	0.8	-2.7	-1.3**	-0.7	2.8
Japanese yen					
2	2.8*				
3	4.1***	1.3			
4	5.7***	2.9	1.6		
5	4.9	2.0	0.7	-0.9	
6	3.8	1.0	-0.3	-1.9	-1.0
British pound					
2	4.2***				
3	3.5**	-0.8*			
5	3.1*	-1.2	-0.4		

Source: Author's calculations.

Notes: The table compares different firms' ability to predict intraday trend interruptions in exchange rates. The measure of predictive ability is based on the "bounce frequency," or the number of times the exchange rate stopped trending after reaching support or resistance levels compared with the total number of times the rate actually reached such levels. The table presents the difference between bounce frequencies (measured as Firm A minus Firm B).

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

*** Statistically significant at the 1 percent level.

Robustness

These results are robust to changes in the test methodology.⁶ They are not changed qualitatively if a hit is defined more broadly or more narrowly (as described earlier) or if one looks thirty minutes rather than fifteen minutes beyond a hit. The results are also unchanged if one splits the sample into morning and afternoon sessions (where the morning session is defined to include positions entered before noon).

Interestingly, the results change somewhat if the sample is split in half chronologically. During the first half of the sample period, when volatility was fairly low by historical standards, bounce frequencies were statistically significant for published levels in all but one case. In the second half, when volatility returned to more normal levels, firms' bounce frequencies still

exceeded those for the artificial levels, but the differences were no longer statistically significant in half the cases.⁷ This outcome is consistent with the market's conventional wisdom that rates tend to "range trade" in periods of low volatility, thus making this type of trend reversal more common.

Quotes versus Transaction Prices

At this point, it is possible to discuss more fully the potential implications of the differences noted by Danielsson and Payne (1999) between exchange rate quotes and actual transaction prices. The first important difference they note is that quotes tend to be more volatile than actual transaction prices. This should not be critical here, because these results concern the direction of price changes, not their magnitude.

Second, Danielsson and Payne (1999) find that quotes tend to be negatively autocorrelated while transaction prices are not. In theory, this could affect the absolute frequency of bounces presented in Table 8. Fortunately, the important qualitative

Could an analyst using support and resistance levels published today have any success predicting intraday trend reversals one week from today?

The answer seems to be yes.

conclusions of the paper are based on the *difference* between bounce frequencies for published and simulated levels, rather than the absolute size of those bounce frequencies. Furthermore, the negative autocorrelation in quote data may largely have dissipated by the end of the fifteen-minute horizon of interest. The reason is that if the exchange rate is required to reach the actual level rather than some nearby level to achieve a hit, bounce frequencies in the simulated support and resistance levels fall slightly short of 50 percent. If negative autocorrelation at the fifteen-minute horizon were an issue, that proportion would presumably exceed 50 percent.

Duration of Predictive Power

Could an analyst using support and resistance levels published today have any success predicting intraday trend reversals one week from today? The answer seems to be yes. Five days after

Table 10

Ability of Support and Resistance Levels to Predict Interruptions of Intraday Exchange Rate Trends after Five Trading Days

	Artificial Levels	Levels Published by Firm					
		1	2	3	4	5	6
		Bounce Frequency (Number of Hits)					
German mark	53.8	58.0 (4,078)	59.0 (2,464)	57.5 (5,902)	56.9 (2,930)	58.3 (1,004)	55.5 (1,148)
Japanese yen	55.4	62.5 (3,531)	60.5 (2,112)	61.2 (4,392)	59.5 (2,373)	59.7 (703)	64.3 (635)
British pound	54.0	57.5 (3,661)	59.0 (2,400)	56.5 (4,641)		57.4 (622)	
		Months $B^P > B^A$ / Total Months (Marginal Significance)					
German mark		22/27 (0.001)	22/27 (0.001)	21/27 (0.003)	16/26 (0.163)	16/23 (0.047)	16/25 (0.115)
Japanese yen		21/27 (0.003)	20/27 (0.010)	22/27 (0.001)	19/26 (0.014)	12/22 (0.416)	16/24 (0.076)
British pound		19/27 (0.026)	17/27 (0.124)	17/27 (0.124)		13/19 (0.084)	

Source: Author's calculations.

Notes: The table shows the results of using published support and resistance levels to predict intraday trend interruptions five business days after the levels' publication date. The measure of predictive ability is based on the "bounce frequency," or the number of times the exchange rate stopped trending after reaching support or resistance levels compared with the total number of times the rate actually reached such levels.

The table shows the bounce frequency for published and artificial support and resistance levels, the number of hits, the number of months in which the bounce frequency for published levels (B^P) exceeds the bounce frequency for artificial levels (B^A), and the marginal significance of this number of months under the null hypothesis that published support and resistance levels are not informative. "Total months" varies across firms and currencies because occasionally a firm contributed too few support and resistance levels to have any hits at all.

their publication, bounce frequencies for our six firms still exceeded those from arbitrary levels for all firms and currencies, and the differences were statistically significant in nine of the sixteen cases (Table 10). Not surprisingly, the published levels were not quite as useful at predicting intraday trend reversals five days after publication as they were on their actual publication day. On average, five days after publication, rates bounced at published levels 1.7 percentage points less frequently than they did on the actual publication day.⁸

The Power of Agreement

If many analysts agree that a particular level is likely to be important, does this imply that the level is more likely than others to be important? I addressed this question by comparing the predictive power of support and resistance levels provided by more than one firm ("agreed levels") on a given day with the predictive power of support and resistance levels provided by only one firm.

As shown in Table 11, the bounce frequencies associated with agreed levels are quite close to the bounce frequencies associated with levels provided by just one firm. Although the agreed levels tend to have higher bounce frequencies, the differences are generally not statistically significant. The one difference found to be statistically significant implies that agreed levels have *less* predictive power than other levels. Overall, these results suggest that, if agreed levels do provide additional predictive power, the benefit is too small to be of much practical importance.⁹

Table 11

Is There Power in Agreement?

	Narrow Agreement			Broad Agreement		
	German Mark	Japanese Yen	British Pound	German Mark	Japanese Yen	British Pound
Agreed levels	58.0	65.9	63.1	59.1	65.2	61.7
Other levels	59.0	63.7	60.6	58.6	63.5	60.3
Months agreed > other/total months	10/28	15/27	17/28	11/28	14/27	14/28
Marginal significance	0.96	0.35	0.17	0.91	0.50	0.57

Source: Author's calculations.

Notes: The table compares the predictive ability of support and resistance levels on which two or more firms agree ("agreed levels") with the predictive ability of support and resistance levels provided by only one firm. The measure of predictive ability is based on the "bounce frequency," or the number of times the exchange rate stopped trending after reaching support or resistance levels compared with the total number of times the rate actually reached such levels. If agreed levels were better able to predict intraday trend interruptions, the numbers would be positive and statistically significant. Two levels were in "narrow agreement" if they were within 2 points of each other; they were in "broad agreement" if they were within 5 points of each other.

Reliability of Estimated “Strengths”

Three of the firms regularly provided estimates of the “strength” of their published support and resistance levels. For example, levels could be categorized as having strength numbers “1,” “2,” or “3,” with 3 being the strongest. The strength of a particular level can be interpreted as a crude measure of the likelihood that an exchange rate that arrives at the level will actually bounce off it.

Were the estimated strengths of support and resistance levels meaningful? To answer this question, I examined the

Table 12
The Meaning of Reported Strength Ratings

Comparison of Strengths 1 and 2	German Mark	Japanese Yen	British Pound
Firm 1	-2.3** 10/27 (0.04)	-4.1*** 8/26 (0.01)	-6.5 12/28 (0.17)
Firm 2	-2.7** 10/27 (0.04)	-5.5 10/25 (0.11)	-3.9* 10/26 (0.08)
Firm 3	2.4 14/25 (0.35)	0.2 11/24 (0.27)	-0.1 11/23 (0.34)

Source: Author’s calculations.

Notes: The table evaluates whether support and resistance levels considered somewhat strong by their publishers actually predict intraday trend interruptions better than those considered least strong. The measure of predictive ability is based on the “bounce frequency,” or the number of times the exchange rate stopped trending after reaching support or resistance levels compared with the total number of times the rate actually reached such levels. Strength 1 corresponds to the support and resistance levels at which trend interruptions are least likely; strength 2 corresponds to support and resistance levels at which trend interruptions are more—but not most—likely.

For each firm listed on the left side of the table, the first row of numbers represents the difference between the predictive ability of support and resistance levels of the two different strengths. If the reported strength levels were reliable, then the numbers would be positive and significant. The first number in each second row represents the months in which the bounce frequency for strength 2 actually exceeded the bounce frequency for strength 1; the second number in each row (following the slash) represents the number of months in which the comparison was valid; the third row of numbers gives the marginal significance of the second row under the null hypothesis that there is no difference between the two sets of numbers.

* Statistically significant at the 10 percent level.

** Statistically significant at the 5 percent level.

*** Statistically significant at the 1 percent level.

relative frequency of bounces off support and resistance levels in three strength categories: (1) least strong, (2) somewhat strong, and (3) strongest. Unfortunately, in many months there were few observations in strength category 3, so the only reliable comparison was between categories 1 and 2.

Results for this comparison are shown in Table 12, where the reported differences would be positive and statistically significant if the strength categories were meaningful. In fact, the reported strength levels seem to have no consistent correspondence with the actual frequency with which exchange rates bounced off support and resistance levels. All but two of the differences are negative, and the three that are statistically significant are negative. In short, published estimates of the strength of the levels do not seem to be useful.

Conclusion

This article has examined the predictive power of support and resistance levels for intraday exchange rates, using technical signals published by six active market participants from January 1996 through March 1998. The statistical tests, which use the bootstrap technique (Efron 1979, 1982), cover support and resistance levels for three currency pairs: dollar-mark, dollar-yen, and dollar-pound.

The results indicate that intraday exchange rate trends were interrupted at published support and resistance levels substantially more often than would have occurred had the levels been arbitrarily chosen. This finding is consistent across all three exchange rates and across all six firms studied. The predictive power of published support and resistance levels varies considerably across firms and across exchange rates. It lasts at least one week. The strength estimates published with the levels are not meaningful. These results are highly statistically significant and are robust to alternative parameterizations.

The predictive power of support and resistance levels has many possible sources, some of which are discussed in Osler (2000). Central bank intervention has been cited as a possible source of the predictive power of other technical trading strategies (Szakmary and Mathur 1997; LeBaron 1999). However, central bank intervention seems unlikely to be an important source of the predictive power of support and resistance levels since there was no reported intervention for the mark and the pound during the sample period. Other possible explanations include clustered order flow, which receives support in Osler (2000), and self-fulfilling prophecies.

The ability of support and resistance levels to predict trend reversals suggests that the intraday currency markets may not be fully efficient. To investigate this possibility, it would be natural to examine whether traders could profit from these predictable bounces on a fairly consistent basis. If it were indeed profitable to trade on these readily available technical

signals, there would seem to be some incentive for rational traders to trade the profits away. This would be an appropriate subject for future research. It might also be appropriate to examine the claim of technical analysts that trends typically are sustained once support and resistance levels are “decisively” crossed.

Endnotes

1. Support and resistance levels are related to but not identical to trading ranges. A trading range has just one support level and one resistance level. The firms examined here usually provided multiple support levels and multiple resistance levels each day.

2. These results are available from the author upon request.

3. That is, all artificial support and resistance levels for the mark and the pound had the form $x.xxxx00$, while all artificial support and resistance levels for the yen had the form $xxx.xx00000$.

4. For some firms, there were few support and resistance levels in some months, and thus few hits and bounces. These months were excluded from the sample for those firms.

5. If intraday exchange rates followed a random walk, the tendency to bounce would, in the abstract, be about 50 percent. The tendency to bounce in the actual data exceeds this benchmark for two reasons. First, changes in the actual and the simulated data have a fairly strong negative first-order autocorrelation, as noted by Goodhart and Figliuoli (1991). Second, to “bounce,” the exchange rate must first reach a level a little above (below) the actual support (resistance) level, and then remain above (below) the actual support (resistance) level for a certain interval. Thus, the exchange rate can continue trending slightly after officially hitting the level yet still be considered as having “bounced.”

6. Results from these sensitivity tests are available from the author upon request.

7. The standard deviation of daily exchange rate changes rose by one-third on average between the first and second halves of the sample period. In the first half, these standard deviations were 0.199, 0.216, and 0.260 for the mark, yen, and pound, respectively. In the second half, the corresponding standard deviations were 0.252, 0.362, and 0.277 (all figures E+3).

8. The reader may also be interested to know whether the tendency of support and resistance levels to be selected as round numbers or as local highs/lows has any influence on the levels' predictive power. In Osler (2000), I examine whether round numbers or local minima/maxima (both of which are known to be sources of published support and resistance levels) have predictive power for exchange rate bounces. I find that they do, from which I conclude that at least some of the predictive power in the published levels comes from the firms' tendency to choose these types of numbers. I also show that the size of the typical move following a hit differs substantially between the published levels of some firms and the artificial levels. I conclude from this that round numbers and local minima/maxima do not incorporate as much information about intraday trend reversals as do some published support and resistance levels.

9. It would be desirable here to weight the advising firms by their order flow. However, order information is very closely guarded by the firms in question. Furthermore, some of the firms do not actually take orders.

References

- Allen, Helen, and Mark P. Taylor.* 1992. "The Use of Technical Analysis in the Foreign Exchange Market." *Journal of International Money and Finance* 11, no. 3 (June): 304-14.
- Andersen, Torben, and Tim Bollerslev.* 1998. "Deutsche Mark–Dollar Volatility: Intraday Activity Patterns, Macroeconomic Announcements, and Longer Run Dependencies." *Journal of Finance* 53 (February): 219-65.
- Arnold, Curtis M.* 1993. *Timing the Market: How to Profit in Bull and Bear Markets with Technical Analysis.* Chicago: Probus Publishing Company.
- Brock, W., et al.* 1992. "Simple Technical Trading Rules and the Stochastic Properties of Stock Returns." *Journal of Finance* 48 (December): 1731-64.
- Chang, P. H. Kevin, and C. L. Osler.* 1998. "Methodical Madness: Technical Analysis and the Irrationality of Exchange Rate Forecasts." *Economic Journal* 109, no. 458 (October): 636-61.
- Cheung, Yin-Wong, and Menzie Chinn.* 1999. "Traders, Market Microstructure, and Exchange Rate Dynamics." Unpublished paper, University of California at Santa Cruz, January.
- Cheung, Yin-Wong, and Clement Yuk-Pang Wong.* 1999. "Foreign Exchange Traders in Hong Kong, Tokyo, and Singapore: A Survey Study." *Advances in Pacific Basin Financial Markets* 5: 111-34.
- Curcio, Richard, et al.* 1997. "Do Technical Trading Rules Generate Profits? Conclusions from the Intraday Foreign Exchange Market." Unpublished paper, London School of Economics.
- Danielsson, Jón, and Richard Payne.* 1999. "Real Trading Patterns and Prices in Spot Foreign Exchange Markets." Unpublished paper, London School of Economics, March.
- Dooley, Michael P., and Jeffrey Shafer.* 1984. "Analysis of Short-Run Exchange Rate Behavior: March 1973 to November 1981." In David Bigman and Teizo Taya, eds., *Floating Exchange Rates and the State of World Trade and Payments*, 43-70. Cambridge, Mass.: Ballinger Publishing Company.
- Edwards, Robert, and John Magee.* 1997. *Technical Analysis of Stock Trends.* 5th ed. Boston: John Magee.
- Efron, B.* 1979. "Bootstrap Methods: Another Look at the Jackknife." *Annals of Statistics* 7: 1-26.
- . 1982. *The Jackknife, the Bootstrap, and Other Resampling Plans.* Philadelphia: Society for Industrial and Applied Mathematics.
- Goodhart, C., and L. Figliuoli.* 1991. "Every Minute Counts in Financial Markets." *Journal of International Money and Finance* 10, no. 1 (March): 23-52.
- Goodhart, C., T. Ito, and R. Payne.* 1996. "One Day in June 1993: A Study of the Working of the Reuters 2000-2 Electronic Foreign Exchange Trading System." In Jeffrey Frankel, Gianpaolo Galli, and Alberto Giovannini, eds., *The Microstructure of Foreign Exchange Markets*, 107-79. National Bureau of Economic Research Conference Report Series. Chicago: University of Chicago Press.
- Hardy, C. Colburn.* 1978. *The Investor's Guide to Technical Analysis.* New York: McGraw-Hill.
- Kaufman, P.* 1978. *Commodity Trading Systems and Methods.* New York: Ronald Press.
- LeBaron, Blake.* 1999. "Technical Trading Rule Profitability of Foreign Exchange Intervention." *Journal of International Economics* 49 (October): 125-43.
- Levich, R., and L. Thomas.* 1993. "The Significance of Technical Trading Rule Profits in the Foreign Exchange Market: A Bootstrap Approach." *Journal of International Money and Finance* 12 (October): 451-74.
- Lo, Andrew W., et al.* 2000. "Foundations of Technical Analysis: Computational Algorithms, Statistical Inference, and Empirical Implementation." NBER Working Paper no. 7613, March.
- Lui, Yu-Hon, and David Mole.* 1998. "The Use of Fundamental and Technical Analyses by Foreign Exchange Dealers: Hong Kong Evidence." *Journal of International Money and Finance* 17, no. 3 (June): 535-45.
- Menkhoff, Lukas, and Manfred Schlumberger.* 1995. "Persistent Profitability of Technical Analysis on Foreign Exchange Markets?" *Banca Nazionale del Lavoro Quarterly Review* 193 (June): 189-215.

References (Continued)

Murphy, John J. 1986. *Technical Analysis of the Futures Market: A Comprehensive Guide to Trading Methods and Applications*. New York: Prentice Hall.

Osler, C. L. 2000. "Are Currency Markets Efficient? Predictable Trend Reversals in Intraday Exchange Rates." Unpublished paper, Federal Reserve Bank of New York, February.

Pring, M. 1991. *Technical Analysis Explained: The Successful Investor's Guide to Spotting Investment Trends and Turning Points*. 3rd ed. New York: McGraw-Hill.

Shabacker, R. W. 1930. *Stock Market Theory and Practice*. New York: B. C. Forbes Publishing Company.

Sklarew, Arthur. 1980. *Techniques of a Professional Commodity Chart Analyst*. New York: Commodity Research Bureau.

Sweeney, R. J. 1986. "Beating the Foreign Exchange Market." *Journal of Finance* 41 (March): 163-82.

Szakmary, Andrew, and Ike Mathur. 1997. "Central Bank Intervention and Trading Rule Profits in Foreign Exchange Markets." *Journal of International Money and Finance* 16, no. 4 (August): 513-35.

The views expressed in this paper are those of the author and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System. The Federal Reserve Bank of New York provides no warranty, express or implied, as to the accuracy, timeliness, completeness, merchantability, or fitness for any particular purpose of any information contained in documents produced and provided by the Federal Reserve Bank of New York in any form or manner whatsoever.