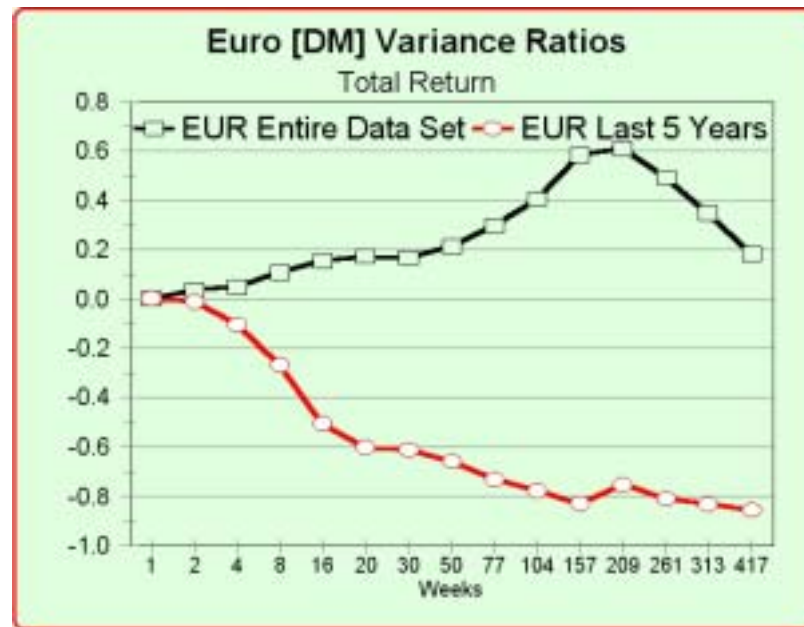


ADAPTIVE MODELING IN VALUATION, RISK ASSESSMENT, AND PORTFOLIO CONSTRUCTION



CHICAGO QWAFEFW MEETING 20 MAY 2004

Michael F. Wilcox, CFA
President, Alford Associates, Inc.

Tel 413-528-8098

michael.wilcox@alfordinc.com

Models [should] imitate life

The need for adaptive models springs from the nature of markets

“...self-organization is the root source of order. [in living systems]”

“In equilibrium systems ... entropy inevitably increases ... (the so-called ergodic hypothesis) ... order ... tends to disappear.” “...for a living system, equilibrium corresponds to death.”

“Failure to predict [natural phenomena] can ... be predicted on at least two grounds. The first is quantum mechanics ... the second ... chaos theory.”

“The theory of computing [shows] that, in most cases by far, there exists no shorter means to predict what an algorithm will do than to simply execute it...”

“...life exists at the edge of chaos.” [generally attributed to Norman Packard]

“In such [an unpredictable] world, we must give up the pretense of long-term predictions. All we players can do is be locally wise, not globally wise.”

Stuart Kauffman in *At Home in the Universe; The Search for the Laws of Self-Organization and Complexity*, Oxford University Press 1995

Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

YET: “Programs that learn, changing the course of calculation as the model accumulates experience, are rare after almost half a century of endeavor. We still have little theory to guide us and few implementations.”

John H. Holland [inventor of the genetic algorithm] in *Emergence*,
Addison-Wesley 1998

Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

Why neither traditional cause-and-effect [linear] thinking nor chaos theory gives proper guidance in predicting outcomes in dynamic systems [e.g. markets]:

“For a dynamical system ... to be orderly, it must exhibit homeostasis; that is, it must be resistant to small perturbations.”

“In the chaotic regime, similar initial states tend to become progressively more dissimilar, and hence to *diverge* farther and farther apart in state space, as each passes along its trajectory. This is just the butterfly effect and sensitivity to initial conditions. Small perturbations amplify. Conversely, in the ordered regime, similar states tend to become more similar, hence *converging* closer together as they flow along their trajectories. This is just another expression of homeostasis. ...networks at the phase transition have the property that nearby states neither diverge nor converge.”

Stuart Kauffman in *At Home in the Universe; The Search for the Laws of Self-Organization and Complexity*, Oxford University Press 1995

Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

“... for a living system, equilibrium corresponds to death.”

“... on rugged fitness landscapes ... learning curves show a special property called a power-law relation.” [avalanches in sand piles or extinctions follow this pattern, as do many other natural and economic phenomenon]

“... diversity may help drive economic growth.”

Stuart Kauffman in *At Home in the Universe; The Search for the Laws of Self-Organization and Complexity*, Oxford University Press 1995

It is my contention that the CAPM and other Markowitz-based “optimal” solutions are to real life as the Prisoner’s Dilemma is to the Repeated Prisoner’s Dilemma [as demonstrated by Robert Axelrod].

That is to say, the [John] Nash equilibrium may not predict behavior if players get a chance to learn from experience.

Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

Adaptive Forecasting Algorithms

“My opinions may have changed, but what hasn’t changed is the fact that I am right.”

Ashleigh Brilliant

$$W_{k+1} = W_k + \rho_k \lambda_k \varepsilon_k X_k$$

Candidates For “X”:

Interest Rate Differentials

PPP Valuations

Past FX Changes

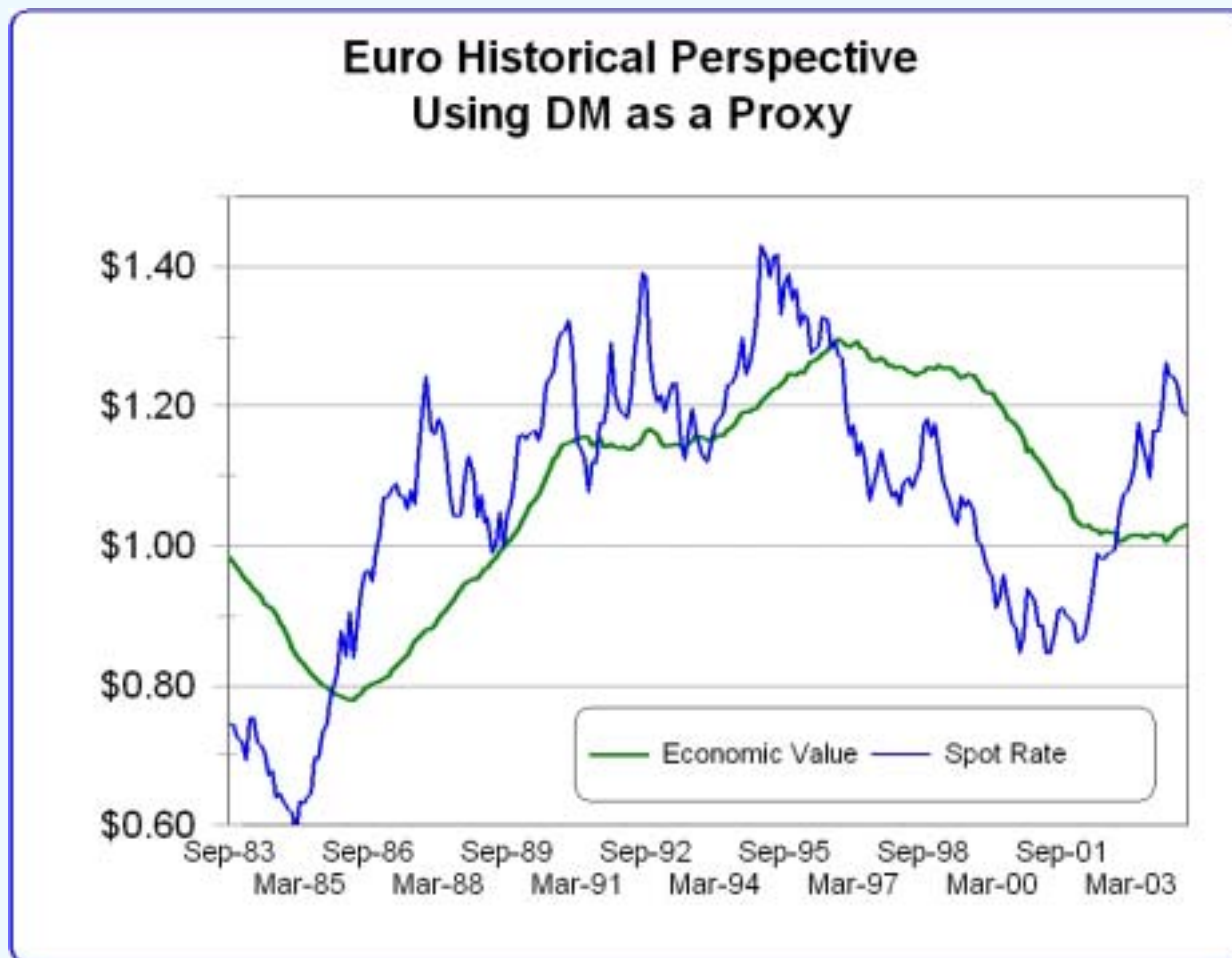
Measures of Internal Economic Balance e.g. Unemployment Rate

Measures of External Economic Balance e.g. FDI

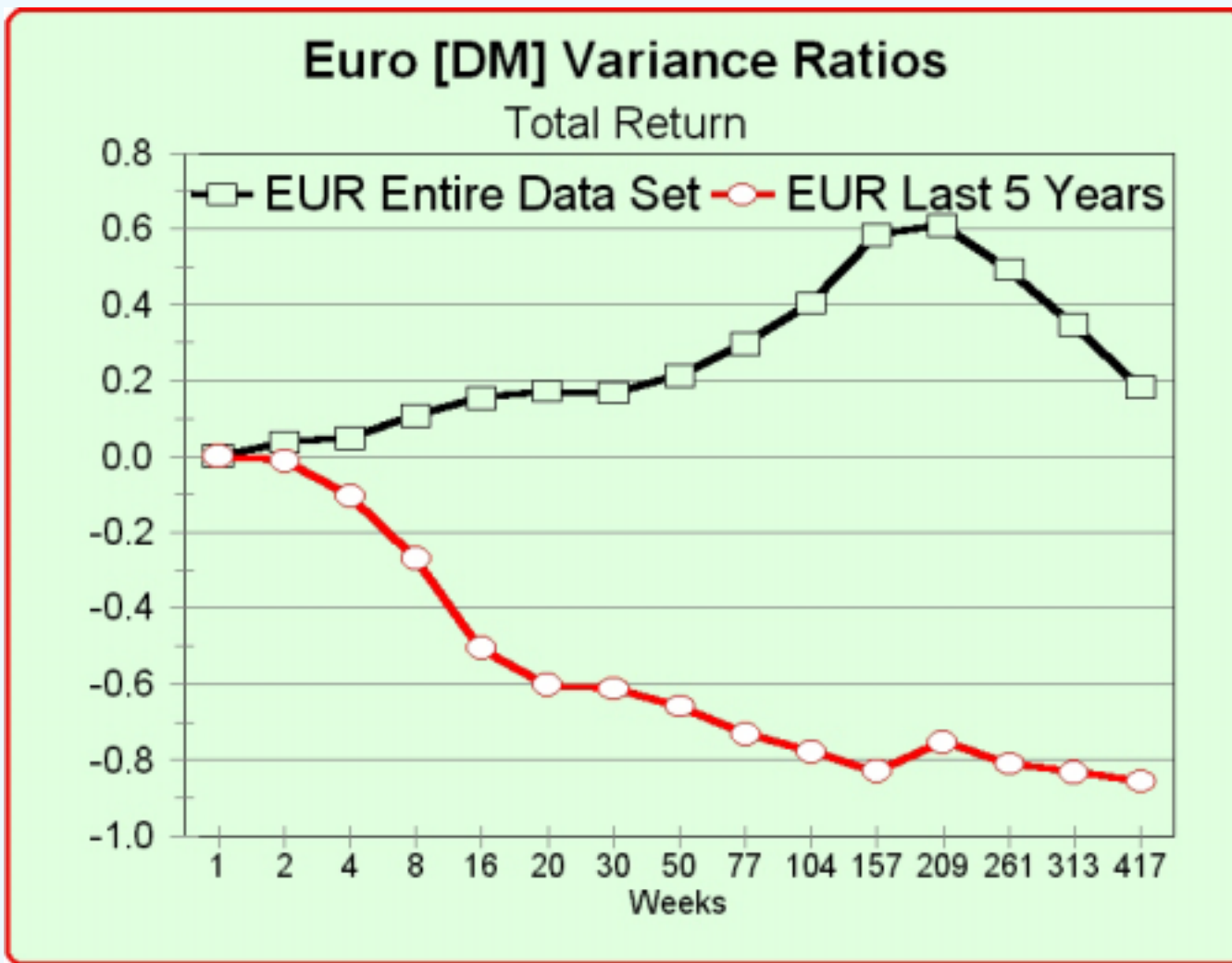
Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction

Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

Valuation Cycles of FX Rates Are Very Long

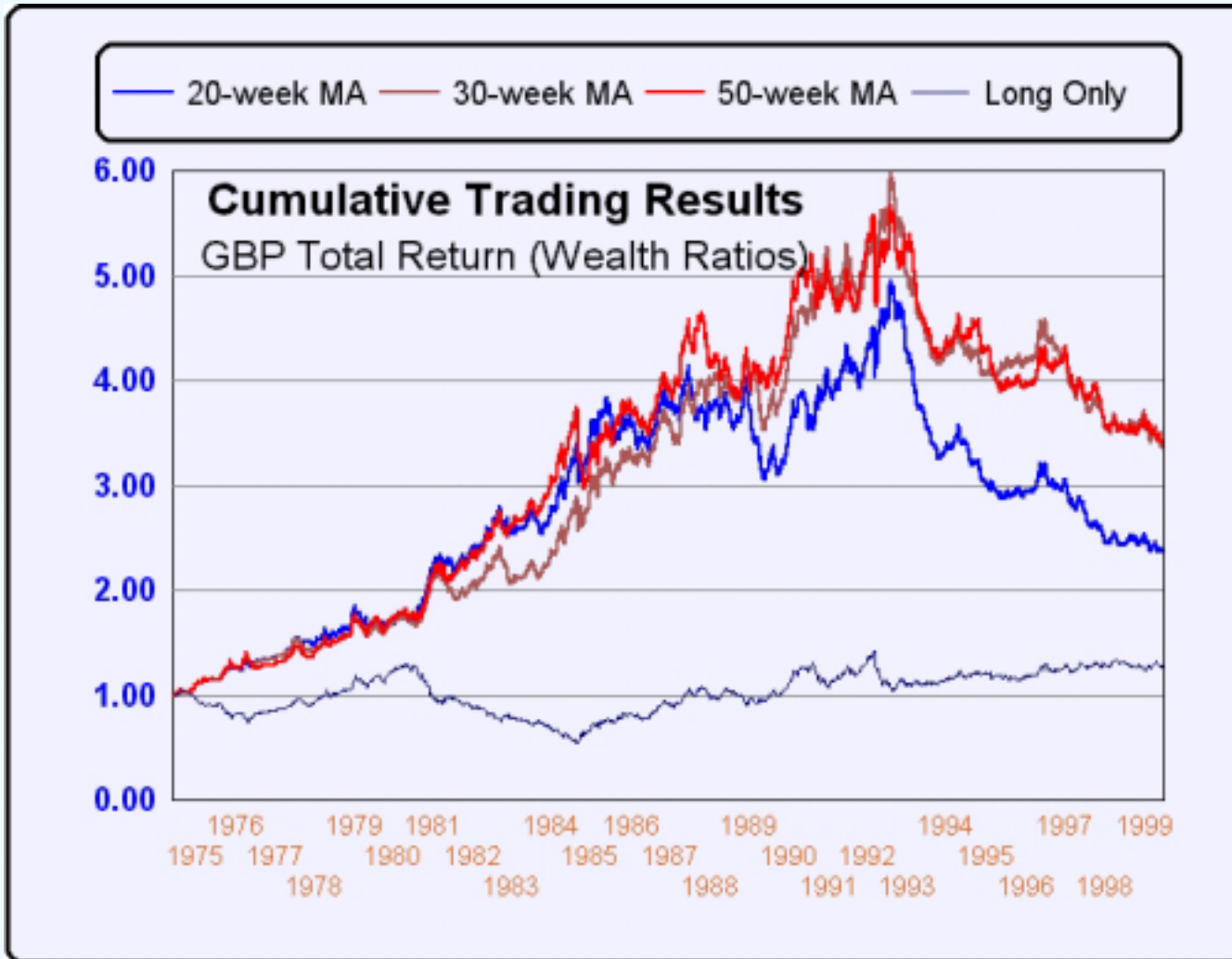


Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com



Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
 Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

They Keep Changing the Rules!



Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

Measuring and Controlling FX Risk

Variance of a Portfolio Containing Domestic (d) and Foreign (f):

$$\sigma_R^2 = w_d^2 \sigma_d^2 + w_f^2 \sigma_f^2 + 2w_d w_f \text{Cov}_{df} \\ + H^2 \sigma_c^2 + 2H(w_d \text{Cov}_{dc} + w_f \text{Cov}_{fc})$$

Note that if $H = 0$ (no currency exposure, or $h = -1$):

$$\sigma_R^2 = w_d^2 \sigma_d^2 + w_f^2 \sigma_f^2 + 2w_d w_f \text{Cov}_{df}$$

But if $H = w_f$ (no hedging):

$$\sigma_R^2 = w_d^2 \sigma_d^2 + w_f^2 \sigma_f^2 + 2w_d w_f \text{Cov}_{df} \\ + w_f^2 \sigma_c^2 + 2w_f(w_d \text{Cov}_{dc} + w_f \text{Cov}_{fc})$$

Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

Minimum Variance Currency Hedging

For a Single Foreign (f) Holding:

$$H = \frac{-\rho_{fc}\sigma_f}{\sigma_c} = -\beta_f$$

or $h = -(\beta_f + 1)$

For a Holding of a Domestic (d) and a Foreign (f) Holding:

$$H = -(w_d\beta_d + w_f\beta_f)$$

or $h = -(1 + w_d\beta_d + w_f\beta_f)$

Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction

Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

Andrew Lo gets dressed

15 Jackets
20 Pairs of Pants
25 Shirts
10 Cuff Links
70 Ties
80 Socks
10 Shoes
5 Belts

21 Billion Combinations!
@ 1 second each, 668 Years

to get dressed in 5 minutes,
would need to perform 70
million evaluations per second

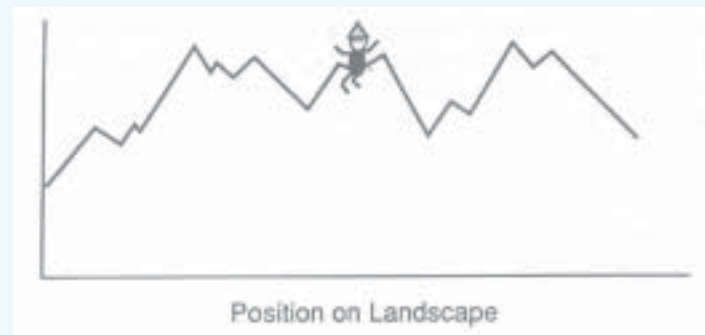
Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

Coevolution

Emergent Behavior (the whole is greater than the sum of its parts)

Fitness Landscapes change in response to evolution.

How is it possible to avoid local maxima (or minima)?



The Conditional Efficient Frontier

Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

THE PRISONER'S DILEMMA

		ONE	
		Rat	Deny
TWO	Rat	10	<div style="display: flex; justify-content: space-between;"> Life Free </div>
	Deny	<div style="display: flex; justify-content: space-between;"> Free Life </div>	Free

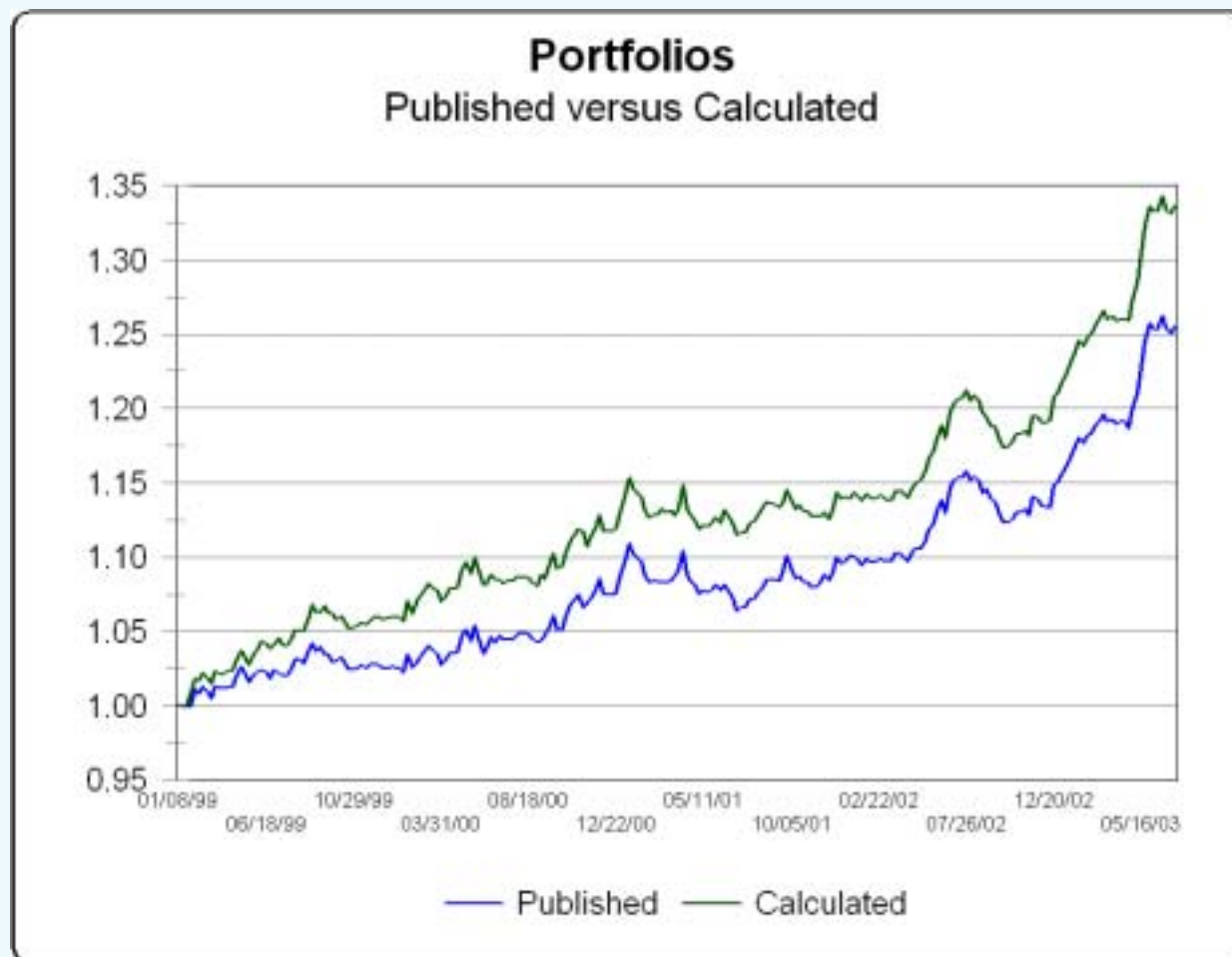
Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
 Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

Currency Forecasting with Adaptive Algorithms

<p>Japan</p> <hr/> <p>Spot Rate as of 20-Jul-01 ¥123.02</p> <p>most recent forecast: ¥128.51</p> <p><u>Intervals:</u></p> <p>Latest Year</p> <p>Latest 2 Years</p> <p>2 years ending 12/31/00</p> <p>3 years ending 12/31/98</p> <p>5 years ending 12/31/97</p> <p>10 years ending 12/31/97</p>	<p>Benchmark Returns</p> <p><i>all numbers are annualized</i></p> <p>Long/Short Strategy</p> <table border="0" style="width: 100%; text-align: center;"> <tr> <td style="width: 33%;">Perfect Foresight</td> <td style="width: 33%;">No Foresight <u>(always long)</u></td> <td style="width: 33%;">Strategy Simulation</td> </tr> <tr> <td>41.8%</td> <td>-19.7%</td> <td>24.6%</td> </tr> <tr> <td>43.1%</td> <td>-6.9%</td> <td>17.6%</td> </tr> <tr> <td>35.4%</td> <td>-5.6%</td> <td>13.4%</td> </tr> <tr> <td>46.7%</td> <td>-7.5%</td> <td>2.8%</td> </tr> <tr> <td>36.5%</td> <td>-3.8%</td> <td>2.0%</td> </tr> <tr> <td>35.9%</td> <td>-2.2%</td> <td>5.1%</td> </tr> </table>	Perfect Foresight	No Foresight <u>(always long)</u>	Strategy Simulation	41.8%	-19.7%	24.6%	43.1%	-6.9%	17.6%	35.4%	-5.6%	13.4%	46.7%	-7.5%	2.8%	36.5%	-3.8%	2.0%	35.9%	-2.2%	5.1%	<p>mu = 0.1</p> <p>k = 0.3</p> <p>22-Jul-2001 08:24 PM -4.58%</p>	<table border="0" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%; text-align: center;">% Right</td> <td style="width: 30%; text-align: center;">Standard Deviations</td> <td style="width: 40%;"></td> </tr> <tr> <td></td> <td style="text-align: center;"><u>Forecast</u> <u>Actual</u></td> <td></td> </tr> <tr> <td style="text-align: center;">75%</td> <td style="text-align: center;">1.2%</td> <td style="text-align: center;">2.9%</td> </tr> <tr> <td style="text-align: center;">67%</td> <td style="text-align: center;">2.4%</td> <td style="text-align: center;">3.5%</td> </tr> <tr> <td style="text-align: center;">71%</td> <td style="text-align: center;">3.0%</td> <td style="text-align: center;">3.1%</td> </tr> <tr> <td style="text-align: center;">50%</td> <td style="text-align: center;">2.8%</td> <td style="text-align: center;">4.5%</td> </tr> <tr> <td style="text-align: center;">55%</td> <td style="text-align: center;">3.5%</td> <td style="text-align: center;">3.5%</td> </tr> <tr> <td style="text-align: center;">58%</td> <td style="text-align: center;">4.8%</td> <td style="text-align: center;">3.3%</td> </tr> <tr> <td style="text-align: center;">Value Added (over no hedging)</td> <td colspan="2" style="text-align: center;">Correlations</td> </tr> <tr> <td style="text-align: center;">44.3%</td> <td style="text-align: center;"><u>1-mo</u></td> <td style="text-align: center;"><u>3-mo</u></td> </tr> <tr> <td style="text-align: center;">19.4%</td> <td style="text-align: center;">0.08</td> <td style="text-align: center;">0.57</td> </tr> <tr> <td style="text-align: center;">15.2%</td> <td style="text-align: center;">0.47</td> <td style="text-align: center;">0.70</td> </tr> <tr> <td style="text-align: center;">12.9%</td> <td style="text-align: center;">0.46</td> <td style="text-align: center;">0.75</td> </tr> <tr> <td style="text-align: center;">6.8%</td> <td style="text-align: center;">-0.04</td> <td style="text-align: center;">0.07</td> </tr> <tr> <td style="text-align: center;">6.0%</td> <td style="text-align: center;">-0.03</td> <td style="text-align: center;">0.07</td> </tr> <tr> <td style="text-align: center;">6.0%</td> <td style="text-align: center;">0.11</td> <td style="text-align: center;">0.22</td> </tr> </table>	% Right	Standard Deviations			<u>Forecast</u> <u>Actual</u>		75%	1.2%	2.9%	67%	2.4%	3.5%	71%	3.0%	3.1%	50%	2.8%	4.5%	55%	3.5%	3.5%	58%	4.8%	3.3%	Value Added (over no hedging)	Correlations		44.3%	<u>1-mo</u>	<u>3-mo</u>	19.4%	0.08	0.57	15.2%	0.47	0.70	12.9%	0.46	0.75	6.8%	-0.04	0.07	6.0%	-0.03	0.07	6.0%	0.11	0.22
Perfect Foresight	No Foresight <u>(always long)</u>	Strategy Simulation																																																																						
41.8%	-19.7%	24.6%																																																																						
43.1%	-6.9%	17.6%																																																																						
35.4%	-5.6%	13.4%																																																																						
46.7%	-7.5%	2.8%																																																																						
36.5%	-3.8%	2.0%																																																																						
35.9%	-2.2%	5.1%																																																																						
% Right	Standard Deviations																																																																							
	<u>Forecast</u> <u>Actual</u>																																																																							
75%	1.2%	2.9%																																																																						
67%	2.4%	3.5%																																																																						
71%	3.0%	3.1%																																																																						
50%	2.8%	4.5%																																																																						
55%	3.5%	3.5%																																																																						
58%	4.8%	3.3%																																																																						
Value Added (over no hedging)	Correlations																																																																							
44.3%	<u>1-mo</u>	<u>3-mo</u>																																																																						
19.4%	0.08	0.57																																																																						
15.2%	0.47	0.70																																																																						
12.9%	0.46	0.75																																																																						
6.8%	-0.04	0.07																																																																						
6.0%	-0.03	0.07																																																																						
6.0%	0.11	0.22																																																																						
	<p>Hedging Strategy</p> <table border="0" style="width: 100%; text-align: center;"> <tr> <td style="width: 33%;">Perfect Foresight</td> <td style="width: 33%;">No Foresight <u>(always hedged)</u></td> <td style="width: 33%;">Strategy Simulation</td> </tr> <tr> <td>32.9%</td> <td>24.6%</td> <td>24.6%</td> </tr> <tr> <td>24.0%</td> <td>7.5%</td> <td>12.4%</td> </tr> <tr> <td>19.8%</td> <td>5.9%</td> <td>9.6%</td> </tr> <tr> <td>25.9%</td> <td>8.1%</td> <td>5.4%</td> </tr> <tr> <td>19.1%</td> <td>4.0%</td> <td>3.0%</td> </tr> <tr> <td>17.9%</td> <td>2.3%</td> <td>3.7%</td> </tr> </table>	Perfect Foresight	No Foresight <u>(always hedged)</u>	Strategy Simulation	32.9%	24.6%	24.6%	24.0%	7.5%	12.4%	19.8%	5.9%	9.6%	25.9%	8.1%	5.4%	19.1%	4.0%	3.0%	17.9%	2.3%	3.7%																																																		
Perfect Foresight	No Foresight <u>(always hedged)</u>	Strategy Simulation																																																																						
32.9%	24.6%	24.6%																																																																						
24.0%	7.5%	12.4%																																																																						
19.8%	5.9%	9.6%																																																																						
25.9%	8.1%	5.4%																																																																						
19.1%	4.0%	3.0%																																																																						
17.9%	2.3%	3.7%																																																																						

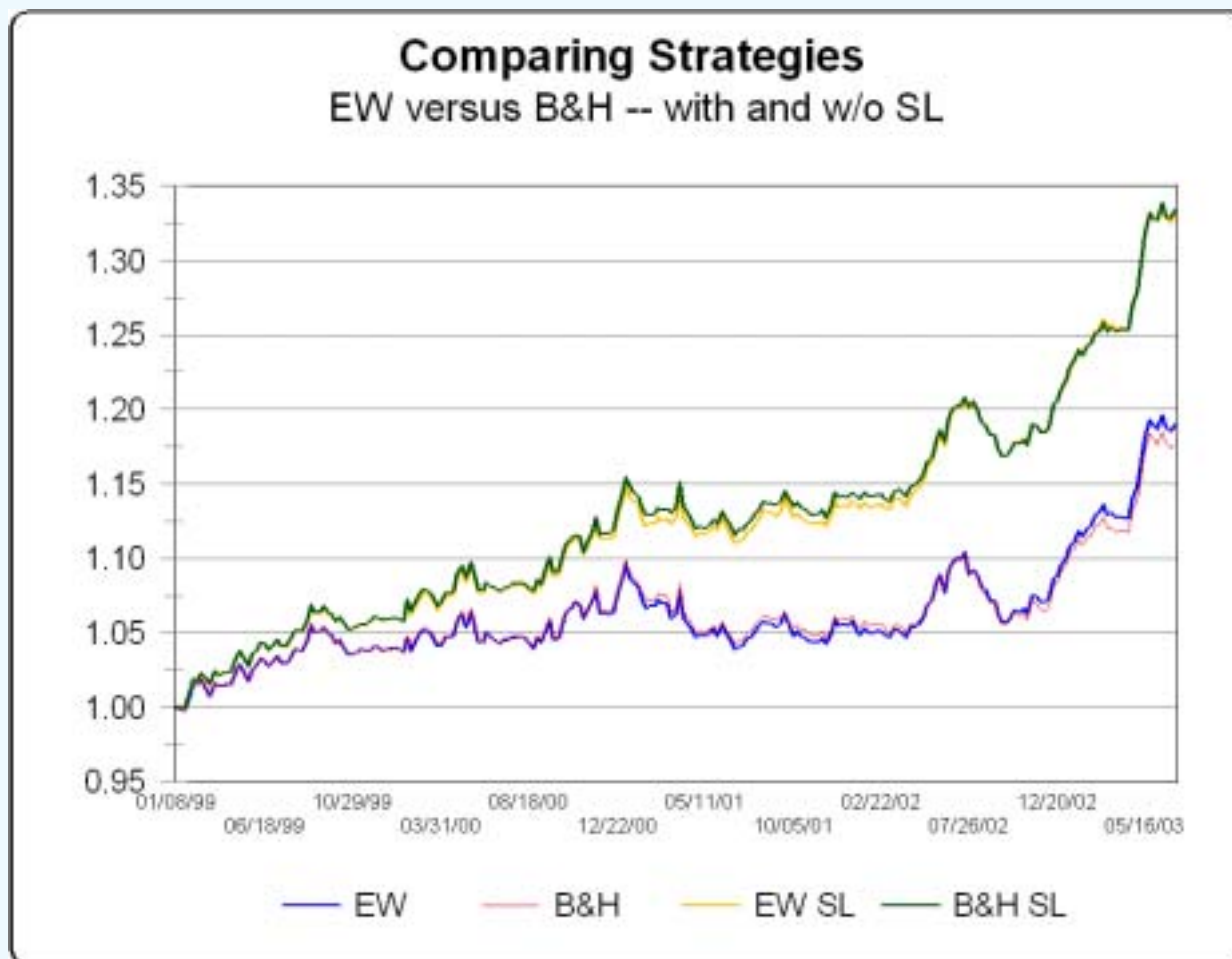
Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
 Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

Interest Rates: The Transaction Costs of FX Trading



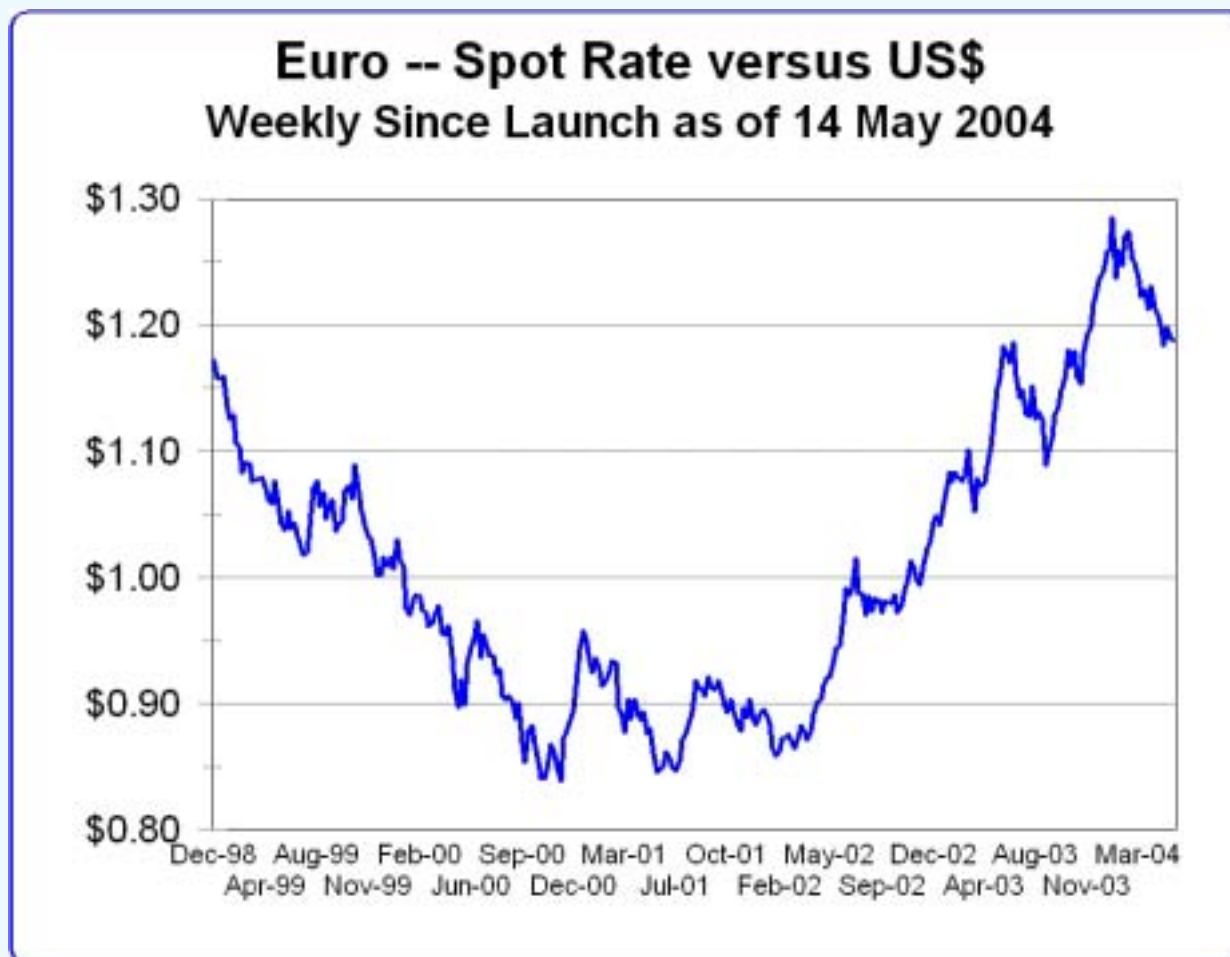
Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

Dynamic Strategies: Rebalancing vs Stoploss



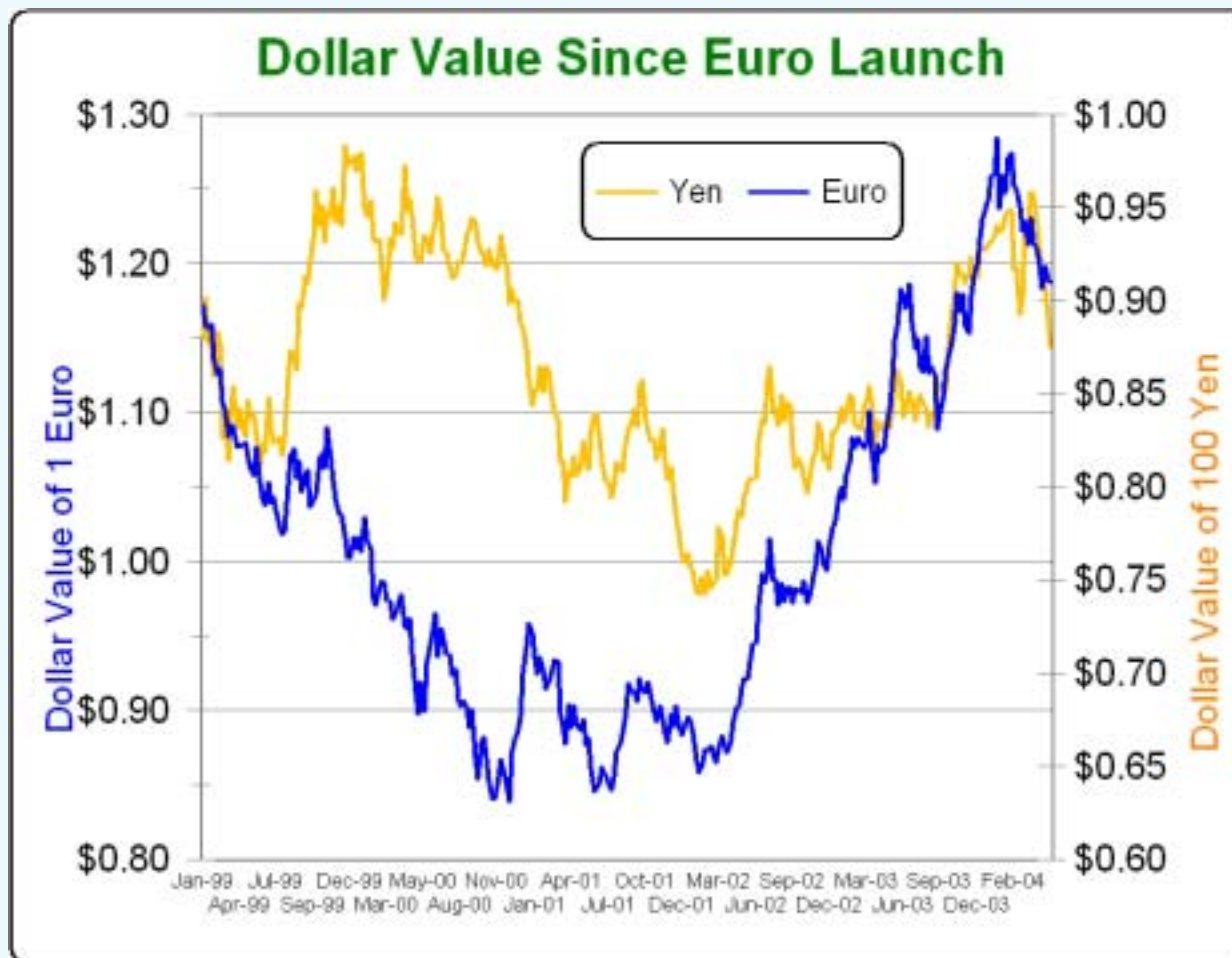
Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

Are Dollar Troubles Behind Us?



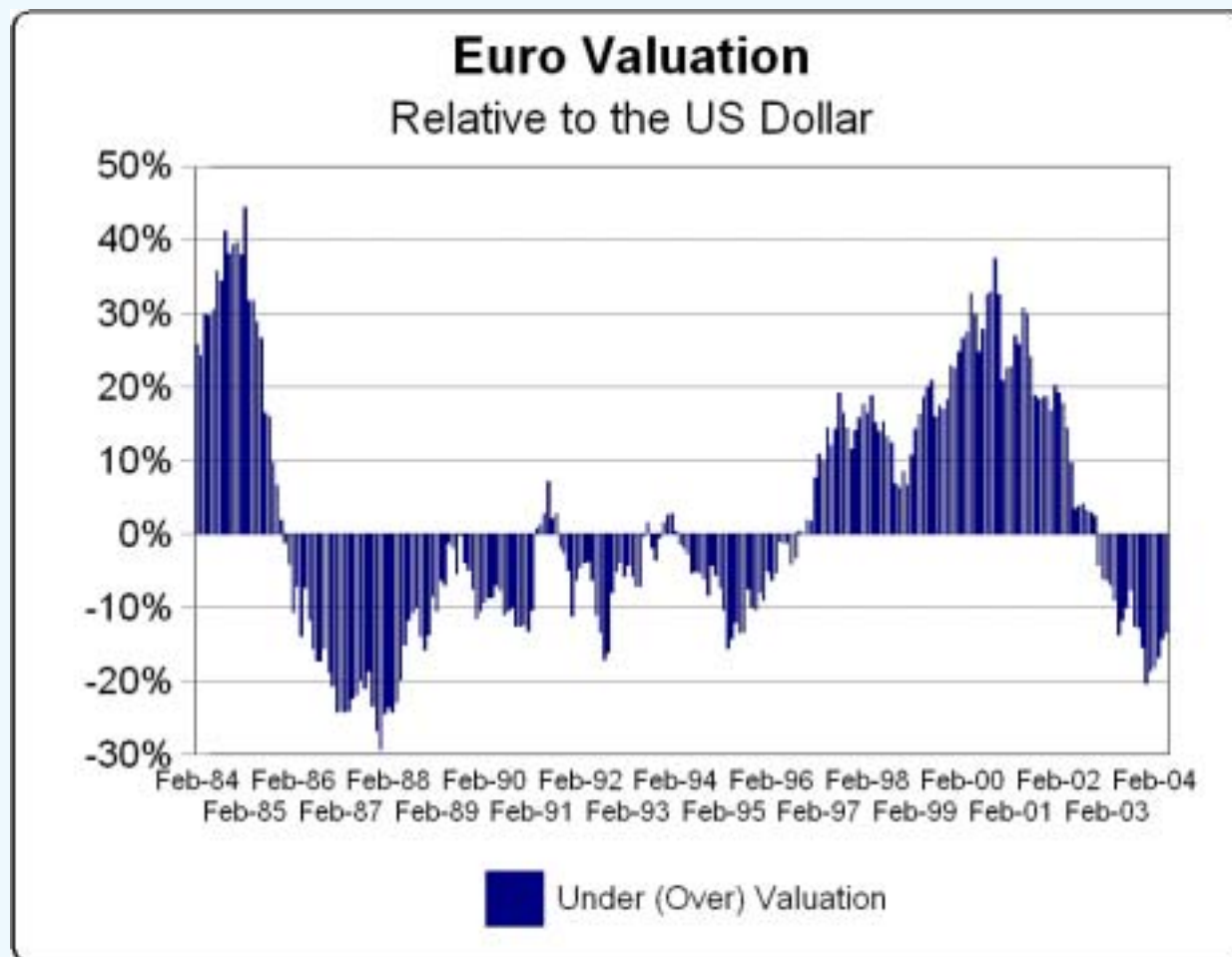
Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

Different Paths to the Same Place



Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com

Unlikely that Economic Shifts Have Been Made



Adaptive Modeling in Valuation, Risk Assessment, and Portfolio Construction
Michael F. Wilcox, CFA, President, Alford Associates, Inc. michael.wilcox@alfordinc.com