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The Fed model: A note ☆

Javier Estrada *

IESE Business School, Av. Pearson 21, 08034 Barcelona, Spain

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Abstract

The negative relationship between market P/E ratios and government bond yields seems to have become conventional wisdom among practitioners. Both (limited) empirical evidence and a (misleading) suggestion that the model originated in the Fed are used to support the model's plausibility. The evidence in this note, from 20 international markets, seriously questions the wide acceptance and use of this model.

JEL classification: G11; G12

Keywords: Fed model; Stock versus bonds; Stock pricing; P/E ratios; Cointegration

1. Introduction

Most practitioners like simple models. A typical example is the CAPM, which remains the most widely-used model to estimate required returns on equity. And although the empirical evidence on it is mixed, at least the CAPM is solidly grounded in the theory of rational investor behavior. However, a simple model that is neither supported by theory nor backed by evidence is simplistic rather than simple. And when such model is widely used by practitioners, it becomes dangerous, not just simplistic. The evidence reported and discussed in this note leads to the conclusion that the so-called Fed model belongs to this category.

☆ This note is an abridged version of my article "The Fed model: The bad, the worse, and the ugly." Alfred Prada and Lydia Nikolova provided valuable research assistance. The views expressed below and any errors that may remain are entirely my own.

* Fax: +34 93 253 4343.
E-mail address: jestrada@iese.edu.

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Section 2 of this note briefly reviews the Fed model and its rationale (or lack of it). Section 3 reports and discusses evidence from 20 developed markets that seriously questions the empirical validity of this model. Finally, Section 4 makes an assessment.

2. The model

The Fed model posits an equality between the forward earnings yield of the market (E/P) and the 10-year government bond yield (Y)[1]; that is,

$$E/P = Y, \tag{1}$$

or, as is sometimes expressed, $P/E = 1/Y$. When $E/P > Y$, stocks yield more than bonds and are therefore a better buy; when $E/P < Y$, the opposite is the case. Only when (1) holds, according to this model, stocks are neither cheap nor expensive (relative to bonds). As simple models go, it does not get much better than this. The question is, however, whether the model has any theoretical and empirical support.

The origins of the Fed model are not entirely clear. In its Humphrey–Hawkings report of July 22, 1997, the Fed noted that "...the ratio of prices in the S&P500 to consensus estimates of earnings over the coming twelve months has risen further from levels that were already unusually high. Changes in this ratio have often been inversely related to changes in long-term Treasury yields...." The report also featured a graph depicting the close relationship between these two variables during the 1982–1997 period. Ed Yardeni, then an analyst at Deutsche Morgan Grenfell, took a cue from the report, named the relationship the Fed's Stock Valuation Model, and published several reports using it to evaluate the level of the stock market; see Yardeni (1997, 1999). Abbott (2000), however, argues that I/B/E/S has been publishing the relationship between the forward P/E of the S&P500 and the yield on 10-year notes since 1986 and calls such relationship the I/B/E/S Equity Valuation Model.

2.1. *Empirical support*

Whatever its origins, the inverse relationship between market (forward or trailing) P/E ratios and government bond yields is widely used by analysts and financial commentators. Any statement that justifies high P/E ratios with the existence of prevailing low interest rates is essentially using the Fed model. And most users of this model usually validate it by showing a chart similar to panel A of Fig. 1, which seems to indicate a strong relationship between (trailing) E/P and Y in the US. However, as panel B of the same exhibit shows, the relationship between 1968 and 2005 is not representative of that for the much longer 1871–2005 period. In fact, the correlation between E/P and Y is 0.75 between Jan/1968 and Jun/2005, −0.19 between Jan/1871 and Dec/1967, and only 0.10 over the whole Jan/1871–Jun/2005 period.

The widely touted empirical support for the Fed model, then, is based on carefully chosen and limited evidence. And the evidence is limited not only from a temporal perspective, as Fig. 1 shows, but also from a cross-sectional perspective; as we will see in Section 3, the international evidence on the model is even more damning.

[1] The forward earnings yield of the market is the inverse of the market's forward P/E ratio and is based on consensus earnings expected for the 12 months ahead. Unless otherwise stated, all earnings yields and P/E ratios in this note are based on forward earnings.

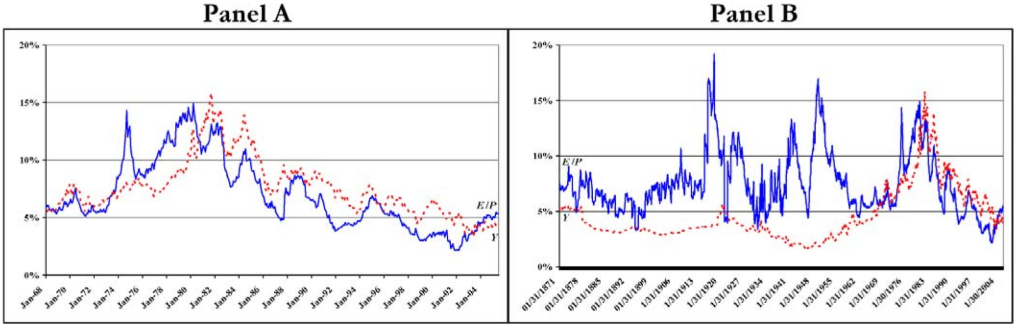

Fig. 1. The Fed model (USA). Panel A: Jan/1968–Jun/2005; panel B: Jan/1871–Jun/2005. S&P500 in Monthly Frequency, Global Financial Database.

2.2. Theoretical support

From a theoretical standpoint, it could be argued that the Fed model is loosely based on the dividend discount model (DDM), but not before imposing on it several strong assumptions. The constant-growth version of the DDM is given by

$$P = \frac{D \cdot (1+G)}{R_f + RP - G}, \tag{2}$$

where P and D denote the current price and dividend, G the expected long-term growth in dividends, R_f the risk-free rate (usually the yield on 10-year notes), and RP the risk premium.

Beginning from (2), dividing both sides by earnings (E), and assuming (1) that all earnings are paid out as dividends ($D = E$); (2) that dividends are not expected to grow in the long term ($G = 0$); and (3) that investors require no more return from stocks than from bonds ($RP = 0$), we obtain $P/E = 1/R_f$, which is precisely the Fed model. In other words, buy these three assumptions, swallow hard, and you get a "simple" model that can be used as an asset allocation tool—which is of course as valid as the assumptions that support it.

Asness (2003) argues the Fed model erroneously compares a real magnitude (E/P) to a nominal one (Y). Earnings are a claim on the underlying assets of the corporate sector, which appreciate with inflation, and therefore the earnings yield is a real return[2]; the bond yield, in turn, is unambiguously a nominal return.

Feinman (2005) argues that although inflation clearly affects bond yields it should not affect earnings yields. This is due to the fact that although changes in inflation are inversely related to stock prices through R_f, they also are positively related to stock prices through the expected growth of earnings (G). In other words, these two effects of inflation on prices should (approximately) cancel out and leave earnings yields unchanged.

3. The evidence

Most of the empirical discussion on the Fed model is based on US data. Exceptions to this are the recent studies of Durré and Giot (2004), Gwilym et al. (2004), Koivu et al. (2005), and Thomas (2005), all of whom consider the US plus other international markets. The evidence

[2] Siegel (2002) argues that the earnings yield is a good estimate of long-term real stock returns. He notes that between 1871 and 2001 the earnings yield of 6.8% exactly matches the real return on equity during the same period.

Table 1
The data

Country	E/P	Y	Rho	Beginning
Australia	7.7%	8.1%	0.89	Dec-87
Austria	6.9%	6.1%	−0.52	Sep-88
Belgium	8.3%	6.5%	0.50	Dec-87
Canada	6.9%	7.4%	0.67	Dec-87
Denmark	6.5%	6.9%	0.39	Dec-87
Finland	6.6%	7.5%	0.21	Jan-88
France	7.0%	6.5%	0.73	Dec-87
Germany	6.2%	5.9%	0.24	Dec-87
Ireland	8.3%	6.5%	0.70	May-90
Italy	6.1%	8.4%	0.26	Dec-87
Japan	3.2%	3.3%	−0.50	Dec-87
Netherlands	7.9%	6.0%	0.63	Dec-87
New Zealand	8.8%	8.1%	0.88	Jan-88
Norway	9.1%	7.5%	0.57	Dec-87
Portugal	7.6%	7.4%	0.84	Jul-91
Spain	7.8%	8.2%	0.72	Dec-87
Sweden	6.8%	7.8%	0.67	Dec-87
Switzerland	7.1%	4.1%	0.64	Dec-87
UK	7.2%	7.4%	0.89	Dec-87
USA	6.6%	6.3%	0.74	Dec-87

Note. Forward earnings yields (E/P), 10-year government bond yields (Y), and correlations between them (Rho) calculated between the beginning of data coverage (indicated in the last column) and Jun/2005. E/P and Y represent averages over each country's whole sample period. E, P, and E/P are based on MSCI indexes. Yield data for Finland based on 5-year government bond yields.

discussed in this note follows from the widest cross-section of international markets assembled on this topic.

3.1. The data

The Fed model as originally portrayed in the Humphrey–Hawkings Fed report mentioned above, or as originally published by I/B/E/S, also mentioned above, involves an equality between the *forward* earnings yield of the market and the 10-year government bond yield. I/B/E/S has been compiling data on forward P/E ratios at the aggregate level since December, 1987, for several international markets. The price behavior of each of these markets can be summarized by several indexes, and the results discussed below are based on the widely-used Morgan Stanley Capital International (MSCI) indices.

Table 1 shows the 20 countries included in the analysis in the first column and the month in which the analysis begins for each country in the last column; data for all countries goes from that date through Jun/2005. The table also shows the average (forward) earnings yield and average (10-year) government bond yield in each country over its whole sample period, as well as the correlation between these two variables over that period.

As the table shows, the correlation between earnings yields and bond yields is quite high in many countries, and positive in all countries with only two exceptions, Austria and Japan. Although these numbers seem to lend support to the Fed model, this is actually not quite the case. First, the Fed model does not posit just a correlation between earnings yields and bond yields but an *equality* between them. That is a much stronger requirement and one that cannot be tested by a simple analysis of correlations. Second, both earnings yields and bond yields are usually characterized by random walk processes, which render correlation analysis basically meaningless. These two issues are addressed in the following two sections.

3.2. Valuation gaps

Although the Fed model posits an equality between earnings yields and bond yields, Abbott (2000) suggests that the model is not intended to provide a precise valuation for the market. Rather, he argues that the model should be thought of as providing a "fair value range" with boundaries of ±10%. In other words, valuation gaps (relative departures from the equality) within the ±10% range are "reasonable" deviations that should not necessarily lead to corrections in prices.

Table 2 reports four valuation gaps that respond to the expressions

$$VG1 = (1/T) \cdot \sum_t \{(E/P)_t - Y_t\}, \tag{3}$$

$$VG2 = (1/T) \cdot \sum_t \left\{\frac{(E/P)_t - Y_t}{Y_t}\right\}, \tag{4}$$

$$VG3 = (1/T) \cdot \sum_t \left|(E/P)_t - Y_t\right|, \tag{5}$$

$$VG4 = (1/T) \cdot \sum_t \left|\frac{(E/P)_t - Y_t}{Y_t}\right|. \tag{6}$$

$VG1$ measures the average monthly gap between the earnings yield and the bond yield. Note, however, that a gap of 200 basis points when bond yields hover around 3% implies a much larger deviation from equilibrium than when bond yields hover around 10%.[3] Therefore, $VG2$ measures the average monthly gap between the earnings yield and the bond yield relative to the level of the bond yield. Note, also, that when calculating $VG1$ and $VG2$ positive and negative gaps of the same magnitude cancel out in the average thus concealing deviations from the model's proposed equilibrium; therefore, $VG3$ measures the average absolute value of the monthly gaps. Finally, $VG4$ measures the average absolute value of the monthly gaps relative to the level of the bond yield.

$VG1$ seems to indicate that deviations from equilibrium are not very large overall. $VG2$, however, indicates that these gaps are far from negligible when assessed relative to the level of the bond yields. Furthermore, recall that in the calculation of $VG1$ and $VG2$ positive and negative gaps of the same magnitude cancel out in the average, concealing departures from the model's proposed equilibrium. As a result, $VG3$ and $VG4$ give a clearer picture of these departures. The latter, in particular, reveals substantial valuation gaps, most of them well above the 10% fair value range (and over 36% on average). Therefore, even if the Fed model is not thought of as a precise valuation tool but only as one that provides an approximate valuation range, the data shows that departures from the model's equilibrium are much larger than what can be reasonably expected from an accurate model.

[3] If $E/P = 4\%$ and $Y = 2\%$, the relative gap is $(4\% - 2\%)/2\% = 100\%$. If $E/P = 12\%$ and $Y = 10\%$ instead, the relative gap is only $(12\% - 10\%)/10\% = 20\%$.

Table 2
Valuation gaps

Country	*VG*1	*VG*2	*VG*3	*VG*4
Australia	−0.4%	−2.1%	1.1%	14.3%
Austria	1.0%	28.3%	2.5%	48.9%
Belgium	1.8%	35.3%	1.9%	36.7%
Canada	−0.5%	−3.4%	1.3%	18.5%
Denmark	−0.4%	2.1%	1.8%	27.9%
Finland	−0.7%	8.8%	3.3%	47.9%
France	0.5%	11.4%	1.2%	22.3%
Germany	0.2%	9.5%	1.6%	29.7%
Ireland	1.8%	36.6%	1.9%	37.9%
Italy	−2.3%	−14.5%	3.4%	37.7%
Japan	−0.1%	69.6%	2.4%	119.5%
Netherlands	1.8%	34.3%	1.9%	36.3%
New Zealand	0.7%	9.2%	1.2%	14.1%
Norway	1.6%	30.2%	2.4%	38.0%
Portugal	0.5%	18.5%	1.6%	29.0%
Spain	−0.4%	7.7%	1.9%	28.4%
Sweden	−0.9%	−4.4%	1.9%	25.9%
Switzerland	3.1%	84.8%	3.1%	84.4%
UK	−0.1%	0.7%	0.8%	12.1%
USA	0.3%	7.3%	1.0%	18.3%

Note. *VG*1, *VG*2, *VG*3, and *VG*4 follow from expressions (3), (4), (5), and (6), respectively.

3.3. Unit roots and cointegration

The correlations between earnings yields and bond yields reported in Table 1 seem to suggest that the Fed model is a good description of the relationship between these two variables. However, it is well known that in the presence of nonstationary variables correlations are a misleading indicator of the strength of the relationship between them; the proper econometric framework is that of cointegration.

Beginning then from the Fed model expressed as $P/E = 1/Y$, the first step is to determine whether these variables follow a random walk. The second and third columns of Table 3 report the test statistics of augmented Dicky–Fuller (ADF) tests for a unit root in $\ln(P/E)$ and $\ln(1/Y)$. At the 5% level of significance, these tests reveal the existence of a unit root in both variables in all countries (the only very marginal exceptions being P/E ratios in Spain and inverse bond yields in Austria). In other words, both P/E ratios and inverse bond yields follow a random walk and, therefore, correlation analysis is largely meaningless. So much for supporting the Fed model with correlations such as those reported in Table 1.

The fourth and fifth columns of Table 3 report the test statistics of ADF tests on the first difference of $\ln(P/E)$ and $\ln(1/Y)$. At the 5% level of significance, these tests reveal that both variables in all countries become stationary after differencing (the only very marginal exception being inverse bond yields in Portugal). In other words, P/E ratios and inverse bond yields are all integrated of order 1.

The validity of the Fed model within a cointegration framework can be assessed in two (slightly different) ways. First, note that if the model properly describes the relationship between P/E ratios and inverse bond yields, then it must be the case that the variable $FM = \ln(P/E) - \ln(1/Y)$ is stationary around a 0 mean. The sixth column of Table 3 shows the test

Table 3
Unit roots and cointegration

Country	$\ln(P/E)$	$\ln(1/Y)$	$\Delta\ln(P/E)$	$\Delta\ln(1/Y)$	*FM*	Coint
Australia	−1.558	−2.468	−4.867	−4.554	−2.789	−2.975
Austria	−2.352	−3.458	−5.219	−3.545	−2.460	−2.344
Belgium	−2.096	−2.983	−3.652	−3.802	−2.155	−1.863
Canada	−1.980	−2.545	−5.246	−4.199	−2.276	−2.186
Denmark	−2.004	−2.859	−5.681	−3.783	−2.720	−2.303
Finland	−2.899	−2.596	−3.657	−4.607	−3.018	−2.851
France	−1.300	−2.941	−6.482	−3.706	−0.304	−1.258
Germany	−2.427	−3.013	−6.161	−3.854	−1.758	−1.953
Ireland	−3.300	−3.219	−5.529	−3.756	−3.925	−3.954
Italy	−2.640	−2.698	−8.345	−3.793	−2.842	−2.545
Japan	−2.180	−2.864	−3.456	−4.780	−2.811	−2.231
Netherlands	−1.377	−3.040	−3.774	−3.544	−1.873	−1.412
New Zealand	−2.780	−2.038	−3.925	−5.344	−4.661	−4.488
Norway	−3.305	−2.089	−4.971	−5.091	−2.769	−2.834
Portugal	−1.403	−2.102	−3.638	−3.394	−2.860	−2.939
Spain	−3.494	−2.052	−4.336	−4.978	−2.052	−2.153
Sweden	−2.245	−2.881	−3.613	−4.196	−2.386	−2.381
Switzerland	−1.485	−2.808	−4.404	−3.628	−2.650	−1.494
UK	−1.719	−2.834	−5.697	−3.847	−2.875	−2.379
USA	−1.264	−3.373	−4.272	−4.641	−1.998	−1.436

Note. Numbers in the second through sixth columns show test statistics of augmented Dicky–Fuller tests for a unit root; the asymptotic critical value for these tests at the 5% level of significance is −3.41. Numbers in the last column show test statistics for (non)cointegration tests; the asymptotic critical value for these tests at the 5% level of significance is −3.78. $FM = \ln(P/E) - \ln(1/Y)$.

statistics of ADF tests for a unit root on *FM*. At the 5% level of significance, these numbers show that this variable has a unit root (and is therefore nonstationary) in all countries with only two exceptions, Ireland and New Zealand.

Second, and perhaps more straightforward, we can ask whether P/E ratios and inverse bond yields are cointegrated. The last column of Table 3 shows the test statistics for Engle–Granger cointegration tests. At the 5% level of significance, these numbers show that the null hypothesis of noncointegration is rejected in only two countries, again Ireland and New Zealand.

In short, then, despite the rather high correlations displayed in Table 1, a proper analysis (given the characteristics of the variables involved) leads to the conclusion that the Fed model properly describes the relationship between earnings yields and bond yields in only 2 out of the 20 countries considered.[4]

3.4. The Fed model and expected returns

Last, but certainly not least, it is critical to ask whether deviations from the Fed model set in motion corrective mechanisms that are useful to forecast real stock returns. This can be explored

[4] In fact, that is an overstatement. On a regression between $\ln(P/E)$ and $\ln(1/Y)$, the Fed model predicts an intercept of 0 and a slope of 1. Although such hypotheses are not rejected in New Zealand, they are rejected in Ireland, which reduces the success of the Fed model to just 1 out of 20 countries.

Table 4
Forecasting real stock returns

Country	β_0	p-value	β_1	p-value	R^2	γ_0	p-value	γ_1	p-value	R^2
Australia	0.044	0.000	0.082	0.003	0.068	0.100	0.002	−0.019	0.150	0.018
Austria	0.009	0.295	−0.079	0.000	0.181	0.287	0.004	−0.101	0.003	0.135
Belgium	0.084	0.000	0.118	0.020	0.049	0.441	0.000	−0.147	0.000	0.280
Canada	0.056	0.000	0.050	0.208	0.016	0.013	0.853	0.019	0.445	0.006
Denmark	0.067	0.000	0.052	0.071	0.031	0.258	0.003	−0.066	0.041	0.053
Finland	0.124	0.000	0.025	0.142	0.017	0.114	0.133	0.006	0.797	0.001
France	0.077	0.000	−0.039	0.382	0.010	0.287	0.000	−0.079	0.000	0.186
Germany	0.055	0.000	0.036	0.306	0.010	0.384	0.000	−0.115	0.000	0.150
Ireland	0.110	0.000	0.356	0.000	0.286	0.837	0.000	−0.315	0.000	0.376
Italy	−0.024	0.002	0.120	0.000	0.426	−0.191	0.000	0.079	0.000	0.157
Japan	−0.031	0.000	0.007	0.394	0.009	0.282	0.000	−0.084	0.000	0.184
Netherlands	0.046	0.003	−0.226	0.000	0.170	0.734	0.000	−0.254	0.000	0.618
New Zealand	0.025	0.024	−0.183	0.039	0.068	0.233	0.010	−0.082	0.026	0.066
Norway	0.047	0.000	0.099	0.000	0.155	−0.070	0.126	0.044	0.034	0.031
Portugal	0.017	0.215	0.162	0.007	0.071	0.683	0.000	−0.255	0.000	0.786
Spain	0.067	0.000	−0.031	0.354	0.005	0.344	0.000	−0.110	0.000	0.141
Sweden	0.062	0.000	0.131	0.003	0.095	0.256	0.021	−0.062	0.135	0.034
Switzerland	0.169	0.000	0.120	0.001	0.082	0.649	0.000	−0.206	0.000	0.462
UK	0.047	0.000	0.170	0.000	0.075	0.369	0.000	−0.122	0.000	0.212
USA	0.094	0.000	−0.404	0.000	0.539	0.713	0.000	−0.232	0.000	0.473

Note. All regressions run from the beginning of each country's sample period (indicated in Table 1) through Jun/2000. Last 5-year real return for all countries estimated over the Jun/2000–Jun/2005 period. Significance is based on the Newey–West heteroskedasticity/autocorrelation-consistent covariance matrix.

by estimating the relationship

$$R_{t+60} = \beta_0 + \beta_1 \cdot \{\ln(P/E)_t - \ln(1/Y)_t\} + u_t, \tag{7}$$

where R_{t+60} denotes the annualized real stock return 5 years (60 months) forward, u_t is an error term, and t indexes months.[5] Note that (7) asks whether deviations from the Fed model in month t are useful to forecast real stock returns over the following 60 months. Note, also, that according to this model β_1 is expected to be negative; that is, the more expensive stocks are relative to bonds (the larger P/E with respect to $1/Y$), the lower real stock returns are expected to be.

It is also important to determine whether the P/E ratio by itself outperforms the Fed model as a tool to forecast real stock returns. This can be explored by comparing the results from (7) to those from the relationship

$$R_{t+60} = \gamma_0 + \gamma_1 \cdot \ln(P/E)_t + v_t, \tag{8}$$

where v_t is an error term. Note that (8) asks whether P/E ratios are useful to forecast real stock returns 5 years forward. Note, also, that γ_1 is expected to be negative, indicating that the more expensive stocks are, the lower real stock returns are expected to be. The results of all estimations are shown in Table 4.

Note, first, that β_1 has the wrong sign in 14 out of the 20 countries considered, being significant (at the 5% level) in 9 of these cases. In fact, in only 4 out of 20 countries β_1 is significant

[5] Asness (2003) runs a similar regression considering real stock returns over 1-, 10-, and 20-year horizons.

and has the expected sign. In contrast, γ_1 has the expected sign in 16 out of 20 countries, being significant (again at the 5% level) in 14 of these cases.

Furthermore, in only 3 countries out of 20 the Fed model outperforms the P/E ratio as a tool to forecast real stock returns in the sense of having a higher explanatory power (measured by the R^2) and at the same time β_1 having the expected sign. Curiously, one of these three countries is the US (the other two being Austria and very marginally New Zealand).

4. An assessment

"Because economic and social phenomena are so forbidding, or at least so seem, ... there is a persistent and never-ending competition between what is right and what is merely acceptable... Just as truth ultimately serves to create a consensus, so in the short run does acceptability... To a very large extent, of course, we associate truth with convenience..." wrote John Kenneth Galbraith when defining the concept of conventional wisdom in his classic book *The Affluent Society*.[6] Conventional wisdom is, precisely, what the Fed model has become: a simple, convenient, and therefore acceptable idea that links stock and bond valuation.

The evidence, however, lends no support to this simplistic model. The deviations from the model's proposed equilibrium are far larger than what could be considered reasonable even if the model is not thought of as a precise valuation tool. Cointegration analysis reveals that in only 2 countries out of the 20 considered earnings yields and bond yields are cointegrated. And P/E ratios by themselves outperform the Fed model as tool for forecasting real stock returns in 17 out of the 20 countries considered.

All in all, then, it should come as no surprise that the so-called Fed model was never officially endorsed by the Fed.

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[6] See Galbraith (1998), Chapter 2 (The concept of conventional wisdom), pages 6–7.