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Some historical perspectives on the Bond-Stock Earnings Yield Model for crash prediction around the world

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ABSTRACT

We provide a historical background on Ziemba's experiences and research on the bond-stock earnings yield differential model (BSEYD), from the time he first used it in Japan in 1988 through to the present in 2014. Over this period, the model has called many crashes, but not all. Those called have had high interest rates in long term bonds relative to the trailing earnings to price ratio. In general, there will almost always be a crash if the model is in the danger zone. The model predicted the crashes in China, Iceland and the US in the 2006–09 period. Iceland had a drop of fully 95%. For the US, the call was on June 14, 2007, and the stock market fell 56.8%. A longer-term study for the US, Canada, Japan, Germany, and the UK shows that, over long periods, being in the stock market when the bond-stock signal is not in the danger zone, and in cash when it is in the danger zone, provides a final wealth which is about double that of a buy and hold strategy for each of these five countries. The best use of the model is for predicting crashes. Finally, we compare Shiller's high PE ratio crash model to the BSEYD model for the US market from 1962–2012. While both models add value, the BSEYD model predicts crashes better.

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1. Introduction

Since the credit for the first publications on the BSEYD and its relationship to the later discovered and widely discussed Fed model has eluded Ziemba, he would like to discuss his early experiences with the model and the history of his involvement with it since 1988. The Fed model is a special case of the BSEYD model.¹

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¹ This paper presents one crash prediction model that has worked well over time in the US, Japan and elsewhere. Other crash prediction models are discussed by Sornette (2009), Sornette and Zhou (2002), and Yan, Woodard, and Sornette (2012a,b), Jarrow, Kohia, and Protter (2011)

2. A bond–stock return crash danger model²

In May 1988, I was invited by Yamaichi Securities for an interview to be the first Yamaichi visiting professor of finance at the University of Tsukuba, a Japanese national university. Yamaichi wished to try to establish the study of finance, especially investments, in Japanese universities, which was not generally taught. They established a five-year program, with five such visiting professors in succession. The teaching at the university (I taught investments, security market anomalies, futures and options)

discuss when a bubble exists. Shiryayev, Zhitlukhin, and Ziemba (2014, in press) discuss a stopping rule model for entering and exiting bubble type markets.

² This section relates to Ziemba's early experience with this model, and so is written in his words.

was supplemented with a two-day per week consulting position in Tokyo, some 60 km southwest of Tsukuba, at Yamaichi Securities, which was then the fourth largest securities firm in Japan, and the sixth largest in the world. In my interview, I asked whether I could study market imperfections (anomalies) and stock market crashes in two study groups with some of the young Yamaichi Research Institute employees who also came up to Tsukuba for my classes.

My proposal was accepted, and the study groups, each consisting of about ten eager young students, proceeded, with me giving lectures on the US experience and them helping me to investigate the Japanese situation. We focused on the postwar period 1948–1988, and much of what I learned appeared in the book *Invest Japan* (Ziemba & Schwartz, 1991), the 1989–1993 research papers of Ziemba and Schwartz, and Stone and Ziemba (1993). My wife Dr. Sandra L. Schwartz and I also wrote the book *Power Japan* (Ziemba & Schwartz, 1992), which discusses the Japanese economy. Sandra had a pretty good idea right away that the Japanese policies that led to astronomically high land and stock prices and massive trade surpluses would lead to disaster, and anticipated that they would eventually lose most of the money that they received from selling cars, stereos and the like. *Power Japan* included a list of prestige buildings that the Japanese paid too much for in the 1987–89 era. Even at the height of their economic power in 1989, only 3% of Japanese assets were invested abroad.

My study groups started in August 1988 and ended a year later. I was asked to remain as a consultant for the fall of 1988, to complete the factor model discussed by Schwartz and Ziemba (2000), which was originally presented at a Berkeley Program in Finance meeting in Santa Barbara in September 1992. The factor model used anomaly ideas, such as mean reversion, earnings surprise, momentum, price-earnings ratios, future earnings over price, and the value embedded in 30 variables, to separate and rank stocks by their future mean performances, from best to worst, for all of the stocks on the Tokyo Stock Exchange first section, which was about 86% of the total capitalization. The model, which was motivated by a similar model for the US by Jacobs and Levy (1988), was estimated yearly but updated monthly. The model performed well out of sample, and so was useful for hedge fund long-short trading as well as long-only investing. The hedge fund Buchanan Partners in London discovered the model that was discussed in *Invest Japan* when they bought the book, and hired me to help them in their Japanese warrant trading, which dealt largely with long underpriced warrants and short overpriced stocks. Their trading was successful, and the model, which was estimated using data during a stock market rise, still worked when the decline came, since the key drivers of the returns were variables such as earnings. For an update of Japanese anomalies to 1994, see Comolli and Ziemba (2000).

In the crash study groups in 1988, I came up with a simple model with only a single variable, namely the difference between stock and bond rates of return.³ The

idea was that stocks and bonds compete for investment dollars, with stocks being favored when interest rates are low, and bonds being favored when interest rates are high. The main point that I wished to focus on was the fact that when the measure, that is, the difference between these two rates, the long bond yield minus the earnings yield (the reciprocal of the price earnings ratio), was very large, there was a high chance of a stock market crash. Here, a crash was defined as a 10% fall in the index within one year. Table 1 and Fig. 1 show that the model explains the October 1987 crash, which is where I got this idea. The bold values indicate that there is extreme danger in the stock market, because the 30-year government bond yields are very much higher than the usual stock market yields, measured by the reciprocal of the previous year's reported price earnings ratio. These high interest rates invariably lead to a stock market crash. Here, the danger indicator crossed a statistical 95% confidence line in April. The market ignored this signal, but did eventually crash in October 1987. There was a similar signal in the US S&P500 around April 1999 that was ignored by most investors, followed by a crash that began in August 2000 and a weak stock market in 2001/02 which is discussed below.

Returning to the story, in 1988–89, I asked one of my young colleagues in my crash study group, Sugheri Iishi, to check the accuracy of the bond-stock prediction model for Japan. We found that there were twenty 10% + crashes during the 40-year *out-of-sample* period, 1949–89. Whenever this measure was in the danger zone (that is, outside the 95% confidence bands), there was a crash of 10% or more from the current level within one year. This was true in 12 cases out of 12, a splendid prediction record. The measure was not in the danger zone for all crashes, but whenever it was, there was a crash, with no misses. Another eight crashes occurred for other reasons. Reinhart and Rogoff (2009), in their study of banking crises, study some of the circumstances that lead to stock market crashes of both the interest rate and non-interest rate driven types. See also the classic book by Kindleberger and Aliber (2011) and the study by Lleo and Ziemba (2015a) of hedge funds and bank trading disasters, how they occur and how they could be prevented.

Thus, the measure was successful at predicting future crashes, but there was no precise way to tell when they would occur or how deep they would be. However, long-run mean reversion suggests that the longer the bull run is and the more over-priced the measure is, the longer and deeper the decline will probably be. One can then use this measure as part of an econometric system for estimating future scenarios.

Each time the spread exceeded the 4.23 cutoff (which was higher than 95% confidence), there was a crash. The measure was a long way into the danger zone in late 1989, and the decline (the 21st crash) began on the first trading day of 1990, with the Nikkei stock average peaking at 38,916. See Fig. 1. It was unfortunate that Yamaichi's top management did not listen to Iishi when I sent him up to explain our results in Japanese; there was much more danger in the market than they realised in 1989. By 1995, Yamaichi Securities was bankrupt and ceased to exist.

The model also indicates that the valuation was still high as of May 29, 1990, at 4.88. Not much later, the 22nd

³ We show later that this difference model is a generalization of the ratio model, known as the Fed model. This model, which seems to date from Fed minutes in 1996, was studied by Koivu, Pennanen, and Ziemba (2005). See Yardeni (1997).

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