Fitting of SSEC Index (Shanghai Composite) from January 2000 to July 2010 Using Random Walk Model*
用随机漫步模型拟合 2000 年 1 月至 2010 年 7 月上海证券综合指数

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Abstract: The random walk model was used to fit the SSEC index dated from January 2000 to July 2010 based on daily, weekly and monthly close prices, as well as average weekly and monthly prices. This study conducted firstly to convert the decimal index into an index walk to use the standard random walk to fit, then to extend the standard random walk with equal sized-step to a decimal sized-step random walk to construct a random index, and finally to find out the best seed in random walk model that fits the index well. The results show that the random walk model can fit different datasets of the SSEC index, suggesting that the SSEC index mainly behaves as a random walk.

Key words: fitting, random walk model, SSEC index

摘要:用随机漫步模型拟合 2000 年 1 月至 2010 年 7 月上海证券综合指数(上证指数)的月收盘价、周收盘价、日收盘价、月均价和周均价。先将十进制股票指数转换成标准随机漫步,再将同等步伐的标准随机漫步扩展为十进制步伐的随机漫步以形成随机指数,最后寻找随机漫步模型中拟合指数的最佳种子。结果显示,上证指数主要呈现随机漫步走势,该模型能够拟合上证指数的不同数据系列。

关键词:拟合　随机漫步模型　上海证券综合指数
中图法分类号:F830.91　　**文献标识码**:A　　**文章编号**:1005-9164(2011)01-0092-05

Several studies suggest that the Chinese stock markets, in particular, renminbi denominated shares (A-shares)[1] seemed to follow a random walk[2~5], whereas an earlier study did not support this hypothesis[6].

Still, many studies are conducted to test whether the stock markets around the world follow the random walk[7~13].

Thus, there are sufficient evidences accumulated to support the hypothesis that a stock market would follow the random walk pattern. This hypothesis was generally confirmed using various statistical tests such as unit root test and variance ratio test[14], but it was also rejected using the same test[6].

To advance our knowledge on this issue, we need to use a random walk model to fit either an in-

收稿日期:2010-08-25

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* This study was partly supported by Guangxi Science Foundation (07-109-001A, 09322001 and 2010GXNSFA013046 and Guangxi Academy of Sciences (08YJ6SW06).

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dividual stock price or a market index. However, to the best of our knowledge, few studies have been conducted along this kind of thought. Hence, it is very important to use a random walk model to fit a real recorded stock index or an individual stock, because this is the only way that (i) we can visibly accept or reject whether a stock index behaves in a random walk pattern, and (ii) we might go along this pathway forwards the more accurate, precise and reliable description of stock trends.

The lack of such studies could be attributed to (i) the lack of suitable algorithm for searching optimal seed in a random walk model; (ii) the standard random walk is a sequential data added by either 1 or −1, whereas any stock index or individual stock are decimal data; and (iii) the real recorded individual stock often has equal close price for several trading days whereas the random walk has no mechanism to generate zero.

Clearly and evidently, we should overcome these obstacles in order to fit the real recorded stock index or individual stock. In this study, we attempt to use the random walk model to fit the SSEC index dated from January 2000 to July 2010, mainly because the index generally has less chance of equal close price for several trading days than individual stock does.

1 Materials and methods

1.1 Data

The historical prices of SSEC index (Shanghai Composite) are obtained from Yahoo Finance[15], which are dated from January 4, 2000 to July 21, 2010 when this study is performed. This dataset comprises 2714 daily close prices, 547 weekly close prices, and 127 monthly close prices. As the weekly and monthly close price are refereed to the last trading day in a week and in a month, so we also computed the average weekly and average monthly close prices for random walk fittings.

1.2 Index walk

As the random walk model starts at zero and at each step moves by ±1 with equal probability[16], whereas any stock index or individual stock are decimal data, we convert the SSEC index into the similar pattern, which could be called as Index walk. In particular, when the SSEC index at certain recording time point is higher than its previous one, we classify it as 1, otherwise we classify it as −1 (column 3, Table 1), and then we add them together as the random walk does (column 4, Table 1).

Table 1 Conversion of recorded index into index walk and generation of random walk for monthly close SSEC index from January 2000 to July 2010*

Date	Recorded Index	Index Step	Index Walk	Generated Random Number	Random Step	Random Walk
2000-01-04	1535		0	−0.25323		0
2000-02-01	1714.58	1	1	0.98818	1	1
2000-03-01	1800.23	1	2	0.99777	1	2
2000-04-03	1836.32	1	3	−0.52373	−1	1
2000-05-01	1894.55	1	4	0.38105	1	2
2000-06-01	1928.11	1	5	−0.95820	−1	1
2000-07-03	2023.54	1	6	−0.10781	1	2
2000-08-01	2021.20	−1	5	0.32171	1	3
2000-09-01	1910.16	−1	4	0.70759	1	4
2000-10-02	1961.29	1	5	−0.86972	−1	3
…	…	…	…	…	…	…
2010-01-04	2989.29	−1	20	0.87794	1	16
2010-02-01	3051.94	1	21	−0.02729	−1	15
2010-03-01	3109.10	1	22	0.98302	1	16
2010-04-01	2870.61	−1	21	−0.81475	−1	15
2010-05-04	2592.15	−1	20	−0.05122	1	16
2010-06-01	2398.37	−1	19	−0.49647	−1	15
2010-07-01	2535.39	1	20	0.11106	1	16

* The random number is generated by SigmaPlot with the seed of 6.03978.

1.3 Generation of random walk

We use the SigmaPlot[17] to generate random sequence with different seeds. Technically, the generation of random walk is quite simple: we generate random number ranged from −1 to 1, and then we classify a random value as 1 if it is larger than its previous one and as −1 if it is smaller than its previous one (column 6, Table 1). Thereafter we add these values as random walk (column 7, Table 1).

1.4 Searching for seed

To find a random walk that is very approximate to the index walk is to find a seed that can generate a random walk we want. To the best of our knowledge, there is no algorism for searching the seed that generates the best fit for the observed dataset, therefore the so-called fitting, which traditionally searches the optimum according to various algorisms, becomes to search all possible seeds in order

to find out the seed that produces the random walk with the least squares between random walk and index walk.

1.5 Extension of random walk

Because the random walk comes from tossing of double-sided coin, accordingly we broaden this concept into tossing of dice, which can be not only six-sided but as many as we need. Thus we can use this imaginary multi-sided dice to generate random numbers (column 3, Table 2), and add them to construct the random index (column 4, Table 2). The fitting of recorded SSEC index is conducted by searching the seeds as described in the above section.

Table 2 Generation of recorded index into random index for monthly close SSEC index from January to July 2010 *

Date	Recorded Index	Generated Random Number	Random Index
2000-01-04	1535		1535
2000-02-01	1714.58	199.0097	1734.0097
2000-03-01	1800.23	38.8518	1772.8615
2000-04-03	1836.32	−177.7398	1595.1217
2000-05-01	1894.55	256.8665	1851.9882
2000-06-01	1928.11	−137.6850	1714.3032
2000-07-03	2023.54	122.5037	1836.8069
2000-08-01	2021.20	135.9473	1972.7542
2000-09-01	1910.16	−174.1059	1798.6484
2000-10-02	1961.29	147.5964	1946.2448
…	…	…	…
2009-12-01	3277.14	157.0678	2748.2668
2010-01-04	2989.29	90.9775	2839.2444
2010-02-01	3051.94	94.8380	2934.0823
2010-03-01	3109.10	39.2938	2973.3761
2010-04-01	2870.61	−62.2408	2911.1353
2010-05-04	2592.15	−217.6424	2693.4929
2010-06-01	2398.37	113.6614	2807.1543
2010-07-01	2535.39	78.4252	2885.5795

* The random number is generated by SigmaPlot with the seed of 3.55278.

1.6 Comparison

We use the least squares between index walk and random walk, and between recorded SSEC index and random index to evaluate our fittings.

2 Results and discussion

Table 1 shows how we construct the index walk and random walk. For the index walk, we have the follows: (i) the starting point is the earliest recorded SSEC index, in our case it was the close price, 1535 (cell 2, column 2), on January 31, 2000 although Yahoo Finance system dated it as January 4, 2000 (cell 2, column 1), and this starting point corresponds zero in sense of index walk (cell 2, column 4); (ii) the second recoded close price, 1714.58 (cell 3, column 2), is larger than the first recorded close price, 1535 (cell 2, column 2), so we assign 1 as index step (cell 3, column 3), (iii) the index walk is 1 (0+1) (cell 3, column 4), and (iv) the similar computation is applied to all the data in columns 2, 3, and 4.

For the random walk, we have the follows: (i) a good seed we found is 6.03978 (legend to Table 1), and this seed generates a series of random numbers (column 5), (ii) the first random number, −0.25323 (cell 2, column 5) is considered as the starting point corresponding to 0 in random walk (cell 2, column 7), (iii) the second random number, 0.98818 (cell 3, column 5), is larger than the first random number, −0.25323 (cell 2, column 5), so we assign 1 (cell 3, column 6), (iv) the random walk is 1 (0 + 1) (cell 3, column 7), and (v) the similar procedure is applied to all the data in columns 5, 6, and 7. In the same way, we construct the index walk and random walk for weekly and daily data.

The left side of Figure 1 shows the application of random walk model to fit the SSEC index walk with respect to monthly close, monthly average, weekly close, weekly average and daily close prices. It can be seen that the fitting of random walk to monthly close prices is the best.

Actually, the completely perfect fitting of index walk is a rare event, for example, there are 127 monthly close prices, thus the completely perfect fitting has the chance of $(1/2)^{127}$ theoretically, which is extremely small. Similarly, the chance for weekly and daily close prices are $(1/2)^{547}$ and $(1/2)^{2714}$ theoretically. Therefore, we can consider the fitting for monthly close prices acceptable in this regard as we have no data on such fittings available using other models for comparison.

Actually we can view the index walk, which is the conversation from its recorded data, as the trend of SSEC index. This is so because the SSEC index walk answers the very basic question of whether a price at certain time point is higher (1) or lower (−1) than its previous price.

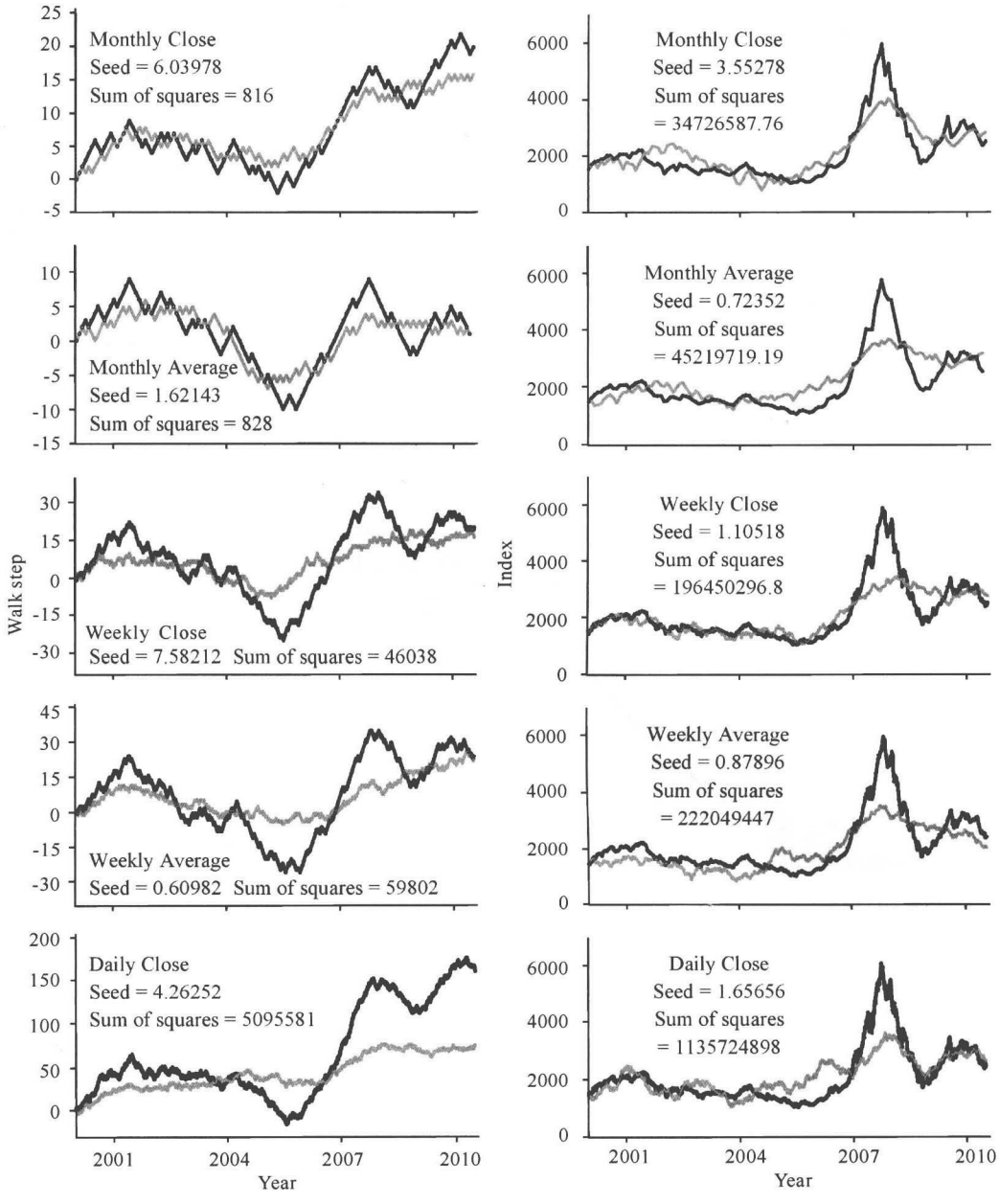

Fig. 1 Comparison of index walk with random walk, real index with random index in SSEC from January 2000 to July 2010.

For the fittings on the left side of Figure 1, the fittings are better for monthly and weekly close price than for monthly and weekly average close prices as evidenced by sum of squares (816 versus 828 and 46038 versus 59802). This implies that the averaging process could change the nature of random pattern, especially for the weekly data. Also, comparing both close and average datasets, it is like that the monthly close price has an increased tendency.

Table 2 shows how we construct a random walk model to fit the real recorded SSEC index, however, we now only need to construct the random index without the need to construct an index walk: (i) the starting point is the first recorded SSEC index, which is 1535 (cell 2, column 2 and cell 2, column 4), (ii) the seed for Table 2 is 3.55278 (see the legend to Table 2), (iii) the first random number generated by this seed is 199.0097 (cell 3, column 3), (iv) we add this value to the previous index datum (1535) resulting in 1734.0097 (cell 3, column 4), and (v) along this procedure, we get the random index in column 4.

On the right side of Figure 1 is the fitting along Table 2 approach. As can be seen, the random walk can fit the different datasets of real recorded SSEC index. In general, the random walk fitting for the monthly close price really indeed goes through the

trend of SSEC index, which would mean that the monthly SSEC index behaves in a pattern somewhat similar to random walk. Again, we can still find that the fitting is worse for monthly and weekly average prices than for their close prices, which once more confirms that the averaging procedure could be harmful to the nature of random pattern.

On the other hand, we also can see that the random walk model has the difficulty to fit peaks in SSEC index, which would suggest that the market entered the "crazy phase" when most people desperately invested in stock markets regardless of the danger of possible collapse of stock market. Naturally, this phase is hard to use random walk to explain, which hence highlights why some studies show that markets behave in random walk pattern whereas other studies do not.

3 Conclusion

We successfully fit the SSEC index using random walk model, and the results show that the SSEC index mainly behaves as a random walk. This study provides new insights on (i) how to convert the decimal index into an index walk to use the standard random walk to fit, (ii) how to extend the standard random walk with equal sized-step to a decimal sized-step random walk to construct a random index, and (iii) how to find out the best seed in random walk model that fits the index well.

Acknowledgements

The authors wish to thank Dr Hong Zhang at Biyee SciTech Inc., MA, USA for helpful discussion.

References:

[1] Charles A, Darné O. The random walk hypothesis for chinese stock markets: evidence from variance ratio tests[J]. Econ Syst, 2009, 33: 117-126.

[2] Karemera D, Ojah K, Cole J A. Random walks and market efficiency tests: evidence from emerging equity markets[J]. Rev Quan Finan Account, 1999, 13: 171-188.

[3] Lima E J, Tabak B M. Tests of the random walk hypothesis for equity markets: evidence from China, Hong Kong and Singapore[J]. Appl Econ Lett, 2004, 11: 255-258.

[4] Balsara N J, Chen G, Zheng L. The Chinese stock market: an examination of the random walk model and technical trading rules[J]. Quart J Bus Econ, 2007, 46: 43-63.

[5] Huang B N. Do Asian stock markets follow random walks: evidence from the variance ratio test[J]. Appl Finan Econ, 1995, 5: 251-256.

[6] Lo AW, MacKinlay A C. Stock market prices do not follow random walks: evidence from a simple specification test[J]. Rev Finan Studies, 1988, 1: 41-66.

[7] Lee U. Do stock prices follow random walk? some international evidence[J]. Int Rev Econ Finan, 1992, 1: 315-327.

[8] Ojah K, Karemera D. Random walk and market efficiency tests of latin american emerging equity markets: a revisit[J]. Finan Rev, 1999, 34: 57-72.

[9] Chang K P, Ting K S. A variance ratio test of the random walk hypothesis for Taiwan's stock market[J]. Appl Finan Econ, 2000, 10: 525.

[10] Abraham A, Seyyed F J, Alsakran S A. Testing the random walk behavior and efficiency of the Gulf stock markets[J]. Finan Rev, 2002, 37: 469-480.

[11] Gilmore C G, McManus G M. Random walk and efficiency tests of central european equity markets[J]. Manag Finan, 2003, 29: 42-61.

[12] Smith G, Ryoo H J. Variance ratio tests of the random walk hypothesis for European emerging stock markets [J]. Eur J Finan, 2003, 9: 290-300.

[13] Worthington A C, Higgs H. Random walks and market efficiency in european equity markets[J]. Global J Finan Econ, 2004, 1: 59-78.

[14] Darrat A F, Zhong M. On testing the random-walk hypothesis: a model-comparison approach[j]. Finan Rev, 2000, 35: 105-124.

[15] Yahoo Finance[EB/OL]. [2010-07-22]. http://finance.yahoo.com/q/hp?s=^SSEC+Historical+Prices. 2010.

[16] Wikimedia Foundation, Inc. Wikipedia, the Free encyclopedia[EB/OL]. [2010-07-22]. http://en.wikipedia.org/wiki/Random_walk.

[17] SPSS Inc. SigmaPlot 2002 for Windows Version 8.02 [CP]. 2002.

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