Cross-Sectional Returns and Fama-MacBeth Betas for S&P Indices

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Abstract

In this paper, we use the Fama-MacBeth regression analysis methodology to determine if twenty indices for the twenty year time period from 1990 to 2009 provide a linear relationship between the index returns and index betas. The time-series of the betas of all the indices except that of Gold and Silver Index for monthly returns of one-year intervals are non-stationary. The betas in four of the five quintiles formed by sorting the indices in order of the highest to the lowest betas are found to be co-integrated. The results of the empirical tests on the gamma coefficients of the Fama-Macbeth regressions do not support the CAPM.

Keywords: Fama-MacBeth betas, S&P Indices, Stationarity of betas, Co-integrated betas, Gamma coefficient analysis

1. Introduction

A market index like S&P 500, Dow Jones Industrials Average or Nasdaq Composite is a portfolio constructed from a set of pre-selected stocks traded on various stock exchanges. Of course, some indices like the Dow Jones Industrials Average may have a fixed number of stocks, whereas other indices like the Nasdaq Composite or the Dow Jones Total Market may have a large number of stocks with some periodic additions and deletions. Fama and MacBeth (1973) use Fisher's Arithmetic Index, an equally weighted average of the returns of all the stocks traded on NYSE at that time, as a proxy for the market return $\tilde{R}_{mt}$. There are several popular market indices whose daily values are reported in the financial press. Also, in recent years, the S&P 500 index has become the proxy for market return.

Many financial planners advise their clients to invest their money in index-based funds. Therefore, it is reasonable to assume that individual investors would look at several market indices before they invest money in stocks, mutual funds (index-based or sector-based) or other assets, and therefore it is to be expected that they would be interested in the betas of the market indices relative to the S&P 500 index. One of the objectives of the current study is to test whether the Capital Asset Pricing Model (CAPM) can be a valid predictor of the cross-sectional returns of some well-known market indices, using the S&P 500 index as proxy for the market return.

Section 2 of this paper discusses the Capital Asset Pricing Model. Section 3 explains the data sample and Section 4 discusses the values of the average monthly returns for the twenty indices which include Dow Jones, NYSE, NASDAQ, S&P, and Russell indices as well as the PHLX Gold and Silver Index. Section 5 discusses the estimates of the Fama-MacBeth betas for the twenty different indices calculated for various time periods and Section 6 discusses the unit root tests for the levels of betas with no intercept or trend of the one-year Fama-MacBeth betas. Section 7 discusses the gamma calculations and tests. Section 8 provides the conclusions of this paper.

2. The Capital Asset Pricing Model

In its most basic form, the Capital Asset Pricing Model (CAPM) defines the equilibrium relationship between the expected return and risk of an asset relative to a market portfolio. The equation (Fama and MacBeth, 1973) that links the expected return and risk of the asset is:

$$E(\tilde{R}_i) = E(\tilde{R}_0) + [E(\tilde{R}_m) - E(\tilde{R}_0)]\beta_i \tag{1}$$

Where: $\tilde{R}_i$ and $\tilde{R}_m$ are the returns on asset i and the market portfolio,

$\beta_i = \text{cov}(\tilde{R}_i, \tilde{R}_m) / \sigma_m^2$, and $\tilde{R}_0$ is the risk-free rate of return with $\beta = 0$.

To test equation (1) empirically, it is re-stated as:

$$\tilde{R}_{it} = a_i + \beta_i \tilde{R}_{mt} + \tilde{\varepsilon}_{it} \tag{2}$$

If i is not a single asset, but a portfolio p made of assets $j, j = 1,2,\ldots,J$, equations (1) and (2) still hold good, and in empirical testable form, equation (2) is written as:

$$R_{pt} = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\hat{\beta}_{p,t-1} + \hat{\gamma}_{2t}\hat{\beta}^2_{p,t-1} + \hat{\gamma}_{3t}\overline{s}_{p,t-1}(\hat{\varepsilon}_i) + \hat{\eta}_{pt} \quad (3)$$

The procedures for constructing a finite number (20 to 100) of different portfolios from hundreds of stocks traded in different markets are described in Fama and MacBeth (1973), Fama and French (1992, 1996), and Jagannathan and Wang (1996). However, in the current study, no portfolios are constructed. A market index replaces the constructed portfolio p.

3. Data Sample

The data for this study is collected from the Global Financial Database (GFD). The market indices that will be included in the study are given in Table 1.

Table 1. Market Indices

Series ID	Name of Market Index	Symbol in GFD	Dates of data availability
R00_SP500	S&P 500	SPXD	1791-2009
R01_DJIA	Dow Jones Industrials Average	DWI_XD	1896-2009
R02_DJTran	Dow Jones Transportation Average	DWT_XD	1889-2009
R03_DJUtil	Dow Jones Utility Average	DWU_D	1929-2009
R04_DJTotal	Dow Jones Total U.S. market	DWCD	1970-2009
R05_NYComp	NYSE Composite (New)	NYAD	1929-2009
R06_NDComp	NASDAQ Composite	OTC_D	1938-2009
R07_ND100	NASDAQ 100	NDXD	1985-2009
R08_NDBank	NASDAQ Bank Index	IXBKD	1971-2009
R09_NDIns	NASDAQ Insurance	IXISD	1965-2009
R10_NDTel	NASDAQ Telecommunications	IXUTD	1971-2009
R11_SP100	S&P 100	OEXD	1976-2009
R12_SP400	S&P 400 Mid-cap	IDXD	1981-2009
R13_SP600	S&P 600 Small-Cap Index	SMLD	1989-2009
R14_SPAero	S&P 500 Aerospace & Defense	GSPAEDD	1928-2009
R15_SPMatl	S&P 500 Materials	GSPMD	1989-2009
R16_SPInfo	S&P 500 Information Technology	GSPTD	1986-2009
R17_SPHeal	S&P Healthcare Composite	HCXD	1987-2009
R18_RS1000	Russell 1000 Index	RUID	1978-2009
R19_RS2000	Russell 2000 Index	RUTD	1978-2009
R20_GoldSil	PHLX Gold and Silver Index	XAUD	1983-2009

For two indices, S&P 600 Small Cap Index and S&P 500 Materials, data is available only from the middle of 1989 onwards. Therefore, the analysis will cover the years from 1990 to 2009 (a time span of 20 years).The selected indices cover a broad spectrum of industries that are of interest to a variety of investors. Some investors may be interested in the Utilities index which is known to be less volatile. Others may be interested in the highly volatile Nasdaq 100 index. Some others may be interested in the Gold and Silver index which appears on the radar screens of investors in times of crises.

4. Average Monthly Returns

The average monthly returns of the different indices are given in Table 2. First, it may be noted that the compositions of the indices are not mutually exclusive; several of these indices contain stocks of many of the largest companies. Therefore, it is expected that the broad indices would exhibit somewhat similar pattern of returns and volatility. Several observations can be made from the results displayed in Table 2: (a) The Nasdaq 100 index (series R07) has the highest mean monthly return of 1.2% over the 20-year period, whereas the Gold and Silver index (R20) has recorded the maximum and minimum monthly returns of 53.4% and −38.2%. Further, the Gold and Silver index also has the highest volatility (standard deviation of monthly returns) of 10.4%. The Dow Jones Utilities index (series R03) has the lowest monthly return. Broader indices such as S&P 500 (series R00), Dow Jones Total Market (series R04), NYSE Composite (series R05), and Russell 1000 (series R18) have comparable returns and volatility.

Table 2. Average Monthly Returns of Different Indices

Series	Mean	Median	Maximum	Minimum	Std. Dev.
R00_SP500	0.575%	1.013%	11.159%	-16.943%	4.328%
R01_DJIA	0.650%	1.002%	10.605%	-15.132%	4.292%
R02_DJTran	0.708%	1.551%	17.455%	-21.992%	6.071%
R03_DJUtil	0.320%	0.825%	11.758%	-13.393%	4.457%
R04_DJTotl	0.605%	1.194%	10.715%	-17.635%	4.405%
R05_NYComp	0.612%	1.039%	10.733%	-19.537%	4.215%
R06_NDComp	0.920%	1.707%	21.976%	-22.902%	6.995%
R07_ND100	1.199%	1.842%	24.981%	-26.405%	7.888%
R08_NDBank	0.718%	1.193%	11.028%	-21.813%	4.743%
R09_NDIns	0.893%	1.220%	13.521%	-16.009%	4.499%
R10_NDTel	0.580%	1.356%	23.694%	-29.029%	8.353%
R11_SP100	0.574%	0.960%	10.792%	-14.591%	4.411%
R12_SP400	0.923%	1.239%	14.753%	-21.835%	5.032%
R13_SP600	0.830%	1.585%	17.309%	-20.242%	5.436%
R14_SPAero	0.883%	1.199%	15.088%	-19.820%	5.741%
R15_SPMat	0.561%	0.820%	24.051%	-22.177%	5.801%
R16_SPInfo	1.043%	1.299%	22.291%	-28.014%	7.866%
R17_SPHeal	0.797%	1.105%	16.081%	-12.842%	4.789%
R18_RS1000	0.597%	1.113%	11.161%	-17.503%	4.373%
R19_RS2000	0.710%	1.598%	16.420%	-20.904%	5.630%
R20_GoldSil	0.676%	0.384%	53.385%	-38.221%	10.424%

Often, Utilities are considered to be the safest of investments. In other words, investors lose the least in severe bear markets, if they own stocks of utilities. However, Table 2 shows that among all the indices, the S&P Healthcare Composite index (series R17) has suffered the minimum loss of 12.84% vis-à-vis the loss of 13.4% suffered by the Dow Jones Utilities index (series R03). The average monthly return from S&P Healthcare Composite index (series R17) is more than double that of the Utility index. These results indicate that investors looking for a safe haven may be better off with Healthcare index than the Utility index.

5. Estimation of Betas

In Fama and MacBeth (1973), the values of betas are calculated based on the monthly returns for four year or longer periods. In the current study, initially, betas are calculated for non-overlapping intervals of one-year, two-year, four-year, five-year, ten-year and the entire 20-year period. The one-year interval yields 20 beta values for each index, since the data covers 20 years. First, the means of the one-year betas are calculated and based on the means of these 20 one-year betas, the indices are sorted into quintiles in order of the highest to the lowest values and displayed in Table 3. By construction, the indices in the first quintile are the most volatile and the indices in the fifth quintile are the least volatile. The indices in the third quintile have a beta, close 1.00, and mimick the market portfolio. Again, the Gold-Silver index (series R20) is an outlier in the sense that its average beta is in the fifth quintile, but among all the indices, its beta has the maximum value of 3.073, and the minimum value of − 0.554 (the only index with a large negative beta). The Dow Jones Utilities Index has a negative minimum beta.

Table 3. Summary Statistics of one-year betas

Index	Mean	Median	Maximum	Minimum	Std. Dev.
Panel A: Quintile 1					
R10_NDTEL	1.491	1.435	2.999	0.788	0.588
R07_ND100	1.445	1.451	2.532	0.301	0.495
R16_SPINFO	1.430	1.422	2.540	0.153	0.549
R06_NDCOMP	1.309	1.270	2.170	0.723	0.389
Panel B: Quintile 2					
R19_RS2000	1.107	1.095	1.875	0.441	0.370
R15_SPMATL	1.103	1.075	1.860	0.421	0.331
R02_DJTRANS	1.083	1.053	1.946	0.416	0.352
R12_SP400	1.080	1.051	1.436	0.799	0.195
Panel C: Quintile 3					
R13_SP600	1.077	1.114	1.647	0.559	0.319
R04_DJTOTAL	1.009	1.001	1.129	0.916	0.065
R18_RS1000	1.006	1.004	1.048	0.973	0.023
R11_SP100	0.992	0.983	1.143	0.851	0.084
Panel D: Quintile 4					
R01_DJIA	0.962	0.952	1.489	0.739	0.167
R05_NYCOMP	0.961	0.967	1.129	0.763	0.105
R14_SPAERO	0.873	0.787	1.923	0.160	0.436
R17_SPHEALTH	0.757	0.729	1.419	0.013	0.362
Panel E: Quintile 5					
R20_GOLDSIL	0.738	0.469	3.073	-0.554	0.930
R09_NDINSR	0.696	0.737	1.248	0.017	0.281
R08_NDBANK	0.639	0.642	1.247	0.095	0.272
R03_DJUTIL	0.461	0.475	1.076	-0.093	0.336

Table 4-A. Betas of Different Indices- Nonoverlapping Time Intervals

Panel A : Values of one-year Betas
(sorted: highest to lowest based on one-year mean beta values)

Year	R10 NDTel	R07 ND100	R16 SpInfo	R06 NDcomp	R19 RS2000	R15 SPMatl	R02 DJTrans	R12 SP400	R13 SP600	R04 DJTotl
1990	1.47	1.56	1.13	1.30	1.23	1.12	1.25	1.22	1.19	1.03
1991	1.00	1.41	0.97	1.12	0.98	0.95	1.44	1.07	0.94	0.98
1992	1.00	1.04	0.97	0.80	0.70	0.83	1.07	0.99	0.70	0.94
1993	2.50	1.68	1.87	1.44	1.12	0.42	0.42	1.12	1.33	1.04
1994	1.10	1.13	1.23	0.95	0.87	1.28	1.29	0.95	0.94	0.95
1995	1.40	0.30	0.15	0.72	1.07	1.86	1.31	1.06	1.22	0.96
1996	0.79	1.46	1.70	1.15	0.79	0.77	0.91	0.86	0.82	0.95
1997	0.90	1.45	1.57	1.07	0.61	0.92	0.78	0.80	0.66	0.92
1998	1.57	1.35	1.25	1.37	1.23	0.80	0.93	1.29	1.23	1.06
1999	1.81	1.92	1.68	1.78	0.94	1.17	0.89	0.89	0.74	1.06
2000	1.27	1.58	1.77	1.37	0.44	0.91	0.85	0.91	0.56	0.94
2001	2.24	2.53	2.54	2.17	1.05	0.84	1.21	1.08	0.99	1.05
2002	1.79	1.66	1.99	1.37	0.88	1.03	0.69	0.81	0.73	0.95
2003	0.89	0.93	0.96	0.97	1.22	1.43	1.46	1.01	1.14	1.00
2004	1.97	1.68	1.77	1.79	1.76	1.15	1.04	1.32	1.51	1.12
2005	1.55	1.87	1.71	1.65	1.72	1.52	1.95	1.40	1.62	1.10
2006	3.00	2.13	2.14	1.91	1.88	1.58	0.67	1.44	1.65	1.13
2007	1.07	1.13	1.20	1.12	1.12	1.00	0.92	1.00	1.08	1.00
2008	1.49	1.30	1.27	1.23	1.30	1.23	1.12	1.33	1.24	1.04
2009	1.00	0.78	0.72	0.89	1.22	1.25	1.48	1.04	1.26	0.96

Panel A (continued): Values of one-year Betas
(sorted: highest to lowest based on one-year mean beta values)

Year	R18 RS1000	R11 SP100	R01 DJIA	R05 NYcomp	R14 SPAero	R17 SPHeal	R20 GoldSil	R09 NDInsr	R08 NDbank	R03 DJUtil
1990	1.02	0.96	0.96	0.97	1.02	1.03	0.13	1.25	0.81	0.39
1991	0.99	0.96	0.90	0.95	0.77	1.21	-0.55	0.71	0.72	0.37
1992	1.00	0.92	0.77	0.94	0.95	1.42	0.10	0.61	0.69	1.08
1993	1.01	0.90	0.84	0.98	0.16	0.64	0.49	0.63	0.69	0.67
1994	0.98	1.01	1.19	0.97	0.70	1.03	0.05	0.80	0.53	0.87
1995	0.98	1.14	1.49	1.03	1.92	0.70	2.87	0.38	0.10	0.71
1996	0.99	1.03	0.86	0.89	0.50	1.30	0.51	0.77	0.50	0.79
1997	0.97	1.09	1.09	0.90	1.11	1.05	0.66	0.47	0.59	0.35
1998	1.03	0.99	0.96	0.99	1.16	0.81	1.54	1.02	1.08	0.25
1999	1.00	1.12	0.88	0.82	0.53	0.57	0.26	0.46	0.48	0.14
2000	1.01	1.05	0.84	0.79	0.55	0.01	0.04	0.61	0.41	-0.09
2001	1.02	1.08	0.94	0.76	0.95	0.22	0.08	0.02	0.31	0.10
2002	0.98	1.08	1.02	0.85	0.27	0.62	0.19	0.41	0.35	0.44
2003	0.98	0.97	0.97	1.08	1.71	0.39	0.44	0.76	0.73	0.97
2004	1.05	0.93	0.90	1.06	0.61	0.91	0.38	1.03	0.91	0.52
2005	1.03	0.85	1.08	0.93	0.70	0.45	1.72	0.86	0.93	0.02
2006	1.03	0.88	0.74	1.13	0.64	0.42	3.07	0.49	0.48	-0.07
2007	1.00	1.03	1.02	1.01	0.80	0.91	1.05	0.85	0.69	0.59
2008	1.04	0.89	0.82	1.09	1.24	0.76	0.98	0.82	0.54	0.62
2009	1.00	0.97	0.98	1.10	1.17	0.68	0.74	0.97	1.25	0.51

Table 4-B. Betas of Different Indices – Nonoverlapping Time Intervals

Panel B : Values of two-year Betas
(sorted: highest to lowest based on one-year mean beta values)

Year	R10 NDTel	R07 ND100	R16 SpInfo	R06 NDcomp	R19 RS2000	R15 SPMatl	R02 DJTrans	R12 SP400	R13 SP600	R04 DJTotl
1990-91	1.33	1.53	1.00	1.29	1.18	1.06	1.39	1.18	1.16	1.01
1992-93	1.61	1.28	1.34	1.04	0.86	0.67	0.83	1.04	0.94	1.00
1994-95	1.25	1.00	0.90	0.98	0.90	1.16	1.37	0.98	1.00	0.99
1996-97	0.90	1.42	1.59	1.08	0.67	0.86	0.84	0.82	0.71	0.98
1998-99	1.61	1.49	1.36	1.46	1.14	0.88	0.92	1.18	1.09	1.02
2000-01	1.82	2.12	2.21	1.82	0.79	0.87	1.06	1.01	0.81	1.02
2002-03	1.73	1.52	1.73	1.32	1.00	1.06	0.86	0.87	0.85	0.98
2004-05	1.75	1.78	1.72	1.71	1.75	1.35	1.54	1.36	1.58	1.04
2006-07	1.58	1.31	1.37	1.28	1.33	1.10	0.85	1.09	1.24	1.01
2008-09	1.25	1.09	1.07	1.09	1.20	1.28	1.18	1.16	1.18	1.02

Panel B (Continued) : Values of two-year Betas
(sorted: highest to lowest based on one-year mean beta values)

Year	R18 RS1000	R11 SP100	R01 DJIA	R05 NYcomp	R14 SPAero	R17 SPHeal	R20 GoldSil	R09 NDInsr	R08 NDbank	R03 DJUtil
1990-91	1.02	0.96	0.93	0.96	0.90	1.09	-0.15	1.05	0.89	0.40
1992-93	0.98	0.92	0.80	0.95	0.67	1.13	0.35	0.60	0.67	0.92
1994-95	0.97	1.03	1.16	0.98	1.07	1.00	0.66	0.80	0.62	0.98
1996-97	0.93	1.06	1.00	0.90	0.89	1.14	0.57	0.57	0.59	0.50
1998-99	1.05	1.02	0.93	0.94	0.98	0.76	1.18	0.87	0.91	0.23
2000-01	1.00	1.07	0.90	0.78	0.79	0.14	0.06	0.27	0.36	0.03
2002-03	0.97	1.04	0.97	0.91	0.59	0.59	0.19	0.49	0.44	0.64
2004-05	1.11	0.89	0.99	0.99	0.65	0.65	1.01	0.95	0.94	0.25
2006-07	1.03	1.00	0.94	1.04	0.75	0.76	1.50	0.77	0.73	0.40
2008-09	1.01	0.93	0.89	1.09	1.16	0.70	0.84	0.77	0.77	0.57

Panel C : Values of four-year Betas
(sorted: highest to lowest based on one-year mean beta values)

	R10	R07	R16	R06	R19	R15	R02	R12	R13	R04
Year	NDTel	ND100	SpInfo	NDcomp	RS2000	SPMatl	DJTrans	SP400	SP600	DJTotl
1990-93	1.35	1.50	1.04	1.25	1.13	1.00	1.31	1.16	1.12	1.01
1994-97	1.02	1.28	1.35	1.04	0.74	0.94	1.03	0.88	0.81	0.94
1998-01	1.87	1.91	1.87	1.70	0.91	0.85	0.92	1.03	0.87	1.02
2002-05	1.73	1.56	1.72	1.38	1.11	1.10	0.96	0.94	0.96	0.99
2006-09	1.28	1.10	1.09	1.10	1.20	1.26	1.12	1.14	1.17	1.01

Panel C (Continued) : Values of four-year Betas
(sorted: highest to lowest based on one-year mean beta values)

	R18	R11	R01	R05	R14	R17	R20	R09	R08	R03
Year	RS1000	SP100	DJIA	NYcomp	SPAero	SPHeal	GoldSil	NDInsr	NDbank	DJUtil
1990-93	1.01	0.95	0.91	0.96	0.86	1.12	-0.11	0.98	0.84	0.47
1994-97	0.98	1.05	1.05	0.93	0.92	1.08	0.56	0.63	0.62	0.66
1998-01	1.02	1.06	0.90	0.83	0.81	0.42	0.59	0.50	0.53	0.11
2002-05	0.99	1.01	0.97	0.93	0.60	0.60	0.29	0.55	0.50	0.60
2006-09	1.02	0.94	0.90	1.09	1.12	0.70	0.89	0.76	0.76	0.58

Table 4-C. Betas of Different Indices – Nonoverlapping Time Intervals

Panel D : Values of five-year Betas
(sorted: highest to lowest based on one-year mean beta values)

	R10	R07	R16	R06	R19	R15	R02	R12	R13	R04
Year	NDTel	ND100	SpInfo	NDcomp	RS2000	SPMatl	DJTrans	SP400	SP600	DJTotl
1990-94	1.33	1.45	1.05	1.22	1.10	1.04	1.32	1.14	1.10	1.01
1995-99	1.33	1.42	1.40	1.30	0.97	0.90	0.91	1.05	0.96	1.01
2000-04	1.82	1.83	1.96	1.59	0.92	0.97	0.97	0.94	0.85	0.99
2005-09	1.29	1.14	1.12	1.12	1.22	1.27	1.16	1.15	1.19	1.02

Panel D (Continued): Values of five-year Betas
(sorted: highest to lowest based on one-year mean beta values)

	R18	R11	R01	R05	R14	R17	R20	R09	R08	R03
Year	RS1000	SP100	DJIA	NYcomp	SPAero	SPHeal	GoldSil	NDInsr	NDbank	DJUtil
1990-94	1.01	0.96	0.94	0.96	0.85	1.10	-0.07	0.96	0.80	0.53
1995-99	1.01	1.04	0.97	0.93	0.99	0.91	1.01	0.75	0.79	0.35
2000-04	1.00	1.05	0.93	0.85	0.69	0.36	0.15	0.40	0.41	0.34
2005-09	1.02	0.94	0.91	1.08	1.11	0.69	0.93	0.77	0.77	0.56

Panel E : Values of ten-year Betas
(sorted: highest to lowest based on one-year mean beta values)

	R18	R11	R01	R05	R14	R17	R20	R09	R08	R03
Year	RS1000	SP100	DJIA	NYcomp	SPAero	SPHeal	GoldSil	NDInsr	NDbank	DJUtil
1990-99	1.01	1.01	0.96	0.94	0.90	0.99	0.50	0.82	0.78	0.44
2000-09	1.01	0.99	0.92	0.96	0.89	0.52	0.54	0.58	0.58	0.45

Panel E (Continued) : Values of ten-year Betas
(sorted: highest to lowest based on one-year mean beta values)

	R10	R07	R16	R06	R19	R15	R02	R12	R13	R04
Year	NDTel	ND100	SpInfo	NDcomp	RS2000	SPMatl	DJTrans	SP400	SP600	DJTotl
1990-99	1.35	1.45	1.27	1.27	1.00	0.93	1.07	1.07	1.00	1.00
2000-09	1.56	1.49	1.55	1.36	1.07	1.12	1.06	1.04	1.01	1.01

Panel F : Values of Betas for the whole 20-year period
(sorted: highest to lowest based on one-year mean beta values)

	R10	R07	R16	R06	R19	R15	R02	R12	R13	R04
Year	NDTel	ND100	SpInfo	NDcomp	RS2000	SPMatl	DJTrans	SP400	SP600	DJTotl
1990-09	1.49	1.49	1.45	1.33	1.03	1.02	1.05	1.04	0.99	1.00

Panel F (Continued) : Values of the Betas for the whole 20-year period
(sorted: highest to lowest based on one-year mean beta values)

	R18	R11	R01	R05	R14	R17	R20	R09	R08	R03
Year	RS1000	SP100	DJIA	NYcomp	SPAero	SPHeal	GoldSil	NDInsr	NDbank	DJUtil
1990-09	1.01	1.00	0.93	0.95	0.88	0.72	0.48	0.67	0.67	0.43

Table 4-A shows the one-year beta values for the 20 indices for each of the 20 years, 1990 through 2009. The indices are sorted on the basis of the mean of the 20 one-year values. The beta values based on the two-year and four-year non-overlapping intervals are given in Table 4-B. Table 4-C contains the beta values based on the five-year and ten-year non-overlapping intervals as well as the whole 20-year period.

6. Unit Root Tests for Betas

A fundamental assumption underlying the Capital Asset Pricing Model is that the betas of the individual stocks or portfolios or indices remain constant. In Fama and Macbeth (1973), the beta values are calculated for periods of four years or longer so as to eliminate the estimation errors. A relevant question at this stage is whether the beta values are affected by the length of the estimation period. The means of the betas calculated from the individual values estimated using intervals of different lengths are given in Table 5.

Table 5. Means of Betas of Different Indices For Time Intervals of Different Lengths

Index	one-year interval	two-year interval	four-year interval	five-year interval	ten-year interval	20-year period
R10_NDTel	1.491	1.483	1.449	1.442	1.458	1.491
R07_ND100	1.445	1.456	1.471	1.459	1.471	1.489
R16_SPInfo	1.430	1.429	1.415	1.382	1.409	1.446
R06_NDComp	1.309	1.308	1.294	1.308	1.314	1.330
R19_RS2000	1.107	1.081	1.018	1.053	1.034	1.026
R15_SPMatl	1.103	1.028	1.029	1.044	1.025	1.021
R02_DJTrans	1.083	1.083	1.070	1.091	1.067	1.047
R12_SP400	1.080	1.069	1.031	1.071	1.057	1.041
R13_SP600	1.077	1.054	0.985	1.024	1.006	0.989
R04_DJTotal	1.009	1.007	0.997	1.007	1.005	1.003
R18_RS1000	1.006	1.008	1.004	1.009	1.008	1.007
R11_SP100	0.992	0.991	1.004	0.995	1.001	1.005
R01_DJIA	0.962	0.952	0.947	0.938	0.937	0.933
R05_NYComp	0.961	0.955	0.947	0.957	0.951	0.946
R14_SPAero	0.873	0.844	0.865	0.906	0.896	0.883
R17_SPHealth	0.757	0.796	0.784	0.765	0.757	0.720
R20_GoldSil	0.738	0.622	0.447	0.505	0.518	0.484
R09_NDInsr	0.696	0.712	0.686	0.720	0.699	0.668
R08_NDBank	0.639	0.690	0.650	0.691	0.678	0.666
R03_DJUtil	0.461	0.493	0.484	0.445	0.445	0.430

One can see from Table 5 that the mean of each index is relatively constant (across the row), though the lengths of estimation intervals are significantly different from each other. Does this imply that the individual beta values are time-invariant or at least stationary? According to Jagannathan and Wang (1996), a primary weakness of the Capital Asset Pricing Model (CAPM) given by equation (1) is that it assumes that β_i remains constant over time. The graphs in Figures 1 through 5 do show that the betas of the indices vary widely from one year to the next. In this context, the following two hypotheses are tested.

Hypothesis H1**:** The time-series of the one-year betas of each index is stationary.

Hypothesis H2**:** The time-series of the one-year betas of the indices grouped in each quintile are co-integrated.

The unit root tests are done only for the set of the one-year betas given in Table 4-A, that are estimated using one-year intervals. Since there are fewer values of betas in other cases (given in Tables 4-B, and 4-C), the unit root tests will not be reliable in those cases. The results of the unit root tests for the one-year betas are given in Table 6. In all cases, the augmented Dickey-Fuller unit root test for the level series (no first or second differences) with no intercept or trend option is used. All indices except the Gold and Silver index (series R20) have a unit root. In other words, all indices except the Gold and Silver index are non-stationary. This result makes hypothesis H1 invalid.

Table 6. Unit Root Tests for the One-year Betas of Different Indices

Index	t-stat	p-value	unit root?
R10_NDTel	−0.581	0.45	Yes
R07_ND100	−1.102	0.24	Yes
R16_SPInfo	−1.051	0.25	Yes
R06_NDComp	−0.909	0.31	Yes
R19_RS2000	−0.699	0.40	Yes
R15_SPMatl	−0.741	0.36	Yes
R02_DJTrans	0.109	0.70	Yes
R12_SP400	−0.242	0.59	Yes
R13_SP600	−0.652	0.42	Yes
R04_DJTotal	−0.138	0.62	Yes
R18_RS1000	0.124	0.71	Yes
R11_SP100	−0.152	0.62	Yes
R01_DJIA	−0.291	0.57	Yes
R05_NYComp	0.073	0.69	Yes
R14_SPAero	−0.228	0.59	Yes
R17_SPHealth	−1.221	0.19	Yes
R20_GoldSil	−2.286	0.025	No
R09_NDInsr	−0.276	0.57	Yes
R08_NDBank	0.324	0.76	Yes
R03_DJUtil	−1.307	0.17	Yes

The results related to the Johansen co-integration tests are given in Table 7. The results in Table 7 are interesting. The indices in the middle quintile which have betas close to 1 are not co-integrated, whereas the indices in other quintiles are co-integrated. Perhaps, the returns of S&P 600 Small Cap Index follow a pattern different from that of the three other indices in the middle quintile. These results prove that hypothesis H2 is valid in four of the five cases.

Table 7. Co-integration Tests for One-year Betas Grouped into Quintiles

Quintile	Indices in the Quintile	Max-Eigen Statistic	p- value	At least One Co-integrating Equation?
1	R10_NDTEL, R07_ND100 R16_SPINFO, R06_NDCOMP	26.75	0.022	Yes
2	R19_RS2000, R15_SPMATL R02_DJTRANS, R12_SP400	24.05	0.052	Yes
3	R13_SP600, R04_DJTOTAL R18_RS1000, R11_SP100	8.59	0.97	No
4	R01_DJIA, R05_NYCOMP R14_SPAERO, R17_SPHEALTH	25.11	0.037	Yes
5	R20_GOLDSIL, R09_NDINSR R08_NDBANK,R03_DJUTIL	28.30	0.013	Yes

Table 8-A. Values of One-Year Betas and Standard Deviations of the Error Terms

Estimates for the one-year intervals covering the years 1990 through1994										
	1990		1991		1992		1993		1994	
Index	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)
R01	0.962	0.0092	0.905	0.0097	0.767	0.0158	0.838	0.0111	1.193	0.0089
R02	1.245	0.0421	1.445	0.0483	1.070	0.0361	0.416	0.0260	1.290	0.0231
R03	0.394	0.0354	0.375	0.0274	1.076	0.0244	0.666	0.0332	0.867	0.0307
R04	1.032	0.0044	0.976	0.0034	0.940	0.0085	1.042	0.0059	0.952	0.0037
R05	0.966	0.0022	0.945	0.0021	0.941	0.0027	0.975	0.0033	0.967	0.0029
R06	1.305	0.0221	1.125	0.0206	0.799	0.0401	1.439	0.0242	0.953	0.0169
R07	1.559	0.0227	1.414	0.0341	1.036	0.0402	1.681	0.0324	1.126	0.0244
R08	0.815	0.0317	0.721	0.0311	0.689	0.0237	0.695	0.0414	0.526	0.0316
R09	1.248	0.0349	0.710	0.0245	0.614	0.0291	0.634	0.0310	0.798	0.0185
R10	1.475	0.0262	0.996	0.0323	1.004	0.0374	2.498	0.0366	1.103	0.0266
R11	0.963	0.0046	0.955	0.0066	0.923	0.0050	0.902	0.0044	1.012	0.0056
R12	1.219	0.0181	1.069	0.0118	0.991	0.0220	1.123	0.0178	0.951	0.0112
R13	1.194	0.0255	0.943	0.0220	0.696	0.0421	1.333	0.0245	0.940	0.0232
R14	1.021	0.0241	0.773	0.0228	0.954	0.0353	0.160	0.0224	0.701	0.0230
R15	1.124	0.0213	0.954	0.0297	0.826	0.0227	0.421	0.0238	1.283	0.0294
R16	1.128	0.0396	0.970	0.0394	0.973	0.0357	1.874	0.0356	1.228	0.0362
R17	1.031	0.0247	1.211	0.0165	1.419	0.0261	0.644	0.0483	1.028	0.0376
R18	1.020	0.0030	0.990	0.0018	1.002	0.0034	1.007	0.0042	0.976	0.0018
R19	1.226	0.0252	0.985	0.0276	0.699	0.0424	1.118	0.0211	0.872	0.0178
R20	0.128	0.0971	-0.554	0.0795	0.105	0.0742	0.493	0.1012	0.045	0.0873
Estimates for the one-year intervals covering the years 1995 through1999										
	1995		1996		1997		1998		1999	
Index	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)
R01	1.489	0.0117	0.863	0.0120	1.089	0.0101	0.960	0.0216	0.876	0.0260
R02	1.310	0.0337	0.913	0.0308	0.781	0.0314	0.931	0.0358	0.893	0.0429
R03	0.712	0.0330	0.791	0.0322	0.348	0.0291	0.248	0.0402	0.141	0.0453
R04	0.961	0.0058	0.952	0.0094	0.916	0.0094	1.059	0.0048	1.055	0.0075
R05	1.035	0.0033	0.893	0.0038	0.899	0.0060	0.986	0.0060	0.816	0.0125
R06	0.723	0.0266	1.147	0.0374	1.066	0.0373	1.370	0.0326	1.780	0.0525
R07	0.301	0.0373	1.457	0.0325	1.445	0.0507	1.346	0.0554	1.919	0.0603
R08	0.095	0.0240	0.505	0.0119	0.595	0.0346	1.078	0.0285	0.477	0.0359
R09	0.375	0.0193	0.773	0.0293	0.466	0.0332	1.023	0.0195	0.464	0.0620
R10	1.395	0.0417	0.788	0.0388	0.904	0.0431	1.565	0.0399	1.808	0.0606
R11	1.143	0.0055	1.026	0.0032	1.085	0.0071	0.992	0.0090	1.117	0.0067
R12	1.063	0.0171	0.861	0.0222	0.799	0.0265	1.294	0.0258	0.889	0.0335
R13	1.216	0.0276	0.816	0.0321	0.659	0.0393	1.234	0.0213	0.738	0.0414
R14	1.923	0.0170	0.504	0.0163	1.111	0.0351	1.157	0.0580	0.531	0.0674
R15	1.860	0.0298	0.769	0.0306	0.919	0.0245	0.800	0.0384	1.173	0.0748
R16	0.153	0.0524	1.704	0.0411	1.572	0.0559	1.249	0.0456	1.678	0.0676
R17	0.700	0.0228	1.305	0.0196	1.053	0.0352	0.806	0.0300	0.573	0.0596
R18	0.980	0.0032	0.993	0.0034	0.973	0.0040	1.030	0.0027	1.004	0.0035
R19	1.073	0.0241	0.793	0.0368	0.614	0.0390	1.230	0.0222	0.945	0.0422
R20	2.869	0.0806	0.510	0.0807	0.663	0.1169	1.545	0.1722	0.255	0.1252

Table 8-A (Continued). Values of One-Year Betas and Standard Deviations of the Error Terms

Estimates for the one-year intervals covering the years 2000 through 2004										
	2000		2001		2002		2003		2004	
Index	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)
R01	0.839	0.0269	0.944	0.0226	1.015	0.0167	0.975	0.0104	0.902	0.0099
R02	0.846	0.0774	1.211	0.0575	0.691	0.0425	1.459	0.0349	1.036	0.0347
R03	-0.093	0.0705	0.101	0.0551	0.438	0.0656	0.970	0.0405	0.517	0.0191
R04	0.942	0.0229	1.049	0.0052	0.947	0.0054	1.004	0.0045	1.122	0.0031
R05	0.787	0.0200	0.763	0.0107	0.852	0.0093	1.077	0.0075	1.065	0.0053
R06	1.366	0.1163	2.170	0.0435	1.375	0.0333	0.974	0.0229	1.791	0.0193
R07	1.582	0.1072	2.532	0.0549	1.663	0.0455	0.934	0.0247	1.683	0.0218
R08	0.412	0.0577	0.312	0.0281	0.346	0.0285	0.730	0.0211	0.907	0.0200
R09	0.606	0.0606	0.017	0.0350	0.414	0.0375	0.764	0.0137	1.028	0.0146
R10	1.272	0.1182	2.242	0.0610	1.792	0.0802	0.894	0.0334	1.968	0.0267
R11	1.054	0.0124	1.084	0.0070	1.076	0.0102	0.965	0.0069	0.927	0.0054
R12	0.915	0.0380	1.076	0.0264	0.811	0.0250	1.005	0.0203	1.321	0.0107
R13	0.559	0.0707	0.988	0.0328	0.729	0.0426	1.145	0.0242	1.514	0.0221
R14	0.552	0.0902	0.949	0.0686	0.266	0.0532	1.707	0.0356	0.607	0.0340
R15	0.914	0.0781	0.839	0.0454	1.027	0.0397	1.429	0.0281	1.154	0.0330
R16	1.772	0.0842	2.540	0.0639	1.994	0.0508	0.960	0.0244	1.766	0.0293
R17	0.013	0.0590	0.217	0.0450	0.623	0.0210	0.387	0.0263	0.909	0.0263
R18	1.011	0.0094	1.020	0.0023	0.978	0.0025	0.984	0.0024	1.048	0.0013
R19	0.441	0.0829	1.048	0.0357	0.876	0.0431	1.220	0.0254	1.760	0.0212
R20	0.045	0.0776	0.082	0.0760	0.191	0.1238	0.444	0.0719	0.383	0.0987
Estimates for the one-year intervals covering the years 2005 through 2009										
	2005		2006		2007		2008		2009	
Index	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)
R01	1.077	0.0070	0.739	0.0065	1.016	0.0089	0.823	0.0146	0.975	0.0120
R02	1.946	0.0274	0.666	0.0486	0.915	0.0309	1.116	0.0361	1.478	0.0292
R03	0.019	0.0374	-0.065	0.0315	0.590	0.0324	0.616	0.0409	0.513	0.0363
R04	1.104	0.0029	1.129	0.0051	0.999	0.0036	1.039	0.0053	0.959	0.0071
R05	0.931	0.0100	1.129	0.0100	1.009	0.0066	1.093	0.0140	1.095	0.0134
R06	1.652	0.0164	1.905	0.0165	1.120	0.0164	1.235	0.0190	0.893	0.0236
R07	1.868	0.0217	2.132	0.0188	1.131	0.0200	1.300	0.0299	0.783	0.0245
R08	0.926	0.0233	0.475	0.0077	0.689	0.0261	0.542	0.0699	1.247	0.0364
R09	0.857	0.0175	0.489	0.0106	0.847	0.0221	0.816	0.0494	0.974	0.0367
R10	1.547	0.0274	2.999	0.0575	1.075	0.0348	1.494	0.0335	1.002	0.0484
R11	0.851	0.0045	0.881	0.0051	1.029	0.0054	0.888	0.0095	0.973	0.0071
R12	1.404	0.0098	1.436	0.0178	1.004	0.0146	1.331	0.0175	1.039	0.0258
R13	1.618	0.0156	1.647	0.0253	1.083	0.0160	1.243	0.0239	1.256	0.0386
R14	0.699	0.0187	0.641	0.0197	0.801	0.0245	1.236	0.0376	1.168	0.0451
R15	1.524	0.0322	1.575	0.0232	0.999	0.0226	1.229	0.0397	1.250	0.0347
R16	1.713	0.0180	2.138	0.0235	1.196	0.0234	1.271	0.0267	0.724	0.0268
R17	0.451	0.0209	0.424	0.0227	0.912	0.0230	0.757	0.0310	0.680	0.0384
R18	1.029	0.0012	1.032	0.0018	1.004	0.0020	1.042	0.0033	0.997	0.0028
R19	1.723	0.0164	1.875	0.0255	1.117	0.0184	1.301	0.0243	1.221	0.0326
R20	1.719	0.0816	3.073	0.0940	1.046	0.0778	0.978	0.1713	0.737	0.1344

Table 8-B. Values of Three-Year Betas and Standard Deviations of the Error Terms

Estimates for the three-year intervals covering the years 1990 through 1996										
	1990-1992		1991-1993		1992-1994		1993-1995		1994-1996	
Index	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)
R01	0.912	0.0116	0.859	0.0122	1.016	0.0126	1.096	0.0114	1.045	0.0119
R02	1.361	0.0413	1.299	0.0372	1.133	0.0300	1.171	0.0291	1.192	0.0286
R03	0.456	0.0289	0.512	0.0280	0.927	0.0289	0.909	0.0314	0.907	0.0307
R04	1.013	0.0061	0.983	0.0060	0.970	0.0061	0.976	0.0051	0.962	0.0064
R05	0.962	0.0025	0.951	0.0027	0.967	0.0030	0.975	0.0032	0.948	0.0034
R06	1.244	0.0296	1.140	0.0286	1.015	0.0278	1.040	0.0223	1.046	0.0268
R07	1.494	0.0323	1.434	0.0346	1.196	0.0314	1.113	0.0312	1.193	0.0317
R08	0.846	0.0384	0.660	0.0320	0.649	0.0338	0.606	0.0323	0.574	0.0238
R09	1.002	0.0328	0.665	0.0274	0.743	0.0268	0.769	0.0228	0.783	0.0223
R10	1.292	0.0352	1.092	0.0377	1.398	0.0377	1.362	0.0394	1.060	0.0350
R11	0.954	0.0052	0.944	0.0052	0.967	0.0050	1.013	0.0051	1.031	0.0047
R12	1.165	0.0176	1.092	0.0171	1.009	0.0169	0.984	0.0152	0.934	0.0165
R13	1.113	0.0330	0.954	0.0295	0.973	0.0304	1.022	0.0246	0.931	0.0264
R14	0.903	0.0269	0.718	0.0274	0.703	0.0275	0.913	0.0240	0.848	0.0223
R15	1.033	0.0240	0.864	0.0246	1.004	0.0252	1.023	0.0290	1.003	0.0304
R16	0.998	0.0372	0.997	0.0372	1.243	0.0355	1.056	0.0416	1.221	0.0437
R17	1.140	0.0283	1.301	0.0347	1.006	0.0389	1.005	0.0378	1.105	0.0272
R18	1.012	0.0029	0.998	0.0032	0.992	0.0032	0.993	0.0031	0.992	0.0028
R19	1.133	0.0332	0.964	0.0300	0.892	0.0281	0.909	0.0207	0.857	0.0258
R20	-0.131	0.0803	-0.432	0.0871	0.266	0.0890	0.485	0.0922	0.600	0.0809
Estimates for the three-year intervals covering the years 1995 through 2001										
	1995-1997		1996-1998		1997-1999		1998-2000		1999-2001	
Index	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)
R01	1.037	0.0124	0.979	0.0157	0.974	0.0201	0.896	0.0241	0.899	0.0239
R02	0.873	0.0309	0.886	0.0335	0.894	0.0378	0.830	0.0535	0.960	0.0593
R03	0.520	0.0307	0.360	0.0334	0.269	0.0377	0.047	0.0541	0.025	0.0604
R04	0.931	0.0079	1.000	0.0084	1.015	0.0080	1.020	0.0138	1.017	0.0137
R05	0.907	0.0044	0.946	0.0062	0.932	0.0095	0.859	0.0155	0.764	0.0150
R06	1.062	0.0326	1.242	0.0350	1.333	0.0459	1.522	0.0754	1.892	0.0775
R07	1.342	0.0407	1.383	0.0477	1.454	0.0588	1.637	0.0779	2.173	0.0782
R08	0.556	0.0253	0.852	0.0349	0.842	0.0405	0.659	0.0471	0.318	0.0419
R09	0.566	0.0272	0.816	0.0295	0.756	0.0423	0.712	0.0519	0.282	0.0528
R10	0.932	0.0400	1.270	0.0442	1.396	0.0522	1.672	0.0835	1.984	0.0884
R11	1.068	0.0057	1.023	0.0071	1.037	0.0088	1.050	0.0103	1.100	0.0095
R12	0.837	0.0211	1.082	0.0260	1.075	0.0294	1.031	0.0351	0.938	0.0330
R13	0.739	0.0317	0.994	0.0337	0.971	0.0364	0.853	0.0508	0.749	0.0495
R14	0.978	0.0299	1.032	0.0415	1.018	0.0533	0.745	0.0733	0.690	0.0741
R15	0.922	0.0285	0.822	0.0312	0.890	0.0498	0.884	0.0640	0.935	0.0643
R16	1.484	0.0495	1.404	0.0477	1.403	0.0572	1.607	0.0690	2.162	0.0728
R17	1.123	0.0261	0.958	0.0289	0.853	0.0445	0.462	0.0550	0.179	0.0555
R18	0.980	0.0034	1.007	0.0035	1.008	0.0035	1.013	0.0058	1.012	0.0057
R19	0.698	0.0322	0.975	0.0351	0.990	0.0371	0.882	0.0559	0.807	0.0557
R20	0.742	0.0925	1.109	0.1244	1.015	0.1360	0.837	0.1281	0.133	0.0910

Table8-B. (Continued) Values of Three-Year Betas and Standard Deviations of the Error Terms

Estimates for the three-year intervals covering the years 2000 through 2006										
	2000-2002		2001-2003		2002-2004		2003-2005		2004-2006	
Index	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)
R01	0.942	0.0215	0.961	0.0166	0.962	0.0129	0.999	0.0090	0.956	0.0085
R02	0.915	0.0585	0.994	0.0459	0.881	0.0377	1.426	0.0323	1.295	0.0379
R03	0.209	0.0674	0.456	0.0554	0.648	0.0454	0.592	0.0334	0.155	0.0292
R04	0.981	0.0134	1.000	0.0054	0.981	0.0047	1.054	0.0036	1.109	0.0037
R05	0.809	0.0141	0.859	0.0103	0.926	0.0082	1.028	0.0076	1.022	0.0084
R06	1.639	0.0738	1.639	0.0397	1.353	0.0262	1.371	0.0214	1.731	0.0168
R07	1.935	0.0743	1.901	0.0501	1.531	0.0329	1.375	0.0244	1.822	0.0204
R08	0.354	0.0382	0.392	0.0256	0.466	0.0239	0.864	0.0209	0.841	0.0179
R09	0.331	0.0453	0.309	0.0318	0.528	0.0246	0.811	0.0152	0.822	0.0147
R10	1.798	0.0873	1.936	0.0633	1.743	0.0533	1.421	0.0321	2.062	0.0394
R11	1.070	0.0096	1.054	0.0081	1.026	0.0079	0.942	0.0056	0.904	0.0055
R12	0.942	0.0299	0.944	0.0235	0.902	0.0194	1.154	0.0144	1.336	0.0137
R13	0.787	0.0494	0.896	0.0332	0.903	0.0310	1.328	0.0206	1.564	0.0206
R14	0.589	0.0712	0.738	0.0572	0.596	0.0459	1.150	0.0321	0.656	0.0237
R15	0.918	0.0545	0.978	0.0375	1.060	0.0334	1.390	0.0295	1.398	0.0282
R16	2.109	0.0675	2.024	0.0537	1.718	0.0388	1.373	0.0255	1.794	0.0232
R17	0.342	0.0478	0.453	0.0323	0.613	0.0238	0.512	0.0239	0.593	0.0226
R18	1.002	0.0056	0.999	0.0025	0.989	0.0022	1.008	0.0018	1.031	0.0015
R19	0.830	0.0561	1.015	0.0343	1.058	0.0316	1.476	0.0211	1.758	0.0203
R20	0.072	0.0925	0.173	0.0890	0.174	0.0963	0.762	0.0821	1.447	0.0897
Estimates for the three-year intervals covering the years 2005 through 2008										
	2005-2007		2006-2008							
Index	Beta	Std(ε)	Beta	Std(ε)						
R01	0.997	0.0079	0.869	0.0105						
R02	1.183	0.0369	0.927	0.0386						
R03	0.266	0.0327	0.644	0.0343						
R04	1.052	0.0040	1.038	0.0046						
R05	1.006	0.0086	1.091	0.0101						
R06	1.401	0.0177	1.203	0.0184						
R07	1.495	0.0229	1.266	0.0249						
R08	0.779	0.0222	0.521	0.0424						
R09	0.786	0.0170	0.683	0.0317						
R10	1.598	0.0429	1.456	0.0439						
R11	0.959	0.0056	0.930	0.0071						
R12	1.175	0.0152	1.193	0.0181						
R13	1.347	0.0196	1.128	0.0232						
R14	0.738	0.0199	1.130	0.0278						
R15	1.249	0.0262	1.244	0.0289						
R16	1.487	0.0232	1.270	0.0254						
R17	0.660	0.0217	0.720	0.0249						
R18	1.013	0.0018	1.029	0.0024						
R19	1.451	0.0208	1.198	0.0242						
R20	1.540	0.0819	0.989	0.1161						

Table 8-C. Values of Five-Year Betas and Standard Deviations of the Error Terms

Estimates for the five-year intervals covering the years 1990 through 1998										
	1990-1994		1991-1995		1992-1996		1993-1997		1994-1998	
Index	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)
R01	0.945	0.0115	0.960	0.0124	0.988	0.0125	1.029	0.0118	1.005	0.0143
R02	1.324	0.0362	1.314	0.0342	1.065	0.0300	0.971	0.0297	0.973	0.0318
R03	0.534	0.0301	0.668	0.0296	0.886	0.0294	0.652	0.0311	0.479	0.0335
R04	1.008	0.0056	0.977	0.0056	0.960	0.0066	0.944	0.0068	0.993	0.0071
R05	0.965	0.0027	0.960	0.0029	0.945	0.0033	0.929	0.0040	0.951	0.0052
R06	1.218	0.0262	1.080	0.0262	1.024	0.0287	1.052	0.0281	1.194	0.0302
R07	1.453	0.0304	1.286	0.0334	1.222	0.0326	1.299	0.0357	1.326	0.0419
R08	0.800	0.0371	0.638	0.0308	0.542	0.0285	0.614	0.0299	0.803	0.0322
R09	0.962	0.0295	0.707	0.0243	0.704	0.0256	0.627	0.0259	0.799	0.0260
R10	1.327	0.0368	1.133	0.0370	1.094	0.0389	1.048	0.0400	1.280	0.0401
R11	0.959	0.0051	0.975	0.0055	1.010	0.0049	1.039	0.0054	1.024	0.0064
R12	1.141	0.0165	1.048	0.0165	0.938	0.0176	0.885	0.0187	1.064	0.0217
R13	1.104	0.0293	0.961	0.0280	0.894	0.0294	0.821	0.0287	0.988	0.0299
R14	0.845	0.0258	0.840	0.0261	0.813	0.0253	0.856	0.0276	1.012	0.0365
R15	1.035	0.0250	0.960	0.0272	0.907	0.0275	0.894	0.0283	0.866	0.0316
R16	1.050	0.0371	0.972	0.0400	1.269	0.0402	1.375	0.0443	1.318	0.0464
R17	1.096	0.0347	1.209	0.0336	1.187	0.0333	1.092	0.0337	0.959	0.0289
R18	1.008	0.0030	0.995	0.0030	0.991	0.0032	0.984	0.0033	1.004	0.0031
R19	1.101	0.0282	0.935	0.0269	0.822	0.0285	0.749	0.0277	0.952	0.0299
R20	-0.070	0.0875	-0.072	0.0862	0.445	0.0848	0.436	0.0947	1.006	0.1091
Estimates for the five-year intervals covering the years 1995 through 2003										
	1995-1999		1996-2000		1997-2001		1998-2002		1999-2003	
Index	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)
R01	0.972	0.0175	0.925	0.0201	0.926	0.0216	0.925	0.0221	0.931	0.0202
R02	0.911	0.0351	0.849	0.0456	0.918	0.0506	0.847	0.0521	0.919	0.0519
R03	0.346	0.0357	0.164	0.0465	0.159	0.0513	0.219	0.0577	0.284	0.0590
R04	1.007	0.0077	0.994	0.0121	1.007	0.0117	1.004	0.0112	0.998	0.0110
R05	0.930	0.0078	0.873	0.0123	0.845	0.0132	0.836	0.0134	0.827	0.0134
R06	1.295	0.0407	1.385	0.0629	1.578	0.0657	1.623	0.0640	1.653	0.0635
R07	1.418	0.0508	1.553	0.0661	1.802	0.0719	1.860	0.0697	1.899	0.0663
R08	0.788	0.0345	0.669	0.0415	0.578	0.0437	0.470	0.0417	0.369	0.0360
R09	0.755	0.0362	0.672	0.0440	0.498	0.0470	0.476	0.0476	0.367	0.0442
R10	1.333	0.0499	1.441	0.0710	1.720	0.0750	1.868	0.0782	1.876	0.0786
R11	1.038	0.0073	1.049	0.0088	1.062	0.0092	1.067	0.0095	1.073	0.0092
R12	1.050	0.0255	0.968	0.0309	0.991	0.0316	0.981	0.0314	0.909	0.0288
R13	0.958	0.0334	0.815	0.0444	0.832	0.0451	0.834	0.0455	0.792	0.0435
R14	0.988	0.0455	0.782	0.0594	0.841	0.0652	0.671	0.0682	0.650	0.0653
R15	0.898	0.0427	0.875	0.0518	0.843	0.0542	0.864	0.0561	0.989	0.0539
R16	1.396	0.0532	1.589	0.0608	1.798	0.0674	1.895	0.0658	1.978	0.0628
R17	0.908	0.0372	0.648	0.0476	0.529	0.0508	0.489	0.0485	0.351	0.0461
R18	1.006	0.0033	1.003	0.0050	1.009	0.0049	1.006	0.0047	1.001	0.0046
R19	0.969	0.0340	0.824	0.0485	0.857	0.0490	0.899	0.0493	0.890	0.0480
R20	1.006	0.1154	0.739	0.1156	0.554	0.1166	0.433	0.1185	0.161	0.0933

Table 8-C. (Continued) Values of Five-Year Betas and Standard Deviations of the Error Terms

Estimates for the five-year intervals covering the years 2000 through 2008										
	2000-2004		2001-2005		2002-2006		2003-2007		2004-2008	
Index	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)
R01	0.927	0.0178	0.956	0.0142	0.964	0.0109	0.975	0.0088	0.873	0.0100
R02	0.969	0.0499	1.051	0.0407	0.941	0.0387	1.249	0.0354	1.020	0.0363
R03	0.343	0.0564	0.464	0.0476	0.570	0.0412	0.534	0.0322	0.619	0.0326
R04	0.994	0.0106	1.011	0.0047	0.995	0.0046	1.048	0.0039	1.050	0.0041
R05	0.850	0.0122	0.874	0.0094	0.935	0.0088	1.032	0.0077	1.080	0.0092
R06	1.594	0.0587	1.637	0.0324	1.389	0.0230	1.345	0.0199	1.261	0.0188
R07	1.831	0.0601	1.885	0.0405	1.570	0.0287	1.356	0.0235	1.323	0.0240
R08	0.408	0.0326	0.431	0.0253	0.497	0.0223	0.834	0.0220	0.590	0.0354
R09	0.397	0.0366	0.372	0.0274	0.546	0.0210	0.805	0.0160	0.722	0.0263
R10	1.820	0.0721	1.922	0.0511	1.789	0.0497	1.469	0.0391	1.461	0.0382
R11	1.047	0.0085	1.035	0.0073	1.011	0.0071	0.956	0.0057	0.916	0.0064
R12	0.942	0.0253	0.982	0.0198	0.951	0.0185	1.140	0.0153	1.220	0.0153
R13	0.846	0.0410	0.959	0.0292	0.980	0.0282	1.308	0.0208	1.193	0.0218
R14	0.685	0.0602	0.735	0.0468	0.609	0.0369	1.013	0.0284	1.063	0.0274
R15	0.971	0.0460	1.002	0.0354	1.110	0.0311	1.289	0.0271	1.250	0.0295
R16	1.962	0.0564	1.982	0.0441	1.725	0.0325	1.371	0.0252	1.313	0.0251
R17	0.363	0.0401	0.476	0.0288	0.594	0.0225	0.593	0.0231	0.703	0.0240
R18	1.003	0.0044	1.003	0.0022	0.993	0.0020	1.009	0.0018	1.031	0.0021
R19	0.923	0.0462	1.080	0.0302	1.137	0.0286	1.437	0.0217	1.268	0.0227
R20	0.151	0.0880	0.237	0.0886	0.393	0.0934	1.003	0.0824	0.972	0.1046

Table 8-D. Values of Ten-Year Betas and Standard Deviations of the Error Terms

Estimates for the ten-year intervals covering the years 1990 through 2003										
	1990-1999		1991-2000		1992-2001		1993-2002		1994-2003	
Index	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)
R01	0.956	0.0147	0.935	0.0165	0.938	0.0176	0.949	0.0177	0.951	0.0176
R02	1.071	0.0364	0.976	0.0410	0.946	0.0413	0.887	0.0422	0.926	0.0429
R03	0.443	0.0330	0.310	0.0399	0.297	0.0431	0.327	0.0467	0.362	0.0478
R04	1.004	0.0067	0.989	0.0094	0.998	0.0095	0.989	0.0093	0.991	0.0092
R05	0.939	0.0060	0.897	0.0090	0.864	0.0097	0.861	0.0100	0.872	0.0105
R06	1.265	0.0340	1.297	0.0481	1.473	0.0510	1.469	0.0504	1.449	0.0506
R07	1.451	0.0417	1.480	0.0522	1.691	0.0561	1.701	0.0563	1.664	0.0565
R08	0.775	0.0357	0.654	0.0369	0.573	0.0370	0.530	0.0368	0.540	0.0352
R09	0.821	0.0333	0.677	0.0356	0.538	0.0378	0.515	0.0381	0.525	0.0373
R10	1.353	0.0437	1.353	0.0564	1.602	0.0601	1.672	0.0635	1.639	0.0632
R11	1.009	0.0066	1.029	0.0074	1.052	0.0074	1.058	0.0077	1.053	0.0080
R12	1.070	0.0217	0.990	0.0246	0.980	0.0255	0.946	0.0259	0.948	0.0260
R13	0.999	0.0316	0.852	0.0371	0.844	0.0378	0.828	0.0378	0.842	0.0378
R14	0.900	0.0370	0.794	0.0457	0.839	0.0496	0.729	0.0518	0.784	0.0531
R15	0.931	0.0352	0.895	0.0413	0.857	0.0427	0.865	0.0441	0.904	0.0447
R16	1.270	0.0463	1.418	0.0523	1.697	0.0556	1.758	0.0566	1.716	0.0566
R17	0.990	0.0358	0.810	0.0421	0.652	0.0440	0.640	0.0429	0.621	0.0410
R18	1.005	0.0032	1.001	0.0041	1.005	0.0041	1.000	0.0040	1.000	0.0039
R19	1.000	0.0315	0.851	0.0392	0.851	0.0398	0.863	0.0397	0.886	0.0402
R20	0.499	0.1037	0.502	0.1024	0.536	0.1014	0.420	0.1064	0.438	0.1032

Estimates for the ten-year intervals covering the years 1995 through 2008										
	1995-2004		1996-2005		1997-2006		1998-2007		1999-2008	
Index	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)	Beta	Std(ε)
R01	0.941	0.0176	0.939	0.0172	0.938	0.0170	0.930	0.0167	0.911	0.0160
R02	0.905	0.0434	0.921	0.0436	0.920	0.0449	0.926	0.0448	0.954	0.0445
R03	0.333	0.0468	0.313	0.0472	0.290	0.0470	0.293	0.0473	0.402	0.0479
R04	0.995	0.0093	0.998	0.0092	1.002	0.0089	1.013	0.0084	1.017	0.0083
R05	0.870	0.0106	0.869	0.0109	0.873	0.0114	0.874	0.0115	0.918	0.0126
R06	1.478	0.0505	1.496	0.0500	1.518	0.0490	1.569	0.0473	1.513	0.0472
R07	1.688	0.0562	1.718	0.0550	1.731	0.0545	1.761	0.0524	1.691	0.0509
R08	0.545	0.0345	0.553	0.0345	0.551	0.0344	0.528	0.0337	0.453	0.0363
R09	0.521	0.0372	0.523	0.0371	0.512	0.0361	0.531	0.0356	0.496	0.0368
R10	1.666	0.0630	1.673	0.0623	1.741	0.0631	1.810	0.0618	1.723	0.0621
R11	1.053	0.0081	1.048	0.0082	1.046	0.0083	1.044	0.0081	1.017	0.0086
R12	0.952	0.0260	0.966	0.0258	0.979	0.0257	1.004	0.0246	1.023	0.0239
R13	0.847	0.0380	0.865	0.0377	0.877	0.0375	0.916	0.0359	0.939	0.0352
R14	0.783	0.0536	0.752	0.0531	0.760	0.0531	0.738	0.0522	0.799	0.0504
R15	0.895	0.0447	0.906	0.0448	0.923	0.0445	0.943	0.0443	1.085	0.0435
R16	1.747	0.0559	1.774	0.0534	1.777	0.0526	1.793	0.0504	1.739	0.0494
R17	0.611	0.0402	0.593	0.0398	0.556	0.0394	0.501	0.0377	0.478	0.0372
R18	1.002	0.0039	1.002	0.0038	1.003	0.0037	1.007	0.0036	1.012	0.0036
R19	0.903	0.0408	0.923	0.0408	0.944	0.0403	0.996	0.0387	1.028	0.0382
R20	0.448	0.1040	0.449	0.1041	0.485	0.1058	0.538	0.1016	0.454	0.0997

7. Estimation and Testing of Gammas

The regression equation to estimate the gamma coefficients is:

$$R_{pt} = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\hat{\beta}_{p,t-1} + \hat{\gamma}_{2t}\hat{\beta}^2_{p,t-1} + \hat{\gamma}_{3t}\bar{s}_{p,t-1}(\hat{\varepsilon}_i) + \hat{\eta}_{pt} \quad (3)$$

To find the gammas, we need the values of betas and the standard deviation of the error term ε_{it}. In Fama and MacBeth (1973), the values of gammas are determined using betas calculated from the monthly returns of periods spanning five to eight years. The returns on many of the mutual funds are reported for periods of one year, three years, five years, and ten years in the financial press. In a similar fashion, in the current study, for purposes of estimating the gammas, the betas are calculated using monthly returns of four different time intervals as described below:

(a) *One-year interval:* The betas calculated using the 12 monthly returns of the previous year are used to estimate the gammas for the 12 months of the current year. For example, betas calculated using the monthly returns of the year 1990 are used in estimating the gammas for the 12 months of the year 1991. In other words, we find the betas for the each of years 1990, 1991, . . . , 2008, and use them to estimate the gammas for each of the years 1991, 1992, . . . , 2009 respectively.

(b) *Three-year interval:* In this case, we use returns of 36 months from the previous three years to find the betas, and use the betas to estimate the gammas for the 12 months of the current year. For example, we find the betas using the monthly returns of the years 1990, 1991, and 1992; then, we use the betas to estimate the gammas for the 12 months of the year 1993. Then, on a rolling basis, the betas determined using the monthly returns of the years 1991, 1992 and 1993 are used to estimate the gammas for the 12 months of the year 1994, and so on until 2009.

(c) *Five-year interval:* The procedure is the same as in the three-year case. Now, we use returns of 60 months from the previous five years to find the betas, and use the betas to estimate the gammas for the 12 months of the current year. For example, we find the betas using the monthly returns of the years 1990, 1991, 1992, 1993, and 1994; then, we use the betas to estimate the gammas for the 12 months of the year 1995. Then, on a rolling basis, the betas determined using the monthly returns of the years 1991, 1992, 1993, 1994, and 1995 are used to estimate the gammas for the 12 months of the year 1996, and so on until 2009.

(d) *Ten-year interval:* Monthly returns of the past ten years are used to determine the betas, which are then used to estimate the gammas for the 12 months of the current year. For example, betas based on the 120 monthly returns of the ten years spanning the interval of 1990 through 1999 are used to estimate the gammas for the 12 months of the year 2000. Then, on a rolling basis, betas are determined using the monthly returns of the period 1991-2000; the betas are then used in estimating the gammas for the 12 months of the year 2001, and so on until 2009.

For purposes of empirical testing, equation (3) can be split into four equations as given below:

$$R_{pt} = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\hat{\beta}_{p,t-1} + \hat{\eta}_{pt} \quad (3a)$$

$$R_{pt} = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\hat{\beta}_{p,t-1} + \hat{\gamma}_{2t}\hat{\beta}^2_{p,t-1} + \hat{\eta}_{pt} \quad (3b)$$

$$R_{pt} = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\hat{\beta}_{p,t-1} + \hat{\gamma}_{3t}\overline{s}_{p,t-1}(\hat{\varepsilon}_i) + \hat{\eta}_{pt} \quad (3c)$$

$$R_{pt} = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\hat{\beta}_{p,t-1} + \hat{\gamma}_{2t}\hat{\beta}^2_{p,t-1} + \hat{\gamma}_{3t}\overline{s}_{p,t-1}(\hat{\varepsilon}_i) + \hat{\eta}_{pt} \quad (3d)$$

The basic assumption of the CAPM is that the return on any asset is a linear function of its beta. It implies that γ_1 should be strictly positive. Further, γ_2 should be zero. If γ_2 were positive or negative, it implies that the relation between the asset return and its beta is nonlinear, which is contrary to the CAPM. The coefficient γ_3 is associated with the idiosyncratic risk or non-beta risk, which cannot be diversified. Since it cannot be diversified, the value of the γ_3 should also be zero. It cannot be positive or negative.

The conditions to be tested empirically to validate the CAPM are that (1) γ_1>0, (2) γ_2=0, (3) γ_3=0, and (4) γ_0>0 or $\gamma_0 = R_f$, where R_f is the risk-free rate. In case of the time intervals involving one year, three years or five-years, we fail to reject the null hypothesis of $\gamma_j = 0, j = 0,1,2,3$ in all the panels (at 5% level of significance). In case of the ten-year interval, in Panel A, γ_0>0 at 5% level of significance, but γ_1 has a negative sign, the opposite of what is expected. In Panel C also, the situation is the same (at 10% level of significance). In Panel D, the parameter γ_1 has a positive sign and is significant at 5% level, but γ_2 and γ_3 which should be equal to zero, turn out to be different from zero at 5% level of significance. None of the conditions that validate CAPM are satisfied. The empirical evidence of this study does not support the CAPM. Roll (1977) has stated that the CAPM cannot be tested or validated since the market portfolio cannot be identified. However, Pasquariello (1999) has tested the CAPM using the original data of Fama and Macbeth (1973) with some improvements in the estimation procedures and found evidence in support of the CAPM. It is not clear whether the approach of Pasquariello (1999) would yield any favorable results in the current study.

The values of the gamma coefficients obtained from equations (3a), (3b), (3c) and (3d) are given in Panels A, B, C, and D of Table 9. For each of the four cases described, the betas and standard deviations of the error term ε are given Tables 8-A, 8-B, 8-C and 8-D.

Table 9. Estimated Values of Gammas

Beta Estimation Interval	γ_0		γ_1		γ_2		γ_3	
	Mean (St. Dev.)	Ttstat (p-vlaue)	Mean (St. Dev.)	t-stat (p-vlaue)	Mean (St. Dev.)	t-stat (p-vlaue)	Mean (St. Dev.)	t-stat (p-vlaue)
Panel A: $R_{pt} = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\hat{\beta}_{p,t-1} + \hat{\eta}_{pt}$								
One-year	0.004	1.257	0.003	0.853				
	(0.053)	(0.105)	(0.061)	(0.197)				
Three-year	0.001	0.220	0.007	1.129				
	(0.076)	(0.413)	((0.083)	(0.130)				
Five-year	-0.001	-0.128	0.009	1.246				
	(0.086)	(0.449)	(0.097)	(0.07)				
Ten-year	0.011	1.671	-0.010	-1.193				
	(0.074)	(0.049)	(0.088)	(0.118)				
Panel B: $R_{pt} = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\hat{\beta}_{p,t-1} + \hat{\gamma}_{2t}\hat{\beta}^2_{p,t-1} + \hat{\eta}_{pt}$								
One-year	0.000	0.006	0.015	1.141	-0.007	-0.940		
	(0.094)	(0.498)	(0.198)	(0.127)	(0.108)	(0.174)		
Three-year	0.001	0.186	0.005	0.355	0.001	0.097		
	(0.107)	(0.426)	(0.220)	(0.362)	(0.126)	(0.462)		
Five-year	0.003	0.279	0.002	0.103	0.003	0.283		
	(0.135)	(0.390)	(0.284)	(0.459)	(0.162)	(0.389)		
Ten-year	0.001	0.188	0.014	0.830	-0.013	-1.259		
	(0.079)	(0.426)	(0.179)	(0.204)	(0.111)	(0.105)		

Panel C: $R_{pt} = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\hat{\beta}_{p,t-1} + \hat{\gamma}_{3t}\bar{s}_{p,t-1}(\hat{\varepsilon}_i) + \hat{\eta}_{pt}$

One-year	0.004	1.004	0.004	1.082			0.010	0.190
	(0.055)	(0.158)	(0.060)	(0.140)			(0.829)	(0.425)
Three-year	0.000	0.087	0.006	1.028			0.045	0.755
	(0.071)	(0.465)	(0.082)	(0.153)			(0.854)	(0.225)
Five-year	-0.003	-0.420	0.009	1.215			0.056	0.871
	(0.081)	(0.337)	(0.096)	(0.113)			(0.865)	(0.192)
Ten-year	0.010	1.308	-0.011	-1.285			0.059	0.912
	(0.083)	(0.097)	(0.092)	(0.101)			(0.713)	(0.182)

Panel D: $R_{pt} = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\hat{\beta}_{p,t-1} + \hat{\gamma}_{2t}\hat{\beta}^2_{p,t-1} + \hat{\gamma}_{3t}\bar{s}_{p,t-1}(\hat{\varepsilon}_i) + \hat{\eta}_{pt}$

One-year	-0.003	-0.314	0.018	1.096	-0.008	-0.888	0.042	0.681
	(0.126)	(0.377)	(0.249)	(0.137)	(0.135)	(0.188)	(0.927)	(0.248)
Three-year	0.002	0.284	-0.001	-0.052	0.005	0.441	0.074	1.094
	(0.123)	(0.388)	(0.250)	(0.479)	(0.148)	(0.330)	(0.962)	(0.138)
Five-year	0.000	-0.033	0.002	0.103	0.004	0.370	0.079	1.140
	(0.127)	(0.487)	(0.267)	(0.459)	(0.161)	(0.356)	(0.935)	(0.128)
Ten-year	-0.012	-1.294	0.032	1.678	-0.021	-1.884	0.133	1.652
	(0.103)	(0.099)	(0.210)	(0.048)	(0.124)	(0.031)	(0.885)	(0.051)

8. Conclusions

In this paper, we do an analysis of the monthly returns for twenty different stock indices that represent a broad sample of the market for the twenty year time period from 1990 to 2009. We compute Fama-MacBeth betas for each portfolio for one-year, two-year, four-year, five-year, ten-year and twenty-year time periods. We perform unit root tests on the one-year interval betas and find that only the Gold and Silver Index is stationary. We perform co-integration tests on five quintiles based on high to low betas for the twenty indices and find that the middle quintile with betas close to one, is not co-integrated while the other four quintiles are co-integrated.

Our empirical results indicate that the Gold and Silver Index has the highest volatility. The S&P Healthcare Composite Index exhibits a level of volatility comparable to that of the Dow Jones Utilities Index, but its average yield is double that of the Utilities Index, making it a safer investment vehicle. The time-series of the betas of all the indices except that of Gold and Silver Index calculated from the monthly returns of one-year intervals are found to be non-stationary. However, the betas in four of the five quintiles are found to be co-integrated.

We perform gamma analysis on the one-year, two-year, four-year, five-year, ten-year interval betas to determine if the betas are consistent with the CAPM. That is, we test to determine if the returns for the indices are a linear function of the index betas. The results of the empirical tests on the gamma coefficients do not support the CAPM.

In a nutshell, we use the Fama-MacBeth regression analysis methodology to determine if twenty indices for the twenty year time period from 1990 to 2009 provide a linear relationship between the index returns and index betas. We find that the empirical results are not consistent with the assumptions of the CAPM. For our time period and our sample of indices, the empirical results based on the gamma tests of the relationship between index returns and index betas do not support the CAPM.

References

Fama, Eugene F., & James D. MacBeth. (1973). Risk, Return, and Equilibrium: Empirical Tests, *Journal of Political Economy*, Vol. 81, No.3, pp 607-636. http://dx.doi.org/10.1086/260061

Fama, Eugene F., & Kenneth R. French. (1992). The Cross-section of Expected Stock Returns, *Journal of Finance*, Vol. 47, No.2, pp 427-465. http://dx.doi.org/10.1111/j.1540-6261.1992.tb04398.x

Fama, Eugene F., & Kenneth R. French. (1996). Multifactor Explanations of Asset Pricing Anomalies, *Journal of Finance*, Vol. 51, No.1, pp 55-84. http://dx.doi.org/10.1111/j.1540-6261.1996.tb05202.x

Jagannathan, Ravi, & Zhenyu Wang. (1996). The Conditional CAPM and the Cross-section Expected Stock Returns, *Journal of Finance*, Vol. 51, No.1, pp 3-53. http://dx.doi.org/10.1111/j.1540-6261.1996.tb05201.x

Pasquariello, Paolo. (1999). The Fama-Macbeth Approach Revisited, *Working Paper*, University of Michigan, Ann Arbor, Michigan.

Roll, Richard. (1977). A Critique of the Asset Pricing Theory's Tests, Part I: On the Past and Potential Testability of the Theory, *Journal of Financial Economics*, Vol. 4, pp. 129-176. http://dx.doi.org/10.1016/0304-405X(77)90009-5