

# Smart Beta, Monkeys and Upside Down Strategies

2013 Morningstar ETF Invest Conference

Rob Arnott  
Chairman & CEO  
Research Affiliates

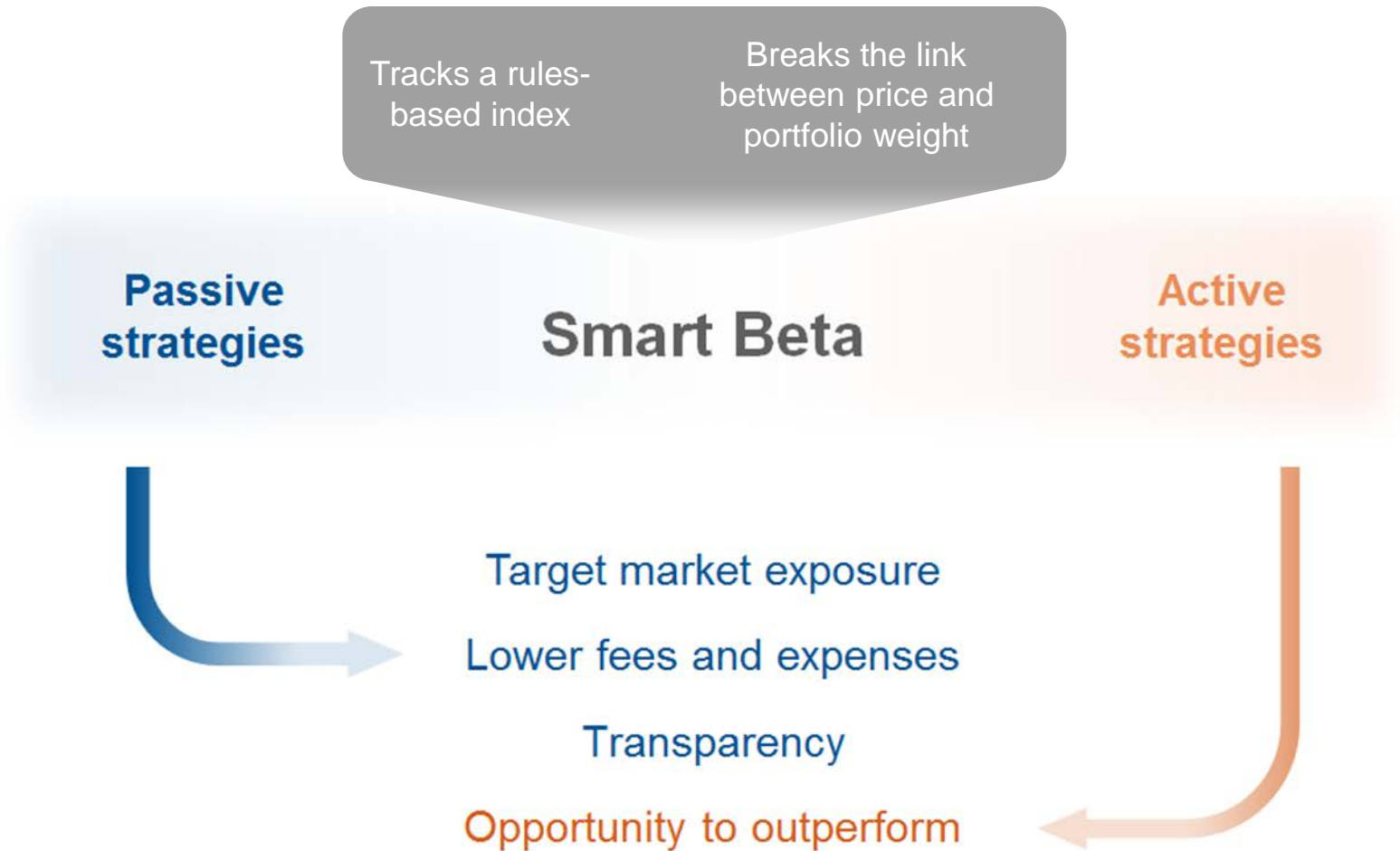
# Smart Beta is Cap-weighting Evolved

---

## CAPM evolves into APT

- » One factor → Multi-factor
- » Market Premium → Market + Value + Size + Low Volatility + Momentum Premiums
- » Cap-weighted traditional index → Smart Betas

# Smart Beta - A New Paradigm



# Equity Smart Beta Strategies

---

Many offerings, many marketing claims, so...

- » How much better are these strategies than market cap?
- » What similarities can we identify?
- » What are critical differences?
- » How do we use Smart Beta strategies?



# The Surprising Alpha from Malkiel's Monkey & Upside-Down Strategies

# High Risk

---

## Claim

- » Investors are compensated for taking risk. The higher the risk of the strategy, the higher the return

## Implications

- » Risk-weighted strategies should have higher return.
- » The following strategies should outperform cap-weighted benchmark:
  - » Volatility Weighted
  - » Market Beta Weighted
  - » Downside Semi-Deviation Weighted

# High Risk Strategies Outperform Cap

---

Simulated U.S. Strategies, 1964–2012

Strategy	Return	Standard Deviation	Sharpe Ratio
Volatility Wt <sup>1</sup>	12.2%	19.1%	0.36
Market Beta Wt <sup>2</sup>	11.9%	19.8%	0.34
Downside Semi-Deviation Wt <sup>3</sup>	12.1%	18.9%	0.37
U.S. Cap Wt <sup>4</sup>	9.7%	15.3%	0.29

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# The Inverse Strategies Also Outperform!

## Simulated U.S. Strategies, 1964–2012

Strategy	Return	Standard Deviation	Sharpe Ratio
Inverse of Volatility Wt <sup>1</sup>	12.5%	15.6%	0.47
Inverse of Market Beta Wt <sup>2</sup>	13.5%	15.0%	0.55
Inverse of Downside Semi-Deviation Wt <sup>3</sup>	12.4%	15.6%	0.46
U.S. Cap Wt <sup>4</sup>	9.7%	15.3%	0.29
Volatility Wt <sup>1</sup>	12.2%	19.1%	0.36
Market Beta Wt <sup>2</sup>	11.9%	19.8%	0.34
Downside Semi-Deviation Wt <sup>3</sup>	12.1%	18.9%	0.37
U.S. Cap Wt <sup>4</sup>	9.7%	15.3%	0.29

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)



# Global Findings

## High Risk—High Reward

---

### Upside-down strategies also outperform!

Global, 1991–2012

Strategy	Return	Standard Deviation	Sharpe Ratio	Information Ratio
Volatility Wt <sup>1</sup>	7.9%	16.9%	0.28	0.19
Market Beta Wt <sup>2</sup>	6.6%	18.8%	0.18	-0.10
Downside Semi-Deviation Wt <sup>3</sup>	8.3%	16.8%	0.31	0.29
Inverse of Volatility Wt <sup>1</sup>	9.3%	13.9%	0.44	0.53
Inverse of Market Beta Wt <sup>2</sup>	9.4%	12.3%	0.51	0.33
Inverse of Downside Semi-Deviation Wt <sup>3</sup>	9.1%	13.9%	0.43	0.48
Global Cap Wt <sup>4</sup>	7.1%	15.1%	0.26	0.00

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# Fundamentals

---

## Claim

- » Strong fundamentals deliver high return

## Implications

- » Strategies weighted on accounting variables should outperform cap-weighted benchmark:
- » Strategies weighted on growth of fundamentals should outperform cap-weighted benchmark

# Fundamentals Outperform Cap

---

Strategy	U.S. 1964–2012		
	Return	Standard Deviation	Sharpe Ratio
Book Value Wt <sup>5</sup>	11.2%	15.7%	0.38
5-Yr Avg Earnings Wt <sup>6</sup>	11.2%	15.1%	0.40
Fundamentals Wt <sup>7</sup>	11.6%	15.4%	0.41
Earnings Growth Wt <sup>8</sup>	12.4%	19.0%	0.38
U.S. Cap Wt <sup>4</sup>	9.7%	15.3%	0.29

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# The Inverse Strategies Also Outperform!

Strategy	U.S. 1964–2012		
	Return	Standard Deviation	Sharpe Ratio
Inverse of Book Value Wt <sup>5</sup>	13.9%	18.5%	0.47
Inverse of 5-Yr Avg Earnings Wt <sup>6</sup>	14.4%	18.3%	0.50
Inverse of Fundamentals Wt <sup>7</sup>	14.1%	18.8%	0.47
Inverse of Earnings Growth Wt <sup>8</sup>	10.3%	18.0%	0.28
U.S. Cap Wt <sup>4</sup>	9.7%	15.3%	0.29
Book Value Wt <sup>5</sup>	11.2%	15.7%	0.38
5-Yr Avg Earnings Wt <sup>6</sup>	11.2%	15.1%	0.40
Fundamentals Wt <sup>7</sup>	11.6%	15.4%	0.41
Earnings Growth Wt <sup>8</sup>	12.4%	19.0%	0.38
U.S. Cap Wt <sup>4</sup>	9.7%	15.3%	0.29

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# Global Findings

## Strong Fundamentals—High Reward

### Upside-down strategies also outperform!

Global, 1991–2012

Strategy	Return	Standard Deviation	Sharpe Ratio	Information Ratio
Book Value Wt <sup>5</sup>	9.5%	16.1%	0.40	0.49
5-Yr Avg Earnings Wt <sup>6</sup>	11.2%	15.3%	0.51	0.76
Fundamentals Wt <sup>7</sup>	11.0%	15.3%	0.49	0.72
Earnings Growth Wt <sup>8</sup>	8.8%	17.1%	0.33	0.40
Inverse of Book Value <sup>5</sup>	10.6%	15.5%	0.48	0.61
Inverse of 5-Yr Avg Earnings Wt <sup>6</sup>	12.5%	15.4%	0.58	0.83
Inverse of Fundamental Wt <sup>7</sup>	12.5%	15.7%	0.58	0.80
Inverse of EPS Growth <sup>8</sup>	6.6%	15.9%	0.22	-0.12
Global Cap Wt <sup>4</sup>	7.1%	15.1%	0.26	0.00

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# Popular Smart Beta Strategies

---

Smart Beta strategies come in a variety of flavors

- » Diversity Weighting—a blend between cap weighting and equal weighting
- » Fundamentals Weighting—strong fundamentals deliver high return
- » Maximum Diversification—return is proportional to volatility
- » Minimum Variance—low risk generates high return
- » Risk Cluster Equal Weight—equally weight country/industry clusters
- » Risk-Efficient ( $\lambda=2$ ) —return is proportional to downside semi-deviation

# Popular Smart Beta Strategies Outperform Cap

Strategy	U.S. 1964–2012		
	Return	Standard Deviation	Sharpe Ratio
Minimum Variance <sup>9</sup>	11.8%	11.7%	0.56
Maximum Diversification <sup>10</sup>	12.0%	14.0%	0.48
Risk-Efficient ( $\lambda=2$ ) <sup>11</sup>	12.5%	16.8%	0.43
Risk Cluster Equal Weight <sup>12</sup>	11.2%	14.6%	0.41
Diversity Weighting <sup>13</sup>	10.5%	15.5%	0.34
Fundamentals Wt <sup>7</sup>	11.6%	15.4%	0.41
U.S. Cap Wt <sup>4</sup>	9.7%	15.3%	0.29

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# The Inverse Strategies Also Outperform!

Strategy	U.S. 1964–2012		
	Return	Standard Deviation	Sharpe Ratio
Inverse of Minimum Variance <sup>9</sup>	12.7%	18.1%	0.41
Inverse of Maximum Diversification <sup>10</sup>	12.5%	17.6%	0.41
Inverse of Risk-Efficient ( $\lambda=2$ ) <sup>11</sup>	12.3%	17.3%	0.41
Inverse of Risk Cluster Equal Weight <sup>12</sup>	13.2%	19.0%	0.42
Inverse of Diversity Weighting <sup>13</sup>	13.4%	18.3%	0.45
Inverse of Fundamentals Wt <sup>7</sup>	14.1%	18.8%	0.47
U.S. Cap Wt <sup>4</sup>	9.7%	15.3%	0.29
Minimum Variance <sup>9</sup>	11.8%	11.7%	0.56
Maximum Diversification <sup>10</sup>	12.0%	14.0%	0.48
Risk-Efficient ( $\lambda=2$ ) <sup>11</sup>	12.5%	16.8%	0.43
Risk Cluster Equal Weight <sup>12</sup>	11.2%	14.6%	0.41
Diversity Weighting <sup>13</sup>	10.5%	15.5%	0.34
Fundamentals Wt <sup>7</sup>	11.6%	15.4%	0.41
U.S. Cap Wt <sup>4</sup>	9.7%	15.3%	0.29

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)



# Malkiel's Monkey

---



“A blindfolded monkey throwing darts at a newspaper’s financial pages could select a portfolio that would do just as well as one carefully selected by experts.”

-Burton G. Malkiel, *A Random Walk Down Wall Street*

# Malkiel's Monkey Throwing Darts Outperforms Cap

Simulation of Random Selection, repeated 100 times, 1964-2012

Strategy	Return (%)	Standard Deviation (%)	Sharpe Ratio
Average of 100 Monkey Portfolios <sup>14</sup>	11.3	18.3	0.33
U.S. Cap Weight <sup>4</sup>	9.7	15.3	0.29

Only 2 (very unlucky) monkeys underperformed the cap-weighted benchmark!

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# Global Findings

## Malkiel's Monkey

---

### Global, 1991–2012

---

Strategy	Return	Standard Deviation	Sharpe Ratio	Information Ratio
Average of 100 Malkiel's Monkey Portfolios <sup>14</sup>	8.1%	16.4%	0.31	0.16
Global Cap Wt <sup>4</sup>	7.1%	15.1%	0.26	0.00

---

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# All Price Indifferent Strategies Outperform

---

Investment Strategy	Break the Link Between Price and Weight	Rebalance
Risk Weighted Strategies	✓	✓
Fundamental Strategies	✓	✓
Smart Beta Solutions	✓	✓
Random Monkey Portfolios	✓	✓
Cap-Weight		



# Value and Size Factors

# Value and Size Factors Risk Strategies

All non-cap-weighted strategies have value and small size tilt

## Four-Factor Model Decomposition (U.S. 1964–2012)

Strategy	Annual FFC Alpha (%)	Alpha t-stat	Market Exposure	Size Exposure	Value Exposure	Momentum Exposure
Volatility Wt <sup>1</sup>	0.23	0.46	1.10	0.55	0.16	-0.04
Market Beta Wt <sup>2</sup>	0.56	1.01	1.13	0.54	0.13	-0.09
Downside Semi-Deviation Wt <sup>3</sup>	0.26	0.52	1.10	0.52	0.17	-0.04
Inverse of Volatility Wt <sup>1</sup>	0.58	1.13	0.97	0.28	0.33	-0.03
Inverse of Market Beta Wt <sup>2</sup>	0.86	1.07	0.91	0.25	0.43	0.03
Inverse of Downside Semi- Deviation Wt <sup>3</sup>	0.48	0.95	0.97	0.28	0.33	-0.02
U.S. Cap Wt <sup>4</sup>	0.00	0.00	1.00	0.00	0.00	0.00

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# Global Findings

## Risk Strategies

**All non-cap-weighted strategies have value and small size tilt**

**Four-Factor Model Decomposition (Global 1991–2012)**

Strategy	Annual FFC Alpha	Alpha t-stat	Market Exposure	Size Exposure	Value Exposure	Momentum Exposure
Volatility Wt <sup>1</sup>	0.12%	0.20	1.10	0.31	0.13	-0.06
Market Beta Wt <sup>2</sup>	-0.13%	-0.13	1.19	0.37	0.03	-0.15
Downside Semi-Deviation Wt <sup>3</sup>	0.55%	0.83	1.09	0.29	0.15	-0.07
Inverse of Volatility Wt <sup>1</sup>	0.77%	1.28	0.92	0.13	0.34	-0.04
Inverse of Market Beta Wt <sup>2</sup>	0.66%	0.64	0.77	0.01	0.44	0.01
Inverse of Downside Semi- Deviation Wt <sup>3</sup>	0.54%	0.90	0.92	0.14	0.33	-0.03
Global Cap Wt <sup>4</sup>	0.00%	0.00	1.00	0.00	0.00	0.00

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# Value and Size Factors Fundamental Strategies

All non-cap-weighted strategies have value and small size tilt

## Four-Factor Model Decomposition (U.S. 1964–2012)

Strategy	Annual FFC Alpha (%)	Alpha t-stat	Market Exposure	Size Exposure	Value Exposure	Momentum Exposure
Book Value Wt <sup>5</sup>	0.54	1.56	1.03	0.03	0.34	-0.10
5-Yr Avg Earnings Wt <sup>6</sup>	0.64	1.92	1.00	0.00	0.31	-0.08
Fundamentals Wt <sup>7</sup>	0.64	1.83	1.01	0.05	0.37	-0.09
Earnings Growth Wt <sup>8</sup>	0.96	1.34	1.09	0.47	0.04	0.00
Inverse of Book Value <sup>5</sup>	1.39	2.14	1.05	0.56	0.39	-0.11
Inverse of 5-Yr Avg Earnings Wt <sup>6</sup>	1.65	2.19	1.03	0.57	0.41	-0.09
Inverse of Fundamental Wt <sup>7</sup>	1.40	2.06	1.05	0.60	0.41	-0.11
Inverse of EPS Growth <sup>8</sup>	-0.95	-2.17	1.07	0.42	0.10	-0.02
U.S. Cap Wt <sup>4</sup>	0.00	0.00	1.00	0.00	0.00	0.00

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)



# Global Findings

## Fundamental Strategies

All non-cap-weighted strategies have value and small size tilt

Four-Factor Model Decomposition (Global 1991–2012)

Strategy	Annual FFC Alpha	Alpha t-stat	Market Exposure	Size Exposure	Value Exposure	Momentum Exposure
Book Value Wt <sup>5</sup>	1.31%	2.22	1.02	0.09	0.40	-0.12
5-Yr Avg Earnings Wt <sup>6</sup>	2.36%	3.28	0.97	-0.01	0.39	-0.09
Fundamentals Wt <sup>7</sup>	1.93%	2.98	0.98	0.09	0.43	-0.11
Earnings Growth Wt <sup>8</sup>	1.55%	1.91	1.11	0.27	-0.02	-0.04
Inverse of Book Value <sup>5</sup>	1.94%	2.60	0.98	0.33	0.46	-0.13
Inverse of 5-Yr Avg Earnings Wt <sup>6</sup>	2.70%	3.28	0.98	0.29	0.50	-0.12
Inverse of Fundamental Wt <sup>7</sup>	2.81%	3.44	0.99	0.35	0.51	-0.15
Inverse of EPS Growth Wt <sup>8</sup>	-1.20%	-1.57	1.02	0.43	0.06	0.02
Global Cap Wt <sup>4</sup>	0.00%	0.00	1.00	0.00	0.00	0.00

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# Value and Size Factors

## Smart Beta Strategies

All non-cap-weighted strategies have value and small size tilt

Four-Factor Model Decomposition (U.S. 1964–2012)

Strategy	Annual FFC Alpha	Alpha t-stat	Market Exposure	Size Exposure	Value Exposure	Momentum Exposure
Minimum Variance <sup>9</sup>	1.05%	1.39	0.70	0.13	0.34	0.00
Maximum Diversification <sup>10</sup>	0.40%	0.54	0.83	0.26	0.26	0.04
Risk-Efficient ( $\lambda=2$ ) <sup>11</sup>	0.63%	1.32	1.03	0.36	0.26	-0.03
Risk Cluster Equal Weight <sup>12</sup>	0.31%	0.49	0.94	0.03	0.21	0.03
Diversity Weighting <sup>13</sup>	0.13%	0.65	1.01	0.07	0.11	-0.01
Fundamentals Wt <sup>7</sup>	0.64%	1.83	1.01	0.05	0.37	-0.09
Inverse of Minimum Variance <sup>9</sup>	0.54%	1.07	1.08	0.45	0.25	-0.04
Inverse of Maximum Diversification <sup>10</sup>	0.52%	0.94	1.07	0.38	0.28	-0.05
Inverse of Risk-Efficient ( $\lambda=2$ ) <sup>11</sup>	0.25%	0.51	1.04	0.41	0.27	-0.03
Inverse of Risk Cluster Equal Weight <sup>12</sup>	-0.16%	-0.19	1.06	0.62	0.41	-0.02
Inverse of Diversity Weighting <sup>13</sup>	0.54%	0.91	1.04	0.59	0.33	-0.04
Inverse of Fundamental Wt <sup>7</sup>	1.40%	2.06	1.05	0.60	0.41	-0.11
U.S. Cap Wt <sup>4</sup>	0.00%	0.00	1.00	0.00	0.00	0.00

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# Global Findings

## Smart Beta Strategies

All non-cap-weighted strategies have value and small size tilt

Four-Factor Model Decomposition (Global 1991–2012)

Strategy	Annual FFC Alpha	Alpha t-stat	Market Exposure	Size Exposure	Value Exposure	Momentum Exposure
Minimum Variance <sup>9</sup>	1.73%	1.33	0.55	0.02	0.30	-0.06
Maximum Diversification <sup>10</sup>	0.12%	0.08	0.65	0.11	0.24	0.01
Risk-Efficient ( $\lambda=2$ ) <sup>11</sup>	0.53%	0.93	0.98	0.19	0.28	-0.03
Risk Cluster Equal Weight <sup>12</sup>	0.97%	0.66	1.00	0.25	0.21	0.08
Diversity Weighting <sup>13</sup>	-0.09%	-0.33	1.01	0.07	0.04	0.00
Inverse of Minimum Variance <sup>9</sup>	0.42%	0.76	1.07	0.24	0.23	-0.05
Inverse of Maximum Diversification <sup>10</sup>	0.50%	0.88	1.04	0.21	0.29	-0.07
Inverse of Risk-Efficient ( $\lambda=2$ ) <sup>11</sup>	0.44%	0.75	1.01	0.22	0.25	-0.06
Inverse of Risk Cluster Equal Weight <sup>12</sup>	0.63%	0.42	1.05	0.14	0.28	0.02
Inverse of Diversity Weighting <sup>13</sup>	0.47%	0.84	1.02	0.34	0.19	-0.03
Global Cap Wt <sup>4</sup>	0.00%	0.00	1.00	0.00	0.00	0.00

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# Value and Size Factors

## Malkiel's Monkey

---

All non-cap-weighted strategies have value and small size tilt

### Four-Factor Model Decomposition (U.S. 1964–2012)

Strategy	Annual FFC Alpha	Alpha t-stat	Market Exposure	Size Exposure	Value Exposure	Momentum Exposure
Avg. of 100 Malkiel's Monkeys <sup>14</sup>	-0.29%	-0.31	1.05	0.37	0.13	-0.02
U.S. Cap Wt <sup>4</sup>	0.00%	0.00	1.00	0.00	0.00	0.00

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# Global Findings

## Malkiel's Monkey

### All non-cap-weighted strategies have value and small size tilt

Four-Factor Model Decomposition (Global 1991–2012)

Strategy	Annual FFC Alpha	Alpha t-stat	Market Exposure	Size Exposure	Value Exposure	Momentum Exposure
Average of 100 Malkiel's Monkey Portfolios <sup>14</sup>	0.15%	0.10	1.02	0.23	0.18	-0.03
Global Cap Wt <sup>4</sup>	0.00%	0.00	1.00	0.00	0.00	0.00

See notes slide for disclosures regarding individual strategies.

Source: Research Affiliates, LLC, based on Arnott, Hsu, Kalesnik and Tindall (2013)

# Value and Size Factors

---

## All smart beta strategies are largely similar

- » Any portfolio return can be decomposed:

$$\begin{aligned}R_p &= n \cdot E[r_i w_i] = n \cdot E[r_i] E[w_i] + n \cdot \text{cov}[r_i, w_i] \\ &= EW + n \cdot \text{cov}[r_i, w_i]\end{aligned}$$

- » *EW*—"Return of equally weighted portfolio—no skill!
- »  $n \cdot \text{cov}[r_i, w_i]$ —"skill from security selection.

## Jonathan Berk: Value and size factors generate returns because they sort stock based on prices!

- » Weighting on price is negatively related to future return
- » Smart Beta weights unrelated to price—no skill
- » *Cap-weighted is the only strategy in the study with negative skill!*

# Implementation Is the Primary Differentiator

---

Many smart beta strategies suffer from high implementation costs.

» Investors should seek to:

## Maximize

Capacity/Liquidity

Economic Representation

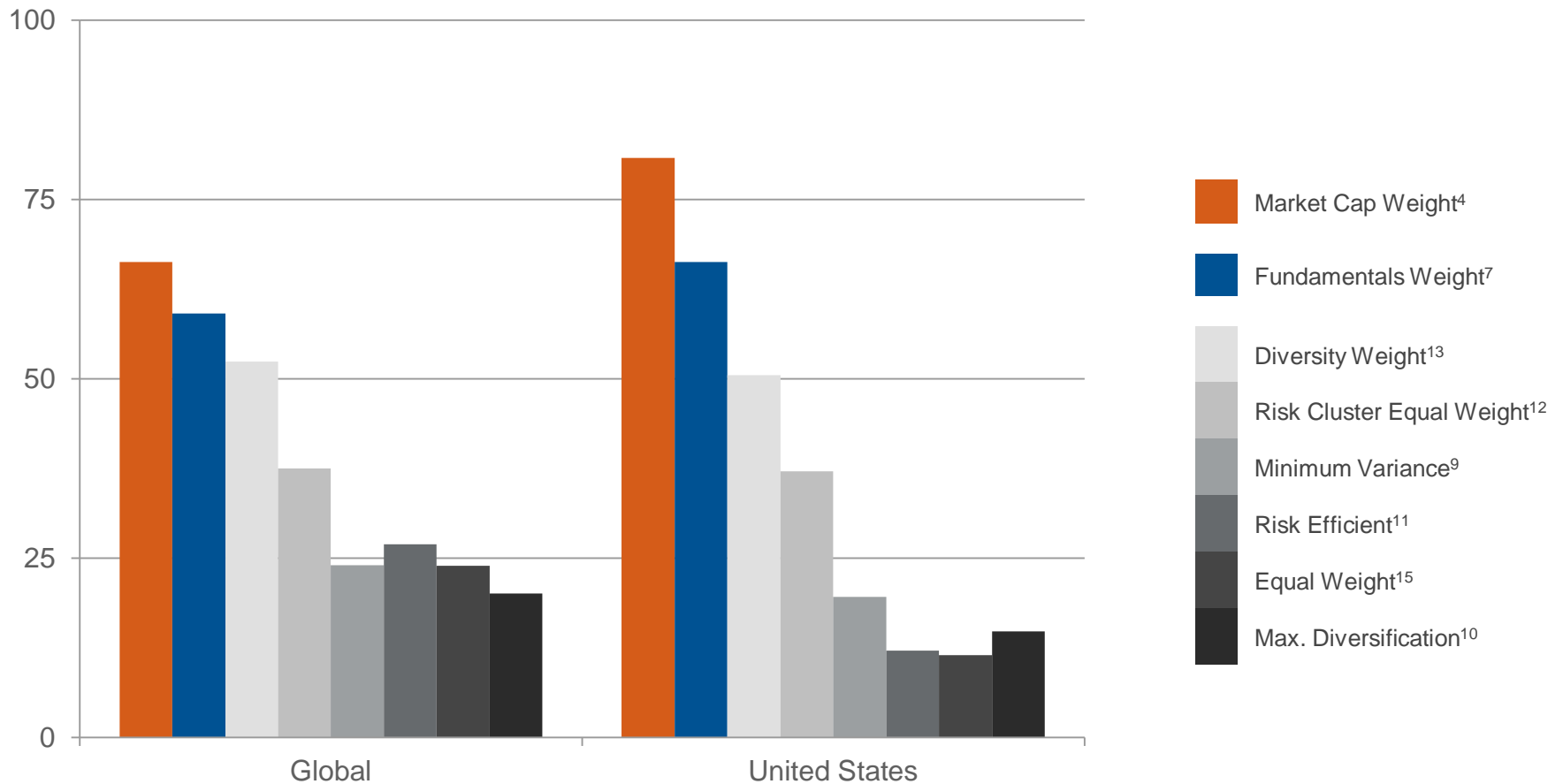
## Minimize

Turnover

Trading Costs

# Fundamentals Weight Has the Greatest Liquidity

Market Cap in USD Billions – Jan 2010

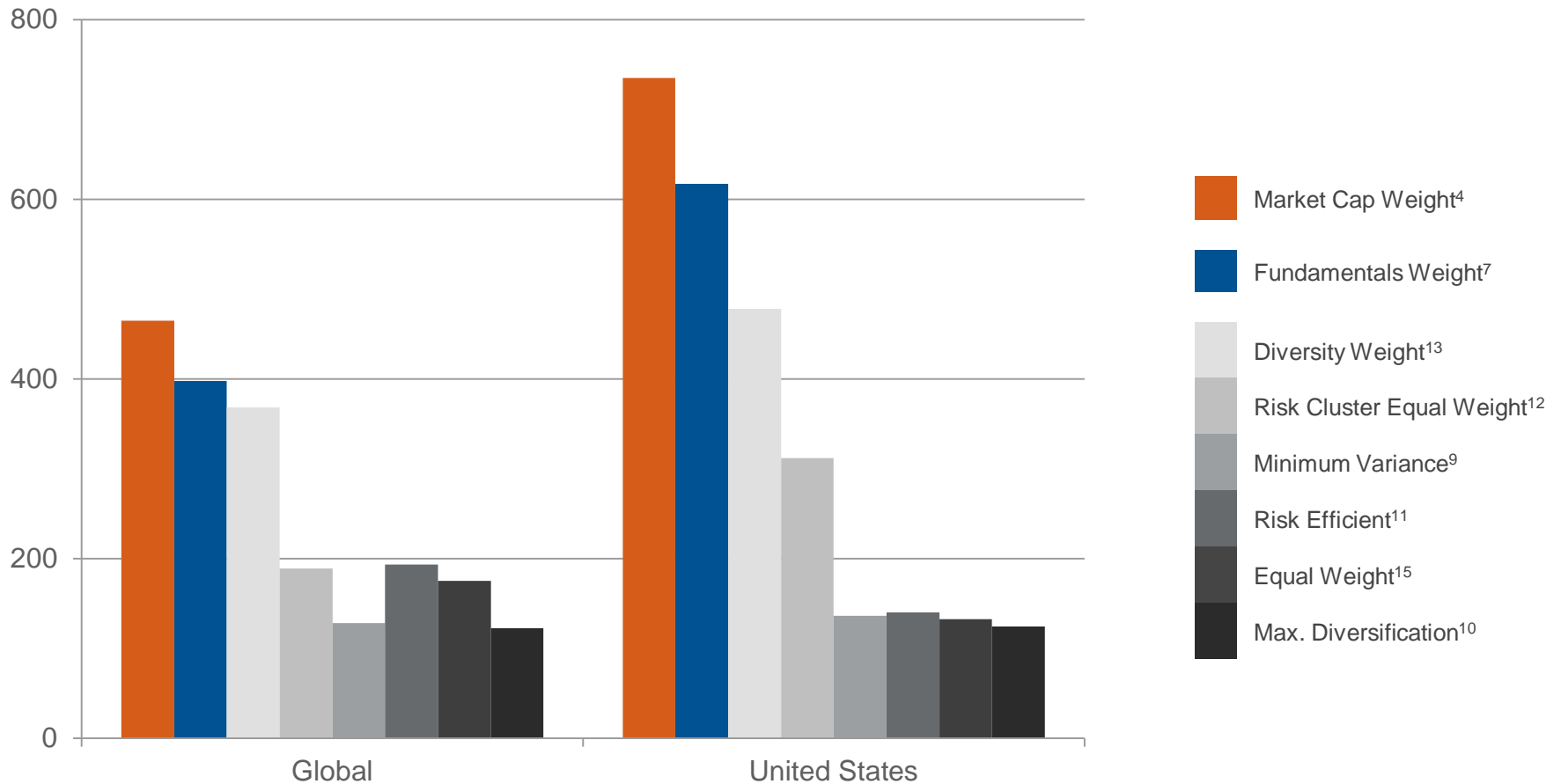


Above figures all represent weighted averages.  
 See notes slide for disclosures regarding individual strategies.  
 Source: Research Affiliates, LLC.



# Fundamentals Weight Leads in Daily Volume

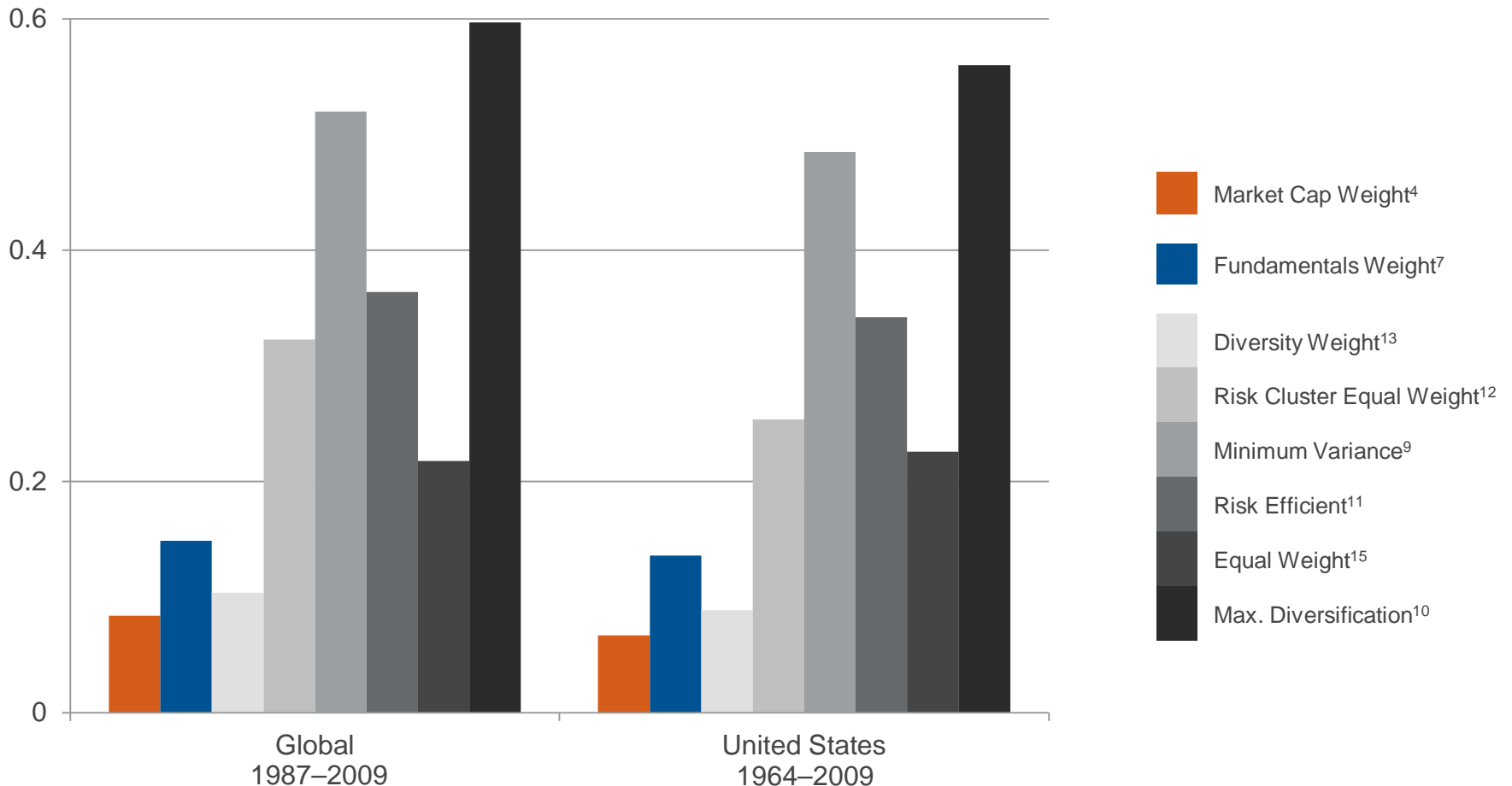
Adjusted Daily Volume in USD Millions – Jan 2010



Above figures all represent weighted averages.  
 See notes slide for disclosures regarding individual strategies.  
 Source: Research Affiliates, LLC.

# Fundamentals Weight Has Low Trading Costs

Average Annual Turnover

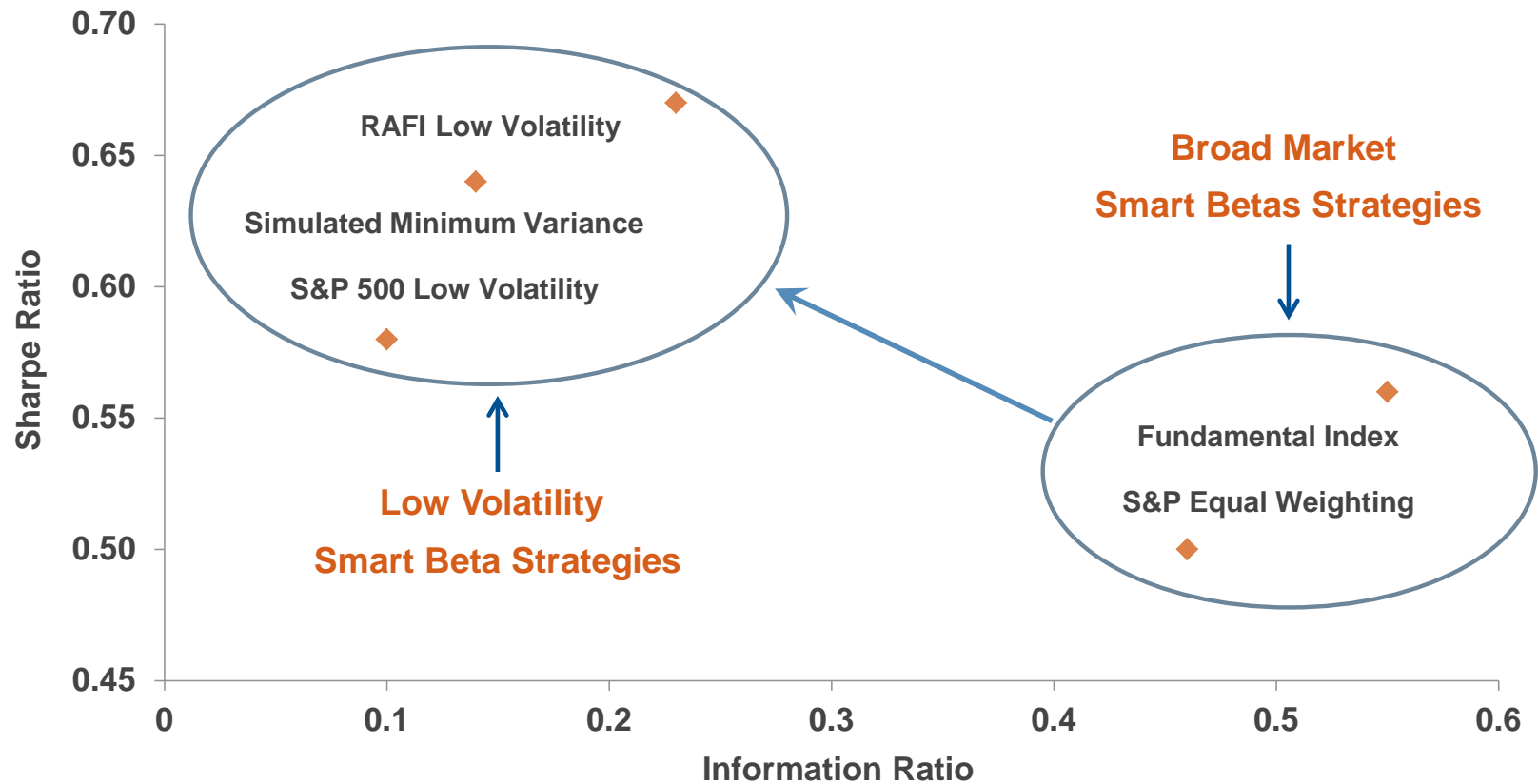


Above figures all represent weighted averages.  
 See notes slide for disclosures regarding individual strategies.  
 Source: Research Affiliates, LLC.

# Information Ratio vs. Sharpe Ratio Investors

## From information ratio to Sharpe ratio

» Is your risk Tracking Error or Volatility?



Source: Research Affiliates, LLC, based on data from CRSP/Compustat and Standard & Poors. Turnover average from 1991-2010. Weighted average market cap as of December 31, 2010.

# Notes: Strategy Simulation Descriptions

---

<sup>1</sup>Volatility weighted: Weighted based on the standard deviation of monthly returns over the five year window prior to index construction.

<sup>2</sup>Market Beta Weighted: Weighted based on CAPM betas using market factor kindly provided by Kenneth French on his website.

The market beta loading is estimated using monthly returns data over five years window prior to index construction.

<sup>3</sup>Downside Semi-Deviation Weighted: Weighted based on downside semi-deviation of the monthly returns over five year period prior to index construction.

<sup>4</sup>Cap-Weighted: Weighted based on market capitalization. The market capitalization is computed using December close of the year prior to index construction.

<sup>5</sup>Book Weighted: Weighted based on the book value of equity. We use the book value from the fiscal year two years prior to index construction. We introduce delay to avoid forward-looking bias.

<sup>6</sup>Five-year Average Earnings Weighted: Weighted based on the average of the five-year earnings. The averaging period covers the five fiscal years ending with the fiscal year two years prior to index construction. We introduce delay to avoid forward-looking bias.

<sup>7</sup>Fundamentals Weighted: Weighted based on the five year averages of cash flows, dividends, sales and the most recent book value of equity. We introduce two year delay to avoid forward-looking bias. Following the original method, we select top stocks with the largest fundamental weight. For details see Arnott, Hsu, and Moore (2005).

<sup>8</sup>Earnings Growth Weighted based on five-year average dollar change in earnings divided by the average absolute dollar value of earnings over the five-year period. The last fiscal years of the measuring window is taken two years prior to index construction. We introduce delay to avoid forward-looking bias.

<sup>9</sup>Minimum Variance: To construct the minimum variance strategy we use the method of Clarke, de Silva, and Thorley (2006).

<sup>10</sup>Maximum Diversification Portfolio optimized to maximize expected diversification ratio, which is defined as the ratio of weighted average risk to the expected portfolio risk. For details see Choueifaty and Coignard (2008).

<sup>11</sup>Risk-Efficient ( $\lambda=2$ ) Mean-variance optimized portfolio assuming that expected excess returns are proportional to the stocks' downside semi-deviation, and with stringent constraint to limit portfolio concentration. For details see Amenc et al (2010).

<sup>12</sup>Risk Cluster Equal Weight Applying statistical methods to identify major market risk factors, assumed to be driven by industries and geographies, and then equally weight these uncorrelated risk clusters.

<sup>13</sup>Diversity Weighting: Weighted based on the market capitalization weight raised to the power of a constant that is between zero and one to tilt the portfolio towards small cap stocks while limiting tracking error. We used the value of 0.76 in our simulation.

<sup>14</sup>Malkiel's Monkey: Average of 100 portfolios, where each of the individual portfolios is rebalanced annually by randomly selecting 30 stocks out of the universe of the largest 1000 stocks by market capitalization.

<sup>15</sup>Equal Weighting: Equally weighted portfolio of 1000 largest stocks by market capitalization

# Important Disclosure Information

---

By accepting this document you agree to keep its contents confidential. You also agree not to disclose the contents of this document to third parties (including potential co-investors) without the prior permission of Research Affiliates, LLC (Research Affiliates, including its related entities).

The material contained in this document is for information purposes only. This material is not intended as an offer or solicitation for the purchase or sale of any security or financial instrument, nor is it advice or a recommendation to enter into any transaction. Any offer to sell or a solicitation of an offer to buy or sell pooled investment vehicles shall be made solely to qualified investors through a private placement memorandum. Separately managed accounts will be based on an investment management agreement. This information is intended to supplement information contained in the respective disclosure documents. The information contained herein should not be construed as financial or investment advice on any subject matter. Research Affiliates does not warrant the accuracy of the information provided herein, either expressed or implied, for any particular purpose.

The index data published herein are simulated, no allowance has been made for trading costs, management fees, or other costs, are not indicative of any specific investment, are unmanaged and cannot be invested in directly. Past simulated performance is no guarantee of future performance and actual investment results may differ. Any information and data pertaining to an index contained in this document relate only to the index itself and not to any asset management product based on the index. With the exception of the data on Research Affiliates Fundamental Index, all other information and data are based on information and data from third party sources.

Investors should be aware of the risks associated with data sources and quantitative processes used in our investment management process. Errors may exist in data acquired from third party vendors, the construction of model portfolios, and in coding related to the index and portfolio construction process. While Research Affiliates takes steps to identify data and process errors so as to minimize the potential impact of such errors on index and portfolio performance, we cannot guarantee that such errors will not occur.

Research Affiliates is the owner of the trademarks, service marks, patents and copyrights related to the Fundamental Index methodology. The trade names Fundamental Index®, RAFI®, the RAFI logo, and the Research Affiliates corporate name and logo are registered trademarks and are the exclusive intellectual property of Research Affiliates, LLC. Any use of these trade names and logos without the prior written permission of Research Affiliates, LLC is expressly prohibited. Research Affiliates, LLC reserves the right to take any and all necessary action to preserve all of its rights, title and interest in and to these marks.

The Fundamental Index® concept, the non-capitalization method for creating and weighting of an index of securities, is patented and patent-pending proprietary intellectual property of Research Affiliates, LLC (US Patent No. 7,620,577; 7,792,719; 8,374,939; 8,380,604; RE 44,098; and RE 44,362; Patent Pending Publ. Nos. WO 2005/076812, WO 2007/078399 A2, and WO 2008/118372). Intellectual property protected by one, or more, of the foregoing may be used in the material presented herein.

© Research Affiliates, LLC. All rights reserved. Duplication or dissemination prohibited without prior written permission.

Thank You

For additional information visit  
**[www.researchaffiliates.com](http://www.researchaffiliates.com)**