



Thematic Investing

For an Exponential World

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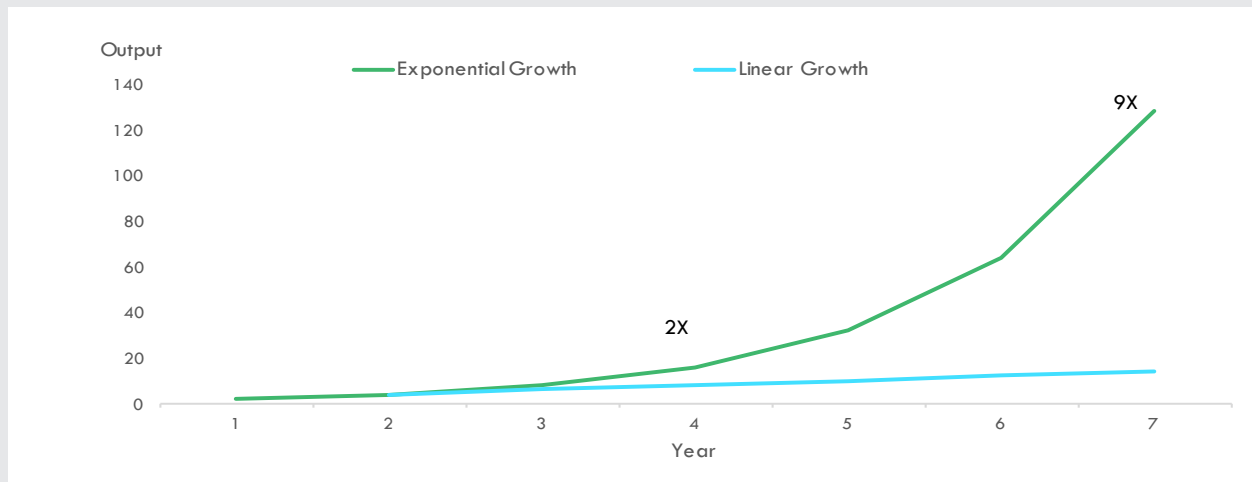


Today, investors are in the throes of change on a scale and at a speed they have never encountered. Whether a cloud-based collapse in the costs of computing, man-machine combinations causing bursts of productivity, or genomic sequencing driving lower costs and better outcomes into health care and farming, markets are unsettled as they encounter and react to disruptive innovations.

In typical broad based benchmark indices, past performance is used to determine portfolio position sizes, an implicit assumption that historical growth rates will remain intact. In the early stages of exponential change such an assumption is a good one, often giving investors false comfort that future changes will continue apace. As exponential change progresses, however, not only do trends change quickly, but the rate of change accelerates with each year.

Forecasts based on linear thinking become increasingly inaccurate as a theme evolves exponentially. In Figure 1, for example, linear and exponential rates of change are roughly on par for the first three years but, in year four, exponential growth pulls away and continues to do so at an increasing rate as time progresses.¹

FIGURE 1
Exponential vs. Linear Change | 2^x vs $2x$



Source: ARK Investment Management LLC

In 2010 Eric Schmidt, Google's then CEO and now Executive Chairman, stated, "Every two days now we create as much information as we did from the dawn of civilization up until 2003." Combining Schmidt's estimates with the rate of data growth from 2010 to 2015, ARK Invest estimates that those two days have shrunk to a matter of hours.² Schmidt went on to say, "I spend most of my time assuming the world is not ready for the [forthcoming] technology revolution."³

1 The graph depicts two simple equations using the scalar multiplier of 2. One equation is exponential, represented by " 2^x ", and the other is linear, represented by " $2x$ ".

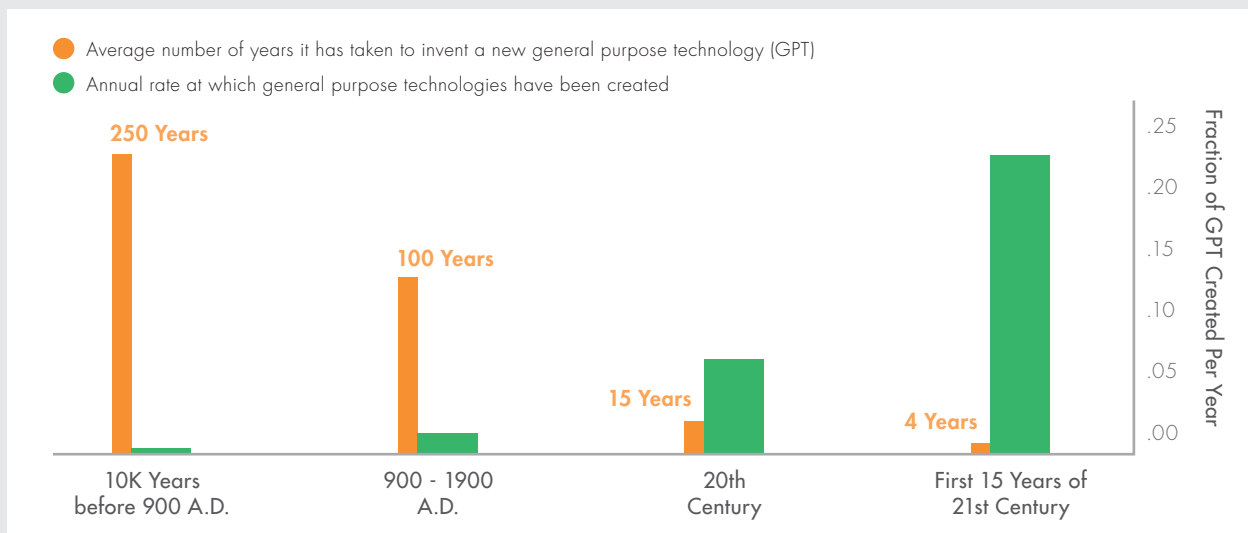
2 Seven hours per ARK Investment Management LLC's estimates.

3 Eric Schmidt: "Every 2 Days We Create As Much Information As We Did Up To 2003," TechCrunch, August 2010, <http://arkinv.st/1mjxHfG>.



With such rapid change comes a compression in the lifecycle of products, services, companies and industries, thanks to tremendous boosts in efficiency and productivity. Underlying this phenomenon are general purpose technologies (GPT),⁴ on which other innovations depend. Notable among them in the past were the wheel, electricity, and the Internet.⁵ As illustrated in Figure 2, the number of years it takes to invent a new GPT has collapsed, implying the rate of GPT creation has accelerated exponentially.

FIGURE 2
Rate at which General Purpose Technologies were Created



Source: ARK Investment Management LLC, based on research by Lipsey, R.G., K.I. Carlaw and C. Bekar (2005)

Thematic investors seek to capitalize on rapidly changing trends— anticipating, identifying, and quantifying multi-year value-chain transformations— normally caused by technologically enabled innovation. Conventional wisdom typically underestimates the implications of these transformations, giving thematic investors opportunities to identify stocks poised to benefit from trends not yet properly priced into the market. Further, while many disruptive innovations initially appear disparate, when viewed with the benefit of hindsight they frequently are seen to have converged to create unprecedented productivity and efficiency gains across sectors, thanks largely to new products and services or lower unit costs. If properly identified, investments in convergent innovations have the potential to provide significant outperformance.

THE INDICES UNDERLYING ARK'S ANALYSIS

During the last two market cycles, several industries— technology, health care, and industrials in particular— have been converging thanks to innovation. This paper aims to show how a thematic approach to investing in converging innovations and industries offers the possibility to produce outsized risk-adjusted returns with a moderate to negative correlation of relative returns to broad based benchmark-sensitive investment strategies.

4 ARK views a general purpose technology (GPT) as an invention that serves as a foundational platform for future innovation and is therefore a keystone to long term economic growth.

5 Lipsey, R.G., K.I. Carlaw and C. Bekar, Oxford University Press, 2005. "Economic Transformations: General Purpose Technologies, and Long-Term Economic Growth." Technologies 10,000 years before 900 A.D. included plant domestication, animal domestication, smelting of ore, the wheel, bronze, writing, iron, and the waterwheel. 900-1900 A.D. included the three-masted sailing ship, printing, steam engine, factory system, railways, iron steamship, internal combustion engine, automobile, and electricity. The 20th Century included mass production, chemical engineering, lean manufacturing, computers, the Internet, and biotechnology. According to ARK Investment Management LLC's research, the last 15 years have included sequencing, mobile connected devices, autonomous robotics, machine learning, and blockchain technology.



We began by constructing four hypothetical portfolios composed of mutual funds.⁶ Three of the hypothetical portfolios focus on themes impacting several industries simultaneously and the fourth is a composite of the other three, focused on convergent innovation at large. To determine the mutual funds that would make up each hypothetical portfolio, we screened the available universe of mutual funds on Morningstar's Premium Fund Screener, first by the Category of "Sector Equity." Next, we screened by applicable sector for each hypothetical portfolio. For the hypothetical "thematic web portfolio," we screened by the equity "Technology" sector, which returned 203 funds. For the hypothetical "thematic health care portfolio," we screened by the equity "Healthcare" sector, which returned 128 funds. And, for the hypothetical "thematic energy and industrial portfolio," we screened by the equity "Energy" and "Industrials" sectors, which returned a combined 134 funds.

To narrow down the participants to thematically focused mutual funds, or funds more likely to focus on powerful innovations impacting multiple sectors, we selected funds with 5% exposure in at least three sectors for both the thematic web and thematic energy and industrial portfolios, and 2% exposure in at least three sectors for the thematic health care portfolio.⁷ Because these funds had allocations to multiple sectors, which is somewhat unusual for sector focused funds, we assumed that these funds were thematic in nature. This thematic screen narrowed the thematic web portfolio from 203 funds to 32, the thematic health care portfolio from 128 funds to 7, and the thematic energy and industrial portfolio from 134 funds to 10. For the hypothetical "thematic innovation portfolio," we equal-weighted its three constituent themes, a third each to thematic web, thematic health care and thematic energy and industrial themes. We calculated performance for the hypothetical portfolios on a total return basis (i.e., reinvested dividends), gross of the underlying funds' fees, with all data sourced from Bloomberg.⁸

We compared the performance of these four thematic portfolios to the total return of four broad based market indices: the S&P 500 Index (SPX), the Russell 3000 Growth Index (RAG), the Russell 3000 Value Index (RAV), and the Russell 2000 Growth Index (RUO). Together, they cover the range of investment styles having core, growth, value and small cap growth strategies, respectively. We also included a comparison of the thematic portfolios to their S&P Select Sector Index counterparts.⁹

For two periods of time, we compared these various investment strategies based on absolute returns, volatility, risk-adjusted returns, and the correlation of relative returns. The following periods capture the performance of the various themes, which by our definition are long term in nature:

- | the last full market cycle from trough to trough (2002 to 2009), which ARK believes is the best recent gauge of long term performance.
- | the last full market cycle plus the current incomplete market cycle (2002 to 2015), which spans over 13 years, and is another perspective on long term performance.¹⁰

ABSOLUTE RETURNS

If the premise behind thematic strategies is to identify innovation and other important tailwinds, then over the long term thematic investing should outperform traditional strategies and benchmarks on an absolute basis. The last full market cycle, as measured from trough to trough, spanned from October 2002 to March 2009,¹¹ as shown in Figure 3.

6 The hypothetical portfolios are not actual portfolios and are not available for investment. The hypothetical portfolios do not represent any portfolios offered by ARK Investment Management LLC.

7 The percent exposure to multiple sectors was smaller for the health care funds in order to allow a larger sample size. One could make the case, however, that the disruptive forces driving health care are more concentrated, warranting less cross-sector exposure.

8 While often cited as an inherent flaw in similar studies, these hypothetical thematic portfolios do not suffer from survivorship bias as funds were "layered in" over time as they were launched, and funds that were closed were "layered out." Performance of the hypothetical thematic portfolios is back-tested and is derived from the retroactive application of a model designed with the benefit of hindsight. Performance of the hypothetical thematic portfolios does not reflect performance of any actual portfolios. Hypothetical and back-tested performance almost invariably will show attractive returns, due to the benefit of hindsight, while actual results going forward may not be as attractive.

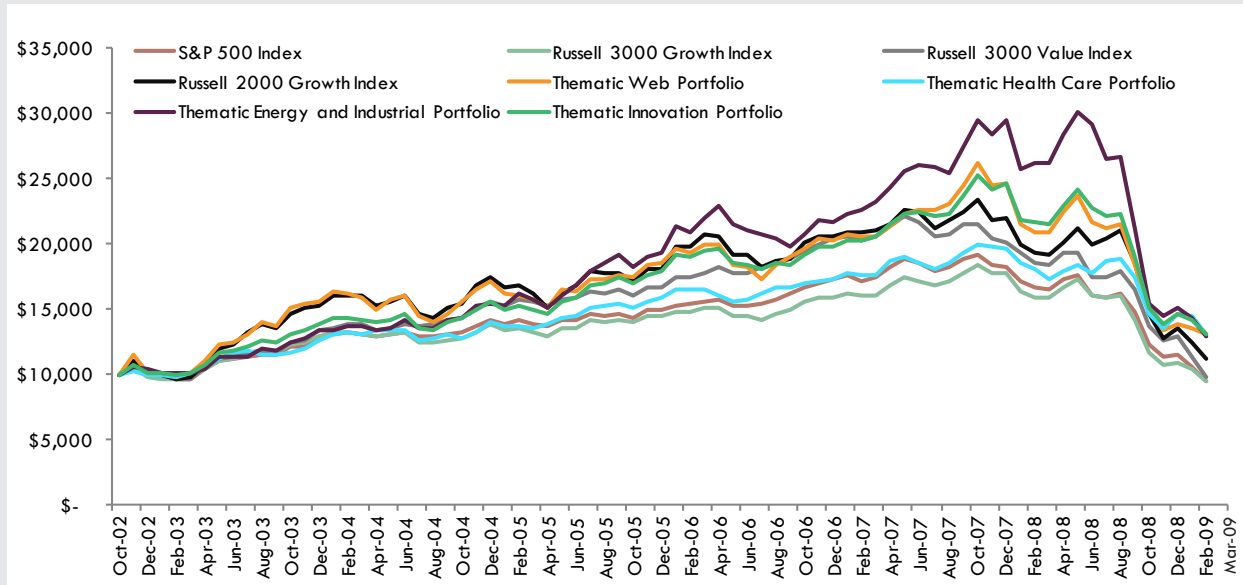
9 All index performance is total return (i.e., reinvested dividends) and was sourced from Bloomberg.

10 The current market cycle has not yet ended with a bear market.

11 A full market cycle is defined as the bottom of a bear market to the bottom of a bear market, with the S&P 500 Index as the market proxy. In 2002, the bear market bottomed on October 9th, 2002, signifying the beginning of a new market cycle from that day on. That market cycle ended on March 9th, 2009. Note, since monthly data was used in ARK's analysis the market cycle ends on February 27th, 2009, as that represented a lower point than March 31st, 2009. For the rest of the paper when 2002 to 2009 is referenced it refers to this period.



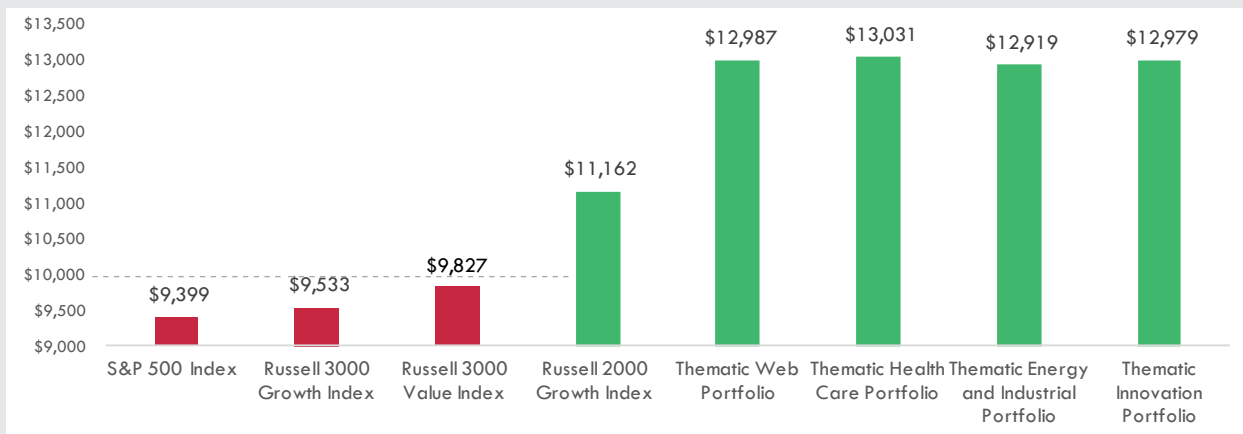
FIGURE 3
Value of a Hypothetical \$10,000 Initial Investment | Full Market Cycle: 2002 to 2009



Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)

Because the Global Financial Crisis in 2008-2009 was a severe blow to the market’s long term uptrend, three indices had negative performance for the period, as is illustrated in Figure 4. The thematic portfolios had positive performance for the period, and outperformed all four indices.

FIGURE 4
Ending Value of a Hypothetical \$10,000 Initial Investment | Full Market Cycle: 2002 to 2009

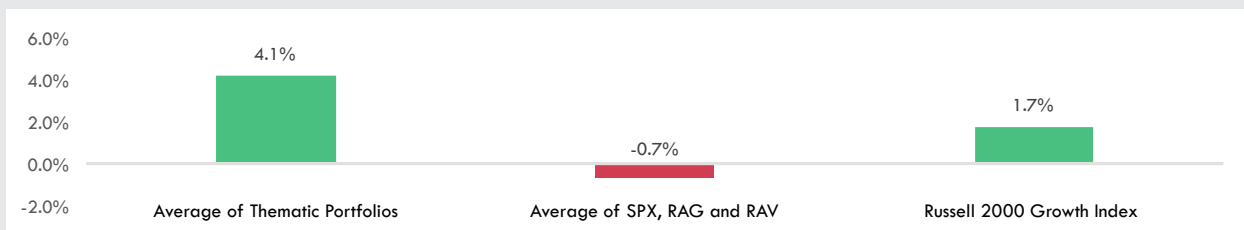


Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)



On average, the four thematic portfolios outperformed the S&P 500 Index, Russell 3000 Growth Index, and Russell 3000 Value Index by 4.8% at a compounded annual rate, as shown in Figure 5.¹² At the end of the cycle, the thematic portfolios were worth \$12,979 on average compared to \$9,586 for the average of the three larger cap indices (SPX, RAG and RAV). Even compared to the Russell 2000 Growth Index, which was worth \$11,162 in March 2009, the thematic portfolios on average outperformed by more than 2.4% on a compound annual return basis.¹³ ARK believes that one likely explanation for the underperformance of the broad market indices is that, over the long term, innovation disrupts well-established companies that have disproportionately high weights in traditional broad based benchmarks.

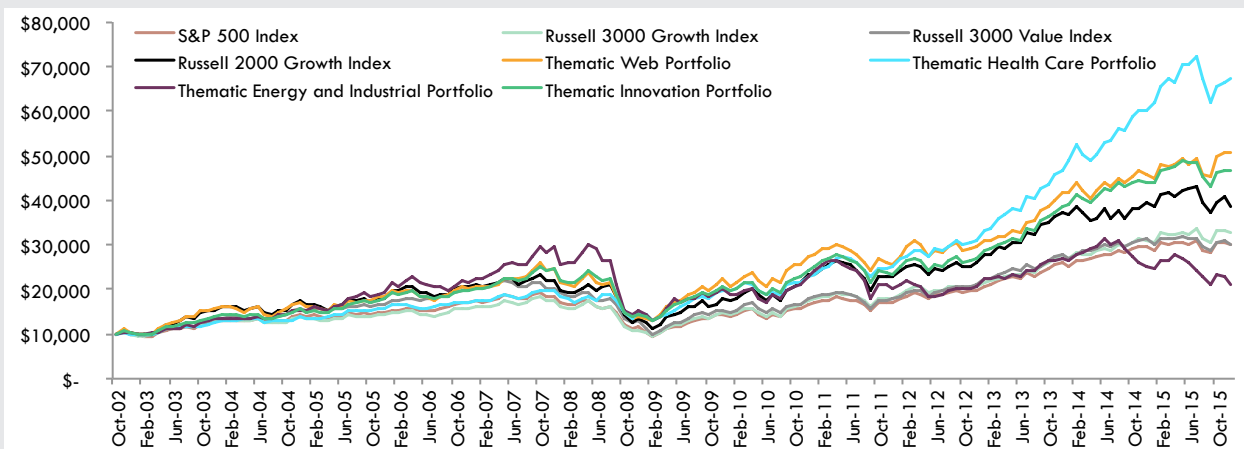
FIGURE 5
 Compound Annual Returns | Full Market Cycle: 2002 to 2009



Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
 Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)

Since 2009, while they have corrected a few times, equities have not dropped into bear market territory, which would create another full market cycle. Consequently, as a second take on long term performance, the following analysis is for the full market cycle just described combined with the current bull market, spanning the last 13 years from October 2002 through the end of 2015.

FIGURE 6
 Value of a Hypothetical \$10,000 Investment | Full Market Cycle + Current Cycle: 2002 to 2015



Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
 Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)

12 This was calculated by taking the avg. ending dollar value of the thematic portfolios and computing the compound annual return in relation to the beginning \$10,000 initial investment. The same process was performed for the avg. compound annual return of the SPX, RAG and RAV.

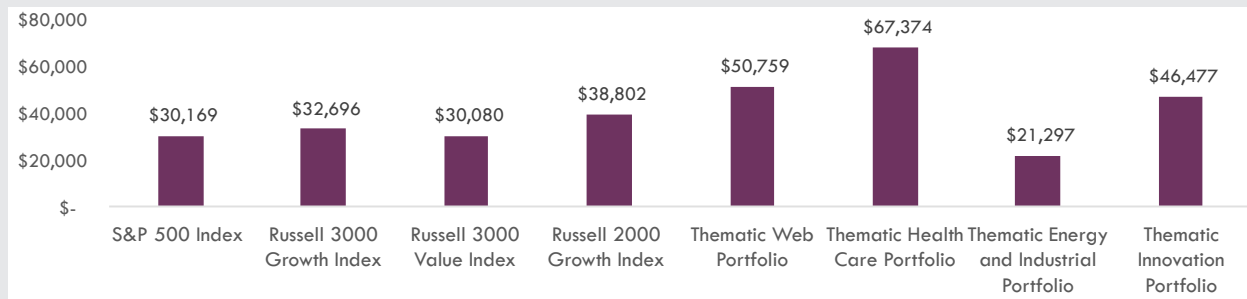
13 Note that the thematic innovation portfolio represents the combined average performance of the three more focused thematic portfolios.



During the past 13 years, as illustrated in Figure 6 and 7, the thematic portfolios grew from a \$10,000 initial investment to an ending value of \$46,477 on average, and the S&P 500 Index, Russell 3000 Growth Index, and Russell 3000 Value Index grew to \$30,982 on average.

FIGURE 7

Ending Value of a Hypothetical \$10,000 Initial Investment | Full Market Cycle + Current Cycle: 2002 to 2015



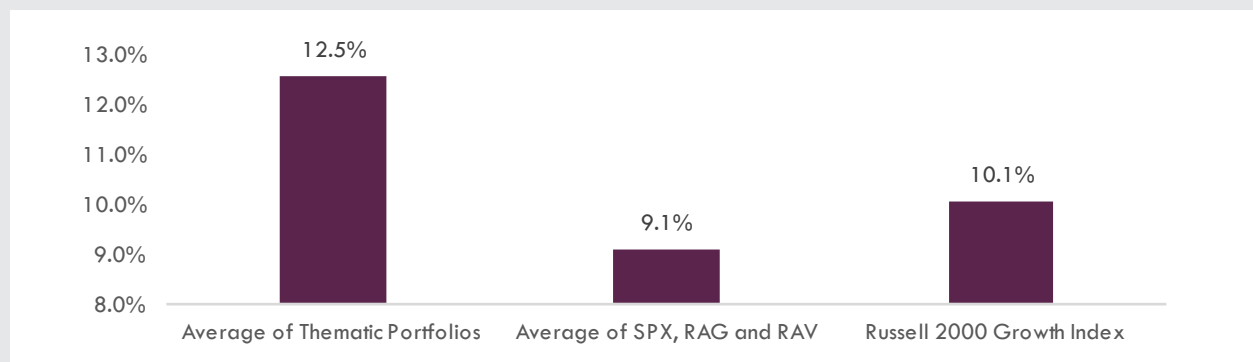
Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)

While the thematic portfolios on average outperformed the four indices over time, not all of the themes have moved in lockstep. From 2002 to 2009, for example, the thematic energy and industrial portfolio enjoyed the tailwinds of a commodity supercycle thanks to the emergence of China and other markets. During the current cycle, however, innovation in thematic energy and industrials has been overwhelmed by the end of the supercycle and falling commodity prices. In contrast, as shown in Figure 7, while the thematic health care portfolio meandered during the last full market cycle, it has outperformed the other thematic portfolios and the four indices in the current cycle, with an ending value of \$15,000 more than any of the other thematic portfolios and indices. Combining the three thematic portfolios, the general innovation portfolio has provided a more even-keeled source of outperformance relative to the indices.

Although they haven't moved in lockstep, the thematic portfolios on average outperformed the three larger cap indices on a total return basis by 3.4% per year. Relative to the Russell 2000 Growth Index, which had an ending value of \$38,802, the thematic portfolios on average outperformed by 2.4% on a compound annual return basis, as shown in Figure 8.

FIGURE 8

Compound Annual Returns | Full Market Cycle + Current Cycle: 2002 to 2015



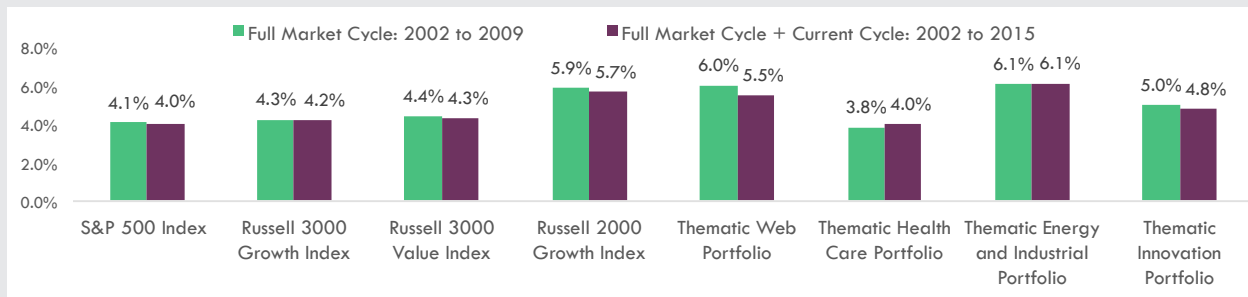
Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)



VOLATILITY

Thematic investing is prone to more volatility than is traditional investing, a good example being the recent behavior of the thematic energy and industrial portfolio. Standard deviation (i.e., total risk) is the most common investment-related measure of volatility. In Figure 9, as measured by monthly standard deviations, the volatility of the thematic portfolios generally was higher than that of the broad based benchmark indices.

FIGURE 9
Monthly Standard Deviation



Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)

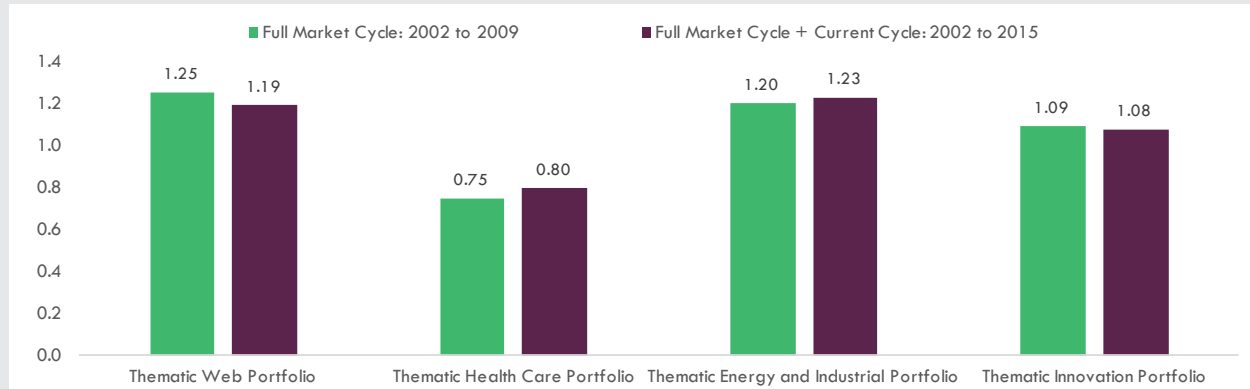
Because of their high active share, the thematic portfolios tended to be volatile relative to traditional broad based benchmarks. In other words, their overlap with benchmark-sensitive strategies was quite low. Consequently, in risk-off periods, when investors seek the “safety” of the benchmark indices, thematic strategies will suffer when assessed by that “measure” of safety. Conversely, as risk appetites grow in a bull market, thematic strategies typically outperform the broader benchmarks, thanks to their high active share. Combining the three thematic portfolios, the thematic innovation portfolio was more diversified and therefore the second least volatile thematic portfolio. The innovations in health care during the past decade were powerful on a consistent basis, enough so that the thematic health care portfolio was the least volatile of the four portfolios.

The relative stability of the thematic health care portfolio can be quantified by its beta. Beta measures how sensitive an equity is to fluctuations in the equity market. A beta greater than 1.0 suggests that an equity is more sensitive to market movements, and a beta less than 1.0 suggests that it is less sensitive. In Figure 10, the beta of each thematic portfolio is calculated relative to the S&P 500 Index, with the three month Treasury bill rate as the risk free rate.

With the lowest beta, the thematic health care portfolio was relatively immune to broad market volatility during the last 13 years, while the thematic web and thematic energy and industrial portfolios had relatively high betas. The beta of the more diversified thematic innovation portfolio fell between the two extremes.



FIGURE 10
Beta of Hypothetical Thematic Portfolios

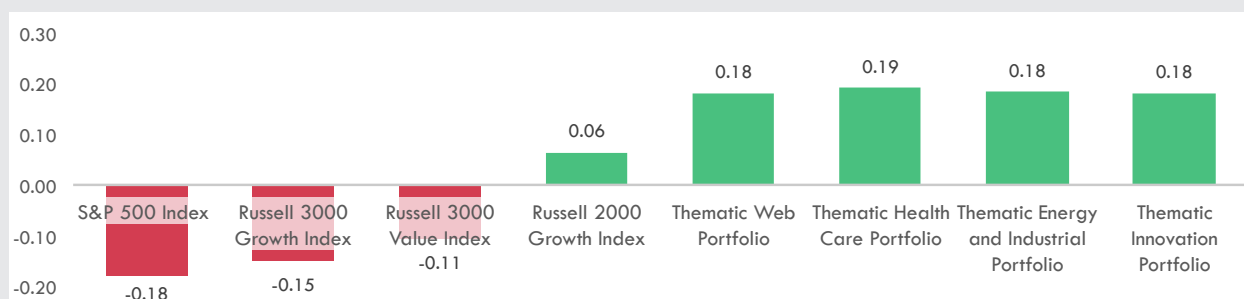


Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)

RISK-ADJUSTED RETURNS

Standardizing reward relative to risk, the Sharpe Ratio adjusts absolute returns for total risk. As the industry standard, the Sharpe Ratio measures returns above three-month Treasury bill rates (i.e., excess returns), per unit of standard deviation. Important to note is the endpoint sensitivity of Sharpe Ratios, suggesting that they are most meaningful when comparing strategies for the same period of time. In Figure 11, ARK annualized the Sharpe Ratio via methods outlined by Morningstar.¹⁴ As illustrated earlier, unlike the Russell 2000 Growth Index and the thematic portfolios, the S&P 500 Index, Russell 3000 Growth Index, and Russell 3000 Value Index all finished the full market cycle from 2002 to 2009 with negative absolute and risk-adjusted returns.

FIGURE 11
Sharpe Ratio | Full Market Cycle: 2002 to 2009



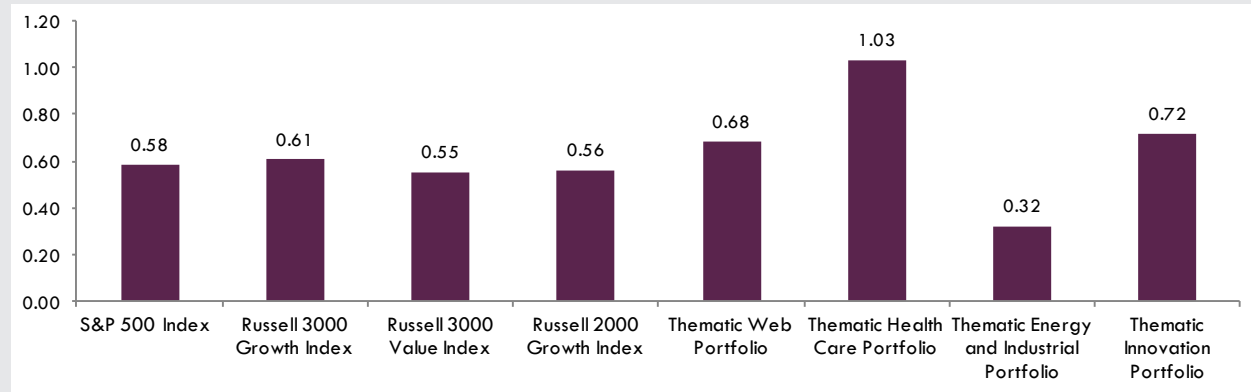
Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)

Notably, the risk-adjusted returns of all four thematic portfolios were more than 2.5 times that of the Russell 2000 Growth Index during the full market cycle. Combining both the full market cycle and the current cycle, three of the thematic portfolios produced the three highest risk-adjusted returns, as shown in Figure 12. The exception was the thematic energy and industrial portfolio, as the bursting of the commodity supercycle overwhelmed innovation themes like energy storage and robotics.

¹⁴ "Standard Deviation and Sharpe Ratio: Morningstar Methodology Paper," Morningstar, Inc., January 2005, <http://arkinv.st/1mjyLjL>.



FIGURE 12
Sharpe Ratio | Full Market Cycle + Current Cycle: 2002 to 2015

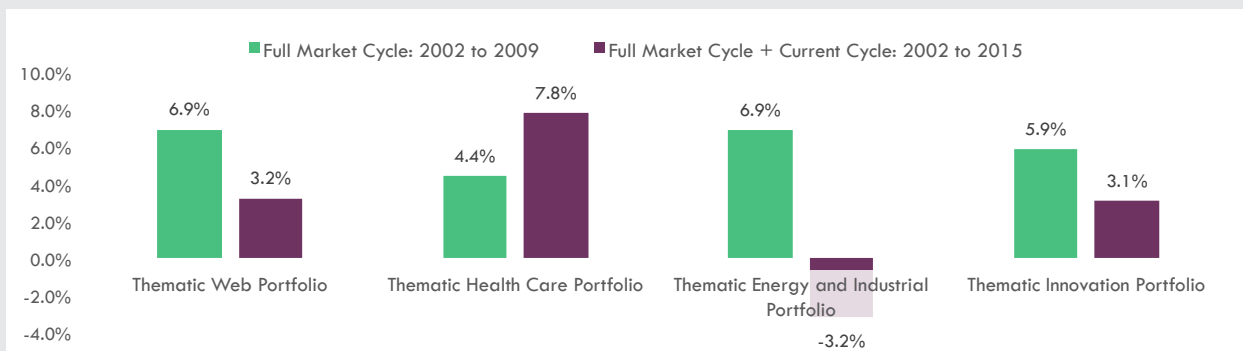


Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)

Figure 12 includes some other interesting nuances. First, the absolute outperformance of the Russell 2000 Growth Index was not significant enough to offset its small cap volatility, putting its Sharpe Ratio below that of the Russell 3000 Growth Index. Second, while the thematic web portfolio outperformed the thematic innovation portfolio on an absolute basis, the more broad based thematic innovation portfolio generated superior risk-adjusted returns thanks to the stability associated with diversification across themes and sectors.

On yet another measure—Jensen’s Alpha (commonly referred to as “alpha”)—the thematic portfolios significantly outperformed the S&P 500 Index on a risk-adjusted basis as shown in Figure 13.¹⁵ Unlike the Sharpe Ratio, which focuses on performance relative to total risk, alpha shows performance relative to a specified benchmark. In other words, alpha strips the returns that could have been captured by investing in the benchmark— in this case the S&P 500 Index— leaving only the relative outperformance of a fund.

FIGURE 13
Jensen’s Alpha (“Alpha”)



Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)

¹⁵ Calculated per Morningstar methods, “Modern Portfolio Theory (MPT) Statistics: Morningstar Methodology Paper,” Morningstar, Inc., May 2009, <http://arkinv.st/1POHNJ7>.

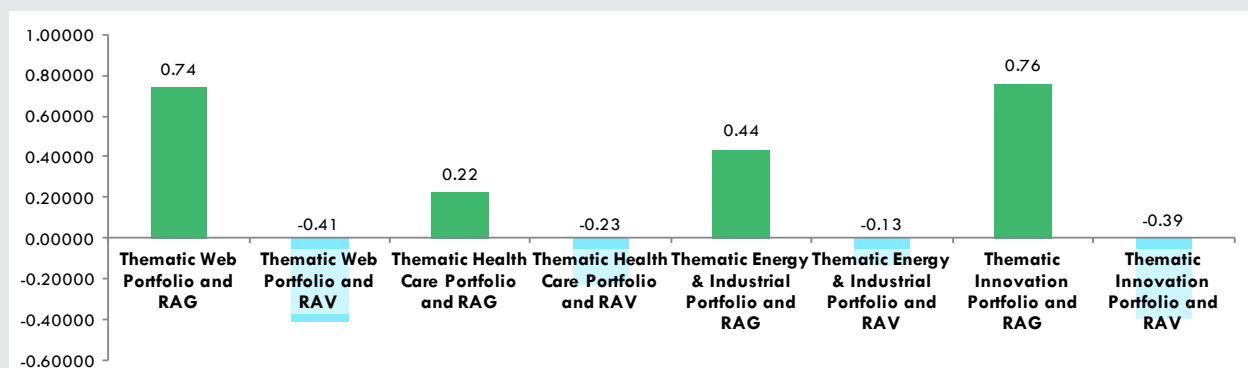


CORRELATION OF RELATIVE RETURNS

According to modern portfolio theory, the best investment strategies eliminate unsystematic risk via diversification. The less correlated assets are in an investment strategy, the lower the risk inherent in the overall portfolio. Thus, a sound investment portfolio includes assets that are attractive on a risk-adjusted return basis and have a low correlation of relative returns. As shown in Figure 14, with the S&P 500 Index as a benchmark,¹⁶ during the last full market cycle the correlation of relative returns of the thematic portfolios to that of the Russell 3000 Value Index (RAV) was negative, and ranged from a low 0.22 to a moderate 0.76 when compared to the Russell 3000 Growth Index (RAG).

FIGURE 14

Correlation of Relative Returns to the S&P 500 Index | Full Market Cycle: 2002 to 2009



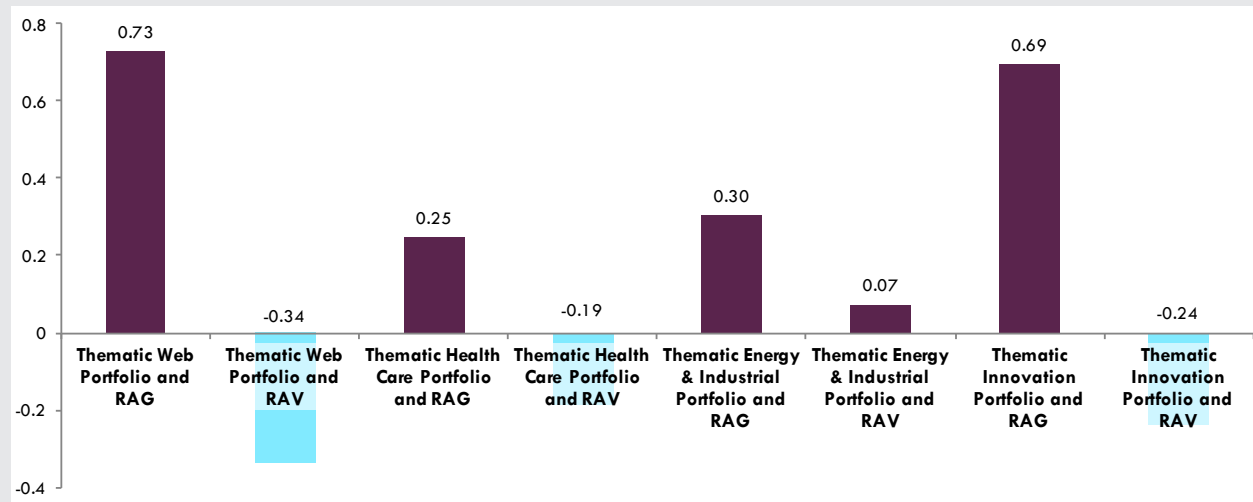
Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)

While the hypothetical portfolios shown in this paper are not available for investment and do not represent the returns of any actual portfolio, they can serve as proxies to demonstrate the benefits of diversification. For example, if over the last 13 years an investor had included exposure to thematic investments focused on web, health care or convergent innovation at large as a complement to a core value portfolio based on the Russell 3000 Value Index, then on days when the core value portfolio underperformed the S&P 500, the thematic investments typically would have outperformed the S&P 500, and vice versa. Relative to the Russell 3000 Growth Index, both the thematic health care and thematic energy and industrial investments would have offered low correlation of relative returns, not only from 2002 to 2009 but also longer term, from 2002 to 2015, as shown in Figure 15.

¹⁶ The S&P 500 Index is used as a relativity benchmark because it is commonly regarded as representative of the equity market as a whole.

**FIGURE 15**

Correlation of Relative Returns to the S&P 500 Index | Full Market Cycle + Current Cycle: 2002 to 2015



Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
 Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)

THEMATIC STRATEGIES VS. TRADITIONAL SECTOR STRATEGIES

Based on the analysis described above, thematic portfolios tend to outperform on both an absolute and a risk-adjusted basis, generally with a low to moderate correlation of relative returns to core growth and a negative correlation of relative returns to value strategies. But, could such performance simply be a sector focus phenomenon?

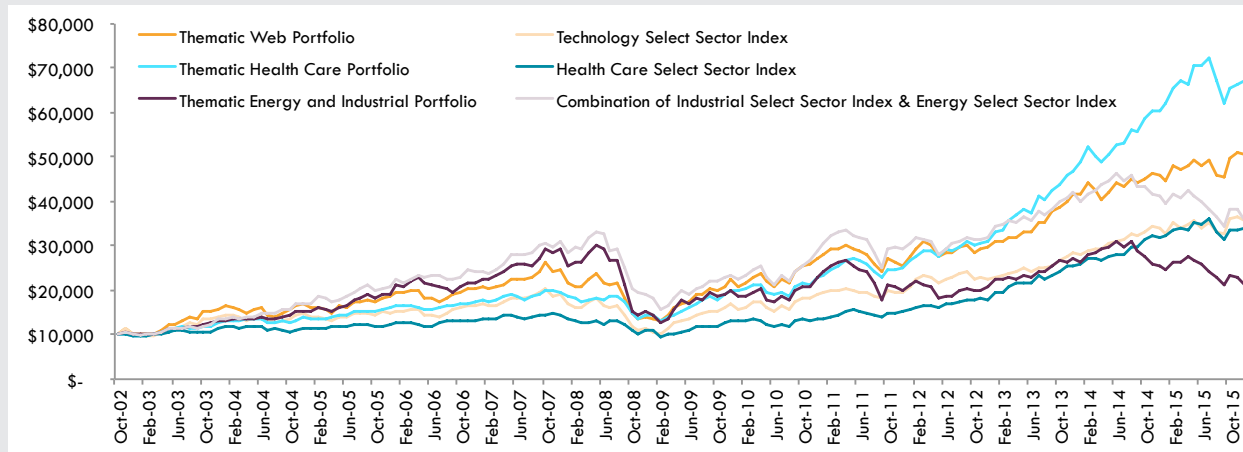
To answer that question, ARK compared the performance of the thematic portfolios during the past 13 years to that of similar sectors in the S&P 500: the Technology Select Sector Index (IXT), Health Care Select Sector Index (IXV), and a combination index of the Industrial Select Sector Index (IXI) and Energy Select Sector Index (IXE).¹⁷

In Figure 16, on a compound annual return basis the combined S&P 500 Energy and Industrial sectors outperformed the thematic energy and industrial portfolio by 4.3%. Meanwhile, the thematic web and thematic health care portfolios outperformed their S&P 500 sector counterparts by 3.0% and 5.9% at an annual rate respectively, yielding the ending values shown in Figure 17. Clearly, the commodity supercycle trounced energy and industrial innovation, as China evolved into an industrial powerhouse during the first half of the 2002-2015 period and then unwound ferociously during the latter half.

¹⁷ These indices were sourced from Bloomberg as total return (i.e., reinvested dividends).

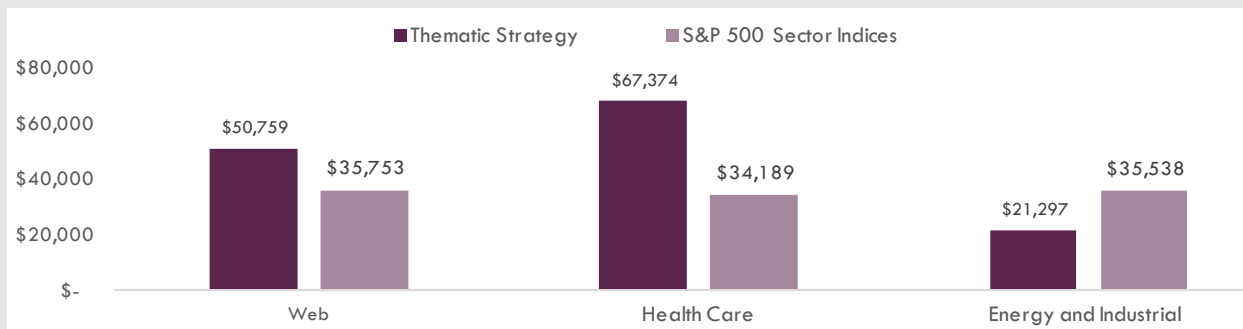


FIGURE 16
 Hypothetical \$10,000 Initial Investment | Full Market Cycle + Current Cycle: 2002 to 2015



Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
 Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)

FIGURE 17
 Ending Value of a Hypothetical \$10,000 Initial Investment | Full Market Cycle + Current Cycle: 2002 to 2015



Source: ARK Investment Management LLC, Morningstar, Inc., Bloomberg
 Note: Performance shown is gross fees and total returns (i.e., reinvested dividends)

Measured in dollars, as shown in Figure 17, the differential performance is quite provocative. An investment of \$30,000 in the thematic web, health care, and energy and industrial portfolios (\$10K in each portfolio) on October 31, 2002 would have more than quadrupled to \$139,430 in net asset value (\$50,759, \$67,374, and \$21,297 in each portfolio, respectively) by December 31, 2015. In contrast, \$30,000 allocated to the S&P Select Sector Index counterparts (\$10K each) would have compounded to \$105,480, giving the thematic portfolios more than a 30% performance edge for the entire period.

The significant outperformance of the thematic portfolios relative to S&P 500 constituents in similar sectors is likely the result of active fund management focused on innovation. Active share will become increasingly important as innovation changes the world at an accelerated rate, putting index-based strategies at a disadvantage. Furthermore, ARK believes that the controversy stirred by innovation cutting across economic sectors provides short term trading opportunities for active managers.



CONCLUSION

ARK believes that broad based benchmark indices, which are backward looking by definition, will be disrupted as the world experiences exponential change. Thematic strategies— which anticipate and embrace these disruptive multi-year changes— position investors to enjoy the rising tides of innovation.

Often, these innovations seem discrete— like mobile and cloud computing— but later converge to produce unprecedented leaps in productivity and efficiency. Due to their initially disparate appearance, innovative themes are not captured adequately by focusing on a single sector, but instead by taking an active approach to investigating the catalysts of change (Figure 16).

Since the ramifications of converging innovations are not well understood, stocks poised to benefit are not priced properly in the market until exponential growth pulls away from linear growth. By anticipating innovations that are misunderstood and mispriced, thematic strategies can position investors to capitalize on inflections in growth. As a result, the majority of the hypothetical thematic portfolios depicted above have outperformed broad market indices on an absolute and risk-adjusted basis over the long term (Figure 11, 12).

Perhaps most importantly, the depicted thematic portfolios had moderate to negative correlation of relative returns to broad based benchmarks— injecting growth while governing risk— showing that thematic strategies can be an attractive complement to traditional investment portfolios (Figure 14, 15). The above characteristics demonstrate that investors potentially could increase returns and lower risk by adding thematic strategies to traditional benchmark portfolios.

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Room for further research

To avoid problems with sample size and data fidelity, ARK chose to start its analysis with the bear market of 2002. Given properly constructed portfolios, a longer term study could prove valuable both to analyze performance over multiple decades and to investigate a larger sample size of behavior within full market cycles.

Additionally, thematic strategies can incorporate sectors, such as commodities, which are not focused on capturing the tailwinds of innovation featured in this analysis. Due to its open source research model, ARK is happy to collaborate with research teams looking to leverage upon and expand this study of the thematic investing space.



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HYPOTHETICAL PORTFOLIOS: The hypothetical thematic portfolios (thematic web portfolio, thematic health care portfolio, thematic energy and industrial portfolio and thematic innovation portfolio) were created by retroactively applying a model developed with the benefit of hindsight. Hypothetical performance results often involve certain material assumptions in creating the portfolios, based on the investment theory espoused, during the relevant historical period and the data set chosen may not be indicative of present or future market conditions. Hypothetical and back-tested performance almost invariably will show attractive returns, due to the benefit of hindsight, while actual results going forward may not be as attractive. Performance for the hypothetical portfolios does not represent future results. Performance for the hypothetical thematic portfolios is gross of fees.

The hypothetical thematic portfolios are not actual portfolios and do not represent any strategy or product currently offered by ARK. Performance for the hypothetical thematic portfolios does not represent the actual performance of any of ARK's client accounts or any products offered by ARK. Performance of ARK's strategies and products would differ.

INDEX DESCRIPTIONS: The Russell 3000 Index measures the performance of the largest 3,000 U.S. companies representing approximately 98% of the investable U.S. equity market. The Russell 3000 Growth Index measures the performance of those Russell 3000 Index companies with higher price-to-book ratios and higher forecasted growth values. The Russell 3000 Value Index measures the performance of those Russell 3000 Index companies with lower price-to-book ratios and lower forecasted growth values. The Russell 2000 Growth Index measures the performance of those Russell 2000 Index companies (the smallest 2,000 companies in the Russell 3000 Index) with higher price-to-book ratios and higher forecasted growth values. The S&P 500 Index is a widely recognized capitalization-weighted index that measures the performance of the large-capitalization sector of the U.S. stock market. The Technology Select Sector Index combines constituents of the S&P 500 Index classified in the GICS Information Technology and Telecommunication Services sectors. The Health Care Select Sector Index includes constituents of the S&P 500 Index classified in the GICS Health Care sector. The Industrial Select Sector Index includes constituents of the S&P 500 Index classified in the GICS Industrials sector. The Energy Select Sector Index includes constituents of the S&P 500 Index classified in the GICS Energy sector. Direct investment in an index is not possible.

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