The Knowledge Effect: Excess Returns of Highly Innovative Companies

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Executive Summary

In this paper, we identify the Knowledge Effect, the tendency of stocks of highly innovative companies to experience excess returns. It results from investors' systematic errors in evaluating companies that invest large sums of money in producing knowledge.

The origins of the Knowledge Effect can be traced to two factors:

1. A surge in the pace of knowledge production catalyzed by the release of the first commercially available semiconductor in 1971. Due to the cumulative nature of knowledge, this acceleration has resulted in an exponential increase in humankind's total knowledge.
2. A mandate by the US Financial Accounting Standards Board in 1974 which ruled that companies must expense knowledge investments in the period incurred. This deprived investors of relevant financial information on corporate knowledge spending at the dawn of this massive surge in the pace of knowledge production.

The Knowledge Effect is grounded in academic literature. It was first discovered in a series of studies in the 1990s where NYU's Baruch Lev analyzed 20 years of financial data and discovered an association between a firm's level of knowledge capital and its subsequent stock performance. Further research advanced the findings, and in 2005, Lev proved the existence of a market inefficiency attributable to missing information about corporate knowledge investments. This phenomenon leads highly innovative companies to deliver persistent abnormal returns.

Knowledge Leaders Capital captures the Knowledge Effect using a proprietary process designed to overcome the informational shortcomings of traditional financial statements. Our methodology capitalizes corporate knowledge investments, measures firm performance on a knowledge-adjusted basis, and selects investments on the basis of knowledge intensity.

Introduction

What drives stock returns? Answering this question has been a goal of investors ever since Harry Markowitz introduced his Modern Portfolio Theory in the 1950s. Later, William Sharpe's Capital Asset Pricing Model illustrated that the market itself is the first and foremost element in explaining a stock's performance. However, empirical research over the past several decades has identified many other effects beyond simply the market that exhibit a strong explanatory power of stock returns. These effects are persistent over time and apply to a broad range of stocks. Some of the more widely known are the small-cap effect, the value effect, and the momentum effect. In this paper, we identify a new anomaly, the Knowledge Effect. The Knowledge Effect is a pricing anomaly that leads to persistent excess returns among highly innovative companies.

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The Knowledge Effect can be traced to two important roots. First, with introduction of the semiconductor, humankind was able to radically accelerate its knowledge production. The semiconductor has enabled humankind to multiply its intellectual strength in a similar way that the steam engine and electric motor enabled humankind to multiply its physical strength. Knowledge production takes the form of corporate investment in research and development (R&D), advertising and employee training. Corporations spend more on knowledge than they do on property, plant and equipment. The second important root for the Knowledge Effect is the dearth of information about corporate knowledge activities that has been amplified by the poorly timed implementation of conservative accounting practices at the start of the greatest period of knowledge production in human history. This information deficiency has led investors to make a systematic error in the way they assess the prospects of companies that invest significantly in knowledge. Ultimately, this systematic error is reflected in a persistent risk premium, or excess return, for companies that invest significantly in knowledge.

The Knowledge Effect was originally discovered by academic researchers, spearheaded by Baruch Lev, who studied 20 years of financial data and discovered an important association between a firm's level of knowledge capital and its subsequent stock returns. Further research advanced the original findings and in 2005 Lev, building on his own earlier research as well as that of others, proved the existence of a market inefficiency traceable to missing information about corporate knowledge investments. This inefficiency has led highly innovative companies to deliver persistently positive abnormal returns in the stock market.

Knowledge Leaders Capital has developed the Knowledge Leaders Indexes as the broadest, longest running, real-time test of the Knowledge Effect. We have developed a proprietary process designed to overcome the informational shortcomings that afflict most investors. Our results suggest that there is an enormous opportunity for investors to capitalize on the Knowledge Effect in both developed and emerging markets.

Two Views On the Drivers of Stock Returns

There are generally two views regarding the factors that drive stock returns: an efficient market hypothesis view and a behavioral view.

The efficient market hypothesis asserts that all market participants are rational and asset prices immediately incorporate all relevant information. Based on this foundation, the rate of return earned is determined by the systematic risk, or market risk, of the stock. This concept was illustrated by William Sharpe in his Capital Asset Pricing Model (CAPM) which showed that a stock's expected return is determined by the risk-free rate plus the systematic risk associated with the stock. The CAPM folded neatly into Modern Portfolio Theory (MPT) since according to MPT an investor is compensated only for taking on market risk, which cannot be diversified away, and is not compensated for the idiosyncratic risk of the stock, which can be diversified away. Any perceived excess return of a stock is simply due to a higher overall level of systematic risk. As we will see later on in the paper, the academic research on the Knowledge Effect identified this as one of the early possible explanations for the persistent abnormal returns of highly innovative companies.

The behavioral view of what drives stock returns begins with the hypothesis that investors make systematic errors. Investors have behavioral biases that lead to these errors. For example, rational investors may be deprived of information about a company's knowledge investments and under-react or over-react to news about the company's growth prospects. Therefore, in addition to the systematic risk of a stock, an investor is also compensated for the systematic errors created by other investors. These systematic errors can create abnormal returns in certain groups of stocks. It is consensus among the academic community that deficient information regarding corporate knowledge production is at the heart of the observed abnormal returns generated by knowledge intensive companies. In other words, the Knowledge Effect is in part a function of insufficient information regarding corporate knowledge investments.

Knowledge Is About Creating Recipes

Economic growth occurs when people deliberately combine resources according to some recipe producing a final good of greater value than the ingredients that went into it. Economic development is the continuous process of combining resources in highly valuable ways. There are billions of different ways to combine resources and much of economic growth is the process of testing these combinations to satisfy human needs or wants. Stanford Economist Paul Romer offers an interesting thought experiment to illustrate the opportunities for discovery. There are roughly 100 different atoms on the periodic table of elements. Imagine the task of combining four of these atoms, in equal proportion, to form a final compound. There would be (100*99*98*97) 94,000,000 different combinations to test. Next, if each ingredient could be used in a proportion on a scale of 1-10 parts, using only whole numbers, then the number of possible recipes goes to (3,500*94,000,000) 330 billion. All these possible recipes stem from just four basic ingredients! The testing of various recipes—picture Thomas Edison in his lab churning through thousands of possible lightbulb filaments—is the creation of knowledge. In 1957, Robert Solow, looking back on US economic growth between 1909 and 1949 concluded that 87% of economic growth was a result of technological innovation, or the successful creation and application of recipes.

General Purpose Technologies Are Engines of Growth

In any given period in time, there is a core technology that performs some basic function upon which many applications are built. Historically this core technology, or general purpose technology, forms the basis of economic development for decades or centuries.

Looking back on the first and second industrial revolutions, it is easy to see the impact of general purpose technologies. Work can be defined as an energy transformation, converting raw materials into some finished product. The clothes we wear begin as raw cotton that needs to be processed into thread, woven into cloth and then formed into shapes. All along this production process energy, whether human, animal or mechanical, must be applied to convert the raw cotton into a series of intermediate goods and then ultimately into a finished good. In the seventeenth century the manufacture of clothing was terribly expensive, employing huge amounts of human energy. By the eighteenth century the manufacture of clothing had been revolutionized by the adoption of the steam engine.

Manufacturers figured out that a very particular type of energy transformation was needed to create clothes—continuous rotary motion—and that this energy could be produced in huge quantities by the steam engine. Of course clothing wasn't the only industry to figure out how to employ the generic function of continuous rotary motion. As more and more industries harnessed the power of the steam engine to perform work, economic growth exploded on the back of this huge productivity increase. The first industrial revolution, which fundamentally changed the trajectory of human development was simply the result of the adoption and diffusion of a general purpose technology—the steam engine—that supplied a generic function in quantities unfathomable before its advent.

In the second industrial revolution, the electric motor supplanted the steam engine as the general purpose technology, performing continuous rotary motion in much greater quantities, and at much cheaper prices. Importantly, the electric motor also allowed for the fractionalization of energy output and hence work. Factories driven by a steam engine needed to be organized vertically because all power was derived from a main shaft. However, this vertical organization made it very difficult to move raw materials into the factory, move intermediate goods along the manufacturing line and to move finished goods out of the factory. The electric motor, with its fractionalized power output, opened up the possibility to reorganize the factory horizontally. In 1900, the electric motor accounted for less than 5% of the total manufacturing horsepower in the US. By 1930, the electric motor was providing 80% of total manufacturing horsepower. While the 1930s stand out in US economic history as one of the worst decades of economic growth and high unemployment, the 1930s was also the decade where the US recorded its highest rate of labor productivity ever. As factories reorganized around the electric motor, productivity surged.

In 1971 Intel released the model 4004, the first commercially available integrated semiconductor. The semiconductor performed a new general purpose form of work—continuous binary logic. The 4-bit central processing unit (CPU) was the first ever monolithic CPU fully integrated into a single chip. Today, the 3rd generation Intel core processor has 1.4 billion transistors or approximately 609,000x more transistors than the Intel 4004. The operating speed of the 3rd generation Intel Core processor is approximately 27,000x faster than the Intel 4004.

While the steam engine and then the electric motor expanded humankind's physical capacity, the semiconductor has expanded humankind's mental capacity. The raw materials we have to work with in the world haven't changed since the dawn of time, but as a result of trial and error, the recipes we have created to combine these raw materials have changed dramatically. The production of knowledge is the development of new and better recipes for combining resources. The utilization of the semiconductor and its continuous binary logic has accelerated the production of knowledge as we have been able to test more and more ways of combining resources.

The essence of R&D spending is the testing of new recipes. Drug companies spend billions every year testing new chemical compounds, seeking the right molecular combination with a beneficial impact on disease. Researchers rely on the existing stock of human knowledge and semiconductors to discover new knowledge. As the performance of semiconductors improves, the rate at which new discoveries can be uncovered accelerates. Similarly, as the stock of human knowledge increases, the rate at which new discoveries can be found accelerates. When the inventory of human knowledge increases and the rate of semiconductor performance improves, the rate of new discoveries moves into what inventor Ray Kurzweil describes as a double exponential rate. Thanks to the continuous binary logic processing of the semiconductor, we are living in a time of accelerating new discovery.

Forty-four years into the semiconductor era, it is easy to see how pervasive the general purpose technology has become. In the health care industry, innovations like DNA sequencing and the genomic revolution are leading to huge improvements in patient quality of living and longevity. In the technology industry, smart phones and mobile communications have transformed how we interact and how business is structured. In the manufacturing industry, sensors, robotics and automation have led to massive increases in industrial productivity and quality. The energy industry has been revolutionized by 3D seismic and computer controlled fracking technologies. Retailing and entertainment has been upended by digital distribution technologies. At the heart of all these new products and processes is the semiconductor, the engine of growth for the last half century.

Accounting for Knowledge Production Turns Conservative

From an economic perspective, companies produce knowledge in a variety of ways. They engage in scientific R&D to discover and commercialize new technologies or applications. They perform non-scientific R&D to conceive and produce artistic work. They inform the marketplace about their products via advertising. They promote their brand, in an effort to gain customer trust. They educate and train their employees to produce products, sell them and service them. They codify company specific information about customers, markets and competitors.

The whole purpose of accounting conventions is to standardize corporate information disclosures about financial and operating performance. Accounting standards themselves are a recipe of sorts—they prescribe a specific combination of financial information collected together in a set of structured financial statements. In theory, financial statements should be a reflection of reality in the sense that they should convey information relevant to investors in such a way to reflect the underlying economic realities of businesses. This information is essential for investors to allocate capital efficiently. The absence of information can lead investors to make errors in assessing the health and growth prospects of companies.

Given the role knowledge production plays in economic development, it makes sense to expect that we have a highly developed accounting standard to measure it. Unfortunately, this is not the case. Current accounting standards do a terrible job measuring knowledge production. Since 1974, accounting standards in the US have mandated that not only must companies expense all knowledge spending, they are not required to provide any information about their knowledge production. According to the Financial Accounting Standards Board (FASB) the information is “not sufficiently objective, is confidential in nature, or is beyond the scope of financial accounting.”

As a result, corporate investments in R&D, advertising, brand development, employee training and firm specific resources must all be expensed. When spending is capitalized, it is not charged against current period revenues and a company records an asset on its balance sheet reflecting the investment. When spending is expensed, the company must deduct the charge from current revenues and does not record any asset reflecting the spending. In theory, any investment that creates long-term value for a company should be capitalized and recorded as an asset regardless of whether the asset is tangible, like a piece of machinery, or intangible, like some new recipe. By forcing companies to expense these knowledge investments, FASB is depriving investors of information central to measuring corporate knowledge production. This has not always been the case.

The first mention of the accounting treatment of R&D was in a 1917 Federal Reserve Board (FRB) bulletin. The FRB accepted that R&D should be categorized as a deferred charge in published financial statements. This is another way of saying that R&D spending should be capitalized rather than being expensed immediately. The deferral treatment of R&D was supported throughout the 1920s, 1930’s, and 1940’s by a variety of financial institutions including the National Association of Cost Accountants (NACA), the Internal Revenue Service (IRS) and again by the FRB.

In the mid-1950s, tax legislation allowed companies to deduct the cost of R&D from taxes. The IRS set the precedent that companies could keep, in effect, two sets of books--one for internal purposes where they capitalized R&D investments and another for tax purposes, where they could deduct the investment. This accounting duality was the best of both worlds for companies because they could lower their tax bills and still count R&D investments as assets. The tax legislation that allowed R&D spending to be immediately expensed for tax accounting purposes was presumably intended to spur R&D investment. Instead it began the distortion of corporate knowledge production.

For the next two decades, there wasn’t a uniform treatment of R&D from an accounting standpoint in the United States. That changed in 1974 when the FASB came out with the Statement of Financial Accounting Standards (SFAS) No. 2 which mandated a direct write-off of R&D expenses. Companies no longer had a choice of how they wanted to treat R&D costs. R&D spending had to be completely expensed in the period it was incurred. Ironically, the FASB put this rule into effect just three years after Intel’s 1971 launch of the Intel 4004 chip that would spark the greatest period of knowledge production in the history of humankind. In this one decision, the FASB would deprive investors of relevant information about corporate innovative activities for decades.

The FASB actually considered four different methods of accounting for corporate R&D when they changed the rule in 1974. They considered: 1) charge all costs when incurred 2) capitalize all costs when incurred 3) capitalize some costs when incurred if those costs met certain specified conditions 4) accumulate all costs in a special category until the future benefits could be determined. In the end, the FASB took the most conservative approach by deciding that all R&D spending must immediately be expensed. The reasons behind the FASB decision to take the most severe approach are shocking and poorly conceived.

The FASB took a myopic viewpoint in determining whether or not the future benefits of R&D could be determined and consequently, whether it should be capitalized as an asset on a company’s balance sheet. They were concerned about the riskiness of individual R&D projects. In their view, there was a very high degree of uncertainty because they believed individual projects had a high rate of failure. However, they completely overlooked the fact that a portfolio of R&D projects can have a much lower aggregate level of risk than any individual project. On a collective basis, an individual R&D project can offset a portion of another R&D project's risk. Investors are quite aware of this interaction between risky endeavors as this is one of the bedrock principles of MPT. Just like a diversified portfolio of stocks has a lower level of risk than any individual security, a diversified portfolio of R&D projects has a lower level of risk than any single project.

In the years immediately after SFAS No. 2 was put into effect, criticisms of the rule began to emerge. In 1975, academics like Bierman and Dukes feared that the result of immediately expensing R&D would "distort corporate decision making" and could lead to "faulty measurement of income and changes in income through time." Because "business firms do not generally begin new product or process development projects until the principal technical uncertainties have been resolved," they believed that the FASB overstated the riskiness of individual R&D projects. The other main criticism by the academic community was that the FASB did an inadequate amount of research into the issues surrounding R&D. In the SFAS No. 2 ruling itself, the FASB admits that it "did not undertake a major research effort for the project. The FASB staff interviewed a limited number of selected financial analysts and commercials banks and reviewed a substantial number of published financial statements."

As we will see in the next section, not all R&D investments are equal and for those companies that follow an innovation strategy the lack of information about R&D spending in financial statements leads to a vast information deficiency among investors. Since 1974, the FASB has been starving the market of information regarding knowledge production. As we will show shortly, this has led investors to make systematic errors when assessing the prospects of highly innovative companies.

Knowledge Intensive Companies Generate Abnormal Returns

Milton Friedman once said the only theory in which economists are in universal agreement is that the value of an asset is determined by the expected benefits it will generate. In its controversial SFAS #2 decision, the FASB raised questions about the reliability, objectivity and value relevance of knowledge production when it stated "a direct relationship between research and development costs and specific future revenue generally has not been demonstrated." The FASB insisted on looking at individual R&D projects, rather than consider the aggregate corporate portfolio of knowledge production. In paragraph 52 of SFAS #2, the FASB stated "For accounting purposes the expectation of future benefits generally is not evaluated in relation to broad categories of expenditures on an enterprise-wide basis but rather in relation to individual or related transactions or projects." Institutional rigidities aside, on a conceptual level it comes down to this: if a relationship can be identified between knowledge investments and future benefits, then these knowledge investments should be capitalized and recorded as assets. If, on the other hand, there is no relationship between knowledge investments and subsequent operating or stock performance, then expensing is the proper approach.

Corporate managements deploy capital into a portfolio of R&D projects with the expectation that in aggregate the portfolio will lead to future sales and earnings. No corporate manager would be held to the standard that every single project must in isolation be a success. That just isn't the way decisions are made in the real world. Given the portfolio approach to knowledge investments that companies take, it makes more practical sense to evaluate whether there is a relationship between a portfolio of knowledge investments and subsequent operating and stock price performance.

In 1996, Baruch Lev and his colleagues from the NYU Stern School of Business challenged the validity of SFAS #2 in a study "The Capitalization, Amortization, and Value-Relevance of R&D." They did two things: 1) They capitalized R&D investments, adjusting current reported earnings and book value, and compared these adjusted values to future stock returns; 2) They measured whether R&D capital over time is related to subsequent stock returns. They found that earnings and book value adjusted by capitalizing R&D were positively associated with future stock prices and returns. They also found that the level of R&D capital within a firm is positively related to subsequent stock returns. These finding indicate that the process of capitalizing R&D yields value-relevant information. In concluding remarks the authors declare, "Taken together, these findings suggest that R&D capitalization yields statistically significantly reliable and economically relevant information, contradicting a major tenet of FASB Statement No. 2: 'a direct relationship between research and development cost and specific future revenue generally has not been demonstrated.'"

Lev also determined that there were two possible reasons for the above average stock market returns of R&D-intensive companies. His first hypothesis, which he believed to be the more credible, was that the above average returns were driven by a "systematic mispricing of shares of R&D-intensive companies." Because of the dearth of information regarding innovative activities caused by the implementation of SFAS No. 2, investors incorrectly react to R&D activities. The market is slow to recognize the future benefits of R&D, but is fully aware of the negative impact expensing R&D has on current net profits, heavily discounting the stock price. This leads to a catch-up period as stock prices rise and analysts quickly move up earnings estimates in future periods as the fruits of R&D investments are borne out. This in turn leads to abnormal stock market returns for R&D-intensive companies. This hypothesis can be viewed through the lens of the behavioral view where real-world investors commit systematic errors. In the spirit of open debate, he also offered an alternative hypothesis consistent with efficient market theory that the perceived abnormal returns were actually just additional compensation for an "extra-market risk factor associated with R&D." In other words because R&D is risky, investors in these companies are taking on a hidden risk and the abnormal returns are simply the additional compensation investors need to take on the additional risk. This hypothesis is consistent with the efficient market view of abnormal returns.

In 2002, siding with Lev's alternative hypothesis, Dennis Chambers, from University of Illinois, wrote in "Excess Returns to R&D-intensive Firms" that the "positive association between R&D levels and excess returns" was most likely due to a compensation for hidden risks than from systematic mispricing. In his study, in which he looked at a large sample of public firms, he found evidence which is consistent with the risk explanation, or the efficient market explanation. Taking a shot at Lev, he concluded that "the positive association between excess returns and R&D investment levels reported in previous studies is more likely to result from failure to control adequately for risk than from accounting-induced mispricing."

Also in 2002, Allen Eberhart of Georgetown University, in a nod to Baruch Lev, wrote “An Examination of Long-Term Abnormal Returns and Operating Performance Following R&D Increases.” In it he asks “Do R&D increases lead to better-than-expected operating performance, and is the market slow to recognize this benefit?” He found that “For the five-year period following their R&D increases, we find consistently strong evidence that firms experience significantly positive abnormal operating performance. We also find consistent evidence that shareholders experience significantly positive abnormal stock returns for the five year period following their firm’s R&D increase. Our results provide strong evidence investors systematically underreact to the benefits of an R&D increase.” At this point the score is 2-1 in favor of the behavioral view over the efficient markets view.

In December 2005, Lev and his colleagues delivered the knock-out blow with their seminal study, “The Stock Market Valuation of R&D Leaders” that took the R&D discussion one step further. If the abnormal returns of highly innovative companies as a whole are due to incomplete risk adjustment, then it would stand to reason that the most innovative companies should possess the most incomplete risk adjustment. In other words, the biggest spenders on knowledge production should have the highest risk—in the form of subsequent earnings and stock price volatility.

Lev recognized that not all R&D spending is the same. In every industry, you have two groups of companies: Knowledge Leaders and Knowledge Followers. On the one hand you have Knowledge Leaders “who introduce new and innovative products.” While on the other hand, you have Knowledge Followers “who mimic or react to the products of the Leaders.” Knowledge Leaders are pushing innovation forward, while Knowledge Followers are just trying to keep up with the innovational spill-over effects created by Knowledge Leaders. If R&D is equally risky for Knowledge Leaders and Knowledge Followers, then the expected future abnormal returns should be similar to both. Also Knowledge Leaders, who are more R&D-intensive than Knowledge Followers, should in theory produce a higher but constant level of future abnormal returns to compensate for bearing more risk due to their more intensive R&D investment strategy. In the end, Lev found Knowledge Leaders had higher “future market share, future sales growth and future return on assets” than Followers which suggests that “[Knowledge] Leaders have sustained future profitability” due to their innovation strategies. He also found that stock return volatility and earnings variability, two measures of risk, were lower for Knowledge Leaders than for Knowledge Followers.

The results were the exact opposite of what one would have expected based on a simple extrapolation of the incomplete risk control perspective of Chambers. If more R&D-intensive companies are actually less risky than lower R&D-intensive companies, then abnormal returns must be attributed to a systematic mispricing of corporate innovation activities. Lev and his colleagues were able to empirically show that there is a market inefficiency in the shares of highly innovative companies, leading to abnormal returns, directly related to conservative accounting treatment of corporate R&D activities. Their research, the definitive body of work on the subject, rejected the efficient market hypothesis view that R&D-intensive companies produce abnormal returns due to a greater level of systematic risk.

Knowledge Leaders Indexes Confirm Knowledge Effect

Building on the work of Lev, Chambers, Eberhart and many others, Knowledge Leaders Capital has created the Knowledge Leaders Indexes. These indexes are designed to isolate the Knowledge Effect through a multi-step quantitative, rules based selection process. They are the most comprehensive, longest running, broadest indexes of highly innovative companies that exist. The results demonstrate that companies that choose to pursue a knowledge-centric innovation strategy generate abnormal returns. The effect is consistent across time and broadly applicable to a large universe of stocks.

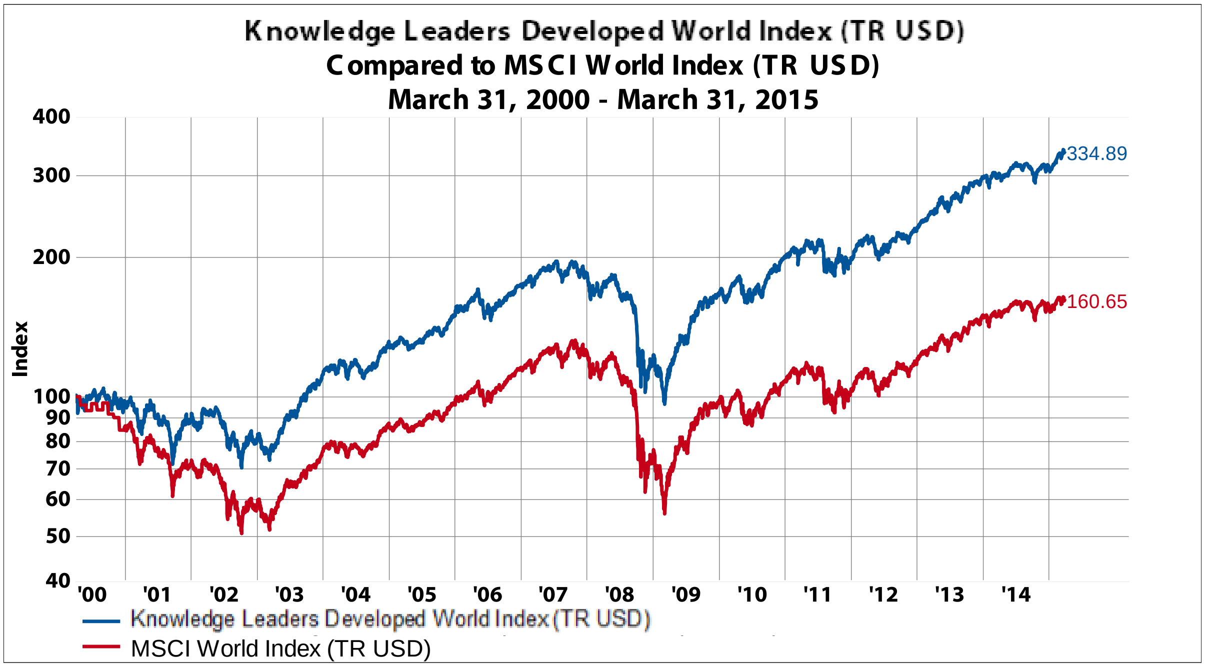
In the Knowledge Leaders Developed World Index (KNLGX, total return index) we begin with all companies located in the 22 traditional developed countries, converting all financial data into US Dollars. In each country we select the companies commensurate with capturing 85% of the market capitalization of the entire country stock index. We eliminate all stocks in the US less than $1. We next impose a liquidity constraint and will eliminate the 10% of companies with the lowest trading liquidity (shares traded * share price). At this point, there are roughly 2,000 companies in our raw selection universe.

Next we transform the financials for all 2,000 companies by capitalizing all of their knowledge investments. We remove from the income statement all knowledge investments such as R&D, advertising, employee training and the production of firm-specific resources. We capture these investments in the investing section of the statement of cash flows, similar to how investments in property, plant and equipment are treated. We then create an asset on company balance sheets to reflect the knowledge investment. We maintain an asset on company balance sheets reflecting the gross cumulative investment in knowledge, the cumulative depreciation and the net cumulative investment in knowledge. Each year, we add a non-cash charge to company income statements to reflect depreciation of their knowledge capital. All knowledge that shows up on company balance sheets is assumed to be 100% equity financed as its balancing counterpart is cumulative retained earnings.

With our knowledge-adjusted financial history of 2,000, we run through all the companies through a screen we have developed to isolate on the most innovative companies. Companies passing the screen must: 1) spend at least 5% of sales on knowledge investments or have at least 5% of assets represented by knowledge, 2) generate over 20% gross margins, 3) have less than 3x gross financial leverage 4) have less than 50% net debt as a percent of capital, 5) have a positive trailing seven year average return on invested capital, 6) have at least a 10% operating cash flow margin on average over the last seven years and 7) have a positive trailing seven year average free cash flow. There are roughly 680 companies from 22 countries that pass our screen and constitute the Knowledge Leaders Developed World Index.

The index is equal-weighted, rebalanced twice a year and data begins on March 31, 2000. In the chart and tables below, we show annual performance and risk metrics of the index compared to the MSCI World Index. Since inception the Knowledge Leaders Developed World Index is up a cumulative 234.9% compared to the MSCI World Index, which was up 60.6% over the same period. On an annualized rate, the KNLGX was up 8.4% while the MSCI World Index was up 3.2%.

Performance Since Inception



Data as of March 31, 2015. Live data begins 7/1/14.
Source: Knowledge Leaders Capital, Factset; Monthly data; Index Publisher: Solactive
An investor cannot invest directly in an index.

Performance Since Inception By Year

Knowledge Leaders Developed World Index - USD			
Fiscal Year	**KNLGX (TR)**	**MSCI World (TR)**	**Difference**
2000	-2.6%	-14.1%	11.5%
2001	-8.6%	-16.8%	8.2%
2002	-10.1%	-19.9%	9.8%
2003	39.3%	33.1%	6.2%
2004	17.7%	14.7%	2.9%
2005	13.5%	9.5%	4.0%
2006	16.5%	20.1%	-3.6%
2007	6.3%	9.0%	-2.7%
2008	-34.8%	-40.7%	5.9%
2009	37.2%	30.0%	7.2%
2010	21.3%	11.8%	9.6%
2011	-1.9%	-5.5%	3.7%
2012	16.1%	15.8%	0.2%
2013	30.6%	26.7%	3.9%
2014	5.1%	4.9%	0.2%
2015 YTD	7.0%	2.3%	4.7%
2000-Current Cumulative	234.9%	60.6%	174.2%
Annualized Return	8.4%	3.2%	7.0%

Data as of March 31, 2015. Live data begins 7/1/14.
Source: Knowledge Leaders Capital, Factset; Monthly data; Index Publisher: Solactive
An investor cannot invest directly in an index.

In thirteen out of the last fifteen years the KNLGX index outperformed the MSCI World Index. The only two years of underperformance were 2006 and 2007, at the height of the financial and commodity bubble that preceded the Great Financial Crisis of 2008-2009. Of particular note is how the index performed during the last two 50% drawdowns in stocks. In the 2000-2003 period, the MSCI World index fell 50% from peak to trough. The KNLGX index was down roughly 32% from peak to trough and then rebounded in 2003 returning 37% vs the MSCI World Index return of 30%. In the 2007-2009 period, both the KNLGX and MSCI World Index were down about 50%, but KNLGX rebounded in 2009 returning 34% while the MSCI World Index returned only 27%.

Risk Metrics Compared to MSCI World Index

Knowledge Leaders Developed World Index Risk Statistics (Annualized, Monthly)		
Risk Metric	**KNLGX (TR)**	**MSCI World (TR)**
Standard Deviation	15.1%	15.8%
Correlation	96.6%	-
Sharpe Ratio	0.53	0.18
Tracking Error	4.1%	-
Beta	0.93	1.00
Alpha	5.4%	-
Information Ratio	1.71	-
Active Share	72.72	-
Max Yearly Drawdown	-34.82%	-40.71%

Data as of March 31, 2015
Source: Knowledge Leaders Capital, Factset; Monthly Data; Index Publisher: Solactive

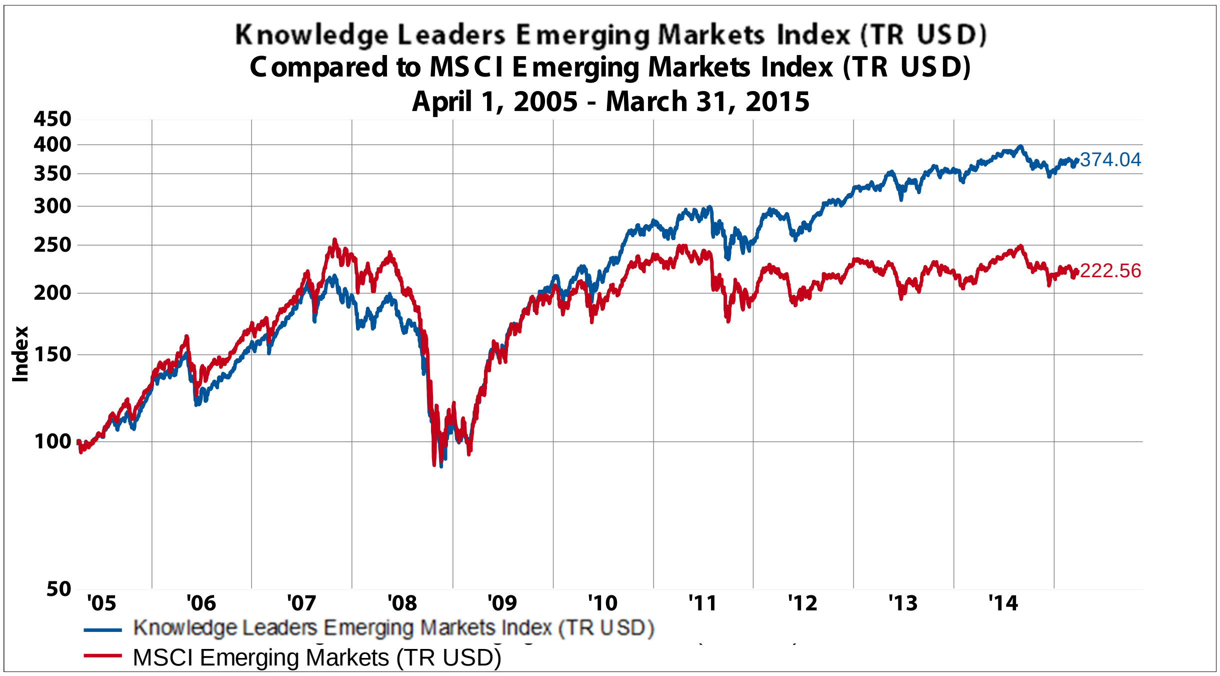
The KNLGX index turned in an annualized alpha of 5.4% since inception compared to the MSCI World Index, with a 0.93 beta. The KNLGX generated a Sharpe Ratio of 0.53, roughly 3x higher than the MSCI World Index of 0.18. The KNLGX maintained a relatively low 4.1% tracking error compared to the MSCI World Index and an information ratio of 1.71. The max drawdown of the KNLGX index was -34.82% compared to -40.71% for the MSCI World Index.

In the Knowledge Leaders Emerging Markets Index (KNLGEX, total return index) we begin with all companies located in the 25 traditional emerging market countries. In each country we select the companies commensurate with capturing 85% of the market capitalization of the entire country stock index, excluding all secondary listings, preferred shares and ADRs. We next impose a liquidity constraint and will eliminate the 50% of companies with the lowest trading liquidity (shares traded * share price). At this point, there are roughly 1,000 highly investable companies in our raw selection universe.

Next we transform the financials for all 1,000 companies by capitalizing all of their knowledge investments and run them through the same knowledge screen as used for the developed world. There are roughly 200 companies from 25 countries that pass our screen and constitute the Knowledge Leaders Emerging Markets Index. The index is equal-weighted, rebalanced semi-annually and data begins on April 1, 2005.

In the chart and tables below, we show annual performance of the index compared to the MSCI Emerging Markets Index. Since inception the Knowledge Leaders Emerging Markets Index is up a cumulative 274% compared to the MSCI Emerging Markets Index, which was up 122.6% over the same period. On an annualized rate, the KNLGEX was up 14.2% while the MSCI Emerging Markets Index was up 8.4%.

Performance Since Inception



Data as of March 31, 2015. Live data begins 9/2/14.
Source: Knowledge Leaders Capital, MSCI; Monthly data; Index Publisher: Solactive
An investor cannot invest directly in an index.

Performance Since Inception By Year

Knowledge Leaders Emerging Markets Index - USD			
Fiscal Year	KNLGEX (TR)	MSCI EM (TR)	Difference
2005	27.2%	31.6%	-4.4%
2006	24.0%	32.1%	-8.1%
2007	25.3%	39.4%	-14.1%
2008	-45.4%	-53.3%	7.9%
2009	95.2%	78.5%	16.7%
2010	31.9%	18.9%	13.0%
2011	-9.1%	-18.4%	9.3%
2012	27.0%	18.2%	8.7%
2013	11.6%	-2.6%	14.2%
2014	-0.7%	-2.2%	1.5%
2015 YTD	5.3%	2.2%	3.1%
2005-Current Cumulative	274.0%	122.6%	151.5%
Annualized Return	14.2%	8.4%	9.7%

Data as of March 31, 2015. Live data begins 9/2/14.
Source: Knowledge Leaders Capital, MSCI; Monthly data; Index Publisher: Solactive
An investor cannot invest directly in an index.

The KNLGEX Index outperformed the MSCI Emerging Markets Index in seven out of ten years, with the biggest relative underperformance again concentrated in the years preceding the Great Financial Crisis in 2008 when the financial and commodity bubble was inflating. Since 2008, the KNLGEX Index has outperformed the MSCI Emerging Markets Index every year.

Risk Metrics Compared to MSCI Emerging Markets Index

Knowledge Leaders Emerging Markets Index Risk Statistics (Annualized, Monthly)		
Risk Metric	KNLGEX (TR)	MSCI EM (TR)
Standard Deviation	21.4%	23.6%
Correlation	95.8%	-
Sharpe Ratio	0.60	0.30
Tracking Error	6.9%	-
Beta	0.87	1.00
Alpha	6.9%	-
Information Ratio	1.41	-
Active Share	85.15	-
Max Yearly Drawdown	-45.41%	-53.18%

Data as of March 31, 2015
Source: Knowledge Leaders Capital, MSCI: Monthly Data; Index Publisher: Solactive

Turning to risk metrics, the KNLGEX index had a beta of 0.87 since inception compared to the MSCI Emerging Markets Index, and generated an annualized alpha of 6.9%. The 0.60 Sharpe Ratio of the KNLGEX index is 2x higher than the 0.30 of the MSCI Emerging Markets Index. The tracking error of the KNLGEX index is 6.9% and the information ratio is 1.41. The KNLGEX index experienced a -45.41% max drawdown while the MSCI Emerging Markets Index experienced a -53.18% max draw-down.

The results of both of our indexes indicate that knowledge intensive companies experience significant abnormal returns. Our findings suggest that the Knowledge Effect exists in the developed markets and the emerging markets. The persistence and applicability of the Knowledge Effect demonstrate its statistical significance.

Conclusion

In *"Thinking, Fast and Slow"* Daniel Kahneman, a Nobel Prize-winning behavioral economist, describes two mental processes we employ when making decisions. All humans have a System-1, as he calls it, our instinctual brain, where we process emotions, avoid danger and process information on a reactionary basis. We also have a System-2 where we process rational thought, weigh options, decide in a very deliberate fashion what to do. Many times our System-1 and System-2 conflict, and the decisions we make reflect this conflict. One well-known conflict in economics is called "myopic loss aversion" which arises because our System-1 is instinctively very risk averse. It is so risk averse, that people sometimes behave in such a way to avoid a financial loss that seems to contradict logic. People experience greater unhappiness losing $1 than they experience happiness making $1, so they behave in ways that reflect this asymmetry. This systematic error is at the crux of many stock market effects, including the Knowledge Effect.

System-2 has difficulty appreciating just what exponential growth truly means. In 2010, then-CEO of Google, Eric Schmidt offered an astounding statistic on information creation at the Techonomy conference in Lake Tahoe, CA. He said that in just two days the world creates as much information as humankind did from the dawn of civilization to 2003. And this was five years ago. The speed at which information is created has only sped up, dramatically increasing the raw ingredients of knowledge. Semiconductors are rapidly being integrated in everyday objects. This integration is commonly referred to as the Internet of Things (IoT). Semiconductors allow objects now to "speak" to one another by transferring data without any human interaction. A decade ago the idea that semiconductors could be used in combination with a bracelet to provide detailed analytics to the user about their activity levels, their sleep patterns, and provide caller ID for your phone (i.e. Fitbit) probably seemed somewhat ludicrous. However, change can occur quickly as the roughly $4.5 billion wearable technology industry is now projected to have revenues of around $53 billion by 2019.

In their 2013 piece, "Is the Information Technology Revolution Over," Federal Reserve researchers David Bryne, David Oliner and Daniel Sichel, suggest that not only is the information technology revolution not over, we could be on the cusp of second wave. They "present evidence that innovation for semiconductors continues to proceed at a rapid pace, raising the possibility of a second wave in the IT revolution." Before the semiconductor wave is over, many industries will be created and disrupted.

Knowledge-intensive companies will be at the heart of this creation destruction, making it increasingly necessary for investors to understand innovative companies. Investors that can take advantage of systematic errors can convert the abnormal returns of highly innovative companies into portfolio alpha.

So, what drives stock returns? History and practice suggest there is no single answer to this question. Fifty years ago, simply the relationship to the broader equity market seemed to be the best answer. A couple of decades later, academics had the breakthrough that there are multiple, some yet to be identified, factors that drive stock performance. In this paper, we propose a new effect that explains stock returns—the Knowledge Effect—that derives from the explosion in knowledge production and the absence of information on corporate innovation. We have created the Knowledge Leaders Indexes to measure and capture the Knowledge Effect.

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Definitions

Alpha is a measure of the portfolio's risk adjusted performance. When compared to the portfolio's beta, a positive alpha indicates better-than-expected portfolio performance and a negative alpha worse-than-expected portfolio performance.

Beta is a measure of the funds sensitivity to market movements. A portfolio with a beta greater than 1 is more volatile than the market and a portfolio with a beta less than 1 is less volatile than the market.

Downside Capture is used to evaluate how well or poorly an investment manager performed relative to an index during periods when the index has dropped.

Max Drawdown is the maximum single period loss incurred over the interval being measured.

The MSCI World Index is a free float-adjusted market capitalization weighted index that is designed to measure the equity market performance of developed markets.

Sharpe Ratio uses a fund's standard deviation and its excess return (the difference between the fund's return and the risk-free return of 90-day Treasury Bills) to determine reward per unit of risk.

Standard deviation is a calculation used to measure variability of a portfolio's performance.

Tracking Error is a measure of how closely a portfolio follows the index to which it is benchmarked.

Upside Capture is used to evaluate how well an investment manager performed relative to an index during periods when that index has risen.

Disclaimer

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The launch date of the Knowledge Leaders Emerging Markets Index (Bloomberg ticker KNLGEX) is 9/2/14 and the base date of the index calculation is 4/1/2005. The returns of the Index prior to the launch date are based on applying the rules in effect as of the launch date retroactively to historical periods to and including the base date. Such historical results are not based on an Index that was maintained in real time. To obtain additional index methodology and constituent components, please click here: KNLGEX index.

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