The Conference Board Innovation α® powered by M-CAM –
A Quantitative Metric of Innovation Value[1]

July 1, 2019

Introduction

Traditional metrics of determining the value of corporations and their associated equity and debt are heavily reliant on economic data reported under Generally Accepted Accounting Principles (GAAP). The value of Intellectual Capital and Intangible Assets around the world is estimated at 57.3 trillion US$ or 52% of global enterprise value. Corporate America accounts for about half (28.3 trillion $) of this global estimate. However, 78.3% of US intangibles (which excludes goodwill) is estimated to remain undisclosed on balance sheets and it does not have any meaningful or reliable reporting mechanism under GAAP.[2] Since the introduction of the latest of the latest System of National Accounts, the U.S. Bureau of Economic Analysis in the U.S., the United Nations and the Organization for Economic Cooperation and Development (OECD) recognize some intangibles, notably R&D and software as a material component of GDP calculations, but this still represents a fraction of all intangibles assets the economy generates.[3] Since 2000, The Conference Board has also worked intensively on estimating the macroeconomic value of intangibles.[4]

As the largest non-financial asset base in the global marketplace, the fact that these assets are opaque to the public investor is not only an accounting anachronism. As most of management's time is spent on managing intangible assets including human capital, brand, innovation, market-advantage and supply-chain dynamics, intellectual property such as patents, trademarks and copyright is increasingly gaining importance in the daily management of business assets. Successfully protecting, valuing and managing IP has become a key strategic advantage for many companies within a variety of industries.

Hitherto investors have relied on arbitrary indices and industry classifiers to estimate market dynamics and associated market behavior related to intangibles. Arguably, this traditional approach has been insufficient to track value created by innovation. Since the 1990s, M-CAM (Mosaic Collateral Asset Management), a firm specializing in international intangible asset underwriting and analyzing work in innovation finance, trade, and intangible asset finance, has developed a sophisticated methodology to better identify the impact of innovation value on stock market performance of companies. It measures the global quality and market deployment of intangible assets in publicly traded and private firms by aggregating innovation data from over 160 countries. The data on intangible assets are assessed for

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[1] This white paper introducing the Innovation α index and its methodology is based on original M-CAM documents.

[2] BrandFinance® Global Intangible Finance Tracker (GIFT™) 2018— an annual review of the world's intangible value, October 2018, https://brandfinance.com/images/upload/gift.pdf

[3] https://www.nsf.gov/statistics/randdef/national-accounts-and-globalization-manuals.htm

[4] See for example, Carol Corrado, Janet Hao, and Ataman Ozyildirim, Rethinking Innovation Spending: What the Data on Intangible Investment Reveals, December 2017. See also, conference report: New Building Blocks for Jobs and Economic Growth: Intangible Assets as Sources of Increased Productivity and Enterprise Value and keynote speech delivered by Ben Bernanke at the conference https://www.federalreserve.gov/newsevents/speech/files/bernanke20110516a.pdf

their uniqueness, their suitability for commercial transactions or contracts, and their utility to create marginal price advantages in the marketplace.

M·CAM has commercially deployed unique unstructured data-mining technologies for banking, trading, and advisory programs internally and for third parties. The index helps to understand market dynamics based on innovation value heretofore inaccessible to investors. Between 2015 and 2018 CNBC published the index as the CNBC 100 Index Powered by M·CAM Innovation α®.

Starting 1 July, 2019, The Conference Board will continue publishing two of the M-CAM indexes as ***The Conference Board Innovation α® indexes powered by M-CAM***, one for the 100 most innovative US companies and another one for the 120 most innovation global companies. The US and global indexes enable a direct look at the financial outcomes of the companies' innovation activity that arises out of their intangible investments. As explained in more detail below, the companies are selected on the basis of an analysis of investments in intangible assets such as patents, trademarks, and copyrights.

Some background

Intellectual Property (IP) is a category of intangible rights protecting commercially valuable products of the human intellect. While the individual components of intellectual or intangible assets are wide-ranging, patents, trademarks and copyrights have been the components most often associated with IP (See Glossary of Terms on p. 6 for definitions).[5] These three forms of intellectual property can hold great commercial value, depending on the amount of protection afforded the property right.

The growing importance of IP is reflected in the steady increase in patent applications and the expanding field of patentable subject matter. By 2000, over a period of 210 years, six million patents were issued by the USPTO. In 2018, the number of patents issued by USPTO was 10 million.[6,7] Part of this growth in patent filings is fueled by the evolving protection given certain types of discoveries.

In essence, a patent provides a government sanctioned exclusivity through well-defined property rights, and the increasing trend in patent litigation validates the perceived value that a patent provides its holder. Patents are increasingly being used by companies to act as competitive barriers to entry against their competition. In 2017, there were over 4000 patent litigation cases filed in US courts.[8] In addition to providing competitive barriers, companies are realizing that new income streams can be generated through licensing patented technologies. Despite a rise in licensing revenues[9], most licensing opportunities remain largely untapped. It has been estimated that United States companies have upward of $1 trillion per year in untapped intellectual property licensing fees.[10]

Notwithstanding the considerable value options resulting from some IP, researchers and investors have long struggled to find market relationships between granted rights and market and equity price effects.

[5] While IP traditionally covers trademark, copyrights and patent rights, the category also includes trade-secret rights, publicity rights, moral rights, and rights against unfair competition. Furthermore, it is recognized that non-traditional intangible rights such as water rights, pollution rights, and other forms of contractual rights may also fit within this class of assets.

[6] http://www.uspto.gov/web/offices/ac/ido/oeip/taf/issuyear.htm

[7] Alan C. Marco Michael Carley Steven Jackson Amanda F. Myers, 'The USPTO Historical Patent Data Files: Two centuries of invention," Working Paper No. 2015-1, June 2015, http://www.uspto.gov/economics

[8] Landan Ansell et. al. 2018 Patent Litigation Study, PWC May 2018, https://www.ipwatchdog.com/wp-content/uploads/2018/09/2018-pwc-patent-litigation-study.pdf

[9] http://www.progressive-economy.org/trade_facts/u-s-share-of-world-intellectual-property-revenue-39-percent/

[10] Web Bryant, Businesses Battle over Intellectual Property, USA Today, Aug. 2, 2000 at 1B.

In research on understanding the implications of intangibles on business valuation, "information complexity" is seen as a barrier to any generalizable application of valuation frameworks.[11,12,13] Even more problematic is the well-publicized problem of the quality of IP granting regimes in which as much as 50% of issued patent rights, for example, are rejected when subject to litigated validity challenges.[14] In short, the preponderance of research on the subject of IP and market value and equity dynamics has shown that, without *a priori* assessment of the quality of the rights held by firms, the contribution of solely macro descriptions of IP offer little to no value in estimating equity dynamics.[15]

Basic Methodology behind Innovation α®

The main contribution of the approach to the development of the Innovation α Index is its ability to assess the "creditworthiness" of Intellectual Property (IP) and Intangible Assets (IA) determining the financial value of innovations. This means that actual intangible assets– contracts, patents, licenses, copyrights, designs, trademarks, permits, etc. – held by firms are examined; are compared qualitatively to the equivalent rights held by other firms.[16] To do this, M·CAM has developed and maintained a very large repository of state-granted rights from over 160 countries representing, in some instances, over 200 years of historical data. This allows for on-going monitoring and tracking of such intangible investment activity.

The discussion below focuses primarily on the patenting because patents represent a unique window into the innovation ***intent of an*** organization; whereas, copyrights and trademarks are applied to existing artifacts. Patents enjoy the unique attribute of inferring current and future meaning and construction and signal intent to a good or service which may exist or may be contemplated for future existence. However, several of the principles below also apply to the investigation of trademarks and copyrights. Patenting represents an attempt by businesses to protect their intangibles investments in innovations. While the dynamics surrounding misrepresented and misappropriated IP rights present an accounting and valuation challenge, they nevertheless create an exceptional mechanism to identify corporations who are seeking to develop equivalent proprietary market advantages. There are only two ways a certain degree of similarity could arise in applications for patents. Two patents could be similar either because one company is deliberately copying or imitating an innovation of another company; or two companies are investing in the same or similar intangible assets which lead to the same innovation simultaneously and independently. Investigating sets of similar patents helps to identify firms that are competing for the same marginal market controls and pricing advantages that are provided by the innovations represented in the patents.

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[11] Gu, F. & Wang, W. 'Intangible assets, information complexity, and analysts earnings forecasts', *Journal of Business Finance & Accounting* 32, 1673–1702. (2005)

[12] Amir, E., Lev, B. & Sougiannis, T., 'Do financial analysts get intangibles?', *European Accounting Review* 12, 635–659. (2003)

[13] B. Lev and F. Gu, *The End of Financial Accounting and the Path Forward for Investors and Managers*. John Wiley John Wiley & Sons, Inc., 2016.

[14] Allison, J. and Lemley, M. "Empirical Evidence on the Validity of Litigated Patents." *American Intellectual Property Law Association Quarterly Journal*, 26, pp. 185-269 (1998).

[15] For example, in Congressional testimony, M-CAM reported that qualitative deficiencies were evident in over 30% of all patents issued by the United States Patent and Trademark Office (USPTO). See Martin, D.E. "Patents: Improving Quality and Curing Defects". Congressional Testimony for the United States House of Representatives Committee for the Judiciary. (2001).

[16] D. E. Martin and P. A. Beling, "Patent Litigation Risk Characterization: Prospective identification of financial risk in patent holdings", Company & Shareholder, Vol 1., No. 2, 2004

Using internationally recognized unstructured text linguistic genomic algorithms, the Innovation α Index aims to detect overlapping market initiatives of companies working to exploit their patents or innovations by measuring the quality of their rights to such innovations. Linguistic genomics method is a method not unlike algorithms that detect academic plagiarism. It involves associating all intellectual property rights to the current holders of those rights. Data quality issues (misfiled names, erroneous bibliographic information, post-merger, license or sale transfers, etc.), corporate transfers, subsidiary and affiliate ownership and other issues are resolved to clarify the actual assets controlled by a company. Reviewing each asset for its legal and commercial enforceability involves comparing the prosecution histories of each patent by examining the factors that altered the patent claims that were first sought and rejected to those that were ultimately issued. This review helps clarify if the patent represents a foundational and new technology or a subtle alteration of the state-of-the-art. Subsequently, a series of data science techniques are applied to take a large volume of unstructured data and associate it to financial data.

After the identification of patents, the commercial consequence of these assets on each enterprise is characterized. The qualitative assessments of patents are then associated with business transactions reported in financial statements, contracts, bid proposals, trade records and other publicly available (but hard to find) data. The methodology relies on a scoring methodology which relies on three sub-scores that are based on 1) the effective life span of a patent (depreciation), 2) breadth of a company's investment in intangible assets such as patents, trademarks, and copyrights (SPI), and 3) level of confidence in a patent's capacity to be used in commercial transactions (OCS).[17] It then provides a relative score of each individual company's innovation portfolio and management thereof, making it possible to compare each company's performance on its innovation rights with others with whom it cooperates or competes.[18,19] The measured difference between better and worse performers in terms of stock market returns is reflected in the Innovation α index.

When substantial overlapping market initiatives are detected, the identity of so-called "peer groups" or cohorts of companies becomes evident, as will be explained in more detail below. Subsequently, the stock market dynamics of companies within cohorts can be quantitatively measured.

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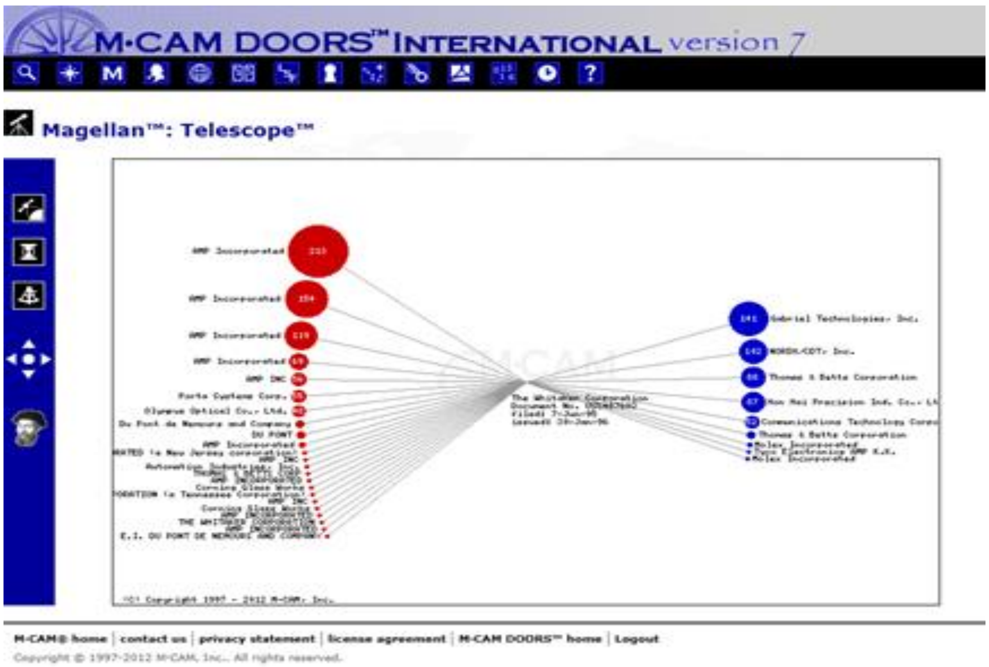
[17] M-CAM holds the following patents on the methodology it has developed for this analysis (i.e. US6,330,547 and US6,665,670)

[18] Ibid.

[19] M-SURE Underwriting Platform Design & Specification AND S-CO-20120326-Compendium of M-CAM Technologies-modified.PDF

The example below is helpful to show how a patent is related to prior and subsequent patents and what we can learn from an analysis of the relationships between patents (see Appendix A for other examples).

Patents and their backwards and forwards relationships to prior and subsequent art



The figure is the Telescope™ view of a target patent (US 5,487,682), found within the M·CAM DOORS™ Magellan™ suite of technologies which is a patent risk management system that allows a user to interrogate a database containing over 90% of all patents issued anywhere in the world using a document vector analysis. Telescope™ is a graphical representation of the target patent with its Cited Prior Art (to the left, in red) and Citing Subsequent Art (to the right, in blue) using a visual frequency of use scale. Citing Subsequent Art (blue) indicates issued patents that are “aware” of the target patent and its technology by citing it as prior art, but these patents are also “chipping” away at the target technology’s future optionality. Each circle represents a specific patent which is tied by citations to the subject patent. The size of a circle represents the number of patents which are tied by citations to that specific patent. For example, the top left red circle represents a patent assigned to AMP Incorporated. This patent has 213 (the number displayed inside of the circle) other patents tied to it by citations. This means that 213 patents are cited by or cite the AMP patent. The subject patent is one of those 213 patents. This approach to visualizing the patents’ relationships to others is used to address the question of whether or not a subject patent lives alone. In this case, there are at least 212 other patents in its ecosystem. This information is valuable in assessing commercial consequence as a patent is less valuable in a transfer scenario if other players already have their own version of the technology patented.

Appendix B discusses the types of analyses that can be performed with this large database of patents. The results of the analyses can be distilled into patent scores using by applying a series of data science methods described in the box above. Then, patent portfolios of a set of companies can be determined and the patent quality scores can be aggregated for each company to be used in further analysis.

Glossary of Terms

Patent

A patent from the United States government or other relevant global authorities gives an inventor the right to exclude others from making, using or selling the patented invention for up to twenty years. Inherent in this right to exclude is the commercially valuable power to control who uses the patented technology.

Trademark

A trademark is a word, phrase, logo or other graphic symbol used by a manufacturer or seller to distinguish its product or products from those of others. The trademark right can exist as long as the business continues to use the mark. The protection of trademarks is the law's recognition of the psychological function of symbols. Some examples include the Nike® swoosh, the Xerox® logo, and the golden arches of McDonalds®.

Copyright

A copyright protects original works of authorship, such as writings, music and works of art that have been tangibly expressed. The holder of a copyright has the exclusive right to reproduce, adapt, distribute, perform and display the work. The Library of Congress registers copyrights, which last the life of the author plus 50 years. Some examples include: Disney's Mickey Mouse character, Grant Wood's famous painting American Gothic and Microsoft's computer software.

Sentinel

A company selected as a leading innovator by virtue of the breadth of their patenting activity (the number of industries or technology classifications into which their patents have applicability) and the quality of that activity (the degree to which their patents are granted without significant rejections, do not evidence excessive uncited prior art risk, and are used by subsequent innovators as defining the state of the art).

Cohort

The group of companies with overlapping innovation activity with one or more Sentinel. These companies have explicit evidence of responding to each other's innovation by filing patents in response to the activities of others. Cohorts exhibit redundant cross-industry activities to their associated Sentinels.

Prior art

Documented evidence preceding a patent claim by more than one year that relates to a claim within an invention which serves to define or limit the scope of interpretation. There are three forms of prior art that are scored by M-CAM's systems: 1) references that were cited by an applicant that showed improvement over the state of the art; 2) references that were cited by an examiner to reject or constrain the construction of a claim; and, 3) references uncited by either the applicant or examiner that cover the semantic and syntactic equivalence to references that were used.

The Innovation α® Index explained in steps[20]

The process underlying the selection of companies in the Innovation α Index is driven by the assembly, classification, and scoring of "raw data" on patents by way of a proprietary unstructured data analysis algorithm. For this it uses the M•CAM DOORS™ database platform, which is a patent risk management system which allows a user to interrogate a database containing over 90% of all patents issued anywhere in the world using a document vector analysis.

Martin and Beling (2004) demonstrate how the patents are analyzed for linguistic and statutory uniqueness, impairment rating, and other bibliographic descriptive data. This process identifies the semantic and syntactic components of a query document and statistically compares the subject to all other documents retrieving those with improbable similarities ("unexamined affinity patent" or "UAP"). Further, the methodology reviews international patent search and citation records from patent offices to determine the degree to which patents have or have not been associated to each other by patent applicants or examiners." (Martin and Beling (2004), p. 3).

The top 100 companies which are the best performers in the control and deployment of IP and which rank the highest among the Russell 1000 set of companies based on the commercial score of their intangible assess portfolios are denoted as the "sentinel companies." Rather than developing a subjective selection of equities based on company characteristics or individual performance, the Index is constructed from a set of quantitatively selected and weighted component firms (see Glossary of Terms on p. 6). Each sentinel company has its own peer group of companies, also called a cohort, and all companies within a cohort attempt to control a certain portion of their supply chains as determined by their portfolios of intangible assets. The cohorts are important in determining relative stock market performance of the sentinels.

The methodology can be described as a stepwise process as follows:

Step 1: Each patent in the database is analyzed to derive a patent score. A patent's score ranges from innovative to defensive (or duplicative) based on its relationship to a network of prior and subsequent patents, and similarity or dissimilarity of those patents.

For this analysis, asset content and competitive positioning were the primary considerations. As such, each patent was individually assessed for legal enforceability of the rights granted by the patent to gauge the extent to which an asset owner could confidently use said assets to exert market and cashflow control. Each patent received one of the following Commercial Fitness Scores depending on their risk exposure due to prior art (see also example on p. 5):

1) Opportunity: These patents are relatively free of prior art risk and are well positioned with respect to competing assets.
2) Normal: These patents have an average prior art risk and competitive positioning profile. These assets are best used to bolster the strength of patents receiving a score of Opportunity.

[20] The discussion in this section focuses on the Innovation α Index for the 100 US companies. The same methodology has been applied to obtain the index for the 120 global companies which is benchmarked against the MSCI ACWI global index. According to the MSCI website: "MSCI ACWI Indexes offer a modern, seamless, and fully integrated approach to measuring the full equity opportunity set with no gaps or overlaps. MSCI ACWI represents the Modern Index Strategy and captures all sources of equity returns in 23 developed and 26 emerging markets.".

3) Threatened: These patents have an above average prior art risk and competitive positioning profile. These patents may be at risk for disqualification if challenged using competing assets and therefore represent a low likelihood of commercial confidence.
4) Weak: These patents may be at significant risk of disqualification if challenged using competing intangible assets.

Step 2: Then, for each company a score for the IP portfolio of the whole company is developed by grouping together the classified patents. Thus, this company "score" is proportional to the value of the company's portfolio of intangible assets and is related to the breadth of the patent portfolio across sectors as well as the firm's marginal profitability.

Selection (annually)

Step 3: Sentinel companies are identified

The Index begins with 100 of the best Russell 1000 performances with respect to their control and deployment of IP according to their ranking by company score. A standardized (z-score) is calculated each measure per year for each company in the Russell 1000 set of companies. The three scores (depreciation, SPI, and OCF) are averaged to get an annual score.

Step 4 Cohorts or peer groups are identified

Cohorts or peer groups are determined by analyzing the network of associations that arise between the patent portfolios held by each sentinel and related patent portfolios held by all other companies.[21] A cohort or peer group is defined by those companies which have invested in and protect or defend similar intangible assets. In other words, the peer group could be viewed as a network of companies that create a field effect in their innovation ecosystem. Note that each cohort or group of companies holding related patents goes well beyond the Russell 1000. A company or a sentinel can be in one or more cohorts

Once the 100 cohorts corresponding to the 100 sentinels are identified, three measures are calculated for each company as a cohort member

1) Count – number of times a company appears in any cohort
   a. [Min/Max: 1/1035; Average: 64; and Median: 35]
2) Wins – number of times a company is the highest scoring member of a cohort
   a. [Min/Max: 0/91; Average: 6; and Median: 3]
3) Average score (standardized)
   a. average score across all cohort appearances for a given company,

Once the competitive Peer Groups (or "Cohorts") of patent holding companies are identified, their equity price advantage of selecting fitness is examined using a modification of a Genetic Algorithm (GA) augmented with Support Vector Regression (SVR), Particle Swarm Optimization (PSO) and measure

[21] Hayden T. Luse and David E. Martin (2014) "Text-Based High Latency, Low Frequency Signal Analysis and Cohort Equity," *Proceedings of the Center for Intelligent Systems and Machine Learning (CISML) Conference.* University of Tennessee Knoxville & Oak Ridge National Labs, reissued as The Conference Board Economics Program Working Paper EPWP #19 – 01.

effect modeling with Dynamic Time Warping (DTW) for directional performance estimation using Random Forest Regressors (RFR) (see box).

For those unfamiliar with the data science techniques used, the following definitions may be useful.

- A *Genetic Algorithm* (GA) is a biomimetic global optimization meta-heuristic based on haploid sexual reproduction. In M·CAM's instance, discrete patent portfolio descriptors represent genes; their interactivity within the IP ecosystem represents the chromosome; and qualitative scoring of originality represents fitness.
- *Support Vector Regression* (SVR) is an extension of Support Vector Machines used for classification tasks. In a given set of labeled training examples belonging to two classes, an SVM uses a specified class of kernel function to transform the data to a higher dimensional product space where the two classes are linearly separable by a maximum margin hyperplane which is equidistant from both sets of points.
- *Particle Swarm Optimization* (PSO) is a biomimetic global optimization meta-heuristic like GA but is much more efficient for solving over a continuous domain than a GA. This methodology is selected as it assists in providing a model for cohort dynamics associated with the creation of the IP ecosystem to understand prospective market responses.
- *Dynamic Time Warping* (DTW) is used to find the expansions and contractions which most closely align two time series, t_1 and t_2. One way to frame the problem is to create a discrete grid such that one move along the x axis corresponds to a tick on t_1, and one move along the y axis corresponds to a tick on t_2.
- *Random Forests* (RFR) are able to naturally include interaction terms while training, which greatly reduces the amount of effort needed to dedicate to feature selection and combination. The input data is highly dimensional, redundant and noisy because of the bag of features transformation performed. This synergizes very well with a Random Forest's strengths as each random feature subspace chosen for a tree by the RFR is likely to contain the information needed to make a useful prediction within, and also noise which is unique to, that subspace.

DTW is used to generate depreciation scores. PSO (Network analysis) is used to generate Sector Proliferative Index (SPI) scores. GA augmented with SVR (linguistics/NLP analysis) is used to generate Orhogonal Confidence Factor (OCF) scores. The resulting sub-scores are aggregated into the company score which is then used as an input into the network analysis and machine learning prediction (Random Forest Estimation) of stock market returns.

Step 5: Annual benchmark update of the selected companies

Every year in January, the Index is benchmarked by replacing up to ten components of the index, or 10% of the portfolio positions. This cutoff is chosen to reduce the frequency with which positions change within this index. The ten highest rankings within unique peer groups (or cohorts) could then replace their respective sentinel companies in the portfolio on an annual basis. The new set of 100 portfolio positions will then serve as the 100 sentinel companies for the next year. The index requires that replacements be from unique peer groups to limit one peer group from being over-represented in the portfolio.

Weighting (annual benchmark)

Initially during the annual benchmarking, each position in the index is given the same weight, 1%. Then, if shares in a company are not expected to outperform their sentinel company, *x*% is removed (i.e., for companies with score ≤ 0) where *x* is equal to the number of companies that are expected to outperform their respective sentinel. The expected performance of each company in the index is determined by M-CAM's random forest regressors algorithm that relates an analysis of a company's intellectual property activity to its expected stock price returns. In order to ensure that the weights sum to 100%, this *x*% is reallocated to other companies among the selected 100 that are expected to outperform relative to respective sentinels. The reallocation percentage is proportional to the extent by which each outperformer is expected to outperform. In terms of formula,

$$\text{outperformer weight} = 0.01 + \left(\frac{r_c}{\sum_S r_c}\right)\left(\frac{n_o}{100}\right),$$
$$\text{non-outperformer weight} = 0.01 - \left(\frac{1}{100-n_o}\right)\left(\frac{n_o}{100}\right)$$

where r_c = company ranking within its peer group, n_o = # of outperforming companies ($r_c > 0$), S = set of outperforming companies.

The index is calculated as a weighted average. That is, the index is equal to the sum of the share prices of the selected companies times their weights.

Weighting (quarterly reweighting)

Step 6: At the end of every quarter, the stock market performance of a company relative to its cohort members is predicted. Thus, although the index only changes its composition (or portfolio) annually, the position weightings are rebalanced quarterly. The prediction is dependent on the contribution of an IP portfolio to company profits which determines cohort membership. This method seeks to overweight positions that are expected to outperform their respective sentinel company. The expected performance is projected by applying random forest prediction to the stock price returns of a given company based on a feature set of financial features (e.g. technical trading characteristics) amended by company specific features (e.g. metrics from balance sheets or 10K statements).

Validation of indexes and results

The resulting Innovation α indexes for the US and Global set of companies are shown in Figures 1 and 2 below. The vertical lines in each chart denote when the indexes went live. The period before the vertical line shows the backtesting results going back to 2007 for the US and global indexes, respectively.

Figure 1: The Conference Board Innovation α United States Index powered by M•CAM

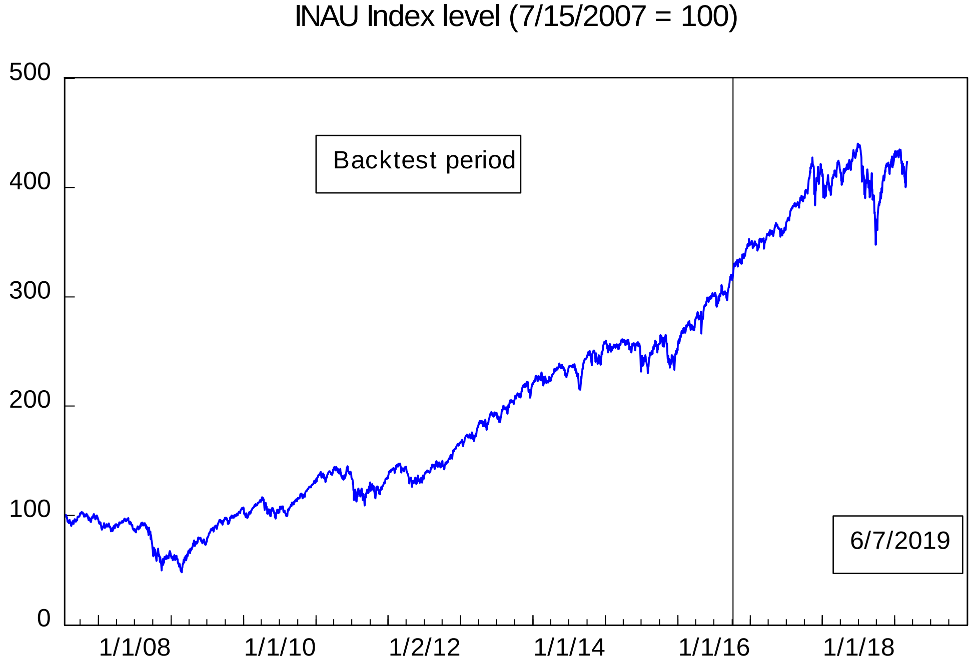
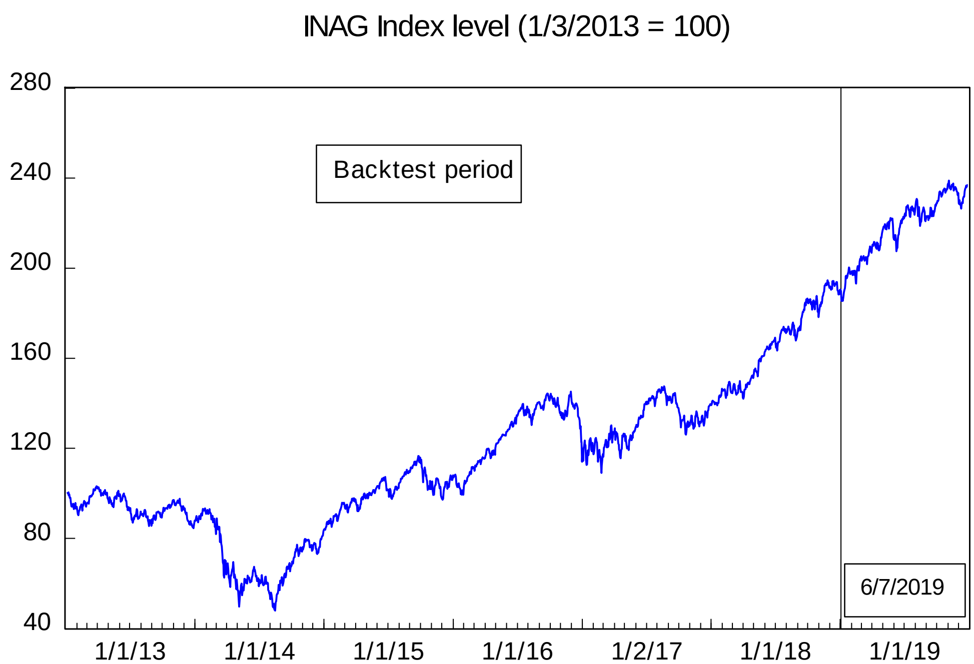


Figure 2: The Conference Board Innovation α Global Index powered by M•CAM



Between 2016 and 2018 the US index was published by the CNBC as the IQ100 index. This index was the subject of a backtesting exercise conducted for the period July 14, 2007 to January 14, 2016. Portfolio returns were calculated using quarterly tick data as the index rebalances position weightings quarterly. The risk-free rate was set to be 5.11% – the yield of the 10-Y U.S. Treasury Note from July 13, 2007.[22]

[22] https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yieldYear&year=2007

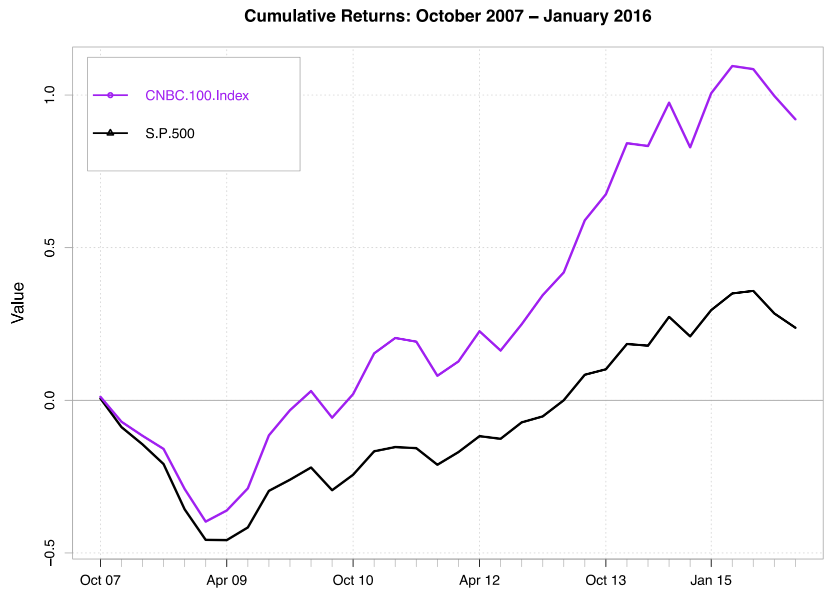
Additionally, this backtest accounted for survivorship bias by using the tick data of delisted companies that had made it into the index at one point or another. The findings showed that the returns were normally distributed and conformed to the assumptions of Modern Portfolio Theory. The moments of the distribution of returns over the backtest are reported in Appendix B.

Performance Analysis

The Innovation α 100 Index employs a smart beta strategy in that it relies on an alternate index construction – both in position selection and weighting – to generate additional return on investment ("alpha") against the S&P 500. Whenever possible, performance should be analyzed relative to the S&P 500. As such, while **Figure 3** shows that the 100 Index enjoys cumulative returns of 92.05% relative to the S&P 500's 23.79% by early 2016, **Figure 4** illuminates these returns more clearly. By plotting the 100 Index returns relative to those of its benchmark, a relative return of 157.27% is apparent.

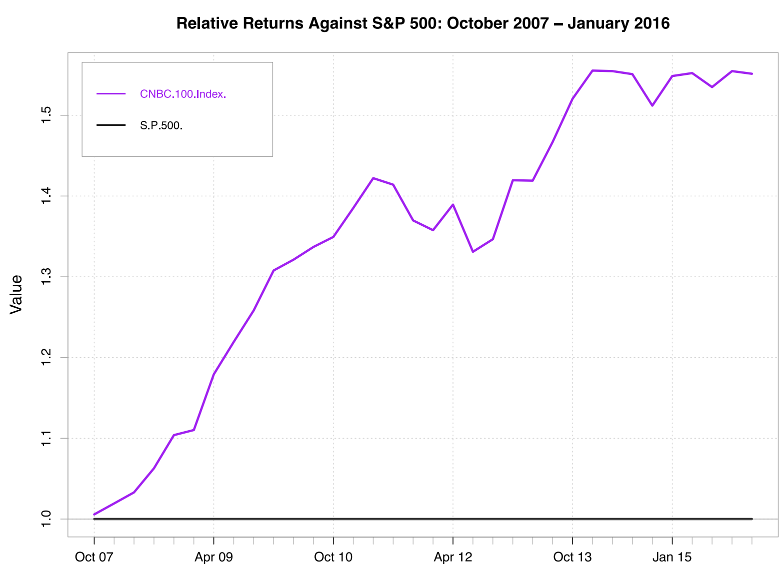
MPT's Capital Asset Pricing Model (CAPM), first developed by William Sharpe in 1964, provides a framework with which an investor can quantitatively justify passive or active investing. **Table 1** shows that the 100 Index generates a Risk Premium of 2.15% over this backtest by remaining nearly market-neutral to its benchmark as evidenced by its 1.07 Beta. Ultimately, this also generates an Alpha of 1.31% over the S&P 500. CAPM, a single-factor model based on risk, demonstrates that the CNBC 100 Index does not take on significant risk to capture additional returns over both its risk-free asset and benchmark. This payoff between risk and return is seen in **Figure 5**. In other words, the greater returns that the CNBC 100 index generated were not due to taking on excessive risk (in exchange for higher expected returns).

Figure 3: *Cumulative Returns on CNBC IQ100 Index through Backtest*



Source: Purple Bridge Management, LLC
Data represents period 7/14/07–1/14/16

Figure 4: *Relative Returns on CNBC IQ100 Index through Backtest*



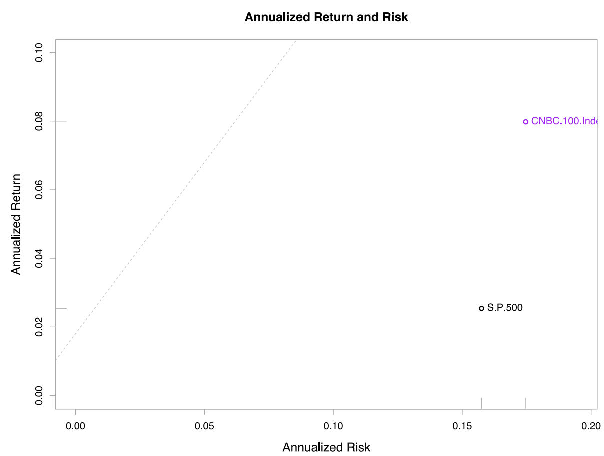
Source: Purple Bridge Management, LLC
Data represents period 7/14/07–1/14/16

Table 1: *CNBC 100 Index CAPM Quarterly Metrics*

	CNBC 100 Index
Risk Premium	0.0215
Alpha	0.0131
Beta	1.0719
Bull Beta (β^{+})	1.1059
Bear Beta (β^{-})	0.8944
Timing Ratio[23]	1.2365
Annualized Sharpe Ratio	0.4205
Annualized Information Ratio	1.1830

Source: Purple Bridge Management, LLC
Data represents period 7/14/07–1/14/16

Figure 5: *Risk and Return Payoff*



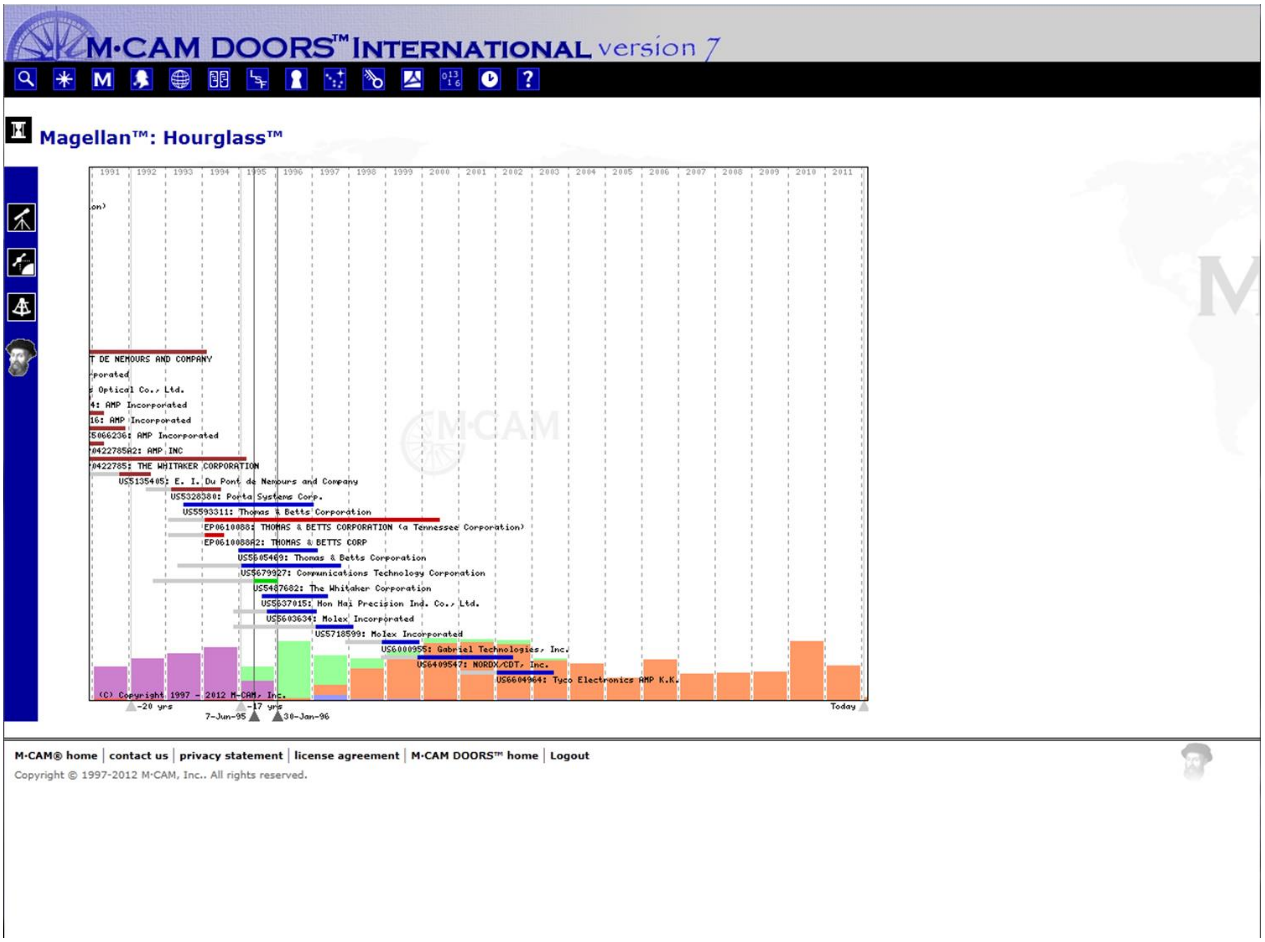
Source: Purple Bridge Management, LLC
Data represents period 7/14/07–1/14/16

For more information on the methodology underlying the Innovation α index please see Hayden T. Luse and David E. Martin (2019) "Text-Based High Latency, Low Frequency Signal Analysis and Cohort Equity," The Conference Board Economics Program Working Paper EPWP #19 – 01. More detail on the methodology and further research on the Innovation α indexes will be available on The Conference Board website at https://www.conference-board.org/data/bcicountry.cfm?cid=18

[23] Timing Ratio $= \frac{\beta^{+}}{\beta^{-}}$; a Timing Ratio greater than 1 indicates that an investment strategy is good a timing asset allocation during bull markets and conversely for a Timing Ratio less than 1.

APPENDIX A Examples of Analysis of M-CAM Doors

The charts below are examples of analyzing patents in the M-CAM DOORS database in addition to the example on p. 5.



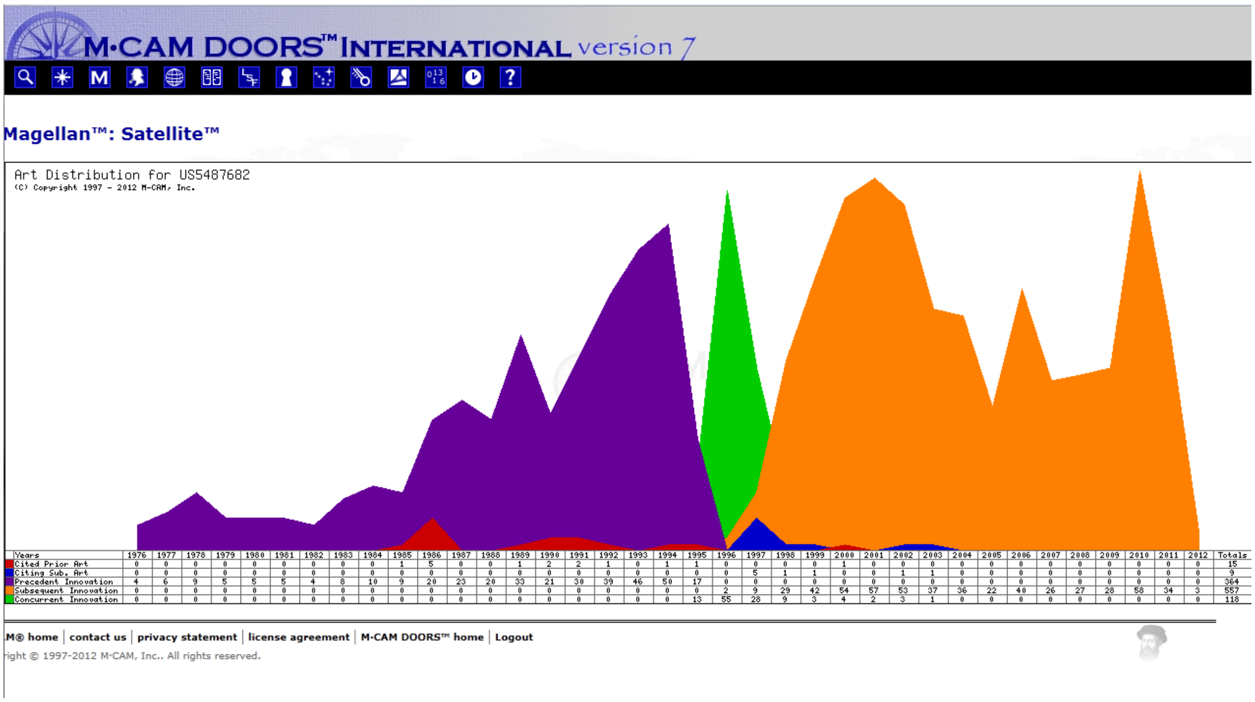
This is the Hourglass™ view of the target patent (US 5,487,682), found within the M·CAM DOORS™ Magellan™ suite of technologies. Hourglass™ depicts the prosecution history of all related patents examined in the context of the subject patent. Yearly issuances of related but uncited patents are displayed in the bar graph.

The colors in the graph correspond to the following:

Red: Cited Prior Art. These are patents the examiner cited as prior art for the target patent.
Purple: Precedent Innovation. These patents predate and are conceptually related to the target but were *not* cited as prior art in the target patent.
Green: Concurrent Innovation. These patents are conceptually related to the target and were co-pending at the US Patent Office while the target was under examination.
Blue: Citing Subsequent Art. These patents came after the target patent and cite the target as prior art.
Orange: Subsequent Innovation. These patents came after and are conceptually related to the target but did *not* cite the target as prior art.

The grey section of the patent bars signifies the prosecution time a patent spent in the patent office before its content was finalized. The colored section of the patent bars represents the time a patent spent in the patent office after being submit in its final form before being issued (the end of the bar). The Hourglass™ module seeks to answer the question of where an asset sits on its technology's obsolescence arc. The slope of the Hourglass™ curve and its integrated area under the curve are used in M-CAM's proprietary underwriting system.

The following view is also helpful in understanding the impact of a patents on its ecosystem.



Years	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Cited Prior Art	0	0	0	0	0	0	0	0	0	1	5	0	0	1	2	2	1	0	1
Citing Sub. Art	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Precedent Innovation	4	6	9	5	5	5	4	8	10	9	20	23	20	33	21	30	39	46	50
Subsequent Innovation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Concurrent Innovation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Years	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Totals
Cited Prior Art	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	15
Citing Sub. Art	0	0	5	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	9
Precedent Innovation	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	364
Subsequent Innovation	0	2	9	29	42	54	57	53	37	36	22	40	26	27	28	58	34	3	557
Concurrent Innovation	13	55	28	9	3	4	2	3	1	0	0	0	0	0	0	0	0	0	118

This is the Satellite™ view of the target patent (US 5,487,682), found within the M·CAM DOORS™ Magellan™ suite of technologies. Satellite™ is a graphical display of the innovation space surrounding the target patent, and helps analysts quickly distinguish between groups of patent art categories over a period of time. All patents represented are related to the target by a conceptual link. The chart below the "mountains" shows the patent count in each category, by year, with the total amount of patents in each subsection found to the far right.

The colors correspond to the following:

Red: Cited Prior Art. These are patents the examiner cited as prior art for the target patent.
Purple: Precedent Innovation. These patents predate and are conceptually related to the target but were *not* cited as prior art in the target patent.
Green: Concurrent Innovation. These patents are conceptually related to the target and were co-pending at the US Patent Office while the target was under examination.
Blue: Citing Subsequent Art. These patents came after the target patent and cite the target as prior art.
Orange: Subsequent Innovation. These patents came after and are conceptually related to the target but did *not* cite the target as prior art.

Looking at the example chart, a large amount of Precedent Innovation patents (purple) could be troubling for enforceability of the subject patent, especially if there is a disproportionate number of Cited Prior Art (red). A large amount of Precedent Innovation signifies much of the technology the target patent describes already existed before the target was issued. A patent which has a very small Precedent Innovation range but larger Subsequent Innovation range signifies a patent which entered the technology space early and is likely more commercially valuable in a transfer scenario. A perfect Satellite™ image would contain an orange mountain with no purple or green. The absence of purple and green would signify that an asset was at the forefront of innovation in the technology. The presence of orange would signify that other entities are engaging in follow-on developments to an asset without citing or crediting the asset. This points to the asset being highly valuable in a transfer scenario as it is the foundational piece in a tech space.

APPENDIX B Backtest results for CNBC IQ100

Results and Discussion

The following is the result of a backtest from July 14, 2007 to January 14, 2016 using the CNBC IQ100 version of the index which was published between 2016 and 2018. Portfolio returns were calculated using quarterly tick data as the index rebalances position weightings quarterly. The risk-free rate is set to be 5.11% – the yield of the 10-Y U.S. Treasury Note from July 13, 2007.[24] Additionally, this backtest accounts for survivorship bias by using the tick data of delisted companies that had made it into the index at one point or another.

Normal Distribution of Returns

A normal distribution of returns is particularly important as it will allow for a more accurate prediction of what returns are to be expected and serves as the basis for Modern Portfolio Theory (MPT).

Examining at the first four moments of a return distribution – mean, variance, skewness, and kurtosis – together will help in establishing a normal return distribution.

Table B1: *Moments of Return Distributions over Backtest*

	CNBC 100 Index	S&P 500
Geometric Mean[25]	0.0194	0.0063
Variance	0.0076	0.0062
Skewness	-0.0739	-0.3436
Kurtosis	2.9127	3.5134

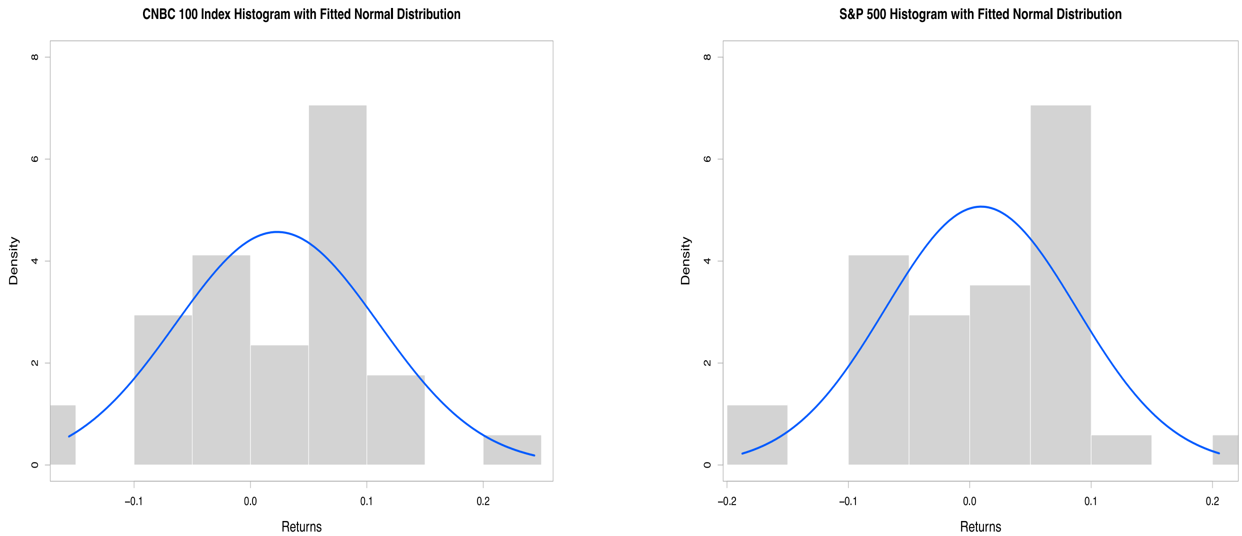
Source: Purple Bridge Management, LLC
Data represents period 7/14/07–1/14/16

With kurtosis values fairly close to 3 and skewness values close to 0 for the 100 Index and the S&P 500, it can be argued that both indices have adequately normal distributions for the purposes of MPT Figure B1 affirms such distributions.

[24] https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yieldYear&year=2007

[25] Geometric mean is used in the place of arithmetic mean as quarterly returns are not independent of one another.

Figure B1: *Histograms of Returns with Fitted Normal Distributions*

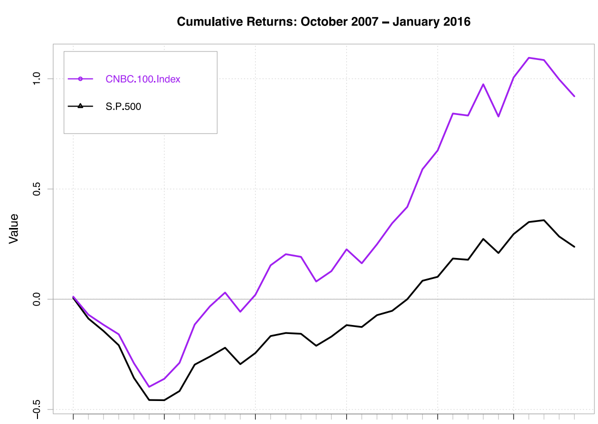


Data represents period 7/14/07–1/14/16
Source: Purple Bridge Management, LLC

Performance Analysis

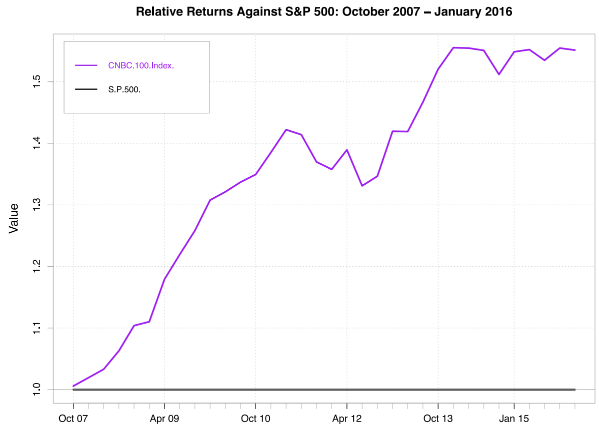
The 100 Index employs a smart beta strategy in that it relies on an alternate index construction – both in position selection and weighting – to generate additional return on investment ("alpha") against the S&P 500. Whenever possible, performance should be analyzed relative to the S&P 500. As such, while ***Figure*** shows that the 100 Index enjoys cumulative returns of 92.05% relative to the S&P 500's 23.79% by early 2016, ***Figure B2*** illuminates these returns more clearly. By plotting the 100 Index returns relative to those of its benchmark, a relative return of 157.27% is apparent.

Figure B2: *Cumulative Returns through Backtest*



Source: Purple Bridge Management, LLC
Data represents period 7/14/07–1/14/16

Figure B3: *Relative Returns through Backtest*



Source: Purple Bridge Management, LLC
Data represents period 7/14/07–1/14/16

MPT's Capital Asset Pricing Model (CAPM), first developed by William Sharpe in 1964, provides a framework with which an investor can quantitatively justify passive or active investing. ***Table*** shows that the 100 Index generates a Risk Premium of 2.15% over this backtest by remaining nearly market-neutral to its benchmark as evidenced by its 1.07 Beta. Ultimately, this also generates an Alpha of 1.31% over the S&P 500. CAPM, a single-factor model based on risk, demonstrates that the CNBC 100 Index does not take on significant risk to capture additional returns over both its risk-free asset and benchmark. This payoff between risk and return is seen in ***Figure B4***.

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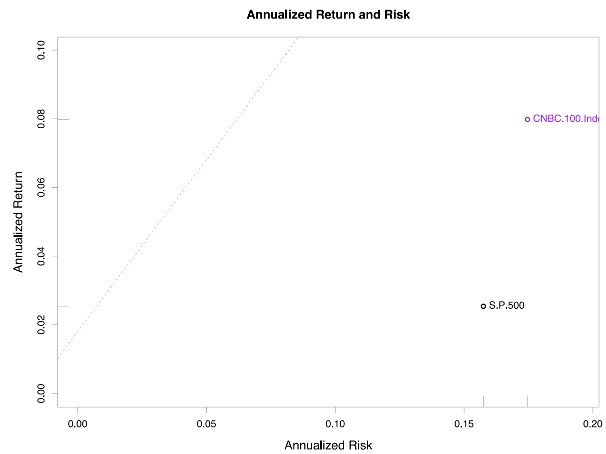
Table B2: *CNBC 100 Index CAPM Quarterly Metrics*

	CNBC 100 Index
Risk Premium	0.0215
Alpha	0.0131
Beta	1.0719
Bull Beta (β^+)	1.1059
Bear Beta (β^-)	0.8944
Timing Ratio[26]	1.2365
Annualized Sharpe Ratio	0.4205
Annualized Information Ratio	1.1830

Source: Purple Bridge Management, LLC
Data represents period 7/14/07–1/14/16

[26] Timing Ratio $= \frac{\beta^+}{\beta^-}$; a Timing Ratio greater than 1 indicates that an investment strategy is good a timing asset allocation during bull markets and conversely for a Timing Ratio less than 1.

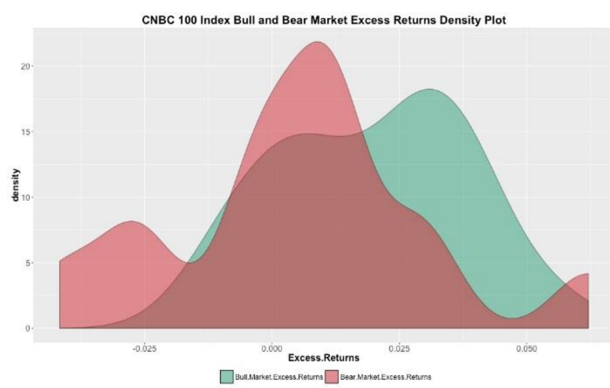
Figure B4: *Risk and Return Payoff*



Source: Purple Bridge Management, LLC
Data represents period 7/14/07–1/14/16

The Innovation α 100 Index is roughly 10% than the S&P 500 in bull and bear markets separately, as evidenced by its β^+ and β^- values (***Table***). A Timing Ratio – a ratio of these two Beta values – of 1.24 argues that this strategy is better at market timing during bull markets than during bear markets. provides a visualization of such a tendency. This figure illuminates the extent to which this index is able to capture additional returns over its benchmarks perhaps more clearly than the Timing Ratio does alone. Its excess returns during bear markets appear to be a roughly normal distribution centered just above 0%. Conversely, during bull markets this index's excess returns are relatively dense between just above 0% and 3.12%. In other words, this index is likely to outperform its benchmark modestly during downturns and more significantly so during market upswings.

Figure B5: *Excess Returns during Bull and Bear Markets*



A bull market is defined to be a quarter in which the S&P 500 had a positive return; a similar argument follows for a bear market. Excess Return = CNBC 100 Index Return – S&P 500 Return.

Source: Purple Bridge Management, LLC
Data represents period 7/14/07–1/14/16