Deutsche Bank
Markets Research

Global

Quantitative Strategy

Data Science

Date
27 February 2017

Creating structure from unstructured text data

Andy Moniz, Ph.D, CFA
andy.moniz@db.com

Spyros Mesomeris, Ph.D
spyros.mesomeris@db.com

Khoi LeBinh
khoi.lebinh@db.com

Miguel-A Alvarez
miguel-a.alvarez@db.com

North America: +1 212 250 8983
Europe: +44 20 754 71684
Asia: +852 2203 6990

In this new series of publications, we lift the lid on the black box surrounding alternative datasets and describe the foundations required to analyze unstructured data starting with text-based signals.

In our view, text signals are not restricted to high frequency strategies. Indeed, our goal is to demonstrate the potential of text analysis for long-only, low turnover investors too.

Collecting publically-available Web data – in our first publication we consider the use case of text analysis for detecting corporate anti-competitive behavior, bribery/corruption issues, environmental pollution violations and product recalls.

Processing text – we describe a computational linguistics technique known as Named Entity Recognition to detect company mentions in text.

Social networks analysis – one application of Named Entity Recognition is a framework to infer 'hidden' connections between companies (both private and publically listed), and potentially 'hidden' stock risks.

Source: Deutsche Bank

Deutsche Bank AG/London

Distributed on: 27/02/2017 11:36:35 GMT

Table Of Contents

A letter to our readers 3
Introduction 4
Text processing 7
Information Retrieval 7
Assessing the relevance of publically available text 10
Mapping security identifiers 13
Final thoughts 14

A letter to our readers

One of the defining characteristics of systematic factor-based strategies is the need to hold a large number of positions expressed as relatively low conviction views. Investment strategies rely upon good quality accounting and pricing data rather than an understanding of each company's business model.

By contrast, a fundamental portfolio manager will develop high conviction views formed partially from insights by meeting company management, listening to conference calls, and attending company site visits.

In our view, the exploitation of unstructured data can help bridge the gap between these two investment approaches, enabling investors to integrate fundamental insights (or proxies of) in an objective and consistent way.

Take, for example, a company plagued by regulatory violations and ongoing litigation risk. A systematic Value strategy may buy into the company on the basis of cheap multiples, with limited awareness of the regulatory overhang to identify if the stock is a potential value trap. Similarly, a low volatility strategy may buy into the company based on a one-dimensional view of historic stock volatility if these risks are not fully priced, while a Quality strategy may buy companies on the basis of earnings and balance sheet strength measures, with limited insights into management quality.

In this publication, we describe the steps required to process text data. In future publications, we'll extend our approach to consider a broader range of media sources, topics (both company-level and macro-related), and test whether unstructured datasets are predictive for risk-adjusted returns.

Regards,

Andy, Spyros, Khoi, Miguel, and the quant team

Deutsche Bank Quantitative Strategy

Introduction

To date, most of the hype surrounding big data[1,2] has focused on the Volume of data (such as in-memory cluster computing solutions), the Variety of data (ranging from credit card transactions, satellite images, sensor data to near real-time news processing), and the Velocity of the data (e.g. the potential of social media analysis to detect events at higher frequency than traditional media newswires).

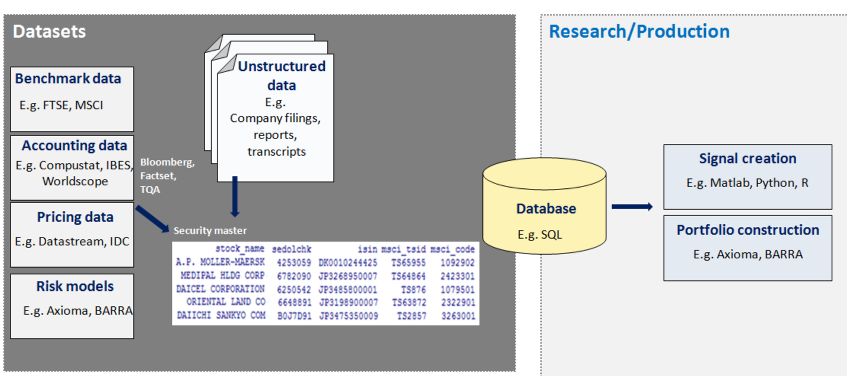
In our view, the fourth 'V' commonly associated with big data, namely Veracity, appears to be largely overlooked. Veracity broadly translates as can the data be trusted? To our mind, the speed of processing a dataset is of secondary importance if a portfolio manager doesn't understand the provenance of a signal.

Often, the proprietary nature of alternative datasets means that vendors are reluctant to open the black-box to provide any insights into how their datasets are collected. This only serves to make the concept of 'big data' even more elusive. In our view, an investor is unlikely to investigate the merits of an alternative dataset unless certain criteria are first fulfilled:

Question 1: Are security identifiers available to integrate datasets into existing investment processes?

As Figure 1 seeks to illustrate, systematic investors rely upon a fully-populated security master table to link datasets together.

Figure 1: Example infrastructure for a systematic investment process



Source: Factset, Deutsche Bank

[1] Big Data in Investment Management, G. Rohal et al., Deutsche Bank, 2016.
[2] Machine Learning in Finance, V.Zoonekynd et al., Deutsche Bank, 2016.

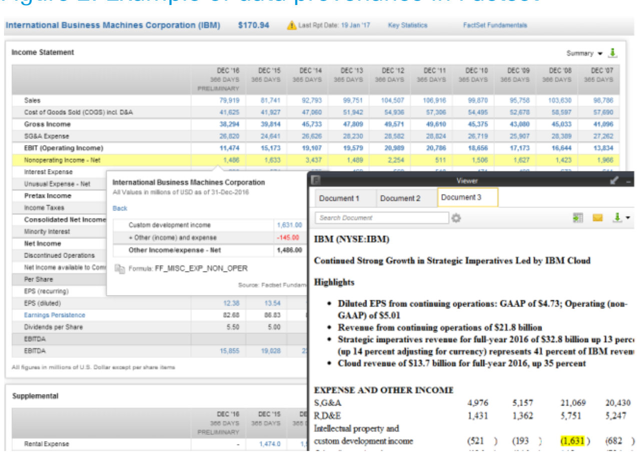
Ultimately, unstructured datasets are just one of many potential signals an investor may consider. All datasets eventually need to be structured so that they can be seamlessly integrated alongside traditional accounting and pricing data.

Question 2: What is the provenance of the data?

Many investors may be reluctant to integrate alternative data signals into their investment processes if the signals cannot be fully understood or explained. In the same way that an investor can click through a company's financial statements on Factset or Bloomberg to see where numbers appear in a firm's reported filings (see Figure 2), why should the provenance of alternative datasets be any different?

We hope that alternative data vendors start to address investors' needs for transparency. Take for instance, Ravenpack's newsflow archive (see Figure 3 for an overview). We are encouraged to see that the dataset now includes title and summary text, the source of the news article, whether the information is fact- versus opinion-based (fact-level tagging), and whether the news is forward or backward looking (temporal analysis). Greater transparency should broaden the appeal of such datasets to more traditional investors.

Figure 2: Example of data provenance in Factset



Source: Factset, Deutsche Bank

Figure 3: Evolution of Ravenpack's news dataset

	Release Date			
Attributes	**2011**	**2013**	**2014**	**2017**
Event coverage	330	1,200	2,064	6895
Historical archive	11+ Years	13+ Years	14+ Years	17+ Years
Named entity recognition:				
Entity coverage	28,000+	170,000+	175,000+	194,000+
Companies	✓	✓	✓	✓
Places		✓	✓	✓
Organizations		✓	✓	✓
Positions of authority			✓	✓
People				✓
Products				✓
Media sources:				
Premium Newswires	✓	✓	✓	✓
Regulatory & PR feeds		✓	✓	✓
Online publications		✓	✓	✓
Sentiment analysis:				
Event Sentiment Score	✓	✓	✓	✓
Fact-level tagging				✓
Temporal analysis				✓

Source: Ravenpack, Deutsche Bank

Question 3: What is the coverage of alternative datasets across stocks and over time?

This remains a concern for many of the alternative datasets we are starting to investigate. Given the novelty of datasets, we believe that some investors may be willing to comprise on the depth of time-series data if there is sufficient breadth of coverage to enable signals to be tested in the cross-section.

To our mind, it is unclear whether alternative datasets based upon app download statistics or mobile sensor data will ultimately have sufficient stock coverage for the design of scalable systematic investment strategies.

Text processing

In our view, the best way to understand the decisions alternative data vendors make in their signal construction process, and to assess the strengths and weaknesses of signals, is to recreate the signals from first principles.

Here, we discuss approaches to process publically-available text. We employ a computational linguistics algorithm to assess whether a given text is relevant for specific companies within an investment portfolio. We then tag companies names mentioned in the text with security identifiers, so that qualitative information can ultimately be transformed and integrated into a traditional financial database.

Information Retrieval

For researchers interested in text analysis, a natural starting point may be to retrieve publically-available regulatory filings. In the case of U.S. regulatory filings, we highlight a number of benefits. First, data are readily available and in a consistent format, see for example, the U.S. Securities and Exchange Commission's EDGAR (Electronic Data Gathering, Analysis, and Retrieval system) database. Second, texts are written in English, and language is relatively formal. This mitigates the need to process text with abbreviations, slang, spelling mistakes, and double negatives often observed in social media. Third, text analysis is simplified by circumventing the need to assess the credibility of the information (a potential concern for news and social media[3]). Finally, there is a growing body of academic literature in this domain, enabling researchers to empirically validate others' findings.

Figure 4 provides an example of a press release published by the SEC. The announcement includes a title and main body text, though notably no security identifiers. We also highlight that the press release is for a non-US company, illustrating both the global reach of U.S. regulators irrespective of a company's domicile, and their abilities to impose substantial fines (as a % of market cap).

[3] See, for example, Allcott, H., Gentzkow, M., (2017), Social Media and Fake News in the 2016 Election, NBER Working Paper No. 23089.

Figure 4: Example of a press release available on the SEC's website

Source: SEC, Deutsche Bank

In particular, we draw the reader's attention to the header and side banners which typically need to be stripped away in a pre-processing step before conducting text analysis. This is because the text in these banners may discuss topics that are substantially different from those in the main body text (potentially biasing signal creation and statistical inference).

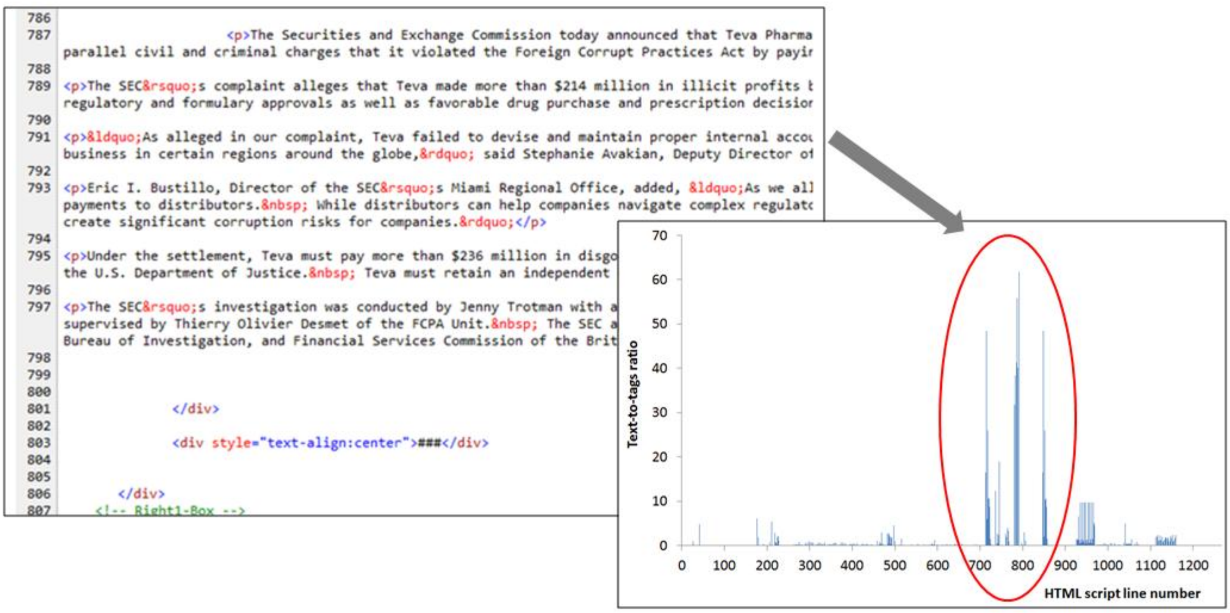
Perhaps a clearer-cut example of this bias is illustrated when applying text analysis techniques to brokers' research reports – in this report alone, almost one-quarter of the text consists of legal/compliance disclosures. The topics discussed in the disclosures are not reflective of the topics discussed in the rest of the text.

One way to extract the main body text from an online document is to simply search for pre-defined markers within the html file. For instance, in Figure 4, the main body text begins after the keyphrase 'FOR IMMEDIATE RELEASE'. In principle, a researcher could search for these tags to analyse the main content of the document rather than the banners. Unfortunately, searching for pre-defined markers does not offer a scalable solution. This is because websites use their own templates with different sets of tags, while templates can change over time. Consequently, hardcoded solutions are unlikely to remain robust.

An alternative approach is to employ a probabilistic solution to detect passages of text in a html file.

A relatively straight-forward approach is to compute the ratio of words written in an html file versus the words surrounded by html tags. This 'text-to-tags' ratio can be computed for every row of code written in the html file. The premise being that rows with a large proportion of text compared to html tags are more likely to contain meaningful content (as illustrated by rows 787-797 in Figure 5).

Figure 5: Example of a html file with the per line ratio of text-to-tags



Source: SEC, Deutsche Bank

Figure 5 illustrates several small clusters of text around the start and end of the html script. These clusters typically represent advertisements, side banners, copyright information and disclosures.

Assessing the relevance of publically available text

There are multiple ways to define relevance. For example, what are the topics discussed in the text, is the text 'new' news and is the information potentially material for stock risk/returns?

We'll return to the question of defining and assessing the materiality of news in a future publication. Here we consider relevance from an Information Retrieval perspective – is the text relevant for specific companies in an investment portfolio? At this stage, our goal is simply to tag security identifiers to a text so that qualitative information can be transformed into a quantitative output and integrated alongside traditional financial accounting and pricing data.

To assess whether a given text refers to specific stocks, we employ a computational linguistics algorithm known as Named Entity Recognition (NER). Many of these algorithms are readily available in Natural Language Processing (NLP) toolkits. The goal of NER algorithms is to locate and classify elements of text into predefined categories. Examples include the ability to identify a person's name, geographic locations, or in this case, company names (see Figure 6).

Locating these elements in text is a challenging task given that there are an infinite number of ways to represent the same name. For example, an article may refer to the company IBM by its popular name rather than by its official name, International Business Machines Inc., or by its Bloomberg/Reuters tickers.

Typically, the output of NER algorithms is a machine-readable JSON (JavaScript Object Notation) file, consisting of "name":"value" pairings (see Figure 7). In our example, named entities include The Securities and Exchange Commission (SEC) and Teva Pharmaceutical Industries Limited, as well as geographical locations.

Figure 6: Illustrative example of entities detected using a Named Entity Recognition algorithm

Entity	Type
Teva Pharmaceutical Industries Limited	Company
The Securities and Exchange Commission	Organization
FCPA	Organization
Foreign Corrupt Practices Act	FieldTerminology
Russia	Country
Ukraine	Country
Mexico	Country
Washington	City
D.C.	StateOrCounty

Source: IBM AlchemyLanguage, Deutsche Bank

Figure 7: Example of the JSON containing named entities

```
"count": "1",
      "text": "Teva Pharmaceutical Industries Limited"
    },
    {
      "type": "Company",
      "relevance": "0.599409",
      "sentiment": {
        "type": "neutral"
      },
      "emotions": {
        "anger": "0.202251",
        "disgust": "0.319806",
        "fear": "0.08498",
        "joy": "0.183728",
        "sadness": "0.296969"
      },
      "count": "1",
      "text": "Teva",
      "disambiguated": {
        "subType": [],
        "name": "Teva Pharmaceutical Industries",
        "website": "http://www.tevapharm.com/",
```

Source: IBM AlchemyLanguage, Deutsche Bank

Having extracted the named entities, we next need to distinguish between whether a company is the subject of the text or simply mentioned in passing (i.e. how relevant is the information). To assess this, one approach is to count the number of times each named entity appears in the text and to record its position (e.g. in the headline, first paragraph, etc.). The more frequently a named entity appears in a text and/or the more prevalent its position, the more likely it is to be the focus of the text.

In Figure 8, for example, Teva is most frequently mentioned entity – once in the title, once in the first paragraph, and a further four times throughout the rest of the text.

Figure 8: Example of Named Entity Recognition

Press Release

Teva Pharmaceutical Paying $519 Million to Settle FCPA Charges

FOR IMMEDIATE RELEASE
2016-277

Washington D.C., Dec. 22, 2016 — The Securities and Exchange Commission today announced that Teva Pharmaceutical Industries Limited has agreed to pay more than $519 million to settle parallel civil and criminal charges that it violated the Foreign Corrupt Practices Act by paying bribes to foreign government officials in Russia, Ukraine, and Mexico.

The SEC's complaint alleges that Teva made more than $214 million in illicit profits by making the influential payments to increase its market share and obtain regulatory and formulary approvals as well as favorable drug purchase and prescription decisions.

"As alleged in our complaint, Teva failed to devise and maintain proper internal accounting controls to prevent the company's payments of bribes to win business in certain regions around the globe," said Stephanie Avakian, Deputy Director of the SEC Enforcement Division.

Eric I. Bustillo, Director of the SEC's Miami Regional Office, added, "As we allege in our complaint, many of these bribes were concealed as legitimate payments to distributors. While distributors can help companies navigate complex regulatory environments and provide valuable industry relationships, they also can create significant corruption risks for companies."

Under the settlement, Teva must pay more than $236 million in disgorgement and interest to the SEC plus a $283 million penalty in a deferred prosecution agreement with the U.S. Department of Justice. Teva must retain an independent corporate monitor for at least three years.

Source: SEC, IBM AlchemyLanguage, Deutsche Bank

To retain information, it is also useful to tag metadata to note the associations between Teva and the other named non-listed entities (e.g. the SEC and U.S. Department of Justice). We consider this next.

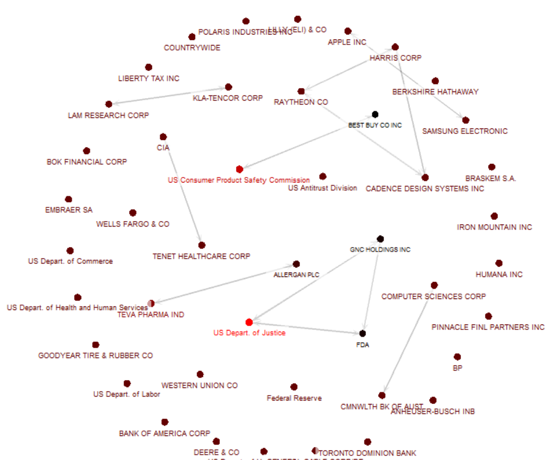
Mapping security identifiers

The third step to structuring text data is to tag security identifiers (e.g. SEDOLs). One approach is to design a string matching algorithm to compare the names detected using the NER algorithm with the company names listed in a financial database. The output of such algorithms is a probabilistic assessment of the accuracy of the SEDOL classification (please contact us for a discussion)[4].

One of the key advantages of text analysis is the ability to identify relationships between companies. In particular, social network analysis techniques have become increasingly popular as a framework for representing relationships between people, groups, in this case interconnected companies (both publically-listed and private companies). Figure 9 shows the results of a network analysis created from a co-occurrence matrix of the named entities associated with regulatory violations.

The approach not only helps visualize which companies are currently associated with regulatory issues but may be used to derive a quantitative score for stock selection strategies. To illustrate this, Figure 10 provides a screen of companies with media allegations of wrong-doing (bribery, corruption, fraud and product recalls), together with quantitative scores derived from a sentiment analysis.

Figure 9: Illustrative example of entities detected using a Named Entity Recognition algorithm



Source: Deutsche Bank

Figure 10: Recent corporate allegations published in media news

Date	Company	Title	Sentiment
20170223	ABB LTD	ABB Hit by Fraud at Unit in Korea Swiss firm alleges that treasurer of its subsidiary is behind	-0.09
20170223	ALTRIA GROUP INC	Altria Sees $50M $70M Hit from Smokeless Tobacco Recall market talk	-0.05
20170223	BOSTON SCIENTIFIC CORP	Boston Scientific recalls Lotus Valve heart devices	-0.04
20170223	CREDIT SUISSE GP	Credit Suisse Under Investigation Justice Department probing whether banks Israeli desk he	-0.01
20170223	CROWN RESORTS LIM	Casino Operator Crown Puts Big China Play on Hold Beijings graft crackdown and arrests of C	-0.03
20170223	MALAYSIA AIRPORT	MACC arrests MAHB senior GM for graft	-0.02
20170223	MAZDA MOTOR CORP	Mazda to recall 460000 cars globally for diesel engine defects	-0.09
20170223	PETROL BRASILEIROS	Brazil Graft Scandal Has Firms Bulking Up Compliance Ranks	-0.05
20170223	VALEANT PHARMACEUTICALS INTL	Former Valeant and Philidor execs plead not guilty in fraud scheme	-0.08
20170222	BRASKEM S.A.	Brazils Braskem Posts BRL2 64B Loss Due to Leniency Agreement	-0.11
20170222	WELLS FARGO & CO	Wells Fargo fires former LA regional president	-0.04
20170220	SAMSUNG ELECTRONIC	Samsung Heir Is Arrested Prosecutors accuse conglomerates de facto leader of bribery and c	-0.13
20170220	VOLKSWAGEN AG	Volkswagens boss accused of telling blatant lies over diesel emissions scandal	-0.14
20170219	BAYER MOTOREN WERK	BMW recalling 19000 i3 plug in hybrids for fire risk	-0.13
20170219	MORRISON(W)SUPRMKT	Morrisons pulls meat product and urges shoppers not to eat it after meningitis bug find	-0.06
20170217	AIRBUS GROUP SE	Austria Chases After Airbus Fraud investigation of fighter jet deal flags over $1 billion in con	-0.11
20170217	BANK OF CHINA LTD	Bank of China to pay fine in Italy money laundering	-0.06
20170216	DEUTSCHE BOERSE AG	Insider dealing claim false Börse chief says	-0.06
20170216	DR REDDYS LABS	Dr Reddy's Aurobindo recall drugs in US	-0.04
20170216	ROYAL BK SCOT GRP	RBS accused of fraud and systematic forgery by customers and former employee	-0.06
20170216	TWENTY-FIRST CENTURY FOX INC	21st Century Fox Faces Probe Over Funds to Settle Sexual Harassment Claims	-0.05
20170214	DIAGEO	CORRUPTION Questions raised over Diageo	-0.03
20170214	ROLLS ROYCE HLDGS	Rolls Royce tumbles as bribery fine sparks record loss	-0.04

Source: Deutsche Bank

We will discuss ways to integrate such information into factor-based strategies in our forthcoming research.

[4] We achieve a precision of 97% (defined as the number of correctly classified SEDOLs in a documents divided by the total number of documents analyzed), using a relatively limited number of model features.

Final thoughts

In this publication we outline the steps required to transform qualitative information into quantitative scores.

We began with a discussion regarding the Veracity of unstructured data. Our working premise is that mainstream investors are only likely to integrate alternative data once they have confidence in the collection process and transparency in signal creation.

We conclude by highlighting the importance of a further three Vs associated with 'big data':

- **Validity –** Where do the data come from? Are the data truth or collective opinions? Are the data publicly available data or behavioral-based (i.e. inferred from consumers' web browsing and buying habits)? How can we evaluate the integrity of the signals (i.e. is there a look ahead bias in signal construction)?
- **Viability –** Can long-only stock selection portfolio managers use such signals? While the potential for satellite imagery and store-level credit card transaction data are interesting datasets, are they sufficiently scalable for stock selection?
- **Value –** How accretive are alternative data signals for risk-adjusted returns versus traditional factors? And can such signals be implemented in a low turnover way?

Appendix 1

Important Disclosures

*Other information available upon request

Prices are current as of the end of the previous trading session unless otherwise indicated and are sourced from local exchanges via Reuters, Bloomberg and other vendors . Other information is sourced from Deutsche Bank, subject companies, and other sources. For disclosures pertaining to recommendations or estimates made on securities other than the primary subject of this research, please see the most recently published company report or visit our global disclosure look-up page on our website at http://gm.db.com/ger/disclosure/DisclosureDirectory.eqsr. Aside from within this report, important conflict disclosures can also be found at https://gm.db.com/equities under the "Disclosures Lookup" and "Legal" tabs. Investors are strongly encouraged to review this information before investing.

Analyst Certification

The views expressed in this report accurately reflect the personal views of the undersigned lead analyst(s). In addition, the undersigned lead analyst(s) has not and will not receive any compensation for providing a specific recommendation or view in this report. Andy Moniz/Spyros Mesomeris

Hypothetical Disclaimer

Backtested, hypothetical or simulated performance results have inherent limitations. Unlike an actual performance record based on trading actual client portfolios, simulated results are achieved by means of the retroactive application of a backtested model itself designed with the benefit of hindsight. Taking into account historical events the backtesting of performance also differs from actual account performance because an actual investment strategy may be adjusted any time, for any reason, including a response to material, economic or market factors. The backtested performance includes hypothetical results that do not reflect the reinvestment of dividends and other earnings or the deduction of advisory fees, brokerage or other commissions, and any other expenses that a client would have paid or actually paid. No representation is made that any trading strategy or account will or is likely to achieve profits or losses similar to those shown. Alternative modeling techniques or assumptions might produce significantly different results and prove to be more appropriate. Past hypothetical backtest results are neither an indicator nor guarantee of future returns. Actual results will vary, perhaps materially, from the analysis.

Additional Information

The information and opinions in this report were prepared by Deutsche Bank AG or one of its affiliates (collectively "Deutsche Bank"). Though the information herein is believed to be reliable and has been obtained from public sources believed to be reliable, Deutsche Bank makes no representation as to its accuracy or completeness.

If you use the services of Deutsche Bank in connection with a purchase or sale of a security that is discussed in this report, or is included or discussed in another communication (oral or written) from a Deutsche Bank analyst, Deutsche Bank may act as principal for its own account or as agent for another person.

Deutsche Bank may consider this report in deciding to trade as principal. It may also engage in transactions, for its own account or with customers, in a manner inconsistent with the views taken in this research report. Others within Deutsche Bank, including strategists, sales staff and other analysts, may take views that are inconsistent with those taken in this research report. Deutsche Bank issues a variety of research products, including fundamental analysis, equity-linked analysis, quantitative analysis and trade ideas. Recommendations contained in one type of communication may differ from recommendations contained in others, whether as a result of differing time horizons, methodologies or otherwise. Deutsche Bank and/or its affiliates may also be holding debt or equity securities of the issuers it writes on. Analysts are paid in part based on the profitability of Deutsche Bank AG and its affiliates, which includes investment banking, trading and principal trading revenues.

Opinions, estimates and projections constitute the current judgment of the author as of the date of this report. They do not necessarily reflect the opinions of Deutsche Bank and are subject to change without notice. Deutsche Bank provides liquidity for buyers and sellers of securities issued by the companies it covers. Deutsche Bank research analysts sometimes have shorter-term trade ideas that are consistent or inconsistent with Deutsche Bank's existing longer term ratings. Trade ideas for equities can be found at the SOLAR link at http://gm.db.com. A SOLAR idea represents a high conviction belief by an analyst that a stock will outperform or underperform the market and/or sector delineated over a time frame of no less than two weeks. In addition to SOLAR ideas, the analysts named in this report may from time to time discuss with our clients, Deutsche Bank salespersons and Deutsche Bank traders, trading strategies or ideas that reference catalysts or events that may have a near-term or medium-term impact on the market price of the securities discussed in this report, which impact may be directionally counter to the analysts' current 12-month view of total return or investment return as described herein. Deutsche Bank has no obligation to update, modify or amend this report or to otherwise notify a recipient thereof if any opinion, forecast or estimate contained herein changes or subsequently becomes inaccurate. Coverage and the frequency of changes in market conditions and in both general and company specific economic prospects make it difficult to update research at defined intervals. Updates are at the sole discretion of the coverage analyst concerned or of the Research Department Management and as such the majority of reports are published at irregular intervals. This report is provided for informational purposes only and does not take into account the particular investment objectives, financial situations, or needs of individual clients. It is not an offer or a solicitation of an offer to buy or sell any financial instruments or to participate in any particular trading strategy. Target prices are inherently imprecise and a product of the analyst's judgment. The financial instruments discussed in this report may not be suitable for all investors and investors must make their own informed investment decisions. Prices and availability of financial instruments are subject to change without notice and investment transactions can lead to losses as a result of price fluctuations and other factors. If a financial instrument is denominated in a currency other than an investor's currency, a change in exchange rates may adversely affect the investment. Past performance is not necessarily indicative of future results. Unless otherwise indicated, prices are current as of the end of the previous trading session, and are sourced from local exchanges via Reuters, Bloomberg and other vendors. Data is sourced from Deutsche Bank, subject companies, and in some cases, other parties.

The Deutsche Bank Research Department is independent of other business areas divisions of the Bank. Details regarding our organizational arrangements and information barriers we have to prevent and avoid conflicts of interest with respect to our research is available on our website under Disclaimer found on the Legal tab.

Macroeconomic fluctuations often account for most of the risks associated with exposures to instruments that promise to pay fixed or variable interest rates. For an investor who is long fixed rate instruments (thus receiving these cash flows), increases in interest rates naturally lift the discount factors applied to the expected cash flows and thus cause a loss. The longer the maturity of a certain cash flow and the higher the move in the discount factor, the higher will be the loss. Upside surprises in inflation, fiscal funding needs, and FX depreciation rates are among the most common adverse macroeconomic shocks to receivers. But counterparty exposure, issuer creditworthiness, client segmentation, regulation (including changes in assets holding limits for different types of investors), changes in tax policies, currency convertibility (which may constrain currency conversion, repatriation of profits and/or the liquidation of positions), and settlement issues related to local clearing houses are also important risk factors to be considered. The sensitivity of fixed income instruments to macroeconomic shocks may be mitigated by indexing the contracted cash flows to inflation, to FX depreciation, or to specified interest rates – these are common in emerging markets. It is important to note that the index fixings may -- by construction -- lag or mis-measure the actual move in the underlying variables they are intended to track. The choice of the proper fixing (or metric) is particularly important in swaps markets, where floating coupon rates (i.e., coupons indexed to a typically short-dated interest rate reference index) are exchanged for fixed coupons. It is also important to acknowledge that funding in a currency that differs from the currency in which coupons are denominated carries FX risk. Naturally, options on swaps (swaptions) also bear the risks typical to options in addition to the risks related to rates movements.

Derivative transactions involve numerous risks including, among others, market, counterparty default and illiquidity risk. The appropriateness or otherwise of these products for use by investors is dependent on the investors' own circumstances including their tax position, their regulatory environment and the nature of their other assets and liabilities, and as such, investors should take expert legal and financial advice before entering into any transaction similar to or inspired by the contents of this publication. The risk of loss in futures trading and options, foreign or domestic, can be substantial. As a result of the high degree of leverage obtainable in futures and options trading, losses may be incurred that are greater than the amount of funds initially deposited. Trading in options involves risk and is not suitable for all investors. Prior to buying or selling an option investors must review the "Characteristics and Risks of Standardized Options", at http://www.optionsclearing.com/about/publications/character-risks.jsp. If you are unable to access the website please contact your Deutsche Bank representative for a copy of this important document.

Participants in foreign exchange transactions may incur risks arising from several factors, including the following: (i) exchange rates can be volatile and are subject to large fluctuations; (ii) the value of currencies may be affected by numerous market factors, including world and national economic, political and regulatory events, events in equity and debt markets and changes in interest rates; and (iii) currencies may be subject to devaluation or government imposed exchange controls which could affect the value of the currency. Investors in securities such as ADRs, whose values are affected by the currency of an underlying security, effectively assume currency risk.
Unless governing law provides otherwise, all transactions should be executed through the Deutsche Bank entity in the investor's home jurisdiction. Aside from within this report, important conflict disclosures can also be found at https://gm.db.com/equities under the "Disclosures Lookup" and "Legal" tabs. Investors are strongly encouraged to review this information before investing.

United States: Approved and/or distributed by Deutsche Bank Securities Incorporated, a member of FINRA, NFA and SIPC. Analysts located outside of the United States are employed by non-US affiliates that are not subject to FINRA regulations.

Germany: Approved and/or distributed by Deutsche Bank AG, a joint stock corporation with limited liability incorporated in the Federal Republic of Germany with its principal office in Frankfurt am Main. Deutsche Bank AG is authorized under German Banking Law and is subject to supervision by the European Central Bank and by BaFin, Germany's Federal Financial Supervisory Authority.

United Kingdom: Approved and/or distributed by Deutsche Bank AG acting through its London Branch at Winchester House, 1 Great Winchester Street, London EC2N 2DB. Deutsche Bank AG in the United Kingdom is authorised by the Prudential Regulation Authority and is subject to limited regulation by the Prudential Regulation Authority and Financial Conduct Authority. Details about the extent of our authorisation and regulation are available on request.

Hong Kong: Distributed by Deutsche Bank AG, Hong Kong Branch.

India: Prepared by Deutsche Equities India Pvt Ltd, which is registered by the Securities and Exchange Board of India

(SEBI) as a stock broker. Research Analyst SEBI Registration Number is INH000001741. DEIPL may have received administrative warnings from the SEBI for breaches of Indian regulations.

Japan: Approved and/or distributed by Deutsche Securities Inc.(DSI). Registration number - Registered as a financial instruments dealer by the Head of the Kanto Local Finance Bureau (Kinsho) No. 117. Member of associations: JSDA, Type II Financial Instruments Firms Association and The Financial Futures Association of Japan. Commissions and risks involved in stock transactions - for stock transactions, we charge stock commissions and consumption tax by multiplying the transaction amount by the commission rate agreed with each customer. Stock transactions can lead to losses as a result of share price fluctuations and other factors. Transactions in foreign stocks can lead to additional losses stemming from foreign exchange fluctuations. We may also charge commissions and fees for certain categories of investment advice, products and services. Recommended investment strategies, products and services carry the risk of losses to principal and other losses as a result of changes in market and/or economic trends, and/or fluctuations in market value. Before deciding on the purchase of financial products and/or services, customers should carefully read the relevant disclosures, prospectuses and other documentation. "Moody's", "Standard & Poor's", and "Fitch" mentioned in this report are not registered credit rating agencies in Japan unless Japan or "Nippon" is specifically designated in the name of the entity. Reports on Japanese listed companies not written by analysts of DSI are written by Deutsche Bank Group's analysts with the coverage companies specified by DSI. Some of the foreign securities stated on this report are not disclosed according to the Financial Instruments and Exchange Law of Japan. Target prices set by Deutsche Bank's equity analysts are based on a 12-month forecast period.

Korea: Distributed by Deutsche Securities Korea Co.

South Africa: Deutsche Bank AG Johannesburg is incorporated in the Federal Republic of Germany (Branch Register Number in South Africa: 1998/003298/10).

Singapore: by Deutsche Bank AG, Singapore Branch or Deutsche Securities Asia Limited, Singapore Branch (One Raffles Quay #18-00 South Tower Singapore 048583, +65 6423 8001), which may be contacted in respect of any matters arising from, or in connection with, this report. Where this report is issued or promulgated in Singapore to a person who is not an accredited investor, expert investor or institutional investor (as defined in the applicable Singapore laws and regulations), they accept legal responsibility to such person for its contents.

Taiwan: Information on securities/investments that trade in Taiwan is for your reference only. Readers should independently evaluate investment risks and are solely responsible for their investment decisions. Deutsche Bank research may not be distributed to the Taiwan public media or quoted or used by the Taiwan public media without written consent. Information on securities/instruments that do not trade in Taiwan is for informational purposes only and is not to be construed as a recommendation to trade in such securities/instruments. Deutsche Securities Asia Limited, Taipei Branch may not execute transactions for clients in these securities/instruments.

Qatar: Deutsche Bank AG in the Qatar Financial Centre (registered no. 00032) is regulated by the Qatar Financial Centre Regulatory Authority. Deutsche Bank AG - QFC Branch may only undertake the financial services activities that fall within the scope of its existing QFCRA license. Principal place of business in the QFC: Qatar Financial Centre, Tower, West Bay, Level 5, PO Box 14928, Doha, Qatar. This information has been distributed by Deutsche Bank AG. Related financial products or services are only available to Business Customers, as defined by the Qatar Financial Centre Regulatory Authority.

Russia: This information, interpretation and opinions submitted herein are not in the context of, and do not constitute, any appraisal or evaluation activity requiring a license in the Russian Federation.

Kingdom of Saudi Arabia: Deutsche Securities Saudi Arabia LLC Company, (registered no. 07073-37) is regulated by the Capital Market Authority. Deutsche Securities Saudi Arabia may only undertake the financial services activities that fall within the scope of its existing CMA license. Principal place of business in Saudi Arabia: King Fahad Road, Al Olaya District, P.O. Box 301809, Faisaliah Tower - 17th Floor, 11372 Riyadh, Saudi Arabia.

United Arab Emirates: Deutsche Bank AG in the Dubai International Financial Centre (registered no. 00045) is regulated by the Dubai Financial Services Authority. Deutsche Bank AG - DIFC Branch may only undertake the financial services activities that fall within the scope of its existing DFSA license. Principal place of business in the DIFC: Dubai International Financial Centre, The Gate Village, Building 5, PO Box 504902, Dubai, U.A.E. This information has been distributed by Deutsche Bank AG. Related financial products or services are only available to Professional Clients, as defined by the Dubai Financial Services Authority.

Australia: Retail clients should obtain a copy of a Product Disclosure Statement (PDS) relating to any financial product referred to in this report and consider the PDS before making any decision about whether to acquire the product. Please refer to Australian specific research disclosures and related information at https://australia.db.com/australia/content/research-information.html

Australia and New Zealand: This research is intended only for "wholesale clients" within the meaning of the Australian Corporations Act and New Zealand Financial Advisors Act respectively.

Additional information relative to securities, other financial products or issuers discussed in this report is available upon request. This report may not be reproduced, distributed or published without Deutsche Bank's prior written consent.

David Folkerts-Landau
Group Chief Economist and Global Head of Research

Raj Hindocha
Global Chief Operating Officer
Research

Michael Spencer
Head of APAC Research
Global Head of Economics

Steve Pollard
Head of Americas Research
Global Head of Equity Research

Anthony Klarman
Global Head of
Debt Research

Paul Reynolds
Head of EMEA
Equity Research

Dave Clark
Head of APAC
Equity Research

Pam Finelli
Global Head of
Equity Derivatives Research

Andreas Neubauer
Head of Research - Germany

Stuart Kirk
Head of Thematic Research

International Locations

Deutsche Bank AG
Deutsche Bank Place
Level 16
Corner of Hunter & Phillip Streets
Sydney, NSW 2000
Australia
Tel: (61) 2 8258 1234

Deutsche Bank AG
Große Gallusstraße 10-14
60272 Frankfurt am Main
Germany
Tel: (49) 69 910 00

Deutsche Bank AG
Filiale Hongkong
International Commerce Centre,
1 Austin Road West,Kowloon,
Hong Kong
Tel: (852) 2203 8888

Deutsche Securities Inc.
2-11-1 Nagatacho
Sanno Park Tower
Chiyoda-ku, Tokyo 100-6171
Japan
Tel: (81) 3 5156 6770

Deutsche Bank AG London
1 Great Winchester Street
London EC2N 2EQ
United Kingdom
Tel: (44) 20 7545 8000

Deutsche Bank Securities Inc.
60 Wall Street
New York, NY 10005
United States of America
Tel: (1) 212 250 2500