

How Systematic Is Default Risk?

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Abstract

This study aims to provide an extensive analysis of systematic (market-wide) and systemic (sector-wide and industry-wide) components of the idiosyncratic default risk. We detect significant heterogeneity among the default risk structure of various industry groups. More specifically, the default probability of institutions affiliated with certain industry groups is more strongly linked to industry-wide risks while others are more heavily tied to sector-wide risks. We further show that systematic and systemic components of default risk alter also relative to up/down market cycles for each industry group. That is, the default risk of companies associated with certain industry groups proves systematic in both uptrends and downtrends whereas others induce the market risk during only bullish or bearish market states.

We further consider a scenario where higher default risk of firms belonging to a specific industry group aggravates the sector risks other than its own and find that an increase in the default risk of various industry groups can in fact destabilize one or more sectors. We notice that the stability of firms within specific industry groups matter more than others for the health of an economy and the wealth of its participants, regardless of the market state while others carry weight with respect to market cycles. Our findings on the direct linkages between idiosyncratic default risk and systematic and systemic risks among financial and non-financial firms provide valuable insights for investors as well as policy makers.

Keywords: Default risk; systematic risk; systemic risk

INTRODUCTION

Investors are exposed to certain risks as a result of trading in stock markets. Those risks are strongly associated with the default probability of companies. Default risk of a company can broadly be defined as the probability that a company will be unable to fulfil its debt obligations. Especially the Global Financial Crisis (GFC) re-raised concerns about the default risk and its decomposition; after the cascade effect of the failure of institutions, researchers as well as macro-prudential regulators turned their attention to the structure of default risk. Since the default risk can turn out systematic if the failure of an institution affects other institutions, the structural composition of the default risk is of high interest not only during crisis periods but also throughout bull-bear market cycles.

To what extent do financial and non-financial institutions differ in terms of their default risk's systematic (market-wide) and systemic (sector-wide or industry-wide) components? Do the systematic and systemic importance of institutions vary relative to up and down-market conditions? Do we observe industry-to-sector type systemic default risk connections among firms? If so, do these interdependencies alter with respect to market cycles? In an attempt to answer aforementioned questions, this study aims to conduct a comprehensive analysis of firm-level default risk and systematic and systemic risk linkages among various industry groups.

Several studies investigate the systematic and the diversifiable components of the default risk (Dichev, 1998; Vassalou and Xing, 2004; Campbell et al., 2008; Fiordelisi and Marques-Ibanez, 2013; Filipe et al., 2016; Anginer and Yildizhan, 2018; Poledna et al., 2018; Zhang et al., 2020; Foglia et al., 2022). However, they do not distinguish between the sector-wide and industry-wide systemic default risk structure of institutions with respect to up and down-market cycles. We further contribute to the existing literature by considering idiosyncratic default risk as a source of industry-to-sector (to other than its own) type systemic linkages.

RESULTS

We examine the firms belonging to each industry group separately and determine whether an increase in their default risk is detrimental to the entire market, sector, or industry. To this end, we slightly modify the model from Fiordelisi and Marques-Ibanez (2013)

and utilize dynamic conditional betas (Bali et al., 2016) as a proxy for systematic and systematic risks for each firm. We regress DCC-betas on the idiosyncratic default risk (z-score), firm-specific, industry-specific and country-specific control variables. The default risk measure, Z-score, is inversely related to the firm's insolvency. Hence, negative and significant coefficients of the default risk variable under both up and down-market conditions indicate that the relevant industry-group's default risk possesses systematic and systemic components.

The results from the three constituent industry groups within financials sector indicate that an increase in the default risk of a bank generates an increase in its market, sector, and industry risk in both up and down-market conditions. The default risk of firms within diversified financials and insurance industry groups is systematic and systemic as well throughout up and down-markets.

In consumer discretionary sector, only the default risk of firms associated with retailing industry group proves systematic under down-market conditions. We also find that consumer services companies' default risk is sector and industry systemic in down-markets.

In consumer staples sector, a food beverage and tobacco firm's default risk directly affects other firms within the same industry if the market follows an upward trend whereas it directly augments the sectoral risk during downtrend periods. These firms' default risk is also systematic in uptrend periods. As for the household and personal products industry group, our findings reveal that up market periods matter for the systematic nature of the idiosyncratic default risk since the firm-level default risk directly impacts the overall market risk in solely uptrends.

An increase in the probability of an energy firm's insolvency put distress on the energy industry (or sector) as well as the entire market. These systematic and systemic components of energy company's default risk manifest themselves only during down-markets.

In healthcare sector, a health care equipment and services company's default risk directly enhances systematic risk when the market follows a downward trend whereas it increases the industry-wide systemic risk during uptrend periods. As for pharmaceuticals, biotechnology and life sciences companies, the default risk does not appear to possess a direct impact on the overall market risk.

In industrials sector, capital goods firm's probability of default directly influences market-wide risk in down-markets while an increase in the transportation company's probability of default rises the market-wide risk when the market follows an uptrend.

In information technologies sector, both technology hardware and equipment, and semi-conductors and semiconductor equipment companies' default risk proves systematic and systemic in down-market periods.

The default risk of firms associated with materials, real estate, telecommunication, and utilities sectors is not systematic under either up or down-market conditions.

In our analyses considering industry-to-sector (other than its own) linkages, we find that a rise in the idiosyncratic default risk of diversified financial institutions puts more pressure on the systemic risk of the consumer discretionary sector whereas an increase in the odds of insurance firm's default leads to an augmentation in the industrials sector risk. This is valid through both up and down-market cycles. Higher levels of default risk in insurance (diversified financials) companies generate further distress in the consumer staples (health care) sector during uptrend periods. When market follows a downward trend, on the other hand, a rise in the insurance firms' default risk enhances health care sector risk. As for diversified financial institutions, higher idiosyncratic default risk aggravates the risk of four sectors (namely, consumer staples, materials, telecommunication, and energy) in down markets.

An increase in the consumer services firms' odds of insolvency generate higher distress in the financial sector during both up and down-market cycles. We further notice a similar pattern in the case of retailing companies. Automobiles and components firms' and consumer durables companies' default risk appear to directly influence financial sector risk in a negative way as well. However, this holds only in up markets.

The systemic characteristics of the default risk of firms within three distinct industry groups associated with the consumer staples sector vis-à-vis the other sectors reveals that an increase in the food, beverage, and tobacco (FBT) companies' default risk causes higher distress on the materials and energy sector whereas a rise in the default risk of household and personal product companies puts more pressure on financials, health care, materials, and energy sector during only down markets. Financials, health care, information technologies, and real estate sector risk is intensified by an increase in the default risk of

food and staples retail firms solely when the market follows an upward trend. Overall, an increase in the food, beverage, and tobacco firms' and household and personal product companies' default risks have an adverse effect on several sectors predominantly in down markets while higher odds of food and staples retail firm's default generate higher distress on various sector mainly in up markets.

We detect a direct relationship between idiosyncratic default risk of health care equipment and services companies and the energy sector risk in down markets. In uptrend periods, on the other hand, higher default risk of health care equipment and services firms puts more pressure on the firms associated with the materials sector leading to an increase in the sector-wide risk in this sector. An increase in the default risk of pharmaceuticals, biotechnology, and life sciences companies has an unfavorable influence on the materials sector as well, however, this effect manifests itself only in down markets. Although to a lesser degree, the detrimental impact of higher default risk of pharmaceuticals, biotechnology, and life sciences companies on the information technologies sector proves significant when the market follows a downward trend. A rise in the odds of pharmaceuticals, biotechnology, and life sciences companies' default leads to an increase in the utilities sector-wide risk in uptrend periods.

In industrials sector, higher odds of capital good firms' insolvency induce distress in financial firms throughout up and down markets whereas an increase in the default risk of commercial and professional services, and transportation companies leads to greater financial sector-wide risk only in downtrend periods. The detrimental impact of higher default risk of capital goods companies on the financial sector proves greater in up markets relative to down markets. Consumer staples sector risk rises when the default risk of capital goods and transportation companies heightens. This is valid under up market conditions. Higher default probability of capital goods and transportation firms also causes greater distress in the companies associated with materials sector leading to higher levels of sector-wide risk, but only during down markets.

As for information technologies sector, we note that higher default risk of technology hardware and equipment companies generate greater sector-wide risk in consumer staples sector through both up and down markets. An increase in the odds of technology hardware and equipment firms' insolvency induce distress in health care sector only when the market

follows a downward trend. In uptrend periods, on the other hand, a rise in the technology hardware and equipment companies' default risk adversely affects four sectors in the market. These are consumer discretionary, materials, telecommunication, and energy sectors. As for software and services firms, higher probability of default leads to greater distress in telecommunication sector in down markets whereas it significantly induces sector-wide risk in the consumer discretionary sector during only up markets.

Firms affiliated with the remaining five industry groups, namely, materials, energy, real estate, telecommunication, and utilities, also constitute the respective sector groups. An increase in the materials firms' default risk rises consumer discretionary sector risk in down markets while it heightens health care and real estate sector risks during up markets. Financials sector is adversely affected by a rise in the energy firms' default probability when the market follows a downward trend. In up markets, however, higher odds of insolvency of energy companies generate higher distress in consumer discretionary, health care, materials, and real estate sectors. We detect a direct relationship between the idiosyncratic default risk of real estate companies and the sector-wide risk of both consumer discretionary and telecommunications sectors. This is valid solely under up market conditions. As for telecommunication firms, higher idiosyncratic default risk of these companies induces greater risk in financial, utilities and energy sectors in downtrend periods. Finally, an increase in the default risk of utilities companies directly influences health care sector risk under down market conditions whereas it directly affects industrials and materials sector risks in up markets. In addition, telecommunications sector risk rises due to higher default risk of utilities companies through both up and down-market states.

DISCUSSION

Institutions affiliated with a specific sector may categorically possess a certain level of heterogeneity although they share a set of common features and are part of the same cluster. If, for instance, the financial sector is put under the microscope, the differences between the functions, business models or risks of insurance, diversified financials and banking industries can easily be noticed. Same applies to other, non-financial, sector-industry group clusters. The default and systemic risk linkages among firms within the same industry group may be quite stronger than that of at the sectoral level; possibly reflecting the absence

or limited extent of inter-industry financial flows within the same sector group. In contrast, these firms may have a more complex and significant default risk ties with firms belonging to different industry but the same sector group, rather than with firms within their industry group. Moreover, even if the default risk of firms within a particular industry group is neither systematic nor systemic on an intra-industry level, these institutions may indirectly destabilize the market assuming that their intra-sector systemic default risk is significant and that the default risk of other industry groups within the same sector possess a systematic component.

The systematic and/or systemic components of the default risk do not manifest themselves during both upward and downward market trends in each sector and industry group. Since various sectors or industries benefit from additional investments when the market cycle is in an upward trend and whereas, in principle, systematic default risk is mostly associated with downturns, it is interesting to examine the structure of an institution's default risk under different market conditions. Systematic or systemic default risks may in fact present themselves or even increase as financial imbalances and vulnerabilities build up during upswings and then, materialize in crises followed by recessions. In the same spirit, there may exist some "strategically important" sectors or industries of which the default of a firm causes a cascade effect and lead to the failure of other institutions only during upswings while their default may be insignificant under bearish market conditions because other institutions' default generate relatively higher distress during subsequent downturns. In other words, the institutions affiliated with such sectors or industries may be the cause of a distress propagated, through time, along other industries, and sectors and thus, along the overall market. Although it is beyond the scope of this study, a possible explanation is that those firms may be valued in excess of their fundamental value by a large margin, extremely sensitive to firm-specific news and prone to investor panic, fear, overreaction and herding. A significant increase in the default risk of these institutions would induce market-wide distress, causing a downward trend in the prices. Since systematic defaults are often observed during downturns, determining institutions that endanger an entire industry, sector and/or market under bullish market conditions may reveal the foundation of market destabilization. Another possibility is that there may be certain industries that may pose a threat to the entire market during both up and down-market periods. Surviving

institutions that fall in this latter category can be considered as “too interconnected to fail” besides being “too systematically important to fail” and, may harm the market regardless of its state; that is, they may trigger a downturn or aggravate and prolong a down market into a deeper recession.

“Industry-to-sector” type systemic default risk analyses reveal whether an increase in the odds of default of an institution belonging to a specific industry group directly affects the variations in other sectors’ risk or not. For instance, an institution affiliated with the retailing industry group is categorized under the consumer discretionary sector. Consider a scenario where an increase in the default risk of such firm does not significantly impact the consumer discretionary sector risk but enhances the sectoral risk of one or more non-financial sectors (other than consumer discretionary), or even that of financial sector. Although its default risk is not systematic (and systemic in terms of consumer discretionary sector), an increase in the odds of insolvency of such institution may indirectly destabilize the market via putting pressure on a sector of which the default risk is systematic.

CONCLUSION

This study investigates the systematic and systemic components of the financial and non-financial institutions’ default risk considering up and down-market states. We do not only consider the differences between the financial and non-financial institutions’ default risk structure but also disentangle between sector-wide and industry-wide systemic default risks when conducting our analyses. We detect significant heterogeneity among the default risk structure of various industry groups. More specifically, the default probability of institutions affiliated with certain industry groups is more strongly linked to industry-wide risks while others are more heavily tied to sector-wide risks. We further show that systematic and systemic components of default risk alter also relative to up/down market cycles for each industry group. That is, the default risk of companies associated with certain industry groups proves systematic in both uptrends and downtrends whereas others induce the market risk during only bullish or bearish market states.

We identify banking, diversified financials, and insurance institutions’ default risk to be systematic during both up and down-market conditions. Yet, an increase in the default risk

of these financial institutions puts more pressure on the entire market in down market cycles. This finding emphasizes the unique systematic importance of financial institutions. Retailing, health care equipment and services, capital goods, semi-conductors and semiconductor equipment, technology hardware and equipment, and energy companies' default risk proves to be systematic solely under down market conditions. On the other hand, food, beverage and tobacco, household and personal products, and transportation firms' default risk is systematic only during uptrend periods. The switching importance of the default risk of these companies highlights the differences between the roles of these institutions within an economy. It also points out to the possible sources of contagion risk under various market states.

Our systemic default risk analyses provide interesting results as well. We find evidence of significant heterogeneity among the default risk structure of various industry groups within the same sector. For instance, an increase in a bank's default risk has a greater effect on banking industry in comparison to that of on the entire financial sector. However, an increase in the default risk of a diversified financials company puts more pressure on the financial sector but causes relatively less distress in the diversified financials industry group during both up and down-market states.

As for the insurance firms, industry-wide systemic default risk proves stronger than sector-wide systemic risk during up markets while this relationship inverts so that, under bull market conditions, an increase in the default risk of an insurance firm aggravate sectoral systemic risk more than industrial systemic risk. These findings, along with other instances in various industry groups, reveal a multi-layered structure of the idiosyncratic default risk. We further consider the possible impact of an institution's default risk belonging to a specific industry group on the sectors other than its own and find that an increase in the default risk of various industry groups can in fact destabilize one or more sectors. To illustrate, we identify industrials, information technologies, and real estate (consumer discretionary) as sectors which are directly affected by an increase in the idiosyncratic bank (diversified financials) risk. Higher default probability of insurance firms generates greater systemic risk in the entire industrials sector. These results are valid through both up and down-market cycles. We further determine that an increase in the consumer services, retailing, and capital goods companies' default risk have an adverse impact on the financial

sector risk in both up and down markets. All combined, we note that the stability of firms within specific industry groups matter more than others for the health of an economy and the wealth of its participants, regardless of the market state while others carry weight with respect to market cycles.

The sector-wise decomposition of financial markets differs from one another. If an increase in the default risk of institutions associated with specific industry groups induce the risk of the predominant sectors, the failure of such institutions may cause further harm and destabilize the market. We show that higher idiosyncratic default risk of institutions belonging to several industry groups induces information technologies, consumer discretionary, and industrials sectors' risk. Considering these three sectors form approximately 15%, 18% and 24% of our sample, we emphasize the significance of several non-financial industry groups (i.e., consumer durables and apparel, food and staples retail, energy) besides the financial ones for the market functioning. Consequently, our findings on the direct linkages between idiosyncratic default risk and systematic and systemic risks among financial and non-financial firms provide valuable insights for investors as well as policy makers.

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Tables

Table 1. Industry-to-sector linkages: Financial sector

Panel A. Banking Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.34* (-1.79)	-0.27* (-1.9)	-0.09* (-1.85)	-0.47 (-1.08)	-0.02 (-0.28)	-0.36 (-0.59)	-0.18** (-2.23)	-0.05 (-0.82)	-0.66* (-1.94)	-0.28* (-1.92)	-0.07* (-1.76)	-0.42 (-1.31)
Z-score(-1)* Up	-0.09* (-1.83)	-0.20* (-1.66)	-0.05* (-1.94)	-0.01 (-0.26)	-0.00 (-0.01)	-0.14 (-1.17)	-0.17* (-1.82)	-0.04 (-0.91)	-0.04*** (-2.83)	-0.05 (-1.55)	-0.00 (-0.24)	-0.03 (-0.62)
Panel B. Diversified Financials Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.55* (-1.83)	-0.35* (-1.8)	-0.09* (-1.89)	-0.20* (-1.68)	-0.07*** (-3.06)	0.11 (1.34)	-0.01 (-0.06)	-0.29** (-2.12)	-0.45 (-1.28)	-0.14** (-2.01)	-0.11 (-0.62)	-0.15* (-1.72)
Z-score(-1)* Up	-0.19*** (-2.62)	-0.05* (-1.67)	-0.06 (-1.13)	-0.04* (-1.89)	-0.02 (-1.23)	-0.01* (-1.71)	-0.01 (-0.52)	-0.04 (-1.2)	-0.03 (-1.27)	0.05 (1.47)	0.01 (0.26)	-0.02 (-0.67)
Panel C. Insurance Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.19** (-2.2)	-0.54*** (-2.82)	-0.41*** (-2.76)	-0.04 (-0.31)	-0.21 (-1.49)	-0.28* (-1.69)	0.02 (0.64)	0.14 (0.7)	0.10 (1.63)	0.24 (1.33)	-0.22 (-0.77)	0.01 (0.1)
Z-score(-1)* Up	-0.05* (-1.92)	-0.29* (-1.75)	-0.29*** (-4.48)	-0.11 (-1.53)	-0.16** (-2.18)	-0.07 (-1.2)	-0.02 (-0.22)	0.04 (0.57)	0.06 (1.16)	-0.09 (-0.73)	0.20 (0.81)	0.00 (0.03)

Table 2. Industry-to-sector linkages: Consumer discretionary sector

Panel A. Automobiles & Components Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.49 (-1)	-1.02 (-1.25)	1.65 (1.02)	-0.40 (-1.44)	0.41 (1.02)	-0.19 (-0.56)	-0.02*** (-3.17)	-0.24 (-1.59)	0.03 (1.04)	-0.79 (-1.04)	2.97 (1.01)	0.74 (1.01)
Z-score(-1)* Up	-0.58 (-1.61)	-0.18* (-1.86)	0.20 (0.45)	-0.07 (-0.88)	0.20 (0.28)	-0.06 (-1.19)	-0.13 (-0.78)	-0.13* (-1.67)	0.07 (0.76)	-0.02 (-0.75)	-0.03 (-0.25)	0.03 (0.21)
Panel B. Consumer Services Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.31 (-1.1)	-0.68* (-1.66)	-0.17 (-1.35)	0.04 (0.23)	0.31 (1.29)	-0.11 (-1.51)	-0.14* (-1.75)	0.13 (1.27)	-0.07* (-1.81)	-0.16* (-1.66)	-0.08 (-1.06)	0.21 (1.33)
Z-score(-1)* Up	-0.11 (-1.3)	-0.29* (-1.72)	0.38 (1.03)	0.33 (0.63)	0.02 (0.36)	0.04 (0.41)	-0.03 (-0.4)	-0.12 (-0.45)	0.23 (0.66)	-0.58 (-1.04)	0.03 (0.41)	-0.13 (-1.03)
Panel C. Consumer Durables and Apparel Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.00 (-0.01)	-0.53 (-0.87)	-0.52*** (-2.76)	-0.34 (-0.77)	-0.30* (-1.67)	0.14 (0.66)	-0.07 (-0.58)	0.04 (0.99)	-0.16 (-0.54)	0.02 (0.2)	0.26 (1.49)	-0.14 (-1.34)

NOTE: This preprint reports new research that has not been certified by peer review and should not be used as established information without consulting multiple experts in the field.

Z-score(-1)* Up	-0.07 (-0.31)	-0.93* (-1.69)	-0.61 (-1.63)	-0.20 (-0.38)	-0.12 (-0.99)	-1.13 (-0.92)	-0.62* (-1.75)	-0.75 (-1.61)	-0.29 (-1.34)	-4.71 (-1.03)	-0.82 (-0.22)	0.00 (0.01)
Panel D. Media Industry												
Variables	DCC-Market Beta	DCC- Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC- Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC- Materials Beta	DCC-Real Estate Beta	DCC- Telecom Beta	DCC- Utilities Beta	DCC- Energy Beta
Z-score(-1)* Down	0.14 (1.35)	-0.36 (-0.85)	-0.01 (-0.21)	0.28 (1.26)	0.06 (0.22)	-0.03 (-0.85)	-0.29 (-1.42)	-0.00 (-0.08)	-0.10 (-0.43)	-0.05* (-1.72)	-0.03* (-1.9)	-0.05 (-0.66)
Z-score(-1)* Up	-0.83 (-1.11)	1.91 (0.45)	0.01 (0.03)	1.13 (1.32)	-0.59 (-0.75)	0.11 (1.27)	-0.34 (-1.19)	-0.50 (-0.4)	0.00 (0.06)	-0.12 (-0.53)	-0.21 (-1.28)	0.07 (0.31)
Panel E. Retailing Industry												
Variables	DCC-Market Beta	DCC- Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC- Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC- Materials Beta	DCC-Real Estate Beta	DCC- Telecom Beta	DCC- Utilities Beta	DCC- Energy Beta
Z-score(-1)* Down	-0.15* (-1.93)	-0.20* (-1.82)	-0.03 (-0.42)	0.37 (1.02)	-0.04* (-1.92)	0.09 (1.41)	-0.04 (-0.34)	-0.16 (-1.17)	-0.19 (-1.1)	-0.13 (-1.6)	-0.10* (-1.69)	-0.04 (-0.28)
Z-score(-1)* Up	0.03 (0.06)	-0.34* (-1.66)	1.04 (1.1)	0.26 (0.72)	-1.00 (-1)	-0.11 (-1.53)	0.70 (0.78)	-0.29* (-1.65)	0.06 (0.2)	-0.08 (-0.2)	1.33 (1.07)	-0.10 (-0.17)

Table 3. Industry-to-sector linkages: Consumer staples sector

Panel A. Food, Beverage and Tobacco Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.45 (-0.62)	-0.61 (-1.39)	0.04 (0.36)	-0.04 (-1.12)	-0.38*** (-2.66)	-0.16 (-1.08)	0.15 (0.98)	-0.07* (-1.71)	0.17 (1.2)	-0.32 (-1.35)	0.17 (1.62)	-0.14* (-1.86)
Z-score(-1)* Up	-0.61** (-2.31)	0.28 (1.11)	0.48 (0.46)	0.31 (1.15)	-0.71 (-0.45)	-0.57 (-0.94)	0.45 (1.53)	-0.95 (-0.85)	0.12 (0.56)	-0.71 (-1.3)	-1.18 (-1.18)	-0.73 (-0.6)
Panel B. Food and Staples Retail Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	0.01 (0.05)	-0.45 (-0.95)	-0.58 (-1.03)	-0.23 (-1.53)	0.73 (1.02)	0.18 (0.82)	0.09 (0.77)	0.26 (1.17)	0.15 (1.35)	0.07 (0.2)	0.06 (0.46)	-0.01** (-2.51)
Z-score(-1)* Up	-0.02 (-0.18)	-0.038** (-2.05)	-0.04 (-0.1)	-0.08 (-0.36)	-0.04 (-0.13)	-0.01* (-1.79)	-0.12** (-2.23)	-0.09 (-1.06)	-0.00* (-1.65)	-0.41 (-1.13)	0.17 (1.3)	-0.01* (-1.73)
Panel C. Household and Personal Products Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	0.13 (0.41)	-0.35*** (-3.14)	-0.08 (-0.6)	-0.12 (-1.14)	-0.23*** (-2.85)	-0.00** (-2.18)	-0.09 (-0.39)	-0.01** (-2.33)	-0.15 (-1.35)	-0.22 (-1.47)	-0.07 (-0.77)	-0.12** (-2.37)
Z-score(-1)* Up	-0.16** (-2.5)	0.21 (0.61)	-0.91 (-1.1)	-1.17 (-1.07)	-0.20*** (-2.61)	-0.03 (-0.32)	0.65 (0.95)	-0.03 (-1.43)	-0.82 (-1.36)	-0.18 (-0.75)	2.01 (0.94)	-0.55 (-1.22)

Table 4. Industry-to-sector linkages: Healthcare sector

Panel A. Health Care Equipment and Services Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.15** (-2.08)	-0.42 (-0.71)	0.00 (0.1)	-0.08 (-1.62)	0.02 (0.44)	-0.00 (-0.06)	0.01 (0.28)	-0.04 (-1.24)	0.08 (0.89)	-0.05 (-1.08)	-0.10 (-0.71)	-0.03* (-1.73)
Z-score(-1)* Up	-0.42 (-1.42)	0.19 (0.4)	-0.16 (-0.38)	-0.43 (-1.23)	0.06 (0.91)	-0.21* (-1.68)	-0.10 (-0.56)	-0.15* (-1.82)	-0.01 (-0.05)	0.03 (0.16)	-0.00 (-0.01)	-0.51 (-0.98)
Panel B. Pharmaceuticals, Biotechnology & Life Sciences Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.03 (-0.55)	-0.04 (-0.96)	-0.01 (-0.2)	-0.04 (-0.93)	-0.01 (-0.99)	-0.08** (-1.98)	-0.02** (-2.02)	-0.06* (-1.77)	-0.03 (-0.71)	-0.00 (-0.18)	0.02 (0.68)	0.01 (0.4)
Z-score(-1)* Up	-0.01 (-0.24)	-0.03 (-0.79)	-0.07 (-1.53)	0.01 (0.46)	0.01 (0.85)	-0.24 (-1.11)	-0.09 (-0.94)	0.02 (0.71)	0.01 (0.32)	-0.00 (-0.07)	-0.03* (-1.7)	0.01 (0.24)

Table 5. Industry-to-sector linkages: Industrials sector

Panel A. Capital Goods Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.37** (-2.31)	-0.31** (-2.02)	-0.17* (-1.79)	0.12 (0.92)	0.03 (0.19)	-0.07 (-0.22)	0.26 (0.6)	-0.04* (-1.76)	0.00 (0.02)	-0.04 (-0.53)	-0.10 (-1.12)	-0.01 (-0.26)
Z-score(-1)* Up	0.64 (0.21)	-0.93* (-1.95)	-0.49 (-0.69)	-0.39 (-0.44)	-0.12* (-1.84)	0.02 (0.35)	0.04 (0.79)	0.47 (0.55)	-0.05 (-1.16)	0.52 (0.39)	-0.02 (-0.11)	-0.63 (-0.56)
Panel B. Commercial and Professional Services Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.15 (-0.9)	-0.14* (-1.81)	-0.01* (-1.83)	-0.03 (-0.46)	0.01 (0.38)	0.43 (1.4)	-0.05 (-0.71)	-0.13 (-1.27)	-0.01 (-0.42)	0.04 (0.37)	-0.11 (-1.43)	0.00 (0.15)
Z-score(-1)* Up	0.67 (1.16)	-0.32 (-0.8)	-0.03 (-0.41)	-0.12** (-2.27)	0.13 (0.65)	0.09 (1.01)	-0.24* (-1.73)	0.20 (0.66)	0.04 (0.88)	0.57 (0.84)	0.12 (0.5)	0.13 (0.65)
Panel C. Transportation Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.04 (-0.23)	-0.22* (-1.82)	-0.04 (-0.67)	0.17 (1)	-0.40 (-1.34)	-0.04 (-0.5)	-0.00 (-0.01)	-0.04** (-2.3)	-0.01 (-0.14)	0.02 (0.38)	-0.07 (-0.87)	-0.02 (-0.23)
Z-score(-1)* Up	-0.57* (-1.79)	-0.00 (-0.02)	0.51 (1.12)	0.87 (1.31)	-0.09** (-2.05)	0.29 (0.79)	0.16 (0.48)	0.09 (0.37)	-0.87 (-1.04)	-0.35 (-1.47)	0.47 (1.51)	1.13 (1.21)

Table 6. Industry-to-sector linkages: Information technologies sector

Panel A. Technology Hardware and Equipment Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.07* (-1.72)	-0.12 (-0.92)	0.06 (0.41)	-0.09 (-0.42)	-0.07* (-1.68)	-0.02** (-2.35)	-0.07* (-1.79)	-0.08 (-1)	-0.49 (-1.1)	0.09 (1.05)	-0.01 (-1.29)	-0.04 (-0.25)
Z-score(-1)* Up	-0.04 (-0.81)	0.00 (0.11)	0.07 (0.95)	-0.07** (-2.54)	-0.05** (-2.29)	-0.00 (-0.12)	-0.01 (-0.63)	-0.03** (-2.25)	-0.00 (-0.13)	-0.04** (-1.97)	0.01 (0.32)	-0.10* (-1.85)
Panel B. Software and Services Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	0.03 (0.24)	0.19 (0.52)	0.01 (0.18)	-0.14 (-0.76)	0.10 (0.91)	0.11 (1.07)	-0.10* (-1.71)	0.03 (0.69)	0.07 (1.57)	-0.01** (-2.09)	-0.06 (-0.47)	0.11 (1.08)
Z-score(-1)* Up	0.25 (0.95)	-0.88 (-1.19)	0.09 (0.08)	-0.28** (-2.35)	0.28 (1.51)	-0.12 (-0.73)	-1.22 (-0.95)	-0.36 (-0.88)	-0.31 (-0.75)	-0.13 (-0.44)	-0.04 (-0.59)	-0.09 (-1.1)

Table 7. Industry-to-sector linkages: Materials, energy, real estate, telecommunication, and utilities sector

Panel A. Materials Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industrials Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-2.1 (-0.39)	-0.27 (-1.04)	0.16 (0.37)	-0.16* (-1.71)	0.14 (0.51)	-0.24 (-0.84)	0.08 (0.85)	0.01 (0.05)	-0.47 (-0.85)	-0.28 (-1.43)	0.17 (0.44)	-0.22 (-0.54)
Z-score(-1)* Up	0.35 (1.47)	-0.06 (-0.25)	-0.08 (-0.79)	0.03 (0.4)	0.02 (0.47)	-0.09* (-1.69)	-0.11 (-1.34)	-0.48 (-1.62)	-0.26* (-1.66)	0.08 (1.09)	-0.19 (-1.1)	0.04 (0.52)
Panel B. Energy Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industry Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.31* (-1.78)	-0.43* (-1.82)	-0.23 (-1.48)	-0.54 (-0.87)	-0.04 (-0.24)	-0.03 (-0.28)	0.13 (1.37)	0.03 (0.29)	-0.05 (-0.92)	-0.07 (-0.85)	0.06 (0.7)	-0.12* (-1.91)
Z-score(-1)* Up	-0.23 (-1.21)	-0.29 (-1.47)	0.1 (0.81)	-0.08* (-1.86)	0.02 (0.55)	-0.05* (-1.71)	0.09 (0.81)	-0.04* (-1.74)	-0.09* (-1.68)	-0.01 (-0.46)	0.05 (0.94)	-0.11 (-0.8)
Panel C. Real Estate Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industry Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.17 (-1.18)	-0.45 (-0.83)	0.33 (0.64)	-0.1 (-0.04)	-0.24 (-0.91)	-0.14 (-0.96)	-0.58 (-1.61)	-0.12 (-1.18)	-1.21 (-0.69)	-1.32 (-0.51)	-0.23 (-0.66)	-0.35 (-0.08)
Z-score(-1)* Up	-0.05 (-0.06)	0.22 (1.62)	0.96 (1.53)	-0.40** (-2.01)	-0.11 (-1.27)	0.07 (0.99)	0.16 (1.2)	-0.09 (-0.47)	-0.05 (-0.31)	-0.24** (-2.41)	-0.05 (-0.79)	-0.22 (-0.5)

NOTE: This preprint reports new research that has not been certified by peer review and should not be used as established information without consulting multiple experts in the field.

Panel D. Telecommunication Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industry Beta	DCC-Consumer Disc. Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.06 (-0.12)	-0.06** (-2.19)	-0.22 (-0.5)	-0.04 (-0.1)	0.00 (-0.03)	-0.57 (-1.16)	-0.54 (-1.25)	-0.38 (-0.89)	-0.93 (-1.22)	-0.31* (-1.9)	-0.14** (-2.07)	-0.16* (-1.7)
Z-score(-1)* Up	-0.64 (-0.68)	-0.09 (-0.49)	-0.01 (-0.03)	0.18 (1.16)	-0.07 (-1.09)	0.38 (1.5)	0.00 (-0.02)	-0.3 (-1.13)	-0.37 (-1.1)	0.25 (1.23)	-0.05 (-0.31)	-0.48 (-1.01)
Panel E. Utilities Industry												
Variables	DCC-Market Beta	DCC-Financials Beta	DCC-Industry Beta	DCC-Consumer Discretionary Beta	DCC-Consumer Staples Beta	DCC-Health Care Beta	DCC-IT Beta	DCC-Materials Beta	DCC-Real Estate Beta	DCC-Telecom Beta	DCC-Utilities Beta	DCC-Energy Beta
Z-score(-1)* Down	-0.01 (-0.03)	-0.23 (-0.54)	-0.56 (-1.06)	-0.83 (-1.48)	0.19 (1.12)	-0.31* (-1.68)	-0.01 (-0.06)	-0.34 (-0.87)	-0.12 (-1.35)	-0.39** (-2.1)	-0.06 (-0.24)	-0.09 (-0.49)
Z-score(-1)* Up	-0.14 (-0.57)	-0.05 (-0.46)	-0.6* (-1.79)	0.09 (0.53)	-0.11 (-0.69)	-0.11 (-0.99)	-0.08 (-0.43)	-0.02** (-2.2)	-0.04 (-0.92)	-0.35* (-1.65)	0.43 (0.65)	-0.1 (-0.84)