The impact of COVID-19 on the technology sector: The case of TATA Consultancy Services

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Abstract
Two of the most unpredictable uncertainty indices could explain the business and stock price performance of TATA Consultancy Services (TCS) before and after the COVID-19 pandemic. This pandemic affects business performance and predictability from uncertainty indices. With the second spread of the pandemic, IT industries have been prepared for the high networking bandwidth. Moreover, the bivariate VAR(1)-GARCH(1,1) model is weaker during the COVID-19 period. IT outsourcing after the worldwide outbreak of the disease is one of the most thriving enterprises globally. The coronavirus crisis is expected to have an impact on the IT outsourcing industry. Most of the uncertainty indices of these days are built up from news outlets explored in the case study of TCS. Quantitative examination strategies have been utilized to explore the impact of doubt indices in TCS and the residuals if the organization's emergency persists.

KEYWORDS
COVID-19, geopolitical risk, information technology, uncertainty indices

JEL CLASSIFICATION
C13; D81; N75

1 INTRODUCTION
Tata Consultancy Services (TCS) was founded in 1968 as a domain of the Tata group. From that point, Tata Consultancy Services has become the most prominent software and management consultancy company internationally, with more than 22,000 experts under the initiative. From the 1970s up until these days, the organization following a creative marketing strategy has become one of the worldwide top-10 software organizations. Over the previous years, TCS has likewise been researched in accounting, information technology (IT), and business management. In 1983, the group had 12 associations. After the year 1947, the government of Nehru had awarded various projects to J. R. D. Tata, who had been raised to the top post in the Tata Group in 1983 as part of the country-developing exertion. Different groups promptly fabricated non-market types of capital—political, social, and reputational. During the 1970s, Tata lost is heretofore short unchallenged conspicuousness to Birla and Reliance in spite of having low product relatedness (Kedia, Mukherjee, & Lahiri, 2006). The present exploration sheds light on the captivating wonder of the ascent of worldwide partnerships based on one of the world's least wealthiest nations and how uncertainty variables, for example, Geopolitical Risk Index by Caldara and Iacoviello (2018) and Economic Political Uncertainty by Baker, Bloom, and Davis (2016) could clarify the TCS stock value performance before and after the worldwide pandemic health emergency of COVID-19. Moreover, the authors explore if the Indian IT stock markets respond to international economic policy uncertainty (EPU) and geopolitical risk (GPR) in the same way, by using a linear regression strategy. Additionally, the EPU record has been widely used as an intermediary for financial ambiguity among the researchers in the few past years. Nonetheless, extensive misfortunes regarding wars, terror assaults, and other comparable events required having another intermediary for fat-homing the internationals crisis, for example, the index of GPR.

There exist essential contrasts in the assessment and nature of these indexes. EPU index is assessed by using a document-mining

DOI: 10.1002/jsc.2397

Strategic Change. 2021;30:137–144. wileyonlinelibrary.com/journal/jsc © 2021 John Wiley & Sons Ltd.
methodology from digital archives of 10 driving news outlets utilizing significant financial event terminology, such as “monetary policy, fiscal procedure, tax.” Alternately, GPR is assessed by using digital archives from 11 newspapers that are identified with geopolitical strains (for example, “terrorism”, “military conflicts”, “political pressures”, “communal disharmonies”) (Baker et al., 2016).

The premise of differentiation among EPU and GPR list lies in how EPU portrays ambiguity regarding the real economy. However, GPR portrays hazard segments identified with war and war-like circumstances (Kannadhasan & Das, 2020). Albeit, both lists become from the promoting intensity of papers. Past examinations explore the impact of EPU on stock returns, and GPR on stock returns independently under an overall view. The present study explores the asymmetric reliance of EPU and GPR in Indian IT stock market returns. The GARCH methodology aids in comprehending the degree of reliance under the diverse stock costs circumstances. Understanding the reliance contrast concerning economic situation helps the financial specialists, portfolio directors, and policymakers settle on speculation choices viably and proficiently (Kyriazis, Daskalou, Arampatzis, Prassa, & Papaioannou, 2019).

The TCS stock unequivocally corresponded with the GPR and EPU indices. Moreover, GPR has been considered a fundamental variant of financial exchange elements and an anticipated investor model (Carney, 2016). Nonetheless, the relation of securities exchange returns with GPR is understudied in literature, with barely any exceptional cases (Balcilar, Bonato, Demirer, & Gupta, 2018; Gkillas & Katsiampa, 2018). Nevertheless, both EPU and GPR indexes have been used to explore their relationship with elective speculation instruments, for example, commodities and cryptocurrencies. For example, a few examinations inspect the relationship between EPU and gold (Balcilar, Gupta, & Pierdiacho, 2016), EPU and Bitcoin (Das, Le Roux, Jana, & Dutta, 2020), among many others. Essentially, the effect of GPR has likewise been concentrated regarding gold (Baur & Smales, 2018), and give the observational confirmations that the GPR index causes constraint in the developed stock market returns. Additionally, EPU and GPR’s effect on stock returns has high significance with important developing economies, such as China and India (Wang, Jiang, & Zhan, 2019). These nations pull in considerable foreign assets and hold a significant share in worldwide GDP. Full investigation of geopolitics is a term that includes various definitions and verifiably refers to the states’ practice to take control of and compete for the territory.

Nonetheless, recently, power battles and different events including a diverse arrangement of specialists—not excluding companies, non-governmental associations, rebel groups, and political parties—have additionally been delegated part of geopolitics. Therefore, the present use of “geopolitics” covers a diverse arrangement of events with a broad scope of causes and outcomes, from terrorist attacks to climate change, from Brexit to the International Economic Emergency (Vakulchuk, Overland, & Scholten, 2020). In characterizing GPR, there is a need for distinguishing circumstances in which specialists’ power battles over areas cannot be settled calmly and justly. Appropriately, the authors characterize geopolitical risk as the risk related to wars, terrorist acts, and pressures between states that influence the typical and tranquil course of worldwide relations. GPR catches both the risk that these events emerge and the new risks related to an acceleration of current events. Our definition intently follows the chronicled utilization of the term geopolitics and—by ongoing appraisals of current worldwide relations among states—incorporates terrorism. Additionally, researchers build the GPR index by including the number of events in driving newspapers of articles examining the geopolitical events and risk portrayed. Specifically, construct a monthly index—with the start year 1985—by running automated text-searches of the electronic files of 11 newspapers: The Boston Globe, The Chicago Tribune, The Daily Telegraph, The Financial Times, The Globe and Mail, The Guardian, The Los Angeles Times, The New York Times, The Times, The Wall Street Journal, and The Washington Post. On a month-to-month basis, the indicated index reflects the number of articles concerning rising geopolitical risks divided by the complete number of published articles. The index is standardized to the average estimated 100 in the 2000–2010 decade (Caldara & Iacoviello, 2018). On the other hand, the outsourcing of IT is considered one of the most prospering businesses internationally. Nonetheless, with the COVID-19 crisis, a combined effect is anticipated in the field of IT outsourcing (Vaishya, Javaid, Khan, & Haleem, 2020). Since various economies are extending the restrictions due to the new coronavirus emergency, revenue creation for the majority of businesses across fields has been impacted while the unemployment percentage has, in a reasonable manner, skyrocketed (Gursoy & Chi, 2020). In the midst of decaying financial circumstances, the nations and businesses that rely largely on outsourcing are attempting to get a hold of the IT service imports to utilize their means to the assigned job (Hafez & Attia, 2020). For instance, two influential organizations of Australia, Telstra and Optus and UK’s Virgin Media, which had partnered for process outsourcing with India and the Philippines, have reported preferring employing candidates in host country only. According to the United Nations report, India is considered among the 15 most impacted economies due to the coronavirus crisis (Kumar, Raut, Narwane, & Narkhede, 2020). Whereas no agreement annulments have occurred so far by the service parties in different geographies, numerous clients have requested decreased assistance for application and maintenance services.

Technology entrepreneurship is key to economic growth in developed countries. At the same time, COVID-19 has a vital role in immigration from developing regions of the world to developed ones significant and ongoing, resulting in new entrepreneurship ethnic heterogeneity (Uğur & Akbıyık, 2020). Despite the rising evidence of highly skilled immigrants in IT companies making strong strides in high-tech entrepreneurship (e.g., Achidi Ndofor & Priem, 2011; Saxenian, 2001; Wadhwa, Rissing, Saxenian, & Gereffi, 2007; Wadhwa, Saxenian, Rissing, & Gereffi, 2007). Ethnicity is pertinent for research on consultant technology entrepreneurship and success. In this type of entrepreneurship, the human aspect and employees intelligence drive the company’s value.

Nevertheless, this evidence is not generalizable because it is limited to a small sample of public Internet ventures operating in a boom time. The disturbance of world exchange due to the COVID-19 crisis
is anticipated to have a trade effect of USD 348 million on India, even though it is lower than its counterparts, for example, Europe (with the UK included), the US, Japan and South Korea. Due to the COVID-19 crisis that the IT business is facing in severe conditions, the associations are needed to witness their production lagging (Donthu & Gustafsson, 2020). Leading IT organizations, like TCS, Infosys, and HCL technologies are at the forefront to bear maximum jolt as the interest from customers in the United States and Europe, which are the most impacted by the pandemic, is anticipated to decrease. It is anticipated that the revenue will be decreased by roughly 3–8% generally affected by the deceleration in decision making, deferment in pipeline transformation and project execution and pricing effect on core business.

Various companies that have never considered redistributing could gain by this circumstance to cooperate with a couple of re-appropriating firms during this chance to extend their wings. Presently, organizations are receiving work from remote areas, requiring more cloud services and IT applications to upgrade and reinforce their data-related security from cyber penetrations successfully. When the Indian IT business is relied upon to observe pressure on new agreements and pricing, there are fragments inside the IT industry wherein outsourcing is expected to increment. Close to term issues persevere; however, similar issues will probably open new occasions to some inside the outsourcing services domain.

1.1 | Information technology and COVID-19

Last decades, IT played an important role in societies’ operational and competitive environment for many years. For this study, IT capabilities are defined as the ability to effectively use IT tools and information sources to analyze, process, and present information and model, measure, and control external events (Benzie, 1997). Furthermore, (Vaishya et al., 2020) discussed the usage of artificial intelligence for COVID-19 management. The IT effect in healthcare and the high contribution of technology companies is mentioned in Javaid et al. (2020) and Singh, Javaid, Haleem, and Suman (2020), who investigate available literature and concluded that the Internet of Things (IoT) is helpful for the detection of symptoms and providing treatment rapidly. The novel coronavirus causes IT changes in early 2020 and has significantly changed global society (Albahri et al., 2020). The new normal refers to a society in which physical and social distancing is needed to help stop the disease’s spread, while the global economy must be unaffected. Consequently significant changes in telecommunication, new technologies, and IT companies reflected how employees interact and behave in society. Entrepreneurs are the recipients of much of these changes as they act as opportunity agents in society (Ratten, 2020). They do not necessarily gain from changes such as those occurring from the coronavirus health pandemic but may trigger significant changes in business direction. The effects of the virus have social and economic effects. Much of the unprepared technological companies affected dramatically under the new required working conditions. Before the virus, some of the largest IT companies in India and the United Stage have already a trend toward digitalization accelerated when the virus’s transmission mode became known (Ting, Carin, Dzau, & Wong, 2020). COVID-19 related uncertainty raises new state and local tax implications to arise for workers, who are now remote due to the crisis (Ashraf, 2020). In addition, tax compliance operations could lag significantly, as newly remote employees lack timely access to information, especially in emerging countries. In the short term, changes to income statements such as short-term losses will affect financial companies forecasts and trading performance.

Moreover, Siddiqui and Siddiqui (2020) defined financial inclusion as “the process of ensuring access to financial services and timely and adequate credit where needed by vulnerable groups such as weaker sections and low-income groups at an affordable cost” including savings, credit, remittance, insurance, and financial literacy apart from having a bank account. The population of emerging countries knows their own money is their most reliable form of social security to manage their financial uncertainty. Households in poverty suffer from inadequate access to financial services.

Finance is a system comparable to public utilities under low competition circumstances with relatively few suppliers (Milana & Ashta, 2012). Subsectors of technology will not be unaffected during this period. Generally, the software was impacted less directly than other subsectors, as it did not experience supply chain issues that burdened other subsectors, such as portfolio management in IT procurement. Some applications will experience tailwinds as the current situation increases dependency on technology. Under these circumstances, portfolio selection management based on uncertainty indices and entrepreneurship management has been rapidly changed. The digital technologies during COVID-19 pandemic used by a firm to manage the digital business are considered the firm’s digital capabilities (de Oliveira Valério, da Silva, & Neves, 2020). An organization’s digital transformation involves multiple digital capabilities, using cloud infrastructure for value creation, relying on data-driven decision-making through analytics, switching the focus from product-based revenue to service revenue, and experimenting with outcome-based business models (Iansiti & Lakhani, 2014). A digitally transformed organization’s significant elements include people, business, things, data, and cloud (Blaschke, Cigaina, Riss, & Shoshan, 2017). During the second spread of the pandemic, IT industries must be prepared for the high networking bandwidth. Over the whole period, the telecommunications industry does relatively successfully, as the demand for supporting services raises significantly. (Ramelli & Wagner, 2020). On the other hand, the logistics technology industry faces delays in shipments of electronic goods and movement control regulations. Many small technology companies have to stop doing business (Alam, Wei, & Wahid, 2020). Besides, pandemic expected to affect a huge and long-term impact on biometrics companies and related technology developers and markets (Carlaw, 2020).

2 | DATA AND METHODOLOGY

The examination dataset covers more than 15 years and 9 months, with monthly data series from January 2004 to September 2020. The
starting date is compelled by the accessibility of the worldwide EPU information and TCS stock cost. Moreover, the required files of EPU and GPR are accessible in month-to-month recurrence. The stock price dataset in INR (India Currency) values is extricated from the Thomson Reuters Datasream. The estimation of covariance between the factors (x, y) defined by \( y(x, y) = E [(x - \mu_x)(y - \mu_y)] \). Moreover, different ways can be applied for assessing the pattern \( m_t \) at time \( t \). A moving normal is an average of a predetermined number of time series values around each value in the time series, aside from the initial few and last few terms. Assume our time arrangement starts at January \( t = 1 \) until the December \( t = 12 \). Figure 1 presents the co-movement of the uncertainty indices and TCS stock price. The indicated standard of two moving averages corresponds to \( t = 7 \) to represent data unpredictability, a model that considers restrictive changes in the difference. An autoregressive structure reached this condition for the variance procedure. Errors prompt the accompanying definition. A series \( \{e_t\} \) is first-order autoregressive conditional heteroskedastic, denoted ARCH (1), if \( e_t = \sqrt{a_0 + a_1e_{t-1}^2} \), where \( \{w_t\} \) is white noise with zero mean and unit variance and \( a_0 \) and \( a_1 \) are model parameters. The first-order ARCH model extended to \( p \)-th-order process by including higher lags. The following equation gives an ARCH(\( p \)) process \[\epsilon_t = w_t \sqrt{\alpha_0 + \sum_{i=1}^{p} \alpha_i \epsilon^2_{t-i}}\] where \( \{w_t\} \) is the white noise with zero mean and unit variance. It is observed that EPU and GPR effect has a significant effect on the TCS stock price. The Augmented Dickey-Fuller (ADF) and Phillips Person (PP) test demonstrate that the returns series are fixed at first contrast. The \( x \)-axis gives the lag \( k \), and the \( y \)-axis gives the autocorrelation \( \{\rho_k\} \) at each lag. The unit of lag is the sampling interval by 0.1 s. Correlation is dimensionless, so there is no unit for the \( y \)-axis. Added expansion, widely used in economic applications, is the generalized ARCH model. A further extension, commonly utilized in financial applications, is the generalized ARCH model, denoted \( \text{GARCH}(q, p) \), which has the \( \text{ARCH}(p) \) model as the special case \( \text{GARCH}(0, p) \). A series \( \{e_t\} \) is \( \text{GARCH}(q, p) \) if \( e_t = w_t \sqrt{h_t} \) where \[h_t = a_0 + \sum_{i=1}^{p} \alpha_i e^2_{t-i} + \sum_{j=1}^{q} \beta_j h_{t-j}\] and \( a_i \) and \( b_j \) \( (i = 0, 1, ..., p; j = 1, ..., q) \) are model parameters. Table 1 reports the basic statistics of return series, including mean, SD, skewness (Skew.), and kurtosis (Kurt.). Moreover, ARCH refers to the empirical statistics of the statistical test for conditional heteroscedasticity of order three. LB are the empirical statistics of the Ljung-Box tests for autocorrelations of order three applied to raw return series. Jarque-Bera is the empirical statistics of the (JB) test for normality based on skewness and excess kurtosis. Finally, the correlation (Corr) refers to the correlation coefficients. *, **, and *** indicate

**FIGURE 1** Uncertainty and TCS stock price indices. EPU, GPR, and GPR-India uncertainty indices co-movement and diversification of uncertainty and TCS stock price during the COVID-19 present. From the early 2004 until 2019, data are high correlated. On the other hand, after 2019 TCS stock price is unpredictable [Color figure can be viewed at wileyonlinelibrary.com]

**TABLE 1** Descriptive statistics of return series

|        | Mean  | SD   | Skew | Kurt | JB    | ARCH  | LB   | Corr. with EPU | Corr. with GPR | Corr. with GPR India |
|--------|-------|------|------|------|-------|-------|------|---------------|----------------|----------------------|
| TCS    | 766.81| 46.91| 0.78 | -0.51| 14.8***| 20.35***| 3.99 | -0.14         | 0.28           | 0.77                |
| EPU    | 95.73 | 3.68 | 1.54 | 1.21 | 33.1***| 75.56***| 12.82| 1             |                |                     |
| GPR    | 135.85| 4.79 | 1.29 | 1.96 | 45.7***| 27.24***| 9.34 | 0.24          | 1              |                     |
| GPR India | 83.89 | 1.22 | 1.66 | 5.61 | 82.3***| 54.29***| 11.45| -0.29         | 0.24           | 1                   |

Note: Uncertainty indices and TCS stock price descriptive statistics. Significant level of 1%, 5%, and 10% appear as +, ++, ++++. JB normality test and ARCH model shows the data normal distribution fit and autoregression model.
the rejection of the null hypothesis of associated statistical tests, respectively at 10, 5, and 1% of significance levels.

Univariate AIC and BIC information criteria were used to choose the optimal $p$ and $q$ lag length values of the univariate GARCH process for each pair of TCS and uncertainty sectors (Table 2).

**TABLE 2** VAR(1)—GARCH(1,1)

| Variables | EPU  | GPR  | GPR-India |
|-----------|------|------|-----------|
| TCS       |      |      |           |
| Constant  | 0.0149* | 0.0025*** | 0.0030 |
| AR(1)     | 0.2689 | 0.2165 | −0.0554 |
| Conditional variance equation | | | |
| $\sigma_{t-1}^2$ | 0.1509** | 0.1375*** | 0.1022* |
| $\mu_{t-1}^2$ | 0.0842 | 0.00450 | 0.0878 |
| $h_{t-1}$ | 0.0573 | 0.8461 | −1.4828 |
| $h_{t-1}$ | 0.7212 | −0.0187 | 0.7327 |
| JB        | 44.23*** | 46.60*** | 38.02++ |
| ARCH(3)   | 7.81   | 9.45  | 25.12    |
| LB(3)     | 25.30** | 22.19*** | 29.22* |
| LB2(3)    | 9.36   | 14.56 | 9.21     |
| AIR       | −6.4809 | −5.6628 | −7.2284 |

Note: The superscripts +, ++, and +++ indicate significance at 1%, 5%, and 10% respectively. The AIC criterion measures the relative goodness of fit of the estimated model. JB, ARCH(3), LB(3), and LB2(3) refer to the empirical statistics of the Jarque–Bera test for normality based on skewness and excess kurtosis, the Engle (1982) test for conditional heteroscedasticity of order 3.

Similar to previous studies (Ling & McAleer, 2003), our results also select one lag for both conditional mean and variance equations for most market pairs studied. Therefore, the authors decide to use the bivariate VAR(1)-GARCH(1,1) to compare empirical results across different uncertainty indices. Diagrammatically the results of VAR(1)-GARCH(1,1) are presented in Figure 2. The assumption of constant conditional correlation may be viewed as restrictive, given the changing uncertainty conditions.

**3 | EMPIRICAL RESULTS AND DISCUSSION**

In this section, the authors first present the empirical results from estimating their bivariate VAR(1)-GARCH(1,1) and regression model for all pairs of uncertainty indices. The authors show how all models’ estimation results can be used to compute the optimal selection of a most effected uncertainty index in TCS. Finally, the diversification and hedging effectiveness across models are empirically compared to assess the real ability of the VAR(1)-GARCH(1,1) between GPR and TCS stock market price. The present study showcases a helpful method to assess a prescient regressive design where a time series of one variable degenerates on lagged variables expected to anticipate it. The prescient factors have a first-order autoregressive model, and their disturbance terms collectively correspond with that of the anticipated variable. For the singular indicator case (Stambaugh, 1999), demonstrates that the OLS-assessed coefficient of the lagged variable is biased when computed from a little sample. Table 3 displays the regression outcomes of the stock prices.

**FIGURE 2** Correlation and probability distribution functions. Autoregressive lag for Economic Political Uncertainty, Geopolitical Risk Index and TCS stock price [Color figure can be viewed at wileyonlinelibrary.com]
Besides, the principal request differentials of time series are provided by

\[ \nabla x_t = x_t - x_{t-1} = z_t - z_{t-1} + \alpha_t. \]

India GPR index dismissed as a critical factor in both sub-periods. Furthermore, altered \( R^2 \) is 70.8% with \( F \)-statistic (3,188) equal to 155.4. Then again, in post COVID period all the unpredictability indices are not critical. The TCS stock prices do not need to be more affected by the uncertainty based on the leading international news from the Indian nation.

The authors build up an assessment strategy for the single and various indicator structures that create a diminished predisposition assessor of the lagged variables’ coefficients, which ends up being indistinguishable in the single indicator case to the assessor inspired by (Stambaugh, 1999). A clear assessment strategy is formatted for a decreased inclination standard error, which was found to apply well in specific variants of the different indicator models. With these standard errors, it is not easy to perform tests of the factors’ measurable essentialness. The linear model fitting among GPR and TCS stock prices is presented in Figure 3. The low value of TCS stock price could be predictable by using the GPR. On the other hand, India’s GPR does not provide further predictability power.

In general, as evidenced, the coefficients of EPU are negative for TCS stock price. Likewise, Table 3 also features how the negative coefficient estimations of EPU are not exactly the GPR. This fact demonstrates the way that GPR dampens the TCS asset prices more seriously than the EPU. It might likewise be regarded that the coefficients of EPU are regularly positive in the smaller quantiles. The general result is that both financial idiocies created from the marketing source could generate estimating abilities in small and in larger quantiles. The COVID-19 effects could speed up de-globalization in countries like India, where IT companies may rely on working from home. However, governments may impose stricter regulations on taxes and services, which create an additional firm-wide risk factor. Besides, from an investment perspective, an essential lesson from the COVID-19 crisis is building bridges and making barriers, domestic and international cooperation, trade and investment, sharing of knowledge, information

### TABLE 3 Regression analysis

| Variables | Coefficient | SE  | p-value |
|-----------|-------------|-----|---------|
| Intercept | 173.3214    | 141.988 | .224 |
| EPU       | -4.6001     | 0.5216 | .001*** |
| GPR       | 8.4828      | 0.4159 | .001*** |
| GPR India | -1.4129     | 1.5925 | .376   |
| R²        | 0.708       |       |        |
| \( F(3,188) \) | 155.4       |       |        |

| Variables | Coefficient | SE  | p-value |
|-----------|-------------|-----|---------|
| Intercept | 2,409.7552  | 3.827 | .012 |
| EPU       | -0.95       | -0.27 | .792   |
| GPR       | 0.057       | 0.03  | .977   |
| GPE India | -2.59       | -0.4  | .705   |
| R²        | 0.067       |       |        |
| \( F(3,8) \) | 181.462     |       |        |

Note: Significant codes for the independent variables 0.001***, 0.01**, 0.05*. TCS stock price is the dependent variable.

**FIGURE 3** Forecasting TCS and GPR volatility model based on GARCH(1,1) model [Color figure can be viewed at wileyonlinelibrary.com]
and resources are the main factors to maintain the economy and the financial impact of the current but also a future pandemic. TCS could prevent uncertainty by spending more on forecasting in their IT services and operational management. Increasing the demand for communication equipment and services could improve employees’ productivity and encourage working from home. As this pandemic crisis continues, the need for faster access to data and automation enhances the focus on 5G network deployments and equipment. TCS should implement digital future work-wide tools for business processes supporting future scenarios with innovation and technology adoption.

4 | CONCLUSION AND FUTURE RESEARCH

The present study investigated the effects of India’s geopolitical risk (GPR), the global geopolitical risk, and the economic and political uncertainty (EPU) on uncertainty and prediction power of TCS stock prices. In general, the outcomes suggest that GPR effect on the TCS stock value futures uncertainty is critical. Policymakers and investors regarding the IT futures market should consider geopolitical events and threads in the context of IT instability forecasting, risk management, and portfolio allocation. The analysis has highlighted the significance of GPR and EPU in risk management and portfolio investments in IT markets and TCS stock value. Organizational studies about portfolio management under uncertainty indices also use daily data after interpolation, which analyses the portfolio’s daily performance. As mentioned, the VAR(1)-GARCH(1,1) applied in GPR is principle-based, and hence the use of a standardized quality index is based on subjective judgments and bias problems. By composing the optimization and nonlinear techniques, many studies give equal weights to each of the content elements of uncertainty. Thus, future studies should first analyze each uncertainty index’s direct effect by ranking the central elements’ importance and quality score. Another critical point is the operationalization of the interpolated data. The interpolation increases the whole data risk management process in the portfolio and has a strong link to prediction reporting.

Furthermore, former studies focus on a single country. It would be much better to have worldwide samples of IT companies to analyze country-specific factors’ impact on management perceptions. It seems crucial for successful bias predictions to establish a new COVID-19 index, including the pandemic’s monthly effect on IT development. From a short-term perspective, the implementation of VAR(1)-GARCH(1,1)-GPR weak on a COVID-19 data sample. Future research should also address these critical factors.

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**How to cite this article**: Ntasis L, Koronios K, Pappas T. The impact of COVID-19 on the technology sector: The case of TATA Consultancy Services. *Strategic Change*. 2021;30: 137–144. https://doi.org/10.1002/jsc.2397