



Research article

The impact of COVID-19 on the valuations of non-financial European firms

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ABSTRACT

This paper assesses the impact of the COVID-19 pandemic on non-financial firms' valuations in the European Union (EU) using a stress testing approach. Notably, the paper investigates the extent to which the COVID-19 may deteriorate non-financial firms' value in the ten EU countries to provide a robust anchor to policymakers in formulating strategic government interventions. We employ a sample of 5342 listed non-financial firms across the selected member states that have consistent analyst coverage from 2010 to 2019. First, we estimate the input sensitivities of free cash flow and residual income models using a random effect panel employed to in-sample data. Second, based on these sensitivities, we compute the model-driven ex-post valuations and compare their robustness with actual price and analyst forecasts for the same period. Finally, we introduce multiple stress scenarios that may emanate from COVID-19, i.e., a decline in expected sales and an increase/decrease in equity cost. Our findings show a significant loss in valuations across all sectors due to a possible reduction in sales and an increase in equity cost. In extreme cases, average firms in some industries may lose up to 60% of their intrinsic value in one year. The results remained consistent regardless of the cash flow or residual income-driven valuation.

1. Introduction

A firm's valuation is probably the most crucial area for various stakeholders ranging from investors, debtors, regulators, and policy-makers. Valuation is essential from a shareholder perspective (Kumar, 2015) and because it represents important information about performance drivers. Consequently, it could support strategic decisions such as mergers, acquisitions, expansion, or specialization (Fernández, 2004). The issues and challenges revolving around the valuation of a firm have always attracted financial market participants, researchers, and financial regulators. There is a large body of the academic literature focused on various aspects of valuations, such as the identification of value drivers of a firm (Rappaport, 1999; Copeland et al., 2000; Damodaran, 2002; Jennergren, 2013) or the best approaches to forecasting the firm's value (Myers, 1984; Barker, 1999; Demirakos et al., 2004; Asquith et al., 2005; Imam et al., 2008).

The importance of valuation significantly exacerbates due to uncertainty, turbulence, and shocks as crises make values divergent from the ordinary course, and the future outlook becomes mosaic. After almost 12

years of the Global Financial Crisis of 2008, the COVID-19 pandemic emerged as a "black swan" event for the financial markets in January 2020 (Yarovaya et al., 2022, 2021a,b; Goodell, 2020), and it is essential to understand what impact this crisis may have on the valuations of firms considering its devastating nature. The pandemic came as an unprecedented event threatening the world's health systems and posing numerous challenges for the financial system. However, it would be naïve to say that financial markets did not have any prior knowledge or understanding of pandemics' risk for the financial system. For example, just a week before the full-fledged breakout of COVID-19, the World Economic Forum, in its global risk report (2020)¹, also listed the health crisis and epidemic as the number 10 risk factor among various risks potential to disturb financial markets. Nonetheless, the spread was so quick, and the impact of worldwide lockdown was devastating, which was unfathomable on an ex-ante basis².

Immediately after the shock, equity markets around the globe witnessed a substantial decrease in stock prices. On February 20, 2020, there was a *global* market crash; and from February 24 to 28, stock markets worldwide reported their largest one-week declines since 2007–08. The

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Euronext 100 index lost almost 25% of its value between January 1, 2020, and March 31, 2020. As stock prices continued to decline, the crisis made the prospects of all firms look worse. Among the various challenges the global economy faces, the question that has attracted researchers, markets, regulators, and policymakers alike concerns how COVID-19 has changed the business outlook.

Enikolopov et al. (2014) state that a firm loses value during a crisis for two reasons. The direct cause is the decline in the magnitude of investment opportunities, which hampers the firm's ability to grow its cash flows as per prior projections. On the other hand, the indirect reason is the loss of access to external finance. It can deteriorate the firm's liquidity and solvency through several channels, increase its risk, and eventually translate into a higher capital cost. In the context of COVID-19, Mirza et al. (2020) reported a significant compromise of the corporate financial flexibility. While there are a good number of studies on the impact of the Global Financial Crisis (2007–2008) and European crisis (2010–2012) on the EU based non-financial firms (Claessens et al., 2011; Ferreira et al., 2016), only limited evidence available that assessed the effects of past pandemics on the valuations. We identify this as a valid research gap and attempt to contribute to the literature and practice of valuation by investigating the effect of COVID-19 on the valuations of non-financial firms in the European Union.

For this purpose, we adopt a multifold strategy. Our sample comprises firms from the ten most impacted member states. We initiate by determining the robustness of free cash flow to firm and residual income models. The input sensitivities are estimated using a random effect panel by employing the data between 2010 and 2019. These factor sensitivities are assessed for within-sample accuracy. Once the accuracy is established, we use these sensitivities to compute the model-driven ex-post valuations and compare their robustness with actual price and analyst forecasts for the same period. After that, we consider the 2019 valuations as the base case scenario and introduce multiple stress scenarios related to a decline in sales and an increase in cost of equity triggered by COVID-19.

Our findings show a significant loss in valuations across all sectors due to a possible decline in sales and an increase in equity cost. In extreme cases, average firms in some industries may lose up to 60% of their intrinsic value in one year. The results remained consistent regardless of the cash flow or residual income-driven valuation. We also report some comfort to valuations if policy interventions provide financial flexibility, and the loss to intrinsic value can be limited to around 10%. These findings highlight the severity of the impact of COVID-19 on firms' valuation and the need for a systematic state response.

The rest of the paper is organized as follows. Section 2 outlines our empirical strategy, section 3 presents the data, empirical findings are discussed in section 4, and section 5 presents some tentative conclusions.

2. Methodology

The COVID-19 outbreak has impacted most EU member states, but the episode has been more significant for some. Therefore, we consider ten countries that have reported the most significant number of infections as of 6 December 2021. Some COVID-19 statistics for these countries are presented in Table 1.

In principle, two broad methods are widely used for firm valuations. These include present value models and the multiplier approach. The valuation from the former is based explicitly on the firm's ability to generate future benefits. Simultaneously, the latter adopts a relative valuation approach to assess a firm's attractiveness within its peer group. The studies like Low and Tan (2016), Realdon (2013) and Berkman et al. (2000) noted that present value fundamental models produce robust estimates. Volkov and Smith (2015) suggested that relative valuations are specifically not suited during recessionary periods.

Therefore, we employ two present value models based on free cash flows and residual income for this study. To assess the impact of COVID-19 on valuations, we consider our base case to be 2019. Using data from 2010 to 2019, we test these models' valuation accuracy by employing a

within-sample approach. To evaluate the accuracy, we use two comparisons. We compare our model-based valuation with the actual year-end price and the available sell-side target price for that year. This requires us to have at least one sell-side target price (analyst forecast hereafter) for each company. This requirement results in a sample of 5342 listed non-financial firms across 10 EU member states that have consistent analyst coverage from 2010 to 2019. Our country and sector-wise sample distribution is presented in Table 2.

Once the accuracy is established, we introduce hypothesized stress scenarios to determine the post-COVID-19 valuations. The details of these models and our empirical strategy are discussed below.

2.1. Free cash flows to firm (FCFF)

This model treats the value of a firm as the present value of future free cash flows. The functional form of valuation using free cash flows can be represented as shown in Eq. (1):

$$V_{i0} = \sum_{t=1}^n \frac{k_{it}}{(1+r_{ci})^t} + \frac{TV_{in}}{(1+r_{ci})^n} - \tau_{i0}(1-T) + \lambda_{i0} \tag{1}$$

where V_{i0} is the value of firm i at present, r_{ci} refers to the cost of capital (cost of debt + cost of equity), TV_{in} is the terminal value of firm i in year n , where in our analysis $n = 1, 2, 3, 4, 5$ years, $\tau_i(1-T)$ is post-tax interest expense, and λ_i represent net borrowing. For this study, we adopt a two-stage model with TV_{in} is subject to a sustainable growth rate $g_{in} = 3.30\%$. k_{it} is free cash flow to the firm i , which is calculated as shown in Eq. (2):

$$k_{it} = EBIT(1-T) + I/S \text{ Adjustments} - \Delta WC - \text{capex} \dots \tag{2}$$

The I/S adjustments include non-cash gains and losses, while capex and WC represent the firm's investment in long term assets and working capital (Kim, 2020) and (Aktas et al., 2015) noted that these corporate investments vary with sales and contribute towards firm value. Therefore, with variation in sales (δS) we expect EBIT, WC, and capex to change subject to the factor sensitivities. Following (De Vito and Gómez, 2020) and (Mirza et al., 2020), we present these below in Eqs. (3), (4), and (5).

$$(\partial EBIT|\partial S) = \frac{\partial S}{S} \times (S - \text{exp} \times \rho_{\text{exp}}) \tag{3}$$

$$(\partial WC|\partial S) = CA_0 + (\partial CA|\rho_{CA}) - CL_0 + (\partial CL|\rho_{CL}) \tag{4}$$

$$(\partial \text{capex}|\partial S) = FA_0 + (\partial FA|\rho_{FA}) \tag{5}$$

Table 1. Selected Covid-19 statistics for EU.

Rank		Total Cases, million	Total Deaths	Total cases per million people	Total Deaths per million people
	World	265.86 million	5.26 million	33,760.67	667.41
1	Spain	5.20	88,159	111,304.62	1,885.95
2	Italy	5.11	134,195	84,633.03	2,222.97
3	Germany	6.20	103,124	73,908.25	1,229.12
4	France	8.02	120,519	118,720.13	1,783.77
5	Belgium	1.83	27,167	157,102.35	2,335.47
6	Sweden	1.21	15,170	119,303.74	1,493.09
7	Netherlands	2.75	20,118	162,668.82	1,171.48
8	Portugal	1.17	18,537	114,751.75	1,823.09
9	Switzerland	1.04	1,938	119,859.30	1,139.93
10	Poland	3.67	1,222	97,135.25	2,266.71

Notes: Data collected from ourworldindata.org, accessed 5 December 2021.

Table 2. Sample distribution.

	Manufacturing	Utilities	Mining, Construction and Chemicals	Wholesale and Retail	Agriculture, Forestry and Fishing	Services	Total
Spain	103	20	97	170	73	103	566
Italy	107	15	84	153	75	107	541
Germany	220	50	163	205	105	193	936
France	205	35	150	195	91	181	857
Belgium	150	10	82	95	53	77	467
Sweden	100	10	94	120	62	79	465
Netherlands	105	12	99	103	69	81	469
Portugal	80	5	50	75	23	53	286
Switzerland	103	15	113	130	83	94	538
Poland	60	3	25	65	27	37	217
Total	1233	175	957	1311	661	1005	5342

Notes: Number of companies from each of the six industries.

where ρ_{exp} , ρ_{CA} , ρ_{CL} and ρ_{FA} represent sales elasticities of expenses, current assets, current liabilities, and fixed assets respectively. Using a panel framework, we will estimate these elasticities as shown in Eq. (6) below.

$$F_{it} = \alpha + \beta_F Sales_{it} + \beta_\mu \mu_t \quad (6)$$

where F represent the factor for firm i at time t (i.e. exp , CA , CL , FA), β_F is the sensitivity of factor F (i.e. ρ_{exp} , ρ_{CA} , ρ_{CL} , ρ_{FA}). The μ_t is a matrix of macro-level control variables representing GDP growth, sector concentration (HHI), inflation rate, and systemic importance (firms revenue to GDP). Similar approach has been used by Mirza et al. (2020), De Vito and Gómez (2020) among others.

2.2. Residual income approach

(Imam et al., 2013) noted that the residual income approach provides a more precise target price forecast than other accounting-based valuation models. The residual income approach values a firm (V_{i0}) as a sum of current book value (BV_{i0}) and the present value of future residual income (RI_{it}). This can be represented as shown in Eq. (7):

$$V_{i0} = BV_{i0} + \sum_{t=1}^n \frac{RI_{it}}{(1+r_e)^t} + \frac{TV_{in}}{(1+r_e)^n} \quad (7)$$

with $RI_{it} = NI_{it} - BV_{it} \times r_e$ and $BV_{it} = BV_{it-1} + NI_{it} - D_{it}$, where NI_{it} is Net Income and D_{it} , is Dividends.

Like FCFE, our RI valuation will also be based on a two stage model with a sustainable growth rate g_{in} . Following our earlier specification, the variation in Net Income given an expected change in sales is

$$(\partial NI | \partial S) = \frac{\partial S}{S} \times (S - exp \times \rho_{exp} - Int \times \rho_t)(1 - T) \quad (8)$$

The elasticities ρ_{exp} and ρ_t will be estimated using the Eq. (6) specified above.

2.3. Cost of capital

Easton and Sommers (2017) highlighted the importance of consistent assumptions for discount rates when different valuation methods are used. The firm's free cash flows are discounted using the weighted average cost of capital (r_e), while residual income is discounted by using the cost of equity (r_e). To estimate the cost of equity for each company in our sample, we use (Carhart, 1997) four factors' framework.

Finally, to compute WACC, the cost of debt and capital structure weights have to be specified. (Wang et al., 2020) recommended the use of the market value of debt for robust estimates of the cost of capital. Since all our sample firms do not have marketable debt, we follow a single

coupon bond approach. The total debt is considered a single coupon bond with a payment equal to interest expense, weighted maturity, and discounted at the current debt cost to calculate the present value. This present value is used to calculate the weight of debt in the capital structure.

2.4. Forecast accuracy for valuation models

An essential step of our research is to establish the accuracy of the valuation models specified in Eqs. (1), (2), and (4). We commence by measuring factor elasticities from the panel specification of Eq. (3). We employ root mean square error (RMSE) and mean absolute error (MAE) to establish their precision for each of these elasticities within the sample. Once these elasticities are estimated, we combine them with ex-post EBIT, NI, non-cash adjustments, WC, capex, net borrowing, and equity and capital cost to arrive at a yearly intrinsic value between 2010 and 2019. The intrinsic values are then compared with the analyst forecast and a year forward actual price to establish our models' valuation accuracy.

In addition to computing prediction error, we use two other methods for assessing the validity of the forecast. Firstly, we compute the correlations between realized returns and potential upside predicted by the analysts and our valuation model (TPC). The realized return is the difference between the one-year forward price (P_{12}) and the current price (P_0) that is scaled by the current price $[(P_{12}/P_0) - 1]$. The forward price is the closing price at the end of the year, while the current price is the price on the first day of the year. The potential upside is calculated as the difference between the target price (analyst and model forecast) and the current price scaled by the current price $[(TP/P_0) - 1]$.

Our second measure is based on the deviation between the target price and the one-year forward price and calls it (TPE). We quantify forecast error as the difference between the one-year forward price and the target price scaled by the current price $[(P_{12}-TP)/P_0]$. Since the numerator sign can be either positive or negative, we take this variable's absolute value ($|TPE|$). The results on TPC and TPE will establish the robustness of our model forecasts.

2.5. Stress scenarios and post COVID-19 valuations

The COVID-19 pandemic has severely impacted revenue growth, which is likely to regress corporate performance and consequently valuations in the medium term. Further, in a recent evidence (Xu, 2020), suggested that during periods of uncertainty, the cost of capital tends to increase due to constrained investment in innovation. Therefore, in principle, we analyze two basic stress situations to quantify their impact on firm valuations while considering 2019 as the base year. The first one

Table 3. Stress scenarios sales decline and cost of equity.

Sales Decline	Year 1	Year 2	Year 3	Year 4	Year 5
S1	75%	50%	25%	15%	10%
S2	50%	25%	15%	10%	5%
S3	25%	15%	10%	5%	0%
Terminal g	3,30%	Euro Area GDP Growth Forecast Post Covid - ECB			
Cost of Equity					
E1	100BP				
E2	200BP				
E3	300BP				
Base Year	2019				

Notes: Stress scenarios for five years.

relates to a decline in sales revenue, and the second will be an increase in the cost of equity (and consequently the cost of capital). These scenarios are presented in [Table 3](#).

The S1, S2, and S3 assume a sales decline over the next five years from the base level of 2019. The S1 is the extreme scenario with an expected decline in revenues ranging from 75% in year 1–10% in year 5. We consider S3 a moderate scenario with an expected decline in sales of 25% in year 1 and 0% in year 5. The E1, E2, and E3 correspond to the assumed increase in the cost of equity of 100–300 basis points, while E0 is the cost of equity as of the base year. We use ECB expected post-COVID-19 GDP growth rate of 3.3% as terminal growth across all scenarios. Based on these stressed scenarios and various factors elasticities calculated from [Eq. \(3\)](#), we will estimate the Post COVID-19 valuations.

2.6. Policy interventions and impact on valuations

The COVID-19 has severely impacted the corporate sector across the EU. The effect has been magnified due to precautionary lockdowns that spanned over almost three months. The union is also putting in place some economic recovery options. Euro 540 billion funding has been committed for public welfare while EIB is extending liquidity support of Euro 40 billion. A bailout plan worth Euro 870 Billion is budgeted for the acquisition of private and public securities. Further, the union's next long-term budget will likely introduce a comprehensive recovery plan for various sectors³.

[Hryckiewicz \(2014\)](#) and [\(Jiang et al., 2014\)](#) reported that Government interventions help in firms' revival and one aspect of recovery is the increase of financial flexibility. [\(Chiu and Tsai, 2017\)](#) and [\(Lin et al., 2014\)](#) suggested that this expectation of financial flexibility improvement translates into a lower cost of equity. We expect that meaningful policy interventions are likely to support the corporate sector. Although the full impact of such support will take some time to reflect, following [\(Chiu and Tsai, 2017\)](#) and [\(Lin et al., 2014\)](#), we assume that expectation of meaningful recovery support should result in a lower cost of equity for the firms. Therefore, we hypothesize three scenarios (P1, P2, and P3) related to possible interventions resulting in a decline in the cost of equity of 50, 100, and 150 basis points, respectively. The results reported in previous literature also suggest that Government interventions may affect firms sales. For example, [Lin and Wong \(2013\)](#) analysed the impact of government intervention on firms' investment and sales growth using. Sample of 6500 firms in 70 countries and show negative effect of government intervention on firm investment and sales growth, while the provision of good-quality services and institutions by government is positively related to firm investment and sales growth. Thus their results demonstrate that in countries with developed institution and legal system government intervention can promote firms' growth and sales. Therefore, in our sample of the European firms, we also can anticipate

that COVID-19 related policy and government interventions might have positive impact on sales in the selected five years period.

3. Data description

This study employs a comprehensive dataset from multiple sources. The within-sample forecast period is from January 2010 to December 2019. The financial statements related yearly data on sales, EBIT, net income, interest expense, non-cash gains and losses, current assets, current liabilities, capex, fixed assets, the book value of equity, and net borrowing is extracted from the data stream. The analyst target price and recommendations are collated from Eikon – Investment Research. Some of these recommendations are hand collected from the websites of sell-side analysts if public dissemination is available.

As mentioned earlier, we only include firms that have remained in business for all these years, and at least one analyst recommendation per year is available. In case there are multiple recommendations at a given point in time, we use the average value as the analyst target price. The intrinsic values are forecasted each year as of December 31st, with a target price of one year forward. We keep this consistent for the analyst report and have included firms where investment recommendations were given at the end of the year.

Based on 5342 sample firms and ten years, this results in total panel observations of 53420. This will also be the number of within-sample firm-level forecasts to establish the proposed models' accuracy for the ten years. The Euro 5 years' government benchmark bond yield is considered the risk-free rate and the S&P Europe 350 Index for the market risk premium. The European SMB, HML, and MoM factors are extracted from Kenneth R French's data library⁴. The macroeconomic data, including GDP growth rate (ex-post and projections), are taken from the European Central Bank.

4. Results and discussion

The sector-wise weighted descriptive statistics from 2010 to 2019 on selected valuation variables are presented in [Table 4](#). We have scaled the financial variables by total assets to make them size neutral. The services firms have a maximum EBIT/TA (0.598), followed by manufacturing (0.280) and wholesale and retail (0.253). Owing to the business model, it is not surprising that maximum working capital investment in proportion to total assets is by manufacturing firms (0.143) followed by wholesale (0.133). The average utility companies have the lowest WC/TA of 0.048.

The services firm demonstrates strong free cash flows with FCFE/TA of 0.45. While this may represent a healthy cash flow capacity, a plausible reason is an overall lower total assets investment than other sectors. A similar trend is observable for average residual income to total assets. We observe some interesting statistics for net borrowing to total assets. Given the continuous need to invest in innovation and create competitive advantages, it is not surprising that all sectors have been net borrowers. Agriculture, forestry, and fishing dominate their peers with maximum net borrowing to total assets (0.0745). This is followed by wholesale and retail (0.068) and utilities (0.059). Mining, construction, and chemicals show the maximum cost of equity (9.23%) and capital (7.51%) for average firms. The utility firms have the lowest cost of capital (4.03%), which in part can be attributed to their robust free cash flows and residual income.

The elasticity estimates of expenses, current assets, current liabilities, fixed assets, and interest from [Eq. \(3\)](#) using random effect panels are reported in panel A of [Table 5](#). Our results demonstrate that the coefficients of all five sensitivities to sales are significant. We observe a 0.81 and 0.73 sensitivity of expenses with revenues for the wholesale and retail, and manufacturing sector. This is understandable because the cost

³ Source: The common EU response to COVID-19, https://europa.eu/europe-an-union/coronavirus-response_en.

⁴ The data library is open source and accessible at http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

Table 4. Descriptive statistics (weighted average, 2010–2019).

		Manufacturing	Utilities	Mining, Construction and Chemicals	Wholesale and Retail	Agriculture, Forestry and Fishing	Services
EBIT/TA	Mean	0,2802	0,1761	0,1930	0,2538	0,2216	0,5987
	Std Dev	0,0351	0,0592	0,0242	0,0069	0,0745	0,0359
WC/TA	Mean	0,1439	0,0486	0,0782	0,1283	0,1335	0,0927
	Std Dev	0,0347	0,0196	0,0339	0,0570	0,0264	0,0224
Capex/TA	Mean	0,0624	0,0374	0,0447	0,0387	0,0481	0,0636
	Std Dev	0,0166	0,0035	0,0292	0,0137	0,0244	0,0313
FCFF/TA	Mean	0,0839	0,1002	0,0800	0,0967	0,0500	0,4524
	Std Dev	0,0129	0,0038	0,0030	0,0210	0,0082	0,0153
RI/TA	Mean	0,1825	0,1288	0,1280	0,1903	0,1581	0,3901
	Std Dev	0,0229	0,0433	0,0160	0,0052	0,0532	0,0234
λ/TA	Mean	0,0351	0,0592	0,0242	0,0689	0,0745	0,0359
	Std Dev	0,0127	0,0167	0,0145	0,0039	0,0216	0,0167
rc	Mean	0,0652	0,0403	0,0751	0,0565	0,0491	0,0576
	Std Dev	0,0198	0,0109	0,0089	0,0247	0,0020	0,0092
re	Mean	0,0781	0,0541	0,0923	0,0698	0,0637	0,0724
	Std Dev	0,0179	0,0135	0,0135	0,0192	0,0092	0,0155

Notes: Weighted average and standard deviation of firms from each sector. Descriptive statistics is significant at 1% level.

of sales dominates in these sectors that vary significantly with sales. Therefore, it is not surprising that services have the lowest expense sensitivity of 0.57, with sales given that expenses are predominantly overheads.

For current assets and current liabilities, a similar sensitivity pattern is observed. Given the massive inventory requirements to support sales by wholesale and manufacturing sectors and overall investment in working capital, it is not surprising to have a current asset loading of 0.925 (ρ_{CL}: 0.803) and 0.822 (ρ_{CL}: 0.861) respectively for these two sectors. Fixed assets' sensitivity to sales is maximum for manufacturing and mining sectors, which is plausible as these sectors face capacity constraints and require continuous investment in fixed assets to support sales. The within-sample forecast for expenses, current assets, current

liabilities, fixed assets, and interest using the sensitivity coefficients are reported in panels B and C. The RMSE and MAE estimates across all sensitivities demonstrate that our random effect coefficients have robust prediction accuracy. This is consistent for all sectors for the sample period.

Once the robustness of estimated coefficients is established, we use them to populate variables for Eqs. (1), (2), and (4) for each year and firm between 2010 and 2019. The firm-level cost of equity and cost of capital is estimated following the procedure described in section 2.3 that is used to discount the future residual income and free cash flow. This results in ex-post yearly firm-level valuation from FCF and RI models.

The next step is to determine the within-sample forecast accuracy of these valuations. We compare our model-driven target price forecasts

Table 5. Variable sensitivities with sales and forecast accuracy - random effect model.

Panel A							
	Manufacturing	Utilities	Mining, Construction and Chemicals	Wholesale and Retail	Agriculture, Forestry and Fishing	Services	
ρ _{exp}	0,7312**	0,7315**	0,6712***	0,8134**	0,7140***	0,5717***	
ρ _{CA}	0,8212**	0,7248**	0,7405***	0,9252***	0,5312**	0,4215**	
ρ _{CL}	0,8612**	0,7415**	0,7671**	0,8037***	0,5907**	0,4612***	
ρ _{FA}	0,0234***	0,0152**	0,0219**	0,0174***	0,0143***	0,0104**	
ρ _τ	0,0173**	0,0180**	0,0201**	0,0175**	0,0213**	0,0107**	
R ²	0,817	0,5327	0,7514	0,612	0,7249	0,6372	
Model Significance	0,0000	0,0000	0,0000	0,0000	0,0000	0,0000	
Panel B - RMSE							
ρ _{exp}	0,00589%	0,00436%	0,00322%	0,00239%	0,00177%	0,00131%	
ρ _{CA}	0,00097%	0,00322%	0,00239%	0,00177%	0,00131%	0,00097%	
ρ _{CL}	0,00072%	0,00053%	0,00039%	0,00029%	0,00021%	0,00016%	
ρ _{FA}	0,00049%	0,00036%	0,00027%	0,00020%	0,00015%	0,00011%	
ρ _τ	0,00042%	0,00031%	0,00023%	0,00017%	0,00013%	0,00009%	
Panel C - MAE							
ρ _{exp}	0,00227%	0,00168%	0,00124%	0,00092%	0,00068%	0,00050%	
ρ _{CA}	0,00037%	0,00124%	0,00092%	0,00068%	0,00050%	0,00037%	
ρ _{CL}	0,00028%	0,00020%	0,00015%	0,00011%	0,00008%	0,00006%	
ρ _{FA}	0,00019%	0,00050%	0,00036%	0,00008%	0,00027%	0,00004%	
ρ _τ	0,00061%	0,00045%	0,00033%	0,00025%	0,00018%	0,00014%	

Notes: Statistics is significant at *10%, **5% and ***1% levels.

with the realized price and sell-side analyst forecast available for these years. The forecast accuracy is presented in Table 6. The FCF model's average signed prediction errors range between -0.61% (mining construction and chemicals) to 2.54% (agriculture, forestry, and fishing). The range represents minimum prediction errors across all sectors suggesting that FCF model forecasts result in minimum noise across our sample companies. The RI model prediction error is slightly here, ranging from -1.72% (utilities) to 2.66% (wholesale and retail). Nonetheless, we believe that for a panel spanning over ten years and 5342 firms, both models' prediction error is negligible.

The results for target price accuracy are also included in Table 6. The correlation between realized returns and model forecasted returns represents the magnitude of the forecasted valuation's usefulness for the investors. The correlation between realized returns and FCF model-driven forecast ranges from 0.85 (services) to 0.94 (wholesale). The RI model forecast's correlation range is between 0.79 (services) to 0.85 (wholesale and manufacturing). The RI model returns depict relatively less correlation with realized returns, but this is worth noting that it is still better than the correlation of realized returns with analyst forecasted returns. The correlation between the analyst forecast and realized returns range from 0.71 (manufacturing) to 0.83 (wholesale). On account of the target price error, our models (FCFF and RI) are better than analyst forecast except for agriculture, forestry, and fishing, where analyst target price forecast error is marginally better than that of RI model.

To provide more robustness for our forecast models, we compare our models' investment recommendations and those presented by sell-side analysts in 2019 (pre-COVID-19). These are presented in Table 7. Our buy recommendation represents a potential upside greater than the risk-free rate. A *hold* recommendation is an upside that is positive and maximum equal to the risk-free rate, while a *sell* recommendation is for a negative target return. The resulting distribution is similar to analyst recommendations with FCFF and RI, respectively, suggesting 58.8% and 59.2% of our sample companies a "buy" compared to 59.1% for analyst forecast. Our models suggest a "hold" for 17.2% (FCFF) and 17.3% (RI) compared to 17.6% for analyst recommendations. Lastly, our forecasts suggest 23.8% and 23.4% of firms as "sell," which is similar to 23.3% of analyst forecast recommendations. These results demonstrate that our model-driven forecasts have adequate accuracy and predictability to be used for COVID-19 imposed stress scenarios.

The impact of post-COVID-19 stresses scenarios related to sales and cost of equity is presented in Table 8 (panel A and B) that shows the variation in valuations from the base year 2019. Even if the cost of equity remains at the 2019 level (E0), we see a significant decline in one-year forward valuations across all sectors. In the extreme sales stress scenario (S1) for the FCFF model, the maximum impact is for services that will experience an average decline of 21.7% in their valuations. This is followed by agriculture, forestry, and fishing that are expected to lose 19.1%. The wholesale and retail remained a bit resilient with an expected average decline of 12.6%. The residual income model with E0 presents a similar story, with services expected to lose 22.9%, agriculture, forestry, and fishing around 20.1% in S1, while wholesale firms are losing an average of 13.3%. In a more optimistic scenario of the FCFF model (S3), we expect services to lose around 13%, while wholesale and retail are likely to be 8.1%. The RI model suggests an anticipated decline in the average valuation of 13.7% and 8.6% for wholesale for S3.

The results are more devastating when we increase equity and capital cost due to the rising uncertainty, as noted by (Xu, 2020). As we move across the increasing cost of equity scenarios (E1 to E3), the valuations severely rout for all sectors. If the cost of equity increases by 300bp (E3), the FCFF model (S1) predicts a decline of up to 60% in firms' average valuations in the agriculture, forestry, and fishing sectors. This is followed by 59.6% for services and 56.1% for wholesale. The RI model predicts a loss of 63.6% for agriculture, 63% for services, and 59% for wholesale. On the contrary, if the cost of equity increases by 100bp (E1), under max sales decline scenario, the services firms will lose an average of 33.6%, agriculture approx. 28.6%, while wholesale firms' valuation can decline by 18.4%. If we compare E1 with E3, the decrease in valuations is not linear. This is in line with (Atauliah et al., 2009), who reported nonlinear patterns in equity valuations. This would imply that if the uncertainty surrounding COVID-19 translates into an even higher cost of equity, the firms' valuations are likely to decline even further. The variations are mostly significant at 1% and 5%.

Table 9 presents valuations results in case the proposed state interventions are expected to provide some financial flexibility and decrease the cost of equity. If the cost of equity decreases by 150bp (P3) from the base year (E0), the services and mining firms will likely lose 11% on their current valuations under S1 as predicted FCFF model. The agriculture, forestry, and fishing firms will have a 10.7% decline,

Table 6. Forecast accuracy - FCFF and RI models.

	Manufacturing	Utilities	Mining, Construction and Chemicals	Wholesale and Retail	Agriculture, Forestry and Fishing	Services
Prediction Error						
FCFF Model - Mean	1,32%	1,93%	-0,61%	0,91%	2,54%	1,96%
FCFF Model - Std Dev	0,10%	0,20%	0,38%	0,17%	0,69%	0,15%
RI Model - Mean	2,45%	-1,72%	1,86%	2,66%	1,50%	1,73%
RI Model - Std Dev	0,45%	0,42%	0,09%	0,22%	0,98%	0,41%
Target Price Correlations - Returns						
RR vs. MF (FCFF)	0,92	0,89	0,92	0,94	0,9	0,85
RR vs. MF (RI)	0,85	0,84	0,81	0,85	0,84	0,79
RR vs. AF	0,72	0,74	0,79	0,82	0,75	0,76
MF (FCFF) vs. AF	0,71	0,76	0,74	0,83	0,73	0,73
MF (RI) vs. AF	0,69	0,78	0,73	0,72	0,68	0,74
Target Price Error						
AP vs. MF (FCFF)	0,015	0,018	0,010	0,008	0,009	0,015
AP vs. MF (RI)	0,019	0,021	0,013	0,012	0,011	0,020
AP vs. AF	0,023	0,022	0,020	0,015	0,008	0,029
MF (FCFF) vs. AF	0,018	0,019	0,011	0,013	0,010	0,017
MF (RI) vs. AF	0,021	0,020	0,014	0,016	0,010	0,015

Notes: Statistics is significant at *10%, **5% and ***1% levels. RR = Realized Return, MF = Model Forecast, FCFF = Free Cash Flow to Firm, RI = Residual Income, AF = Analyst Forecast, AP = Actual Price.

Table 7. Valuation recommendation distribution for sample firms as of base year (2019).

	Manufacturing	Utilities	Mining, Construction and Chemicals	Wholesale and Retail	Agriculture, Forestry and Fishing	Services
Model Forecast (FCFF)						
Buy	700	100	450	752	340	803
Hold	200	30	250	200	134	108
Sell	333	45	257	359	187	94
Total	1233	175	957	1311	661	1005
Model Forecast (RI)						
Buy	693	121	457	760	341	794
Hold	185	25	253	210	142	112
Sell	355	29	247	341	178	99
Total	1233	175	957	1311	661	1005
Analyst Forecast						
Buy	703	98	447	760	344	805
Hold	210	32	252	197	140	109
Sell	320	45	258	354	177	91
Total	1233	175	957	1311	661	1005

Notes: For model Forecast, our recommendations are based on following criteria of Target Price (TP).

Buy = If Upside > Rf.

Hold = If Upside >0 < Rf.

Sell = If Upside <0.

The analyst recommendation are based on actual investment thesis.

wholesale 6.8%, utilities 6.2%, while manufacturing firms will experience a loss of 5.8%. On the contrary, if there is a 50bp decrease in the cost of equity (P1), for the extreme sales scenario, the services firms will lose 10.8%, agriculture firms 12.3%, and wholesale around 6.8%.

We report similar results for the RI model. A decrease in the cost of equity (P3) results in a decline in valuations to the extent that the

wholesale firms will lose up to 7.1%, services about 12% and utilities around 6.7%. While we only consider three scenarios, any further decrease in cost of equity will further support the firms. These results indicate that if state interventions can comfort the cost of equity, this can stabilize the valuations and, consequently, the financial system. Our findings are similar to the results of (Uchida et al., 2015) and (Brei et al.,

Table 8. Mean variation in post covid valuations under stress scenarios.

Panel A - Model Forecast Free Cash Flow

	Manufacturing			Utilities			Mining, Construction and Chemicals		
	S1	S2	S3	S1	S2	S3	S1	S2	S3
E0	-0,158 **	-0,128 ***	-0,105 ***	-0,170 ***	-0,134 ***	-0,092 ***	-0,187 ***	-0,153 ***	-0,128 ***
E1	-0,188 **	-0,166 **	-0,139 *	-0,207 **	-0,180 *	-0,153 **	-0,238 ***	-0,205 *	-0,174 *
E2	-0,242 **	-0,218 **	-0,186 **	-0,238 **	-0,216 **	-0,176 **	-0,284 ***	-0,242 **	-0,204 *
E3	-0,387 ***	-3546 ***	-0,304 ***	-0,378 **	-0,331 **	-0,283 **	-0,463 **	-0,407 ***	-0,357 **
	Wholesale and Retail			Agriculture, Forestry and Fishing			Services		
	S1	S2	S3	S1	S2	S3	S1	S2	S3
E0	-0,126 **	-0,107 ***	-0,081 **	-0,191 **	-0,171 *	-0,148 **	-0,217 ***	-0,174 *	-0,130 **
E1	-0,184 *	-0,163 **	-0,136 **	-0,286 **	-0,231 *	-0,198 *	-0,336 **	-0,273 *	-0,188 **
E2	-0,315 **	-0,291 *	-0,216 **	-0,422 **	-0,353 *	-0,314 **	-0,499 ***	-0,374 **	-0,286 **
E3	-0,561 *	-0,526 ***	-0,390 **	-0,605 *	-0,517 *	-0,524 *	-0,598 *	-0,491 **	-0,406 **

Panel B - Model Forecast Residual Income

	Manufacturing			Utilities			Mining, Construction and Chemicals		
	S1	S2	S3	S1	S2	S3	S1	S2	S3
E0	-0,171 **	-0,139 ***	-0,114 ***	-0,184 **	-0,145 *	-0,100 **	-0,202 **	-0,165 **	-0,138 *
E1	-0,203 **	-0,180 *	-0,150 ***	-0,223 **	-0,195 **	-0,165 **	-0,258 **	-0,222 **	-0,188 *
E2	-0,262 *	-0,235 **	-0,201 **	-0,257 **	-0,233 **	-0,191 **	-0,307 **	-0,262 **	-0,220 **
E3	-0,419 **	-38,347 **	-0,329 ***	-0,409 *	-0,358 **	-0,307 ***	-0,500 *	-0,440 **	-0,386 **
	Wholesale and Retail			Agriculture, Forestry and Fishing			Services		
	S1	S2	S3	S1	S2	S3	S1	S2	S3
E0	-0,133 **	-0,112 *	-0,086 **	-0,201 *	-0,180 **	-0,155 **	-0,229 **	-0,183 **	-0,137 **
E1	-0,194 **	-0,171 ***	-0,143 **	-0,301 **	-0,243 **	-0,208 *	-0,354 **	-0,287 *	-0,198 **
E2	-0,331 **	-0,306 *	-0,228 *	-0,444 **	-0,371 **	-0,331 **	-0,526 *	-0,394 **	-0,301 *
E3	-0,590 **	-0,553 **	-0,410 **	-0,636 **	-0,544 **	-0,552 **	-0,630 **	-0,516 **	-0,428 **

Notes: S1, S2 and S3 correspond to sales decline while E1, E2 and E3 relates to increase in cost of equity (and consequently capital).

*** represent significance at 1%, ** at 5% and * at 10%.

Table 9. Mean variation in post covid valuation with interventions.

Panel A - Model Forecast Free Cash Flow

	Manufacturing			Utilities			Mining, Construction and Chemicals											
	S1	S2	S3	S1	S2	S3	S1	S2	S3									
P1	-0,150	**	-0,117	**	-0,094	**	-0,151	***	-0,117	**	-0,081	**	-0,177	**	-0,136	**	-0,107	**
P2	-0,077	***	-0,056	**	-0,042	**	-0,105	***	-0,077	**	-0,058	**	-0,153	***	-0,108	**	-0,096	**
P3	-0,058	**	-0,044	**	-0,032	**	-0,062	*	-0,053	***	-0,047	**	-0,117	**	-0,088	**	-0,075	**

	Wholesale and Retail			Agriculture, Forestry and Fishing			Services											
	S1	S2	S3	S1	S2	S3	S1	S2	S3									
P1	-0,118	**	-0,089	***	-0,068	**	-0,159	**	-0,143	**	-0,123	***	-0,181	**	-0,145	**	-0,108	***
P2	-0,099	**	-0,064	**	-0,047	**	-0,135	**	-0,116	**	-0,080	**	-0,153	**	-0,102	**	-0,077	*
P3	-0,068	**	-0,040	**	-0,028	**	-0,107	**	-0,087	**	-0,049	**	-0,115	***	-0,077	**	-0,042	*

Panel B - Model Forecast Residual Income

	Manufacturing			Utilities			Mining, Construction and Chemicals											
	S1	S2	S3	S1	S2	S3	S1	S2	S3									
P1	-0,160	**	-0,126	*	-0,101	**	-0,162	**	-0,126	*	-0,087	***	-0,190	*	-0,146	**	-0,114	**
P2	-0,083	**	-0,060	**	-0,045	**	-0,113	**	-0,083	**	-0,062	***	-0,164	**	-0,116	*	-0,103	**
P3	-0,062	*	-0,047	**	-0,034	**	-0,067	**	-0,057	**	-0,051	***	-0,126	**	-0,094	**	-0,080	**

	Wholesale and Retail			Agriculture, Forestry and Fishing			Services											
	S1	S2	S3	S1	S2	S3	S1	S2	S3									
P1	-0,123	***	-0,093	**	-0,071	**	-0,166	**	-0,149	**	-0,129	**	-0,189	**	-0,151	***	-0,113	***
P2	-0,104	***	-0,066	**	-0,049	**	-0,141	**	-0,121	**	-0,084	**	-0,160	**	-0,107	**	-0,081	*
P3	-0,071	***	-0,041	**	-0,030	**	-0,112	**	-0,091	*	-0,051	**	-0,121	**	-0,080	*	-0,044	**

Notes: P1, P2 and P3 relates to increase in cost of equity due to policy interventions.

*** represent significance at 1%, ** at 5% and * at 10%.

2019), who proposed that state interventions are meaningful in mitigating the consequences of natural disasters among different measures.

5. Conclusion

Firms' valuations provide a holistic overview of the business and help in identifying the key strengths and stress points. More importantly, because valuations are dynamic, they also provide an opportunity to understand the subtle business model of a company that is sensitive towards changes in the macro and micro-level operating environments. Therefore, valuations are central for investment appraisals and are of interest to a broader audience, including creditors, regulators, and policymakers. The outbreak of COVID-19 has resulted in severe economic pressures that are likely to persist for most of the firms, and this situation is warranting state interventions across the globe. The estimate of the extent to which COVID-19 may deteriorate valuation provides a robust anchor to policymakers in formulating strategic government interventions.

In this research, we have adopted a multifaceted strategy to evaluate the impact of COVID-19 on the valuations of a comprehensive sample of non-financial European firms. As the extent to which this pandemic is likely to impair business revenues and financial flexibility is not precisely quantifiable at this point, we consider some hypothetical stress scenarios related to a decline in sales and increase in the cost of equity. Under each of these scenarios, our findings report significant deterioration in valuations across all sectors. Even if the cost of equity does not increase, the decline in sales revenue can result in a substantial loss of value for an average firm. This became worse if the uncertainty surrounding COVID-19 may increase the cost of equity. In that case, we predict a one-year forward loss of up to 60% in valuations owing to declining sales and increasing cost of financing. These results remained robust regardless of the choice of valuation models. The extent of this loss in intrinsic value warrants significant intervention. Consistent with the literature and to understand the possible support of this intervention, our analysis assumes scenarios with a potential decline in equity cost. The results show

that albeit decreasing revenues, if policy interventions could provide comfort to financing costs, the impact of COVID-19 can be moderated, and the loss in valuations will be modest. Our findings contribute to the growing body of literature assessing the effects of the COVID-19 pandemic (Sharif et al., 2020; Yarovaya et al., 2021c).

While we present the results on possible loss in valuations, we would like to caution our readers. These results provide valuation estimates for firms conditioned upon the exact or approximate realization of specific scenarios that we assumed. The exact extent of the impairment is not quantifiable at this point, and therefore the variations in valuations will be as dynamic as the spread (or confinement) of COVID-19. Nonetheless, we provide evidence highlighting the significance of the probable impact that can help businesses, governments, and policymakers envisage and devise optimal intervention plans.

Declarations

Author contribution statement

Syed Kumail Abbas Rizvi: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Larisa Yarovaya: Conceived and designed the experiments; Wrote the paper.

Nawazish Mirza: Conceived and designed the experiments; Performed the experiments; Wrote the paper.

Bushra Naqvi: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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