FIRM AGILITY AND DIGITALISATION LESS HELPFUL THAN EXPECTED DURING THE COVID-19 PANDEMIC, BUT VALUABLE IN THE LONGER RUN

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Abstract: *Firms' performance during exogenous crises depends on several factors, from strategic foresight, financial readiness, and a number of firm-specific as well as sectoral aspects, also including luck and government support. The aim of this paper is to investigate the extent to which the 'crisis readiness' of firms, defined by factors like a proactive strategic approach, digitalisation, and financial constraints, as well as the reliance on or availability of government support, is responsible for the outcome during the COVID-19 crisis compared to the long-run contribution made by these factors. The empirical investigation uses a unique combination of firm-level balance sheet data and unique survey data concerning the strategic focus and implementation of Industry 4.0. While the literature suggests that digitalisation, a strategic proactive approach, and crisis readiness (itself depending on several factors) impacted the firms significantly during the COVID-19 crisis, the results show firm performance primarily depended on other (sectoral) aspects serving as a major exogenous factor impacting their performance. During the crisis, digitalisation was additionally mentioned as an important adjustment factor. However, using firm-level data we show that while companies were able to mitigate certain impacts of the supply and demand shocks triggered by COVID-19 using their internal resources and characteristics, including strategic elements, the biggest explanatory factor remains the sector involved. This leads to important managerial and policy recommendations, principally stressing the importance of proactivity and agility for firms' long-run performance, whereas in the short run the state must help mitigate the effects.*

Keywords: *COVID-19, firm performance, crisis readiness, digitalisation, firm-level evidence.*

JEL Classification: *D22, E32, O32.*

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Introduction

The world had only just bounced back from the 2009 crisis when in 2020 COVID-19 triggered one of the biggest crises in almost a century, according to the OECD (2020b), causing a major disruption to world health, economic activity, well-being, and jobs. Estimated GDP performance in 2020 shows the 27 members of the European Union on average lost 6.1% of GDP compared to 2019 and around 660,000 jobs, despite substantial government support. The greatest decline was seen in Italy, losing almost 11% of GDP over 2019. Spain, Greece, and Croatia lost 8% or more of GDP, being hit largely due to their dependence on tourism. CEE economies lost between 2.7% (Poland) and 5.6% (Slovenia) of GDP (Eurostat, 2021).

While aggregate estimates have been available for a few months, very little evidence can be found on the crisis' impact on the firm level and the contribution made by various factors to differences in firm performance in 2019. The unprecedented simultaneous supply and demand shock caught many firms off guard. While in theory crisis readiness on the firm level depends on several factors, from market dynamism, the general uncertainty firms face in normal conditions, firm financial and non-financial performance (Parnell, 2021), firm strategy and size as well as perceived likelihood of a crisis (Baah et al., 2020; Golubeva, 2021; Parnell, 2021), these elements are insufficient to explain the actual differences between companies. Literature also suggests that a higher level of digitalisation was an advantage due to the ability to adjust faster, i.e., build digital resistance, and that it would also widen the gap between leaders and laggards in the K-shaped recovery (Bai et al., 2021; Borrett, 2021). While one can find evidence focussed on a certain sector (e.g., tourism, hospitality, health), little general evidence is available concerning the impact of external, environmental, internal, and firm-level factors on country-level or cross-country firm performance during the COVID-19 crisis.

The aim of this paper is to investigate firm performance during the crisis by studying the determinants of sales and value added. The key research question is to what extent did 'crisis readiness', defined by a proactive strategic approach, digitalisation, financial constraints as well as reliance on or availability of government support (e.g., furlough schemes), contributed to firms' relative performance once the external factors are controlled for, as largely determined by industry type, firms' position in the global value chain, diversification of markets. The analysis relies on a combination of three datasets: (1) an administrative firm-level; population-wide database of financial statements of 120,000 firms per year, along with: (2) International Federation Robotics data to include the digitalisation aspect on the sectoral level. For a subpopulation of firms, (3) detailed survey data on a firm's proactive and reactive approaches, Industry 4.0, and financial and non-financial obstacles are used to complement the analysis and facilitate a contrast between firms that are generally more or less 'crisis-ready' firms.

The analysis offers several important insights into the impact of the crisis on firms. While a more proactive approach is important in the long run and in that time frame more proactive firms do have higher value added per employee, the analysis also shows that in 2020 the effect of different strategies was not significant. The most important factor was the sectoral aspect. This holds important implications for both management and policymakers, stressing the value of sector-specific support.

In the continuation, the paper first provides the theoretical background, defining the determinants of crisis readiness and their expected impact on firm performance. Following a description of the methodology, the results are presented and discussed, including the limitations and suggestions for future research.

1. Theoretical Background and Hypothesis Development

1.1 Firm Agility, Motivation, Performance, and Crisis Readiness

Firm performance depends on several factors, from external macroeconomic, industry and market determinants as well as business environment factors, but also on several firm-level determinants. We are particularly interested in the firm's intrinsic motivation as a determinant of firm performance. Two sets of firm motives are investigated: proactive and reactive. *Proactive motives* include expected competitive advantage, revenue, and turnover growth (Čater et al., 2019), market share increase, improved productivity, speed and flexibility, achievement of economies of scale,

efficiency and motivation, decision-making, and others (Zimmerman & Blythe, 2013). *Reactive motives* reflect firms' reactions to changes in the environment (Alonso-Almeida et al., 2015) and are also important for firm performance. These include pressures from the competition, buyers and suppliers, the requirements of partners within global value chains (e.g., requirements of horizontal and vertical integration), and reaction to requirements from a more competitive business environment, such as regulatory changes and other pressures from the outside. Companies with stronger proactive motivation and a stronger reactive drive can be expected to perform better. We call these companies more agile. Empirical research shows that the 'business as usual' approach leads to comparatively worse long-term results. For example, in Slovenia, laggard firms have been characterised by the 'business as usual' approach and, despite them acknowledging the lag, have not adjusted their strategy (Prašnikar, 2010). On the contrary, the best firms were highly motivated by both internal desires to grow, innovate, and strengthen their competitive positions. They also absorbed the available information from the environment and reacted quickly to pressures from suppliers and buyers. Normally, they also operated in more dynamic environments, which required quick reactions to maintain their long-term competitive position (Prašnikar, 2010; Prašnikar et al., 2017). Motives are not important just for the achievement of the firm's better performance but also in relation to other broader goals. For example, Prajogo (2011) establishes a positive relationship between motivation, operational performance and implementation and broader environmental goals (general relationships).

1.2 Crisis Performance and Crisis Readiness

In March 2020, the COVID-19 outbreak was declared a pandemic. By then, the economic impact was already obvious. COVID-19 influenced economies and companies via three key channels: containment measures, supply-side influences, and demand-side effects (OECD, 2020a). The initial containment reactions by governments referred to quarantine, travel bans, and restrictions and closures of public places. These restrictions placed serious strain on the supply side, hampering the normal organisation of production and business processes in both manufacturing and services and disrupting processes in global value chains and international trade. Some factories temporarily closed due to both health issues and supply-related problems (supply chain and provision of services). The demand side was also affected. The greater uncertainty, containment measures, and changed lifestyles (remote work, home-schooling) impacted patterns of demand and the structure of consumption, notably in some service sectors (retail, hospitality, personal services) (Domadenik et al., 2020).

The European economy was significantly affected by the virus. Overall, the 2020 data show that GDP declined across the EU-27 (2020) by 6.1%, and in Slovenia by 5.5%. While in 2020 the COVID-19 crisis was milder than the impact of the 2009 crisis, the effect is still expected to be more fully revealed in the next few years. More detailed data show that in Slovenia other services (NACE R, S, T) respectively declined by 29%, 31% and 17% in the first and third quarters of 2020 and first quarter of 2021. Hospitality lost 21% in the first quarter of 2020 and professional services 19%. In contrast, manufacturing 'only' lost 15.3% in the same quarter (Statistical Office of the Republic of Slovenia, 2021). The decline is very pronounced in revenue generation and value added, while employment was moderately affected, declining from 76.4% to 75.6%, whereas the unemployment rate rose from 4.5% to 5% (Eurostat, 2021).

In the longer run, Baldwin and di Mauro Weder (2020) point to "the accumulation of *'economic scar tissue'",* which refers to the long-term channels of influence and their enduring effects. These refer to the lower tangible and intangible (including technological) investment and loss of potential output, lost competitiveness, loss of firm-specific intangible capital, loss of human capital, deterioration of skills, which are particularly dangerous amid the technological transformation and increased global competition, impacting both firm growth and the ability to survive (Bettiol et al., 2019; Pereshybkina et al., 2017; Piccarozzi et al., 2018; Portes, 2020). However, the effects of these aspects remain to be observed.

Crisis readiness on the firm level is another vital aspect. Crisis readiness refers to preparing a firm to address crisis events proactively, avert, or mitigate the effects of a crisis (Parnell,

2021). Of course, whether this involves crisis management or not depends on the firm's size, dynamics of the environment, etc. It can be observed from an internal perspective, a managerial perspective and also from a financial perspective because firms with more cash resources and are less indebted are likely to overcome the crisis better. Empirical evidence suggests that accumulated debt in an uncertain environment can cause the amplification of the crisis and a series of failed firms due to a credit crunch (Bole et al., 2018). From the managerial and organisational perspective, crisis readiness also refers to developing a certain structure, culture, reactiveness or agility. Mills and Keremah (2020) argue that agility matters, while Dykes et al. (2020) believe that both speed and agility matter. Following Parnell (2021), we contend that firms operating in more dynamic markets (including those under greater pressure from competitors, buyers, etc) bringing a higher level of uncertainty will lead the firm to become more agile and more prepared to face changes. In addition, internal proactive motives can be expected to contribute positively to crisis readiness. Still, given the extent of the COVID-19 crisis and the simultaneous and unprecedented supply and demand shocks, the question is whether a firm's readiness was able to significantly impact its performance amid such heavy external restrictions.

1.3 Implementation of New Technologies, Industry 4.0, Digitalisation, and COVID-19

Industry 4.0 or the 4th Industrial Revolution has been changing the nature of production and doing business generally. With key technologies ranging from digital process management system (e.g., ERP, CRM, RFID) to robotisation, smart factories, artificial intelligence as well as 'simple' technologies, the nature of doing business has been changing rapidly. Companies implement new technologies with many motives, but primarily due to the expected long-term strategic benefits over short-term efficiency (e.g., cost savings and flexibility) (Černe et al., 2017). Although technology enhances performance, it can bring additional social costs (Chiacchio et al., 2018; Graetz & Michaels, 2018; Rüßmann et al., 2015; Thoben et al., 2017). During the COVID-19 crisis, the expectation following the lockdowns was that the more technologically advanced firms, firms that could therefore more easily switch over to remote work or put many of their processes on-line (e.g., e-commerce), were less affected by the shock or better retained their competitive position in the pandemic (Bettiol et al., 2019; Borrett, 2021; Golubeva, 2021). However, evidence is scarce and fails to fully incorporate aspects of the sectoral perspective.

1.4 Firm Performance

Firm performance is a multidimensional concept (Fernández-Temprano & Tejerina-Gaite, 2020; Golubeva, 2021) measured by the return on assets, return on investment, return on equity, but also firm goals like sustainability (Zabkar & Redek, 2020). While any comprehensive assessment of firm performance should also be multidimensional, relying on a set of financial and non-financial indicators (Lebas & Euske, 2002), empirical analyses focus on either measuring the achievement of long-term strategic goals, value added, profitability, firm growth (using value added, ROA, ROI, sales growth, profitability growth, also corporate reputation, customer loyalty, etc) and monitoring their short-term efficiency and measurement of the achievement of operational goals (costs, sales, quality, etc) (Čater et al., 2019). Studies have employed either value added (Iazzolino & Laise, 2013; Langford & Haynes, 2015; Shubita, 2019), return on assets, investments or equity or a combination of these (Giudici & Bonaventura, 2018; Nakatani, 2019; Park et al., 2019; Sewchurran et al., 2019; Visconti, 2020; Yanagi, 2018) as indicators of longer-term firm performance. The value added approach is the most established in economics (Arellano & Bond, 1991; Levinsohn & Petrin, 2003; Olley & Pakes, 1996; Rovigatti & Mollisi, 2018) for measuring firm performance in the longer term.

In the short run, especially in a crisis like COVID-19, other measures of performance are important, chiefly revenue, investment, and employment elasticity to demand. We focus on revenue in the analysis as such data are currently the most reliable and following Bachas et al. (2020), who argue that COVID-19 created a revenue shock. They added that the analysis predicted that less than half of the firms would remain profitable by the end of 2020, about 5–10% of the formal aggregate annual payroll would be lost, and firm exit rates would double. In the USA as well, the data show that COVID-19 had a significant negative sales impact. This

was most prominent in the 2nd quarter of 2020, with an average loss of 29% seen in sales (Bloom et al., 2021). Yet, the overall pronounced negative effect reveals significant heterogeneity, "with over 40% of firms reporting zero or a positive impact, while almost a quarter report losses of more than 50%" (Bloom et al., 2021). In Slovenia, some industries, among them construction, finance and insurance, in part information and communication technology and some branches of manufacturing, have recorded a significant increase (Statistical Office of the Republic of Slovenia, 2021; see also Oblak, 2021; Čehajić & Košak, 2021). The EU and national governments helped the heavily affected economy (Dauti & Elezi, 2022; Milanović & Stamenković, 2022) and jobs during the pandemic with considerable support programmes during the lockdowns, focused on retaining employment and job furlough schemes (Republic of Slovenia, 2021b), and an ambitious recovery plan for Europe concentrated on boosting post-COVID-19 growth with R&D, the green transition, and increasing general resilience (European Commission, 2021).

Following the literature, we argue that proactive firms are on average more successful than reactive ones and achieve higher value added per employee in the longer run.

H1: More agile firms achieve higher revenue growth per employee over the long run.

H2: More agile firms are on average more successful than less agile ones and achieve higher value added per employee over the longer run.

H3: Exports has a positive impact on value added and more agile firms are more export-oriented.

On the contrary, given the sudden unexpected supply- and demand-side (OECD, 2020) shocks, we hypothesise that the 2020 performance was affected more by external factors than firm-level determinants.

H4: During the COVID-19 period in 2020, differences in performance among firms did not depend on agility, but primarily depended on internal factors related to liquidity as well as the industry and other external factors (including export orientation, access to credit).

H5: Digitalisation and the use of new technologies positively impacted the performance of firms during the crisis.

H6: Government support had a positive impact on firms' performance.

2. Research Methodology

2.1 Data

The analysis relies on a combination of three datasets. The first is the population dataset with balance sheet and income statement data for all firms in Slovenia (in total, around 120,000 per year). These data are to be used while analysing the financial performance of firms in the sample. This dataset allows us to also present the sample in comparison to the general Slovenian population of firms. Second, we use data from a vast survey conducted among Slovenian companies in 2018/2019 with a focus on Industry 4.0. The survey questionnaire comprised 29 question sets with sub-questions. It investigated: (1) the use of new technologies, intention to use, and understanding of the need for future use; (2) motives for the implementation and use of new technologies (proactive and reactive motives of firms for investments and other motives (usefulness, ease of use, absorptive capacity, etc); (3) obstacles to implementation (financial and non-financial, perceived risks); (4) the actual use of technologies (which processes, intensity of use, intention for future use); (5) firm performance, Industry 4.0 results and impacts on firm performance (efficiency, strategic goals); and (6) firm demographics. The survey was completed by 218 managers, mainly of larger companies. Third, International Federation of Robotics data are used to control for the general use of technology in the sector.

The sample of firms studied in the survey comprised a total of 218 companies. Data were collected in 2018 and 2019. Most companies (41.7%) were medium (50–249 employees), 14% of firms were large, the rest were small. All companies were enterprises – the group comprised no sole-proprietors. Manufacturing (NACE C) was the sector for 168 companies, while the rest came from different services with wholesale and retail trade (NACE G) and professional and scientific services (NACE M) dominating. We investigate the performance of companies between 2017 and 2020, assuming that the companies were operating in a similar internal and external environment already 1 year prior to the survey. In addition, we assume that in 2020 the companies were as agile as they were in 2019 when the data were collected, i.e., the internal environment has not changed since 2019 (when the data collection ended) and that the (financial) results in 2020

also reflect the readiness of firms developed in 2018–2019.

2.2 Methodology

A combination of statistical and econometric approaches was used to study the contribution of a firm's strategic behaviour to its performance in the short term in both 2020 and the longer term.

Survey Data and Empirical Estimation

The key variables for dividing firms into more and less agile firms were based on the survey. Scales for measuring the intensity and importance of proactive and reactive motives that shape firm behaviour were built using established scales from the literature (Tab. 1 with a relevant reference for each factor). Each motive was measured using a set of four statements evaluated on a 7-point Likert scale (Tab. 1).

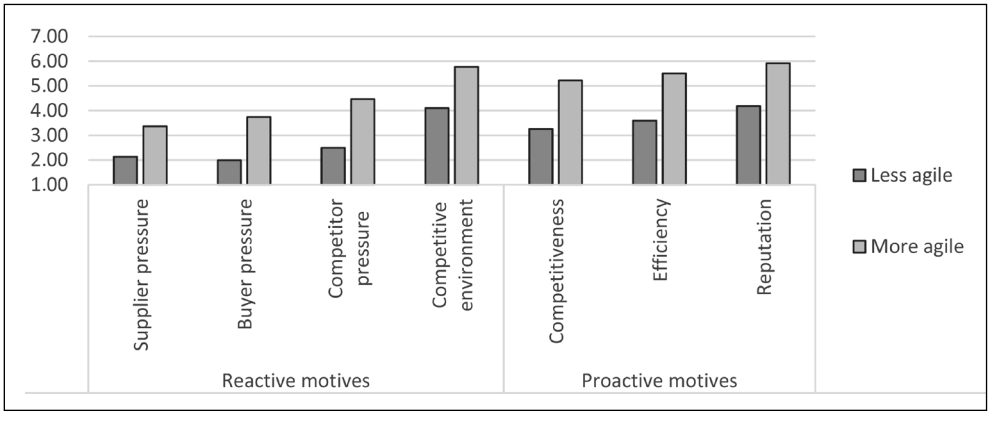
Proactive and reactive motives push companies to adjust more quickly to the market or to drive the change themselves. We assume that companies which are more driven by either proactive or reactive motives are more agile. To estimate the level of proactive or reactive behaviour, the average value of all proactive or reactive motives was calculated. The correlation (0.96; sig. 0.000) shows that the firms which are more reactive are also more proactive. Both are thus considered as an indicator of agility. Firms were thus divided into two groups based on the median value of the sum of both proactive and reactive factors to discriminate between those under greater pressure from outside factors as well as their proactive drive and are thereby

Tab. 1: Firm motives for change

Reactive	Proactive
Supplier pressure (Obal, 2017); Buyer pressure (Obal, 2017); Competitor pressure (Obal, 2017); Environment competitiveness (Dill, 1958; Volberda & van Bruggen, 1997)	Expected competitive advantage (Obal, 2017); Expected efficiency improvements (Weiss et al., 1999); Firm reputation (Weiss et al., 1999)
Minimum score 4; maximum score 28	Minimum score 3; maximum score 21

Source: own

Fig. 1: Average value of reactive and proactive motives in the two groups



Source: own

more agile than those that are less reactive and less proactive in total. Firms in the more agile group had both the sum of the proactive factors and the sum of reactive factors above their respective median values. In total, among the 218 firms, 82 firms were not highly motivated, while 136 were in the highly motivated, more agile group. Fig. 1 summarises their proactive and reactive motives. Survey data were used to estimate selected differences between firms, but also as an input for the production function estimation.

2.3 Empirical Approach to Estimating the Production Function

In the longer run, we follow the standard approach to estimating productivity by explaining the elasticity of value added to a series of explanatory variables. The production function estimation was done using the prodest module, relying on the Levinsohn-Petrin estimators (Levinsohn & Petrin, 2003), with the Ackerberg-Caves-Frazer correction in the empirical estimation (Rovigatti & Mollisi, 2018).

Regression analysis was undertaken to estimate the importance of intangible capital for firm productivity in the *longer run*. The regressions followed the standard approach. In order to explore the impact of intangible assets on firm performance, we focus on exploring the correlation between firm productivity and intangible assets. We estimate a relatively parsimonious production function:

$$\ln(value\ added)_{it} = \alpha + \beta_1 \ln(capital)_{it} + \\ + \beta_2 \ln(employ)_{it} + \delta A_i + \beta_{3j} X_j + \gamma I + \delta T + \varepsilon_{it} \quad (1)$$

where $value\ added_{it}$, $capital_{it}$ and $employ_{it}$ are value added (as the difference between sales and materials and services costs), fixed assets, while $employ_{it}$ is the average number of full-time employees. We also consider the importance of financial indicators (cash availability, short-term debt), digitalisation (number of different Industry 4.0 technologies used, number of digitalised processes), export-orientation (share of exports in total sales) and firm agility (A). We further control for time (T) and industry (I) fixed effects in all specifications. ε_{it} is the error term.

In the *short run*, we are especially interested in sales. While firms cannot impact fixed costs in the short run very much, the impact on value added would be under the considerable influence of the cost structure. On the other hand, sales exhibit the effect of the crisis more directly. In addition, it is more under the influence of the firm's agility or its ability to make the right decisions. We also look at the financial indicators as above since they are very important in the very short run (e.g., ability to pay materials), and at the industry. We also include among the other explanatory technological aspects, as mentioned above. Due to the limited number of observations, OLS is applied. Descriptive statistics are provided in Tab. A1 in the Appendix.

$$\ln(sales)_{it} = \alpha + \beta_1 \ln(\text{capital})_{it} + \\ + \beta_2 \ln(material\_costs)_{it} + \\ + \beta_3 \ln(employ)_{it} + \delta A_i + \beta_{3j} X_j + \gamma I + \varepsilon_{it} \quad (2)$$

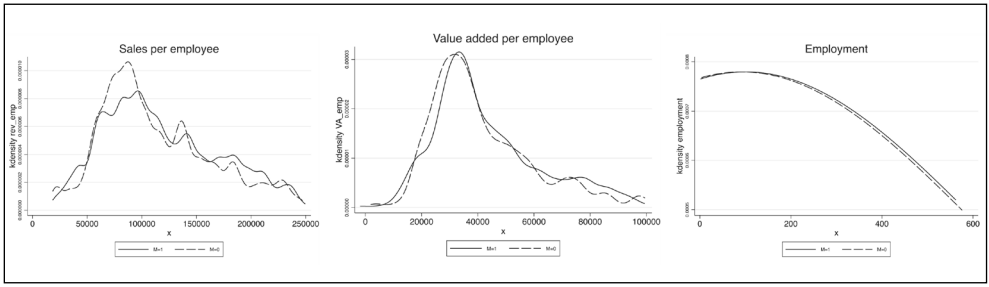
3. Research Results

3.1 Comparative Performance of Firms in the Longer Run

Firms that are more driven by external reactive motives or internal proactive motives or both perform better in the longer run. This is tested using both perceived performance as well as the firms' financial statements data. Sales per employee in the more agile group was more than twice the level than in the less agile group, €327,000 compared to €149,000. In both cases, the distributions of sales per employee (Fig. 2) are skewed, although the more agile group has a stronger right tail. Similar is seen for the distribution of value added per employee. In the more agile group, value added per employee in the pre-COVID-19 period was €522,000 per employee compared to €451,000 in the less agile group. Moreover, the median values for both sales and value added per employee show the more agile group performed statistically significantly better (Fig. 2, Tab. 2).

The more agile companies are on average bigger, with 195 employees in comparison to 164 employees, yet the differences are not statistically significant ($p = 0.1113$). The more agile companies are also more export-oriented, with total exports on average representing 57% of all sales compared to 'just' 48.6% in the less agile group, with the difference being highly statistically significant. The Slovenian economy is highly export-oriented with exports at around 80% of GDP, ranging for example from 2016 to 2020 between 77.6% and 84.8% of GDP (Statistical Office of the Republic of Slovenia, 2021).The most export-oriented company even

Fig. 2: Distribution of revenue per employee, value added per employee, and employment



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Tab. 2: Comparison of firm performance between 2017 and 2019

		Mean	Median	p5	p95	Std. dev.	Min	Max	N
Value added per employee** (in €)	Less agile	45,147	37,608	19,367	86,931	27,719	1,870	218,501	249
	More agile	52,190	39,487	17,998	104,527	58,011	−1,874	733,774	409
Revenue per employee** (in €)	Less agile	148,714	111,872	49,776	296,859	154,309	20,794	1,432,748	249
	More agile	326,946	125,186	45,186	491,194	1,558,217	18,407	19,900,000	409
Net return on assets	Less agile	7.03%	4.86%	0.00%	20.32%	7.94%	−3.11%	58.05%	252
	More agile	6.02%	5.02%	0.00%	16.19%	5.65%	−4.06%	41.97%	409
Number of employees	Less agile	164.0	63.7	11.4	734.1	306.0	0.0	1,928.6	249
	More agile	195.1	73.6	12.3	781.0	437.6	0.0	4,390.7	409
Exports share***	Less agile	48.61%	48.72%	0.00%	98.67%	35.84%	0.00%	99.98%	249
	More agile	57.00%	67.19%	0.74%	98.74%	34.79%	0.00%	100.00%	409

Source: Agency of the Republic of Slovenia for Public Legal Records and Related Services (2021)

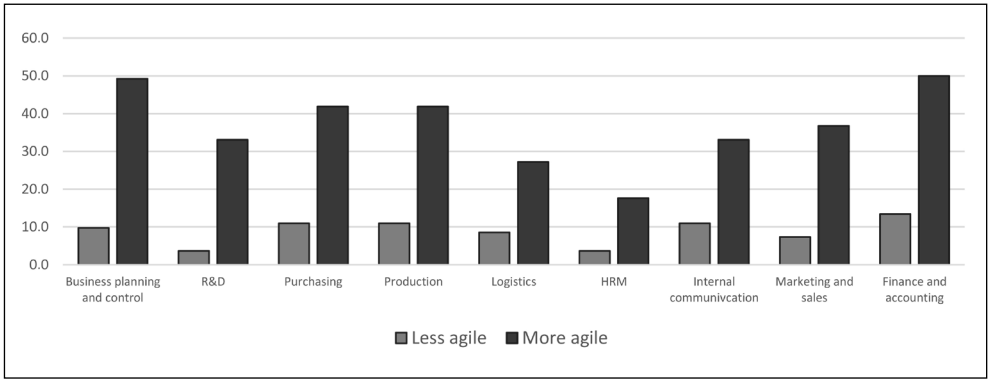
Note: Significant differences: * 5%; ** 1%; *** 0.1%.

exported all of its products and was in the more agile group.

The more agile group was also significantly more digitalised. On a 4-point self-evaluation scale of the intensity of digitalisation (novice, partially digitalised, advanced, digital champion), 45% of the less agile group were novices and another 46% partially digitalised. In the more agile group, 16% in total were either digital champions or advanced users, and only 31% were novices. From the 16 available Industry 4.0 technologies (see Fig. 3), on average the more agile group used 5.4 different technologies, while the less agile one just 2.9 (significance 0.000). When comparing the number of digitalised business processes, the more agile had on average 3.31 processes digitalised, while the less agile had only 0.79. Among the more agile firms, even 50% had in place digitalised finance and accounting and 49.3% business planning. More than 40% of the agile firms had digitalised purchasing and production. The situation is completely different in the less agile group. A mere 13.4% of the group digitalised accounting and finance – and this was also the business process that was the most digitalised.

As self-reported, the more agile group was also more likely to excel above the industry average than the less agile one (Fig. 4). The differences were statistically significant in sales and profit growth, market share growth, in success with the introduction of new products and services, and (the most highly significant)

Fig. 3: Share of all firms in the group with digitalised processes

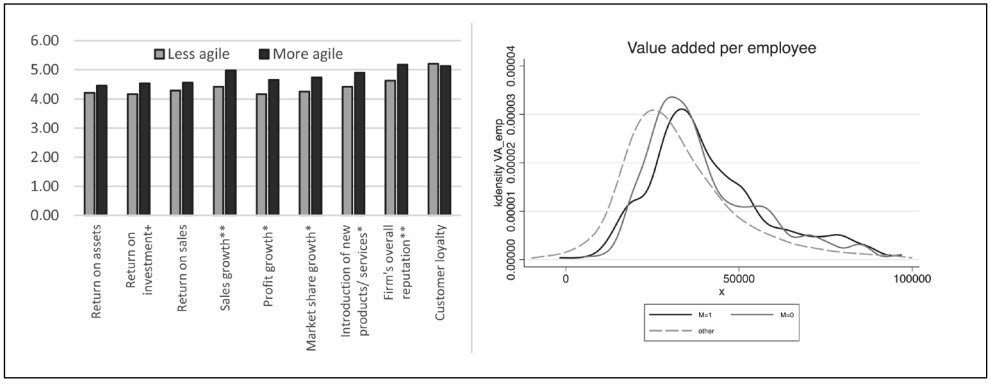


Source: Survey of the Agency of the Republic of Slovenia for Public Legal Records and Related Services (2021)

in the firm's reputation. The difference in value added as the most important indicator of a firm's performance is statistically significant not only between the two groups, but also when compared to the industry average, confirming the validity of the self-assessment.

To test the importance of a firm's agility from the perspective of its performance in the longer run, the Olley-Pakes estimation method with an ACF correction employing the prodest Stata module was used, estimating the elasticity of value added for a standard set of productivity determinants with additional controls, the first including agility, then the level of technological advancement being measured by the number of different Industry 4.0 technologies used in

Fig. 4: Perceived relative assessment of firms compared to the industry average* (left) and value added per employee from financial statement data for manufacturing (NACE C) (right)



Source: Survey of the Agency of the Republic of Slovenia for Public Legal Records and Related Services (2021)

Note:
Likert scale: 1 = much worse than industry average; 7 = much better than industry average.
Significant differences: * 5%; ** 1%; *** 0.1%; † 10%.

Tab. 3: Regression results on intangible capital's contribution to firm performance in the whole sample and by firm size (Levinsohn Petrin with ACF correction)

	ln*(value added)*	ln*(value added)*	ln*(value added)*
ln*(employment)*	0.46595***	0.46535***	0.55658***
	(0.00035)	(0.00033)	(0.00317)
ln*(capital)*	0.55727***	0.55456***	0.50811***
	(0.00118)	(0.00076)	(0.00234)
ln*(cash assets)*	0.04115***	0.04358***	0.04330***
	(0.00089)	(0.00072)	(0.01483)
ln*(short-term debt)*	−0.02441***	−0.02002***	−0.05993***
	(0.00080)	(0.00015)	(0.01754)
Share of exports in sales	0.14981***	0.15286***	0.07550***
	(0.00033)	(0.00090)	(0.00432)
Agile group dummy	0.05642***	0.03416***	0.08011***
	(0.00103)	(0.00040)	(0.00526)
Manufacturing dummy	0.00985***	0.00970***	
	(0.00103)	(0.00015)	
Robots in industry	0.00580***	0.00801***	
	(0.00161)	(0.00205)	
Number of different I4 technologies used	0.01405***		0.01991***
	(0.00045)		(0.00592)
Number of digitised processes in firms		0.01940***	0.01804**
		(0.00076)	(0.00836)
Observations	181	181	362
Number of groups	95	95	176

Source: Survey of the Agency of the Republic of Slovenia for Public Legal Records and Related Services (2021)

Note: Standard errors in parentheses; *** p < 0.01; ** p < 0.05; * p < 0.1.

the firm and the number of different business processes that are digitised (formula 1). Since the 3-year period is not very long, we also include the firm's financial situation. First, cash assets are included as a positive indicator of financial stability and short-term debt as a negative indicator. To control for differences between digitalisation of the company and the sector, we include the number of robots in the sector. A manufacturing dummy was used as well. Tab. 3 presents the results.

Estimates show that, as expected, the biggest proportions of value added can be explained by dependence on employment and capital, the estimated elasticities are high and largely also highly statistically significant. In addition, exporting status measured with the share of exports in total sales also significantly contributes to value added. Manufacturing on average excels relative to services. Firms were also differentiated based on their financial soundness. While short-term debt has a negative impact, the cash assets coefficient is as expected positive. In all cases, the results are statistically significant. We are particularly interested in the impact of firm agility. While the effect is modest, it is highly statistically significant in all cases. Digitalisation in general, whether measured on the sectoral level (number of robots in an industry) or firm level (number of different Industry 4.0 technologies used or number of digitised business

processes) has a very modest, albeit positive and highly significant impact. Overall, based on a combination of firm-level financial statement data, survey data that provided information about the on the firm-level strategy and use of new technologies and International Federation of Robotics data, these estimates confirm the hypotheses; namely that: (1) more agile firms achieve higher value added over the long run (*H2*) and have higher revenue per employee (*H1*); (2) are more export-oriented and their exports have a positive impact on value added (*H3*). The statistical analysis also confirmed the differences in the levels of sales per employee and value added.

3.2 Impact of Agility and Digitalisation During COVID-19

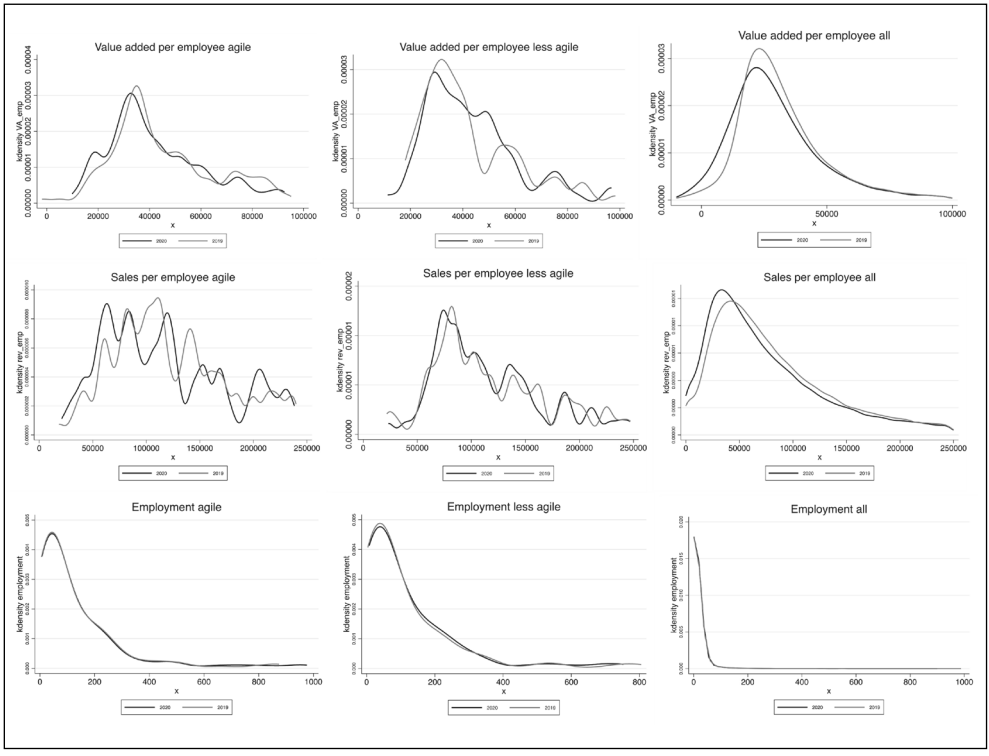
COVID-19 significantly impacted the firms. On average for the total economy, sales, value added and also employment declined. In the sample, in the more agile group, the mean company lost 4.6% revenue per employee, dropping from €149,000 to €145,000 on average, while the median company lost even 10% of revenue per employee. Moreover, the mean and median value added per employee fell by 4.6% and 3.8%, respectively. The number of employees declined on average by 10%, although the median company increased its number of employees from 74 to 77. Profits declined on average by 5.8%, while the median company recorded a 0.6% decline in profits. In the less agile group of the sample, revenues declined by 3% on average (median decline 1.3%), profits dropped on average by 12% and employment increased slightly on average (0.84%) (Fig. 5). These changes are comparable to the change seen in the economy at large, where revenue per employee fell by 4.9%, value added declined by 7.8%, while employment remained relatively stable, with the median remaining the same (0.42 employees) and the average company losing 1.4% of employees.

The data show the more agile firms were in fact experiencing the crisis in a different manner. First, the decline was significantly more pronounced in services than in manufacturing. For example, the average services company in the sample saw revenue per employee decline from €283 to €216 per employee, while the median from €141 to €117. The median company also lost almost 2 employees, whereas median company employment fell from 49.3 to 43.4 employees and value added on average declined by 11.5%. In manufacturing, the decline was overall less strongly pronounced – the average company (regardless of agility) lost 'only' €7,000 in revenue per employee since revenue declined from €264,000 to €257,000, value added per employee remained almost unchanged dropping from €476,000 to €473,000, while on average employment in fact fell more (which also explains the part on value-added behaviour) from 205 to 193 employees. In the manufacturing sector, short-term contracts were not extended while agency workers holding short-term contracts were also no longer hired, adding to the decline. In the services sector, due to the nature of the state furlough schemes the scheme was used more in response to the crisis' heavy impact. In manufacturing, following the impact of the first wave production adjusted, with such adjustment happening more through the adjustment of employees holding fixed-term contracts.

Differences were found between industries in the manufacturing sector. Some sectors (e.g., NACE 21 – pharmaceuticals) recorded 2-digit growth. Manufacture of machinery and equipment and the automotive companies from our sample (NACE 28 and 29) respectively recorded over a 6% and even an 18% decline in sales (but only 4 companies from NACE 29). In some sectors, the decline was 1–2%, in others there was a modest increase. COVID-19 caused a serious supply and consequent demand shock and is thereby a unique example of a shock with varying impacts on different sectors depending on the extent of the shock, which was initially largely expected to depend on the ability of sectors to work remotely (Bodnár et al., 2020; OECD, 2020a). However, in Slovenia following the spring 2020 lockdown shock production was not closed or remote work required, but in services the state imposed severe restrictions (Republic of Slovenia, 2021a). Despite the initial shock, manufacturing adjusted, while in many services this was not possible due to the government restrictions. Retail, hospitality, professional services and especially different personal services were completely or drastically restricted, leading to a significant decline in services (Statistical Office of the Republic of Slovenia, 2021).

To test the hypothesis that the companies were unable to adjust to the externally imposed restrictions, we ran an OLS regression

Fig. 5: **Changes in revenue per employee, value added per employee, and employment in the more agile and less agile groups, and the economy**



Source: Agency of the Republic of Slovenia for Public Legal Records and Related Services (2021)

(formula 2), considering the elasticity of sales to the standard capital, labour and material costs, and that the companies might be further restricted by having no access to external capital due to higher short-term debt or were possibly financially solid, including with higher cash resources. We are particularly interested if companies that are more agile could overcome the COVID-crisis better and whether digitalisation has a positive impact. Agility is measured using three different approaches. First, the agile group dummy as described in the methodology was employed. Second, we used only the sum of the value of all proactive motives and all reactive motives. We also control for industry and add firm size because smaller firms were more affected by the crisis. We also add state support. Tab. 4 presents the results.

The estimates show the strongest and most significant contributions made by capital and labour. As expected, access to finance has a significant impact, regardless of the specification used. Availability of internal cash resources has a notable and primarily strong and significant positive impact, whereas indebtedness, which usually restricts access to external capital, particularly in a crisis, has a negative impact, albeit it is not statistically significant. The state supports the companies through different programmes. While the financial statements data do not reveal whether the funds received from the state were related to the COVID measures or some other measures, the funds have a positive impact on firm performance, although the impact was again non-significant in all cases.

With regard to the variables of interest – agility and digitalisation, the results show no significant impact, as would be expected, given the crisis' length and characteristics. While the coefficient on the agile group dummy is positive,

it is highly non-significant. Therefore, we tested only the proactive motives (the sum of values of all three proactive factors) and reactive motives (sum of all four reactive factors). Similarly, the coefficient is positive, yet insignificant. The effect of digitalisation was measured using two different variables: number of different Industry 4.0 technologies used, indicating how advanced in digitalisation the company is, and number of digitised processes.

As expected, the results are not significant. The number of different technologies used

Tab. 4: Regression results on intangible capital's contribution to firm performance in the whole sample and by firm size (OLS) during 2020

VARIABLES	ln*(sales)*	ln*(sales)*	ln*(sales)*	ln*(sales)*	ln*(sales)*	ln*(sales)*
ln*(employment)*	0.14634***	0.14541***	0.16002***	0.14519***	0.15992***	0.15967***
	(0.02068)	(0.02101)	(0.02259)	(0.02105)	(0.02263)	(0.02248)
ln*(material cost)*	0.68993***	0.68980***	0.69110***	0.68915***	0.69093***	0.69141***
	(0.01848)	(0.01854)	(0.01826)	(0.01863)	(0.01828)	(0.01817)
ln*(capital)*	0.18452***	0.18416***	0.18162***	0.18409***	0.18209***	0.18168***
	(0.02284)	(0.02294)	(0.02245)	(0.02301)	(0.02250)	(0.02238)
ln*(cash assets)*	0.01452**	0.01462**	0.01648**	0.01447**	0.01658**	0.01659**
	(0.00722)	(0.00725)	(0.00711)	(0.00728)	(0.00712)	(0.00708)
ln*(short-term debt)*	−0.01233	−0.01213	−0.01091	−0.01169	−0.01049	−0.01089
	(0.00747)	(0.00753)	(0.00740)	(0.00749)	(0.00735)	(0.00738)
ln*(state supports)*	0.00046	0.00054	−0.00082	0.00081	−0.00071	
	(0.00320)	(0.00323)	(0.00318)	(0.00325)	(0.00319)	
Share of exports	0.01171	0.01224	0.01211	0.01369	0.01262	0.01111
	(0.04273)	(0.04290)	(0.04193)	(0.04303)	(0.04197)	(0.04164)
Agile group dummy	0.02212	0.01974	0.01987			0.01979
	(0.02601)	(0.02748)	(0.02687)			(0.02679)
Number of digitised processes in firms				−0.00373		
				(0.00587)		
Number of different I4 technologies used		0.00112	0.00138	0.00307	0.00153	0.00147
		(0.00407)	(0.00400)	(0.00468)	(0.00402)	(0.00398)
Strength of 4 reactive motives				0.00106		
				(0.00203)		
Strength of 3 proactive motives					0.00110	
					(0.00183)	
SME company dummy			0.20244**		0.19924**	0.20035**
			(0.09860)		(0.09864)	(0.09799)
Large company dummy			0.11603		0.11135	0.11499
			(0.11475)		(0.11480)	(0.11436)
Constant	1.62134***	2.44632***	1.52764***	2.44278***	1.52208***	1.52582***
	(0.25439)	(0.26889)	(0.26752)	(0.27184)	(0.26821)	(0.26668)
Observations	189	189	189	189	189	189
R-squared	0.99046	0.99047	0.99101	0.99047	0.99100	0.99100
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes

Source: Agency of the Republic of Slovenia for Public Legal Records and Related Services (2021)

Note: Standard errors in parentheses; *** p < 0.01; ** p < 0.05; * p < 0.1.

is positively related to value added, however (despite being highly non-significant) the number of different digitised processes has a negative coefficient. This may be explained by the fact that some of the most digitised companies are in the automotive and machinery sectors. Industry dummies were included, but not on the NACE 2-digit level due to the sample size. To determine whether the effect on sales was different for firms of various types, we included dummies for Large and SME, with micro firms being the base. Small and medium-sized firms perform significantly better, while the coefficient on large firms is also positive, although non-significant. Among the industry dummies, the effects are significantly negative mainly in in services, including utilities (NACE D, NACE L most often, yet the sample size is too small to allow generalising).

4. Discussion

4.1 Discussion of the Results and Implications

This paper discusses the importance of firm agility, presence of internal motivation, being reactive to external changes, and the use of new technologies in the context of the COVID-19 crisis. COVID-19 has been a particularly demanding shock by bringing a simultaneous supply and demand shock on top of the government-imposed containment measures. Companies have also been influenced by changes in global value chains. The pandemic significantly (more than others) impacted some companies due to their position in the global value chain. We argued that in the very short run (2020), the nature and extent of the crisis means firms were unable to overturn the effects, regardless of their agility. This is confirmed by the empirical analysis. The results show that the impact, albeit positive, is highly non-significant. Possibly within 1 or 2 years, companies that in 2020 were more agile and possessed more developed technology will be able to adjust and in fact achieve better results than those that started in 2020 in a comparably worse position with respect to agility and technology. The period between March and December 2020, when the crisis began and the end of the financial reporting year, is very likely not long enough to adjust, especially to a crisis with so many unknowns. However, the results also confirm that both agility and technology have a positive and statistically significant impact in the medium term. Their contribution was evaluated between 2017 and 2019. The results show that, besides the standard variables also with the greatest explanatory potential (capital, labour), the aforementioned variables make a positive significant contribution.

The results hold several relevant *implications for managers and policymakers*. First, in line with the literature, both internal proactive motives to achieve higher efficiency, improve competitiveness and increase corporate reputation, as well as reactive motives in response to supplier, buyer and competitor pressure, or the intensity of the competition, will develop greater agility and contribute positively to value added in the longer run. In addition, being slow to implement new technologies will negatively impact value added while the company's competitive position will deteriorate in the longer term. Managers should thus strive to be agile, constantly implement relevant novelties, and keep up with market trends. From the short-term perspective, it is also important that firms are ready for possible shocks, chiefly bearing in mind that financial soundness is very important in the case of a crunch, as both the lessons from 2009 and our estimates show. From the policymaking perspective, the results highlight that firms were caught in a situation they were unable to resolve by themselves, whereas significant variations occurred between industries. Data-driven policymaking should hence identify the differences and address the problems and thereby use the scarce funds more rationally.

4.2 Contributions to the Literature

The paper provides the first comprehensive evidence of the impact of firm agility and technology implementation on firm performance during the COVID-19 crisis. While an abundance of literature claimed technology is important for overcoming the crisis more easily, the results show that technology and digitalisation are not enough and what is primarily important is how suited (and if it is used) to the company it is. In addition, firm agility, discussed in combination with firm-level micro data for the first time, was similarly unable to overcome the crisis in the very short run. To the best of our knowledge, our paper is the first to link firm-level financial statement data for 2020 with firms' data on agility and their use of different technologies.

4.3 Limitations and Challenges for Future Research

The analysis also entails some limitations, which acts as suggestions for future research. First, the sample size could be larger to provide more details on the sectoral level. Second, the survey could be extended to 2021 and 2022 to build a panel and observe the effects after a few years to determine the impact of digitalisation and agility in the medium term.

Conclusions

This paper presents a novel study on the impact of agility of the firm on its COVID-crisis performance. In general, firm agility is expected to both drive firm performance and increase the firm's crisis readiness. During the COVID-19 pandemic, agility and technological readiness were expected to be important. This empirical study, based on a rich combination of datasets and primarily also containing firm-level financial statements data for 2020, is the first such study and reveals that in the very short run these two factors – agility and technological development – did not have a significant effect on firm performance. COVID-19 is responsible for a specific demand and supply shock that also comprised significant government restrictions. Despite their characteristics, firms were unable to overcome the shock. However, we also show that in the long run both firm agility and technological development do contribute positively to firm performance.

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Appendix

Tab. A1: Descriptive statistics for key variables

Variable	Obs	Mean	Std. dev.	Min	Max
Value added per employee	879	49,233.99	51,672.26	−1,873.681	837,373.5
Revenue per employee	879	256,652	1,228,867	18,406.59	1.99e+07
Subsidies from the state	883	5,877.148	22,438.83	0.00	216,549
Employment	883	181.67	395.67	0.00	4,429.14
Share of exports in revenue	879	0.53	0.35	0.00	1.00
Supplier pressure	724	3.07	1.26	0.75	6.25
Buyer pressure	720	3.32	1.39	1.00	6.5
Competitor pressure	720	3.99	1.46	1.00	6.75
Environment competitiveness	681	5.44	1.33	1.00	7.00
Expected competitive advantage	681	4.83	1.23	1.00	7.00
Expected efficiency	681	5.13	1.21	0.75	7.00
Expected reputation	681	5.58	1.39	1.00	7.00
Number of technologies used	883	4.45	3.44	0.00	16.00
Number of digitalised processes	883	2.35	2.79	0.00	9.00

Source: Agency of the Republic of Slovenia for Public Legal Records and Related Services (2021)