

DISCUSSION PAPER SERIES

IZA DP No. 15608

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among Digitalized Self-Employed**

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## ABSTRACT

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# German Financial State Aid during COVID-19 Pandemic: Higher Impact among Digitalized Self-Employed\*

In response to strong revenue and income losses that a large share of the self-employed faced during the COVID-19 pandemic, the German federal government introduced a €50bn emergency aid program. Based on real-time online-survey data comprising more than 20,000 observations, we analyze the impact of this program on the subjective survival probability. In particular, we investigate how the digitalization level of the self-employed influences the program's effectiveness. Employing propensity score matching, we find that the emergency aid program had only moderately positive effects on the confidence of the self-employed to survive the crisis. However, the self-employed whose businesses were highly digitalized, benefitted much more from the state aid compared to those whose businesses were less digitalized. This holds true only for those self-employed in advanced digitalization stages, who started the digitalization processes already before the crisis. Moreover, taking a regional perspective, we find suggestive evidence that the quality of the regional broadband infrastructure matters in the sense that it increases the effectiveness of the emergency aid program. Our findings show the interplay between governmental support programs, the digitalization levels of entrepreneurs, and the regional digital infrastructure. The study helps public policy to increase the impact of crisis-related policy instruments.

**JEL Classification:** C14, H43, L25, L26, J68, O33

**Keywords:** self-employment, emergency aid, treatment effects, COVID-19, entrepreneurship, digitalization, resilience

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## 1. Introduction

The lockdowns to contain the spread of COVID-19 significantly affected the economy, especially the service sector. The strict containment measures paralyzed many self-employed individuals. Accordingly, empirical evidence shows that entrepreneurs, self-employed, and micro-businesses (referred to as “self-employed” from now on) were more likely to face income losses than employees and that the income losses were also stronger among self-employed than among employees (see *inter alia* Graeber et al., 2021, Kalenkoski and Pabilonia, 2022). In response, governments in many countries introduced ad-hoc emergency aid programs to financially support the self-employed during the pandemic to get through the crisis. In Germany, the Minister for Economic Affairs announced a €50bn emergency aid program (*Soforthilfe*) at the end of March 2020, offering one-off lump-sum payments of up to €15,000 to those facing substantial revenue declines and stated at the program announcement on March 10, 2020, “that we will not let any firm-owner down,” thus aiming to increase the resilience of self-employment to survive the crisis.<sup>1</sup> The program received a wide response with more than 2.6 million applications from about 4.2 million self-employed persons in Germany (BMW, 2021). Given the huge amount of taxpayer money that was made available for the program, it is important to understand whether, and in particular under what conditions, this support program was effective.

At the same time, a public discussion started about the extent to which the digitalization level of self-employed increases their ability to survive such a crisis, in that self-employed with higher levels of digitalization are better able to react flexibly to exogenous shocks and take advantage of new entrepreneurial opportunities. Prior literature points to positive effects of digital entrepreneurship on firm performance in crises times (Papadopoulos et al., 2020). For instance, during the 2008/09 financial crisis, highly digitalized firms were hit less hard by the consequences of the crisis than firms with a low degree of digitalization, thus emphasizing the importance of digital technologies for firm resilience (Bertschek et al., 2019).

This article combines the public policy with the digital entrepreneurship perspective. We investigate how the effectiveness of the support program depends on the degree, type, and stage of digitalization among entrepreneurs. Moreover, we assess the role of the regional digital infrastructure. We argue that digitalization helps self-employed to react to the business restrictions introduced through lockdown and containment measures, maybe also taking advantage of new entrepreneurial opportunities. By doing so, we reveal the interplay between

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<sup>1</sup> Minister for Economic Affairs press conference on March 10, 2020 (see <https://www.businessinsider.de/wirtschaft/handel/altmaiers-versprechen-in-deutschland-soll-kein-unternehmen-wegen-des-coronavirus-pleite-gehen/>, accessed May 21, 2021).

the support program and the digitalization level of entrepreneurs impacting their resilience and confidence to survive the crisis.<sup>2</sup>

In our analysis, we proceed in two steps. We start by investigating the overall effects of the emergency aid program on the self-employed and examine whether the program increased the subjective assessment of the self-employed to get through the COVID-19 pandemic without having to quit their business. In our main analysis, we then study the role of digitalization in leveraging the benefits of government support programs in times of crises. In this regard, we examine i) the relationship between the confidence to survive the crisis and the degree of digitalization of the self-employed; and ii) how this relationship depends on digitalization area (digitalization of the product, process, customer relations and distribution channels), digitalization stage, and regional digital infrastructure.

Our empirical analysis is based on a survey comprising the answers from more than 20,000 self-employed individuals in spring 2020. The resulting data set contains information on crisis-related sales losses, resulting liquidity constraints, and the willingness to apply for financial support from the emergency fund. It also comprises information about whether financial support was actually received. Finally, the respondents provided information on several individual- and firm-related characteristics relevant for self-employment, including information on the state of digitalization in the business. Our outcome variable is a measure based on the subjective assessment of the individuals about the probability that they will have to exit from self-employment due to the COVID-19 pandemic in the 12 months that follow. This measure informs us about the confidence of the self-employed to get their businesses through the pandemic. As such confidence is the crucial condition for the self-employed to actively run and further invest in their firms, we interpret this measure as an indicator for resilience (Ayala and Manzano 2014), which is needed for entrepreneurial survival and success in challenging times (Chadwick and Raver, 2020; Hartmann et al., 2022).

To study the role of digitalization in the self-employed's ability to resist economic crises and how it complements a state support program, we estimate a treatment effects model with propensity score matching. We hypothesize that self-employed whose businesses have a higher degree of digitalization – either prior to the crisis or obtained through investments in the first months of the crisis – are more flexible and better able than other self-employed to react to new entrepreneurial opportunities, which allows them to benefit more from the support program.

The results of our study support this notion. We find that the program was able to achieve its goals, but increased the confidence to survive the crisis only among those self-employed whose businesses were at advanced digitalization stages. Moreover, taking a regional perspective, we find suggestive evidence that regional digital infrastructure matters and the quality of the broadband infrastructure increases the effectiveness of the emergency aid program. With our study, we contribute to the growing literature on digitalization and digital

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2 We apply the psychological approach of resilience, i.e. the ability of the self-employed to master a shock and to be able to continue to serve their customers despite the significant changes in customer demand that were induced through the pandemic and its containment measures (Bhamra et al., 2011, Fletcher and Sarkar 2013).

entrepreneurship (Berger et al., 2021, Nambisan, 2017; Steininger, 2019; Steininger et al., 2022) as well as on how digitalization helps entrepreneurs achieve greater flexibility and resilience (Kreuzer et al., 2022; Ojala et al., 2018; von Briel et al., 2018). Our study also contributes to the literature on entrepreneurship in crisis situations (Doern et al., 2019, Belitski et al., 2022; Newman et al., 2022) and how state aid can help entrepreneurs to master such challenging situations. In the context of public support for entrepreneurship, our study shows that the effect of state aid depends also on regional digital infrastructure. This aspect of our study connects to a discussion on how the regional digital context and infrastructure shapes the mindset, actions, and resilience of entrepreneurs and their regions (Sussan and Acs, 2017, Naldi et al., 2020, Belitski et al., 2021, Biru et al. 2021).

## **2. Policy Context and Previous Research**

### **2.1. The COVID-19 pandemic and policy measures in Germany**

Germany observed its first COVID-19 cases in January 2020, which increased steadily over the following months. At the time of the survey in April and May 2020, Germany was among the most affected countries. On March 22, 2020, two weeks before our data collection, the German government imposed severe restrictions. Among others, the government closed schools and daycare centers, public events were canceled, and most shops, restaurants, and hotels, except for supermarkets were shut down. In particular, the travel and hospitality industries were severely restricted. Only two individuals were allowed to meet in a public gathering, and a distance of at least two meters had to be kept from each other in public spaces. Simultaneously, the Institut für Weltwirtschaft (IfW 2020) predicted that the GDP will decline by up to 9% in 2020. The self-employed were among the most affected by the policy measures to stop the spreading of COVID-19. Many of them had to deal with a temporary inability to work, not being able to generate revenues to cover the operating costs of their business or their personal living costs.

To help the economy as well as to avoid massive unemployment and a severe recession, the German government initiated several policy measures to reduce the economic consequences of the pandemic. Targeting employees, *Kurzarbeit* - short-time work - was opened for the pandemic, with the Federal Employment Office covering a substantial portion of wage costs for affected employees (Cahuc, 2014). The self-employed, however, were not covered by this instrument. That is why the government launched the *Soforthilfe*, which was an emergency aid package comprising €50 billion. The package was accessible between end of March and end of May 2020. This ad-hoc program aimed to help solo self-employed and owners of micro firms (with up to 10 employees) maintain their ventures and increase their chances of entrepreneurial survival. The applicants to this program could receive up to €15,000 as immediate financial assistance in case they were able to demonstrate strong revenue declines. Its main limitation

was that it could be used only for covering fixed operating costs, but not for living costs (Federal Ministry for Economic Affairs and Energy, 2020). The analysis of this program's effectiveness is at the center of our analysis.

## **2.2. Existing research on self-employment during the COVID-19 pandemic**

Crisis-related research on self-employment is considerable (see, e.g., Doern et al. 2019, Laskovaia et al. 2019). Three strands of literature can be distinguished when analyzing relationships between the COVID-19-pandemic and entrepreneurship. The first strand documents that there is one important difference between the COVID-19 pandemic and earlier crises in the current century: the COVID-19 pandemic affected the majority of the self-employed population. Contemporaneous research shows how, and who among, the self-employed suffered most strongly, in an economic sense, from the consequences of the COVID-19 pandemic (Bartik et al., 2020, Blundell and Machin, 2020, Fairlie and Fossen, 2022b, Graeber et al., 2021, Kalenkoski and Pabilonia, 2022). Further research points to other effects of the pandemic on self-employed people beyond economic losses: First descriptive (Torrès et al., 2022) and causal (Caliendo et al., 2022) evidence reveals a worsening of mental health among the self-employed in the wake of pandemic-driven market distortions.

Beyond examining on how the pandemic affected the self-employed, a second strand of research investigates how the self-employed coped with the early stages of the COVID-19 pandemic. Bertschek and Erdsiek (2020) show that self-employed with a higher degree of digitalization are less affected by the crisis. Block et al. (2022a) investigate how self-employed tried to maintain their liquidity, particularly through the use of bootstrap financing, while Meurer et al. (2022) demonstrate how entrepreneurial online communities offered support to the affected entrepreneurs.

The third strand investigates the role of financial support and other government programs in responding to this economic disruption. Various public instruments were developed and provided by governments around the world in response to the financing needs of entrepreneurs and small businesses. Fairlie and Fossen (2022a) provide a disbursement analysis of two programs, the Paycheck Protection Program and the Economic Injury Disaster Loan Program, both in the US, that aimed to help disadvantaged groups. Atkins et al. (2022) add to the understanding of the role of race in loans made through the Paycheck Protection Program. For China, Liu et al. (2022) show the supportive role of Chinese state-owned banks on small businesses' lines of credit where a broad policy mix was introduced consisting of loan guarantees, direct lending to small businesses, grants, and equity instruments. Block et al. (2022b) for Germany, and Belghitar et al. (2022) for the UK investigate the effects of governmental policies for SMEs during COVID-19, and examine whether these interventions affected their ability to survive the pandemic. Dörr et al. (2022) point to the downside of such policies as they claim to have detected an insolvency gap that is characterized by firms that were already struggling before the pandemic.

The current study bridges the above three strands of literature. While earlier impact studies of public support programs find only moderate effects and argue that such programs may only postpone the insolvency, our analysis explores heterogeneities among the self-employed and shows which factors among the treated influence the effectiveness of such programs. In other words, by investigating which kind of activities among the self-employed themselves increase the impact of state aid, we are able to further the understanding how entrepreneurial resilience can be developed to master and survive a challenging crisis like COVID-19. This way, our study not only contributes to the entrepreneurship literature dealing with COVID-19 but also to the more general literature on the antecedents of entrepreneurial resilience (Hartmann et al., 2022) and the role of digital entrepreneurship therein.

### **3. Theory and Hypotheses**

In this study, we aim to analyze how the emergency aid impacts the subjective survival probability of the self-employed to remain in this occupational form despite the COVID-19 pandemic, and how its impact is determined by digitalization. Our theoretical arguments are derived from the growing digitalization literature applied to the particular context of the COVID-19 pandemic. Digital technologies differ from other technologies in a number of important aspects. As general-purpose technologies (Bresnahan and Trajtenberg, 1995), they are characterized by rapid change (technological dynamism), by general applicability (pervasiveness), and by innovational complementarities, i.e. firms who apply these technologies, are able to develop new products, services, new business models, or new distribution channels, thus making their processes more efficient.

There are different methods to measure firms' use of digital technologies and level of digitalization. A first approach employs general measures like investments in digital technologies or information and communication technologies (ICT) (see for instance Bertschek and Kaiser, 2004; Bloom et al., 2014; Bresnahan et al., 2002). A second method focuses on the adoption and use of specific technologies, like enterprise software (e.g., Engelstätter, 2012) or big data analytics (e.g. Niebel et al., 2019). A third line refers to the digitalization of different business areas. For instance, Trischler and Li-Ying (2022) point out that products and services of the self-employed as well as production, distribution, and administrative support processes could be digitalized. Rosin et al. (2020), based on Hull et al. (2008), consider digital products and services, digital processes, digital customer interaction, and digital collaboration. In a similar vein, in our analysis, we consider the digitalization of (1) products and services, (2) internal business processes, and (3) customer relations and distribution channels. In our large-scale survey the self-employed were asked to self-assess the degree of digitalization of these

three business fields on a five-point Likert scale, which we use to construct three levels of digitalization: low, medium and high (see section 4.1 for details).<sup>3</sup>

### **3.1 How digitalization boosts the impact of the emergency aid through entrepreneurial opportunities and flexibility (the digitalization effect)**

The unique characteristics of digital technologies, particularly its general applicability and innovational complementarity, provide important benefits for its users in terms of new entrepreneurial opportunities and additional flexibility. We argue that these two benefits of digitalization help the self-employed to master the COVID-19 pandemic and increase the impact of the emergency aid received.

Using digital technologies does not just affect efficiency, e.g., through more efficient communications or a reduction of production costs. It also creates new *entrepreneurial opportunities* for the self-employed, e.g., through expansion into new markets and enabling new ways of value creation and value capture leading to new business models (Berger et al., 2021; Steininger, 2019; Steininger et al., 2022). A self-employed individual with a primarily local customer base is able to use digital tools or networks to expand into new geographical areas. Research shows that digital entrepreneurs recognize and exploit emergent opportunities differently from non-digital entrepreneurs (Kreuzer et al., 2022). Moreover, they can use digital platforms to grow and internationalize more rapidly (Ojala et al., 2018; Jean et al., 2020).

Digitalization also provides the self-employed with greater *flexibility* to react to unforeseen situations, challenges, and opportunities. Adaptability through reprogramming and scalability makes it easy to adjust the products, services, internal processes, and business models to new situations (Lyytinen et al., 2016). For instance, a self-employed individual offering consulting services normally face-to-face is able to offer these services online using videoconferencing tools. In line with this example, research from the 2008/09 economic and financial crisis shows that firms with a high level of digitalization were more flexible in the sense of being able to implement process innovation and to maintain a high level of productivity throughout the crisis (Bertschek et al., 2019), thus being more resilient.

The advantages of digitalization described above put self-employed individuals with a high degree of digitalization into a better position to benefit from the emergency aid. Hence, the impact of the emergency aid on highly digitalized self-employed should be larger. As pointed out above, we distinguish between the digitalization in three business areas, namely products/services, internal processes, and the customer relations and distribution channels. We hypothesize for all three areas a positive digitalization effect. Our baseline hypothesis is:

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3 Some authors differentiate between digitization and digitalization (see for instance Ritter and Pedersen, 2020). We refer to digitalization as using digital technologies in order to change products and services, internal business processes or customer relations and the way of distribution. The term digitization as the process of converting information from a physical format into a digital one is not applied here.

**H1 (the digitalization effect):**

*The impact of the emergency aid for self-employed on the subjective survival probability in self-employment is stronger for self-employed with a high degree of digitalization than for self-employed with a low degree of digitalization. This digitalization effect should apply for digitalized products or services, digitalized internal processes, and digitalized customer relations/distribution channels.*

After having derived the basic digitalization effect that strengthens the impact of the emergency aid, we now dig deeper into the heterogeneous nature of this effect. Thereby, we consider the moderating effects of digitalization area, initial digitalization stage, and the regional digital infrastructure. Such a perspective is consistent with a process perspective on digital transformation comprising different stages (Matt et al., 2015; Verhoef et al., 2021), as well as the ecosystem approach in the context of resilience among entrepreneurs (see Iacobucci and Perugini, 2021) and digital entrepreneurship (Sussan and Acs, 2017).

**3.2 The influence of digitalization area on the digitalization effect**

We argue that the digitalization effect differs by digitalization area. This can be explained by the nature of the COVID-19 pandemic. The COVID-19 pandemic and the related business restrictions had a particularly strong effect on product distribution and customer interaction as it was not possible to meet customers in person or, for instance, visit trade fairs. Digital ways of product distribution and customer interactions became of high importance and those self-employed with digital distribution channels and digital customer interactions were more flexible and had an advantage compared to other self-employed. Digital marketing research has investigated the benefits of digital marketing in great detail. Digital tools, platforms, and marketplaces allow firms to apply dynamic pricing (e.g. Bigne et al., 2021; Wurman, 2001), to involve their customers in the innovation and production processes designing more customized and individualized products and services (e.g. Franke and Piller, 2004; Maier et al., 2021), and to reach a broader and more heterogeneous customer base (e.g. Dinner et al. 2014; Li und Kannan 2014). Moreover, digital marketing tools help firms to keep contact with their existing customers, thus increasing brand and customer loyalty (Lou and Xie, 2012), while also leveraging and creating opportunities for cross-selling and repeat purchases (Kumar et al., 2016). The latter two aspects should be of particular importance in the context of the COVID-19 pandemic. Such comparative advantage resulting from digitalization may be weaker for digital internal (administrative) processes as such processes could still be carried out in a non-digital way during the COVID-19 pandemic. Accordingly, the digitalization effect with regard to the impact of the emergency aid should be stronger for the digitalization of distribution channels and customer interaction as compared to the digitalization of internal processes. The following hypothesis applies:

**H2a:** *The digitalization effect is stronger for digitalized distribution channels or customer relations than for digitalized internal processes.*

A similar argument is raised for the case of digital products and services or physical products with digital elements. The COVID-19 pandemic particularly affected those self-employed with non-digital products and services. Sectors like gastronomy and accommodation, events, and wellness were hit particularly hard (see, for example, Bertschek and Erdsiek, 2020; Graeber et al., 2021, Zopiatis et al., 2021). Performing such non-digital services was impossible as a physical customer interaction is an integral part of the service provision. However, depending on their sector affiliation, some self-employed intensified the digitalization of their products and services during the pandemic. Such digitalization efforts allowed them to still deliver their products and services to their customers despite not being able to meet their customers in person. For example, knowledge-intensive (professional) service firms involved in teaching, consulting, and coaching used the COVID-19 pandemic as an opportunity to deliver their services off-site (from home) instead of providing them on-site on the customer's premises. Walsman (2022), analyzing the operational adaptations that consulting firms made in response to COVID-19, shows that the pandemic was an important booster for service innovation in the activities of these professional service firms.

To summarize, we posit that self-employed with a digital product or service or a high level of digitalization in their products or services had a comparative advantage compared to those with a lower level of digitalization in their products or services. Such self-employed are better able to benefit from the emergency aid and use this aid to defend or improve their competitive position. This digitalization advantage should be weaker for self-employed with digitalized internal processes that, despite the COVID-19 pandemic and the mandated restrictions, can only be carried out in a non-digital way. The following hypothesis is formulated:

**H2b:** *The digitalization effect is stronger for digitalized products or services than for digitalized internal processes.*

### **3.3. The influence of initial digitalization stage on the digitalization effect**

Digitalization is not a one-off event but rather a long and complex process (see, for example, Brynjolfsson and Hitt, 2000, Brynjolfsson et al., 2019). Several models of digitalization maturity or readiness exist in the literature (e.g., Lokuge et al., 2019; Mittal et al., 2018). The process involves substantial (organizational) set-up and adaptation costs, with the benefits of, for instance, new entrepreneurial opportunities and increased flexibility taking time to materialize. Those self-employed who only started to digitalize their products, processes, and distribution channels *during* the crisis are still at a relatively early stage of the digital transformation and, thus, may not yet have seen and experienced the advantages associated with

digitalization. They are still in a situation of high uncertainty, primarily experiencing the psychological and economic costs associated with the digitalization process and what this means for the entrepreneurial business models and working life.

In turn, self-employed who already started with the digitalization *before* the crisis are at a more advanced stage of the digitalization process and, hence, are more likely to realize the advantages of digitalization. The uncertainty with regard to the transformation process and digitalization benefits is lower. Thus, public subsidies, like the emergency aid, may have a larger effect on their subjective assessment to survive the crisis with their firms. Moreover, digital technologies are considered general purpose technologies, enabling new ways to create value for customers (von Briel et al., 2018). Only firms beyond a certain level of digitalization may benefit from the opportunities associated with digitalization as an enabling technology. Related to this reasoning, digitalization provides flexibility to firms that was of high value during the COVID-19 crisis. This additional flexibility only becomes visible beyond a certain level of digitalization.

**H3:** *The digitalization effect is stronger for those self-employed who started the digitalization process already before as compared to during the crisis.*

### **3.4. The influence of regional digital infrastructure on the digitalization effect**

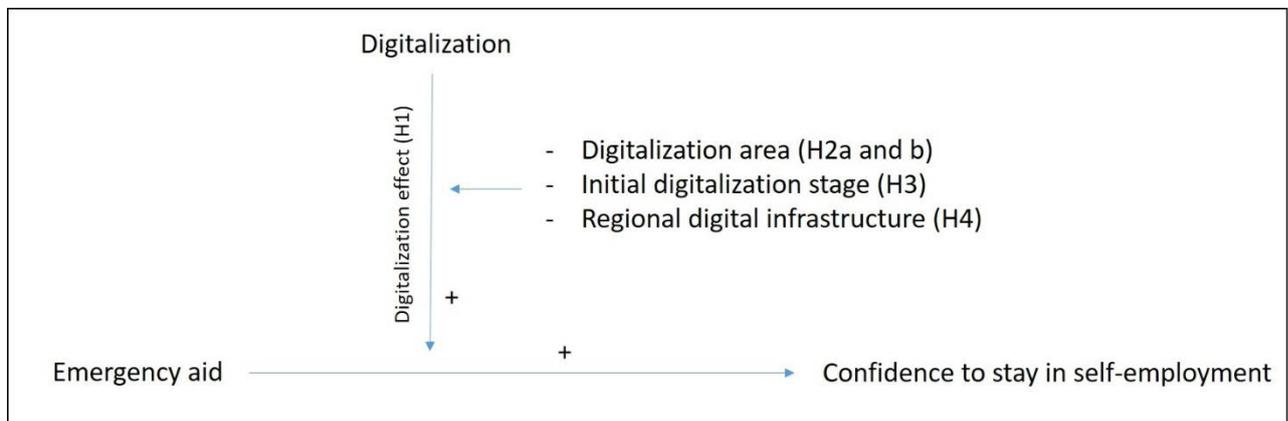
In this section, we argue that regional disparities in digitalization may exist and that these regional disparities influence the impact of state subsidies for the self-employed, like the emergency aid. The main argument is that a minimum level of digital infrastructure, in terms of available wireline- or mobile-based fast broadband, is needed so that the self-employed are better able to benefit from their investments in digitalization (see for example Akerman et al., 2015, on the relevance of broadband availability for firm performance, or Duso et al., 2021, showing that advanced broadband applications increase firm productivity, and Barrero et al., 2021, on the relevance of internet access on working from home during the COVID-19 pandemic). Digital technologies have strong (direct and indirect) network effects, meaning that the value of using digital technologies increases with a larger number of users, amount of available data, and the installed base (Katz and Shapiro, 1985; Gregory et al., 2021). Oftentimes, these network effects are highly localized (Kim et al., 2021) meaning that it is not the total number of users of a digital tool or platform that matters but how many close collaborators are using the platform or tool. We suggest that, for the above described digitalization benefits to occur, it is not enough that the self-employed themselves have a good digital infrastructure, their customers, suppliers, and other business partners also need to have a good digital infrastructure and a digital mindset so that a strong regional ecosystem of digital entrepreneurship and small businesses can emerge (Belitski et al., 2021; Sussan and Acs, 2017). This may become a problem for locally-oriented self-employed individuals from regions with a weak digital infrastructure where negative spillover effects may occur. Thus, we argue that

the impact of the emergency aid for self-employed depends not only on the digitalization level of the self-employed themselves but also on the digitalization level of the region in which they are located. Accordingly, we hypothesize:

**H4:** *The digitalization effect is stronger for those self-employed located in regions with a strong digital infrastructure as compared to self-employed located in regions with a weak digital infrastructure.*

Figure 1 provides an overview of our conceptual framework displaying our baseline hypothesis about the digitalization effect as well as the moderating hypotheses relating to the effects of digitalization area, stage, and regional digital infrastructure.

Figure 1: Conceptual Framework



Source: Own depiction

## 4. Data

### 4.1. Survey data

We empirically analyze the hypotheses using unique real-time online-survey data collected from more than 27,000 self-employed persons at the beginning of the COVID-19 pandemic between April 7 and May 4, 2020, in Germany (Bertschek et al. 2022). The data set contains rich information on the self-employed persons' financial situation, subjective future prospects, their willingness to apply for government support programs, the application process and outcome regarding the emergency aid program, as well as socio-demographic and business characteristics including details on the ventures' digitalization level. Block et al. (2022b) give a detailed description of the survey setup and present various descriptive statistics. Importantly, they show that the applicants for the emergency aid program were severely affected by the crisis and that they expected financial hardship to continue for at least 6 months.

After cleaning the data of clearly erroneous entries (e.g., inconsistent entries reporting application dates before the policy measure was introduced etc.), missing values, and after excluding persons living outside of Germany, we obtain an estimation sample of 16,859 self-employed individuals. Half of the persons are less than 50 years old and 48% of the surveyed are male. The majority is highly educated, with 61% possessing a university degree. The regional dispersion is shown in Table 7 in the appendix and follows the German population pattern, with most of the surveyed living in the most-populated states (North Rhine-Westphalia, Bavaria, and Baden-Württemberg) and in larger cities like Berlin, where the share of self-employed persons in total employment is particularly high (Fritsch et al., 2015, IfM, 2019). Our survey slightly oversamples self-employed persons in Berlin and Hamburg, while it underrepresents those in Baden-Württemberg, which we account for in the empirical strategy. At the time of the survey, 59% of the respondents had applied for the government support program and 34% had received the payment. The remaining persons were either waiting for the payment (4%) or for a decision (19%). Overall rejection rates were low.

The self-employed were asked to assess their degree of digitalization on a five-point Likert scale (very low, rather low, medium, rather high, very high). We summarized the categories very low and rather low as well as rather high and very high leading to three categories. Having detailed information on the ventures' degree of digitalization prior to the crisis as well as changes in the degree of digitalization during the first months of the crisis, we uncover important differences in the stage of digitalization within and across ventures. As the first panel in Table 1 shows, 59% of the respondents had digitalized internal processes prior to the crisis (medium + high level), whereas a smaller share of respondents had made investments into digitalizing products and services, as well as customer relations. This changed to a certain extent during the first months of the crisis (March to May 2020), with about 20% of the respondents reporting to have increased the digitalization level of their products and services, or their customer relations (Table 1, second panel). The variation shows that when the COVID-19 pandemic started, entrepreneurs were at different stages in their digital transformation processes and, thus, had different prerequisites to meet the challenges posed by the containment measures and the economic recession.

Table 1: Digitalization level among German self-employed persons in 2020

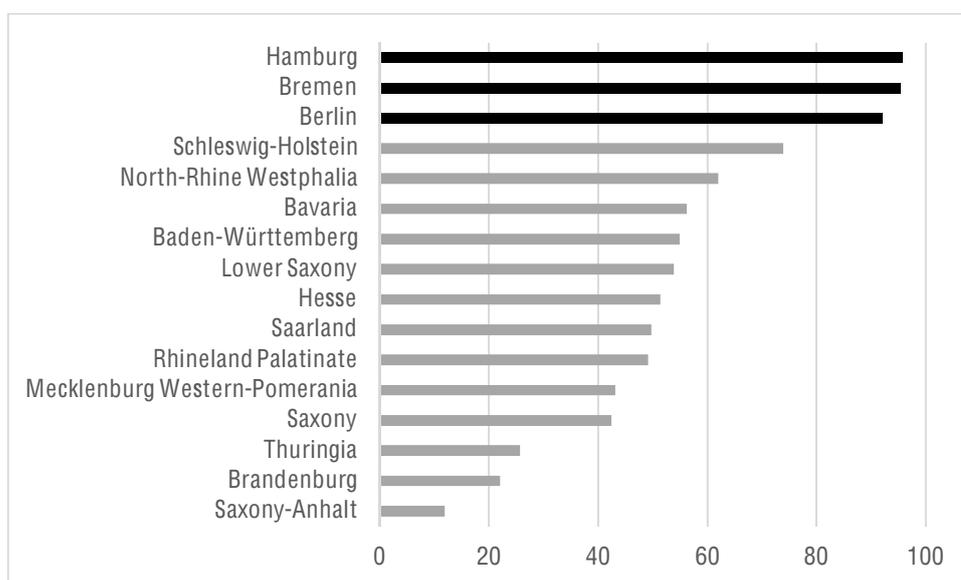
	products and services	internal processes	customer relations/ distribution channels
	before COVID-19 crisis		
low	.38	.24	.33
medium	.16	.21	.22
high	.29	.38	.26
	during COVID-19 crisis		
decreased	.07	.07	.09
unchanged	.54	.63	.53
increased	.22	.12	.19

Source: Survey on self-employment during COVID-19 crisis in Germany - wave 2020 (doi:10.25652/diw\_data\_S0021.1), own calculations.

## 4.2. Regional disparities in broadband infrastructure

To test whether the impact of the emergency aid is larger in regions with a strong digital infrastructure, we combine the survey data with information on the broadband infrastructure at the federal state level. Fast internet access is widespread in the German city states of Berlin, Bremen, and Hamburg, while federal states that are characterized by rural regions, in particular the federal states in eastern Germany, lag behind. Thus, whereas almost every household in the city states has the possibility of connecting to the internet at the minimum speed of one gigabit per second, only 12% of the households in Saxony-Anhalt can do the same (Figure 2).

Figure 2: Percentage of households with fast broadband access ( $\geq 1$  Gbits/s) by federal state



Source : FMDT (2020).

## 5. Empirical Approach

### 5.1. Estimation strategy

To address our main research question and to study the role of digital technologies in the ventures' ability to survive the pandemic crisis, we estimate a treatment effects model and analyze how a firm's digitalization status affects its future when taking advantage of the government support program. As the main outcome measure, we use the reported subjective assessment of remaining in self-employment within one year after receiving financial support, where we compare between ventures that are in different stages of the digital transformation process. We estimate the average treatment effect of the treated based on the Roy (1951) – Rubin (1974) model with two potential outcomes,  $Y_1$  and  $Y_0$ , and a binary treatment variable  $D$  equal to one if the individual receives the treatment and equal to zero otherwise. Since we do not observe the counterfactual outcome of the treated had they not received the government payment (and vice versa), we cannot estimate the individual treatment effect but follow Roy (1951) and Rubin (1974) by relying on population

averages and assuming conditional independence. The latter builds on the fact that the counterfactual outcome of the treated cannot be easily approximated by the observed outcome of the untreated since individuals might self-select into treatment and the treatment group might systematically differ from the control group. Conditional independence controls for these systematic differences and assumes that, once we condition on a set of observable characteristics  $X$ , the potential outcome is independent of treatment assignment, obtaining the following formula for the ATT:

$$ATT = E[Y_1|D = 1] - E[Y_0|D = 1] = E[Y_1|X, D = 1] - E_X[E[Y_0|X, D = 0]|D = 1].$$

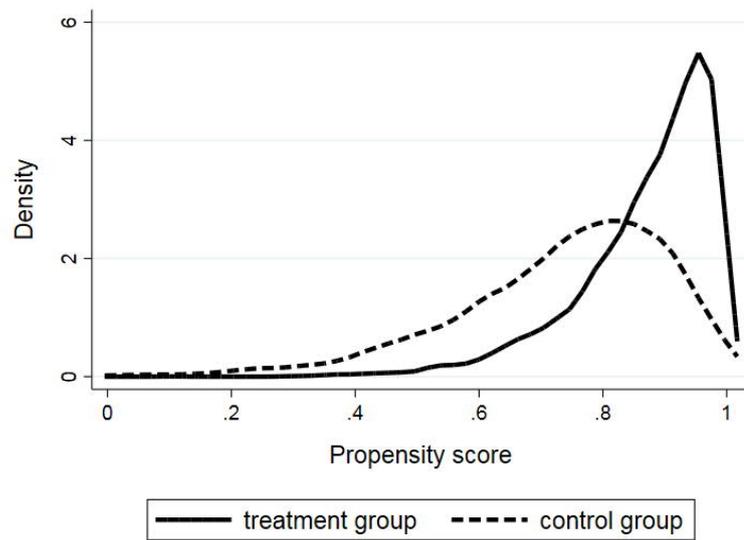
Thus, the individuals from the comparison group are matched to the treated units in such a way that the mean distribution of the covariates in the matched control group resembles that of the treatment group, which is formally expressed by the outer expectation  $E_X[. | D = .]$  (Caliendo and Kopeining, 2008). We apply propensity score matching to reduce the covariates distributions to a single balancing score  $P(X)$ . We trim the sample to observations within the region of common support using the criteria  $\max(\min\{P(X)|D=1, P(X)|D=0\})$  and  $\min(\max\{P(X)|D=1, P(X)|D=0\})$  at the tails of the propensity score distribution to ensure that all individuals with the same values of  $X$  have a positive probability of being treated and untreated. For the matching procedure, we use an Epanechnikov kernel to obtain a weighted average of control units whose outcome is compared to the treated unit, with the kernel bandwidth being chosen by cross-validation.

Our outcome variable is the subjective assessment of the self-employed persons in spring 2020 to remain in this occupational form over the next 12 months despite the COVID-19 pandemic. We consider this outcome measure as useful: it allows us to measure the psychological response in times of a crisis. The aim of the emergency aid program was to avert the firm closure or bankruptcy of the self-employed and micro-sized ventures with up to 10 employees whose economic survival was threatened by the COVID-19 pandemic. In addition to financial support, the program was also intended to provide the self-employed with psychological support, reassuring them that the government would not abandon them and that they could continue their business despite the crisis. This psychological component is particularly important in the context of entrepreneurship and resilience: the personal assessment of the self-employed about their future prospects influences the effort they put into their venture and, thus, the likelihood of its survival. In fact, a positive subjective survival probability is a prerequisite for realized survival, since it is the entrepreneurs who make the decision whether or not to continue their business. We measure the outcome as a binary variable set to 1 if the self-employed perceive continuation as likely and 0 otherwise, which allows us to interpret the estimated ATT as percentage point changes in survival probability.

Our treatment variable is the participation in the government program, where our focus is on comparing the treatment effect between ventures with different levels of digitalization. Possessing detailed information on each individual's application process and outcome, we consider all individuals who received the payment out of the emergency aid program ( $n=5,743$ ) as treated. The control group comprises all persons who were planning to apply for the program but have not yet done so at the time of the survey ( $n=1,013$ ). The advantage of this approach is

that respondents who are inclined to apply are likely to share important characteristics with those who have already applied regarding their financial situation, their venture's characteristics, etc., compared to individuals who did not (and will not) apply. In addition, we apply propensity score matching to match treated and untreated individuals based on a rich set of covariates that are likely to affect the application for the emergency aid as well as the respondents' expectations about their ventures' prospects. Notably, we control for (i) personal characteristics such as age, gender, self-employment experience, education, and risk tolerance; (ii) for venture characteristics covering full-time vs. part-time self-employment, the number of employees, industry, the location of the business (federal state); and (iii) the self-employed person's financial situation measured by the private costs of living, support from the basic income scheme, solvency, and the revenue decline due to the crisis. Finally, we control for the expected duration of financial hardship and the calendar week in which each individual was surveyed.

**Figure 3: Common support**



Source: Own calculations.

We verify the quality of the propensity score matching by calculating standard statistics such as the mean absolute standardized bias (Rosenbaum and Rubin, 1985) which is reduced to 2.1% after the matching compared to 6.8% before the matching. Caliendo and Kopeining (2008) argue that successful bias reduction should result in a mean absolute standardized bias of below 5%. Furthermore, we calculate Rubin's B, obtaining that the means of the covariate distributions in the treatment and control group are 0.26 standard deviations away from each other after matching, which is close to the optimal value of one quarter suggested by Rubin (2001). The ratio between the propensity score's variances of both groups, commonly referred to as Rubin's R, is 1.28 and, thus, well inside of the optimal interval [.5;2] (Rubin, 2001). To verify that there is sufficient overlap in the propensity score distributions between the treatment group and the control group, we plot the distributions in Figure 3. We find continuous common support within the interval [.11,.99], confirming that the min-max-trimming criterion was valid and unrestrictive.

## 5.2. Main results

We present the main results in Table 2: we observe that the emergency aid program positively affected the self-employed in their assessment of future prospects, with the subjective survival probability of the self-employed who received financial support being moderately increased by 6.5 percentage points. Turning to the underlying factors that make some entrepreneurs more confident to survive the crisis than others, we reveal important effect heterogeneities with respect to digitalization. Notably, positive effects only occur among those individuals whose ventures were highly digitalized prior to the crisis (11.0 percentage points) – whereas in ventures with low or medium degrees of digitalization, the survival probability did not significantly increase despite their participation in the emergency program (*hypothesis 1*). We observe this pattern in all digitalization areas (cf. Table 3 and Table 4), further confirming *hypothesis 1*. Moreover, Table 4 suggests that effects are particularly strong among those who had digitalized their customer relations as well as their products and services, with an increase in the subjective survival probability of 13.9 percentage points and 10.8 percentage points, respectively. The latter finding is plausible given the fact that social distancing measures during the COVID-19 pandemic especially affected these areas (*hypotheses 2a and 2b*). However, due to the smaller sample sizes, the coefficients are less precisely estimated and are not significantly different from each other at the 5-percent-level. Consequently, while indicative evidence is suggested, we cannot confirm *hypotheses 2a and 2b* from a statistical point of view.

Table 2: ATT by digitalization level before and during the crisis

	main	digitalization level pre-crisis			digitalization level during crisis		
		low	medium	high	decreased	unchanged	increased
Dependent variable: self-assessment to remain self-employed within the next 12 months (yes/no)							
ATT	.065	.053	.070	.110	.076	.074	.036
SE	(.023)	(.033)	(.109)	(.040)	(.091)	(.035)	(.045)
p-value	.004	.113	.521	.006	.401	.037	.427
N matched	6,284	3,210	798	2,344	729	3,403	2,258
N unmatched	472	53	121	230	89	23	145
N total	6,756	3,263	919	2,574	818	3,426	2,403

Notes: Epanechnikov-kernel estimator with min/max trimming criterion. Standard errors were bootstrapped with B=1,999 replications. Source: Survey on self-employment during COVID-19 crisis in Germany - wave 2020 (doi:10.25652/diw\_data\_S0021.1), own calculations.

During the crisis, many self-employed decided to make ad-hoc investments into digitalizing their distribution channels and customer interactions in order to catch up with respect to their digitalization strategy. Therefore, we also investigated in the empirical analysis whether it matters for the program effect when these investments happened. As a matter of fact, the emergency aid could only increase the confidence of the self-employed to master the crisis if they had made their digitalization investments before the crisis started. For those who tried

to catch up by spontaneously investing into digitalizing their businesses during the first months of the crisis, the emergency aid program had no effect (Table 2, last column) (*hypothesis 3*).

Table 5 examines further heterogeneous program effects, distinguishing the German city states of Berlin, Bremen, and Hamburg, which have very high shares of households with access to high-speed Internet (cf. Figure 2). These cities contrast with the rest of Germany, including more rural regions. The results show that the government program was effective throughout Germany. Although the estimated coefficients suggest that the program was more effective in the urban areas (*hypothesis 4*), the difference between the two coefficients is not significantly different from zero. Hence, there is only first indicative evidence that differences in the broadband infrastructure between rural and urban areas affect the confidence of the self-employed to master the crisis with the help of the government program. To gain further insights and obtain more robust results, it would be necessary to classify each observation according to the population density of its county, which, unfortunately, is not possible due to missing information on the exact location of the surveyed persons and their business.<sup>4</sup>

Table 3: ATT for ventures with low digitalization level by digitalization area

	pre-crisis low digitalization level in...		
	products / services	internal processes	customer relations / distribution channels
Dependent variable: self-assessment to remain self-employed within the next 12 months (yes/no)			
ATT	.014	.043	.004
SE	(.035)	(.045)	(.036)
p-value	.684	.346	.902
N matched	3,036	1,782	2,539
N unmatched	310	191	281
N total	3,346	1,973	2,820

Notes: Epanechnikov-kernel estimator with min/max trimming criterion. Standard errors were bootstrapped with B=1,999 replications. Source: Survey on self-employment during COVID-19 crisis in Germany - wave 2020 (doi:10.25652/diw\_data\_S0021.1), own calculations.

These results show that a high degree of digitalization is an important factor for the confidence to survive the crisis, making financial support more effective in terms of resilience and the assessment of future perspectives. However, this also implies that digitalization is a tedious process that cannot be made up in the short term. Therefore, developing a long-term strategy for digitalizing different business areas is a prerequisite for building up such confidence that one will be able to master the consequences of such a crisis. Further, digitalization should not be restricted to internal business processes, but should comprise the development of digital products and services as well as the relationship with customers and the distribution channels. The latter were particularly decisive for getting through the COVID-19 crisis.

<sup>4</sup> We only observe the federal state where the business is located in without any further information on the county or municipality.

Table 4: ATT for ventures with high digitalization level by digitalization area

	pre-crisis high digitalization level in...		
	products / services	internal processes	customer relations / distribution channels
Dependent variable: self-assessment to remain self-employed within the next 12 months (yes/no)			
ATT	.108	.088	.139
SE	(.045)	(.038)	(.045)
p-value	.016	.020	.002
N matched	1,790	2,893	1,856
N unmatched	179	85	159
N total	1,969	2,978	2,015

Notes: Epanechnikov-kernel estimator with min/max trimming criterion. Standard errors were bootstrapped with B=1,999 replications. Source: Survey on self-employment during COVID-19 crisis in Germany - wave 2020 (doi:10.25652/diw\_data\_S0021.1), own calculations.

Table 5: ATT by region

	Berlin, Hamburg, and Bremen	other regions
Dependent variable: self-assessment to remain self-employed within the next 12 months (yes/no)		
ATT	.123	.052
SE	(.061)	(.025)
p-value	.044	.038
N matched	1,626	4,937
N unmatched	133	60
N out of common support	0	0
N total	1,759	4,997

Notes: Epanechnikov-kernel estimator with min/max trimming criterion. Standard errors were bootstrapped with B=1,999 replications. Source: Survey on self-employment during COVID-19 crisis in Germany - wave 2020 (doi:10.25652/diw\_data\_S0021.1), own calculations.

### 5.3. Robustness checks

In the main analysis, we use an Epanechnikov kernel estimator to match the treated individuals to the control group. We aim to assess the robustness of these results and, therefore, re-estimate the treatment effects model using nearest-neighbor-matching with two neighbors and replacement to check whether our results depend to the choice of the matching algorithm. The results, listed in Table 6, are very similar to those obtained with the Epanechnikov kernel estimator in terms of both size and efficiency. The results for the digitalization area analysis are shown in the Appendix, Table 8 and Table 9. They confirm once again the pivotal role of digitalizing customer relations and distribution channels in weathering the crisis.

Table 6: ATT with nearest neighbor-matching

	main	digitalization level pre-crisis			digitalization level during crisis		
		low	medium	high	decreased	unchanged	Increased
Dependent variable: self-assessment to remain self-employed within the next 12 months (yes/no)							
ATT	.068	.047	.080	.107	.094	.084	.016
SE	(.022)	(.029)	(.089)	(.028)	(.054)	(.025)	(.038)
p-value	.002	.111	.366	.000	.083	.001	.671
N total	6,756	3,263	898	2,574	759	3,426	2,403

Notes: Nearest neighbor matching estimator with two neighbors and replacement. Observations with perfect treatment probability were discarded. Robust standard errors were estimated following Abadie and Imbens (2016). Source: Survey on self-employment during COVID-19 crisis in Germany - wave 2020 (doi:10.25652/diw\_data\_S0021.1), own calculations.

## 5.4. Limitations

Our analysis has some limitations referring to the data used and the methodology applied. As with all cross-sectional studies relying on propensity score matching, we are not able to account for unobserved characteristics that might explain differences in resilience or in the fact that an entrepreneur receives emergency aid. For instance, although we know the self-employed's propensity to take risks, we do not have information on further dimensions of entrepreneurial orientation such as innovativeness and proactiveness. The degree of proactiveness could affect not only the likelihood of applying for the program (treatment), but also correlate with the impression to have control over the situation and, thus, influence the optimism about weathering the crisis. Likewise, innovativeness could help in adapting the business model to new circumstances during the crisis. Using a rich dataset with very detailed information on the self-employed, their venture, and the application process – for instance also including information about the expectations of the self-employed regarding the duration of the pandemic and the financial hardship it will cause – we are confident to have minimized any biases from omitting relevant aspects from the analysis. However, we cannot rule out the possibility that some bias remains. In addition, we are not able to deepen the regional analysis since we only have information on the federal states the self-employed are located in. We can neither control for broadband availability in the self-employed's exact municipality nor for socio-demographic differences between urban and rural regions. To tackle these challenges, panel data and more precise information on the location of the self-employed is necessary.

## 6. Discussion and Conclusion

The COVID-19 pandemic and the related government-mandated lock-down measures severely affected the self-employed. In response to the crisis, the German government introduced a financial support program for which €50bn was budgeted and €13.7bn spent. It was intended to help the self-employed bridge the negative economic consequences of the COVID-19 pandemic and to survive the crisis with their businesses. At the same time, during the early stage of the

pandemic, it became clear that the self-employed would be better able to cope with the consequences of the lock-down measures if they had digitalized their businesses. Therefore, we investigate in this study, how the German emergency aid program affected the confidence of the self-employed to get through the crisis and how the level of digitalization of the self-employed's business impacts the effect of the emergency aid. In other words: we are interested in the interplay between the support program and the digitalization strategy of entrepreneurs. For our analysis, we use a real-time online survey answered by more than 20,000 self-employed individuals in spring 2020, which captured a rich set of information on variables that influence the selection into the treatment as well as the outcome variable, namely the subjective survival probability. We use these data to implement a propensity score matching approach and compare the self-employed with differing digitalization levels who received the grant versus those self-employed with the same digitalization levels, but were planning to apply for this support.

Our analysis delivers three important findings: First, overall, the emergency aid program had only a moderately positive effect of 6.5 percentage points on the subjective survival probability among all observed self-employed. However, the self-employed whose businesses were highly digitalized benefitted significantly more strongly from the state aid than the self-employed with less digitalized businesses. Effects are particularly strong among those who had digitalized their customer relations, as well as among those who digitalized their products and services, with an increase in the subjective survival probability of 14 percentage points in the former case and 11 percentage points in the latter. Second, these particularly strong positive effects among those self-employed who were running highly digitalized businesses only hold if the digitalization processes had happened *before* the crisis. Third, at the regional level, there is indicative evidence that the quality of the digital infrastructure - an important prerequisite for introducing and using digital technologies that is generally better in urban areas - supports the effectiveness of the emergency aid program in the same direction: effects seem to be stronger in urban areas with a high quality of digital infrastructure than in rural areas.

Increasing the confidence in being able to survive such a crisis is an important condition for self-employed to further believe in their own business and for their willingness to further invest in it. Therefore, we interpret increases in the confidence to survive such a shock of the pandemic as an increase in resilience. In that sense, our findings imply that having sufficiently digitalized their businesses ahead of the crisis was an important prerequisite for the self-employed in developing resilience to this kind of unforeseen economic shock. The digitalization of businesses enables them to react in a flexible way to changes in demand and disruptive events affecting their business processes. The provided financial support then seems a crucial complement to such investments, as it significantly increased the confidence of these self-employed to get through the crisis, even though these businesses had also suffered from the crisis. This psychological effect is important in the context of entrepreneurship, since the entrepreneurs' personal assessments of future prospects influence their efforts and decisions taken with respect to business development and, thus, business survival (Chadwick and Raver, 2020). Our analysis reveals that the confidence of self-employed persons whose ventures were

poorly digitalized did not increase despite financial support from the government. It shows that financial support from government alone is insufficient and cannot fully take effect in times of crises if, at the same time, there is a lack of the necessary capacity among the ventures (Simón-Moya et al., 2016) for exploiting the financial support in a sensible way or for developing plans for alternative scenarios under the circumstances of the crisis.

Of similar importance is the insight that the emergency aid program had no effect among those who invested into digitalizing their businesses during the crisis. It seems that only ventures that have developed long-term strategies to embed digital technologies into their business processes are able to face the crisis and remain confident. Short-term digital solutions, despite the financial support from the government, do not seem to inspire the necessary confidence to master the crisis.

Our analysis is not restricted to the effects of the support program at the individual level; it also looks into regional effects. Accordingly, our results referring to the regional perspective provide indicative evidence that a strong broadband infrastructure could support the effectiveness of an emergency aid program, thus influencing resilience not only at the individual but also at the regional level (Audretsch and Belitski, 2017). Still this part of the analysis needs to be supplemented with further research, but it shows that a strong digital infrastructure is a prerequisite for adopting and using digital technologies as well as for being able to connect to suppliers, customers, and other business partners.

From a more general point of view, our findings imply that it is important to consider the interplay between a support program and factors of heterogeneity that are connected to the treated individuals, in this case the level of digitalization of businesses. In this specific case, digital technologies do not just shape how self-employed engage with customers but also the effectiveness of policy instruments meant to support the very same self-employed. This is an important policy conclusion of our analysis for the design of future policy measures, when public policy aims to increase the resilience of self-employed during a crisis and to avoid deadweight losses or the financing of firms that have no real perspective ahead. Moreover, it becomes clear that developing resilience as an entrepreneur appears to be a long-term process and part of a more complex strategy in which digitalization represents an important component. Such investments will need to be well-prepared to unfold positive effects in times of unforeseen shocks and economic crises. In that sense, developing resilience strategies has become a key issue for entrepreneurs. Against this background, public programs targeting at the digitalization of small and medium-sized enterprises (SMEs) such as the German ‘go digital’ program might play an important role in supporting SMEs’ or self-employeds’ long-term digitalization and, thus, long-term resilience in times of crises. Designing such programs in a way that allows their proper evaluation with respect to SMEs realizing higher degrees of digitalization as well as their contribution to a better resilience is an important task for policymakers as well as for researchers. Developing a digitalization strategy and investing in digitalization remains, however, first and foremost the task of the self-employed.

Moreover, supporting the expansion of a strong digital infrastructure, especially in rural areas, is important if self-employed individuals should become able to digitalize their own products, services, and customer relations, thus improving their resilience in times of crises at the individual and regional levels. The important role of broadband infrastructure for economic growth is the subject of previous research, however, more evidence is needed on the regional contribution of broadband to businesses' resilience in times of crises.

Overall, we conclude that the program had strong positive effects on the confidence of the self-employed to survive the crisis, but only if they had digitalized their businesses, while it had no measurable impact on non-digitalized businesses. This points to potential cleansing effects among the self-employed in the sense that, thanks to this government support program, self-employed with digitalized businesses will have survived the crisis with higher probability than those who had not yet digitalized their businesses, even if also the latter ones had been financially supported. In that sense, the program, although costly, has been helpful to strengthen those entrepreneurs and self-employed who use digital technologies. Our results refer to the German economy, which is characterized by a large share of SMEs compared to other European countries. However, German SMEs have a relatively low level of digitalization compared to many other countries (European Commission, 2022). This implies that our results represent a kind of lower limit of the effects of an emergency aid program in such a context. Future research needs to follow-up on this and analyze the long-term impact of the pandemic, the government measures, and the digitalization strategies on firm survival.

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## Appendix

Table 7: Self-employed persons by region

Region	share inhabitants in German population	self-employed persons by region	
		Germany	Sample
<b>South</b>			
Baden-Württemberg	.13	.13	.10
Bavaria	.16	.17	.17
<b>West</b>			
North-Rhine Westphalia	.22	.19	.22
Hesse	.08	.08	.08
Saarland	.01	.01	.01
Rhineland Palatinate	.05	.05	.04
<b>North</b>			
Bremen	.01	.01	.01
Hamburg	.02	.03	.05
Lower Saxony	.10	.09	.08
Schleswig-Holstein	.04	.04	.03
<b>East</b>			
Mecklenburg-Western Pomerania	.02	.02	.01
Brandenburg	.03	.03	.03
Saxony	.05	.05	.05
Saxony-Anhalt	.03	.02	.01
Thuringia	.03	.03	.02
Berlin	.04	.07	.11
Sum	1.00	1.00	1.00

Source: Survey on self-employment during COVID-19 crisis in Germany - wave 2020 (doi:10.25652/diw\_data\_S0021.1), Destatis 2022, IfM Bonn 2019, own calculations.

Table 8: ATT for ventures with low digitalization level by value chain component (NN2 matching)

	pre-crisis low digitalization level in...		
	products / services	internal processes	customer relations / distribution channels
Dependent variable: self-assessment to remain self-employed within the next 12 months (yes/no)			
ATT	.013	.057	.020
SE	(.035)	(.031)	(.031)
p-value	.709	.072	.513
N total	3,346	1,973	2,820

Notes: Nearest neighbor matching estimator with two neighbors and replacement. Observations with perfect treatment probability were discarded. Robust standard errors were estimated following Abadie and Imbens (2016). Source: Survey on self-employment during COVID-19 crisis in Germany - wave 2020 (doi:10.25652/diw\_data\_S0021.1), own calculations.

Table 9: ATT for ventures with high digitalization level by value chain component (NN2 matching)

	pre-crisis high digitalization level in...		
	products / services	internal processes	customer relations / distribution channels
Dependent variable: self-assessment to remain self-employed within the next 12 months (yes/no)			
ATT	.088	.050	.142
SE	(.059)	(.027)	(.033)
p-value	.135	.066	.000
N total	1,958	2,978	2,015

Notes: Nearest neighbor matching estimator with two neighbors and replacement. Observations with perfect treatment probability were discarded. Robust standard errors were estimated following Abadie and Imbens (2016). Source: Survey on self-employment during COVID-19 crisis in Germany - wave 2020 (doi:10.25652/diw\_data\_S0021.1), own calculations.