COVID-19 and Human Capital: Cataclysm and Catalyzer
(The C4-Project)

The COVID-19 pandemic started out as a medical crisis that quickly turned into a recession as governments introduced measures that locked-down large parts of the economy. Even for firms not in lockdown, a steep decline in demand forced a large number of firms to make dramatic changes to how they invest, deploy, and manage their human capital. This raises the general question of how the pandemic impacts firms' human capital decisions, and the short- and long-term economic and labor market consequences this implies - both for firms and individuals. Independently of the crisis, firms were already (to varying extent) going through processes of digitalization. It seems reasonably clear that the pandemic will accelerate this digital transformation. It pushes a wide range of business activities online, some of which will lead to lasting changes in organizational- and consumer-behavior. The crisis thus encouraged firms to implement digital technologies earlier than anticipated, and it seems to have rewarded firms that were highly digitalized before it started. We therefore believe that to understand the economic- and labor market consequences of the COVID-19 pandemic, it is important to realize that human capital decisions following the crisis and the process of digital transformation are intertwined. The interplay between the crisis and the digital transformation is expected to have a dramatic impact on the labor market, and potentially on economic inequality.

0. Relevance to the call

The C4-Project is a response to the Research Council of Norway call for research on *Economic and "Labour-market Consequences of the COVID-19 Pandemic for Norwegian Business and Working Life"*. It will be executed by an **interdisciplinary research team** covering labor economics, strategy, sociology, and innovation and entrepreneurship research. The team has substantial expertise and experience from research on crises and recessions, specifically with respect to labor markets and human capital. The involvement of Virke (Enterprise Federation of Norway) and HK (The Norwegian Union of Commerce and Office Employees) assures that our project is relevant for firms and individuals. The C4-project will tackle the call in four main ways:

First, it examines **labor market consequences of the COVID-19 crisis**. We intend to study how firms make strategic decisions with respect to human capital (i.e. dismissal and retention of workers, reallocation of excess capacity in human capital, changes in staffing arrangements and work processes) in response to the crisis, and how different firm and industry characteristics interact to affect these decisions. This includes a particular emphasis on **the role digitalization plays** in these decisions, which is also specifically mentioned in the call. Second, it analyzes the consequences of firms' human capital decisions on individuals and their labor market outcomes, addressing the call's focus on **the negative consequences of the crisis distributed across individuals with different characteristics.** We will use data from Norwegian Labour and Welfare Administration (NAV) to **gather real-time data**. As the crisis unfolds NAV, a data provider for the project, will provide monthly data on labor market mobility, furloughing and layoffs, which we will integrate with other registry data to provide a high frequency picture of the changes occurring. Moreover, we have already started collecting survey data that will be linked to data from NAV and other registry data, and we intend to do repeated surveys throughout the crisis. Fifth, we will **evaluate government interventions and policies by linking them to these detailed and high frequency data**, allowing us to assess their influence on human capital decisions by firms and labor market outcomes for individuals. We will obtain external validity by carrying out comparative studies with data for other countries, also contributing to the **internationalization of the research agenda**. Specifically, the team has already established collaboration with a research group in Denmark gathering similar real-time data, and we are in dialogue with researchers in Sweden and the US about similar collaboration.

1. Excellence

1.1 State of the art, knowledge needs and project objectives

State of the art

Where in academia can the state of the art be found on these issues? A natural starting point would be to look at the academic fields that have dominated research on recessions: macroeconomics and finance. Macroeconomics (e.g. Aghion et al., 2012; Bernanke, 1983; Petersen & Strongin, 1996) tends to focus on aggregate effects downplaying the variation in micro behavior and micro outcomes we seek to understand. The

recession literature in finance (Campello, Giambona, Graham, & Harvey, 2010; Campello, Graham & Harvey, 2010) mainly emphasizes variation in capital structure and access to credit, and implications for investments in physical capital. Neither of these literatures offer a rich treatment of variation in (and implications for) human capital or digitalization during a recession, let alone how they interact.

In the fields of strategy and management, human capital does indeed have a prominent position. Here, researchers typically stress the importance of differences in knowledge stocks and organizational- and human capital for understanding firm behavior and firm performance (e.g. Barney, 1991; Dierickx & Cool, 1989; Coff, 1997). In the wake of the financial crisis, research in strategy and management also turned some attention to understanding responses and consequences of a recession. For example, why and when firms use excess capacity created in a recession to increase investments in training or other types of development work and when they respond with downsizing (Knudsen & Lien, 2015), the sensitivity of different types of knowledge investments to demand reductions and credit constraints (Knudsen & Lien, 2014, 2019), and how firms modify their business models in response to recessions (Saebi, Lien & Foss, 2018). However, recession related research in strategy and management has gradually come to a standstill as the financial crisis receded from view and topics related to digitalization caught the research attention.

The silver lining is that the increased focus on the impact of digital technology has produced a highly relevant literature on how human- and organizational capital interacts with digital technology, and how firms change and innovate their business models as a result (Chesbrough, 2010; Foss & Saebi, 2015, 2017). Yet, this literature is still largely unconnected to recessions and crises, since the present recession is the first time we can fully observe the interaction between human capital, digital technology, and business model innovation.

The human resource decisions firms make have immediate consequences for individuals, and for how and why these consequences vary across individuals. In labor economics, there is a strong focus on the role of human capital when firms and the economy as a whole adjusts to structural shocks and to business cycles. With respect to research on previous recessions negative effects on employment have been found to cause rising inequalities (e.g., Meyer & Sullivan 2013). The variation in the impact on individuals is partly due to their heterogeneous human capital characteristics, but human capital decisions by firms also plays an important but often unobserved role (Kroft et al. 2016).

Also within labor economics, the role of digital technology -- automation and artificial intelligence (AI) -- as a driver of inequalities has become pronounced and it is expected that these technologies will fundamentally change labor markets (Acemoglu & Restrepo, 2020). Adoption of new technologies such as robots – which is a pervasive trend also in Norway in both manufacturing and the service sector – is labor saving and skill-biased as there is an increased demand for more skilled or educated workers and with an increase in the skill premium (Katz & Murphy 1992; Autor, Katz, & Krueger, 1998), which creates inequalities on the labor market. At the same time, more skilled workers hired or retained in firms undergoing changes, may induce firms to upgrade their technology (Acemoglu (1998), Beaudry & Green (2003), and thus possibly contribute to the digitalization efforts of firms. The general idea is that with a sufficiently large inflow, human capital has a particular role in restructuring firms through this type of endogenous technological change. The same argument goes for establishing new firms or entrepreneurship of high-tech firms. In Hanlon (2015) and Carneiro, Lui, & Salvanes (2018) the role of human capital in technology adoption is analyzed using micro data. Similar to the field of strategy and management, the intersection of recession, human capital and technological change has not been studied explicitly, but here too, much of the foundations are present.

Knowledge needs

The economic effects of the COVID-19 pandemic became visible and dramatic when firms started making abrupt changes to their human capital stocks (e.g. dismissing workers) and their human capital management practices (e.g. altering staffing arrangements and work processes). How individuals are affected by a recession such as this one will as noted depend on the human capital decisions firms make. Currently, our understanding of what shapes human capital decisions during a recession, is limited. In particular, we do not have a good understanding of the weights and interaction effects between firm-, industry- and employee characteristics, and the interactions between these and the various government interventions. In other words, how different firms, in different industries react to specific government interventions, and which type of individuals are affected, in which way. To make significant progress we need to integrate the knowledge about the firm level (i.e. strategy and management) with knowledge about the level of individuals and labor markets (i.e. labor economics).

Given the prominent role of digitalization in this crisis we have the unique opportunity to investigate the impact of a recession on digitalization and the effects of different levels of digitalization as a moderator of the impact of the recession. Digitalization becomes a key firm characteristic that impacts how firms adjust, deploy, invest and manage their human capital. We currently know little about how highly digitalized firms respond differently from firms that are less digitalized, and how different aspects of digitalization influence firm responses. Given the uncontroversial assumption that most firms will over time become increasingly digitalized, understanding how different levels and aspects of digitalization affect how firms respond will provide a useful window to how firm responses to recessions might change in the future, as digitalization inevitably proceeds. Besides firm-level implications, we also need to understand the interaction between recessions and digitalization on the level of the individual, both as a driver of labor market inequalities and as an opportunity for knowledge upgrading and human capital investment in a period of low capacity utilization.

Due to the public health risk associated with the COVID-19 pandemic, the level and nature of government interventions is unprecedented. Not only in Norway, but in most other countries as well. Since these policy measures are to a considerable extent new, knowledge about their effects are limited, and understanding the impact of those interventions seems both necessary and valuable - both academically and practically. Studying the effects of government interventions is best done if data from Norway is compared and contrasted with data from other nations.

Finally, to make significant advances on all these issues, higher quality data is required. We need to be able to integrate data on characteristics of firms (e.g. size, age, financial resilience, strategies, digital technologies used, business models deployed, etc.) and industries, with data on the characteristics of individuals and government interventions in a common dataset to understand their interactions and relative effects. Moreover, we believe significant advances can be made if we can get more detailed data on the dynamics occurring *within* a recession. Usually recessions are studied retrospectively, using three time periods: before, during and after. In addition to hindsight bias, this also means that we cannot unpack the changes that occur *during* a recession as expectations change and firms respond to new information and new developments. This requires high frequency data collected during the crisis in real-time, and data on expectations that needs to be collected as the crisis unfolds.

Project objectives

The main objectives of the C4-Project are: (i) to inform firms and relevant government agencies on the impact of the COVID-19 crisis on human capital decisions, and the short and long-term economic and labor market consequence this entails; and (ii) to move the research frontier on the economic and labor market consequences of recessions, in particular with respect to the intersection between human capital and digital technology. To achieve this, we have formulated the following sub goals:

1. Build a multilevel database and research design that allows us to investigate human capital decisions by firms, and the labor market consequences for individuals, over the course of the recession.

2. Deliver high quality interdisciplinary research based on this database.

3. Set up and execute an (online) communication strategy to effectively disseminate our research findings to the relevant audiences.

1.2 Novelty and ambition

The C4-Project is novel along several dimensions. First, it opens new lines of inquiry regarding the dynamics of recessions. The current recession is different from previous ones in at least two respects. One is related to the joint presence of a recession and a digital transformation process. Existing research on recessions and human capital has not yet systematically asked what the roles of digitalization and digital business models are, in a recession. The other is that the abrupt and acute nature of the crisis has stimulated government interventions that are unprecedented and therefore poorly understood. We will pursue these questions with all the resources and data our project can bring to bear.

Second, we will build a unique database where we integrate an unprecedented wide range of data covering detailed data on individuals, firms and industries, linked with survey data collected during the recession (rather than after it). This database will provide a uniquely high pixeled picture of the effects of firm decisions and government interventions. Our data will also be unique in another respect. We will combine high frequency data from NAV with expectation data which we are collecting through four rounds of surveys. This will give

us an unprecedented ability to study the dynamics of the recession as it unfolds, and to understand the changes and dynamics occurring *during* the recession. We will also be able to do comparative work on the effects of the policies implemented here in Norway, compared to Denmark (and potentially Sweden and the US).

Third, to reach our objectives we require a broader perspective on human capital and recessions than previous research. We are unusually broad in terms of the composition of the research group and the theoretical lenses this group brings to the table (cfr 1.3). We expect this multidisciplinarity to add novelty to our research approach and to our research output.

1.3 Research questions and hypotheses, theoretical approach and methodology

Our research questions can be sorted under two overarching themes. The first asks how and why *firms* change their human capital - and knowledge stocks - and the management of those stocks - in response to the recession, and furthermore: how this changes over the course of the recession. Our second question turns to the level of *individuals* and labor markets, and asks how the consequences of the recession are distributed across individuals, how this changes as the recession evolves, and the implications this will have for inequality of labor market outcomes. The effects of digitalization and the effects of government interventions permeate both these overarching themes.

Theme 1: Firm level effects of the COVID-19 recession

Firms make a range of human capital decisions in response to a crisis (Lien and Knudsen, 2010; Knudsen, 2014). One such decision revolves around dismissal or retention of employees (Knudsen & Lien, 2015). When demand decreases, or disappears entirely, excess capacity results. Firms are then confronted with the decision about *whether*, and if so, *how many* employees will be entirely or partially laid off/furloughed, or kept in the firm. This leads to a natural follow up question about *which* employees the firm keeps, and which it does not? Among those employees that are dismissed, which employees are laid off first and which are laid off last? Similarly when firms start rehiring or bringing people back from furlough, who are brought back, and in which order? A related question is how firms adjust their staffing arrangements in terms of the balance between internal employees and various types of external work arrangements. In addressing these questions we also investigate whether there are significant gender differences, both with respect to those making the decisions and those impacted by them.

A second key aspect is how the employees that are kept in the firm are managed. If employees have excess capacity in their normal functions, are they reallocated to training, to development work, to innovation, to new tasks created in response to the recession, or perhaps to other tasks normally performed by those the firm did not keep? How do firms change their HRM-practices to keep their workforce motivated and coordinated during the recession?

Third, as highlighted previously, the COVID-19 crisis cannot be treated separately from the ongoing digital transformation of firms. Some industries and some firms relied more on digital technology than others going into the crisis. This has had consequences for both the impact of and the responses to the crisis, but there is no systematic knowledge about the size and composition of these effects. Others were forced to adopt digital technologies and digital business models sooner and perhaps in a different way than originally intended. Some firms succeeded with this accelerated digitalization, others failed. Again, we have little systematic knowledge about these patterns and their underlying causes. To the best of our knowledge neither how digitalization affects responses to a recession, nor how a recession affects digitalization has ever been systematically researched before. Our data will allow us to do so.

Finally, a crisis is inherently a dynamic phenomenon. Firms continuously adjust their human capital decisions over the course of a recession. These adjustments take place as a result of changes in expectations following new developments and new information. Previous research on recessions has not been able to capture much of this dynamic, mainly due to insufficient data. Our access to high frequency data on the human capital decisions firms make, as well as to expectation data collected at several points during the crisis, we will be able to observe and study the dynamics of adjustments and changes in expectations as the recession evolves.

Theme 2: Labor market implications of the COVID-19 pandemic

The decisions firms make in response to the recession have consequences for how individuals with various characteristics are impacted by the recession. Some individuals, in some firms, in some industries, in some local labor markets, will be more vulnerable than others. Some will be entirely or partially pushed out of the

labor market during the recession, some will move from one job to another - potentially at a lower wage, or to a lower skilled job. For some individuals the labor market consequences will be more enduring than for others. Government interventions will interact with industry, firm and individual characteristics to determine the distribution of labor market consequences across individuals. It is important to stress here that when we talk about industry, firm and employee characteristics, we include digital maturity and digital literacy as a key characteristic at all three levels.

In this theme, through the use of our unique database, we want to map not only how the consequences for individuals vary, but also how this changes as the recession unfolds. This means that the effects of the crisis on economic inequality and labor market participation can be better assessed. Furthermore, in addressing these questions, we actively consider the heterogeneous characteristics of the firms and industries these individuals are linked to. One specific focus, which previous research has omitted, is to investigate explicitly the role of real-time expectations about the duration and impact of the recession. This opens up an unexplored line of inquiry linking firm expectations and labor market dynamics. It is also important to note that government interventions to a large part work by influencing the expectations and beliefs of decision makers in the economy. This mediating role of expectations is usually abstracted away.

Theoretical background

The researchers that will carry out the project cover a range of different fields and theoretical backgrounds that are all complementary when it comes to understanding the impact of the COVID-19 crisis on human capital decisions of firms, and the short and long-term economic and labor market consequences. The academic fields and theoretical background represented in the C4-Project are labor economics, strategy, innovation and entrepreneurship, human resource management, and sociology. The diversity of the research group and its theoretical perspectives will help ensure that we are able to see the phenomena we are studying from several perspectives, that we can recognize and identify more mechanisms at play during the recession, and that we have a greater arsenal of methodologies to exploit our data. This also means that we will not single out one theoretical perspective as the dominant one, but instead we will actively and consciously seek to be theoretically eclectic, and work at the intersection of all the approaches represented in our research team.

Methodology

A particular strength of the C4-Project is the data we will be able to bring to bear on our research questions, making data and methodology one of the key pillars of the project. Data will be collected in real time, covering the whole Norwegian economy, thereby providing a more detailed and accurate picture of how the recession affects Norwegian firms and Norwegian labor markets.

One key datasource will be registry data. As mentioned, NAV will act as a data provider to the project and will be able to provide us with monthly updated data (delivered at regular intervals) on employment relationships, unemployment and furloughing. This means we will have detailed data on all employee mobility both across firms, and in and out of the labor market. This covers the entire population of Norway. Furthermore, we will be able to link this with accounting data, providing us the performance history of each firm and each industry in the Norwegian economy. Registry data will also be used to collect data on the characteristics of each individual. This includes their education background, their accumulated work experience, the roles they have had in different jobs, their wage level, and more. This means that we can provide good estimates of an employees' human capital, even controlling for education, industry and firm effects.

Another key source is survey data. We have already completed the first wave of a survey to collect data on how over 1000 Norwegian firms are affected, how they have responded, and what their expectations are about how deep and long lasting the crisis will be. In the survey we collect information not available from registry data, such as the strategies, (digital)business models and management practices of the firm, and changes firms make in these. We also ask to what extent firms believe they will benefit from various government support schemes. Project partner Virke, which is an enterprise federation in Norway, has since the introduction of government interventions collected data among members with regular intervals, we see these two data sources as highly complementary. All this information will be linked with the registry data. This allows us to have the retrospective data we need to assess pre-crisis characteristics and performance, but also the ability to investigate the (human capital) changes these firms went through, as well as trace performance effects.

Besides utilizing data already collected, we schedule a series of four follow up surveys that will be conducted with regular intervals on a representative sample of Norwegian firms. Given the way we distributed our existing survey it is possible to return to respondents in the first wave, allowing us to establish a panel. Through

these surveys we will observe changes, but also to include new questions that will inevitably arise as we learn more during the course of the project. In the design and distribution of the surveys we will collaborate closely with our project partners, Virke and HK (the Norwegian Union of Commerce and Office Employees). These organizations represent both firms (23.000 members) and workers (75.000 members) on both sides of the employment relation in similar industries. We have also agreed to collaborate with researchers from Aarhus University, who are collecting similar data in Denmark, and we are in dialogue with researchers in the US and Sweden who work on similar issues. This enables us to make international comparisons of how government measures have affected firm's human capital decisions and national labor markets.

The sum of all this is that we believe we will have an unprecedented dataset in several respects. We will get data on how expectations form and change, and how these expectations shape decision making in firms. We will be able to track mobility and exits from the labor market at a very high frequency and granular level, which means we can capture much more of the dynamics of the crisis than researchers before us.

Risks

The C4-Project's strength lies in its data collection, but here lies also the greatest risk. For empirical rigor, we rely on access to a sufficiently large and representative sample of relevant respondents to our surveys. In times of recession, both access and response rates are under pressure.

We manage this risk in several ways. First, we have already started to collect data and secured access to additional data sources, with NAV as data provider, conditional on getting funding. This means we already have a foundation on which to conduct our research. Second, the involvement of Virke will assist us with providing additional access to data during the project period, including access to relevant respondents to conduct our follow up surveys. To secure high response rates, we will also employ survey agencies to provide additional support and access. Third, the organization of the project (see Section 3.2) includes a dedicated work package on data collection, coordinating the data collection and data management across all researchers involved in the project.

Ethical issues

The main ethical issue in this project revolves around storage and protection of data, which will be supported by NHH's infrastructure for secure storage of data, and will be made available through the institutional repository. A data management plan will be prepared at the beginning of the project. The registry data will be prepared and administered in cooperation with the Norwegian public authorities, who must comply with the GDPR regulations. The research group has considerable experience working with large, sensitive datasets of this kind.

Gender issues

The C4-Project will actively examine gender effects. Understanding whether there are gender effects in the human capital decisions firms make, depending on the gender distribution of managers and owners, is an obvious line of inquiry, and one that is easily pursued with our data. Similarly, our data is also very well suited to examine whether there are gender effects in terms of who bears which consequences of the human capital decisions firms make. In our theme on the effects of the recession on individuals and labor markets, we have a research question dedicated to inequality, which naturally incorporates inequality issues across genders. The research team consists of 4 females and 5 males.

2. Impact

2.1 Potential impact of the proposed research

Research in strategy, management and labor economics has much to contribute to our understanding of the impact of macroeconomic crises on firms and labor markets, and the role of digital technology in shaping this impact. As mentioned in Section 1.1, these fields have yet to fully realize this potential. One important constraining factor is lack of sufficiently accurate and detailed data, and the ability to integrate data on firms, industries and individuals in a common dataset. The database we are going to establish in this project will be unprecedented in terms of overcoming these constraints, allowing us to address research questions previously out of reach for empirical research. It will also enable us to revisit previously studied questions with new precision and confidence. Consequently, the research output from the project will leave a lasting mark on research on recessions in these fields, while contributing to the larger literature on the impact of recessions and crises.

An important aspect of overcoming data constraints is that the real time nature of our data will provide us with a better understanding, not only of the dynamics and consequences of decisions at the firm level, but also of the effects of specific interventions by policymakers. Our collaboration with international research groups will further strengthen this ability.

Overall, our research output will inform managers about how to make better human capital decisions that will help firms survive and recover from this and future crises. Issues related to digitalization deserve to be highlighted specially. How managers integrate digitalization in work processes and business models will affect both how they deal with the crisis itself, and their performance in its aftermath. Since little systematic knowledge exists about this, we think this is likely to be of great interest to decision makers in firms and government alike.

The C4-Project also aligns with the Sustainable Development Goals (SDG). Knowledge about human capital implications of the crisis provides valuable insights in developing road maps directly addressing SDG8.2 in achieving a higher level of productivity through technological upgrading and innovation. In addition we explicitly address issues related to (gender) inequality, both the extent to which we observe changes in inequality, but also to increase our understanding of why such inequality effects arise. This will provide insights into how inequality can be reduced, therefore directly addressing: SDG5.1 ending all forms of discrimation against women; SDG5.5 ensuring women's full and effective participation and equal opportunities; SDG5.b on enhancing technology to promote the empowerment of women; SDG10.3 on ensuring equal opportunities and reducing inequalities of outcomes; and SDG10.4 in the adoption of policies to achieve greater equality. Finally, the crisis has affected the way firms deploy digital technologies, thereby changing the way we work but also providing access to goods and services. In our project we will deliver knowledge about how the role of, and adjustment to, digital work processes and digital business models, affects human capital decisions made by firms; consequently, our project also addresses SDG9.5 by enhancing scientific research and upgrading the technological capabilities of industrial sectors in all countries.

2.2 Measures for communication and exploitation

The C4-project will produce data and multidisciplinary research results that will be communicated to different audiences all with their specific communication strategy. An overview of these strategies is provided below.

The academic audience. The results of the C4-project are expected to produce at least 15 scientific papers to be published in ABS-ranked scientific journals, such as SMJ, AMJ, AER and Labor Economics. We will also disseminate the results via presentations at academic conferences, seminars, and workshops in Norway, and abroad. We expect that many future academic events will revolve around the short- and long-term implications of the COVID-19 pandemic and its aftermath, giving us additional opportunities to present our findings. The COVID-19 crisis will also feature in research, teaching and supervision initiatives that target students - on all levels, i.e. bachelor, master and PhD. We expect these activities to continue for many years after the project itself has ended.

The business audience. Our research will inform business leaders on issues related to strategy, organization and business model design, with respect to the implications of the COVID-19 crisis, and the actions managers can take to address challenges and grasp opportunities. We will target this audience through a range of different channels. First, we have access to a large number of firms through our collaboration with Virke, who can communicate research results directly to their 23.000 member firms. Second, NHH has established the Digital Transformation HUB which has as its main objectives to act as an information and experience exchange platform related to digitalization. Being a platform, it is both a channel for dissemination of research, but also an arena where researchers in the project can receive relevant information and feedback from business leaders that can inform and influence our COVID-19 crisis research agenda. We will actively participate in and use the Digital Transformation HUB. Third, our research team is actively engaged in executive education at NHH, which is a well-established dissemination platform for research conducted at NHH. We intend to establish an online project site, and a digital communication strategy where we disseminate findings from our online survey and other research findings, here we build on the expertise at FAIR. This online platform and digital communication strategy will also target the other audiences we have identified. Finally, we have agreed with the practitioner-oriented journal Magma to produce a special issue on the findings of the C4-Project (first issue of 2022). This is the house journal of Econa, the interest organization/labor union for graduates in economics and business administration in Norway. This journal is distributed among all its 24.000 members.

The policy audience. Labor market interventions by governments have played a central role in guiding the economy through the early stages of the COVID-19 crisis. Given that the C4-Project focuses on the role these interventions have played, we will produce research results that can be exploited by policy makers while formulating or adjusting policy for this recession, as well as for future ones. We will target this audience by the publication of policy briefs summarizing the findings as well as conferences and workshops. To this end we will use our extensive network of contacts in the Ministry of Labor, Industry, and Finance and direct a substantial part of our outreach activities towards this audience group (5-10 talks). With the expertise and political power of our main collaborators (Virke and HK), we add additional weight to the dissemination towards this audience.

The general public. The implications of the COVID-19 pandemic will be a general interest topic for a larger audience, which means that the general public is also an important target audience for the C4-Project. This target group will be addressed in layman language to ensure that relevant information is more easily disseminated. To do so efficiently, we intend to make active use of social media and our partners to direct attention to the topics and our easy access publications of findings. In addition, researchers and collaborators involved in the project plan to give interviews explaining the impact of the COVID-19 crisis on Norwegian labor markets and Norwegian industry in leading national newspapers. We aim for at least 12 such articles during the project period. Contributors to the C4-project have featured on a regular basis in these outlets. Furthermore, these outlets have already shown a strong interest in running COVID-19-related research because of its relevance for business and society at large. Due to international recognition of how Scandinavian countries, and Norway in particular, have dealt with the COVID-19 crisis, there should also be opportunities for significant international exposure.

3. Implementation

3.1 Project manager and project group

Project manager. Professor Lasse B. Lien, professor of strategy at NHH, will lead and coordinate the project. He has focused on strategic human capital and digitalization. He was previously project leader on NHH's project *"Crisis, Restructuring and Growth"* which studied the effects of the financial crisis of 2008-09. Lien led the group focusing on firm level responses and has since co-authored a number of papers on human capital and knowledge investments in recessions. Lien is also a principal investigator in NHHs upcoming research initiative on digitalization (DIG), and leader of NHH's research group on strategy, organization and performance (S T O P).

Project Team. Kjell G. Salvanes is a professor of labor economics at NHH. He is a deputy director of FAIR and his research output is an important cornerstone for empirical research in combining Norwegian registry data and quasi-experimental identification strategies. On a day-to-day basis the project will be co-chaired between Lien and Salvanes. In addition to Lien and Salvanes, the C4-Project consists of an interdisciplinary group of researchers from NHH and representatives from our collaborators. **Aline Bütikofer** is a Professor at the Department of Economics at NHH. She has proven expertise in the use of state-of-the art empirical methods in applied economics and furthered the knowledge on (gender) inequality and the consequences of Norwegian educational policy. **Sissel Jensen** is an Associate Professor at NHH and a faculty member at FAIR. She has contributed to a growing literature on the gender wage and on how policy changes affect labor market outcomes for women. **Eirik S. Knudsen** is an associate professor in Strategy at NHH. He wrote his PhD, "Firms in Recession", as part of the "Crisis, Restructuring and Growth" project. Knudsen has (co-)authored several papers on human capital and knowledge in recessions. He is part of NHH's upcoming research initiative DIG, and a co-founder of the research group S T O P at NHH. **Karen M. Olsen** is professor at NHH with special interests in Human Resource Management and employment relations. Her background is in sociology focusing on employment relations, non-standard work arrangements and job quality. **Tina Saebi** is an associate professor with a focus on digitalization and business model innovation and coordinates activities on digital business models in the upcoming DIG research center at NHH. **Bram Timmermans** is professor at NHH. His research focuses on the role of human capital (stocks and flows) in innovation, entrepreneurship and regional development. Relying extensively on the use of register- and survey-data. He is affiliated with the S T O P research group and the upcoming research initiative DIG. **Alexander Willén** is an assistant professor at NHH and has worked extensively on understanding the consequences of labor market shocks and education policies. Table 1 provides an overview on the professional expertise of the project members relevant to the C4-Project.

Table 1: Professional expertise of the C4-Project members

Team member	Labor Economics	Strategy and management	Recessions	Human Capital	Digitalization	Inequality
Bütikofer	✓			✓		✓
Jensen	✓				✓	✓
Knudsen		✓			✓	
Lien		✓	✓			
Olsen		✓		✓		✓
Saebi		✓			✓	
Salvanes	✓		✓	✓		
Timmermans		✓				
Willén	✓					✓

Our **partners**, Virke and HK will be actively involved in our data collection, research and dissemination activities. Virke will be particularly active in assisting us with survey data, while HK will provide us with additional employee-related insights in developing our survey. Both Virke and HK will help secure that the research project covers questions that are practically relevant. Virke is particularly close to the world of affected firms, and HK is particularly close to the world of affected individuals. Both Virke and HK have research and analysis units and staff that will be able to engage and challenge NHH faculty on research-related topics. Last but not least, Virke and HK both have extensive networks and they are central and visible actors in Norwegian society. They will therefore be important assets for our research dissemination activities.

International partners. Faculty at FAIR and DIG have an extensive network of international researchers. This opens the possibility to do comparative work. Currently, we have established a relationship with Aarhus University, specifically Professor Lars Frederiksen, who just received a research grant from the Danish Industry Foundation to investigate the implications of the COVID-19 crisis. Their project investigates issues comparable to ours. We expect that we will be able to extend our international collaboration network beyond Denmark during the course of the project, not least because the unique dataset we plan to establish will make us attractive research partners.

3.2 Project organisation and management

The C4-Project is structured in 4 work packages, and its daily coordination and implementation will be led by the project manager in close collaboration with Salvanes. Table I details the content of the work packages (WP), the milestones and deliverables associated with each, the starting date and completion date for all deliverables. Note that the academic output specified is in the form of finished working papers. The reason is that the speed (or lack thereof) of publication processes in top journals makes it impossible to deliver accepted publications in a two-year project.

Table 1: Work Packages and milestones/deliverables

Work Package/milestone	Start		Completion	
	From		To	
WP$_1$: Data collection and methods				
WP$_1$/M$_1$: Establish integrated registry and survey database (v1)	2020	4	2021	1
WP$_1$/M$_2$: Conduct 2 new surveys (#1-2) and integrate with registry data	2020	4	2021	2
WP$_1$/M$_3$: Update and extend registry database (v2)	2021	4	2022	1
WP$_1$/M$_4$: Conduct 2 new surveys (#3-4) and integrate with registry data	2021	3	2022	2
WP$_2$: Firm level effects				
WP$_2$/M$_1$: Complete 3 academic working papers on firm responses	2020	4	2021	2
WP$_2$/M$_2$: Complete 1 popularized papers on firm responses	2020	4	2021	2
WP$_2$/M$_3$: Complete 5 academic working papers on firm response	2021	2	2022	3
WP$_2$/M$_4$: Complete 3 popularized papers on firm responses	2021	2	2022	3

WP$_3$: Labor market implications				
WP$_3$/M$_1$: Complete 2 academic working papers on labor market implications	2020	4	2021	2
WP$_3$/M$_2$: Complete 1 popularized papers on labor market implications	2020	4	2021	2
WP$_3$/M$_3$: Complete 5 academic working papers on on labor market implications	2021	2	2022	3
WP$_3$/M$_4$: Complete 2 popularized papers on labor market implications	2021	2	2022	3
WP$_4$: Outreach				
WP$_4$/M$_1$: Establish C4 dissemination website	2020	4	2020	4
WP$_4$/M$_2$: Media appearances and interviews, minimum 6	2020	4	2021	3
WP$_4$/M$_3$: Produce special issue of Magma (poular journal)	2021	3	2022	1
WP$_4$/M$_4$: Media appearances and interviews, minimum 6	2021	3	2022	3
WP$_4$/M5 : Talks to business and policy audiences, minimum 12	2020	4	2022	3

Research infrastructure and other resources

The C4-Project will be located at NHH, embedded in two large research center initiatives at NHH; i.e. FAIR and DIG. The relation to these centers will provide access to additional research infrastructure, like administrative support and access to physical facilities that allow for meetings, seminars and workshops for disseminating our research results. Both centers have a well-developed communication strategy, including staff specialized in social media outreach. We will actively draw on these resources to support outreach in this project. The project will also be able to draw on the expertise of faculty from these research centers, as well as hiring research assistants to support data collection, data management and other research activities.

Critical research infrastructure will be associated with collecting, storing and securing the data. Such infrastructure is currently in place for other projects at NHH. A data protection officer will assist us in making sure all legal requirements are met, and we have an IT staff that has collaborated extensively with data protection agencies to set up secure data servers.

Allocation of responsibility among project members

The project members are each assigned responsibility for at least one area of focus in the project. To secure interdisciplinarity, project members are expected and encouraged to contribute to multiple work packages, and to collaborate on different tasks to exploit the complementarity that exists in the team. Timmermans and Willén, based on their experience in the use of survey and registry data, will take the lead on WP$_1$ actively involving the other project members in coordinating data collection. Based on expertise on firm level human capital deployment and Knudsen and Lien will take the lead on this part of WP$_2$. With her expertise in HRM, Olsen takes the lead on the HRM-side of WP$_2$, while Saebi oversees the digitalization and business model aspects of WP$_2$. Bütikofer with her general labor economics background will have responsibility for the general labor market implications in WP$_3$, while Jensen, based on her expertise in labor markets and inequality will oversee our work on inequality. Salvanes, with his expertise in restructuring combined with the effects of digitalization on labor markets takes the lead on this part of WP$_3$. Knudsen and Lien will take responsibility on the outreach activities in WP$_4$.

Virke and HK, in particular their representatives in the project, have expertise in data collection, outreach *and* research. To assure relevance, these project members are involved in all work packages, but where HK will be more heavily involved with WP$_3$, while Virke's expertise is more closely connected to WP$_2$. Our international partners will join us for comparative research efforts in all work packages we have overlapping interests and data, as well as provide a forum for discussion and exchange of experiences related to our surveys.

Organization and management structure

The project leader, Lien together with Salvanes will constitute the management team of the project. This team will receive administrative support from Irene Haukås Moe, who has considerable experience running RCN projects. The members of the management team have offices in the same building, which allows for regular monthly meetings to coordinate activities in the project, as well as continuous informal meetings and collaboration on a day-to-day basis. Indeed, the whole research group has this collocation advantage. All coordinators who are assigned specific tasks will be actively involved in research in their work packages, while

also stimulating and participating in research across the different WPs and tasks to capture the strength in the interdisciplinary background of the project members.

The partners in the C4-Project, Virke and HK, will be participating actively in the WPs and the underlying tasks, by helping us formulate the specific research questions in the different work packages, by contributing to data collection during the project, and dissemination of findings as these are produced. Through this involvement, we ensure that the research is relevant for stakeholders and users, and can be of use to the organizations and labor market institutions these partners represent, and also that the research output reaches important audiences.

References

Acemoglu, D., & Restrepo, P. (2020). Robots and jobs: Evidence from US labor markets. J*ournal of Political Economy*, 128(6), 000-000.

Acemoglu, D. (1998). Why do new technologies complement skills? Directed technical change and wage inequality. *The Quarterly Journal of Economics*, 113(4), 1055-1089.

Aghion, P., Askenazy, P., Berman, N., Cette, G., & Eymard, L. (2012). Credit constraints and the cyclicality of R&D investment: Evidence from France. Journal of the European Economic Association, 10(5), 1001-1024.

Autor, D. H., Katz, L. F., & Krueger, A. B. (1998). Computing inequality: have computers changed the labor market?. *The Quarterly journal of economics*, 113(4), 1169-1213.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of management*, *17*(1), 99-120.

Beaudry, P., & Green, D. A. (2003). Wages and employment in the United States and Germany: What explains the differences?. *American Economic Review*, 93(3), 573-602.

Bernanke, B. S. (1983). Non-monetary effects of the financial crisis in the propagation of the Great Depression (No. w1054). National Bureau of Economic Research.

Campello, M., Giambona, E., Graham, J. R., & Campbell, R. (2010).

Campello, M., Graham, J. R., & Harvey, C. R. (2010). The real effects of financial constraints: Evidence from a financial crisis. *Journal of Financial Economics*, 97(3), 470-487.

Carneiro, P. M., Liu, K., & Salvanes, K. G. (2018). The supply of skill and endogenous technical change: evidence from a college expansion reform. *NHH Dept. of Economics Discussion Paper*, (16).

Chesbrough, H. (2010). Business model innovation: opportunities and barriers. *Long range planning*, *43*(2-3), 354-363.

Coff, R. W. (1997). Human assets and management dilemmas: Coping with hazards on the road to resource-based theory. *Academy of Management Review*, 22(2), 374-402.

Dierickx, I., & Cool, K. (1989). Asset stock accumulation and sustainability of competitive advantage. M*anagement Science*, 35(12), 1504-1511.

Foss, N. J., & Saebi, T. (Eds.). (2015). *Business model innovation: The organizational dimension*. OUP Oxford.

Foss, N. J., & Saebi, T. (2018). Business models and business model innovation: Between wicked and paradigmatic problems. *Long Range Planning*, 51(1), 9-2

Hanlon, W. W. (2015). Necessity is the mother of invention: Input supplies and Directed Technical Change. *Econometrica*, 83(1), 67-100.

Katz, L. F., & Murphy, K. M. (1992). Changes in relative wages, 1963–1987: supply and demand factors. *The Quarterly Journal of Economics*, 107(1), 35-78.

Knudsen, E. S., & Lien, L. B. (2014). Investments in recessions. *Advances in Strategic Management*, 31, 3-36.

Knudsen, E. S., & Lien, L. B. (2015). Hire, fire, or train: Innovation and human capital responses to recessions. *Strategic Entrepreneurship Journal*, 9(4), 313-330.

Knudsen, E. S., & Lien, L. B. (2019). Hitting the gas or the brake? Recessions and firms' knowledge investments. *Managerial and Decision Economics*, 40(8), 1000-1015.

Kroft, K., Lange, F., Notowidigdo, M. J., & Katz, L. F. (2016). Long-term unemployment and the Great Recession: the role of composition, duration dependence, and nonparticipation. *Journal of Labor Economics*, 34(S1), S7-S54.

Meyer, B. D., & Sullivan, J. X. (2013). Consumption and income inequality and the great recession. *American Economic Review*, 103(3), 178-83.

Petersen, B., & Strongin, S. (1996). Why are some industries more cyclical than others?. *Journal of Business & Economic Statistics*, 14(2), 189-198.

Saebi, T., Lien, L., & Foss, N. J. (2017). What drives business model adaptation? The impact of opportunities, threats and strategic orientation. *Long Range Planning*, 50(5), 567-581.