



CREATIVE DISRUPTION - TECHNOLOGICAL INNOVATION, LABOUR DEMAND AND THE PANDEMIC

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Economic crises affect technology and labour demand

- Economic crises can induce aggregate economic growth through creative destruction in which older, less productive arrangements and resources is freed to be available for new productive innovations (Schumpeter, 1942).
 - Recessions engender innovations:
 - i) opportunity costs of reallocation is low (Caballero and Hammour, 1996),
 - ii) productivity growth is costly in terms of current production (Aghion and Saint-Paul, 1998),
 - iii) marginal value of time lower due to lower congestion costs (Hall, 2009),
 - Recessions might strongly magnify and reinforce ongoing processes (Herschbein and Kahn, 2018; Jainovic and Siu, 2020):
 - The great depression accelerated shift of innovation into larger firms (Babina et al., 2021)
 - The great recession accelerated routine-biased tech change (Herschbein and Kahn, 2018)

Firm productivity distribution and tech implementation

- Creative destruction gives rise to a productivity distribution across firms (Klette and Kortum, 2004; Aghion and Howitt, 1992; Moene and Wallerstein, 1997)
 - Frictions or increasing marginal innovation- or adoption-costs needed, sufficient to curtail the new technology from immediately taking over the whole market (Klette and Kortum, 2004)
- Widening productivity distribution within industry (Barth et al, 2014; Bryson et al, 2014), due to suspected technological change (Acemoglu and Autor, 2011)
- Whether and how firms adopt new technologies depends, at the micro level, to a large extent, on firms' profit maximising strategies:
 - Uncertainty (Bloom et al., 2007; Christiano et al, 2014)
 - Available funding, external/internal, provided by imperfect capital markets (Stein, 2003; Fee et al., 2009).
 - Firm characteristics: union density (Barth et al., 2020) and local bargaining (Bryson and Dale-Olsen, 2021).

Firm innovations, labour demand and the pandemic

- February/March-2020: the world was hit by an unanticipated health shock: the COVID19-pandemic.
 - Social distancing, (temp) closed businesses, supply chain crisis
- Very limited evidence on how such a shock affect technology innovations and labour demand:
 - small-scale evidence on less than 400/600 firms (UK/US): accelerated adoption, primarily digital tech (Riom and Valera, 2020) and low flex firm increasingly relying on automation (Barry et al., 2021).
 - Current processes involve automation/digitalisation, affecting skill groups adversely (Acemoglu and Restrepo, 2017, 2020; Arntz et al., 2020; Dauth et al., 2021)
 - Contributions at this conference!

Our paper answer four simple questions:

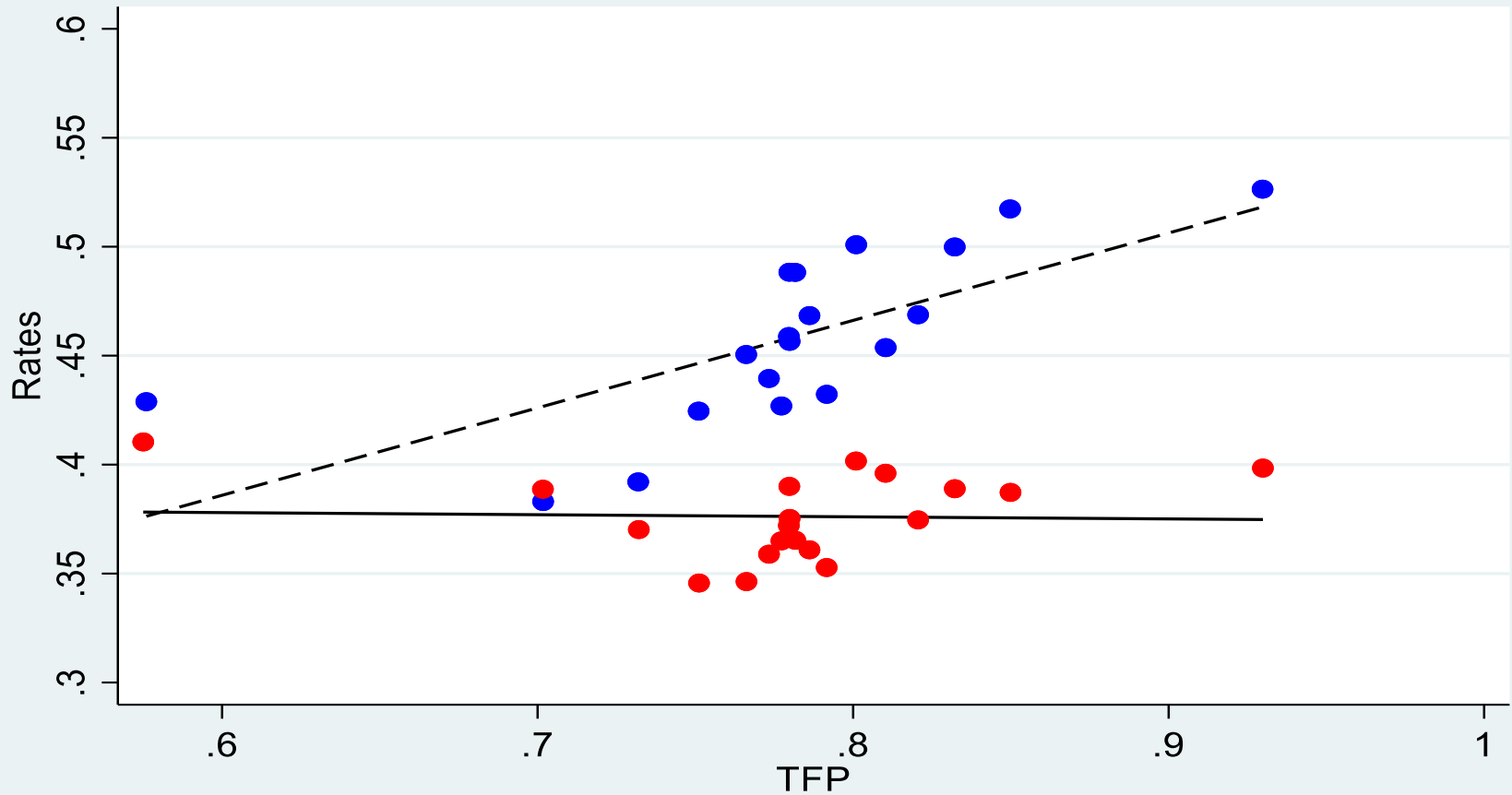
- 1) How did a shock like the pandemic affect firms' innovations?
- 2) How is this related to previous barriers to innovation?
- 3) How did these innovations affect their demand for skills?
- 4) Do workers benefit from these innovations?

Findings:

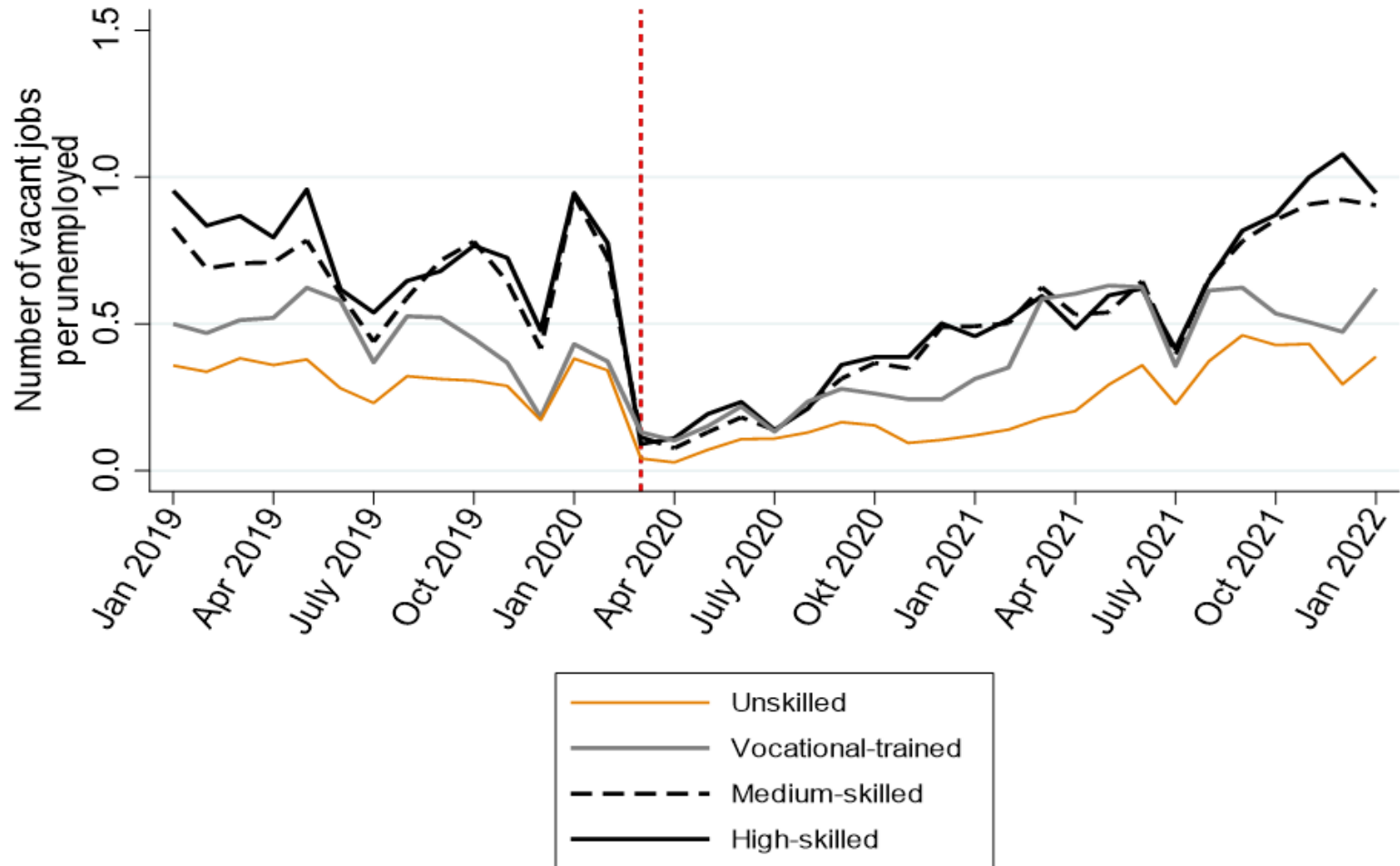
Firms respond by not only postponing investments, but also introducing new technologies

- More productive firms innovated, less productive firms postponed
- Most innovations were permanent, not due to acceleration of existing plans (but these were the most productive) = the pandemic yields long-term influence in directions unanticipated pre-pandemic
- The new technologies are associated with increased labour demand for skilled workers, and reduced demand for unskilled workers, particularly for the more productive firms.
- The pandemic acts as an accelerator!

Introduction of new tech and postponement of tech investments: TFP



Labour demand and the Pandemic



Findings:

- Firms respond by not only postponing investments, but also introducing new technologies
- More productive firms innovated, less productive firms postponed
- Most innovations were permanent, but not planned = the pandemic yields long-term influence in directions unanticipated pre-pandemic
- The new technologies are associated with increased labour demand for skilled workers, and reduced demand for unskilled workers, particularly for the more productive firms.
- Skilled workers benefit from the introduction of new tech by higher log hourly wage growth, un-/low-skilled not.
- The pandemic acts as an accelerator enlarging inequality!

Data

- Digitalisation, organisation and technology 2020 (DoT2020)
 - Questionnaire survey on Norwegian private sector firms with more than 10 employees.
 - 30% sample of the firm population, response rate 70%
 - Nearly 7000 respondents
 - Linkable to administrative microdata on workers and firms
- Statistics Norway's administrative register data (2000-2022)
 - Tax Authorities and Social Services information on individuals/jobs
 - Accounting registers, workplace and enterprise registers
- Measure 2019 TFP-productivity using ACF-approach (Cobb-Douglas production function based on 2005-19-data)

(Ackerberg et al , 2015; Gandi et al, 2020)

Introduction of new technology due to the pandemic or postponed investments in new technology (all excluding zoom/teams/digital meeting programs)

		<i>The postponement of new technology due to the pandemic</i>					
<i>The introduction of new technology due to the pandemic</i>		Not postponed		Postponed		<i>Total</i>	
		Firms	Workers	Firms	Workers	Firms	Workers
Not introduced new technology		0.42	0.33	0.17	0.14	0.59	0.47
Introduced new technology		0.20	0.28	0.21	0.25	0.41	0.53
<i>Total</i>		0.62	0.61	0.38	0.39	1.00	1.00

Empirical strategy

- Bivariate Probit on introducing new tech and postponing investments due to the pandemic, as function of 2019-TFP and barriers/promoters of technology.
- 3(4)-variate Probit on **types** of new tech and postponing of investments due to the pandemic 2019-TFP and barriers/promoters of technology.
- 4-variate Probit on the introduction of new tech and **reasons** for postponement of new tech, as function of 2019-TFP and barriers/promoters of technology (not shown)
- Generalised Ordered Probits on the demand for types of labour and how the introduction of new tech affects this.
- We focus on average marginal effects (paper comprises parameters).
- Linear FE-regression of log hourly wage growth within jobs (from 2019-20 and 2020-21) on the introducing new tech (and types) and postponing investments due to the pandemic.

Barriers and promoters of tech investments (biprobits)

Outcomes:	Model 1				Model 2			
	No	No	Yes	Yes	No	No	Yes	Yes
Introduce technology								
Postpone technology								
TFP	-0.061 (0.063)	-0.083* (0.039)	0.110** (0.046)	0.035 (0.046)	-0.052 (0.068)	-0.077 (0.049)	0.099* (0.047)	0.025 (0.050)
Lacking skills(index)					-0.029** (0.006)	-0.007 (0.004)	0.016** (0.003)	0.020** (0.005)
Lacking financial resources (index)					-0.110** (0.009)	0.038** (0.008)	-0.011* (0.005)	0.083** (0.004)
Change temp. layoff rate					-0.148** (0.052)	0.014 (0.063)	0.027 (0.080)	0.107** (0.035)
Public support (>1000k)					-0.024 (0.022)	0.027** (0.010)	-0.023* (0.009)	0.020 (0.016)
Trade union agreement					-0.049** (0.017)	-0.006 (0.007)	0.020* (0.010)	0.034** (0.012)
Workforce size/100					-0.013** (0.004)	-0.007** (0.002)	0.013** (0.004)	0.008** (0.002)

Controls

Additional controls: industry dummies (17), dummies for service provider and machine users.

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Barriers and promoters of *types* of tech investments

	4-variate Probit – Permanency of innovation			3-variate Probit – technology associated with innovation	
	Temporary innovation	Permanent innovation	Accelerated planned innovation	Robots & automation	New digital tools
TFP	-0.032 (0.046)	-0.010 (0.031)	0.213** (0.039)	0.039* (0.017)	0.090 (0.055)
Lacking skills	-0.010* (0.005)	0.018** (0.004)	0.026** (0.004)	0.005** (0.001)	0.033** (0.004)
Lacking financial resources	0.036** (0.006)	0.027** (0.004)	0.011** (0.002)	0.004* (0.001)	0.071** (0.007)
Change in temp. lay off rate	0.048 (0.063)	-0.052 (0.035)	0.101* (0.051)	0.023 (0.016)	-0.031 (0.070)
Considerable public support	-0.010 (0.015)	0.030** (0.008)	-0.021^x (0.012)	-0.006 (0.008)	0.013 (0.021)
Trade union agreement	0.025^x (0.013)	0.006 (0.009)	0.019** (0.005)	-0.001 (0.006)	0.049** (0.018)
Workforce size/100	-0.014** (0.003)	0.017** (0.005)	0.047** (0.009)	0.001 (0.008)	0.050** (0.015)
<i>Controls</i>					

Additional controls in all regressions: industry dummies (10) and dummies for service provider and machine users.

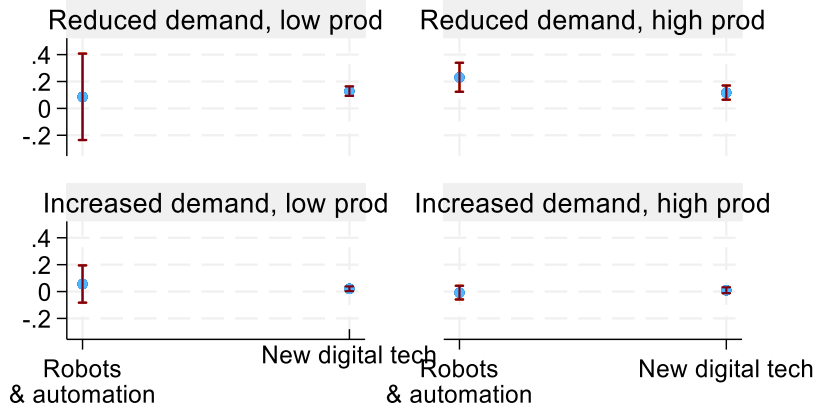
Tech investments and labour demand

(Generalised ordered probits)

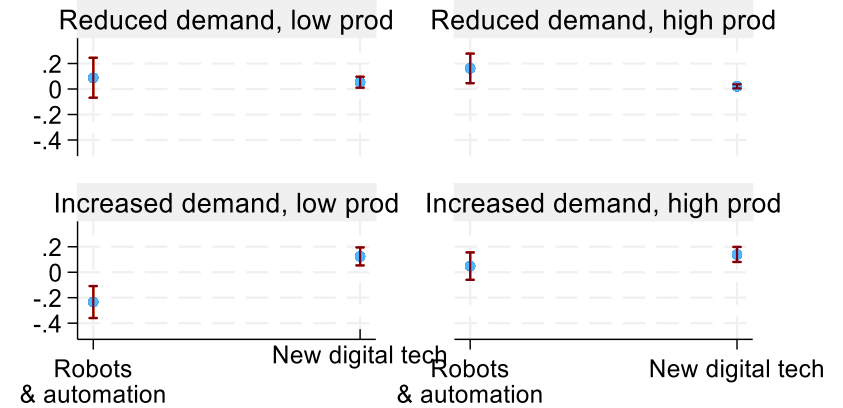
	All types of labour		Unskilled labour		Vocational training		High school / intermediate skills		University/ high-skilled individuals	
	Reduction	Growth	Reduction	Growth	Reduction	Growth	Reduction	Growth	Reduction	Growth
<i>a) General</i>										
Introduction of new technology	0.011** (0.004)	0.091** (0.006)	-0.107** (0.014)	0.012** (0.003)	0.024** (0.005)	0.109** (0.011)	0.015** (0.003)	0.126** (0.007)	0.012** (0.004)	0.100** (0.009)
<i>b) Type of technology</i>										
Robots & Automation	0.036 (0.0031)	0.047** (0.018)	-0.148** (0.054)	0.006 (0.026)	0.065** (0.012)	0.076** (0.047)	0.047** (0.012)	0.084** (0.039)	0.026* (0.011)	0.170** (0.034)
New digital tools	0.013** (0.004)	0.102* (0.008)	-0.114** (0.016)	0.012* (0.005)	0.019** (0.004)	0.125** (0.015)	0.012** (0.004)	0.141** (0.009)	0.011* (0.005)	0.106** (0.013)
N	5638		5638		5949		5852		5299	

Changes in labour demand following tech innovations for skill groups and productivity levels

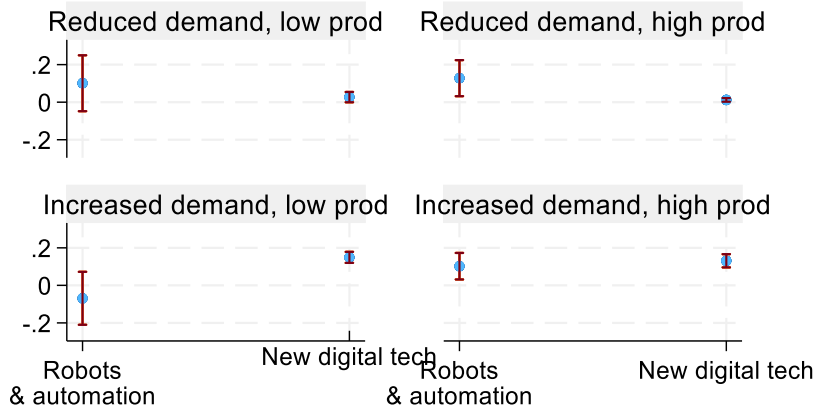
Unskilled workers



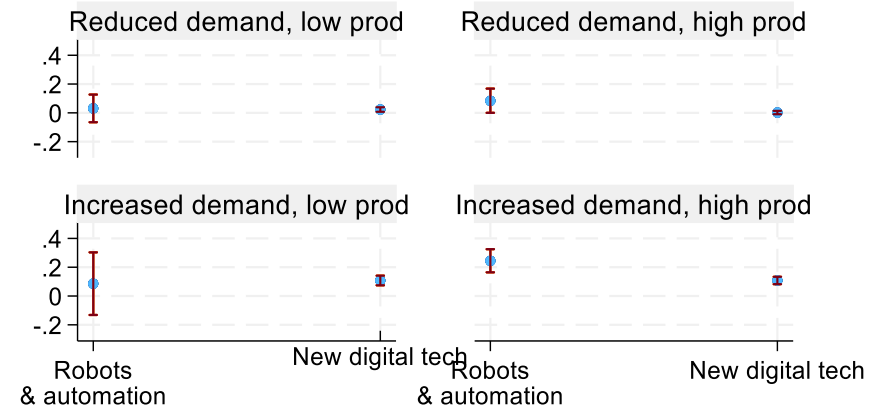
Vocational training



Skilled



High-skilled



The impact on log hourly wage growth within job of the introduction of new technologies induced by the pandemic

	All	Unskilled	Vocational	Skilled	High skilled
Panel A) All					
Introduced new tech	0.025** (0.006)	-0.009 (0.013)	0.007 (0.008)	0.026** (0.008)	0.013 (0.008)
Panel B) Tech types					
Robots & automation	0.061** (0.023)	-0.081 (0.052)	-0.005 (0.024)	0.071* (0.029)	0.029^x (0.015)
New digital tech	0.024** (0.006)	-0.007 (0.014)	0.007 (0.019)	0.022** (0.007)	0.012 (0.008)
Other tech	0.011 (0.013)	-0.008 (0.026)	0.009 (0.027)	0.028^x (0.015)	-0.004 (0.042)
Additional controls in all regressions: year dummy and industry FE.					
For all:					
Workers	716571	45121	186542	353275	154447
Firms	6690	3247	3595	6302	6206
N	1240856	71431	313796	589553	265613