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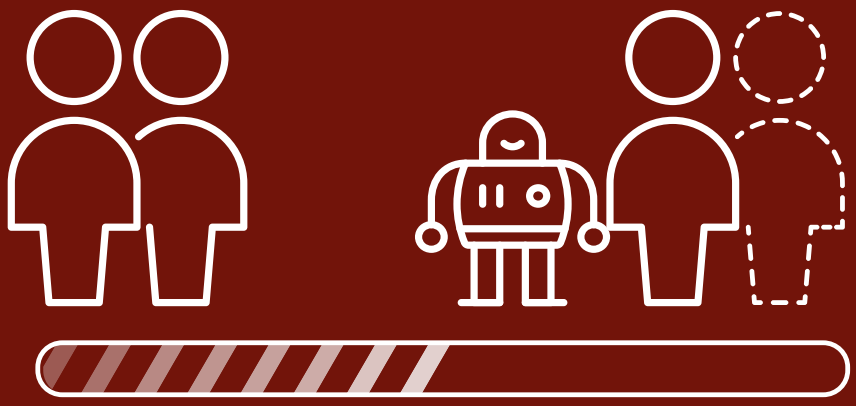
Job Market Boom or Oppressive Change? The Effects of the Digital Transformation on the Workplace and the Labor Market

Florian Englmaier and *Oliver Falck, Dmitri Koustas, Jean-Victor Alipour, Oliver Falck, Alexandra Mergener* and *Simone Schüller, Thomas Fackler* and *Nadzeya Laurentsyeva, Christopher T. Stanton* and *Catherine Thomas, Eliza Forsythe*



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Digital transformation, triggered by the advances in artificial intelligence, robotics, and the availability of “Big Data", is leading to rapid changes in economic and production structure. At the same time, it also poses serious challenges for workplaces, business organization, labor markets, and the welfare state. Yet it is not clear whether the digital transformation will ultimately create or destroy more jobs. For this volume of the CESifo Forum we have contacted the best contributors of last year’s CESifo and LINER–AUEB conference on “The Effects of the Digital Transformation on the Workplace and the Labor Market”. They share their latest insights on this topic – including how the Covid-19 crisis has affected the global labor market.

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RESEARCH REPORT

REFORM MODEL

DICE DATA ANALYSIS

MACRO DATA INSIGHTS

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Florian Englmaier and *Oliver Falck*

Introduction to the Special Issue on "The Effects of the Digital Transformation on the Workplace and the Labor Market"

On 28–29 November 2019, CESifo and LINER–AUEB organized a conference on the topic of "The Effects of the Digital Transformation on the Workplace and the Labor Market" held at CESifo in Munich. This Focus collects a number of papers presented at this conference.

Advances in artificial intelligence, robotics and the availability of "Big Data" are changing the world and, in particular, the workplace. It is widely agreed that these technologies will lead to an increasing number of automatized tasks that are so far carried out by humans. Many aspects of how this change affects the workplace are to date understudied and yet are highly relevant for decisions of policy makers, the structure of firms and the well-being of employees.

For instance, people increasingly worry that large numbers of jobs in the economy will disappear. While there is disagreement on the exact time scale and on whether there is going to be a massive loss of jobs, it is undisputed that effects on the workplace and the labor market will be fundamental.

The CESifo and LINER–AUEB conference on "The Effects of the Digital Transformation on the Workplace and the Labor Market" therefore brought together researchers from economics and related fields, such as business research, data science and computer science, who are studying the challenges and opportunities resulting from the digital transformation for firm organization, labor markets and the welfare state.

Dmitri Koustas (University of Chicago) presents "Insights from New Tax-Based Measures of Gig Work in the United States." He argues that despite increasing attention to the "gig" economy in recent years, properly measuring economic activity in the gig economy has proven elusive. In his paper he discusses new

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measures of gig work in the United States derived from tax data and presents insights about the gig economy using these new measures. He documents that, while gig work has been growing, most gig work is done as a second job rather than full-time work. This is especially true for the work being done on new online platforms. These facts about the ways households interact with gig work are important to document, and they can help inform the way researchers model gig work and policymakers regulate it going forward. While we cannot say to what extent these findings apply to the gig economies of other countries, these new approaches may provide lessons for researchers interested in measuring gig work in other countries.

Jean-Victor Alipour (ifo Institute), along with Oliver Falck, Alexandra Mergener, and Simone Schüller, presents his work on "Wiring the Labor Market Revisited: Working from Home in the Digital Age." They document Working from Home (WfH) patterns in the German labor market in the digital age and highlight three features relevant for evidence-based policy making: first, increases in WfH over time are mainly due to its occasional use. Second, WfH is very heterogeneous in terms of quality and quantity, particularly with regard to varying occupational requirements and different flexibility needs of employees (e.g., due to childcare or commuting). Third, currently unused WfH capacities are likely to be exploited in the future, mainly by carrying out some (rather than all) occupational tasks at home.

Nadzeya Laurentsyeva (LMU Munich), with Thomas Fackler, discusses her recent work on "Gravity in Online Collaborations: Evidence from GitHub." Gravity models are well established in the study of international trade where they are employed to explain the bilateral trade of goods and services or in labor economics where they describe migration flows between geographical units. They have not been used to study exchanges in virtual markets to date. As immaterial goods are becoming increasingly important for modern economies, the question arises to which extent standard barriers to trade or labor mobility are still relevant for outputs and production processes that can be performed entirely online. Using microdata from GitHub, the world's largest hosting platform for collaborative software projects, Nadzeya provides evidence that barriers, such as distance, country borders or language, still matter for virtual collaborations. Most collaborations originate within the same city, and the role of physical barriers does not seem to decrease over time.

Catherine Thomas (LSE), in joint work with Christopher Stanton, describes "The Gig Economy Beyond Local Services and Transportation" in her contribution. She starts with the observation that online platforms create opportunities for remote, electronically delivered work and expand the set of feasible matches for tasks beyond local labor markets. However, she shows that in the United States, the supply of individuals engaging in high-end gig work appears limited based on an analysis of self-employment trends as it relates to education levels, and the share of work done online has been slow to overtake traditional work arrangements even when it is technically feasible and offers potential labor costs savings.

Eliza Forsythe (University of Illinois at Urbana-Champaign) discusses "Automation and Technological Change: The Outlook for Workers and Economies." Since the advent of mechanization, predictions regarding the demise of jobs have accompanied each labor-altering technological advance. Going back to 1930, John Maynard Keynes coined the phrase "technological unemployment" to express the idea that technological change may lead to gross and potentially permanent declines in employment. While past episodes of technological progress did not lead to permanent unemployment, many fear this time is different. Eliza Forsythe now documents that, while technology may replace tasks, this occurs in conjunction with the addition of new tasks to jobs. For example, in the case of office support jobs, the modern support worker is asked to perform a wider variety of tasks, resulting in such jobs persisting with fewer, higher-skilled workers. The vast majority of automation technology now available or on the horizon will cause jobs to change but not disappear. Moreover, as with many economic disruptions, gains and losses are unevenly distributed. In particular, losses appear the greatest for those without college degrees. Policy makers should be aware that the continued march of technological change is likely to lead to disruptions in individuals' careers.

Dmitri Koustas

Insights from New Tax-Based Measures of Gig Work in the United States[1]

The "gig" economy has received a considerable amount of media and policy attention in recent years. Amid the active debate about the merits of gig work, there is also new literature that has emerged on measuring gig work (e.g., Katz and Krueger 2018; Collins et al. 2019; Abraham et al. 2018). Measuring the number of gig jobs and especially the growth rate of these jobs has proven difficult in the United States and in other countries. This is because, in most cases, gig work cannot be directly observed in government labor market surveys. The main approach to measuring gig work has been to launch new ad-hoc survey-based measures of gig work. While insightful, survey-based measures of gig work have important limitations and, in most cases, do not provide evidence on changes in gig work over time.

I begin by clarifying the definition of gig work used in this paper. I then describe the problem of measuring gig work in more detail. I highlight cross-country evidence and discuss literature from the North American context suggesting the main government labor market surveys may not accurately capture gig work. I briefly summarize new ad-hoc survey approaches to measuring gig work that attempt to better capture this sector. I then summarize new measures of gig work in the United States derived from tax records and discuss how these new estimates add to our understanding of gig work.

WHO IS A GIG WORKER?

The term "gig economy" has been used in different ways by the media and in the literature. In this paper, I will be using the term gig work to describe work done by self-employed workers who are being contracted by a firm. These types of workers are also referred to as "independent contractors" or "freelancers." This relationship with a firm is the distinguishing feature of gig work, in contrast to consumer-facing self-employment such as running a family-owned shop or restaurant.

Gig workers are one component of a broader "alternative workforce." The alternative workforce also includes temporary and contingent jobs done by wage employees. One important distinction to be made is that gig workers are self-employed, hence, they are not employees of firms they work for or with. This employee/non-employee distinction is important legally in the United States and many other countries because being classified as an employee carries a different legal status. Labor laws such as minimum wage, overtime provisions and protections for organizing a union only apply to wage employees and not self-employed gig workers. Benefits provision that occurs through firms, such as employer-sponsored health care in the United States, would also only apply to wage employees.

Gig work can encompass many different industries and occupations, from doctors to hair stylists to taxi drivers. Some new work that has emerged in recent years and that is being mediated by new online platforms, such as Uber and Etsy, appears to blur some of the lines described above. This new platform work has a consumer-facing element, but the platform workers must adhere to the platform policies, and can receive substantial direction and control by the platform. However, these workers, at least in the United States, have so far been legally classified as non-employees.[2] This new gig work mediated by new online platforms simply did not exist before the 2010s, which is evidence that at least some gig work must have grown over the last decade. These new gig jobs tend to have unique policy concerns, which is why it is useful to be able to separately measure online platform work alongside other long-term gig work.

THE SELF-EMPLOYMENT PUZZLE

Much of our understanding of modern labor markets comes from analyzing government labor market surveys, such as the Current Population Survey (CPS) in the United States. For researchers interested in studying gig work, however, these surveys have important limitations, as gig work is typically not separately identifiable. As a subset of self-employment, any rise in gig work should show up in self-employment statistics, all other factors being equal. Self-employment is identifiable in labor market surveys, so self-employment is a natural

[1] Special thanks to Florian Englmaier, Olivier Falck, Peter Kuhn, and other seminar participants at the CESifo and LINER-AUEB Workshop, "The Effects of the Digital Transformation on the Workplace and the Labor Market" for their valuable comments and suggestions. This paper draws from Collins et al. (2019), and Garin et al. (2020).

[2] This classification is currently facing a legal challenge in the US state of California - see, for instance, Rosenberg, E., "Can California Rein in Tech's Gig Platforms? A Primer on the Bold State Law That Will Try", *The Washington Post*, 14 January 2020, https://www.washingtonpost.com/business/2020/01/14/can-california-reign-techs-gig-platforms-primer-bold-state-law-that-will-try/.

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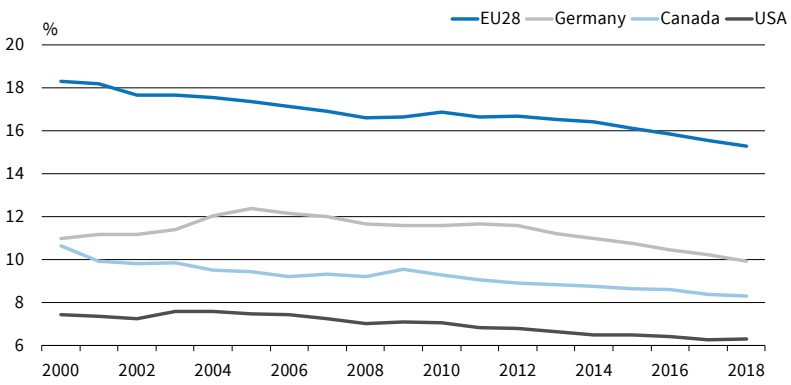
Figure 1
Self-employment Trends Across Selected Countries



Source: OECD. © ifo Institute

place to look to see if gig work might be growing. A priori, the United States might be expected to follow different trends from other countries in cross-country comparisons. New gig platforms largely started in the United States, and many operate there with far less regulation than in Europe or other OECD countries. Self-employment rates in the United States might therefore be expected to rise earlier and more sharply from the early 2010s.

To examine this hypothesis, Figure 1 shows self-employment rates since 2000 for Canada, Germany, the US and the EU28 from each country's respective labor-market survey (OECD 2020).

Somewhat surprisingly, there is no noticeable trend break in self-employment in recent years. US self-employment statistics appear to follow a similar negative trend seen in many other countries. This decline in self-employment is part of a long-run trend away from self-employment, documented in Blanchflower (2000).[3] In short, if the nature of work has been changing, it appears to have been steadily changing away from self-employment, not toward more self-employment.

Researchers studying self-employment in North America have noted a puzzling situation when comparing these survey-based measures of self-employment with counts of self-employed *tax filings*. As discussed in Abraham et al. (2018) in the context of the gig economy, but noted earlier in Abraham et al. (2013), self-employment tax filings are increasing in the US, in contrast to the household survey data on self-employment. A similar phenomenon has been observed in Canada (Jeon et al. 2019). To my knowledge, this direct comparison between survey and tax data has not een carried out for other countries and presents an opportunity for future research.

There are a variety of interpretations for this discrepancy between survey- and tax-filing-based measures of self-employment. One explanation specifically related to the gig economy is misclassifying gig work as wage employment instead of self-employment. Because gig workers do work for a firm, they might not realize they are self-employed, or think of themselves in this way when interviewed for a household survey. For example, a worker on the Amazon Mechanical Turk platform is technically an independent contractor, but they might think of themselves as "working for Amazon." This may lead gig workers to show up as wage employed on a labor market survey, even if they are technically self-employed for tax purposes.

In an attempt to better measure gig work, new surveys and survey questions have been created specifically that address gig and other forms of informal work. Some examples include Bracha and Burke (2016); Katz and Krueger (2019); Abraham et al. (2018); and Boeri et al. (2020). Because the wording of questions is designed to be more inclusive and, in many cases, encompass informal work more broadly, these surveys can sometimes show large numbers of workers engaged in gig work. Abraham et al. (2020) find that estimates of gig work can be very sensitive to the phrasing of the survey instrument, making it difficult to compare across surveys. While certainly insightful about the number of gig workers at a point in time, a disadvantage of fielding new ad-hoc surveys is that the results are only valid cross-sectionally, making it difficult to know whether gig work has increased over time. One notable exception of a survey facilitating comparisons over time is the US Bureau of Labor Statistics' Continent Worker Supplement (CWS) to the CPS, which has been fielded in 1997, 1999, 2001, 2005 and 2017. The CWS shows very little rise in its main estimate of independent contracting over time. One disadvantage of the CWS is that it focuses on full-time/primary work, although additional questions about electronically mediated work were added to the 2017 survey and asked to all workers.

Before moving on, I would like to briefly discuss bank data as another novel data source being used to measure platform gig work. Because many companies pay workers by making a direct deposit into a bank account, data where these transactions are observable can allow researchers to measure gig work. The research institute at one prominent bank in the United States has been measuring platform gig work using this methodology (Farrell et al. 2018). I have also identified platform gig workers using data from a personal financial aggregator (Koustas 2018 and 2019). The main advantages of this approach are that gig work can be observed in high frequency, work on multiple platforms can be observed, and the nature of these datasets is that they provide a link to other income and in some cases expenditures. This methodology only really works for measuring work on new online platforms where direct deposit is often required, and the payer string is easily identifiable and is clearly associated with gig work. Other types of gig jobs outside of the major platforms will be difficult if not impossible to observe

[3] One noticeable exception to this trend is Britain, which has seen self-employment rise by 3 percentage points from 2000–2018.

in the data, even if a researcher knew exactly what to look for.

Of course, another potential data source is the gig platforms themselves. The platforms collect additional data useful for researchers, such as worker hours, and the platforms may allow researchers scope for designing experiments. While it has been possible for researchers to collaborate with particular companies, collaborating with many companies on a large scale is likely not feasible for measurement questions unless reporting were mandated by governments.

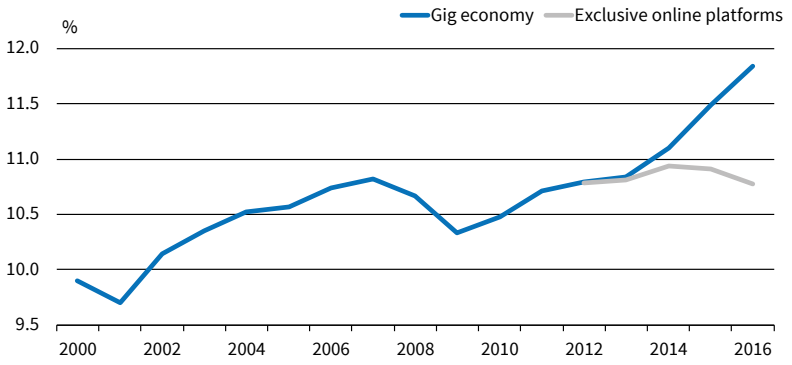
A NEW TAX-BASED MEASURES OF GIG WORK FOR THE UNITED STATES

In the US, new measures of gig work have been derived from tax data that overcome some of the limitations described above (Jackson et al. 2017; Collins et al. 2019; Lim et al. 2019). Measurement is made possible by a unique feature of tax-reporting in the United States: US firms are required to report to tax authorities the income they pay to their gig workers. As is the case in many countries, wage and salary employees will have their income reported directly by their firms to US tax authorities. Self-employed workers, on the other hand, will voluntarily report self-employment earnings when they fill out their taxes. Of course, self-employment income should be backed up by financials and there is always the risk of having these financials audited. The income of gig workers is double reported: firms report payments to gig workers of at least $600 to the tax authorities, in a similar way as they do for employees,[4] and gig workers also report this income as self-employment income when filing their taxes. These reports by firms can be used to estimate the number of gig workers in the United States and to gather other descriptive statistics on this workforce. To my knowledge, the United States is the only country where gig relationships are reported by firms to tax authorities, presenting a unique opportunity to isolate gig work from other self-employment filers.

These firm reports of gig workers have a number of advantages in terms of measurement. First, because the payers are observed by tax authorities, the data allows new online platform work to be separately identified from other gig work. Second, since the income is third-party firm reported, workers do not actually need to file their taxes to be counted. Tax filing can change from year to year for many reasons. For instance, tax filing tends to fall in recession years when fewer workers have income above tax-filing thresholds. Finally, while it is well known that self-employment income tends to be underreported, firms have no incentive to underreport gig relationships (in fact, the incentive is just the opposite, since firms will deduct these expenses as part of their business costs).

Figure 2

Gig Work and Self-employment in the United States



Source: Collins et al. (2019). © ifo Institute

KEY FINDINGS

One of the most basic questions is whether gig work is growing over time. Figure 2, from one of my papers (Collins et al. 2019), shows the share of the workforce with any gig work over the period 2000-2016. We find that the share of the workforce with income from gig work has grown by 1.9 percentage points of the workforce from 2000 to 2016, and now accounts for 11.8% of the workforce.

The time series shows interesting patterns. Gig work grew in the early 2000s, long before the rise of online platforms. It declined during the Great Recession and has increased by around 1 percentage point of the workforce since 2012. The dashed line excludes gig workers who work for firms identified as online platforms. We find that virtually all expansion of the gig workforce since 2011 comes from online platform work. By 2016, about 2 million Americans, or 1 percentage point of the workforce, had income from an online platform.

While gig work has grown as a share of the workforce, we find that workers in 2016 were no more likely to earn their livelihood through *full-time* gig work than they were a decade earlier. In the overall gig economy, about 60% also have a wage or salary job over the course of the year. Among work for new online platforms, the share with another wage job over the course of the year is much higher, approximately 80%. In fact, most workers on online platforms make less than 2,500 US dollars. These findings shed important light on the way workers interact with and use gig-economy jobs. Moreover, these findings present lessons and challenges for survey measures of gig work. Since gig income is for small amounts and may occur intermittently, people might not recall this income on annual surveys. Moreover, given that much of the work is part-time, it will be explicitly excluded

[4] Technically, firms report compensation to non-employees on tax Form 1099MISC. Some online platforms use a different tax form with different reporting requirements (Collins et al. 2019) for more details.

from surveys that ask about a primary job, like the CWS in the United States.

We find important heterogeneity in our trends across demographic groups and regions of the United States. Men are considerably more likely to do gig work, and virtually all the growth in gig work among men has come from platform work in recent years. On the other hand, the propensity of women to do gig work has grown by about 25% since 2000, and women are much less likely to do platform work. Platform work is much more common among younger workers, whereas other gig work is more common among older workers. Platform work also tends to be more common in cities in the US, which is likely due to network effects, whereas non-platform gig work is much less concentrated and much more common in rural areas in the Plains and southern states.

We also find differences in the way households use gig work compared with other self-employment. In Garin et al. (2020), we compare and contrast new online platform work with other gig work, as well as with consumer-facing self-employment. We find that people who start platform work do so around smaller income losses than other gig workers. The biggest declines in income occur when starting consumer-facing self-employment. In addition, we show that it is more common for non-gig self-employed workers to claim tax incentives like the Earned Income Tax Credit (EITC), a refundable tax credit in the United States for lower-income households, when they start gig work. This may be because self-reported self-employment may be more likely to be reported when incentivized by the tax code. Recall that our measure of gig income based on firm reports is not subject to these same incentives because it is reported by firms.

Because gig income is double-reported in the US, this also allows us to study the share of gig work that is being reported to tax authorities. Not all gig work requires reporting in the US: profits (i.e., net revenues after accounting for expenses) must exceed a reporting threshold.[5] Moreover, there is non-compliance with the tax code. Among the online platforms, we find that around 40% of gig workers do not show up in individual self-reported tax filings. While much of the non-reported income is likely for small amounts, the bottom line is that firm-reported measures will do a better job of showing a more complete picture of the gig workforce.

DISCUSSION AND CONCLUSIONS

In this paper, I discussed some limitations of labor force surveys for measuring gig work and presented a new measure of gig work in the United States that is able to overcome some of these issues. This measure is based on firm-reporting of gig relationships to tax authorities. To my knowledge, this is a unique feature of the US tax system. Using this measure, I presented some new insights about gig work in the United States. A key finding is that while gig work has been growing, most gig work is done as a second job rather than full-time work. This is especially true for the work being done on new online platforms. These facts about the ways households interact with gig work are important to document, and they can help inform the way researchers model gig work and policymakers regulate it going forward.

It is not immediately clear how similar US gig work is to the gig work of other countries and exploring any differences across countries remains an exciting area for future research. Measuring gig work outside the US will continue to require new data collection efforts on top of labor force surveys or simple counts of self-employment tax filings. Surveys that run continuously for many years and employ scientific survey methods will undoubtedly be the most useful for understanding trends in gig work. However, this type of survey is costly, particularly if multiple questions are required to elicit participation in gig work. Other sources may exist or could be modified in the future to measure gig work. The OECD has recently released draft guidelines for reporting platform gig work to tax authorities that, if adopted, may facilitate measurement of the platform component of the gig economy (OECD 2020b). I hope the issues and new approaches discussed in this paper will provide insights for researchers and policy-makers in other countries who are interested in measuring gig work.

[5] Around 400 US dollars in the United States.

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Jean-Victor Alipour, Oliver Falck, Alexandra Mergener and *Simone Schüller*

Wiring the Labor Market Revisited: Working from Home in the Digital Age

In his seminal paper "Wiring the Labor Market," published in the *Journal of Economic Perspectives* in 2001, David Autor identifies three channels through which the Internet is likely to change the labor market fundamentally. First, the Internet will change how workers and firms search for one another. Second, the Internet will facilitate outsourcing business services. Third, workers will increasingly carry out their work via the Internet rather than at their physical workplace at the firm.

The first two predictions have already come true: job ads in daily newspapers have become rare and over the last two decades, business services have grown faster than the overall economy. However, measurement issues make it difficult to detect whether "working from home" (WfH) is in fact on the rise. Should the WfH capacity of a job or the actual realization (WfH usage) of this capacity be considered? The WfH capacity can be measured by surveying employees (or employers) or by having experts assess which tasks of a job can be done from home. WfH may also differ in terms of quality and quantity. Do employees only sometimes work from home, for example, when they have to care for their sick children, or do they work from home regularly or even always? Do workers receive full recognition for time worked from home?

The coronavirus pandemic has shone a spotlight on WfH, as it has allowed maintaining economic activity even in times of lockdown. Based on survey data from the Socio-Economic Panel (SOEP), Schröder et al. (2020), for example, estimate that of all employed persons in Germany, around 34% worked partly or completely from home in April 2020. Many policymakers are keen to maintain this awareness for WfH in the post-coronavirus era, for example, by proposing a legal right to work from home.

The aim of this essay is to document the extent of WfH and to draw conclusions about its future. We do this using the example of Germany, an industrialized country that is representative in that it is neither a forerunner nor a laggard in the age of digital transformation. We mainly use data from the 2018 BIBB/BAuA Employment Survey (ETB). This representative survey of more than 20,000 employees with a minimum of 10 working hours per week includes extensive information on workplace characteristics, occupational tasks, requirements, qualifications, employment history, personal characteristics and differentiated information on WfH. These data are complemented by time-series evidence from the European Labor Force Survey (LFS) and the German Socio-Economic Panel (SOEP). The richness of our data allows us to comprehensively describe and analyze WfH in Germany from different perspectives.

WFH TRENDS IN GERMANY

Figure 1 depicts WfH trends drawing on two longitudinal surveys in Germany that record employees' WfH practices: the SOEP and the *Mirkrozensus*, which feeds into the European Labor Force Survey (LFS). Due to missing data, the WFH shares derived from SOEP for the period after 2014 are extrapolated. The figure reveals a remarkable pattern: until the beginning of the 2000s, the two WfH trends appear very consistent, with each share of employees reporting some WfH ranging between 12% and 14%. However, parallel to the expansion of broadband Internet that facilitates WfH, the trends start to diverge considerably. Whereas the WfH share computed from the SOEP increases sharply, the trend calculated from the LFS data even tends to decline. A closer look into the SOEP data reveals that the first phase of the WfH boom is primarily driven by employees taking up WfH on an occasional basis, i.e., "only when necessary" or "every 2–4 weeks." Only after 2009 does the share of regular WfH homeworkers, i.e., "daily" or "several times a week," approach that of occasional homeworkers.

But why is David Autor's prediction reflected in the SOEP but not in the LFS? This could be due to different measurements and framing of the surveys. In the SOEP, for instance, respondents are asked whether "[it

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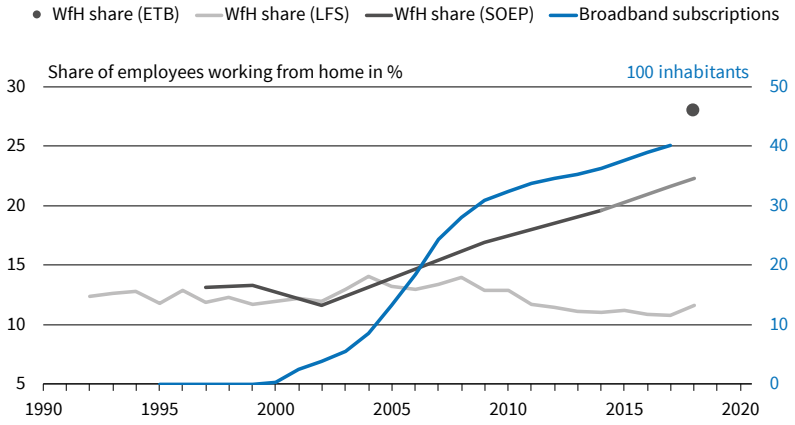
happens that] they work from home" (yes/no). In the LFS, however, respondents are asked whether they worked from home *in the last three months*, and can choose from the answers: "More than half of my working days," "Fewer than half of my working days" and "Never."[1] Thus, on the one hand, the LFS is more likely to miss sporadic WfH due to the temporal constraint. On the other hand, the question in the LFS understands WfH more as entire days rather than fractions of days worked from home. As we document below, even frequent homeworkers tend to spread their hours worked from home over several days. Consequently, the LFS probably records WfH practices for a very selected group, which might also explain why the LFS trend does not catch up after 2009, according to the SOEP survey, and frequent WfH becomes more prominent. David Autor's prediction is therefore not refuted. On the contrary, it seems to apply to a type of WfH that is more occasional (at least until 2009) and less institutionalized, i.e., not contractually organized.

In the following section, we shed light on two approaches to measure access to WfH, i.e., its capacity, and discuss different types of WfH practices in relation to workers' needs. We draw on the 2018 wave of the ETB, which is the most recent representative survey about WfH among the working population. The ETB determines the prevalence of WfH using a similar question found in the SOEP: "Do you work for your company – even if only occasionally – from home?" (yes/no). The emphasis on *occasional* WfH in the ETB might explain the gap between the WfH share from the ETB and the projected WfH share from the SOEP in 2018 (Figure 1).

Figure 1

Work from Home (WfH) Trends and Diffusion of Broadband Internet



Note: WfH-trend based on SOEP data extrapolated after 2014. Sample includes employees (i.e., no freelancers, assisting family members, self-employed or marginally employed) aged 15–64.
Source: SOEP; LFS; ETB International Communications Union; authors' calculations. © ifo Institute

MEASURING GERMANY'S WFH CAPACITY

To draw conclusions about the future development of WfH, one should consider an economy's WfH capacity – in addition to the mere actual use of WfH. The measure of an economy's WfH capacity provides a general upper limit for the extent of WfH and is informative about possible developments and limits of WfH in the near future. WfH capacity is especially relevant in a post-pandemic world in which many reservations of employees and employers regarding WfH have become obsolete. However. before the coronavirus crisis, the actual use of WfH did not even come close to the overall WfH capacity; the WfH surge during the crisis suggests that WfH usage will continue to converge toward WfH capacity.

Essentially two approaches for calculating an economy's WfH capacity have been proposed in the recent empirical literature. These approaches provide two distinct types of information: one approach relies on expert judgment as to which tasks of a job can be done from home (see e.g., Dingel and Neiman 2020). The other approach relies on survey evidence on how employees assess the feasibility of WfH in their specific jobs (see e.g., Alipour, Falck and Schüller 2020; Mergener 2020a). It is important to note that the "expert" approach by Dingel and Neiman (2020) provides an estimate of how many jobs can be performed *entirely* from home. That is, every job that contains *at least one commonly performed task*, which according to experts cannot be performed at home, is considered entirely incompatible with WfH. Other tasks of a job that could plausibly be performed from home are not taken into account. Yet, as pointed out above, it is occasional and partial WfH that has been on the rise since the beginning of the digital age. In contrast to the "expert" approach, the "employee" approach provides an estimate of how many jobs can be carried out from home *at least partly or temporarily*. That is, a job is only considered incompatible with WfH if *no essential part* of the job can be performed at home.

To compare these two measures in the German context, we employ both approaches and calculate the two types of WfH capacity measures ("expert"[2]

[1] In some years, possible response options or the temporal constraint are slightly different.

[2] More precisely, we calculate expert-judgment-based WfH capacity in line with Dingel and Neiman (2020) by defining an individual's job as incompatible with WfH if at least one of the following conditions

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and "employee"[3]) based on data from the 2018 ETB. The data contains detailed information on occupational tasks as well as information on employees' self-reported feasibility of WfH in their respective job. We present the results at the 1-digit occupational level according to the German Classification of Occupations 2010 (KldB 2010). In the light of political discussions about a universal right to WfH, it is important to consider the heterogeneity of WfH capacity across occupational groups. Figure 2 depicts both WfH capacity measures at the time of the survey in 2018.

Both measures of WfH capacity are strongly correlated across all occupation groups. Considerable heterogeneity of WfH capacity across occupational groups is evident in both measures. However, the measure based on expert judgement is considerably lower than the measure based on employee reports for every occupation group. This is probably not only due to differences in the assessments of experts and employees, but rather indicates a strong discrepancy between the potential to work entirely from home and the potential to work at least partly or occasionally from home. In a nutshell, it appears that the capacity to work from home at least partly/temporarily is considerably larger than the capacity to work entirely from home.

It is interesting to note from Figure 2 that the share of employees in an occupational group that may potentially work entirely from home is relatively close, and sometimes even less than, the share of employees that actually use WfH. This could be a tentative indication of the relative importance of occasional vs. full modes of WfH in different occupational groups. For example, in the agriculture, construction, health and natural sciences professions, in which the actual use of WfH surpasses the capacities to entirely WfH, occasional rather than full use of WfH might play a dominant role. These professions are also the occupational groups in which differences between the capacity to partly and the capacity to entirely work from home are most pronounced. Given that these groups include occupations in which physical presence, e.g., on a field, on a construction site, in a hospital or laboratory, is often at least temporarily necessary, entirely working from home may not be feasible for many employees in these occupational groups. At the same time, however, these occupations entail tasks that can be carried out from home, such as documenting, email processing, preparing work processes or training, which still allow employees to work at least occasionally from home.

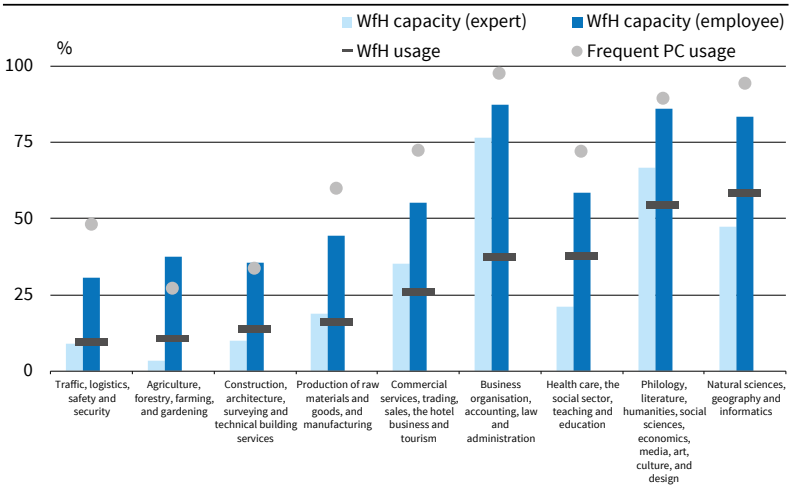
Another striking observation illustrated in Figure 2 is that the share of employees in an occupational group that may at least partly WfH is close to the share of frequent occupational PC users in that occupational group. In fact, the massive increase in professional PC use since the late 1990s, in combination with widely accessible broadband Internet infrastructure, might make it possible to perform more and more occupational tasks from home. However, it does not necessarily allow workplaces to be entirely moved into employees' homes.

is met: (a) never uses PC, Internet or email; (b) frequently carries loads of more than 10kg (women)/20kg (men); (c) frequent exposure to smoke, dust or gases; (d) frequent exposure to cold, heat, moisture, humidity or drafts; (e) frequently works with oil, grease, dirt; (f) frequent exposure to microorganisms; (g) works the majority of time outdoors; (h) frequently engages in nursing, caring or healing; (i) frequently engages in protecting, guarding, monitoring, regulating traffic; (j) frequently engages in cleaning, waste disposal, recycling; (k) frequently engages in monitoring, controlling machines or technical processes; (l) frequently works standing up; (m) frequently engages in transporting, storing, shipping.

[3] In calculating the employee-reported WfH capacity, we follow Alipour, Falck and Schüller (2020) as well as Mergener (2020a) and assume that a job cannot be performed at home, if the respondent does not work from home and indicates that WfH is "not possible" in his/her job even if the employer were to grant the option. The survey question reads "If your company allowed you to temporarily work at home, would you accept this offer?"– (*Yes; No; Is not possible with my work*).

Figure 2

Expert-judgement and Employee-survey Based Measures of WfH Capacity, Wfh Use, and Occupational PC Use by Occupational Group



Note: Weighted data; sample includes employees (i.e., no freelancers, assisting family members, self-employed or marginally employed) aged 18–65.
Source: ETB 2018; authors' calculations.

DIFFERENCES IN THE EXTENT AND RECOGNITION OF WFH TIME

When estimating WfH capacity, we find indications for differences for occasional vs. full modes of WfH. This heterogeneity is reflected in the actual use of WfH.[4] Only about one-eighth of all employees who work from home do so entirely, the others do so frequently, sometimes or rarely (each with a share of about 30%). The proportion of weekly working time that employees work from home ranges on average from 7% (rarely), to 12% (sometimes) and to 29% (frequently). Employees who sometimes work from home spread their working hours over 2.2 working days; those working from home frequently distribute their working hours over 3.7 days. Almost 30% of all

[4] For details, see Mergener (2020b).

hours worked from home are not fully recognized as working time.

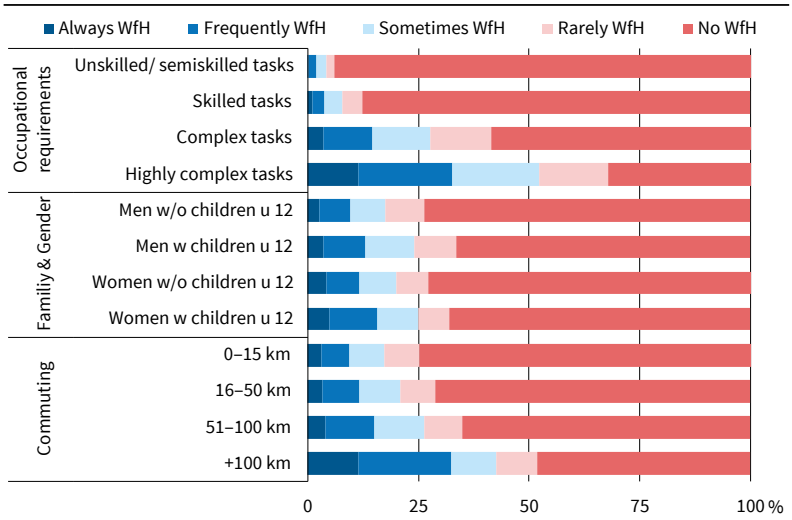
Mergener (2020a) shows that the capacity for WfH increases with the number of cognitive, mostly complex, tasks associated with a job, whereas manual tasks reduce this capacity. We find a comparable pattern for the actual use of WfH (Figure 3). It is more frequent in occupations with (highly) complex requirements. Working entirely from home is particularly common in jobs with highly complex tasks, while WfH frequently is also widespread among employees with complex tasks. However, WfH sometimes or rarely is of importance not only for jobs with (highly) complex tasks but also for those involving (un)skilled tasks.

In particular, employees with young children and commuters are in need of flexibility in choosing where they work. Parents of children under the age of 12 living in the same household more frequently work from home than employees without young children. Mothers in particular are slightly more likely to work entirely or at least frequently from home (see also Arntz et al. 2020). This WfH time consists primarily of contractually recognized hours worked from home (74% fully recognized, 16% not at all). Women without children more often work from home outside their recognized working hours (68% fully recognized, 23% not at all). Fathers use WfH arrangements more irregularly or on demand, i.e., sometimes or rarely. The proportion of unrecognized working time from home is higher for fathers (21% not at all recognized, 6% partially) than for mothers, but is not significantly different from men without children (22% not at all recognized, 7% partially).

WfH arrangements are often discussed as an instrument to reduce commuting, e.g., employees whose place of residence is located (very) far away from the employer's premises can especially benefit from such flexibility. We find that WfH increases with the distance between home and workplace at both the extensive and intensive margin. More than half of the employees with a commuting distance of 100 km or more state that they work from home (11% always and 21% frequently). In addition, long-distance commuters also work irregularly from home. However, the proportion of employees who sometimes or rarely work from home does not differ significantly between employees with longer and shorter commuting distances (it is about 10% in all distance groups). Regarding the contractual recognition of working time, it becomes obvious that long-distance commuters, who do a large part of their work from home, more often receive full recognition (82% fully recognized, 13% not at all). This proportion decreases with the commuting distance.

Figure 3

Extent of WfH in Terms of Occupational Requirements, Family & Gender, and Commuting Distances



Note: Weighted data; sample includes employees (i.e., no freelancers, assisting family members, self-employed or marginally employed) aged 18–65.
Source: ETB 2018; authors' calculations.

WHAT DOES THE FUTURE OF WFH LOOK LIKE?

The evidence in this paper suggests that the increasing prevalence of WfH in the last two decades has been primarily driven by occasional homeworkers who spend only fractions of days rather than entire days working from home. Moreover, we show that the needs of employers and employees vary considerably, and that WfH is hardly feasible (at least completely) for some professions. Given this heterogeneity, a legal right to work from home is controversial. Nevertheless, it is likely that WfH will continue to gain importance even after the coronavirus crisis, so that parts of the unexploited potential from the pre-coronavirus era will be used. During the course of the pandemic, reservations and stigmas concerning WfH have dissolved. Necessary adjustments, such as digitizing work processes or introducing suitable communication tools, were implemented swiftly and many employees have developed or improved their digital skills.

The immediate benefits of such a shift are evident: companies can cut down on expensive office space; employees no longer lose time in traffic jams or crowded subways. A reduction in traffic would ultimately benefit the environment as well. The fact that people would no longer have to live near their place of work may also have a positive effect on the precarious situation in today's urban housing market. This, in turn, may benefit employees who cannot work from home, for example, healthcare workers. In addition, eliminating physical distance as a limiting factor could improve matching jobs between job seekers and employers, and ultimately boost overall economic productivity.

However, there are also arguments against a radical shift to WfH. Many employees experience permanent work from home as a burden rather than a relief. Employees who work from home often lack social exchange and report loneliness (Bloom et al. 2015). In fact, there is a large body of empirical ev-

idence suggesting that it is precisely the personal exchange of ideas, knowledge, etc. that drives agglomeration and explains higher productivity in metropolitan areas.

If this type of exchange cannot be shifted to the digital realm, innovation and productivity-enhancing capacity could be lost. It is thus more probable that companies and employees will prefer a hybrid form of work. This would reconcile the flexibility and autonomy of working from home with the possibility of engaging in personal exchange at the office. In this case, office space would serve less as a mere place of work but as a communicative meeting place for employees. Future research should investigate how these changes in work organization will affect job performance and satisfaction for both employers and employees.

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Thomas Fackler and *Nadzeya Laurentsyeva*

Gravity in Online Collaborations: Evidence from GitHub

Growing importance of immaterial goods and increasing digitization have enabled virtual production processes and have made virtual teamwork possible. Modern digital technologies not only reduce communication costs, but also help create powerful environments with apparently no physical barriers for close collaboration or for exchange of knowledge and ideas. Does it mean that traditional obstacles, such as bilateral distance, country borders, language barriers or cultural differences do not matter in the virtual production processes? We try to answer this question by estimating the gravity model for collaborations on GitHub—the world's largest online platform for software development.

The gravity models are well established in the Economic literature and help to identify the determinants of bilateral trade in goods and services or of migration flows between geographical units. By applying the gravity model to an online setting, we can identify the determinants of virtual collaborations and compare them with those established in trade or migration literature.

Cross-city and cross-country code contributions are not only related to trade, but also to the literature on knowledge flows and knowledge production. Knowledge has been shown to be more localized than what would be expected from agglomeration effects alone (Jaffe et al. 1993). Furthermore, knowledge spillovers to other countries has been shown to take time (Hu and Jaffe 2003; Jaffe and Trajtenberg 1999), and the effect of international localization has turned out to be more robust than within-country localization (Thompson and Fox-Kean 2005).

Our results show that there is gravity in online collaborations on GitHub. The estimations suggest that it is weaker than in trade, but statistically significant, despite the fact that both the production process and the output of programmers are immaterial. The effect of distance between locations is non-linear, i.e., an additional kilometer decreases collaboration more when distance is low than when owner and committer are already far apart. This is in line with the idea that offline work and personal contact are still important and different modes of transport are used, such that moving from what may be a commuting distance to one that is usually traveled by plane changes the cost of an additional kilometer.

In addition, when distance is controlled for, traditional determinants of international trade such as language barriers and country borders matter for international code contributions, although here too the magnitudes of the effects are smaller than for trade.

CONTEXT AND DATA

GitHub is a platform for software development that was launched in 2007 and hosts a collaborative version control system. Projects can be started by individual users and companies. The repositories cover a wide variety of (mostly) software projects, some of which are aimed at other developers and some at a wider audience. GitHub allows users to have private and public repositories for the project's code. Our data contains only the latter. These public repositories are usually licensed under common open-source licenses such as the GNU General Public License.

To contribute to projects or create new ones, users have to set up an account and can provide their real name, location (usually city) and additional biographical information. Each project has only one owner. The owner may invite other users to contribute and become project members. Users can also initiate and contribute to a project before being invited (McDonald and Goggins 2013). Users who are not project members cannot only report issues but also suggest modifications to the code, which the project members can review and accept into the project.

In public projects, all of these activities can be observed by everyone. This makes collaborative software development a unique setting that gives researchers a detailed and, in terms of code, comprehensive view of worker interaction. Users' profile pages on GitHub show their contributions to different projects, while project pages reveal which users have contributed. Thanks to the version control system, the development history of a project is recorded down to the addition of each line of code. In addition to tools

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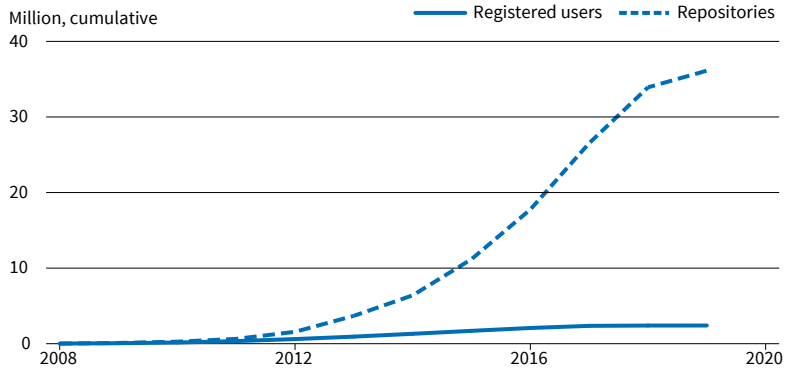
Figure 1

Cumulative Number of Registered Users and Repositories on GitHub



Note: Only users with reported location; only repositories owned by users with reported location.
Source: Data from GitHub Torrent project (snapshot from June 2019). © ifo Institute

for software development, GitHub also shares some features of social networks, giving users the ability to get updates about each other's activities, as well as watch projects and give "stars" to the ones they like. Motivations of open source contributors have been the subject of economic research and include paid work at software companies, career concerns (showcasing skills), as well as writing software for one's own needs or to help others (Belenzon and Schankerman 2008; Hergueux and Jacquemet 2015; Lerner and Tirole 2001 and 2005).

For this study, we mainly look at "push events," i.e., submissions of commits to a repository, and here in particular, the ones involving project owners and committers from different countries.

We use a snapshot from GitHub Torrents (Gousios 2013) and the GitHub Archive Dataset, as well as a Gravity dataset from CEPII. Both Torrents and Archive datasets provide a mirror of the GitHub public event stream from 2012 onward. Both are publicly available in the Google Cloud Platform. We use the two datasets in a complementary way. We take the event stream data from GitHub Archive as it is updated in real time and allows us to incorporate the most up-to-date activity data. We then merge the events with data on users (in particular, their reported geographic locations), which is available in the Torrents dataset. We use the latest available snapshot of GitHub Torrents from June 2019. Thus, our event data spans from 2012 to July 2020, conditional on the involved users (project owners and project committers) being registered on GitHub as of June 2019.

Our final dataset has several features. First, it contains the available information from *public* repositories only, as we cannot observe the activity of private projects stored on GitHub. Second, given our research question, we have to limit the data to events where we can identify the location of project owners and project committers. As Figure 1 shows, that leaves us with about 2.4 million registered users and about 36 million repositories.[1] Third, to focus on the collaborative work, we keep only those events on GitHub where a project committer is different from the project owner.

GEOGRAPHY OF THE ACTIVITY AND COLLABORATIONS ON GITHUB: DESCRIPTIVE DATA

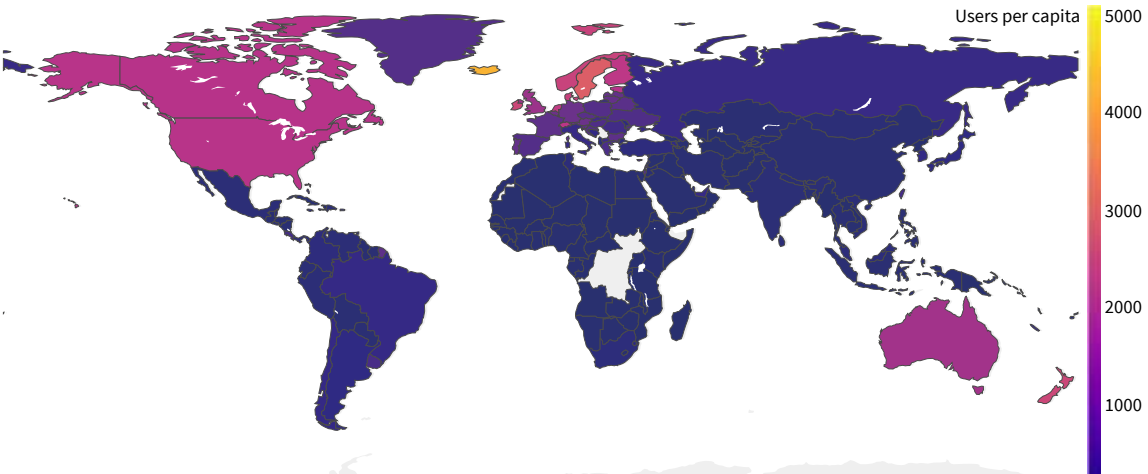
Since its start in 2007, GitHub has become popular with users around the world. Figure 2 shows the number of GitHub users in our data relative to a country's population (in millions). Overall, more advanced countries have a higher share of registered users. It should be noted that even though per-capita activity is highest in North America, Europe and Oceania, populous countries such as India and China have sizable user bases on GitHub as well.

The scatter plot in Figure 3 shows that the share of GitHub users per capita is highly correlated with

[1] In total, as of June 2019 there were 32 million registered users on GitHub and 125 million repositories.

Figure 2

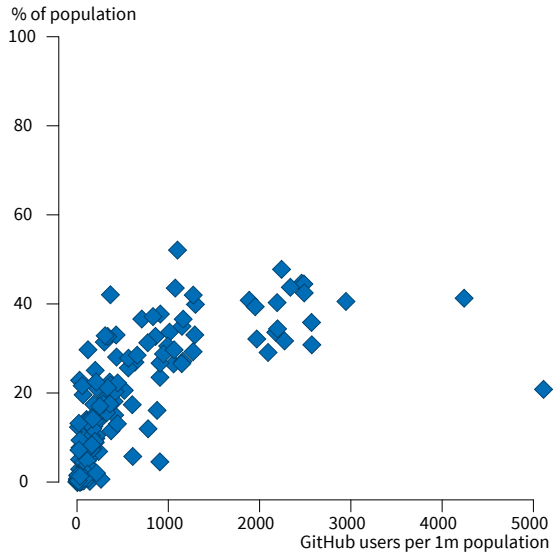
Number of GitHub Users per Capita



Note: This map shows the number of GitHub users per capita (population in millions, i.e. users per one million inhabitants). Only users with reported location; only repositories owned by users with reported location.
Source: Data from GitHub Torrents project (snapshot from June 2019). © ifo Institute

Figure 3

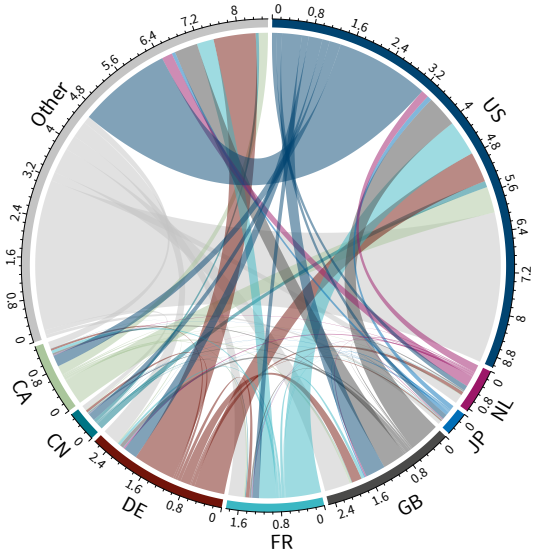
Broadband Subscriptions as a Share of Population and Number of GitHub Users per One Million Population



Note: This scatter plot shows the number of GitHub users per one million inhabitants of a country on the horizontal axis and the number of broadband subscriptions relative to a country's population on the vertical axis.
Source: Data from GitHub Torrents project (snapshot from June 2019); World Bank World Development Indicators 2018. © ifo Institute

Figure 4

Bilateral Flows on GitHub



Note: Number of contributions in millions. Only users with reported location; only repositories owned by users with reported location.
Source: Data from GitHub Torrent project (snapshot from June 2019). © ifo Institute

the number of broadband subscriptions per capita. Even though a slow Internet connection is technically sufficient for working on GitHub, broadband certainly helps, especially when other tools, such as video conferencing, are used for coordination purposes. Of course, a country's level of technological development correlates with both the share of programmers and the share of Internet users in a country. Our data shows that there is also a positive, although weaker, correlation between the share of information and communications technology in a country's exports and the number of users per capita.

Figure 4 depicts the flows of contributions between the eight most active countries on GitHub in our data in terms of international contributions (US, Great Britain, Germany, France, Canada, the Netherlands, China, and Japan), as well as to and from the set of all other countries. Within-country contributions are excluded. The circle shows how the international contributions between the illustrated countries are divided by committers' countries. The flows go toward the project owner's country.

The largest flow between two countries is from committers in France to projects whose owners are in the US (about 700,000 cross-border events), closely followed by commits from Great Britain (600,000), Germany (600,000) and Canada (500,000) to the US. The next-largest flow between countries is from the US (committers) to Great Britain (owner location), which is about two-thirds the size of the reverse flow. Among the countries shown, the top three countries by inflow of contributions to projects owned in the country are the US, Great Britain and Germany. The top three by "outflows" are the same countries, but Germany is in second place and Great Britain is third.

If the total of "outflows" (contributions to foreign projects) is divided by the total of "inflows" (contributions to local projects by foreigners), Germany has the highest ratio (about 2.4) and the US the lowest (0.6). This is interesting in view of the discussion about Germany's scarcity of technology start-ups relative to the US, despite the availability of local engineering talent. It is also in line with the political debate about Germany's export strength and American concerns about the trade balance, even though we are analyzing numbers that do not enter trade statistics. Japan and China, however, are the other two among the shown countries with a ratio smaller than one, despite their export strength.

ESTIMATION OF THE GRAVITY EQUATION

The gravity equation models bilateral interactions between geographic units where economic size and distance effects enter multiplicatively. In particular, the scope of interactions is positively related to partner size, which could be measured by GDP, income or population, and negatively related to bilateral distance. Such models have been used as a workhorse for understanding the determinants of bilateral trade flows for over 50 years, since being first introduced by Tinbergen (1962) – see Head and Mayer (2014) for a recent survey. They have also been widely applied to study the determinants of migration flows, see Beine et al. (2016) and Ramos (2017) for reviews of modelling approaches, and Mayda (2010) and Migali et al. (2018) for applications to international migration.

To estimate the gravity equation for collaborations on GitHub, we aggregate the data at a city-pair and year level. We further restrict our dataset to about 500 of the most active cities on GitHub (as proxied by the number of registered users as of June 2019).[2] These cities together account for over 70% of all commits by users with reported locations. We construct a strongly balanced panel dataset by forming all possible city pairs from our sample for a period between 2012 and 2020, which results in about 2.3 million observations.

We estimate several variations of the gravity model. Our baseline specification is the following:

$$cijt = \beta_0 + \beta_1 dij + \beta_2 X + \tau t + Eijt$$

c*ijt* is the number of collaborations between a city pair *ij* in a year *t*; we measure it by the number of contributions (commits to a project) done by users from a city *i* and submitted to a project owned by users from a city *j*. In our setting, direction matters: collaborations between city pairs *ij* and *ji* are treated as two observations. To make an analogy in terms of the trade and migration literature, we think of a city of committers as an origin (e.g., origin of service providers—exporters) and a city of the project owner as a destination (e.g., destination of services—importers). *dij* is geographic distance between two cities. We calculate it as the shortest path (in km) between cities, using their coordinates. *X* includes a vector of controls. We control for the number of users in origin and destination cities registered on GitHub as of a given year. In addition, we add a dummy for foreign country and a dummy for common language (for cross-border collaborations). Conditional on distance, these dummies capture the effects of state borders and language barriers. All the specifications include year fixed effects, and standard errors are clustered at a country-pair level to allow for correlations in residuals.

In our baseline estimations, we take natural logarithms of our dependent and non-categorical independent variables. Therefore, we can interpret the coefficients of interest as elasticity. However, given that we have count data and many zero observations, for robustness, we estimate the regressions using zero-inflated Poisson method.

[2] We set a cutoff of at least 450 registered users per city as of June 2019, resulting in 511 cities.

Table 1

Gravity Model for Collaborations on GitHub

Variables	(1) Contributions	(2) Contributions	(3) Contributions	(4) Contributions intensive
Distance	– 0.180***	– 0.167***		
	(0.023)	(0.037)		
1–50 km			– 3.038***	– 1.489***
			(0.443)	(0.375)
50–100 km			– 4.372***	– 2.691***
			(0.121)	(0.108)
100–300 km			– 4.931***	– 3.080***
			(0.122)	(0.085)
300–700 km			– 5.072***	– 3.217***
			(0.123)	(0.128)
>700 km			– 5.172***	– 3.342***
			(0.119)	(0.094)
Users, destination	0.111***	0.111***	0.106***	0.305***
	(0.026)	(0.026)	(0.025)	(0.039)
Users, origin	0.097***	0.097***	0.092***	0.204***
	(0.025)	(0.026)	(0.024)	(0.041)
Foreign country		– 0.097	– 0.221***	– 0.427***
		(0.117)	(0.020)	(0.040)
Common language		0.046**	0.021**	0.049
		(0.018)	(0.010)	(0.082)
Observations	2,331,693	2,313,405	2,313,405	94,619
R-squared	0.132	0.135	0.253	0.264
Clusters	5184	5041	5041	2170

Note: The dependent variable is the number of contributions (natural logarithm + 1) between a given city pair. Column 4 presents results conditional on non-zero contributions in a city pair. In Columns 1–2: distance represents the length in km (natural logarithm + 1) of the shortest path between two cities. In Columns 3–4: we use dummies corresponding to different distance bins, where distance = 0 (same city) is the reference category. Economic size is proxied by the number of registered users in an "origin" city (city of a committer) and a "destination" city (city of a repository's owner). All specifications in-clude year fixed effects. Standard errors are clustered at a country-pair level.

Source: Own calculations.

RESULTS

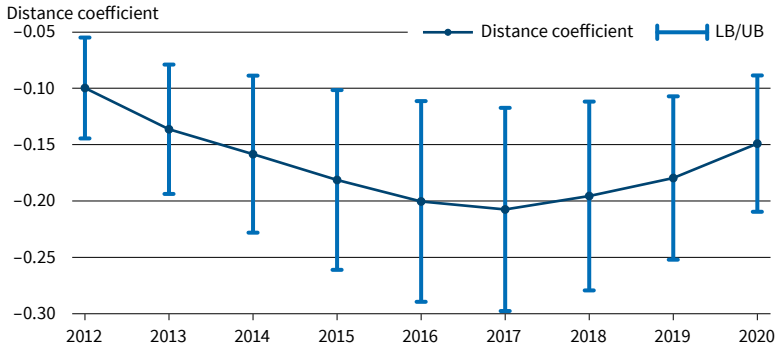
Table 1 presents our main results.[3] Columns (1) and (2) use a continuous measure of distance as the explanatory variable. The effect of geographic distance on online collaborations is negative and statistically significant with an estimated elasticity of 0.17–0.18. The magnitude of the effect is smaller compared to those established for trade (around 0.85 – 1) and slightly smaller compared to those found in the international migration literature (around 0.25). Yet, the effect is still sound, meaning that geographic distance matters even in virtual environments. Column (3) uses distance bins instead of a continuous distance measures to capture non-linear distance effects. The reference category corresponds to collaborations within the same city. The results highlight non-linearity in the distance effect and suggest that interactions on GitHub are substantially more likely to happen within the same city, i.e., between people who know each other personally and/or can collaborate in an offline setting. Beyond the distance of 100 km (roughly commuting distance), the effect stays at about the same level. Columns (2–3) also control for state borders and language. As in the trade and migration literature, conditional on distance, the state borders reduce virtual collaborations, while a common language slightly mitigates this negative effect. Column (4) focuses on the intensive margin and shows that geographic distance as well as state borders also matter for the intensity of collaborations.

[3] All our results are qualitatively robust to including city fixed effects and to an alternative estimation method with zero-inflated Poisson.

Figure 5 investigates whether the effect of distance on GitHub collaborations changed between 2012 (the launch of the platform) and 2020. Despite increases in Internet speed and online collaboration tools, our data suggests that the role of distance on GitHub did not substantially decrease over the last several years (if anything, it increased slightly between 2013 and 2017). The figure, however, is hard to interpret as the platform grew rapidly between 2013 and 2017. One possible explanation is that new users are more likely to start their collaborations locally or that recent user growth comes from professional users, who might be more likely to be co-located in offices than unpaid volunteers in open-source projects.

Figure 5

Distance Elasticity of Collaborations on GitHub in 2012-2020



Note: Distance elasticity is calculated by running separate regressions (same as the specification (2) in Table 1) for each year.
Source: Authors' calculations.

CONCLUSION

To summarize, results in Table 1 and Figure 5 highlight that standard barriers found to affect trade and migration flows also matter in a virtual environment. This is particularly interesting given that (monetary) search costs for a relevant project, technology or a potential partner on GitHub are zero. There are neither the usual "trade" costs, such as tariffs or quotas, nor any travel costs. Moreover, in a transparent setting such as GitHub, the information about the quality of a potential project or a contributor is easy to observe for all the actors. This finding is consistent with Singh and Marx (2013), who show that advances in communication technologies and lower costs of traveling hardly reduce the localization of knowledge over time.

There could be several explanations behind the effect of distance and country borders on GitHub. First, it could be driven by the motivation of programmers working on GitHub. If a programmer's main motivation to contribute to a certain project is career driven and if they consider mainly geographically close labor markets, they might focus their activity on local projects. Second, it is likely that personal contact and offline communication among co-workers matter even for online production processes. While GitHub offers infrastructure for virtual collaboration, certain problems (especially those related to the strategic development of a project) require personal interaction. Third, while software products and programming languages are relatively standard, substantial geographic differences in the contents, available technologies, and approaches to work are likely to exist, making projects from different cities and countries non-compatible. From a non-technical perspective, cultural differences could also play a role. For instance, Lyons (2017) uses data from an online contract labor market and shows that team organization improves outcomes when workers are from the same country. She argues that the effect is driven by easier communication among team members. Laurentsyeva (2019) uses GitHub data and provides evidence that political conflicts (which are completely exogenous to the functioning of GitHub) increase ingroup-outgroup biases among programmers from the affected countries and decrease cross-border collaboration.

Disentangling the exact reasons behind gravity in online collaborations using micro-level data from GitHub is a promising avenue for further research.

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Christopher T. Stanton and *Catherine Thomas*

The Gig Economy Beyond Local Services and Transportation

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The gig economy characterizes a wide variety of short-term freelance work, typically intermediated via online platforms that facilitate matching between buyers and providers. The widespread growth of ride-sharing platforms such as Uber and Lyft has led many to equate gig-economy work with tasks carried out face to face after matching on a platform. However, many gigs or tasks can be both contracted and performed remotely, particularly when the output can be delivered electronically. Platforms that enable this type of work are referred to as online labor markets.

The hiring process in these settings differs from those in traditional offline labor markets in that rapid matching happens for relatively short assignments. Most platforms have a core set of features, such as reputation systems, portfolios of past work, a partially standardized skills canon, payment handling, and provisions to prevent taking work off the platform. The precise contract form is often at the discretion of a buyer, ranging from those paying an hourly wage to those offering fixed fees negotiated for a specified output.

Blinder and Krueger (2013) estimate the extent to which occupations in the United States are amenable to online production, or, in their terminology "offshorable." They conclude that a reasonable estimate of the offshorable share of US employment given the technology available at the time was around 24%. This covers activities that required both skilled and unskilled labor. In information and professional, or scientific and professional, services, the offshorable share was even higher, at around 35%; office and administrative support occupations came in at 41%. Earlier work on services occupations by Jensen and Kletzer (2010) estimated that 93% of computer and mathematical and 64% of office and administrative support occupations could be offshored.

When it is technically feasible, the potential labor costs savings of remote work are substantial. The pay comparison website payscale.com reported that the annual salary in 2018 for a 25-year-old Software Developer with a Bachelor's degree and three years of experience was USD 112,000 in San Francisco, USD 24,000 in Warsaw, and USD 8,000 in Dhaka. A growing literature on market power in the labor market suggests local opportunities, rather than productivity differences alone, contribute to this wage gap (Ashenfelter et al. 2010; Caldwell and Danieli 2018). If wage differences of this order of magnitude can be realized at the level of tasks done online, then the variable cost savings would make it a very appealing option.

However, while several individual platforms have matured into liquid marketplaces (Kässi and Lehdonvirta 2018), aggregate adoption rates for online work remain low. This becomes apparent when considering the public earnings reports from the leading online platforms. At the time of writing, the combined revenues of publicly traded online labor platforms was only a fraction of the traditional staffing firm Manpower's annual USD 20 billion in revenue. Macroeconomic statistics yield similar conclusions. The US Census' Characteristics of Businesses Survey found that only 1.5% of all firms outsourced or transferred any business function and/or service to a company outside the US in 2015. The industry with the largest number of firms reporting this activity was Information (NAICS code 51, producing and distributing information and cultural products; providing the means to transmit or distribute these products as well as data or communications, and processing data), at 6.9%, and the US State with the largest reporting share was California at 2.6%.

Turning to the supply side, in the US over recent decades, there has been a decline in the share of self-employment among more highly educated workers relative to less-well educated workers. This suggests that those at the higher end of the labor market are not as likely to engage in gig work—which is, by definition, self-employment—at least as their primary form of employment. This is also likely consistent with analysis from tax records on the rise of the platform economy, which shows that the majority of new gig-like work arrangements tend to be coming from ride sharing or co-located services (Collins et al. 2019).

REASONS FOR THE LIMITED GROWTH OF ONLINE FREELANCE WORK

Considering the aforementioned trends together, the limited growth of online freelance work in spite of its technical feasibility and low cost is consistent with an existing barrier in the form of coordination costs or contracting frictions that exist at firm boundaries. This paper explores the composition of tasks that are conducted via online labor markets and offers some comments on why adoption is not yet as widespread

as in more standardized gig economy sectors such as ride sharing.

Because of the differing trends in gig work by skills required and education level, it is interesting to first ask what types of skills are demanded online and by whom. Data show that the majority of potential buyers are in English-speaking countries and are looking for temporary freelance workers to complete discrete tasks. On most platforms, buyers must include a task description in the vacancy posting that goes into quite some detail about the skills required. Various sources show that most tasks are either of a technical nature (e.g., web or software development), or require specific skills such as design or translation. Nonetheless, vacancies in administrative support and data entry are also common.

Historical data from a leading platform reveals whether it is possible to predict which potential buyers will end up becoming frequent users of the platform from their observable characteristics. Data from 2008 to 2010 that contains information on over 60,000 buyers shows some evidence that buyers of technical services are relatively less likely to adopt the platform after trying it out. Buyers in larger enterprises are also less likely to adopt the platform than sole proprietors or smaller enterprises. Other than these factors, observable buyer characteristics or attributes of the vacancy posting have little explanatory power for platform adoption.

Given these two factors, it seems likely that buyer fit with online labor relates to the willingness or ability to carve out well-defined tasks that can be done by a specific individual and then integrated with other production activities. Complex technical jobs or those requiring integration into larger production processes may make the up-front investment in writing specifications and the onboarding and monitoring of arms-length contractors difficult to justify relative to a local, known alternative.

Much of the other work on these platforms has studied providers' careers or earnings (Horton 2010; Pallais 2014; Stanton and Thomas 2016), and the impact of the gig economy for the labor force as a whole – see Koustas (2020) in this volume, and Datta et al. (2018). The data on self-employment trends in the US show that more highly educated individuals, who tend to be in occupations that require interaction with other activities, are tending to remain within firm boundaries. Hence, it is plausible that the challenges associated with communication across tasks have proved to be a barrier to more rapid growth of task-based online work.

The Oxford Internet Institute's Online Labour Index[1] documents a 50% increase in job postings between May 2016 and March 2020 on the five largest online platforms. This paper concludes by providing results that suggest how the growth rates of online platforms may be impacted by the Covid-19 pandemic that hit the English-speaking world from March 2020 onward. Initial evidence shows that demand declined steeply until the first week of April, but rose to unprecedented heights up to the end of May. The increase was particularly steep in software development and technology tasks and from buyers located in the US. It is likely that many new buyers turned to these platforms for the first time, experimented with their use and learned how to hire and how to coordinate remote work. In this vein, recent work shows that gaining experience with this form of labor sourcing can help buyers to become long-term adopters (Stanton and Thomas 2020). This finding is analogous to recent literature suggesting that the pandemic revealed that, at least for some firms, workers were more productive working from home or in new arrangements (Bartik et al. 2020).

As countries ease out of lockdown, it will be interesting to observe whether the increased experimentation with online labor that has occurred during the last few months is sufficient to convince buyers of its overall appeal.

WHO BUYS ONLINE LABOR SERVICES?

The Online Labor Index tracks activity across the five largest English-language online labor platforms, which represent over 70% of the total market. The index measures supply and demand across countries and job types by tracking the number of projects posted across the different platforms in real time. According to these data, in the first week of July 2020, 38% of the value transacted online originated in the US, 9% in the UK, and 6% each in Canada and Australia. As the largest source of service providers globally, demand from India also made up 8% of this value. In the same week, 46% of the value was in software development and technology tasks, and 20% was in creative and multimedia tasks.

At the start of this index, in May 2016, 53% of vacancies were posted by buyers in the United States, and 35% were in software development and technology. Going back even earlier, in microdata from a single large platform dating from 2008 to 2010, 57%, or just over 67,000 buyers, were located in the US. 49% of all vacancy postings were in technology jobs, either web development or software development. At this time, the other main types of vacancies posted were tasks in Administrative Support (15%), Sales and Marketing (11%), Writing and Translation (10%), and Design and Multimedia (10%).

Around half of all vacancy postings were for tasks that lasted less than one month. This suggests potential buyers had defined discrete objectives to be delivered, and were not seeking to contract for ongoing deliverables. That is, the work content tended to be task- or gig-based. Technical tasks and tasks in design and multimedia were more likely to be short term,

[1] See http://ilabour.oii.ox.ac.uk/online-labour-index/.

consistent with the idea that the deliverable output is a discrete piece of work. Customer Service and Administrative Support vacancies were more likely to be longer term, consistent with these tasks being recurring for most businesses, rather than project-based.

WHEN DOES ONLINE PRODUCTION REALLY WORK?

Data from the large platform also reveals which potential buyers ended up being intensive users of this technology, and for what types of tasks. Amongst all buyers who posted at least one vacancy on the platform, outcomes were very heterogeneous. 11% hired five or more times over the next two years, while 73% didn't hire at all. For the rest of this paper, this 11% of buyers is referred to as the "adopters."

The data permits tracking all the buyers who tried out the platform during this time and, hence, at what stage the non-adopters opt out. In seeking to explain why some buyers adopt the technology and some do not, it is important to understand whether they differ from non-adopters in observable characteristics or in their early actions on the platform. Figure 1 compares adopters with all buyers. Adopters are slightly more likely to be located in the US, at 62% vs 57%. This may suggest that US buyers find it easier to contract at arm's length for the type of discrete tasks that are suited to these platforms. They may also have more flexibility in their labor-sourcing decisions or in regulations that enable this type of contracting.

Figure 1 also shows that the buyers who end up adopting the platform are less likely to have posted their first vacancy in a technical job category. Relative to expectations when deciding to try out the platform, it could be that these types of tasks require more communication and are harder to coordinate at arm's length. In contrast, there is no real difference between all buyers and those who adopt the platform as part of their first job posting, as measured by whether the first vacancy is likely to last over one month.

The final two pairs of bars in Figure 1 show that adopters differ from typical buyers in that they are more engaged with the platform right from the start. From the outset with their first posting, they are more likely to conduct applicant interviews, at 82% versus 63%, and they are much more likely to fill their first vacancy posting on the platform. In fact, 32% of adopters hire on the first posting as compared to 15% overall.

The figure therefore shows that early engagement is correlated with becoming an adopter. Adopters also conduct a larger number of interviews on the first posting and are more likely to hire when controlling for the week of first posting, the job category, and the country where the buyer is located. Even a buyer who does not hire on the first vacancy is more likely to become an eventual adopter if they conducted interviews for the first vacancy. Of course, these summary figures are consistent with either more engaged buyers doing more to figure out how the platform works and how to manage workers—actions that increase the utility from contracting with online labor—or due to unobserved heterogeneity across buyers. We now turn to the question of whether this selection either in or out of early engagement and eventual platform adoption is based on some unobservable buyer characteristic or is instead due to the early actions taken on the platform.

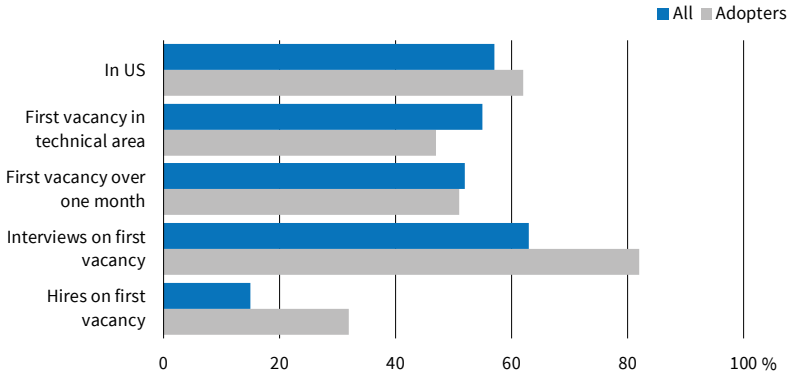
WHY DOES EARLY ENGAGEMENT VARY?

Ideally, buyer heterogeneity versus engagement with the platform could be disentangled using a well-designed experiment. In the absence of this kind of evidence, models of buyer engagement that account for the composition of the applicant pool, the prices offered, and details about the vacancy can be estimated. Accounting for the buyer and vacancy characteristics that are observed by potential applicants, seemingly random variation in the applicants seen early on may shape buyers' eventual adoption by affecting their initial experience. Furthermore, if some buyers adopt the platform despite receiving lower-quality applications and others opt out despite receiving high-quality applications, it is likely that heterogeneous buyer types are trying out the platform and eventual adoption is unrelated to their early experiences. Stanton and Thomas (2020) conduct this analysis, and the results put weight on both these explanations. That is, buyers' early actions play an important role in accelerating or hindering platform adoption even after attempting to account for differences in buyer types.

To illustrate how this procedure distinguishes between various explanations, imagine there are two types of buyers: one type places a high value on online hiring when trying it out, whereas the other type is skeptical. Because of their initial enthusiasm, type-one buyers are likely to hire even when the set of applicants is rather lousy. On the other hand, the

Figure 1

All Buyers vs Adopters



Source: Proprietary Data from a Large Online Labor Market.

type-two buyer will only hire when the applicant pool includes star providers. The distribution of buyer types can be inferred from buyer responses to receiving varying applicant pools. Still, within each type, some fraction of buyers will hire and some will not. The analysis shows that even when conditioning according to type, buyers that hire early on post more later vacancies and are more likely to become adopters. That is, early actions to engage with the market by hiring lead to long-term future use.

WHAT ELSE CHANGES WITH EXPERIENCES?

Having overcome any barriers to first using the platform, buyers appear to learn how the platform works as they hire labor services. The data contain two variables about the intensity of search to fill each vacancy: the length of the task description, in characters, as well as the number of interviews.

Regressions that include buyer fixed effects show that the length of the description of the work in the vacancy posting tends to shorten on successive posts. Figure 2 plots the average number of characters in the description, controlling for the week, the type of task, and the expected duration of the vacancy, along with buyer fixed effects. The grey bars are for those buyers who go on to become adopters, and the blue bars show non-adopters who are posting vacancies in the market after having made a number of hires, but will drop out before making five hires. Because buyer fixed effects are included, the average number for both groups is the same prior to doing any hires, and, because adopters are defined as those who make at least five hires, there are no non-adopters in the data at this experience level. The grey bars show significant declines after making one hire, with adopters posting descriptions that are 14% shorter after making five hires.

This reveals either that the buyers that become adopters learn to communicate their needs more effectively or learn that providing detail about the task does not improve matching applicants to the tasks.

Figure 3 plots the average number of interviews conducted at different levels of hiring experience, controlling for week, job category, and buyer fixed effects. Again, the grey bars are for those buyers who go on to be adopters and the blue bars represent all other buyers in the data after making the relevant number of hires. Both series show a reduction in the number of interviews on successive posts, and, while this decrease is even greater for the non-adopters, adopters decrease the number of interviews by 36% by the fifth hire.

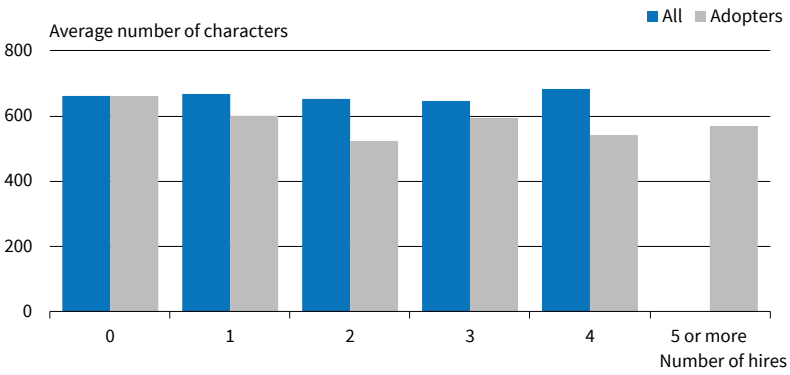
This finding could mean that all buyers learn how to select applicants for interviews or how to differentiate between applicants more easily during interviews. It could also mean that buyers learn that interviews are not particularly helpful in differentiating among applicants. In either case, Figures 2 and 3 suggest the vacancy posting and search process is less time consuming once buyers have learned how the platform works.

Gains from experience hence appear to include reducing the cost of using the platform, but many buyers drop out before reaping these benefits. A key question for the future growth of these technologies, then, is whether it is possible to lower the costs of engaging with the platform when first trying it out. Recent work by John Horton addresses this question by studying interesting market design interventions that seek to lower these costs (Horton 2017 and 2019), and which are shown to be effective in doing so on the margin.

The fact that buyers opt out of the market after posting vacancies suggests they were initially uncertain about the extent of engagement costs. One way to overcome this uncertainty about the platform would be for buyers to run small tests to determine whether the market works for them. In fact, in most models of experimentation, one would expect buyers to post short tasks to evaluate whether the platform meets their needs, after which they would scale up hiring. The microdata, however, offer no evidence that buyers operate this way. For example, the propensity to post a long versus short vacancy varies little over the buyer life cycle. This suggests that one barrier to

Figure 2

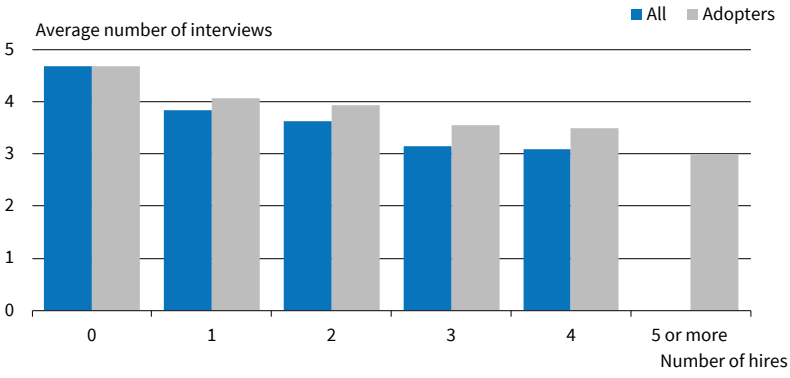
Length of Job Description, Controlling for Expected Duration and Buyer Fixed Effects



Source: Proprietary Data from a Large Online Labor Market. © ifo Institute

Figure 3

Number of Interviews by Number of Previous Hires, Controlling for Buyer Fixed Effects



Source: Proprietary Data from a Large Online Labor Market. © ifo Institute

adoption may be the difficulty in fragmenting tasks into their sub-parts, because, to conduct a short experiment on the platform, a buyer must first design a short and self-contained task. Instead, buyers appear to jump in headfirst with whatever task needs to be done. There is also evidence that buyers default to hiring providers who are more likely to be familiar to them (Ghani et al. 2014). When the first vacancy posting and first hire go well, and buyers find that the platform is a good fit, they post more vacancies on the platform and look for providers to do tasks that vary in work content but not in length.

Among the possibilities suggested by the data, one likely explanation for why some buyers opt out of platform use is that posting the vacancy and viewing applicants shows them that coordinating online work is relatively costly and they decide to go no further. Unlike the act of summoning an Uber, online labor markets require a buyer to be actively involved in project management, and this management is likely to be costly.

WHAT'S NEXT FOR ONLINE WORK?

Turning back to data on self-employment in the US, among the educated (those with a BA or higher degree), long differences in employment trends show that the highly educated—those whose skills are well-suited to online work, particularly to technical tasks—are much less likely to be self-employed than they were historically. This is displayed in Figure 4, which uses data from the CPS ASEC surveys for males over time. The left panel looks at changes in self-employment within the education cell and shows large drops for those with Bachelor's or higher degrees. The focus here is on males to avoid confusion with secular increases in female labor supply. Of course, educational attainment increased over this period, so the rightmost figure considers changes to the population share of self-employment. Rising educational attainment partially offsets the decline in per-capita self-employment for those who hold at least a Master's degree. The direct implication of these trends is that more economic activity among skilled individuals is occurring within firms rather than via self-employment.

It is also notable that the population-level decline in self-employment ends around 2011 for those with a high-school degree or a lower level of education. The rate of self-employment even begins to turn upward in 2015, coincident with the rise of the driving economy (Collins et al. 2019). No such uptick exists for the highly educated.

Although there are a number of factors at play, differences in the task content of jobs may explain some of these differences. According to O-NET data, educated workers are less likely to be in routine jobs and are more likely to be in jobs that require math skills, social skills and interaction with others (Deming 2017). For these types of occupations, the need to combine technical skills and coordination on the job likely increases the overhead of managing contracts beyond firm boundaries.

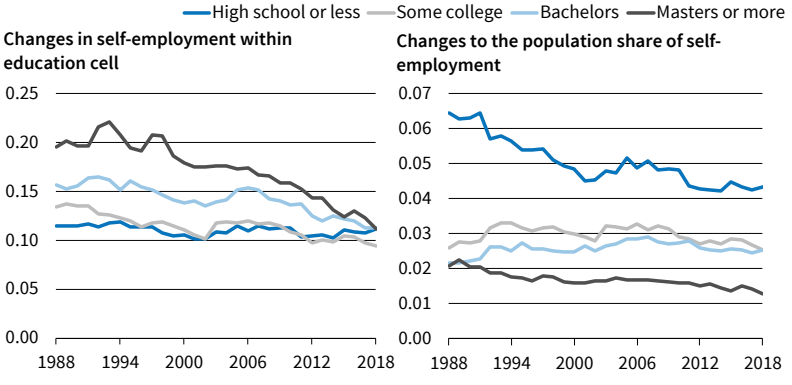
Tying this back to online labor markets, why then are technical tasks such a large fraction of vacancy postings if these tasks require interaction and coordination? One possibility is that automation is putting pressure on more routine activities in administrative support, allowing employers to turn away from labor markets altogether and toward computing power for their needs. Another possibility is that tasks come with a fixed cost in terms of management time, and higher-value technical tasks may yield larger gains relative to fixed costs than doing routine tasks.

What do these findings mean for the future of remote work? The first half of 2020 has seen perhaps the largest shock to its prevalence, following national lockdowns in countries worldwide that meant that work should be done at home whenever feasible, even within firm boundaries. In a recent working paper, Stephany et al. (2020) document some very interesting patterns in the demand for arm's-length US online workers from buyers located in countries that went into lockdown. In the early days of a country's lockdown, demand for freelance online services fell, but, as the local lockdown continued, demand for online labor increased and soon overtook initial levels. For example, by the start of April, Korea had been in lockdown for several months and demand for online labor had risen to levels above those seen prior to the crisis. Germany saw a later upturn, and the US upturn was even later, as the crisis played out at different times in these countries.

It may well be that once a large share of the workforce is working from home, confronting all of the challenges of coordination and communication across diverse locations, undertaking such activities at arm's length, across firm boundaries, will also start to appear less daunting. If potential buyers are able to capitalize on what they have learned over the last few months, then demand for all types of remote online work may continue to grow, even when local economies return to more typical working conditions.

Figure 4

Male Self-employment by Education



Source: CPS ASEC Universe for Ages 18–65 and Years 1988–2018.

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Eliza Forsythe

Automation and Technological Change: The Outlook for Workers and Economies

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Since the advent of mechanization, predictions regarding the demise of jobs have accompanied each labor-altering technological advance. In 1930, John Maynard Keynes coined the phrase "technological unemployment" to express the idea that technological change may lead to gross and potentially permanent declines in employment (Keynes 2010). In recent decades, the rise of big data, machine learning and robotics promised a dramatic reorganization of industrialized economies, which always seems to be just around the corner. While past episodes of technological progress did not lead to permanent unemployment, many fear this time is different. Dire predictions have been made, such as a report by Frey and Osborne (2017) arguing that, with current and emerging technology, over 47% of all jobs stand to be automated in the coming decades.

UNDERSTANDING TECHNOLOGICAL CHANGE

To understand how technology changes jobs, it is useful to first divide jobs into component tasks. An economy can be envisioned as a large number of tasks to be performed, groups of which are bundled into jobs, which are then further bundled into firms. A new technology can change the task distribution in two ways: first, it can replace tasks that were previously performed by individuals; for instance, mechanical looms developed in the eighteenth century directly replaced artisanal weavers. Second, a technology can require the development of new tasks, typically in order to operate, maintain and improve technology; in the case of the weavers, mechanical looms were operated by individuals untrained in weaving and maintained by mechanics and technicians. The mechanization of textiles thus led to a massive reallocation of labor, creating new jobs for women and children, but destroying those for the artisanal weavers who could not compete with mass-produced textiles. Similar patterns play out today with modern industrial robots, which directly replace factory workers, but create new jobs for developing, assembling, programming and maintaining the robots.

For other types of technological change, the effect on workers is more nuanced. Consider the case of secretaries and office support workers. Until the 1980s, the majority of secretarial tasks consisted of typing and re-typing documents, as well as filing and maintaining physical databases. Several rounds of innovation, beginning with the widespread adoption of personal computers in the 1980s, have moved secretarial jobs away from these routine tasks. Job ads for office support workers now request a variety of skills related to software and technology, and list a broad array of required tasks, ranging from accounting, customer service, writing and beyond. Evidence suggests that technological change did not cleave tasks from secretarial jobs, but rather broadened the scope of tasks involved in the job through having secretaries operate newer technologies. We can refer to such cases as "worker-augmenting" technology, as opposed to the "worker-replacing" technology in the aforementioned cases of textiles and industrial manufacturing.

For many white-collar and skilled jobs, emerging technologies are best described as worker-augmenting. For instance, radiologists can be assisted by AI that evaluates films and flags patterns the radiologist may have missed, making a radiologist more accurate and perhaps increasing the volume of scans a single radiologist can oversee. Nonetheless, AI is unlikely to replace other aspects of a radiologist's job, which include synthesizing information from scans with the rest of the patient's medical history to make a diagnosis and treatment plan, and communicating with other physicians and patients. Thus, radiologists may increasingly be asked to have technical skills to operate the AI. Further, like office support workers, the adoption of radiology in AI is likely to allow radiologists to specialize in the aspects of the job that are much harder to replace with technology.

This occurs because of the comparatively narrow range of tasks that modern technology can perform. To use terminology popularized by Autor et al. (2003), computers, AI and robots excel at *routine tasks*, that is, narrow and well-defined tasks performed repeatedly. When such tasks are combined with human intellect, individuals can harness the power of the technology to improve their own productivity and performance. However, this is very different from replacing a radiologist with AI.

Jobs that primarily consist of performing routine tasks, such as assembly line workers, switchboard operators or travel agents, are more likely to be at risk from technology. Most jobs, however, are more broadly based, encompassing routine, interpersonal and cognitive tasks. In these jobs a facility with work-

er-augmenting technology can provide great dividends to individuals and their employers.

UNDERSTANDING THE ADOPTION OF TECHNOLOGY

A search of current job postings finds a handful of firms advertising for switchboard operators. This may seem surprising, as automated options for telephone switching have existed for decades. A large gap exists between what futurists predict for jobs, what technology is currently available, and what technology has been actually implemented in a widespread way.

Adopting new technology often requires large costs, both upfront and recurring. The machine or technology must be installed and customized, after which it must be maintained by skilled technicians, who are often harder to come by than the workers that usually perform the tasks that the technology is replacing. If the technology is to be used by the current workers, they must be trained and convinced to "buy in" to the new technology, as many businesses discover after purchasing an expensive software product only to find that none of their employees make use of it. Adopting a new technology hence relies on a cost-benefit equation, such that many firms will appear to lag in adoption due to the cost barrier.

In light of Covid-19, such calculations may be altered dramatically. Disease mitigation requires humans to keep a certain distance from other humans, giving an edge to automated processes. Technology that completely replaces humans or allows businesses to operate with fewer in-person staff gains significant value in this context. Businesses previously undecided on adopting such technology will be more likely to move ahead with it. However, as the accompanying recession will likely curtail capital investments, I do not expect this effect to be widespread.

Adopting worker-assisting technology is likely to be curtailed during the pandemic. In addition to economic limitations on new capital investment, the necessary worker retraining and buy-in for new technologies are difficult to accomplish under distanced or other extraordinary pandemic conditions. As economies recover, however, businesses may take advantage of the opportunity to invest and hire new workers skilled in new technologies (see Hershbein and Kahn 2018), accelerating adoption at that point.

The overall effect of technological change on wages and employment is, therefore, quite mixed. Both worker-replacing and worker-augmenting technologies may reduce the employment demand for workers in the affected job. In the former case, workers are directly replaced, while in the latter case, broadening the job to encompass additional tasks may offset the drop in demand directly due to technology replacing aspects of the job.

As for overall employment, predictions are ambiguous. Why? Although less worker time is spent performing the automated task, new tasks may be created (such as operating or building the technology), and the productivity gains may spread throughout the economy. Depending on the magnitude of these spillover effects, growth can be either positive or negative and overall wages can fall or rise. What is undeniable is that the impacts are unequal, as some workers will lose their jobs at the same time as new opportunities open up for others. Policy regarding technological change should be crafted to mitigate these inequalities.

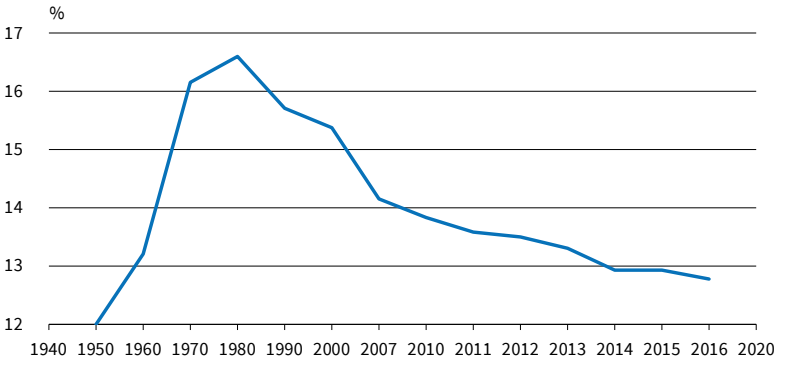
CASE STUDY: OFFICE SUPPORT WORKERS

We can examine the direct and spillover effects of technological adoption more closely by focusing on one field. In Dillender and Forsythe (2020), we investigate recent changes for office and administrative support (OAS) workers due to technological adoption. Figure 1 shows the trajectory of employment of OAS workers in the United States, peaking in the 1980s and falling dramatically thereafter. Although OAS employment has fallen from a peak of 16% of all US employment, at 13% it still represents a greater share of workers than manufacturing. Predictions by Frey and Osborne (2017) suggest that OAS workers could be almost wholly replaced by technology, making this an important focal group.

We drew from over 8 million online job postings for office support workers between 2007 and 2016 to investigate the changing task content of jobs. Figure 2 shows the increase in the appearance of particular phrases as employers list new technologies and software packages in the postings. Over time, the jobs require more skills, with employers asking for additional higher-skill tasks such as writing, accounting and finance and cognitive tasks. We do not find evidence that more-basic office support tasks are disappearing; on the contrary, employers still mention copying, filing, and answering phones in their descriptions. This is indicative that these jobs are becoming more skill intensive and broader, with office support workers being asked to perform a wider variety of tasks.

Figure 1

Office and Administrative Support: Share of Employment



Source: Dillender and Forsythe (2019). © ifo Institute

Why might these jobs become more skilled? One possibility is that, in order to employ individuals who are adroit in handling modern technology, employers are hiring individuals who are skilled in other ways. This allows employers to include a wider variety of office tasks in the job description. Importantly, the addition of new tasks and skills makes OAS jobs less similar to the routine jobs that are most at risk for replacement by automation. The additional tasks are more likely to rely on judgment, interpersonal skills, and higher-level thinking—exactly the types of tasks that humans excel at and that machines perform poorly. Thus, while technology has dramatically reshaped these jobs, it appears to have insulated these jobs from elimination due to future technological change.

Tasks shifted to OAS jobs include many that used to be in the domain of higher-skilled office jobs such as accountants, human resources managers and other specialists. This suggests that employers are shifting tasks between job titles as skilled and technologically augmented OAS workers are able to take on more tasks. All these facts point toward a far more optimistic view of the future of OAS jobs than a static view of jobs would suggest.

THE EFFECT OF OFFICE SUPPORT TECHNOLOGY ON THE BROADER LABOR MARKET

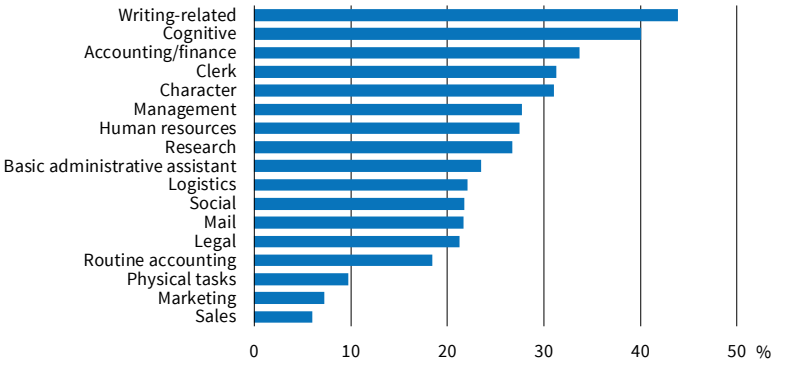
Although a broader skill portfolio insulates OAS jobs from elimination, we saw in Figure 1 that the share of OAS employment continues to fall. To investigate the effects of technological adoption in a specific field on the broader labor market, we look (Dillender and Forsythe 2020) at labor market outcomes for the surrounding geographic area. By comparing locations where employers have adopted more technology to those whose employers have adopted less and by using nationwide industrial trends, we can isolate the *effect* of technological adoption on labor market outcomes. (In the paper we describe this methodology in detail.)

We find that more OAS technology usage results in less employment in these jobs, which is consistent with the evidence suggesting that fewer individuals are increasingly able to perform more work, and with the general downsizing (but not-elimination) of secretarial workers in the modern office. However, despite these job losses, the local areas in which more technology was adopted show *higher* overall employment. Thus, rather than killing jobs overall, this type of technological change leads to job growth. As discussed above, this may be due to increased productivity, which can grow the local labor market.

It is important to note that this is not a general result about technological adoption. For instance, Acemoglu and Restrepo (2020) find that adopting industrial robots *reduces* overall employment. The key difference seems to be that industrial robots represent job-replacing technology, whereas OAS technology is operated by OAS workers and hence is job-augmenting. Nonetheless, since much white-collar automation is more likely to share similarities with the adoption of OAS technology, our results suggest that such technological change may increase overall employment.

Figure 2

Job Ads: Percentage Increase in Frequency



Source: Dillender and Forsythe (2019). © ifo Institute

Although total employment rises, the gains do not benefit all workers. We find that employment growth is concentrated among women with college degrees, while wage losses are largest for women without a college degree. This suggests two simultaneous processes: less-educated and predominantly-female workers are pushed out of OAS employment (or are never hired to begin with), leading to increased competition for jobs that do not require a college degree, leading to decreased wages for these workers. Meanwhile, the increased productivity of office support workers increases productivity for all white-collar workers, as they work hand-in-hand. This expands employment in white-collar jobs, opening up opportunities for women with college degrees. Adopting technology thus pushes the labor market to favor more highly educated workers, while leading to worse outcomes for the less educated.

We do not find a discernible effect on average wages, as less-educated workers experience losses whereas other workers see gains. However, since employment increases, total earnings in the local area rise.

CONCLUSION FOR POLICY MAKERS

There are several conclusions one can draw from our research. First, jobs are not written in stone. Instead, employers can adjust job duties and requirements, often without even changing the job title. This means that, while technology may replace *tasks*, this occurs in conjunction with new tasks being added to jobs (not the least of which is using the technology). In the case of office support *jobs*, the modern support worker is asked to perform a wider variety of tasks, resulting in such jobs persisting with fewer, higher-skilled workers. This will be the case in any job

requiring employees to operate or interact with new technologies. The vast majority of automation technologies now available or on the horizon will cause jobs to change, but not disappear.

Second, the overall effect of such technologies on the labor market is mixed. If history is a guide, in the longer term we should expect employment to continue to grow. In the case of OAS technology, we find overall growth in local employment accompanies adopting ongoing technological innovation. While automation and technological change require active labor market policies to manage transitions, this progress should be welcomed.

Third, as with many economic disruptions, gains and losses are unevenly distributed. In particular, losses appear greatest for those without college degrees. Policy-makers should be aware that the continued march of technological change is likely to lead to disruptions in individuals' careers. Individuals who experience such technological displacement need support to find employment in suitable alternative careers. Such support should include income support and access to training.

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Oliver Falck and *Johannes Koenen*

Resource "Data": Economic Benefits of Data Provision*

ABSTRACT

The importance of data for economic growth and development in Germany and Europe is undisputed. This study identifies various factors that may cause market failures for the good "data". As a consequence, markets alone may not lead to efficient allocation of, optimal access to and sufficient participation in data that is collected and stored. At present, different market-based, political and regulatory efforts are being undertaken in this context: State intervention such as a right to data access is pursued in parallel with private sector solutions such as data trusts or platforms. Given the complex issues underlying potential market failures, competition between different solutions is welcome.

Data has replaced oil as the world's most valuable resource over the past decade. In June 2008, according to the Financial Times Global 500 list, the four most valuable companies in the world were oil companies, whereas in mid-2018, the seven companies with the highest market capitalization were Internet and technology companies. Their business models are based, to a significant extent, on collecting, analyzing and using data. Whereas the success of oil companies relies on a resource that is finite and only available in certain places around the world, data is not subject to physical scarcity – on the contrary, current technological developments are leading to a rapid increase in both the amount of digital data available and its potential economic value. Collecting data has become much cheaper. Falling costs of digital sensors have accelerated the development of the Internet of Things (IoT) and proliferating smart devices generate streams of data. This process is likely to speed up further, as economic activity continues to shift to the Internet and increasingly complex digital devices are brought to market. For example, it is estimated that each autonomous vehicle produces three orders of magnitude (or more than 1,000 times) more usable data than the average Internet user (Schlosser 2018). Storing the data itself has become cheaper not only "technically" (falling prices for storage media), but also "organizationally": specialized market players such as cloud providers are providing solutions that exploit economies of scale on a grand scale and reduce the necessary initial investment for users (Carrière-Swallow and Haksar 2019). From the perspective of the collecting companies, this means that fixed investment costs are converted into variable costs. Beyond collection and storage, there are increasingly better possibilities for evaluating and analyzing collected data. Machine learning (ML) and artificial intelligence (AI) can identify underlying structures in existing data and generate forecasts or gain insights into user behavior. This may enable more efficient production, targeted advertising, automatic interaction with customers (via bots) or, in the near future, autonomous vehicles. Therefore, data is becoming increasingly valuable – and as a consequence the question of who controls data is drawing substantial attention.

German and European politics are increasingly focusing on access to and the free movement of data. The EU initiative for a Single European Data Space (European Commission 2017 and 2018) is a good example of this. From the German point of view, it is a particular concern to keep small and medium-sized enterprises competitive through access to data – this is expressed, among other things, in the key issues paper on SMEs by Economics Minister Altmaier (BMWi 2019).

After a brief description of the empirical role of data economics in the German and European economy, we examine which specific economic characteristics of "data" may cause market failures requiring

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regulatory intervention. We first analyze the incentives for data production and collection, followed by an examination of the extent to which (market) transactions and the exchange of data do or do not lead to efficient allocation of data. Only if and where there are market failures, for example in the face of externalities, a potential need for data regulation arises: This then raises questions on how to implement it in practice, which are discussed in the final section.

THE CONTRIBUTION OF DATA TO ECONOMIC PERFORMANCE IN EUROPE

Within the framework of the European Data Monitoring Tool, the European Commission has commissioned a study on how the data economy is developing in Europe (IDC 2019) based on a wide range of measures, including: the number of data-centric jobs and firms, the value of traded data-based services and products and the contribution of the data economy as a whole to the European gross national product. In 2018, 283,000 companies in Europe were classified as data providers – i.e., their main activity is to provide digital, data-based products and services. Compared to 2017, this number had risen by around 4.3%. The growth was even stronger for employees collecting, storing, managing, analyzing and visualizing data (an increase of 8.4% from 6.6 to 7.2 million). Therefore, 3.4% of all persons employed in the EU were working in the data economy. Growth appears to be limited by the lack of supply of data experts: in 2018, about 571,000 vacancies for data jobs in the EU could not be filled. Overall, the "data market" in the EU – i.e., the products and services based on the evaluation of data – was valued at EUR 71 billion – a substantial increase of 9.7% over the previous year. Taking multipliers (the data sector generates additional value for other industries) into account, the data economy generated around EUR 377 billion worth of output in the EU in 2018, or 2.6% of the overall economy. With a rate of 12%, the data sector is growing far faster than the overall economy on the continent (around 2%). This continued a lasting episode of extremely rapid growth (since 2014, the data economy in the EU has grown by around 50%). In addition to the lack of specialists mentioned above, a second central obstacle for further growth has been identified both by researchers and policymakers: The current regulatory environment requires reform, which will be a focus in the further course of this study.

CHARACTERISTICS OF THE "RESOURCE" DATA AND INCENTIVES FOR DATA COLLECTION

The focus of this study is data in digital form. We define data as digitally stored information that can be put into relation to other information and analyzed. For example, a temperature indication alone is not a data point; whereas, when it is combined with the time and place of measurement the information can be used for analysis or as an input into a service or product. Furthermore, it is valuable to know who (and, if applicable, with what type of instrument or sensor) collected the data point in order to assess the reliability of the observation (Koutroumpis et al. 2017).

Depending on the form in which data is available, the amount of effort required to analyze it differs substantially. One speaks of "unstructured" data, if the information is not organized in a database (or a comparable structure), but is, for example, distributed over various files and formats, or is available in a pure text form. Creating a structure (such as a database) in which data can be collected and organized and bringing it into a form that is conducive to analysis and evaluation requires effort and incurs substantial costs. Figure 1 illustrates this as one of the steps in the data value chain. Once data has been collected and structured (not necessarily by the same actor), it is passed on for analysis. At this point, the structured data is combined and enriched with further information, if necessary. Based on this dataset, systematic relationships in the data are examined using algorithms from the fields of AI and ML. The results of these analyses are in turn passed on to actors for whom they generate value. Based on the findings, e.g., advertising can then be tailored to the data subjects, or maintenance cycles of machines can be optimized.

Different settings are observed in practice. Each of these steps may be performed by the same actor – one example is Amazon: the platform observes user searches and purchasing behavior, evaluates it itself and finally places its own advertisements and recommendations (but also passes the information on to advertising partners). However, Figure 1 also suggests that, for example, a company specializing in ML approaches depends on access to data collected by others. Access to data is essential for SMEs and start-ups without data collection capacities, as well as in AI development, for example to "train" algorithms. How this access is implemented in practice depends to a large degree on the nature of the underlying data, as discussed below.

The Economic Value of Data

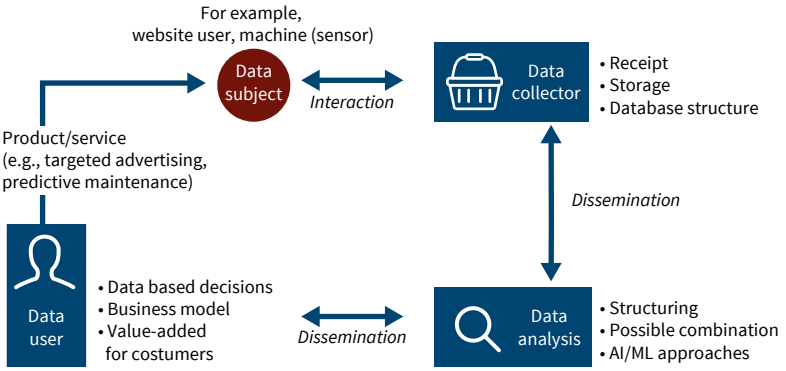
Conceptually, there are three central mechanisms for generating additional value from data and its analysis:

1. Through data-generated insights, business processes can be made more efficient and better decisions can be made (e.g., Brynjolfsson et al. 2011).
2. Integrating data enables the development of new products and services.
3. Data analysis potentially solves information problems and reduces information asymmetries, from which some market players can benefit.

Data may provide companies with more efficient organization or new "smart" products and services. However, point (3) above implies possible negative effects on some market participants. Lacking information can limit market efficiency: there may be less exchange than would be optimal and thus welfare is lost. However, a central result of information theory say that asymmetric information is associated with information rents for some actor(s). This includes some fundamental examples: If a retailer does not know a customer's exact willingness to pay, it cannot set prices in such a way that leaves no rents to each customer – even if the retailer has significant market power. The retailer therefore has an interest in learning its customers' willingness to pay as a pathway to obtaining a larger share of the consumer surplus through price differentiation or clever bundling of products. Conversely, if this happens, customers lose some of their surplus – they pay a higher price for the same product or service.

Figure 1

The Data Value-added Chain



Source: Authors' own compilation based on Li et al. (2019). © ifo Institute

Types of Data

Different classes of data can be distinguished according to their source of origin and content. We present a selection of the most important data types in Table 1.

In recent years, there has been considerable progress in the availability of **public data.** In addition to the EU portal mentioned above, comparable efforts are being made, for example, in the USA (data.gov), the UK (gov.uk), Austria (data.gv.at), as well as in various cities or by the London Transport Authority. The objective of these efforts is to create efficient access to public data via standardized interfaces (API). The aim is for companies to use this access to launch new or improved products and services.

With regard to the **machine-generated data,** some fundamental problems and conflicts of interest regarding the data are already apparent, which can probably be best illustrated using the example of data generated through motor vehicle operation (Kerber and Frank 2017). Considerable data streams are generated when a car is operated, especially in the context of navigation, safety systems and on-board diagnostic systems. The data subject here is the driver, and additional information is generated about his or her driving behavior. The right to collect and evaluate the vehicle's data is typically transferred to the vehicle manufacturer at the vehicle purchase (e.g., in the course of signing up for additional services). The manufacturer collects the resulting information in a structured form – in some cases in cooperation with cloud providers – and evaluates it in order to make forecasts about the wear and tear of parts, for example. However, there are other parties besides the manufacturer who are interested in accessing the data:

– Car parts manufacturers: their components provide part of the data (e.g., assistance systems).

Table 1

Selected Data Types

Data type	Description	Examples
Public, non-personal data	Data of public administration and authorities that are available in electronic form. There are international initiatives to make this data available to companies via standardized interfaces (API), such as the EU's open data portal.	Geographic maps, tendering databases, information on local and long-distance public transport, e.g., the Open Data initiative of Transport for London (Deloitte 2017).
Automatically generated data	Sensors and usage data of networked devices, machines and objects (IoT data).	Usage profiles of machines, data from the operation of motor vehicles, ambient temperature.
Data from internal IT systems of companies	Internal data required for the operation of the company, in particular from the areas of personnel, sales, logistics, customers, product quality and supplier management.	Personnel data (e.g., hiring, terminations by area), ERP data, CRM data, content of shared drives.
User and transaction data	Data resulting from the interaction of users with websites and platforms. This provides Information on completed transactions as well as the usage behavior and the length of stay on the website.	Logs and protocols of usage patterns and transactions, website cookies and other tracking.

Source: Authors' compilation.

By evaluating the information, the functionality of the parts can be improved.
- Workshop operators: these have an interest in access to wear information, for example, in order to be able to bring services to markets that compete with manufacturers' predictive maintenance offerings. Evaluating the vehicle's diagnostic systems is essential for maintenance and repair.
- Car insurance providers: aggregated driving profiles (e.g., by model) enable insurers to better assess the risks in the vehicle population. Access to individual driving profiles would make it possible to tailor individualized insurance offers.

In each of these cases, the interests of the data collector (manufacturer) and the other parties are not completely aligned. This suggests that manufacturers will tend to restrict data access for these actors (Kerber and Frank 2017). European legislators have considered this issue and the Regulation (EU) 2018/858 obligates manufacturers to grant independent actors access to large parts of the collected data (especially in the area of maintenance and diagnosis). This example is a clear indication that there could be generic problems with machine-generated data in similar constellations that are not solved by the market.

Internal data from company IT systems represent another interesting case. The issue here is not that other actors have a legitimate independent interest in the data, but rather that external specialists may be capable to initiate improvements in company processes by analyzing internal data or activating institutional knowledge that is partly lying idle on company hard drives. The potential of such analyses is reflected in the evaluation of the Munich start-up Celonis, which specializes in process analyses and has achieved a market value of more than one billion USD within less than ten years (Handelsblatt 2018).

Finally, the perhaps most discussed context of data collection is **user and transaction data**. An interesting special case here is the data on transactions of traders on online platforms, where the platform obtains and withholds information on the traders' own transactions. Here, the interests of the trader (building up an own, platform-independent customer base) sometimes collide with those of the platform (control over processes, primacy of the transaction on the platform, prevention of unwanted communication with customers). Depending on the type and origin of the data, different conflicts of interest and problems can arise.

The Economic Characteristics of Data

In order to analyze the reasons why regulation is potentially required in the context of data exchange and trade, it is also necessary to understand some specificities of data compared to other goods.

(1) Economies of Scale and Scope

Expensive infrastructure is needed to collect and analyze digital data: data centers with servers, storage media and software. Efficient data management and analysis require specialized skills and knowledge. Due to these factors, both economies of scale and economies of scope typically occur in connection with data.

- One speaks of economies of scale if the average costs incurred (e.g., per unit of stored data) decrease as the volume of data increases. Given that there are significant fixed costs when companies invest in data infrastructure and that the cost per additional unit of stored data is very low, economies of scale do exist (Duch-Brown et al. 2017).
- A related concept is economies of scope. Data collectors are able to process and analyze new data on related topics faster and at a lower cost, or to extract more value from them. The value of existing data on the road traffic situation in a city increases, for example, when information on load factors and delays in local traffic is added (Deloitte 2017). In this sense, different data can be complementary.

In practice, both mechanisms are further reinforced by the presence of **network effects.** Data collectors with a larger user-base generate a higher volume data stream, which for example enables faster progress in the development of AI and ML products, leading to better search results or user experience (Goldfarb and Trefler 2019). This in turn attracts new users, further enhancing the effect like a flywheel. At the same time, it should also be emphasized that economies of scale and scope are limited by the respective technological possibilities for storing and processing data (Varian 2014). Data sets can become too large and complex to be evaluated. Taken together, these effects thus provide, up to a certain point, significant economies of scale in data collection and analysis. They also explain why companies with a data-driven business model display such a "hunger for data" (Duch-Brown et al. 2017). In practice, this even has an impact on the structure of markets when acquisitions of companies are driven by data that targets have collected. On the other hand, due to the existence of scale and scope economies, it is potentially problematic from a welfare perspective if complementary data sets are kept separately by different actors (OECD 2019). In this context, one speaks of fragmentation, hoarding or silo formation.

(2) Non-rivalry and Limited Exclusivity

The analogy of data as resource is misleading in one important respect. Resources such as oil or gas are consumed in their use. The same data, on the other hand, can be analyzed and evaluated by any number

of parties without affecting the information content and the knowledge gained (Carrière-Swallow and Haksar 2019). In the case of data, there is technological non-rivalry of use. However, a distinction must be made with regard to the incentives of data collectors. In many cases, the value of data results from the relative information advantage that users derive from it. This information advantage is automatically lost if all competitors have the same information at a given time. To put it bluntly: the first competitor invests in data-based target-group-marketing to increase the effectiveness of its advertising message. The second competitor invests to level out this advantage.

If data use leads to more efficient business processes, the widest possible use of this data would be desirable from a societal perspective, due to the non-rivalry of use. But here too, individual players have an incentive to hoard their data in silos in order to secure efficiency advantages over competitors. Private incentives thus tend to lead to too-low data sharing and too-little data exchange (London Economics 2019). At the same time, excluding other players from the use of data poses an organizational and technical challenge. In most cases, an interface to the outside world via the Internet is required to collect and analyze data, so in principle, access possibilities from outside also exist. In digital form, data can be duplicated and distributed at very low cost. To prevent this, i.e., to be able to actually exclude others from access and use, considerable investment in technical and organizational solutions is necessary. These efforts can be supported or hindered by the regulatory framework.

(3) Externalities

The collection of data may also involve significant negative externalities. In the context of personal data, the privacy of data subjects is affected. Furthermore, in the context of non-personal machine data, reducing information asymmetries can produce losers, for example, when manufacturers gain more precise information about the cost structure of their suppliers and adjust purchase prices accordingly.

On the other hand, there are possible positive externalities of data collection and data use. Up-to-date traffic data can reduce congestion and waiting times for all road users. In agriculture, data analyses can reduce the use of fertilizers and pesticides, and therefore contribute to improving the quality of groundwater (Wolfert et al. 2017). Reviews by hotel and restaurant guests help other consumers to make decisions.

Individual market participants disregard these external effects of data collection when making decisions – depending on the context, private incentives to collect data may therefore be too strong (driven by privacy and information rents) or too weak (in terms of reducing negative externalities).

(4) Data as an Intermediate Product or Raw Material

In its original form, data itself has little economic value. In order to generate value from raw data, it must be processed in several steps, some of which are time-consuming. These steps include designing a suitable database structure, collecting, evaluating and finally transferring it into a suitable business model for monetization. In this respect, data is actually comparable to a raw material or intermediate product (Jones and Tonetti 2018). In the data value chain, the end products are, for example, information on market segments, studies, analyses or services. It is at this stage of the value chain that a large part of the revenues of the data economy is generated, e.g., through ad auctions (Google) or the sale of ad space to customers with pre-selected characteristics (Facebook). The fact that these end products provide only limited insight into the underlying data makes it easier for integrated data companies – i.e., companies that cover all or several value creation stages – to protect their stored information from access (Duch-Brown et al. 2017). This means that those actors and companies that do not have approaches and skills for data analysis and use are, to a certain extent, lacking incentives to collect, structure and store their data, even if they have the potential to create considerable value added. Conversely, firms that are active at the various stages of the value chain accordingly have a reduced incentive to grant other actors (and thus potential competitors in the field of data analysis and evaluation) access to their collected data.

(5) Investment – Data as a By-product of Economic Activity

Finally, the question arises as to what extent the necessary (and, as presented, considerable) investment in data collection requires intervention by policy makers. In the area of innovative investment, it is well known that state support can provide targeted incentives to avoid underinvestment by private actors (Jaffe 1986). The stronger the (positive) externalities of data generation and the higher the incidence of free riders, the more likely it is that underinvestment may occur in the area of data economics (Duch-Brown et al. 2017). Consequently, in areas where negative externalities are more likely to occur (especially in personal data), even too high investments or too much collected data are to be expected. The extent to which state actors should influence the incentives to collect data thus depends strongly on the context and individual case. The need to differentiate here is further underscored by the fact that, in many cases, data is a by-product of the economic activities of companies. Examples of this are production or transaction data that are required for operations and may have to be stored for legal reasons. Once the neces-

Table 2

Causes of Market Failure in Data Transactions

Cause	Description	Effect
Asymmetric information – uncertain data quality	Potential buyers are subject to considerable uncertainty about the quality of data including: • Care in collecting • Consistency of formats etc. • Legality of the data ownership of the seller (e.g., compliance with legal regulations) • Completeness It is difficult to demonstrate data quality without providing access to the whole data set.	Higher complexity and thus higher transaction costs. Importance of relationship and trust between transaction partners, especially problematic for anonymous markets.
Non-transparent offer	There is no central market and no public directory for available data. Actors who would benefit from the analysis of existing data (sets) often have no knowledge of their existence. Intermediaries can reduce this problem, but they cause additional costs and are not yet relatively well established – and not available in all sectors. Since data is not (yet) a standardized product, it is difficult for buyers to compare the offers. Consequently, there are no »market prices« – according to market players, transaction prices are based on the (perceived) willingness of buyers to pay.	Advantageous and efficiency-enhancing transactions are potentially absent because buyers are unaware of the offer or sellers misjudge the willingness of buyers to pay.
Transaction costs	With regard to data transactions, quality standards and certification are still largely lacking. There are also no standardized »products« in terms of pre-defined data formats and database structures. In addition, the rights of the buyer in handling the data must be defined and his behavior must be checked, if necessary, with regard to: • Intended use • Right to combine with other data sets (risk of and de-anonymization of data subjects) • Passing on data, or analyses or services based on such data to third parties • Protection of data from unauthorized access after acquisition Compliance with regulatory requirements by purchasers (e.g., GDPR).	A lack of standardization makes detailed and therefore expensive contract drafting necessary. The resulting considerable transaction costs represent a market obstacle which particularly affects those smaller players who, for example, do not have a specialized legal department, to a greater extent.
Externalities	Analogous to the case of data collection, externalities on the part of the data acquirer can lead to the volume of data transactions being too low (positive externalities on the part of the acquirer, e.g., non-commercial actors), or too high (negative externalities, e.g., sending unwanted emails to acquired addresses).	The existence, magnitude and direction of the market failure depend on the context.
Market power, barriers to market entry	Market players behave strategically. In particular, vertically integrated companies (which collect data and also operate their own business models of exploitation) will often perceive buyers as potential or actual competitors; in such cases, there are strategic incentives to refrain from selling data in order to make it more difficult for others to enter the market.	Transactions and thus market access are made more difficult for players who do not have their own data sources.

Sources: Authors' compilation; Acquisti et al. (2016); London Economics (2019); Duch-Brown et al. (2017); Koutroumpis et al. (2017); and Carrière-Swallow and Haksar (2019).

sary data infrastructure is established, the marginal costs of data collection are extremely low (Farboodi and Veldkamp 2019).

DATA OWNERSHIP AND TRANSACTIONS

In the previous section, when examining incentives for data collection, the assumption was implicitly made that data collectors hold the rights to and have the control over the resulting data (-bases); this is very close to the legal reality in the United States, for example. Here we turn to the question of data ownership: what role do ownership rights, in particular the rights to use and exclude other actors, play in the context of data? Second, we analyze the barriers to data transactions or, in other words, how well a free market for data can function.

The Coase Theorem

The objective of data legislation and regulations should be the following: from a societal perspective, ownership of (or access to) data should ultimately be given to the actor who can generate the highest value (or benefit) from them. In economic theory, there is a simple solution to this: it is sufficient to define ownership rights to the object in a clear way. Via market transactions, the object should then be finally owned by the person with the highest willingness to pay – this is the basic logic of the Coase theorem (Coase 1960). In this case (which would be the second central insight), it is irrelevant from a welfare perspective to ask to whom the property is originally assigned. This is because the market ensures that it will end up with the "right" actor once a set of transactions has been

completed. In order to achieve an efficient allocation through the market, two conditions must therefore be met: on the one hand, there must be clearly defined ownership rights to data; on the other hand, the market for data must function sufficiently well to enable and bring about the necessary transactions. If both conditions are met, there is no reason for the regulator to intervene in the market.

In the following section, we explain why the assumptions of the Coase theorem may not apply to data and in which areas there may be room for regulatory intervention. Furthermore, the original allocation of rights to data does play a central role in the distribution of rents between data subjects, collectors and users. Through the resulting investment incentives, this also affects, as discussed above, macroeconomic growth prospects and is thus of great importance for the economy as a whole (Acquisti et al. 2016).

Possible Causes of Market Failure

Which factors are potentially responsible for data markets failing or not developing at all (Koutroumpis et al. 2017)? Various properties of data and related market conditions can contribute to the fact that advantageous transactions of data are not possible and pure market mechanisms are thus not able to ensure an efficient allocation of data (London Economics 2019). In Table 2, we present an overview of the main causes of such market failures and their consequences in the context of data.

Each of the five factors analyzed above hampers the functioning of the market. The intensity of market failure, and hence the need for regulatory intervention, depends strongly on the individual context. In particular, a distinction should be made according to the size of the (potential) transaction parties. Transaction costs normally affect SMEs relatively stronger than large players with specialized legal departments – this applies both to contract costs and the costs of compliance with regulatory requirements (Koenen et al. 2018). Smaller market players are also less likely to employ specialized staff who observe the market environment in order to identify potential data sources. Thus, the intransparency of the offering tends to have a stronger impact on smaller companies as well. At the other end of the spectrum, there are cases where the market power of large, vertically integrated players "hoarding" data prevents potential competitors from entering the market.

Another point that deserves emphasis: the lack of standards and certificates for data transactions, together with the uncertain data quality in the run-up to the purchase, contributes to the fact that the relationship between buyer and seller plays an important role. If the actors trust each other (e.g., because of a grown business relationship or in expectation of further interactions in the future), the probability of misconduct decreases and the drafting of contracts becomes easier and cheaper. This in turn means that data transactions between larger, trusted parties are more likely to occur than the cases where smaller anonymous parties are involved (Duch-Brown 2017). This fact makes it more difficult for young, vertically non-integrated firms to enter the market, beyond strategic incentives of established players to implement entry barriers.

Case Study: Machine as a Service

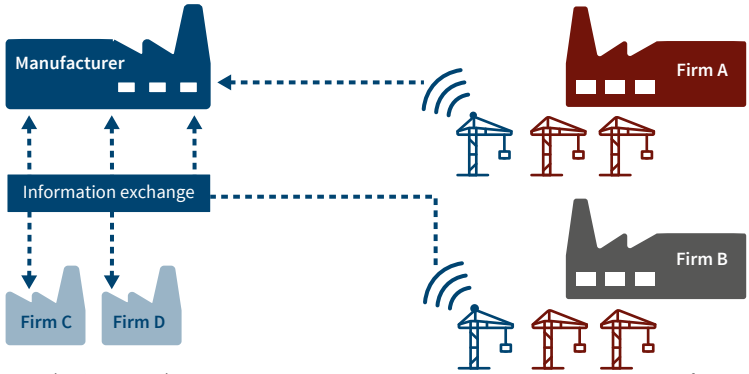
The complexity of the factors (to be taken into account in data transactions) and the role of mutual trust are well illustrated by a case study which plays an increasingly important role in practice: the "Machine as a Service" (MaaS) model. For industry, and especially mechanical engineering in Germany, services play an increasingly central role in business models (Falck et al. 2019). This process is also known as "servitization". MaaS represents an important case: in this model, the customer no longer buys the machine from the manufacturer, but still receives and integrates it into his own production process in exactly the same way as he would with a purchased machine.

The difference is that instead of the fixed purchase price, the customer pays the manufacturer fees for the actual use of the machine. Instead of buying a compressor, for example, the customer purchases the "service" of compressed air from the manufacturer as demanded. Instead of the (high, one-off) fixed costs for the purchase of the machine, the user incurs variable costs that are completely based on use. In return, the manufacturer and provider of the service generates a more even payment flow. The provider usually guarantees the customer the complete functionality of the machine, i.e., he is also responsible for maintenance. The structure of the model is shown schematically in Figure 2.

Data plays a central role in the MaaS model: here the customer would have incentives to report lower-than-actual capacity utilization to the manufacturer. In addition, he might not take care of the

Figure 2

Machine as a Service - Schematic Diagram



Source: Authors' own compilation.

machine (e.g., let it get too hot), because the manufacturer is liable for breakdowns – a moral hazard for the customer. This problem can be solved by having the machine continuously send a stream of "real-time" data (related to usage, ambient temperatures, tool condition, etc.) to the manufacturer. Using this data, the manufacturer has a quasi-view of his customer's production process. Since he not only receives data from company A, but also from company B (and his other MaaS customers), he is able to detect possible misbehavior on the part of the customer with a high degree of probability, and is able to anticipate any maintenance work that may be necessary and therefore carry it out in a very efficient way. Without these data transfers, the MaaS model would not be viable. However, since the manufacturer's machine does not operate autonomously, but in interaction with other machines (e.g., compressed air as an energy source or turbines propelling an aircraft), the provider can gain insights into the customer's production process and its capacity utilization. The MaaS customer becomes "transparent" to a certain extent. The manufacturer, on the other hand, gains a "treasure trove" of data that can form the basis for new business models (Economist 2019).

For the MaaS model to work, it must be clarified what the manufacturer may use the collected data for. Customers must also be confident that the data infrastructure on the manufacturer's side is secured in such a way that sensitive information about their own business processes does not inadvertently fall into the wrong hands.

Consequences of Market Failures: Fragmentation, Data Silos

MaaS is a practical example of how data transfers in industry can lead to new business models. But what are the consequences if, due to market failure, shared access to data remains the exception or does not occur in some sectors? Companies that own and control data build silos where they store their data without giving access to active or potential competitors (Jones and Tonetti 2018). The ability to exclude others from using data blurs the boundaries between ownership and possession.

This fragmentation of data has two immediate negative effects. First, it is detrimental to competition, since firms in the data analysis field are effectively discouraged from entering the market. Second, it does not make efficient use of economies of scope, a key economic characteristic of data. The combination of complementary data sets can lead to increases in value, which can go unused if the necessary data sharing is not possible.

The fact that markets do not achieve efficient results derives from conditions of the Coase theorem being violated. Equally important, from a welfare point of view, it does matter to which party the original ownership rights to data are assigned. If data ownership is originally assigned to the data collectors, then this, combined with the data subjects' lack of market power and the existing network effects, is the basis for dominant market positions and high rents (Arrieta-Ibarra et al. 2018). If there are additional negative externalities of data use (e.g., with regard to private data), then an undesirable equilibrium results, in which large amounts of data are collected by multiple parallel players in an inefficient manner and, at the same time, too little data exchange takes place due to silo formation.

PROMOTING DATA SHARING AND ACCESS

International Laws and Regulation

Given the considerable economic importance of data, it is surprising to what extent the legal framework for data ownership is still unclear. In the status quo, which is particularly valid in the American lead market, data ownership is largely equivalent to ownership in terms of the use of data, unless personal rights of the individual make this difficult. Since, on the other hand, copyrights are not applicable to collected information, there is no legal possibility for the creators of databases to exclude others from using and duplicating them: they must rely on technical (copy protection, encryption) and organizational (secrecy) solutions. This increases the transaction costs for data, as described above.

The European legislators recognized relatively early that Europe is lagging behind the United States in terms of developing its data economy. The Database Directive (96/9/EC), adopted in 1996, was intended as an instrument to stimulate investment and the market in this area by defining ownership rights in databases. The Directive gives database creators two types of rights for a period of 15 years:

1. The structure of the database (but not the data it contains) is protected by copyright if it is "an intellectual creation of its author". This allows authors of protected databases to prevent other databases with identical structure from being made publicly available.
2. A new sui generis right is created which prohibits others from extracting or using substantial parts or all of the collected data. However, this is subject to the condition that the creation of the database requires "a substantial investment in qualitative or quantitative terms".

Official evaluations of the Directive conclude that the Directive has not had a significant impact and needs to be revised due to the fact that the creation of databases is increasingly automated.

In contrast, the European Data Protection Basic Regulation (GDPR, Regulation 2016/679) creates an

effective legal framework for handling personal data, which has been in force since May 2018. The GDPR grants those data subjects who are natural persons a number of inalienable rights to their personal data, including in particular the rights of access, revocation, deletion, rectification, and a right to data transferability. Companies are bound by the principle of collecting only that data necessary for providing the service and using it only in the appropriate context. The GDPR is supplemented with regard to non-personal data by Regulation 2018/1807 on a framework for the free flow of non-personal data in the European Union. It aims at creating a European Data Area in which no additional barriers to data transfers exist caused by the national borders.

A detailed analysis of the GDPR is not the aim of this study. In summary, it can be said that, on the one hand, it substantially increases the regulatory requirements and the corresponding investment needs for companies that handle personal data. On the other hand, it establishes a clear legal framework for rights to data in the EU, which in the medium term can help to establish clear standards for the collection and transfer of data, which can reduce transaction costs.

Possible Solutions for Data Sharing

However, the problem of a lack of access to data, especially by small- and medium-sized enterprises, is not solved by the regulations mentioned above. In order to address this specific problem, various approaches are currently being put forward in the political and public debate, which we will now discuss.

(1) The Right to Data Access within the Value Chain

In the course of this study, we have identified various situations in which different parties had different, or even incompatible, interests with regard to data access. On the one hand, machine data can contribute to more efficient operation or better maintenance, yet it can, on the other hand, provide unwanted insights into the operator's production processes. In many cases, these problems can be solved through bilateral agreements, as shown in the MaaS example. This is more likely to succeed if the parties have a long-term business relationship and if they are larger players. By contrast, the problems appear to be more difficult to resolve if several rather small companies have a legitimate interest in access to data owned by another market player.

The German Ministry of Economics Paper on SMEs (BMWi 2019) indicates that politicians are considering a right to data access in value chains for SMEs. That such laws are within the realm of possibility is shown for example by EU Regulation 2018/858 discussed above, according to which other parties are also entitled to access automotive data. Through these approaches, legal compulsion is exerted to ensure the data "participation" of (smaller) market participants. In the case of automotive data, the data must be provided in a standardized "open" form, so that the necessary investments on the part of the data recipients remain relatively low. Therefore, one can anticipate that these approaches will be effective and actually allow access to the stored data.

However, it should be borne in mind that, at least in some fields, negative side effects of such measures are to be feared. The need for data transparency is potentially accompanied by the possibility of providing access to production and product information. Once this information becomes public, it is no longer reversible. A unilateral compulsion to disclose provides only very limited opportunities to protect the legitimate interests of the data collector. In certain cases, especially when data collection involves investment and costs, such legislation significantly dilutes incentives to invest. However, this argument does not apply in those cases where there is a business or legal need to collect the data anyway. In conclusion, implementing such a regulation raises the question of what state of data the disclosure requirement concerns: the original "raw data", a structured form (this is how EU 2018/858 is to be interpreted), or information enriched from multiple sources? Such a regime will then potentially affect not only the incentives to collect data, but also the investment in more complex business models based on it. Overall, more insights into the impact of such a law – for instance, based on a careful evaluation of EU 2018/858 – would be desirable before it is implemented within a broad impact framework.

(2) Data Authority, Data Trusts or Platform Solutions

A law with disclosure requirements offers relatively little scope for solutions that consider the different interests of all stakeholders on a case-by-case basis. In a recent analysis of the competition problems in data-based markets in the UK, the appointed expert commission came to the conclusion that government intervention in the provision of data was necessary (Furman 2019). Instead of a legal solution, however, this Commission proposes establishing a specialized authority whose core task would be to resolve conflicts of interest in data access. Such an authority could operate its own data centers and require companies to share their data with these centers. Actors with a legitimate interest in accessing the data could then approach the data authority and make a request to access the data. According to pre-defined criteria, the authority could then decide on a case-by-case basis whether to grant the data access under consideration of the interests of all stakeholders and the resulting welfare effects. This represents a considerable advantage over the legal solution. It must be noted, however, that there is little or no experience on the part of the state in operating data centers with re-

al-time access to massive volumes of data. Moreover, with a large, centralized state data silo, the consequences of a security gap or data loss would be extremely problematic. On the way to implementation, a series of pilot tests would therefore be indispensable, building on the expertise and experience of existing state data authorities (Federal Statistical Office and state offices).

"Data trusts", i.e., private-sector data trustees, represent a private-sector alternative to such a data authority. Similar to the authority, such private companies with the mandate to manage the entrusted data in accordance with a defined charter can make case-based decisions regarding access to the managed information (Mills 2019). In the international context, the UK already has initial experience with pilot projects (ODI 2019). Unlike a public authority, companies must voluntarily submit their data to a data custodian. Accordingly, there is a coordination problem: why should companies share their data, that they would otherwise keep secret, with the trustee? The rationale is that data trustees are a way to solve the prisoner's dilemma in the context of data silos. If two companies operate an own data silo with complementary data, then considerable value added could be created if each had access to the other party's data. Each individual actor, however, has an incentive to keep its own data secret, so that a market equilibrium is created in which no access is granted. If, however, there is an instrument by which both companies can commit themselves to grant each other access, then they are able to break out of the prisoner's dilemma and achieve the allocation that is better for both, in which the data is shared.

This consideration also makes it immediately clear, however, that (voluntary) data trustees cannot solve all the problems associated with data sharing. Firms will generally have no incentive to grant data access to actors via the trustee without any potential economic advantage over the initial situation. Approaches to circumvent this problem are to combine a data trustee with a (commercial) industry platform. Within this framework, access to the data can be granted either in the course of providing the data oneself or through financial participation in the platform. Practical examples show that such approaches are more likely to work if the market players are relatively symmetrical, for example in medium-sized mechanical engineering or across industries in connection with the verification of personal data, and if there is no single dominant player.

In the context of data platforms, the state can play an important role in the design and start-up financing. State involvement also ensures with a higher probability that a critical mass of players can be attracted to the platform. Such an initiative at European level exists in the Gaia-X platform initiative, which is supported by the German government (Handelsblatt 2019).

CONCLUSION

The importance of data economics for developing economic performance in Germany and Europe is undisputed. In this study, we have identified various factors that can cause market failure of data. It is therefore doubtful that the market alone can lead to an efficient allocation of data, and to optimal access to and sufficient participation in the collected data. Initial initiatives, such as the 1996 EU Database Directive, have not had the desired effect on the market. At present, work is urgently underway on possible solutions, whereby state intervention, such as a right to data access, is being pursued in parallel with private sector solutions, such as data trusts or platforms. Due to the complexity of the problem – depending on the extent of external effects, the necessary investment costs and the existing market structure (dominant players or symmetrical market participants) can vary greatly – competition for solutions appears to be desirable. Pilot projects in industries and further research in this area will surely contribute to a better understanding.

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Jürgen Matthes

China's Market Distortions and the Impact of the Covid-19 Crisis

ABSTRACT

Subsidization in China is pervasive at numerous levels of government and appears to be an inherent element of Chinese state capitalism. Despite a severe lack of transparency, the available information seems to suggest that the extent of Chinese subsidies is extraordinarily large. Moreover, the resulting overcapacities could lead to considerable and increasing distortions on the world market in certain sectors. An initial assessment of the potential effects of the Covid-19 crisis on China's industrial policy model does not suggest a major change in subsidization policy. This constellation bodes ill for the future of the multilateral trading system.

Until a few years ago, China was primarily a large and growing market and a low-cost production location for European firms. In the meantime, however, Chinese companies have become serious competitors. This is confirmed by various surveys of German and European firms (GTAI 2018; AHK 2019; European Chamber 2019). If the increasing competitive pressures from China were to be based on fair conditions, it would primarily be the task of European companies and economic policymakers to meet this challenge. In fact, to some extent China derives normal competitive edges from cost advantages and economies of scale as well as from investing heavily in education and research. But beyond this, the Chinese state also employs problematic measures that seriously distort competition: subsidies, forced technology transfer, and unequal market access conditions. In particular, the Chinese government provides extensive direct and indirect subsidies for industrial policy purposes. However, the related empirical evidence is scarce because the state-capitalist system is complex and intransparent. Against this background, this article provides an overview of several available relevant studies that shed light on subsidy-induced competitive distortions by China.

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Regarding the rapidly increasing competitive pressure from Chinese companies, the question arises as to how much of their competitiveness is based on explicit and implicit distortions of competition. To the extent that this is the case to a considerable extent, it can be expected that the spill overs of Chinese subsidies to the world market will become ever greater due to China's enormous and continuously increasing economic size, signified by the large and rapid increase of China's global export market share. In addition, China is catching up rapidly in terms of technology — also as a result of forced technology transfer (European Commission 2018a and 2018b; USTR 2018). With its "Made in China 2025" strategy, which is supported by massive state aid, China also intends to catch up further in innovative capacity, particularly in sectors in which many European companies have their specialization advantages (Wübbecke et al. 2016; Zenglein and Holzmann 2019). The combination of these developments and ambitions, if relevant and successful, has the potential to jeopardize the prosperity of the established industrialized countries in the medium term (Samuelson 2004; Matthes 2007) and to overstretch their structural adaptability (Autor et al. 2013; Dauth et al. 2014).

This should be a relevant concern of policy makers, unless China constructively engages in multilateral cooperation and agrees to a sufficient reduction of competitive distortions domestically or at least through a reform of the relevant WTO rules. So far, however, despite strong pressure from the EU, the US and other industrialized countries, the Chinese government has refused to make any relevant concessions in this regard.

The question arises whether the coronavirus crisis will fundamentally change this situation. Does the crisis make it more likely that China will be prepared to make sufficient concessions, or will the opposite be the case? Various aspects play a role: the development of multilateral cooperation, the depth of the crisis in China and globally, the development of the financial power of the Chinese state, and possible changes in global value chains at China's expense. In this paper, relevant factors of the Covid-19 crisis impact, their direction of influence and their interdependence will be considered. First, however, a detailed overview of the numerous and multifaceted distortions of competition in China is given. After the consideration of the Covid-19 crisis impact, gaps in the WTO rules on industrial subsidies and proposed reform approaches are addressed.

THE ROLE OF STATE-OWNED ENTERPRISES

Chinese state-owned enterprises (SOEs) play an important role in China's economy and in the pursuit of industrial policy goals (European Commission 2017; WTO 2018a). For example, SOEs account for more than half of the revenues of listed companies in China.[1] Until the early 2000s there was a tendency in China to reduce the importance of SOEs and to give more weight to market economy principles. But after that, and especially under Xi Jingping, the promotion of SOEs became more relevant again. Lardy (2019) points out that it increased particularly sharply between 2013 and 2016, when the share of lending to non-financial SOEs rose from about one-third to over 80% of total lending. He also provides further evidence that their overall economic importance continued to grow. Another cause for concern is that the Chinese government is allowing ever-larger mega SOEs to be created through mergers, in some cases with the aim of creating national or global champions (BusinessEurope 2020). According to the Forbes Global 2000 list, the share of SOEs among the Chinese firms in this list of the 2000 world's largest public companies amounts to nearly 70% (EP 2020).

State ownership of SOEs is not problematic per se. However, SOEs receive various subsidies. Garcia Herrero and Ng (2020), quoted in EP (2020), show that SOEs are privileged by the government relative to privately owned Chinese enterprises in terms of effective tax rates and interest burdens. Moreover, SOEs are also used by the Chinese government to achieve its industrial policy goals and to grant subsidies to other parts of the economy. Particularly problematic are cases of severe market distortions when large subsidies allow SOEs not to behave in an entrepreneurial and profit-oriented manner, to offer their products at prices that do not cover costs, or to remain in the market even if they lack profitability or are de facto insolvent.

SUBSIDIZED ACCESS TO PRODUCTION FACTORS

China's distorting subsidy practice reaches deeply and broadly into the economy as it also includes below-market prices of important production factors. This artificially increases the price competitiveness of Chinese companies that use these subsidized inputs, to the detriment of their competitors (Think!Desk 2015; European Commission 2017).

- **Access to labor:** labor costs for low-skilled workers tend to be below market conditions, thus creating a significant cost advantage. The reasons for this are the low bargaining power of the employees, as there are no free trade unions and no right to strike. Moreover, migrant workers, whose labor rights are even lower and who often receive very low wages and social benefits, account for more than one third of all employees (European Commission 2017). Despite some improvements, this problem remains in principle.
- **Access to capital:** measures that distort competition include generous financing of companies that enjoy state favor by several means comprising financing volumes above market levels and interest rates below market levels, because of a lack of adequate consideration of default probabilities in risk premiums. State banks play an important role in this practice. Equity injections, generous guarantees or loss compensation by state institutions are also sometimes used.
- **Access to real estate for commercial use:** land is largely state-owned and used for industrial policy purposes. Real estate prices for industrial settlements are generally low as, regional authorities compete for manufacturing firms. Especially companies from strategic sectors that are important in terms of industrial policy receive preferential conditions. In case of forced relocations for environmental reasons, when competition between locations tends to be particularly intense, inexpensive access to land is granted as compensation.
- **Energy prices** are also controlled by the state and are kept artificially low, especially for strategic industries and national champions. As part of the competition for industrial settlements, large discounts are granted at the local level, and in some cases access to electricity is completely free of charge. In high-tech zones, this support sometimes extends, in a similar form, also to all resident companies (Think!Desk 2015). It is true that the Chinese government relies on higher electricity prices to foster environmental protection and sometimes also to induce industrial capacity reductions. However, this applies only to a limited extent to strategic sectors and SOEs in energy-intensive industries.
- Regarding important **raw materials**, the Chinese government also provides favorable access conditions in favor of domestic companies and at the expense of other foreign firms. China is a central supplier of certain raw materials. However, export rules for important raw materials tend to be restrictive in order to allow Chinese companies to benefit from lower raw material prices than their foreign competitors. This strategy also aims at pushing the next stages of the value chain into the country. Moreover, China uses its strong market position (e.g., in rare earths) sometimes in political conflicts by threatening export bans or restrictions.

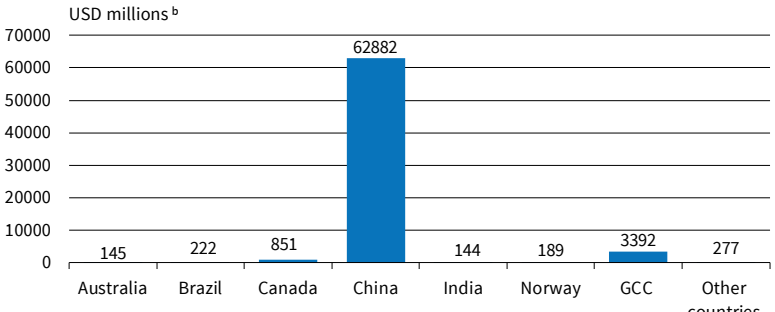
[1] For this and other information on the relevance of state-owned companies, including sources, see BusinessEurope (2020). The International Monetary Fund (2019) provides further evidence of the importance of Chinese SOEs.

SUBSIDIES FOR INPUTS IN UPSTREAM PARTS OF VALUE CHAINS

Price distortions are also relevant in China for important inputs in the production of many manufactured goods. Direct and indirect sectoral subsidies tend to be the higher the more upstream in the value chain a sector is producing. This applies particularly to iron and steel, and non-ferrous metals such as aluminum. These industries are dominated in China by a few large SOEs which are heavily subsidized. A detailed evaluation of the subsidies received was carried out in the aluminum industry (OECD 2019a) and the non-ferrous metals industry (Think!Desk 2017). In both cases an international sample of companies, that is broadly representative for the world market, was selected for an in-depth analysis.

With a sample of 17 companies worldwide, the OECD (2019a) covers about two thirds of global **aluminum sector** production and half of the melting capacity. Nine companies from China are included in the sample, which roughly corresponds to China's share of almost 60% of global aluminum production, that has increased very strongly over time in China. Of the total global financial and non-financial subsidies recorded in the sample for the period 2013 to 2017, around two-thirds are granted by the Chinese state alone (Figure 1), with a focus on financial subsidies. Chinese subsidies are concentrated on very few companies (predominantly SOEs) and are mainly allocated to aluminum production and less to the downstream stages of the aluminum value chain. The latter are, however, subsidized indirectly in this way because they use the highly subsidized aluminum as a key input. The cumulative subsidy volume in the period from 2013 to 2017 is particularly large in relation to the size of Chinese companies. For five of the Chinese companies under review the cumulated amount is roughly equivalent to the total revenues of 2016, while for another three companies the share is between one-third and over half. By contrast, companies from industrialized countries are subsidized to a much lesser extent in this sector relative to their size.

Figure 1
Subsidies in the Aluminum Sector, 2013–2017



[a] OECD calculations based on a global firm panel; Gulf Cooperation Council; "Other countries" include New Zealand, Russia, Spain, and the US.
[b] Total government support.
Source: OECD (2019a).

THINK!DESK (2017) analyzes a sample of 65 companies in the **non-ferrous metals industry** and arrives at qualitatively similar results. While it only focuses on China and not on the global market, the authors also analyze numerous subsidy categories, with a focus on direct financial subsidies that affect the company's income in the year of payment. Again, there is strong concentration on very few companies. Almost two thirds of the subsidies from 2011 to the first half of 2016 are accounted for by four large Chinese SOEs alone, which are apparently supposed to act as national champions. The top ten recipients of direct financial subsidies also consist solely of SOEs, some of them at local level. In 2015, these payments, cumulated across all the companies considered, accounted for 53% of their total after-tax profits. As in the aluminum sector, the relevance of these subsidies appears to be, on average, of considerable importance from a company perspective. In some cases, the authors consider that losses might have been offset with the subsidies received. Between 2011 and 2014, direct financial subsidies increased by around 50%. Only in 2015 was there a minimal decrease in Chinese currency, but not in euros.

The OECD (2018) analyzes the role of SOEs in the **steel sector** in a worldwide dimension but does not examine the allocation of subsidies. However, the authors point out that SOEs in the steel sector tend to suffer from profitability problems and are often heavily indebted, which is likely to point to relevant subsidization, especially in developing and emerging countries. China is not reported separately but results for the aggregate of East Asia can be broadly applied to China, since China's share of East Asia's crude steel capacity is well over 90% (OECD 2019b). In fact, SOEs in East Asia account for more than half of all companies, with only a good 10% of the companies being clearly identified as private (the rest not being clearly attributable). By contrast, SOEs play no role in the EU. Thus, the state influence—and the probable relevance of subsidies—differs substantially between the EU and China. No direct consequences of such market distortions for the steel market are analyzed. However, the immense increase in steel production in China is unlikely to be independent of this approach. According to the OECD's (2019b) regular estimates, China has increased its share of nominal crude steelmaking capacity very sharply since the turn of the millennium—from around one-seventh in 2000 to around half (Figure 2).

In addition, the OECD (2019c) has also examined another important (highly innovative) **semiconductor sector**. While this sector is not located at the beginning of the value chain, the picture of market distortions is similar, with particularly high subsidies relative to company size in China. The OECD has defined a global sample of companies with a certain representativeness for the industry. The 21 companies selected, which include Intel and Infineon as well as

four Chinese companies, cover more than two-thirds of global revenues in the semiconductor industry. From 2014 to 2018, more than 50 billion US dollars in government funding were awarded to these companies. While Chinese companies do not account for the bulk of the absolute subsidies due to their relatively small size, for two of the Chinese companies the subsidies amounted to more than 30% of annual consolidated revenues. This percentage is by far larger than for firms from other countries. It is striking that the bulk of state funding in China did not flow via direct state subsidies, especially for research activities as is the case with most other companies, but indirectly via subsidized financing through SOEs.

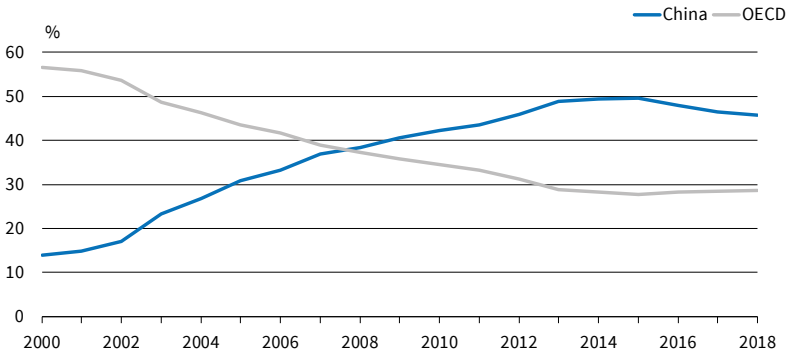
CHRONIC OVERCAPACITIES AND RESULTING GLOBAL MARKET DISTORTIONS

China's industrial policy and extensive subsidies lead to large overcapacities in some sectors, resulting in considerable distortions of competition on the world market. This applies, for example, to the above-mentioned metal products such as steel and various non-ferrous metals, as the studies of the OECD (2019a) and THINK!DESK (2017) clearly demonstrate.

However, China's industrial strategy also leads to similar competitive distortions in newer product fields. This applies, for example, to the solar panel industry (Bertelsmann Foundation et al. 2019). While Germany focused on promoting the *demand* for solar panels from 2009 onward, so that supply capacities could be geared to serve the resulting demand, large Chinese subsidies were targeted mostly toward the supply side. This approach created considerable overcapacities with which Chinese companies then entered the global market. While this approach involved major and costly inefficiencies in China, in the end, Chinese firms were able to increase their share of global solar energy capacity from 1% in 2009 to around 33% in 2017, also at the expense of European suppliers. In 2018, the eight largest manufacturers in the solar industry were based in China.

These examples highlight chronic allocative inefficiencies in China that increasingly tend to spill over into the global market. Chinese companies and especially SOEs can apparently build up capacities despite insufficient demand (and thus profitability) for the goods produced. Chronic overcapacities tend to occur because the industrial policy goals of the central government are often implemented very ambitiously by many local administrations without sufficient central coordination. This inherent and fundamental problem is exacerbated by the fact that overcapacities are not sufficiently reduced when profitability problems occur. Instead, production capacities tend to be upheld by ongoing subsidies (sometimes despite high corporate indebtedness) and by the lack of a strict insolvency law, which prevents necessary market exits.

Figure 2
China's Relevance in the Global Steel Market



[a] Share of global nominal crude steelmaking capacity.
Source: OECD (2019b).
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When Chinese overcapacities spill over into the world market, the sheer economic size of China means that this will likely result in a significant global oversupply. Global product prices tend to come under pressure due to oversupply and because Chinese companies are often pushing their products into the global market at prices significantly lower than those of their competitors (OECD 2019b). This reduces the profit margins of competing European companies and can cause severe consequences in terms of global allocation efficiency. While more productive companies in Europe that comply with high environmental and social standards may have to reduce capacity or even stop production altogether due to the competitive distortions, less efficient Chinese SOEs may survive and continue to grow.

This danger is also relevant regarding third-country markets, where Chinese overcapacities can also lead to displacement effects. It becomes even more relevant, as China increasingly supports Chinese firms globally by using export credit support programs that allow firms to offer very favorable financing conditions for their customers (Dawar 2020; BusinessEurope 2020).

Looking at the near future, Chinese market distortions and the threat of overcapacities cause concerns of relevance:

- The MIC25 strategy and the massive support it provides could create similar overcapacities in sectors where European firms have specialization advantages. This applies, for example, to robotics, battery production, and electric cars (Bertelsmann Foundation et al. 2019).
- The example of the solar panel industry could bode ill for potential innovative climate abatement technologies that will be developed in Europe in the future. The Green Deal of the EU relies on the presumption that the induced structural change will not endanger the well-being of Europeans because "old and dirty" production will be replaced by "new and green" production capacities. This assumption would prove problematic

if China also used the same aggressive industrial policy strategy—as in the case of solar panels—for new green technologies.

IMPACT OF THE COVID-19 CRISIS

The coronavirus crisis is having a broad impact on economic activities and might, in the medium term, lead to significant changes in economic allocations and policy decisions. In this context, the question arises whether the crisis will render the depicted Chinese market distortions relevant.

Currently, it would be premature to attempt a definite answer. However, several factors can be identified that could influence the preparedness of China to significantly reduce subsidies or to agree to relevant reforms of WTO rules. Figure 3 provides a structured overview of several relevant factors. Nevertheless, the following evaluation remains speculative at this stage. Three different strands of arguments could become relevant.

First, different factors could influence China's general preparedness for more **multilateral cooperation**. On the one hand, it could be negatively affected by a rising distrust of other countries vis-à-vis China, e.g., due to China's opacity in dealing with the corona virus health crisis or due to its misinformation campaign. Related criticism of China and possible additional reactions could lead to growing resentment to global cooperation in China. The same effect is likely if the US-China trade dispute escalates further. However, China's will to cooperate might be influenced positively by a feeling of global interdependence commonly shared in many countries and by the related experience of mutual support to mitigate the effects of the coronavirus health crisis (e.g., by providing masks and other medical support). The overall effect on China's inclination to cooperate is unclear, but more likely to have a negative tendency, as the former two aspects appear to outweigh the third factor to some extent.

Second, the Covid-19 crisis made many countries, including some European countries, realize how dependent they are on supplies from other countries, particularly from China, which is viewed by some as the "factory of the world". This perception could lead to a **reorganization of global value chains** and to more diversification among supplier countries from the point of view of the purchasing countries. This trend could lead to a relocation of modern and innovative economic activity away from China. Such relocation effects would reduce economic activity in the medium term and deal a blow to China's intention to increase its innovative production capacities. Therefore, the need for government support (particularly for innovative activities) would increase in the medium term.

Third, the **economic crisis** reduces economic activity in the short term and potentially also in the medium term. Moreover, the crisis also leads to lower public revenues and higher public spending; both factors tend to increase government debts. These effects increase the perceived necessity for government support of the economy in the short and medium term. However, the ability to finance higher subsidies would be negatively affected by lower public revenues in the short term and by higher public debts in the medium term.

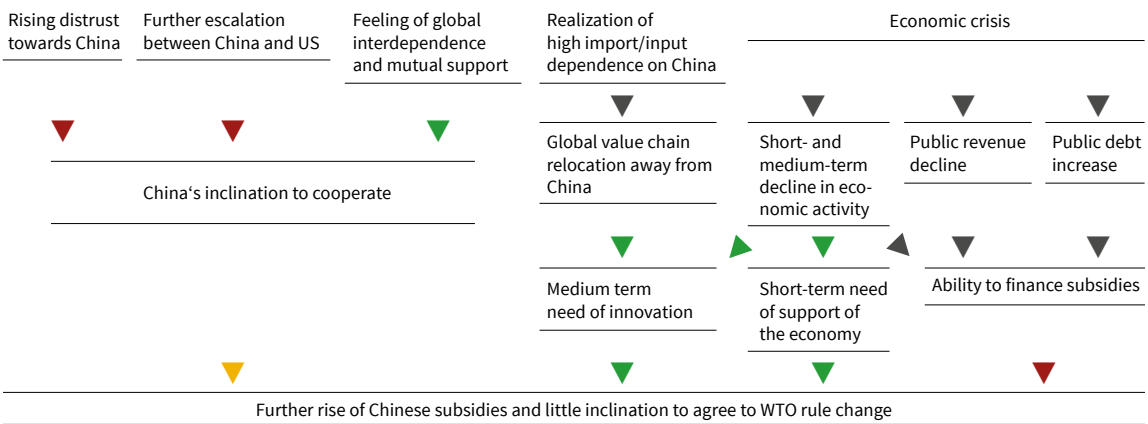
Overall, the corona virus crisis might not change much in these respects, as it appears difficult to draw definite conclusions concerning the balance of the portrayed positive and negative effects of the crisis on Chinese subsidies and on China's inclination to agree to more binding WTO reforms.

TRADE POLICY: DEFICIENCIES OF THE WTO RULES AND RECOMMENDATIONS FOR REFORMS

In fact, many concrete proposals for reforms of WTO rules regarding subsidies and market distortions do exist. They are based on the fact that the existing relevant WTO rules (the Agreement on Subsidies and

Figure 3

Possible Impact of the Covid-19 Crisis on Chinese Market Distortions



Note: Arrow colors imply grey= "leads to", green = "has positive impacts on", red = "has negative impacts on", and orange = "has unclear impacts with negative tendency on".
Source: Author's own compilation.
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Countervailing Measures – ASCM) lack sufficient disciplines in important respects. For example, many countries, particularly developing countries, including China, do not adequately notify their subsidies with the WTO as is foreseen in the (non-sanctionable) WTO rules (USTR 2019; WTO 2018b). Moreover, the definition of prohibited and actionable industrial subsidies in the WTO's rules framework is rather restrictive and does not cover important kinds of subsidies relevant in practice and especially in China (European Commission 2018b). This pertains particularly to the use of SOEs in China's industrial policy strategy (European Commission 2017; WTO 2018a; Bown 2018).

The EU and other industrialized countries have vainly attempted to induce China to cooperate on reforms of the ASCM for several years (WTO 2015). Recently, a Trilateral Meeting of the EU, the US, and Japan has brought more momentum to these initiatives. Based on one of several proposals introduced by the Trilateral Meeting over time, in 2018 several countries introduced a concrete reform proposal to increase the incentives to adhere to the notification duties in the WTO by applying a "naming and shaming" strategy (WTO 2018c). More far-reaching, the Trilateral Meeting has proposed reforms to broaden the definition of prohibited and actionable industrial subsidies, including also stricter disciplines on SOEs (Joint Statement 2020). Accordingly, for example, the following subsidies should be unconditionally prohibited in the future: unlimited guarantees, certain direct forgiveness of debt, subsidies to an insolvent or ailing enterprise in the absence of a credible restructuring plan. However, despite such increasing pressures, China continues to refuse negotiations about a reform of the ASCM. Due to the WTO's consensus principle, China's resistance renders a meaningful reform of relevant WTO rules elusive, so that the multilateral route as the first best option for reforms appears barred for the time being.

Therefore, unilateral and bilateral avenues must be used in order to better discipline the competitive distortions of China's state capitalism.

- The US has chosen an aggressive route by waging an open trade war with China. However, the resulting Phase-1-deal of January 2020 between the US and China does not deal with subsidy-related distortions of competition (Schott 2020).
- The EU continues to negotiate with China, e.g., in the framework of a bilateral Comprehensive Investment Agreement (CIA), however without sufficient progress. Therefore, it is also time for the EU to play its cards with more determination. In this respect, the European Commission's (2019a) new China strategy is a first positive step.

However, more reform incentives and pressure appear to be necessary to induce China to a more cooperative strategy. To this aim, the EU should close ranks with the US even more on issues of common interest such as industrial subsidies and forced technology transfers. In addition, the EU should also unilaterally apply a more robust trade policy stance in order to broaden the protection of EU firms against unfair competition from China. To be clear, such steps, if correctly applied, would not qualify as protectionism but as attempts to level an unlevel playing field (at least to some extent).

Examples of a more robust trade policy stance should include more WTO disputes against Chinese market distortions. Moreover, the EU should expand its toolbox of defense instruments by introducing the International Procurement Instrument (IPI) (European Commission 2016 and 2019a) and by tackling competitive distortions from Chinese firms active in the Single Market, as recently proposed with a non-discriminatory approach by a far-reaching White Paper of the European Commission (2020).

Furthermore, a more active use of existing trade defense instruments (TDIs) is commendable. This is possible within the WTO framework that the EU used to interpret relatively restrictively in the past to champion open markets (BusinessEurope 2020; Bertelsmann Foundation et al. 2019, Matthes 2019 and 2020). As a matter of fact, the EU has used TDIs to a declining extent over time and to a much smaller degree and with lower tariffs as the United States (EP 2019 and 2020). This is particularly true for countervailing (anti-subsidy) measures. One likely reason is that the administratively tedious TDI procedures in the EU tend to overburden firms (particularly SMEs). Firms could also suffer from a coordination problem because the initiation of a TDI procedure induces positive external effects for other competing European companies (Matthes 2020).

Thus, the European Commission could initiate more TDI procedures (ex officio). Moreover, TDI procedures should be streamlined as far as possible within the WTO framework, particularly for SMEs that also need more capacity building supported by the Commission and by business organizations. The EU should also consider making better use of the leeway the WTO framework provides, as far as it pertains to the Union interest test and the TDI tariff levels by further reducing the use of the lesser-duty rule (Matthes 2020). The use of countervailing measures and of counter notification of subsidies at the WTO should be increased based on the insights from a relatively new database on subsidies investigated by EU (European Commission 2019b). In summary, and different from some instances in the past, TDIs should be employed before European firms get into serious trouble due to competitive distortions by China, as was the case with solar panels. This requires better monitoring of markets by Commission and business organizations.

CONCLUSION

Subsidization in China is pervasive at numerous levels of government and appears to be an inherent element of Chinese state capitalism. However, despite initial attempts to shed more light on the subject, there is still a severe lack of transparency regarding the diversity of subsidies and their scale. The available information, however, suggests that the extent of Chinese subsidies is extraordinarily widespread and that the resulting overcapacities tend to lead to considerable and increasing distortions on the world market (European Commission 2017). Multiple efforts of the international community to induce China to change its approach have hardly led to any substantial progress. This is not very likely to change in the future, as the state capitalist model has proved remarkably successful for China. Along the same lines, an initial assessment of the potential effects of the corona virus crisis on the Chinese industrial policy model does not suggest a major change in Chinese market distortions. This constellation bodes ill for the future of the multilateral trading system.

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Covid-19: Economic Policy Interventions Across Continents

ABSTRACT

Coronavirus has changed the way we live and work in many ways and has presented hurdles for businesses and individuals. Countries around the world have taken action to help their economies overcome the crisis and have applied various measures to stimulate the economy by supporting businesses and individuals. Although the approaches are similar, many measures differ in their precise design and their implementation. This article presents some recent fiscal policy measures in terms of public spending, taxes, and other financial support in eight countries, including Australia, Brazil, China, Germany, Italy, South Africa, Sweden and the US.

The coronavirus (Covid-19) rapidly evolved into a worldwide pandemic and spread to 216 countries. Within a few weeks, coronavirus cases nearly tripled from over 9 million in June to almost 24 million cases at the end of August (World Health Organization 2020). This pandemic represents a new, unprecedented situation for all countries and poses new challenges both for social life as well as the world economy. As shown by a study conducted by Oxford University, not only the time course of the infections varies significantly from country to country, but there is also a huge variation in government responses in dealing with the challenge of curbing the virus in relation to social distancing measures implemented by individual countries (Hale 2020).

The research was conducted for eight countries located on six continents; all countries were carefully selected based on their economic relevance, approach to policy intervention as well as their varying degree of the evolution of the virus as shown in Figure 1. The list of countries comprises Australia; Brazil—which is experiencing the fastest spreading rates of coronavirus and high death tolls; China for being the first country affected; Germany, which has been prone to implementing early intervention measures; Italy, which is viewed as one of the world's worst hotspots; South Africa; Sweden, due to its approach which is different from other countries; and the United States, which leads in terms of absolute number of cases. This article describes the various economic measures that these countries are applying to help their economies overcome the recession.[1]

RESEARCH DESIGN

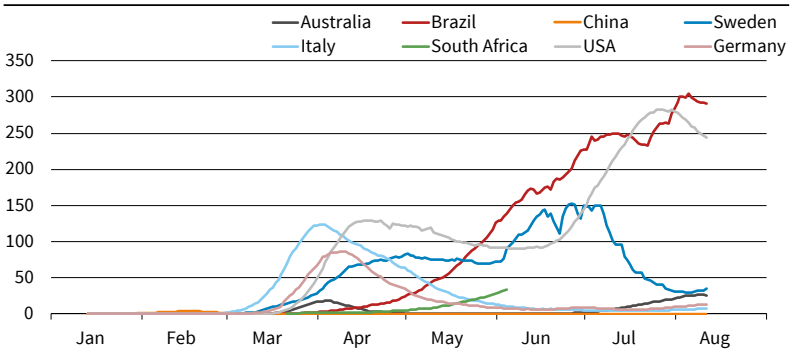
At present, there are intensively researched and well-documented overviews that collect information on how countries have responded to the unprecedented challenge of the coronavirus crisis—the OECD Policy Tracker in particular provides very detailed and regularly updated policy information across countries and continents (OECD 2020). As the coronavirus spread around the world, we also tried to gather information on how countries react economically to the crisis. While these results are less comprehensive, they complement the OECD collection by categorizing some of the measures slightly differently. In the following section, policy activities are grouped according to the following types of measures:

1. Measures related to government spending, taxes and employment (see Table 1).
2. Measures related to financial assistance (not involving taxes) and interest rates to some extent (see Table 2).

Figure 1

Evolution of Corona Cases in Selected Countries in 2020

14-day notification rate of new Covid-19 cases per 100,000 inhabitants



Note: Not all dates available for South Africa.

Source: European Centre for Disease Prevention and Control (2020).

* ifo Institute.

[1] The list of measures described in this article, as well as the list of countries, are not exhaustive. The measures were collected as of June 2020 and may be subject to change. Furthermore, the authors cannot guarantee whether the measures mapped out have already been successfully implemented. The information provided in this report is at a descriptive level and the information was mainly collected from two main resources, namely, the "Government Response – Global Landscape" (KPMG 2020), and the "Policies Responses to COVID-19" (International Monetary Fund 2020).

ECONOMIC MEASURES RELATED TO COVID-19 IN SELECTED COUNTRIES

The following sections present economic measures that the investigated countries have taken to stimulate the economy, along with direct government intervention measures shown in Table 1 and other financial support measures displayed in Table 2.[2]

Direct Intervention Measures Implemented by the Government That Are Related to Public Spending, Taxes and Employment

In order to smooth fluctuations and stabilize the economy during or outside crises such as Covid-19, governments use fiscal policy to adjust public spending. In addition, tax increases and reductions can influence the investment behavior of companies and the consumption behavior of citizens. Tax changes affect citizens directly and are implemented from a political point of view, a more far-reaching measure.[3] During the current economic downturn triggered by Covid-19, all observed countries have taken measures related to taxes and government spending. Table 1 presents some key measures at the company and individual level as they relate to tax postponement, tax relief, subsidies and employment.

I. Tax Postponement

In all examined countries, tax postponement for companies in one form or another are an integral part of the action plan to combat the negative consequences of the lockdown. Germany, Italy, Sweden, and South Africa allow the deferral of several taxes over a longer period. The US, China, Australia, and Brazil offer such facilitations as well, but to a lesser extent.

Germany allows the deferral of income tax, corporate tax and the VAT until the end of the year without interest. In Italy, social security and welfare contributions can be deferred in addition to withholding tax and VAT. This is similar to the measures taken in Sweden, where companies can delay their social contributions, the VAT, payroll taxes, and small medium enterprises (SMEs) can defer all of their taxes. South Africa's "pay-as-you-earn" approach enables companies to defer 35 percent of tax payments. In the United States, the federal income tax can be deferred. In China, the possibility of deferring corporate income tax is concentrated on small enterprises and self-employed individuals. The Australian "pay-as-you-go" system allows companies to defer income tax, whereas in Brazil, companies can postpone social contributions.

These measures vary in their extent and duration. Germany, for example, offers a comprehensive package of tax measures for companies where payments can be postponed until the end of the year. The US, China, Australia, and Brazil have fewer measures, and some of them are only offered for a shorter period.

In addition to corporate measures, some countries, such as Italy and South Africa, have introduced measures for individuals. For example, the *Disaster Management Relief* in South Africa allows individuals to defer taxes for debt and interest and other financial payments until the end of September.

II. Tax Relief

In contrast to tax postponements, other taxes have been reduced or completely waived. Such measures were introduced in all countries but Sweden at the time this research was conducted.[4] The countries selected in this overview can be divided into a group with rather generous measures, such as South Africa, Germany and, Australia; and a group of countries with more restrained measures, such as the US and Italy. For China, no commitments relating to tax relief could be identified. In Germany, the number of advance payments on income tax, corporation and business tax have been adjusted. Australia waived the payroll tax for hospitality tourism, the seafood industry and small businesses until the end of the financial year. In addition, the depreciation rules for tax write-offs have been considerably extended in Australia. In Italy, the formal audits of tax returns have been suspended and a 60 percent tax credit on commercial rents has been introduced, while companies can retain payroll taxes in the amount of creditable sick pay in the US. South Africa assists employers with a tax reduction of 80 percent in the employee tax.

Also, the measures for providing relief to individuals vary by country. In Germany, prepayments and payments based on the calculated income loss are compensated and the VAT has been reduced. In Italy, the withholding tax on revenues and fees was reduced. In the US, tax returns are now automatically filed. Australia grants tax-free withdrawals from pension funds, including one-off incentive payments through the social security system. China grants income tax exemptions in special cases, such as donations, medical institutions working on Covid-19 prevention, and on social security contributions. In Brazil, the deadline for tax declarations has been extended.

III. Subsidies and Transfers

In addition to postponing or completely exempting certain taxes, some countries have committed themselves to supporting companies and individuals in

[2] For a more extensive collection of economic policy responses, see also OECD (2020).
[3] See, for example, https://ourworldindata.org/taxation.
[4] However, according to the OECD (2020), 100 percent of the taxable profit of sole proprietors and partners in Swedish partnerships can be allocated to the tax reserve up to SEK 1 million for the year 2019, which can then be offset against possible future losses.

need financially. In South Africa, for example, eligible employees receive a tax allowance. Germany has a similar measure, but it applies only to the income tax of single parents, while Brazil provides temporary income support for vulnerable households. Sweden provides additional expenditure on wage subsidies, and China accelerated the payment of the unemployment insurance to natives as well as migrant workers. Australia grants a one-off subsidy to small businesses, while Brazil compensates workers who have been furloughed and provides tax breaks and credit lines to companies to help them save jobs.

Furthermore, many countries have agreed on employment-related measures, which are usually direct measures to support employers and employees. In Germany, for example, the government compensates 70 to 80 percent of salary losses of childless workers, and 77 to 87 percent of workers with children under the short-time working scheme (*Kurzarbeit*) if the working hours have been reduced by at least 50 percent (see e.g., OECD 2020). This system was already in place before the pandemic and was largely adopted throughout the country during the coronavirus crisis.

Overall, governments use similar types of measures to stimulate their economy. Nevertheless, the design of such measures varies greatly from country to country. One possible reason could be differences in present institutional and economic characteristics. On the other hand, other variables related to trade and politics certainly play a role. For example, Germany as an export nation (GTAI 2020a) faces different challenges in this recession than do countries that tend to be more reliant on imports, such as South Africa (GTAI 2020b).

Other Measures Relating to Financial Assistance (without Taxes) and Interest Rates

Economic activities around the world have been stalled due to the severity of the coronavirus and lockdown measures were implemented in several countries, leading to closures of several businesses over an extended period of time. This has led to higher unemployment rates, a drop in business sentiment and a contraction in GDP, plunging countries into deep recessions. In this case, money supply can play a major role in maintaining economic stability. In an attempt to ensure price stability, policymakers resort to financial and monetary measures controlling inflation, unemployment and exchange rates. In terms of monetary policy, several regulatory and interest rate-based interventions are applied to facilitate lending and borrowing money, some of them shown in Table 2. The measures presented in the table are divided into various categories, namely, loan schemes, funds and guarantees, investment incentives and transfers, and other measures.

I. Loans, Funds and Debt Relief

This subsection includes loan schemes and repayment deferral, lending facility, increased funding limits and credit extension given to businesses by banks. Institutions provide easier access to loans, often at reduced interest rates and fewer bureaucratic hurdles, or defer the repayment of existing loans due to the coronavirus. SMEs are particularly affected in the wake of the coronavirus in terms of their business survival and liquidity positions, because SMEs generally represent a large proportion of firms contributing to the economy in many countries and are less resilient to shocks.

Some countries have provided assistance in terms of loans at reduced interest rates to be repaid on a longer-term basis and have facilitated access to assistance loans for companies provided, for example, by the state-owned Bank Group, KfW Bankengruppe, together with the government in Germany. In addition, some countries, such as Italy and China, have extended funding limits for its banking system to back up subsidized loans to SMEs and other businesses. Further support for SMEs include loan payment deferment. In China, the *funding-for-lending scheme* was introduced to finance 40 percent of local banks' new unsecured loans. *The Swedish Central Government Loan Program* guarantees a 70 percent stake participation in any new bank loan provided to companies and has extended credit to export-oriented companies. South Africa also had a *Covid-19 Guaranteed Loan Scheme,* covering up to three months of SME expenses and the *Small, Medium, and Micro-business South African Fund* will enable soft loans at an interest rate of less than five percent.

Brazil is using its *Fundo de Amparo ao Trabalhador*, the worker's support fund, to provide credit for micro and small enterprises. Furthermore, an agreement among the five biggest Brazilian banks means that all five banks are considering extending debt maturing liabilities for SMEs. In China, credit lines of micro- and small enterprises have been extended. Important lending programs in the US were the *SBA Economic Injury Disaster Loans*, which focus on lending to businesses harmed by Covid-19 without repayment, and the *SBA Express Bridge Loan*, enabling businesses with fast turnaround to get up to USD 25,000 in loans. In the US, the Small Business Association incentivized companies by paying six months of their associated fees and microloans disbursed before 27 September 2020. As part of debt relief, countries have also deferred loans and promoted lending facilities. This is the case in South Africa, where a *Debt Relief Fund* was created in order to provide debt relief on existing liabilities of eligible SMEs.

II. Other Monetary and Financial Measures

Investments have declined systematically during the coronavirus pandemic, creating supply disruptions

Table 1

Direct Government Measures Related to Public Spending, Taxes and Employment

	TAX POSTPONEMENT		TAX RELIEF		SUBSIDIES AND TRANSFERS	
	Companies	**Individuals**	**Companies**	**Individuals**	**Companies**	**Individuals**
AUSTRALIA	**Payment date deferment**. ("pay as you go" – PAYG Installments), income tax assessments, fringe benefits tax assessments and excise; Quarterly reporting cycle to opt into monthly goods and services tax (GST) -> reporting to get quicker access to GST refunds	N/A	Business investment acceleration – **tax depreciation** write-off rules are significantly expanded with an increased instant asset write-off for immediate deductions of certain asset purchases and a 50% accelerated depreciation deduction in addition to the existing depreciation deduction for certain eligible asset purchases; **Waiver of payroll tax for:** Hospitality tourism and seafood industry (for the last 4 months of this financial year), small to medium businesses with an annual payroll of up to AUD 5 million in Australian wages (March to June 2020), businesses with payrolls of up to AUD 10 million, with a deferral available for larger businesses (rest of 2019–2020); 25% reduction benefit on the 2019-2020 land tax liability for commercial and residential landlords; Businesses can claim an immediate deduction for multiple assets	**Tax-free** withdrawals from pension funds. It includes one-off stimulus payments, to be made through the social security system;	**One-off grant** AUD 17,500 for small businesses; **Non-profits-free payments** made to certain employers (to support small and medium-size businesses) for business; **Cash-flow boosts** will be automatically credited for those employers who filed their 2018–19 income tax return of activity statement prior to 12 March 2020	N/A
BRAZIL	**PIS/ PASEP and COFINS contributions** regarding March and April 2020 are postponed to August and October 2020. **Social Contribution postponement** related to March and April 2020 should be paid in August and October 2020; **Extend the submission** of the **Tax Accounting Bookkeeping** (ECF), giving more time for companies to adapt to current situations	N/A	**Lower taxes** and **import levies** on essential medical supplies, and new transfers from the federal to state governments to support higher health spending and as cushion against the expected fall in revenues	**Installment payments** deadlines from the Federal Revenue Service and the Attorney General's Office National Treasury in May, were extended to June and July, and the ones in August, were extended to October and December; **Zero tax reduction** on financial transactions daily rate (0.0041% or 0.0082% per day) and its complementary rate (0.38%) levied on credit transactions carried out by individuals and legal entities	**Employment support** (partial compensation to workers who are temporarily suspended or who have had cut in working hours, as well as temporary tax breaks and credit lines for firms that preserve employment)	**Temporary income support to vulnerable households** (bringing forward the 13th pension payment to retirees (USD 9.2 billion), and expanding Bolsa Familia (USD 620 million) program with inclusion of over 1 million more beneficiaries cash transfers to informal and unemployed workers (USD 8 Billion), and advance payments of salary bonuses to low income workers

CHINA	**Deferral of CIT payment** for Small Enterprises and self-employed from 1 May 2020 to 31 December 2020 to filing period in 2021	N/A	N/A	**Income Tax Exemption** on specific receipt types; Full tax deductibility in case of donation done to support non-profit organizations, government authorities or medical institutions treating and preventing Covid-19. Tax relief and waived social security contributions	N/A	**Accelerated disbursement of unemployment insurance** and extension to migrant workers
GERMANY	**Deferral of certain taxes** until 12/31/2020 and in principle free of interest (e.g., income, corporate and value added); Postponement of due date of import turnover tax to the 26th of the following month	N/A	Adjusted amount of **advance payments** (2020) on income tax, corporation tax, business tax	**Refund of prepayments** (for 2020) and amounts paid for 2019, based on a flat-rate calculated loss for the current year; **Reduction of VAT** from 19% to 16%; reduced rate from 7% to 5% (from 7/1/2020–12/31/2020); **Waiving of enforcement** of overdue tax debts and surcharges for late payment until 12/31/2020	**Short-time work compensation** until 12/31/2020 **"Corona-Soforthilfe für Kleinstunternehmen und Soloselbständige":** Cash transfer for companies with financial problems due to Covid-19 of EUR 9,000 (up to 5 employees)/ EUR 15,000 (up to 10 employees)	**Tax subsidy for single parent's income tax:** extension of relief contribution in income tax to EUR 4,000 for 2020 and 2021; **Notfallkinderzuschlag (KiZ):** Eligible parents receive EUR 185 per child per month; due to Covid-19 the access is now easier: by applying for KiZ after 4/1/2020 proof of income is no longer required for the last 6 months, but only for the last month; **One-off payment** of EUR 300 per child for parents (double allowances for single parents) **Short-time work compensation:** 70%/ 80% for employees without children, 77%/ 78% for employees with children
ITALY	**Deferral of withholding tax** on the pay of employees and equivalent workers, VAT, social security and welfare contributions, and INAIL insurance premiums	**Suspension of tax obligations** (e.g., VAT declaration) other than payments and withholding taxes, expiring in March 2020; due date: 06/30/2020	Suspension of all **formal audits of tax returns**; 60% tax credit on commercial rents	**Revenues and fees** received between 3/17/2020 and 3/31/2020 are not subject to withholding tax	**Moratorium on loan repayments** for SMEs, including on mortgages and overdrafts; **State guarantees** on loans to all businesses; **Support check** ("integrazione salariale") as support of salary payment by the state for employers with suspended/ reduced work activity due to Covid-19	**Last resort income support** for employees and self-employed workers having ceased, reduced or suspended employment relationship or business **Redundancy Fund** (boosted by EUR 5 billion) for 9 weeks' salary for workers not covered by other social safety nets **Allowance** of EUR 600 for autonomous workers and seasonal workers (tourism, agriculture) for March
SOUTH AFRICA	**Pay-as-you-earn (PAYE):** possible deferment of 35% of payment without penalties or interest	**Disaster Management Tax Relief:** possible deferment of tax payments belonging to "Tax Treatment of Excessive Debt Financing, Interest Deductions and Other Financial Payments" from 4/17/2020 to 9/30/2020	**Pay-as-you-earn (PAYE):** possible deferment of 35% of taxes without penalties or interest; **Draft Disaster Management Tax Relief Administration Bill:** only 80% of the employees' tax due need to be paid	N/A	**Subsidies** for SMEs under stress, mainly in the tourism and hospitality sectors, and small-scale farmers operating in the poultry, livestock, and vegetables sectors	**Employment Tax Incentive (ETI):** eligible employees (age 18-65) will receive a tax subsidy of up to ZAR 500 per month; **Draft Disaster Management Tax Relief Administration Bill:** only 80% of the employees' tax due need to be paid

SWEDEN	**Deferral** of companies' social contributions, VAT, payroll taxes and SMEs taxes. SEK 27 billion – SEK 315 billion VAT: 2019 (SEK 7 billion); SMEs taxes SEK 13 billion	N/A	N/A	N/A	**Loans** to SMEs; **Funding** to the media, cultural and sports sectors; Temporary **rent subsidies** to vulnerable sectors; Temporarily more generous **unemployment benefits**; **SEK 40 million Foreign contribution** to the international response against Covid-19 through WHO's contingency fund; **Swedish airlines and companies credit guarantees** (SEK 235 billion) **Capital contribution** from the government to Almi Företagspartner AB of SEK 3 billion to help it assist SMEs lending needs	Short-term leave employees SEK 170 billion – additional expenditures on wage subsidies
US	**Deferral** of federal income tax payments due on 4/15/2020 to 7/15/2020 without penalty or interest	N/A	**CARES Act:** 50% payroll tax credit for severely affected businesses not benefitting from business interruption loans and agreeing to maintain employment levels; **Families First Coronavirus Response Act:** Possibility of retaining an amount of the payroll taxes equal to the amount of qualifying sick and child care leave that they paid; **Duty relief on medical products from Section 301:** Chinese-Original Medical Supplies (before: duty of up to 25% on the import of Chinese goods due to special Section 301 tariffs)	"**Economic Impact Payments**" for people without filed tax return in 2018/ 2019, but with dependents (USD 1,200 + USD 500 per eligible child)	**Grants** for airlines, air cargo and support firms under the CARGO Act; **Paid sick leave credits** in case of employees' illness, child caring activity by employee (up to 10 days)	**Paid sick leave** in case of illness due to Covid-19, health care activity, childcare (expanded paid family and medical leave)

Notes: Last updated in June 2020. N/A means that no action was found at the time of the research.

Sources: KPMG, IMF, OECD as well as other national and international sources collected by the authors (2020).

Table 2

Other Measures Related to Financial Assistance

	LOANS, FUNDS AND DEBT RELIEF	OTHER MONETARY AND FINANCIAL MEASURES
AUSTRALIA	**Loan repayment deferral**, banks will defer loan repayments for small businesses for 6 months; **Lending facility**, term funding facility for SMEs covered by AUD 90 billion at 25bps; **Liquidity scheme**, one-month and three-month repo operations daily;	**Temporary relief from capital requirements**, enabling banks to use large buffers to facilitate ongoing lending to the economy as long as minimum capital requirements are met; **Government allocation** of AUD 15 billion to the Australian Office of Financial Management to invest in wholesale funding markets used by smaller lenders; **Dividend level**, Australian Prudential Regulation Authority (APRA) expects banks and insurers to consider deferring decisions on the level of dividends or approve a dividend at a materially reduced level; **Establishment of SWAP facility** (dollar liquidity arrangements) with US Federal Reserve of USD 60 million; **Yield Targeting:** 3-year government bonds at around 0.25 percent through purchases of government bonds in the secondary market; **Policy rate cut** (twice) by 25bps
BRAZIL	**Lending facility** to provide loans to financial institutions backed by private corporate bonds as collateral; **Fundo de Amparo ao Trabalhador (FAT):** Credit for Micro and Small Enterprises (USD 1 billion); **Debt Liabilities**, five largest banks in the country agreed to consider requests extension of individuals maturing debt liabilities	**Repo Operations** undertaken by central bank; **Liquidity Injection** in the financial system (reduction of reserve requirements and capital conservation buffers, and a temporary relaxation of provisioning rules, among others); **Establishment of SWAP Facility** with US Federal Reserve of USD 60 million for the next 6 months **Policy Rate (SELIC)** cuts lending by 2.25%
CHINA	**Re-lending & re-discounting facilities** at low-interest rates by RMB 1.8 trillion for SMEs and agricultural sector; **Funding-for-lending scheme:** zero-interest and covered by RMB 400 billion scheme to finance 40% of local banks' new unsecured loans and incentivize them to extend payment holidays for eligible loans by subsidizing 1% of loan principles (RMB 40 billion) - support SMEs lending; **Tolerance increase** for higher NPLs and reduced NPL provision coverage requirements; **Delay of loan payments**, eased loan size restrictions for online loans, and other credit support measures for eligible SMEs and households **Credit extension** covered by RMB 350 billion to Micro- and Small Enterprises	**Reverse Repos (RR)** and **Medium-term Lending Facilities (MLF)** to foster a liquidity injection of RMB 4.6 trillion in the banking system; **Bond Issuance Increase** – additional financing support for corporates; **Reduction** of the 7-day and 14-day **Reverse Repo Rates** by 30bps; Reductions in the 1-year Medium-term Lending Facility (MLF) Rate by 30bps and Targeted MLF Rate by 20bps; **Targeted RRR** cuts by 50-100 bps for large- and medium-sized banks that meet inclusive financing criteria which benefit micro- and small-sized enterprises (MSEs), an additional 100 bps for eligible joint-stock banks, and 100 bps for small- and medium-sized banks in April and May to support SMEs; **Reduction of the interest on excess reserves** to 35bps; **Flexibility** in the implementation of the **asset management reform**
GERMANY	**Easier access to assistance loans** for companies due to liability takeover by KfW and the Federal Government and simplification of risk assessment; **"KfW-Unternehmerkredit"**/ **"ERP-Gründerkredit"** granting loans of up to EUR 1 billion with terms of up to 5 years; **KfW Quick Loan Program:** loans for all businesses at 3% interest for terms of 10 years without further risk assessment	**Easier financing** with venture capital and equity substitutes for start-ups without venture capitalists among shareholders and small SMEs; **Regulatory easing** performed by BaFin reducing countercycle capital buffer for banks to 0%; **No change in key ECB interest rates** since 9/18/2019
ITALY	**Increased funding limit** for banking system (from EUR 1 billion to EUR 3 billion) for subsidized loans to SMEs, mid-caps, micro-enterprises, freelancers and sole proprietorships **Central Guarantee Fund ("Fondo centrale di garanzia"):** Guarantees (90–100%) free of charge to companies suffering loss of income due to Covid-19; **Guarantees for loans** granted to all companies (70–90% of granted loans' amount by SACE)	**Postponement of payments** for holders of debit accounts; **No change in key ECB interest rates** since 9/18/2019
SOUTH AFRICA	**Covid-19 guaranteed loan scheme for SMEs:** Funds covering up to 3 months of expenses; 6-month **repayment holiday of interest and capital repayment**; **Unified lending rate** for all banks (tracked with repo rate); **Small, Medium and Micro-Business South African ("SMMESA") Fund:** Soft loan of up to R 500,000 at an interest rate of prime less 5%; **Giving for Hope Fund:** Loans to SMMEs of up to R 1 million at no interest; **Debt relief fund:** Relief on existing debts and repayments for eligible SMEs	**Business growth or resilience facility:** facility offering working capital, stock, bridging finance, order finance and equipment finance; **Liquidity coverage ratio** (LCR) of banks was reduced from 100% to 80%; **Reduction of key interest rate** from 6.25% (1/17/2020) to 5.25% (3/20/2020) to 4.25% (4/15/2020) to 3.75% (since 5/22/2020)

SWEDEN	**Central government loan program for SMEs:** Government will guarantee 70% of any new loan provided by banks to companies - Limit of SEK 75 million per borrower; **Bank lending facility:** unlimited amount given adequate collateral with 3-month maturity; Possibility for Banks to **borrow against collateral** from US - USD 60 billion Lending rate reduction by 0.2%; **The Swedish Export Credit Corporation's credit framework** will be increased from SEK 125 billion to SEK 200 billion – incentive to assist Swedish export companies; **The Swedish Export Credit Agency** have increased credit guarantees totaling SEK 500 Billion and lower risk for banks	Purchase of securities by the government amounting to SEK 300 billion; Regulatory easing, for Bank, recognizing all credit institutions under the supervision of the Swedish FSA as counterparties; Establishment of SWAP Facility with US Federal Reserve of USD 60 million; No change in key ECB interest rates since 9/18/2019;
US	**Small Business Associations (SBA) Economic Injury Disaster Loans (EIDL):** Loans of up to USD 10,000 for eligible businesses harmed by Covid-19 without repayment; **SBA Express Bridge Loan:** Loans of up to USD 25,000 for eligible businesses with fast turnaround; **SBA debt relief:** Payment by SBA of 6 months for principal, interest, and any associated fees and microloans in regular as well as new servicing status and microloans disbursed prior to 9/27/2020	**Money Market Mutual Fund Liquidity Facility (MMLF):** Loans for eligible financial institutions secured by high-quality assets purchased by the financial institution from money market mutual funds; **Term Asset-Backed Securities Loan Facility (TALF):** Supporting flow of credit to consumers and businesses; **Primary Market Corporate Credit Facility (PMCCF):** Bridge financing of four years; **Secondary Market Corporate Credit Facility (SMCCF):** Providing liquidity for outstanding corporate bonds; **Paycheck protection program:** Fully forgiven loans for payroll costs, interest on mortgages, rent, and utilities without collateral or personal guarantees and fees; **Decrease in FED interest rate:** From 1.75% (10/30/2019) to 1.25% (3/3/2020) to 0.25% (since 3/15/2020); **Establishment of SWAP facilities** with several other countries; **Easing and Encouragement:** Reserve requirement reductions, capital buffer relaxation and encouraging big banks to use their deposit window

Notes: Last updated in June 2020.

Sources: KPMG, IMF, OECD as well as other national and international sources collected by the authors (2020).

and demand contractions. Several other measures have been employed to stimulate financial activities, including monetary and financial measures by the central banks.

In China, more bonds were issued as additional support for corporations. In Australia, capital requirements were relaxed temporarily, as well as three-year government bond yield. Additionally, liquidity was increased by injecting capital into the financial system in Brazil. In the US, the *Term Asset-Backed Securities Loan Facility* supports credit flow to consumers and businesses. Another facility in the US is the *Primary Market Corporate Credit Facility,* which provides four years of bridge financing to companies. The *Secondary Market Corporate Credit Facility* focuses on providing liquidity for outstanding corporate bonds. The *Money Market Mutual Fund Liquidity Facility* secured loans given to qualified financial institutions with high-quality assets from money market mutual funds.

Some countries implemented interest rate measures that aimed to facilitate financial activity. Low-interest rates ease borrowing for individuals and companies and support spending and investment. The European Central Bank has not changed the key interest rate since September 2019 and thus not directly influenced European countries, such as Germany and Italy. In contrast, central banks in countries outside the European Union have lowered their policy rate. The central bank in Brazil cut its policy rate by a quarter point to an all-time low. The Fed reduced its policy rate from 1.75 percent to 0.25 percent within five months. Also, South Africa had its interest rates largely reduced from 6.25 percent to 3.75 percent within the first five months of the crisis (see Table 2).

SUMMARY

Amid Covid-19, a series of measures were taken to control the economic impact caused by the spread of the pandemic worldwide. This report describes some key policy measures implemented by various countries around the world.

In summary, one can say:

a) Tax postponements for companies were largely granted in all investigated countries, whereas at the time of the investigation only Italy and South Africa offered this type of assistance to individuals.

b) In several countries, measures for full or partial tax relief were found for both companies and individuals.

c) All countries concerned provided subsidies and transfers to both companies and individuals.

d) All countries facilitated lending, deferral of loans and took action to implement regulatory easing for companies, and SMEs in particular.

e) The key interest rate was adjusted in countries outside the European Union.

The scope of this report is limited in the following respect: (i) the list of financial measures for the eight concerned countries is not exhaustive: measures other than those mentioned may have been considered and implemented, (ii) if and to what extent some of these measures have been implemented is still to be seen in the coming months, and (iii) other policy areas, such as trade and exchange-rate policies, are not discussed in great detail. Nevertheless, this article is an attempt to show how these eight countries have responded with different economic measures to combat the negative consequences of the Covid-19 crisis.

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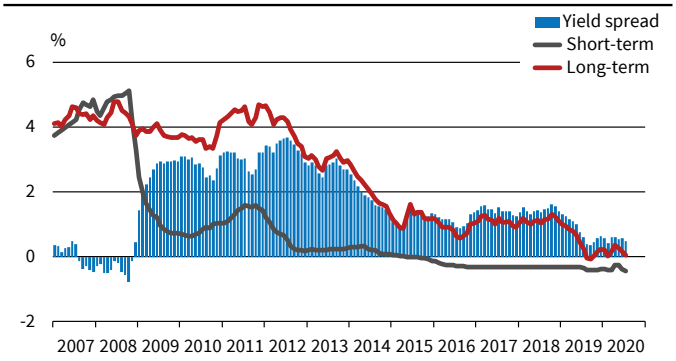
Statistics Update

Financial Conditions in the Euro Area

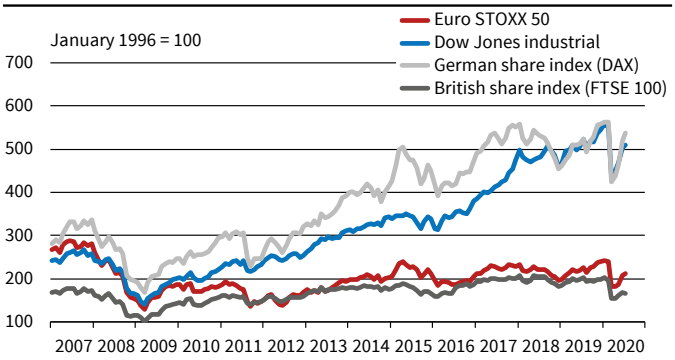
Nominal Interest Rates [a]



[a] Weighted average (GDP weights).
Source: European Central Bank; calculations by the ifo Institute. © ifo Institute

In the three-month period from May 2020 to July 2020 short-term interest rates decreased: the three-month EURIBOR rate amounted to – 0.44% in July 2020 compared -0.27% in May 2020. The ten-year bond yields also decreased from 0.27% in May 2020 to 0.05% in July 2020, while the yield spread reduced from 0.54% to 0.49% between May 2020 and July 2020.

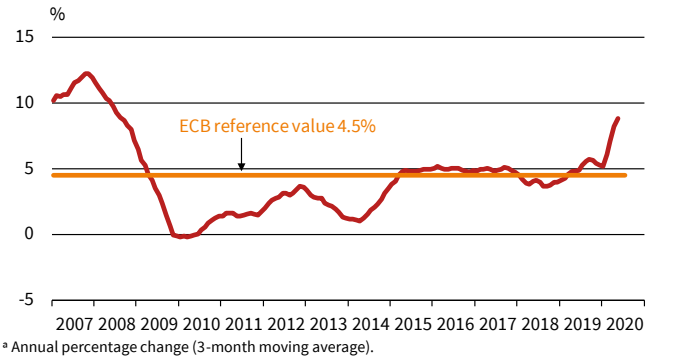
Stock Market Indices



Source: Deutsche Börse; Dow Jones; FTSE; STOXX. © ifo Institute

The global fears about the spread of the coronavirus, oil price drops caused by an oil price war between Russia and the OPEC countries, and the possibility of a recession led to the stock market crash in March 2020, and global stocks saw a severe downturn in this month. Yet the German stock index DAX continued to grow in July 2020, averaging 12,741 points compared to 10,987 points in May 2020, while the UK FTSE-100 also increased from 5,956 to 6,167 in the same period of time. The Euro STOXX amounted to 3,237 in July, up from 2,909 in May 2020. The Dow Jones Industrial also increased, averaging 26,362 points in July 2020, compared to 24,280 points in May 2020.

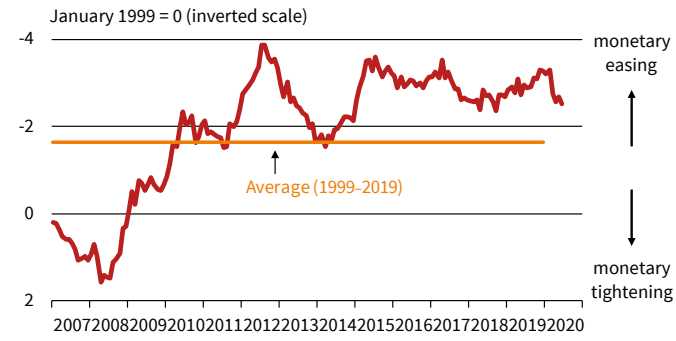
Change in M3 [a]



[a] Annual percentage change (3-month moving average).
Source: European Central Bank. © ifo Institute

The annual growth rate of M3 increased to 9.2% in June 2020, from 8.9% in May 2020. The three-month average of the annual growth rate of M3 over the period from April 2020 to June 2020 reached 8.8%.

Monetary Conditions Index

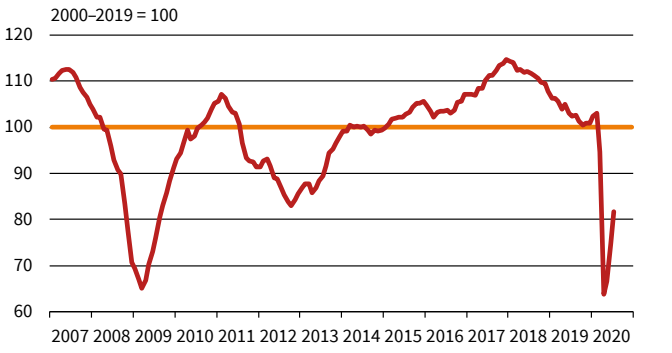


Source: European Commission. © ifo Institute

Between April 2010 and July 2011, the monetary conditions index had remained stable. Its rapid upward trend since August 2011 had led to the first peak in July 2012, signaling greater monetary easing. In particular, this was the result of decreasing real short-term interest rates. In May 2017 the index had reached one of the highest levels in the investigated period since 2007 and its slow downward trend was observed thereafter. A continuous upward development prevailed since October 2018 was abruptly stopped in March 2020 as the Covid-19 crisis started. A further slight decrease of the index was observed in June 2020.

EU Survey Results

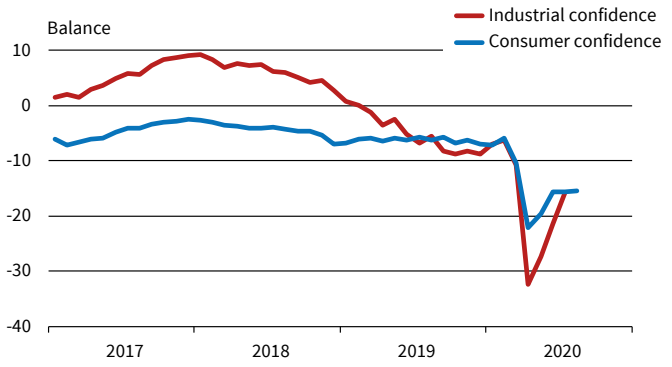
EU27 Economic Sentiment Indicator
Seasonally adjusted



Source: European Commission. © ifo Institute

In July 2020 the recovery of the Economic Sentiment Indicator (ESI) continued from the record slumps of March and April caused by the global Covid-19 shock: it increased in both the euro area (by 6.5 points to 82.3), and the EU27 (by 6.9 points to 81.8).

EU27 Industrial and Consumer Confidence Indicators
Percentage balance, seasonally adjusted

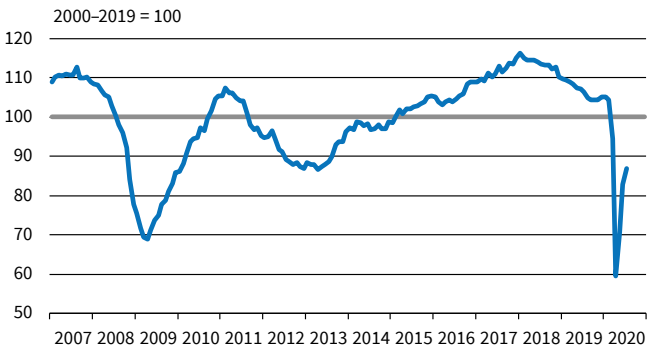


Source: European Commision. © ifo Institute

* The industrial confidence indicator is an average of responses (balances) to the questions on production expectations, order-books and stocks (the latter with inverted sign).
** New consumer confidence indicators, calculated as an arithmetic average of the following questions: financial and general economic situation (over the next 12 months), unemployment expectations (over the next 12 months) and savings (over the next 12 months). Seasonally adjusted data.

In July 2020, the *industrial confidence indicator* increased by 5.0 in the EU27 and by 5.4 in the euro area (EA19). The *consumer confidence indicator* remained unchanged in the EU27 but decreased by 0.3 in the EA19 in July 2020.

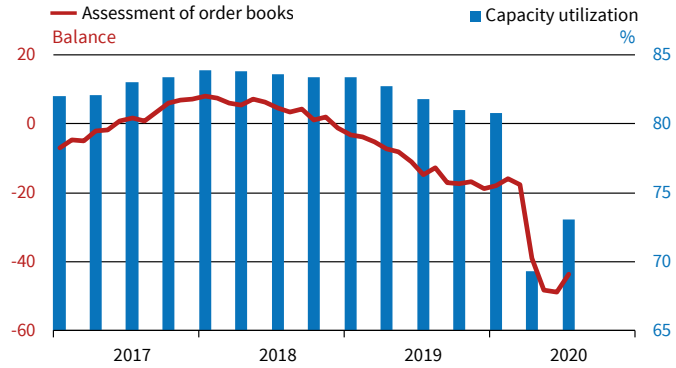
EU27 Employment Expectations Indicator
Seasonally adjusted



Source: European Commission. © ifo Institute

In July 2020 the Employment Expectations Indicator (EEI) improved for the third month in a row (by 4.0 points to 87.0 in the euro area and by 4.1 points to 87.0 in the EU27.

EU27 Capacity Utilisation and Order Books in the Manufacturing Industry
Seasonally adjusted

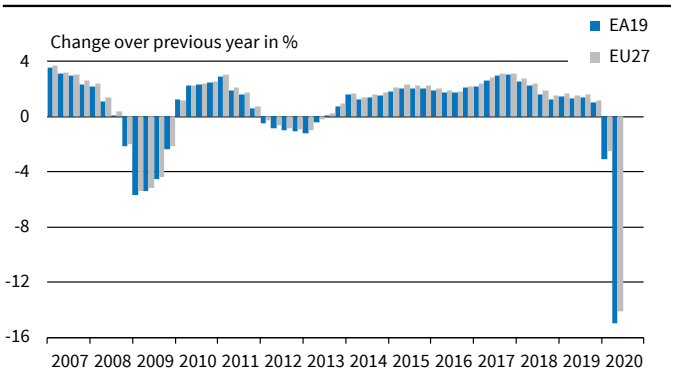


Source: European Commission. © ifo Institute

Managers' assessment of *order books* reached – 43.5 in July 2020, compared to – 48.7 in June 2020. In May 2020 the indicator had amounted to – 48.3. *Capacity utilization* stood at 73.1 in the third quarter of 2020, up from 69.3 in the second quarter of 2020, again showing the improvement from the Covid-19 shock.

Euro Area Indicators

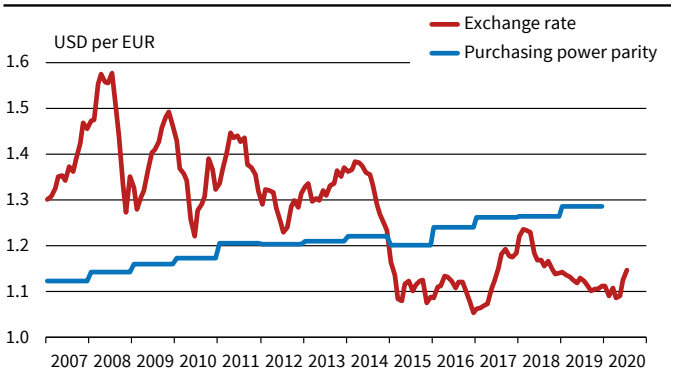
Gross Domestic Product in Constant 2015 Prices



Source: Eurostat. © ifo Institute

According to the Eurostat estimates, GDP decreased by 12.1% in the euro area (EA19), and by 11.7% in the EU27 during the second quarter of 2020, compared to the previous quarter. These were the sharpest declines observed since 1995. In the first quarter of 2020 GDP had decreased by 3.6% in the EA19 and by 3.2% in the EU27. Compared to the second quarter of 2019, i.e., year over year, seasonally adjusted GDP decreased by 15.0% in the EA19 and by 14.1% in the EU27 in the second quarter of 2020.

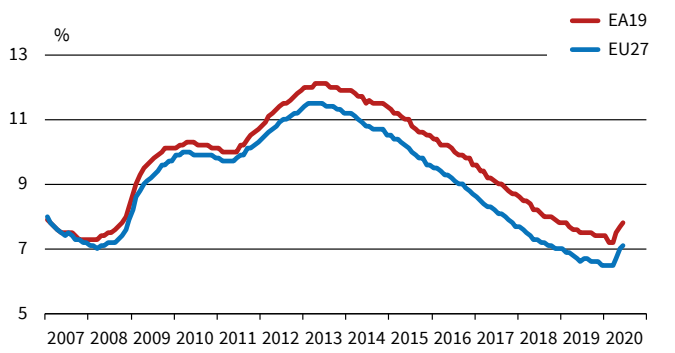
Exchange Rate of the Euro and Purchasing Power Parity



Source: European Central Bank; OECD; calculations by the ifo Institute. © ifo Institute

The exchange rate of the euro against the US dollar averaged approximately 1.12 $/€ between May 2020 and July 2020. (In April 2020 the rate had also amounted to around 1.09 $/€.)

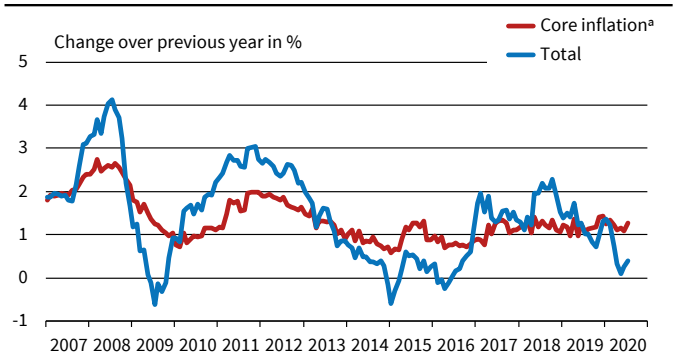
Unemployment Rate



Source: Eurostat. © ifo Institute

Euro area unemployment (seasonally adjusted) amounted to 7.8% in June 2020, up from 7.7% in May 2020. EU27 unemployment rate was 7.1% in June 2020, again up from 7.0% in May 2020. In June 2020 the lowest unemployment rate was recorded in Czechia (2.6%) and Poland (3.0%), while the rate was highest in Spain (15.6%) and Greece (15.5%).

Euro Area Inflation Rate (HICP)



[a] Total excl. energy and unprocessed food.
Source: Eurostat. © ifo Institute

Euro area annual inflation (HICP) amounted to 0.4% in July 2020, up from 0.3% in June 2020. Year-on-year EA19 core inflation (excluding energy and unprocessed foods) also went up to 1.3% in July 2020, from 1.2% in May 2020.