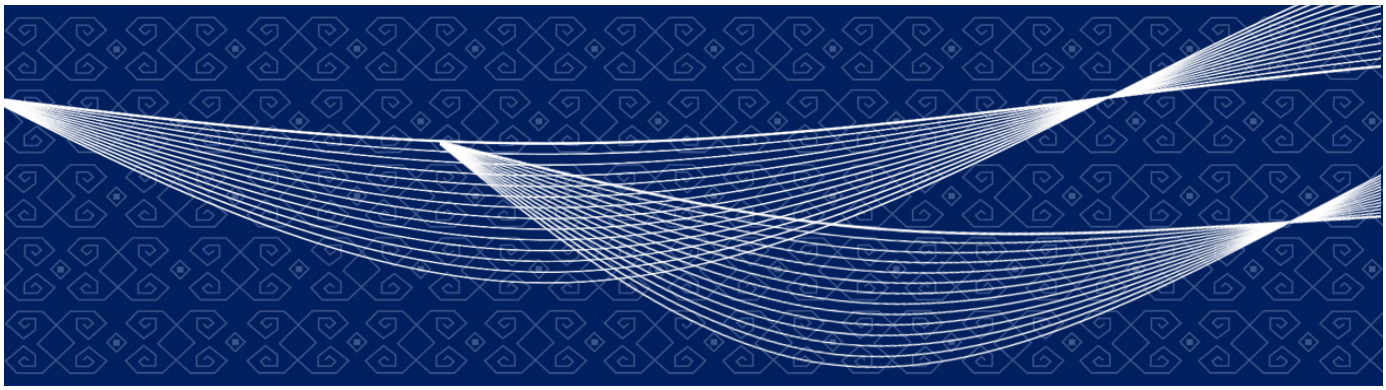
BANK INDONESIA
BANK SENTRAL REPUBLIK INDONESIA



WP/10/2021

WORKING PAPER

THE LABOR MARKET IMPACT OF COVID-19 AND THE ROLE OF E-COMMERCE DEVELOPMENT: EVIDENCE FROM INDONESIA

Masagus M. Ridhwan
Asep Suryahadi
Jahen F. Rezki
Immanuel Satya Pekerti

2021

A THE LABOR MARKET IMPACT OF COVID-19 AND THE ROLE OF E-COMMERCE DEVELOPMENT: EVIDENCE FROM INDONESIA

Masagus M. Ridhwan[1], Asep Suryahadi[1,2], Jahen F. Rezki[1,3], Immanuel Satya Pekerti[1]

Abstract

We This study assesses the impact of COVID-19, measured by the reduction in work mobility and e-commerce growth, which has been expected to counteract the adverse effect of COVID-19, on the labor market outcomes of individual workers in terms of their employment prospects, work hours, total earnings, and earnings per hour in Indonesia. The data analyzed are combined from the labor force survey and e-commerce transaction values collected by Bank Indonesia, which is unique and publicly unavailable. The findings confirm that COVID-19 has adverse effects on workers' labor market outcomes. However, e-commerce growth did not counteract the negative impact of COVID-19 as expected, but it still played a role as an employment buffer during the crisis. While e-commerce growth creates jobs, those jobs are mainly self-employment. Furthermore, e-commerce growth tends to suppress the earnings of workers. Our results imply that to optimize e-commerce to improve labor market outcomes beyond jobs creation in the informal sector, efforts are needed to increase the productivity of workers involved in e-commerce, such as through skills enhancement and other capacity-building programs.

Keywords: COVID-19, labor market, mobility, e-commerce, Indonesia

JEL Classifications: J22, J23, J46, J63, O33

Acknowledgment: With the usual disclaimer we are grateful to Bank Indonesia's Department of Statistics for helping us to provide the e-commerce data. Corresponding author: Asep Suryahadi. Email: *suryahadi@smeru.or.id* [1]Bank Indonesia Institute, Bank Indonesia [2]SMERU Research Institute, [3]Institute for Economic and Social Research (LPEM-FEB UI)

1. Introduction

COVID-19 pandemic has created crises in various markets, creating significant economic disruptions. One of the markets most adversely affected by COVID-19 is the labor market. The pandemic adversely affects both the supply and demand sides of the labor market. On the supply side, infected workers, fear of infection, and mobility restrictions policy imposed to reduce the spread of the virus reduce the supply of workers. On the demand side, a decrease in goods and services markets has reduced the derived demand for workers. The net effect of these pressures in the labor market is increased unemployment and reduced workers' work hours and income, causing deterioration in household welfare.

Previous studies have generally pointed out that COVID-19 hurts the labor market. The pandemic has been found to affect the labor market adversely in the form of the declining number of available jobs, either in terms of vacancies and positions (Hensvik et al. 2021; Ranchhod and Daniels 2020; Brochu et al. 2020) or working hours (Béland et al. 2020; Anderton et al. 2020; Lemieux et al. 2020). However, some studies also found that unemployment did not rise proportionally. Instead of being unemployed, many have opted for early retirement (Coibion et al. 2020; Anderton et al. 2020). The study by Brochu et al. (2020) found that individuals of older age have remarkably low reemployment probability after the relaxation of restriction, which might explain the trend. Another emerging trend is to move to other less affected sectors, found through the job seekers' behavior on the online job board (Hensvik, Le Barbanchon, and Rathelot 2021) or empirical evidence of labor market churning (Brochu et al., 2020).

In terms of earnings, there is a less convergent result across several pieces of evidence. Prediction by Bell and Blanchflower (2020) from the early UK and US data suggests that nominal earnings growth will slow down and real take-home pay will decline, while Béland, Brodeur, and Wright (2020) found that this is not the case from their US analysis. They found that the pandemic has no significant impact on wages. Another evidence is provided by Schotte et al. (2021), who found that the earning only declines as an immediate impact after the imposition of lockdown but will bounce back to its normal level approximately four months after the relaxation. Anderton et al. (2020) offer additional insights by suggesting that, in the European case, labor productivity per employee has decreased while labor productivity per hour increased slightly, which is a clear indication of reduced work hours.

Delving deeper, the earning effect is different when considering some characteristics. The earnings of informal workers (Balde, Boly, and Avenyo 2020), especially the self-employed ones (Schotte et al. 2021), are evidently the hardest hit by the pandemic. Despite argument by Balde, Boly, and Avenyo (2020), which suggests that formal contract serves as a job security measure, a particular type of contract does not necessarily help, such as a zero-hours contract which allows the employer to reduce employee's work hours indefinitely (Crossley, Fisher, and Low 2021). Another important aspect to consider is the excess labor market supply during the COVID-19 pandemic. Brief by the International Labor Organization points out the concern about labor market slack and the downward pressure on wages that it might cause (Elder et al., 2021).

Evidence has also pointed out that the pandemic has disproportionately affected parts of the labor market due to their work nature. These sectors are hotels and restaurants, retail trade, arts, along with leisure and recreation activities (Borland and Charlton 2020; Lemieux et al. 2020; Byrne et al., 2020; Barrot et al., 2020), and, to some extent, construction and education (Boukar et al., 2021). Several studies have also proposed that the ability to do remote work might have a cushioning effect (Anderton et al., 2020). This argument is reinforced by the findings of Barrot et al. (2020), which suggests that GDP impact variation is partly explained by the propensity to telework, and of Lin and Meissner (2020) which found that states with more jobs can be done from home have lost fewer jobs, albeit with weak statistical significance. Evidence hints that a better cushion to the adverse shock of the pandemic is the wage subsidy

programs instituted by some countries. Some studies have provided evidence that programs, such as the job retention scheme in the United Kingdom (Crossley et al., 2021) and the JobKeeper in Australia (Borland and Charlton 2020), have successfully dampened the impact.

Some studies have also documented that COVID-19 has a disproportionate impact on particular worker characteristics. The most affected of the labor force is the young, women, informal workers, especially the self-employed, the less-educated, the low-skilled, racial minority or immigrant, non-union or low-tenured workers, also workers who have jobs with temporary or zero-hours contracts, low-paid jobs, and jobs in low-productivity services (Hassink et al., 2020; Schotte et al. 2021; Ranchhod and Daniels 2020; Lemieux et al., 2020; Bell and Blanchflower 2020; Crossley et al., 2021; Béland et al., 2020; Borland and Charlton 2020; Brochu et al., 2020; Pouliakas and Branka, 2020; Casarico and Lattanzio, 2020).

The young workers are severely impacted for several reasons. First, the majority, if not all, young workers are low-tenured. Brochuet al. (2020) estimate that unemployment is substantially higher in low-tenured jobs due to heterogeneity in match quality. Another data-based finding from the United States by Inanc (2020) shows that youth are the dominant workforce in the hardest-hit industries, such as retail and hospitality, and the work which they do mostly can not be done from home. Outside of the labor force, there is also the problem of disruption to the education system, which may cause increased dropout figures and dropping enrolment rates (Lee et al., 2020). The major concerns that may arise are youth unemployment and problematic transition to the workforce, leading to wage scarring in the long run.

The next category of concern is women workers. Some literature points out that women are also disproportionately affected by the pandemic compared to their male counterparts. While analytical results (Borland and Charlton 2020; Churchill 2021; Abraham, Basole, and Kesar 2021) confirmed a higher likelihood of women workers losing their jobs, Lee, Schmidt-Klau, and Verick (2020) offer insight as to why this is the case. They found that 40 percent of women workers worked in the hardest-hit sectors during the pandemic, compared to men's 36.6 percent. Churchill (2021) has also found that this might be the case for Australian young women workers. However, Casarico and Lattanzio (2020) did not find gender to be a significant predictor of job loss in general. Nevertheless, they found that females with upper secondary education and domestic work have a significantly higher separation rate.

Furthermore, women workers also face more difficulties in things after separation. Brochu, Créchet, and Zechuan (2020) and Abraham, Basole, and Kesar (2021) found that women face more difficulty in their recovery to employment. Additionally, they are more likely to exit the labor force during this time. Some studies suspect that there are an increasing burden of household works, lack of childcare services to support child-rearing during school shutdowns, the fact that some jobs that women workers took are not "family-friendly" and can not be done from home, and gender norms (Abraham et al., 2021; Churchill 2021; Lee et al., 2020).

Meanwhile, digitalization has been proposed to potentially counteract the adverse effects of COVID-19 on the economy. Digitalization allows various transactions to be implemented virtually, reducing or eliminating the need for physical interactions among economic agents to complete transactions. Thus, digitalization is a safe alternative for people's health, given the danger of physical interactions due to COVID-19. Digitalization includes many dimensions of economic activities from production, distribution, to consumption and supporting systems of the economy such as finance. One of the fastest-growing digitalization dimensions is e-commerce, making it possible to sell and buy goods and services through online markets.

One of the silver linings from the COVID-19 pandemic has been the dramatic rise of digitalization in almost every aspect of human life (World Bank, 2021a). Businesses are no exception in the wave of pandemic-induced adoption of digital technologies. While innovation is widely accepted as one of the main drivers of productivity and job creation, the discourse about whether innovation in terms of digitalization would create or destroy jobs is still heavily

debated. Some literature has argued that man and machine are in a race, dating back to Leontief (1952). Current literature (Acemoglu and Restrepo, 2018; Balsmeier and Woerter, 2019), found that investment in digitalization is linked to higher employment of high-skilled labor, while low- and medium-skilled labor tends to be reduced or stay at the same level.

The COVID-19 pandemic created an unprecedented shock to the labor markets by limiting the ability to work with high intensity of human contact and lowering the demand for labor caused by the decrease in demand for goods and services. The adoption of digital technologies such as the use of the internet, social media, specialized apps, and digital platforms to replace the pre-COVID-19 conventional practice of business has been one of the most highlighted firms' strategies in coping with the pandemic situation. However, digitalization allows remote work but not to the same extent for all jobs. Dingel and Neiman (2020) showed that remote works are primarily applicable for higher-educated or higher-skilled workers, who are more immune to the risk of automation and artificial intelligence.

Autor and Reynolds (2020) discussed the possibility of the long-run impact of the pandemic on low-skill workers. If remote work becomes more prevalent post-pandemic, there would be a sharp decline in demand for accommodation, transportation, and other jobs that are meant to fulfill the demand of people that spend their time outside of the house for business reasons. Therefore, a long-run decrease in demand in these sectors would mean significant job losses and substantial transformation of labor markets, especially for low-skilled workers.

In Indonesia, COVID-19 was first discovered in March 2020 in the capital Jakarta. Since then, it has spread continuously all over the country. By September 2021, the infection of the virus has accumulated to reach more than 4.2 million people, with more than 140.000 deaths. The government policy to contain the spread of the virus consists of increasing contact tracing and testing of suspected COVID-19 cases, enhancing the COVID-19 vaccination, and imposing mobility and activity restrictions (Suryahadi et al., 2021).

Like in other countries, the pandemic has caused severe disruption to the Indonesian economy. During 2020, the economy has contracted consecutively in the last three quarters, resulting in the negative economic growth of 2.07% during the whole year. There are signs of improvement in the economy in the first half of 2021, with the first quarter economic contraction of only -0.74% and turning to the positive economic growth of 7.07% in the second quarter. The economic contraction has adversely impacted the labor market, where many workers are laid off or furloughed. The unemployment rate had increased significantly, and there has been an apparent informalization of the labor market, indicated by an increase in the proportion of informal workers (Suryahadi et al., 2021).

Meanwhile, Indonesia has experienced a fast growth of e-commerce since before the COVID-19 pandemic. The onset of the pandemic has accelerated e-commerce growth further as people used it as an alternative strategy or solution to the mobility and activity restrictions policy. As a result, the contribution of e-commerce to the trade sector's GDP has jumped from around 2% in 2016 to around 20% in 2020. The growth of e-commerce has been expected to counteract the adverse effects of COVID-19 on the labor market as it allows people to conduct transactions without endangering health.

The simultaneous developments of the COVID-19 pandemic and e-commerce growth in Indonesia since early 2020 make Indonesia an ideal case to assess how far e-commerce growth can counteract the adverse effects of mobility and activity restrictions during the COVID-19 pandemic. Hence, this study aims to investigate the impact of COVID-19, measured by the reduction in work mobility, and the growth of e-commerce on workers' labor market outcomes in terms of their employment prospects, work hours, total earnings, and earnings per hour.

This study finds that COVID-19 has adverse effects on workers' labor market outcomes. However, e-commerce growth did not counteract the negative effects of COVID-19 as expected, but it still played a role as an employment buffer during the crisis. While indeed e-commerce

growth creates jobs, those jobs created are mainly in the form of self-employment, strengthening the effect of COVID-19 on increasing the share of informal workers. Furthermore, e-commerce growth tends to suppress the earnings of workers, which did not help the efforts to improve people's welfare. This implies that to realize the potential of e-commerce development to contribute to the improvement of labor market outcomes beyond jobs creation in the informal sector, efforts are needed to increase the productivity of those involved in e-commerce activities, such as through skills enhancement and other activities capacity-building programs.

The remaining of the paper is structured as follows. Section two reviews the developments of the COVID-19 pandemic and digital economy in Indonesia. Section three provides the conceptual framework and empirical strategy used in this study. Section four discusses the results of the analysis. Finally, section five presents the conclusion and policy implication.

2. The Developments of COVID-19 Pandemic and Digital Economy in Indonesia

2.1 The COVID-19 Pandemic

The first declaration of the COVID-19 case in Indonesia took place on 2 March 2020. However, the attention to the disease had begun on January 22, 2020, when the Provincial Government of DKI Jakarta issued a warning notice about the 'heavy pneumonia plague' which has infected China and neighboring countries (Diskominfotik DKI Jakarta, 2020). Since then, up until September 2021, Indonesia has recorded more than 4.2 million cases with 140 thousand deaths. Various containment measures have been put in place to fight the propagation of the virus.

The pandemic has disrupted various activities and the economy in general. The disruption due to COVID-19 has brought down economic growth from the steady growth of around 5% during the pre-COVID-19 period to a bottom of -5.3 in the second quarter of 2020, implying a drop of around 10 percentage points from its steady growth path. The economy has contracted consecutively in the last three quarters of 2020, resulting in negative economic growth of 2.07% during the whole year. Up until the first quarter of 2021, economic growth continued to be in the negative territory but with lesser magnitude, implying a relative improvement in the economic condition.

However, the impact has not been uniform across sectors. While the COVID-19 pandemic has hard hit some sectors, some other sectors have grown positively. During 2020, when the Gross Domestic Product (GDP) of the overall economy contracted by 2.07%, the GDP of several sectors expanded. Out of 17 sectors recorded by Statistics Indonesia (BPS), seven sectors have managed to have positive GDP growth during 2020: health services and social activities by 11.60%, information and communication by 10.58%, water and recycling by 4.94%, financial services and insurance by 3.25%, education services by 2.63%, real estate by 2.32%, and agriculture by 1.75%.

Similarly, the impact has not been equal for all workers. While millions of workers have lost jobs and/or reduced income, some other workers have managed to increase their income (Ridhwan et al., 2021). While most households have reduced their per capita consumption during 2020, households in the top 5% managed to increase their per capita consumption, indicating that they had a higher income during the pandemic (Suryahadi et al., 2021).

There are signs of economic improvement in the first half of 2021, with the first-quarter economic contraction of only -0.74%. Only in the second quarter of 2021, economic growth returns to the positive territory with a growth of 7.1%. The drop in growth is caused by, most notably, a reduction in the contribution by household consumption and gross fixed capital formation (Olivia et al., 2020; Sparrow et al., 2020). The magnitude of impact varied across sectors. Characteristics of sectors that are the most affected by the pandemic such as, vulnerable to mobility restriction (e.g., accommodation), highly dependent on international trade and

supply chains (e.g., wholesale and retail, manufacturing, etc.), and dependent on government projects (e.g., construction sector) (Sparrow et al., 2020; Manning 2021a).

The Indonesian labor market is another point of concern. Manning (2021a) offers historical and comparative insights which might be applicable in the Indonesian case. While unemployment is a good measure for labor market difficulties, he hinted that underemployment and informality might promise more insights into the problem. Suryahadi et al. (2021) find that the shock due to COVID-19 has increased the proportion of informal workers from 56.50% in February 2020 to 60.47% in August 2020. Along with the improvement in the economy, the proportion of informal workers fell slightly to 59.62% in February 2021.

Meanwhile, the underemployment rate jumped from 6.3% in February 2020 to 10.2% in August 2020 and decreased again to 8.7% in February 2021. This is consistent with the finding of Temenggung et al. (2021), which points out the increase of the unpaid family worker during the recent labor force survey as a form of adaptation to recent shock. They also suggest that labor market adjustment might have a disproportionate effect on a particular demographic category. Sparrow et al. (2020) also have raised similar concerns that this might lead to longer-term structural unemployment due to the possibility of skill-biased recovery, which may render a younger, more educated workforce advantageous.

COVID-19 also changed the sectoral share of employment. Suryahadi et al. (2021) find that the sector that experienced the largest increase in the number of workers in agriculture, where most of its workers are informal workers, with additional 2.8 million workers from August 2019 to August 2020. On the other hand, the sector experienced the largest reduction in the number of workers in manufacturing, where most of its workers are formal workers, with a reduction of 1.7 million workers in the same period. At least some of the displaced, mostly male, workers from manufacturing, transport, and construction probably moved into agriculture temporarily. The labor force data show that new jobs were not only in their home villages but also in urban locations where new forms of agriculture have grown during 2020 (Manning, 2021b). The other sectors that experienced a relatively large change in the number of their workers are trade with an increase of 540 thousand workers, and construction with a reduction of 610 thousand workers, during the same period.

Next, Manning (2021a) discussed the relationship between informal sectors and employment. He found that the distancing and mobility restriction measures have directly hit the informal sectors, with two-thirds ceased their business activities, facing cash-flow problems and leading to the retrenchment and lay-offs. This finding is confirmed by Prospera's business survey (Temenggung et al., 2021). This leads to the next important point of concern on how the laid-off workers cope with the adjustment. Manning (2021a) pointed out that this pandemic is different from what happened in the 1997 Asian Financial Crisis. As previously discussed on the shift to the informal sector as a form of adaptation, there is concern that this might not be as effective as usual due to activity restriction happening during the pandemic, which is hard-hitting, especially towards the informal sector.

Finally, in terms of the efforts to mitigate the adverse impact, Suryahadi et al. (2021) find that social protection programs have an important role in mitigating the social impact of the COVID-19 pandemic. They estimate that the effect of the COVID-19 pandemic without increased social assistance would be to increase the poverty rate from 9.2% in September 2019 to 14.2% in September 2020. Because of the effect of the social protection programs, the actual poverty rate in September 2020 was only 10.2%. Hence, they conclude that about three-quarters

of the potential effect of COVID-19 on poverty has been mitigated by the social protection programs.

2.2 The Development of Digital Economy

The development of digital technology is projected to have an important contribution to Indonesian economic development. Das et al. (2016) predict that, by 2025, digitization will bring an impact of 150 billion US dollars and additional employment for 3.7 million people. For example, the number of startups in Indonesia has grown significantly from 1,400 in 2017 to 2,200 in 2019, placing Indonesia in the second rank in Asia and fifth in the world after the US, India, UK, and Canada, as reported by the Startup Ranking website in 2020. Furthermore, the potential of electronic commerce (e-commerce) in Indonesia in 2022 is projected to reach 55-65 billion dollars. The impact will be felt on the absorption of the workforce, including the female workforce (Das et al., 2018).

Related to this development, Indonesia's internet connectivity has grown steadily over the years. The number of adults with internet connections increased almost four times, from 13 percent in 2011 to 51 percent in 2019 (World Bank, 2021a). This increase was driven by major information and communication technology (ICT) infrastructure development, such as constructing a 36,000 km Palapa Ring fiber optic project in various areas, including rural areas, to facilitate uniform high-speed internet access across Indonesia.

The adaptation of digital technology has been translated to a substantial increase in e-commerce transactions. E-commerce total transaction increased almost five times from 42 trillion rupiahs in 2017 to 205 trillion rupiahs in 2019. Even in the recession year of 2020, e-commerce transactions still increased to a total of 266,3 trillion rupiahs. According to Indonesian E-Commerce Association data, as of May 2021, the number of medium, small, and micro enterprises (MSMEs) that have joined the Indonesian digital ecosystem have reached 13.7 million, or about 21% of the total number of enterprises. Nevertheless, connectivity gaps exist across regions, income levels, generations, education levels, and gender (World Bank, 2021a).

Digital apps such as ride-hailing services have been an integral part of Indonesian daily activity, especially in big cities. Many startups have been popping up in Indonesia to provide digital solutions to customers in almost every aspect of life. These digital advancements have boosted consumer welfare by supplying a variation of goods and services that were not accessible before. COVID-19 has accelerated the digitalization of enterprises to cope with restrictions due to limited mobility and interaction. For example, many food sellers have joined the food delivery platforms so that they can still operate without providing a dine-in place. However, this adoption is disproportionately higher for larger firms (World Bank, 2021a).

Besides firms that utilize digital technologies to continue their operation, digital technologies also give opportunities for people to produce and deliver services specifically using online platforms. These types of jobs are typically known as "digital gig jobs". These digital gig workers are typically hired as "partners" without regular work time or a specific workload. One of the most typical examples for Indonesian gig workers is the driver of ride-hailing apps. Digital gig workers earn more than similar informal workers and are less likely to have second jobs (World Bank, 2021a). Overall, the digital economy in Indonesia has been growing substantially over the years and has been amplified by the necessity to adopt digital technologies caused by the COVID-19 pandemic.

COVID-19 pandemic has accelerated the growth of e-commerce. Since the pandemic, Indonesia has seen 21 million new digital consumers, where 72% are from non-metro areas, indicating a growing penetration in the regions. Meanwhile, those who have already used the services since before the pandemic have consumed an average of 3.6 more services since the pandemic began. Overall, all internet sectors rebounded strongly with double-digit growth.

Indonesia's gross merchandise value (GMV) is expected to reach a total value of $70B in 2021, a 49% year-on-year increase. This steep increase is underpinned by a 52% growth in e-commerce. Indonesia continues to be one of the most vibrant digital financial services markets due to its relatively open regulatory framework (Google, Temasek, and Bain & Company, 2021).

However, the increase in digital adaptability is still unequal among various socioeconomic strata. Internet access is still uneven across regions, gender, income levels, education levels, and business sectors. For example, in 2019, only 2% of the total workforce in the agricultural sector uses the internet, while the number of workers in this sector reaches 27% of the total number of people working in Indonesia. Furthermore, the internet is still mainly considered a mere means of communication and entertainment, not yet widely considered a means of business (Bachtiar et al., 2020). Furthermore, internet availability has only a small significant effect on the female labor force participation rate and no statistically significant effect on the employment rate. It also reduces the probability of women with a low level of education working in the formal sector. However, it increases the probability of women having a full-time job, especially for women aged 15–45 and those with a low level of education (Kusumawardhani, 2021).

A survey conducted by the World Bank in Indonesia in June 2020 showed that many firms had adjusted their strategy in response to COVID-19 by adopting digital technologies (World Bank, 2021a). However, the uptake was higher among larger firms, although the number for medium and micro firms is not negligible. Higher-skilled workers and larger and more formal firms can adopt digital technologies. Overall, digitalization has enabled firms to adapt to the new working circumstances caused by the COVID-19 pandemic. Nevertheless, the adoption of digital technologies seems to be more beneficial for larger firms and high-skilled workers. On the other hand, the shift to remote working might negatively affect some jobs predominantly occupied by low-skilled workers. Indonesia is no exception in this condition. Therefore, appropriate policies such as increasing digital readiness, developing skills for the digital economy, and strengthening social protection are needed to alleviate this trend of job polarization (Park and Inocencio, 2020).

3. Conceptual Framework and Empirical Strategy

3.1 Conceptual Framework

An early proposition by Hausmann (2020) proposes that the pandemic is "first and foremost a supply shock," which means that it is not the matter of the purchasing power, but rather about where to spend the money when all the stores are closed, or about how the factories are going to produce when the workers have to stay at home. To further shed light on the impact mechanism of COVID-19 on the labor market, Guerrieri et al. (2020) propose a theoretical framework along with possible outcomes in various market settings.

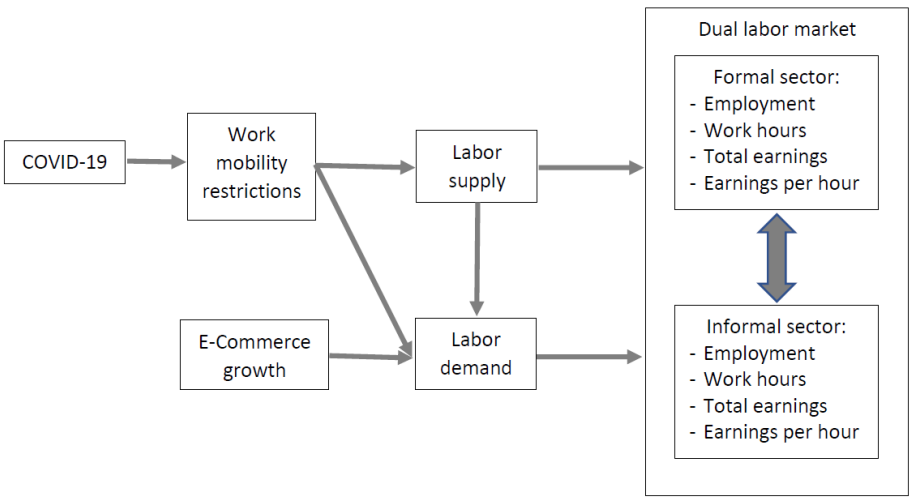
Theoretically and empirically, studies also found that the pandemic impact on the economy does not come from the health aspect itself, but rather from the restriction or the lockdown policy. Eichenbaum, Rebelo, and Trabandt (2020) formulated a model which captures the interaction between economic decisions and epidemiologic outcomes. Their model confirms that the containment of the virus might take a toll on the economy in the form of a recession. This is also confirmed by Hassink, Kalb, and Meekes (2020) in the case of the Netherlands, where the location of where the policy is imposed explains the economic decline better than the number of cases. Another interesting yet relevant piece of evidence is provided by Schotte et al. (2021), who found that workers located in districts under lockdown had a 34.3% lower chance of working than the control group in Ghana. Further evidence is found from the analysis of European labor market data (Anderton et al., 2020), British labor market survey data (Crossley et al., 2021), and Indonesian consumer survey data (Ridhwan et al., 2021).

To facilitate our understanding of the impact of COVID-19 on the labor market, this study uses the framework as illustrated in Figure 1. To contain the spread of COVID-19, the government has imposed mobility and activity restrictions, including mobility to the workplace (Ridhwan et al., 2021; Suryahadi et al., 2021). In addition, workers get infected, reducing production capacity (Hausmann, 2020). Furthermore, fear of being infected may also reduce labor supply as people choose to stay at home rather than go to work, and these cause a negative labor supply shock.

These would lead to a demand shock. As people lose jobs or face shortened working hours, their earnings decline, resulting in lower household income and reduced consumption. Hence, demand for goods and services declines. Moreover, in countries with incomplete markets and liquidity-constrained consumers, the initial supply shock could lead to amplified demand shocks (Guerrieri et al., 2020).

In developing countries, including Indonesia, unemployment benefits are absent, while the social protection system is weak and insufficient. Hence, workers could not remain unemployed for long, forcing them to return to the labor market to earn income. Since the formal sector has shrunk, they enter the informal sector, increasing the economy's informalization. The existence of a dual labor market, which consists of the formal and informal sectors, makes this mechanism possible. The informal sector provides a buffer for workers who lost jobs and cannot find one in the formal sector. The expectation is that they will return to the formal sector during the recovery.

Like many other countries in the world, Indonesia has experienced a fast growth of e-commerce, which has accelerated during the COVID-19 pandemic. It appears that people used e-commerce as an alternative strategy or solution to the mobility and activity restrictions policy imposed by the government. This has the effect of increasing labor demand, potentially offsetting the adverse effects of COVID-19 on the labor market.[1] This means that to fully understand the impact of COVID-19 on the labor market, we need to look at the impact of both COVID-19 and e-commerce growth on individual workers' job prospects, work hours, total earnings, and earnings per hour in both the formal and informal sector of the labor markets.



Source: Author

Figure 1 Framework of the Impacts of COVID-19 and E-Commerce Growth on Labor Market Outcomes of Workers

[1] In the long run, e-commerce development can also affect labor supply through technological change.

3.2 Empirical Method and Data Description

3.2.1 Method

To assess the impact of COVID-19, measured through work mobility, and e-commerce growth on the probability to work, work hours, total earnings, and earnings per hour in the formal and informal sectors for individual workers during the COVID-19 pandemic, we estimate the following multilevel model with province and time fixed-effects:

$$U_{ijt} = \vartheta + \sigma M_{jt} + \omega E_{jt} + \theta D_{jt} + \mu S_{jt} + \pi Z_{ijt} + \rho X_{jt} + \varphi_j + \tau_t + \varepsilon_{ijt}$$

where U is an outcome variable to measure employment prospects (0 = not working, 1 = working), work hours, total earnings, and earnings per hour, M is mobility index, E is e-commerce growth, D is labor demand shifter (the employment rate), S is labor supply shifter (labor force growth), Z is a vector of worker characteristics variable (gender, education level, years of experience, etc.), X are province characteristics, ϕ is province fixed-effect, τ is time fixed-effect, while i indexes an individual worker, j indexes province, and t indexes time. The unit of observation is individual workers with the time period from August 2019 until February 2021.

For the model with employment prospects as the outcome variable, the model is estimated using the Linear Probability Model (LPM) method. Similarly, the model is estimated using the Ordinary Least Squares (OLS) method for work hours, total earnings, and earnings per hour. Furthermore, the model is estimated separately for each outcome variable for the formal and informal sectors. Since work mobility declined during the COVID-19 period compared to the pre-pandemic period, a positive coefficient of the work mobility (M) variable indicates a negative effect of COVID-19 on the outcome variable.

3.2.2 Data

We construct a combined dataset from Indonesia's National labor Force Survey (*Survei Angkatan Kerja Nasional*, SAKERNAS) at the individual level and national accounts at the provincial level, both from Statistics Indonesia (*Badan Pusat Statistik*, BPS), and other provincial-level datasets including the Google Mobility Report and e-commerce transaction values summary provided by Bank Indonesia, and several other data from various sources for control variables. Our study has the advantage of using the e-commerce transaction value summary data provided by the Bank Indonesia, which is not publicly available, to delve deeper and gain insights into the role of e-commerce in the labor market dynamics during the pandemic.

Table 1 in the provides the descriptive statistics of the provincial-level dataset, and Table 2 provides the descriptive statistics of the individual-level dataset.

Table 1 Summary Statistics of Provincial-level Dataset

Variable	Obs	Mean	Std. Dev.	Min	Max
unemp	4,410	0.055974	0.019297	0.011706	0.130949
informal	4,371	0.390159	0.291397	0	1
lfpr	4,410	0.679254	0.038618	0.597675	0.798299
grdpgr_labprod	4,346	0.084473	1.241831	-0.91666	69.87325
grdp_gr	4,410	0.033292	0.083926	-0.87541	1.434979
gmi_work	4,410	-5.95458	11.5534	-41.3571	7.6
ecomm_totaladj_gr	3,672	0.646013	0.940197	-0.44649	4.109032
lfgr	3,780	0.00399	0.03439	-0.11199	0.097257
pop_density	4,284	575.0969	2090.868	7.292903	12457.41
grdp_manuf	4,371	0.162014	0.109962	0.012087	0.438532
grdp_serv	4,371	0.134821	0.062135	0.028395	0.320248
educ_secprop	4,410	0.45817	0.08695	0.307916	0.699465
inf_pavedrd	4,284	63.40265	41.94924	0.183898	100
inf_btsprop	4,284	46.75885	20.27199	6.428313	91.38577
openness	4,410	0.341091	0.397539	0	2.097776

Source: Authors' calculation

Table 2 Table Summary Statistics of Individual-level Dataset

Variable	Obs	Mean	Std. Dev.	Min	Max
workstatus_working	1,982,956	0.628694	0.483154	0	1
workstatus_0	1,982,956	0.237957	0.425833	0	1
workstatus_1	1,982,956	0.390737	0.487916	0	1
workstatus_2	1,982,956	0.036895	0.188505	0	1
workstatus_3	1,982,956	0.33441	0.471784	0	1
lwork_hr	1,266,454	4.838051	0.626625	1.386294	6.510258
lwork_earning	803,054	14.20564	0.916241	-0.04885	19.08202

lwork_earninghr	782,997	9.275108	0.874391	-4.46233	15.57917
gmi_work	1,982,956	-9.18215	11.08494	-41.3571	7.6
ecomm_totaladj_gr	1,982,956	0.207091	0.230013	-0.44649	1.588482
emprate	1,982,956	0.976778	0.022681	0.918093	1.036085
lfgr	1,982,956	-0.00045	0.030822	-0.11199	0.097257
male	1,982,956	0.494823	0.499973	0	1
work_exp	1,982,956	30.29838	18.06377	-1	92
educ_sec	1,982,956	0.494118	0.499966	0	1
educ_tert	1,982,956	0.099645	0.299526	0	1
indv_training	1,982,956	0.104088	0.305375	0	1
indv_training_prakerja	1,982,956	0.031149	0.17372	0	1
indv_internet	1,982,956	0.157732	0.36449	0	1
indv_wfh	1,982,956	0.020601	0.142043	0	1
indv_disab_mod	1,982,956	0.086371	0.280911	0	1
indv_disab_sev	1,982,956	0.012722	0.112072	0	1
indv_essentialwkr	1,982,956	0.330991	0.47057	0	1
urban	1,982,956	0.43628	0.495923	0	1
pop_density	1,982,956	522.9119	1596.459	7.292903	12457.41
grdp_manuf	1,982,956	0.191657	0.123849	0.012087	0.431785
grdp_serv	1,982,956	0.123963	0.059375	0.028395	0.320248
educ_secprop	1,982,956	0.448711	0.081842	0.316802	0.699465
inf_pavedrd	1,982,956	89.84603	15.4809	23	100
inf_btsprop	1,982,956	48.68342	18.29306	8.640864	91.38577
openness	1,982,956	0.268785	0.29818	0	2.030804

Source: Authors' calculation

SAKERNAS data contains information on activities during the past week and other work-related information of individuals aged 15 years old and older. This is the data source for calculating labor force participation, unemployment rates, and other Indonesian labor market statistics. The national accounts provide data on the Gross Domestic Product and its components at the expenditure and production sides at the province level. Meanwhile, The Google Mobility

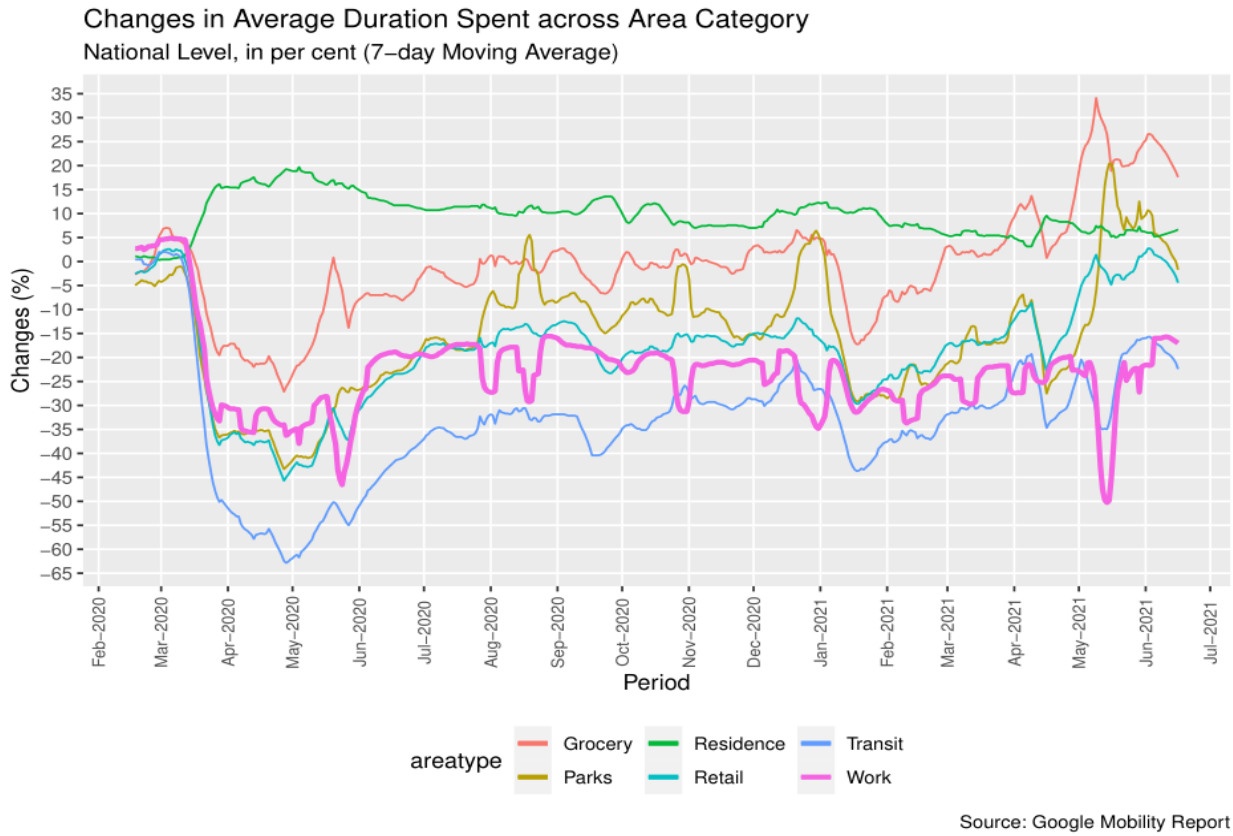
Report provides data of people's mobility on six activity categories – retail and recreation, groceries and pharmacies, parks, transit stations, workplaces, and residential – at the province level relative to the baseline of 3 January - 6 February 2021 period.

In merging the data from different sources, we need to do two alignments to make the merging possible. First, there are differences in the economic sectors in the structure of GDP and the structure of the labor force (SAKERNAS). Hence, we need to concordance between the two structures of economic sectors. Second, there are differences in the time period of GDP data and employment data. The GDP is measured quarterly, hence there are four observations of GDP every year, while the labor force survey is conducted twice a year, each in February and August. To align the two data, we collapse the four quarterly GDP data into two semesterly GDP data by first adding the previous year's fourth-quarter GDP data with the current year's first-quarter GDP data and then merging the combined GDP data with the February labor force data. Second, we add the second and third quarter GDP data of a given year and merge the combined GDP data with the August labor force data.

4. Results and Discussion

4.1 People's Mobility During the COVID-19 Pandemic

Like many other countries, Indonesia has experienced a significant change in mobility due to the pandemic. Following the implementation of the large-scale social restriction (*Pembatasan Sosial Skala Besar*/PSBB) or lockdown policy in April 2020, the mobility index for several categories has started to change. Using the data from Google Mobility Report, Figure 2 depicts the 7-day moving average change of mobility from February 2020 to June 2021 for six different categories at the national level. We can observe that the impact of PSBB on people's mobility in Indonesia is quite heterogeneous. In April 2020, people's mobility of most categories started to decrease, especially outside residential areas (e.g., parks, transit, work, retail, and grocery). As a result of PSBB and work from home policy, people's mobility within the residential area has increased by almost 15-20% between April and May 2020.



Source: Google Mobility Report

Figure 2 Average Change of Mobility in Indonesia During February 2020 – June 2021 Relative to January-February 2020

Nonetheless, the mobility index to transit and retail areas were among the categories that faced a significant decrease in mobility in the early period by approximately 55% and 36%, respectively. Until June 2021, more than one year after Indonesia experienced the first COVID-19 case, the mobility index for many categories started to reach the pre-COVID condition. Especially people's mobility to groceries, parks, and retail, where these three categories have shown a higher mobility index. This trend suggests that people's mobility in Indonesia has started to improve, even though some categories (e.g., work and transit) are still nowhere near the pre-pandemic condition. Mobility index to work areas has not been showing a significant improvement.

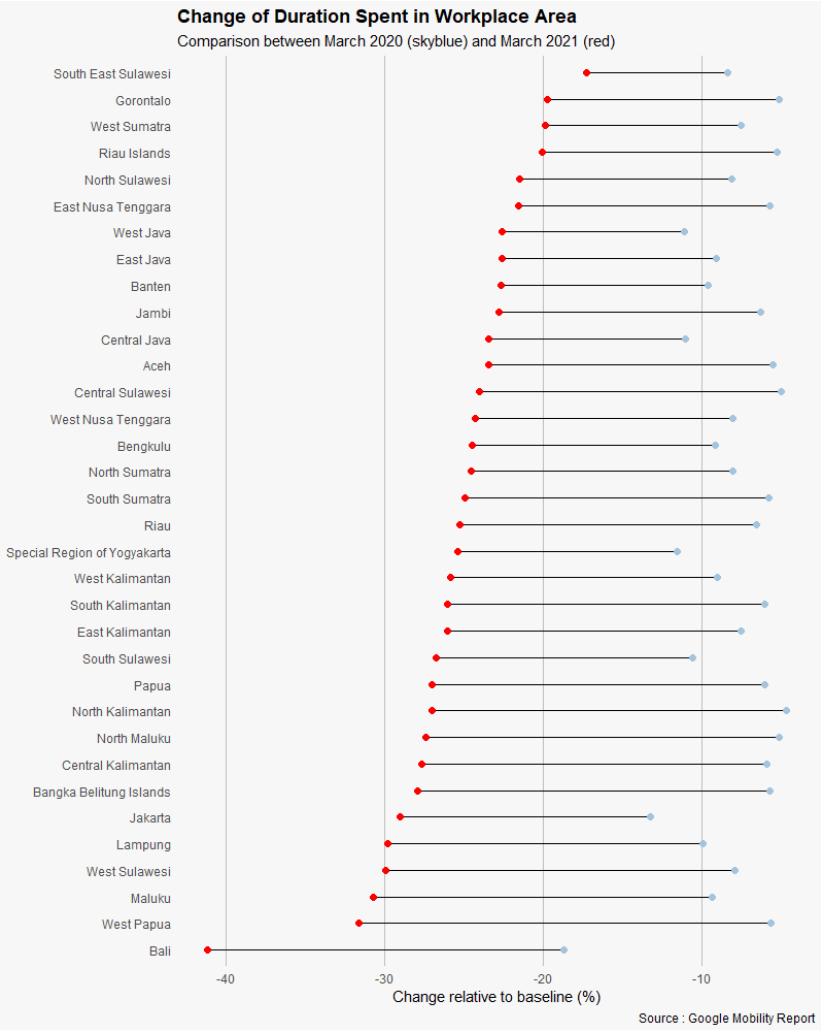
Along with the mobility index to transit areas, these two indexes suggest a negative change compared to the baseline period, especially between January and July 2021. The trend for transit and work areas also suggests that a significant proportion of workers work remotely from home rather than going to the office. This condition is also because the government regulation related

to mobility restriction restricts companies to have full capacity and requires the workers to work at home unless for several essential sectors.[2]

How does mobility to workplace areas change across regions? This question remains an exciting topic that needs to be answered because the implementation of lockdown policies varies across regions in Indonesia. Therefore, we would also expect mobility to the workplace within Indonesia might be heterogeneous. Figure 3 illustrates the average change of workplace mobility at the province level between March 2020 and March 2021 compared to before the pandemic (January-February 2020). The sky-blue node represents the change of duration spent in the workplace in March 2020 compared to the baseline period. The red node captures the change of time spent at the workplace in March 2021 compared to January-February 2020.

We can observe that all areas in Indonesia have lower mobility to the workplace in March 2021 compared to in March 2020. Southeast Sulawesi was the province with the lowest reduction in time spent in the workplace compared to all provinces in Indonesia (from -8.39% in March 2020 to -17.26% in March 2021). Bali, however, became the province that had the most considerable reduction in time spent in the work area. In March 2020, the mobility index to the work area in Bali had already reduced by -18%. However, in March 2021, the figure reached -42%. In general, most areas have reduced mobility to the workplace in both March 2020 and March 2021, but the impact is quite heterogeneous across regions. This evidence suggests that mobility restrictions will reduce activity in several places, especially the workplace. However, the impact in specific areas might vary depending on the characteristics of the regions (e.g., size, economic sector) and the implementation of the lockdown policy itself. Even though the national government has introduced lockdown policies, local governments decided not to introduce this policy in some areas.

[2] The essential sectors are energy, health, security, logistics and transport, food and beverage industries and supporting industries, petrochemical, cement, national vital objects, disaster management, national strategic projects, construction, basic utilities, and daily necessities-producing industries.



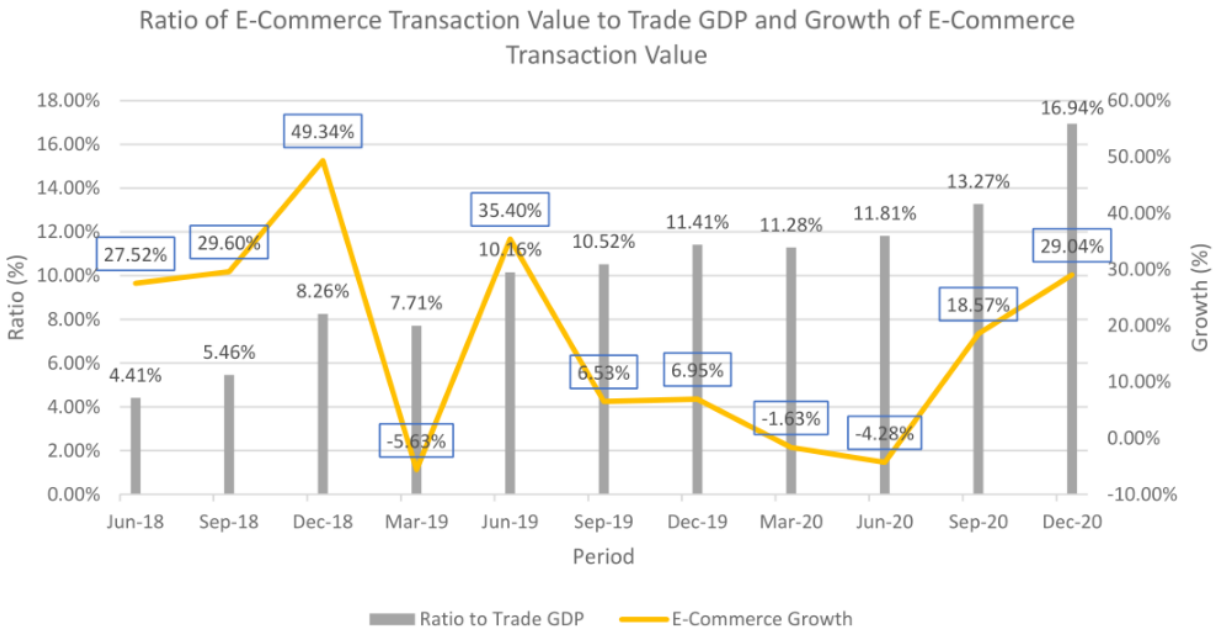
Source: Google Mobility Report

Figure 3 Average Change of Workplace Mobility at Province Level During March 2020 and March 2021 Relative to January-February 2020

4.2 The Development of E-Commerce During The COVID-19 Pandemic

To understand the development of e-commerce in Indonesia and how significant the impact of COVID-19 is in accelerating the use of e-commerce, we need to see the trend for this sector even before Indonesia faced the pandemic outbreak. Using the data from marketplace platforms collected by Bank Indonesia, Figure 4 illustrates the ratio between the total transaction value of the Top-4 Marketplace in Indonesia relative to total GDP and the e-commerce growth in the country. The contribution of e-commerce to total GDP in Indonesia has shown a significant increase from 4.41% in June 2018 to 16.94% in December 2020. The contribution of e-commerce to GDP in December 2020 was the highest compared to all the previous periods. This number suggests that e-commerce contribution to Indonesia's economy has been significant in the past three years.

In terms of the growth of the e-commerce transaction, Figure 4 suggests that e-commerce growth has a fluctuating trend throughout the period. The growth reached its peak in December 2018, where the growth of e-commerce was around 49.34%. Nonetheless, it was followed by a significant drop in e-commerce growth by almost -5.63% in March 2019. From this figure, we cannot easily see the impact of COVID-19 on the growth of e-commerce. However, we can see that after facing a slowing down the growth rate in March and June 2020, the growth of e-commerce in Indonesia has found its pace in September and December 2020 with a growth rate around 18.56% and 29.04%, respectively.



Source: Authors' calculation??

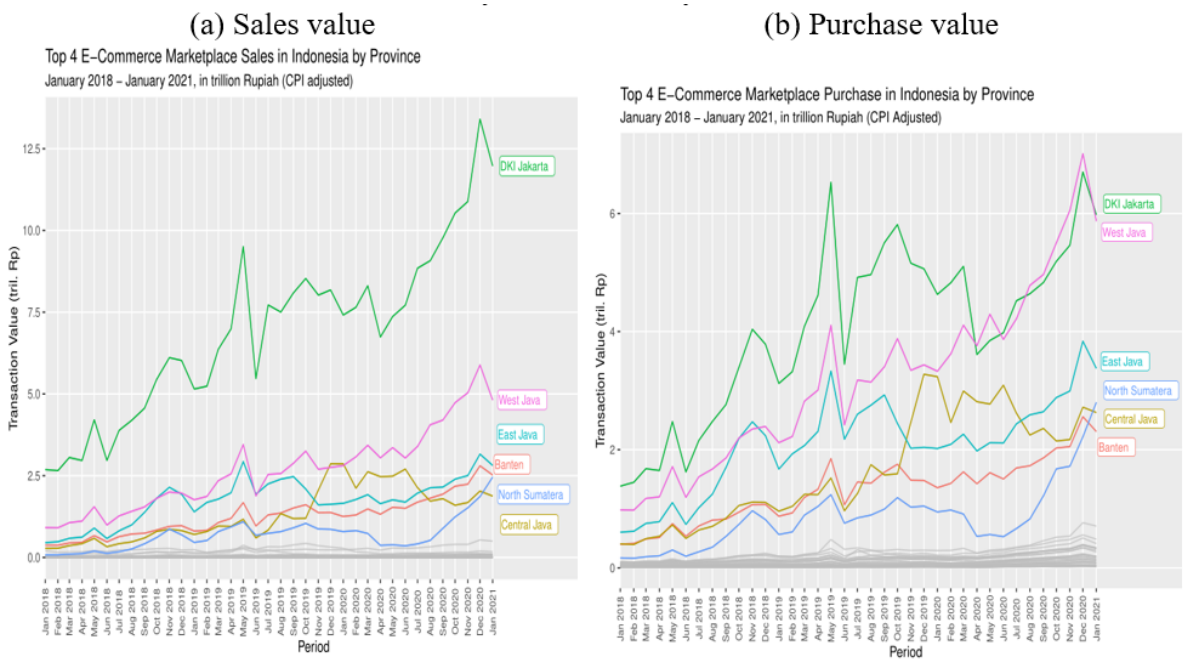
Figure 4 The ratio of Transaction Value of Top-4 Marketplace to GDP of Trade Sector and Growth of Transaction Value of Top-4 Marketplace in Indonesia, Q1 2018 – Q4 2020

Figure 5 allows us to see the total sales and purchase value of the Top-4 marketplace across provinces between January 2018 and January 2021. Figure 5a shows that the total sales value of the Top-4 marketplace has shown considerable growth. However, the growth in sales value is mainly driven by a notable increase in transaction values in 6 provinces (DKI Jakarta, West Java, East Java, Banten, North Sumatra, and Central Java). Even though from Figure 5a we cannot infer any correlation between COVID-19 and the sales value, we can see that sales value after March 2020 has found its pace, especially in DKI Jakarta and West Java. This trend might suggest that due to pandemics and several lockdown policies that restrict people from going to

commercial places or groceries to buy goods, people tend to use e-commerce to fulfill their consumption needs.

We also observed the same pattern for purchase value from Figure 5b. DKI Jakarta, West Java, East Java, North Sumatra, Central Java, and Banten were the areas where the total purchase in e-commerce was significantly higher compared to other provinces from January 2018 to January 2021. Even though there were some volatilities in terms of the growth in the purchase, almost all provinces had a higher total value in January 2021 compared to January 2018. This evidence suggests that many consumers are starting to move towards e-commerce to fulfill their needs. In terms of the impact of COVID-19 on purchase, again, we need to be cautious to interpret the result. Indeed, total sales have increased in some areas, especially after May 2020 (see DKI Jakarta, West Java, and East Java). Nevertheless, in a province like Central Java, after June 2020, the growth of total sales has shown a decline.

The critical story from Figure 5 is that six provinces dominate the total sales and transactions of e-commerce in Indonesia. This evidence might suggest an inequality in terms of the level of the economy. Consumers in these six provinces have higher welfare than the rest of the provinces; thus, it allows people in these areas to utilize e-commerce. Moreover, this finding may be due to the disparity in access to the digital economy that hinders many consumers outside these six provinces from utilizing e-commerce. Nonetheless, these two possible explanations need to be considered to understand that the role of e-commerce might be determined by other factors such as access to the digital economy and the initial level of the economy. Thus, it is also essential to address these two issues to maximize the role of e-commerce in the economy.

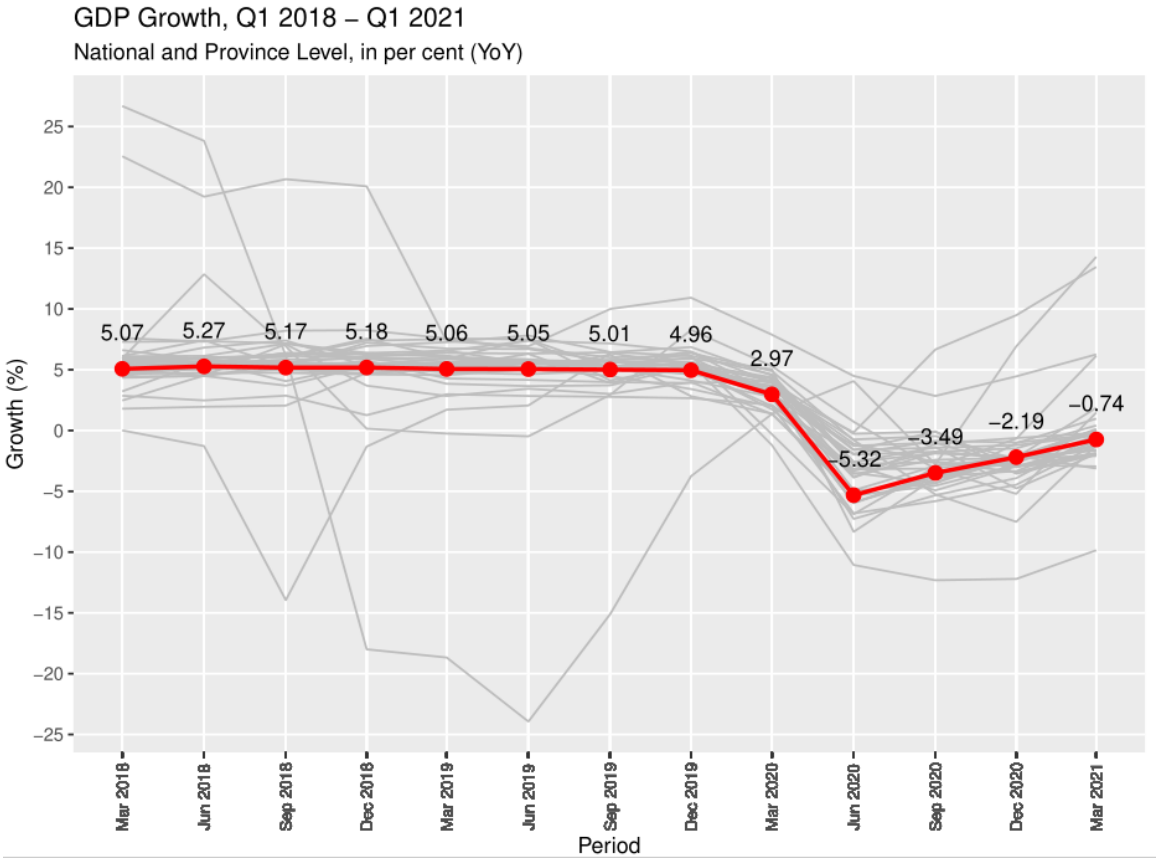


Source: Authors' calculation

Figure 5 Monthly Real Sales Value and Purchase Value of Top-4 Marketplace by Province, January 2018 – January 2021

4. 3 Changes in the Labor Market During the COVID-19 Pandemic

Using the national and provincial GDP data, Figure 6 shows the national economic growth trend from 2018 until the first quarter of 2021. Before COVID-19, the Indonesian economy grew at around 5 percent annually. In the first quarter of 2020, the economic growth slowed down to 2.97 percent YoY (year-on-year) due to anticipation of the beginning of a global pandemic, even though the first official case in Indonesia was only recorded in March 2020. As COVID-19 cases were surging dramatically globally and locally, Indonesia's economy shrank by 5.32 percent in the second quarter of 2020. The contraction slowed down in the third and fourth quarter of 2020 and the first quarter of 2021, reflecting the gradual recovery of Indonesian economic activity. Overall, the economy contracted by 2.1 percent in 2020, becoming the first annual contraction since the 1998 crisis. Consequently, households' income, savings, and consumption declined (Ridhwan et al., 2021). The shutdown in economic activity especially in the first half of 2020 also hit firms' ability to operate and generate income. Micro, small, and medium enterprises (MSMEs) experienced the worst drop by around 40 percent drop in sales (World Bank, 2021a).



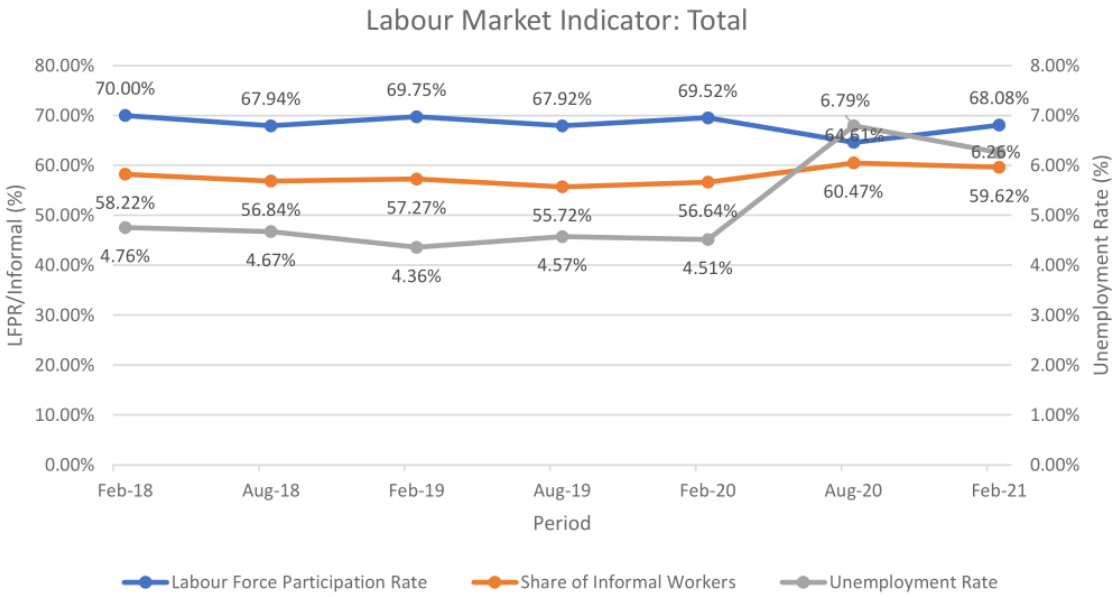
Source: Authors' calculation

Figure 6 Economic Growth of Indonesia and Province Level, Q1 2018 – Q1 2021

Indonesia's labor market performance seems to fluctuate between February 2018 and February 2021. Using SAKERNAS data from February 2018 until February 2021, Figure 7 depicts labor market indicators in Indonesia and suggests that employment outcomes, e.g., labor force participation rate (LFPR), the share of informal workers, and unemployment rate tend to fluctuate between February and August each year, indicating seasonal effects. The labor force participation rate has been stable between 70% in February 2018 and 69.5% in February 2020. However, the pandemic reduced labor force participation where the indicator slightly dropped to 64.61% in August 2020 and performed relatively better in February 2021 by going up again to 68.08%. The labor force participation rate decline indicates that the COVID-19 pandemic caused some workers to quit the labor force by returning to school, taking early retirement, or simply staying idle waiting for the labor market condition to improve.

The reduction in labor force participation was also followed by an increase in the unemployment rate. Unemployed workers in Indonesia remain stable between February 2018 and February 2020. However, the pandemic had boosted the unemployment rate from 4.51% in

February 2020 to 6.79% in August 2020. The pandemic has also shifted the structure of the economy, even though in terms of magnitude, the size is not substantial. The share of informal workers went up to 60.47% in August 2020 from 56.64% in February 2020.[3]

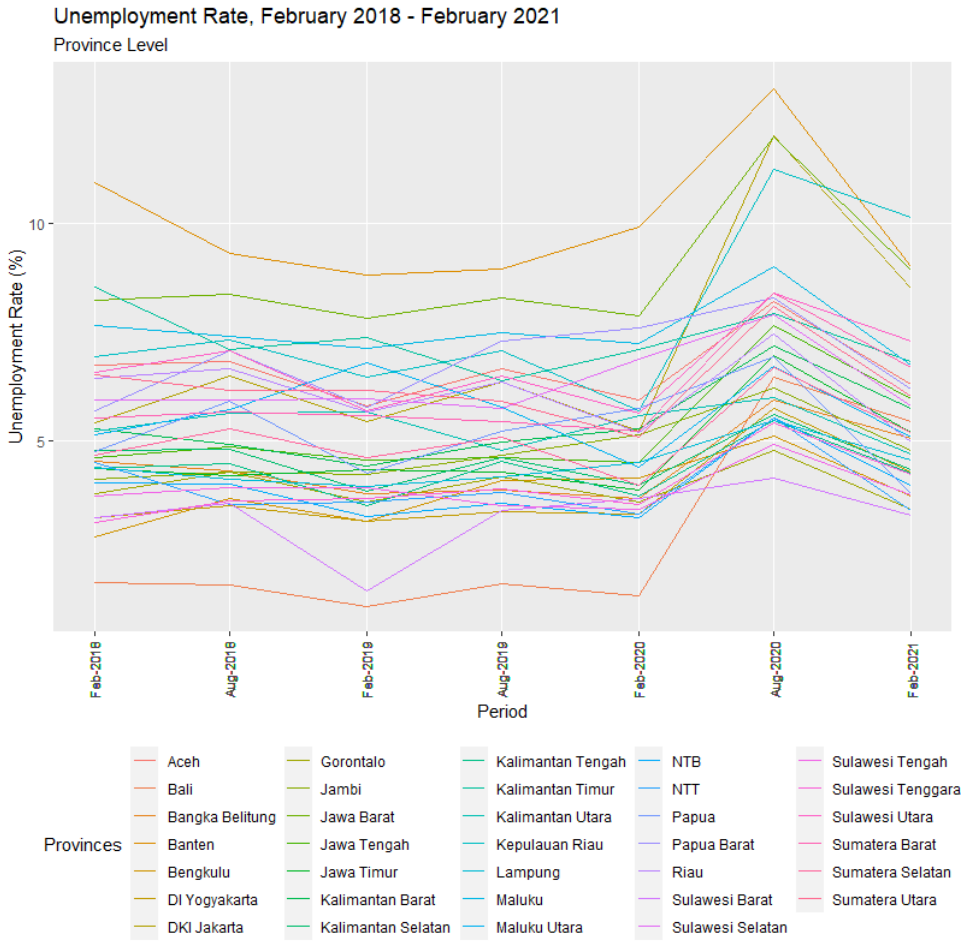


Source: Authors' calculation

Figure 7 Labor Market Indicators in Indonesia, February 2018 - February 2021

The impact of the COVID-19 pandemic on the labor market indicators has shown a similar trend across provinces. For example, Figure 8 shows the unemployment rate by province between February 2018 and February 2021. Before February 2020, the unemployment rate remained stable even though there were some fluctuations in some areas. However, after the pandemic hit Indonesia, many workers lost their jobs and became unemployed. The unemployment rate in Indonesia's province went up in August 2020 and started to decline again in February 2021. Nonetheless, there are some variations in terms of the recovery speed. Some provinces could accelerate the recovery process, by increasing the number of jobs needed, yet in other provinces, the number of new jobs was still limited. This can also be explained due to the sectoral composition and economic characteristics of each region being quite heterogeneous.

[3] These indicators were calculated from the SAKERNAS microdata. There are some slight differences with the official figures published by BPS.



Source: Authors' calculation

Figure 8 Unemployment Rate by Province, February 2018 - February 2021

4.4 The Effects of COVID-19 and E-Commerce on Workers' Outcomes

This section presents the results of estimations of Equation (2) on the effects of changes in work mobility and e-commerce growth on the four labor market outcomes for individual workers: probability to work, which indicates the employment prospects of workers (Table 3), work hours (Table 4, total earnings (Table 5), and earnings per hour (Table 6), which is an indicator of labor productivity. Each outcome is separated into the formal and informal sectors. The data used for the estimations are pooled four rounds of SAKERNAS individual workers data from August 2019 to February 2021.

4.4.1 Employment Prospects

The estimation results on probability to work in Table 1 show that our variables of interest, work mobility and e-commerce growth, have statistically significant coefficients. The work mobility variable has a positive coefficient on the formal sector and a negative coefficient on the informal sector. Since COVID-19 caused work mobility to decline, these coefficients indicate that COVID-19 caused the prospects of workers to find jobs in the formal sector to

decline and, on the other hand, increased the employment prospects in the informal sector. This means that as COVID-19 caused massive layoffs, the workers who lost jobs and the new entrants to the labor markets could not find jobs in the shrinking formal sector, so they flock into the informal sector by creating self-employment jobs. Similar to the previous crises, the informal sector has played a role as a buffer of employment for many job seekers.

Meanwhile, the e-commerce growth variable has a significant coefficient for the informal sector with a positive sign, while the coefficient for the formal sector is not significant. This indicates that e-commerce growth did not affect the probability of workers finding jobs in the formal sector, but it increased their employment prospects in the informal sector. This shows that most jobs created by the growth of e-commerce are of self-employment type, such as opening an online shop to sell goods.

Labor demand and supply conditions apparently affect the employment prospects of workers. The coefficients of both labor demand shifter, represented by the employment rate variable, and labor supply shifter, represented by labor force growth, are significant. The coefficients of employment rate are positive for the formal sector and negative for the informal sector. This means that increasing labor demand, which indicates a favorable economic condition, increases workers' employment prospects to work in the formal sector and reduces the probability that they have to work in the informal sector. Meanwhile, the coefficients of labor force growth are positive for both the formal and informal sectors, indicating higher labor force growth increases the probability of workers working in either the formal or informal sector.

The employment prospects of individual workers are also affected by their characteristics. Male workers have a significantly higher probability of finding jobs in formal and informal sectors than female workers. As workers become more experienced, they have less probability of working in the formal sector but are more likely to work in the informal sector, indicating that more experienced workers tend to stop working as employees and start their businesses. This is also probably related to the fact that formal job recruitment is more interested in younger workers. The education variables strongly indicate that the higher the educational attainment of workers, the more likely they work in the formal sector and the less likely they work in the informal sector. Meanwhile, workers with disabilities are less likely to find jobs in both the formal and informal sectors, and the more severe the disability the less likely they find jobs.

Table 3 Estimation Results of Probability to Work Using Linear Probability Model, August 2019 - February 2021

	(1) Formal	(2) Informal
Work mobility	0.000512***	-0.000393***
	(0.000103)	(0.000133)
E-commerce growth	-0.000405	0.00831***
	(0.00129)	(0.00162)
Labor Demand and Supply Shifters:		
Employment rate	0.216***	-0.407***
	(0.0428)	(0.0518)
Labor force growth	0.0852***	0.0302*
	(0.0123)	(0.0159)
Workers Characteristics:		
Male	0.0995***	0.0987***
	(0.000503)	(0.000634)
Work experience	-0.000483***	0.00531***
	(0.0000159)	(0.0000221)
Secondary education	0.0204***	-0.0995***
	(0.000664)	(0.000859)
Tertiary education	0.237***	-0.225***
	(0.00131)	(0.00132)
On the job training	0.0668***	-0.0582***
	(0.00104)	(0.00109)
Training for unemployed	0.0241***	-0.00612***
	(0.00184)	(0.00212)
Using internet for work	0.325***	-0.0854***
	(0.00111)	(0.00111)
Work from home	0.187***	-0.0156***
	(0.00206)	(0.00197)
Moderate disability	-0.0356***	-0.147***
	(0.000796)	(0.00127)
Severe disability	-0.0646***	-0.440***
	(0.00106)	(0.00208)
Essential sector	0.206***	0.236***
	(0.000689)	(0.000758)
Urban	0.0160***	-0.159***
	(0.000565)	(0.000676)
Constant	-0.110	0.672
	(0.258)	(.)
Province Characteristics	Yes	Yes
Province Dummies	Yes	Yes
Time Dummies	Yes	Yes
N	1,982,956	1,982,956
R^2	0.330	0.193

Source: Authors' calculation

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

There are also other workers' attributes that affect their employment prospects. Attended training, both on the job training and training for the unemployed,[4] increases the probability of trained workers working in the formal sector and reduces the probability of working in the informal sector compared to workers who never attended the training. As expected, workers who use the internet for work and can work from home have higher prospects to work in the formal sector and a lower probability of working in the informal sector. Workers in the essential sectors, i.e., the sectors that are allowed to continue operating during the pandemic, have a higher probability of working in formal and informal sectors. Lastly, workers who reside in urban areas have a higher probability of working in the formal sector and a lower probability of working in the informal sector than workers who reside in rural areas, reflecting that most formal jobs are available in the urban areas.

4.4.2 Work Hours

The estimation results on work hours in Table 4 show that work mobility has an insignificant coefficient in the formal sector but has a negative and significant coefficient in the informal sector. This means that COVID-19 did not affect work hours in the formal sector, but workers in the informal sector tended to work longer hours. Similarly, e-commerce growth does not affect work hours in the formal sector but increases the work hours of informal sector workers. This means that during the pandemic, workers in the informal sector worked longer hours due to both the effects of COVID-19 and e-commerce growth.

Labor demand and supply conditions also affect workers' working hours. The coefficient of employment rate variable is negative and significant in the formal sector, but not significant in the informal sector. This means that a favorable economic condition benefits workers in the formal sector in the form of shorter work hours, but it does not influence the work hours of informal sector workers. Similarly, the coefficient of labor force growth is negative and significant in the formal sector, but not significant in the informal sector. This indicates that a growing labor force reduces the work hours of existing workers in the formal sector, but it does not affect the working hours of informal sector workers.

[4] Training for the unemployed in the SAKERNAS data represents the participants of the Prakerja (Pre-employment) Program.

Table 4 Estimation Results of Work Hour Using OLS, August 2019 - February 2021

	(1) Formal	(2) Informal
Work mobility	0.000190	-0.00225***
	(0.000290)	(0.000294)
E-commerce growth	0.000275	0.0337***
	(0.00335)	(0.00345)
Labor Demand and Supply Shifters:		
Employment rate	-0.276**	0.155
	(0.109)	(0.127)
Labor force growth	-0.119***	0.0539
	(0.0361)	(0.0353)
Worker Characteristics:		
Male	0.126***	0.204***
	(0.00154)	(0.00145)
Work experience	-0.00284***	0.00201***
	(0.0000649)	(0.0000610)
Secondary education	-0.0294***	-0.0120***
	(0.00215)	(0.00173)
Tertiary education	-0.113***	-0.0330***
	(0.00270)	(0.00485)
On the job training	-0.0262***	-0.0652***
	(0.00181)	(0.00356)
Training for unemployed	-0.00965**	0.0133**
	(0.00471)	(0.00518)
Using internet for work	0.0366***	0.0195***
	(0.00156)	(0.00267)
Work from home	-0.235***	-0.0500***
	(0.00348)	(0.00906)
Moderate disability	-0.0663***	-0.112***
	(0.00424)	(0.00274)
Severe disability	-0.159***	-0.205***
	(0.0299)	(0.0155)
Essential sector	0.164***	0.367***
	(0.00163)	(0.00165)
Urban	0.0833***	0.0457***
	(0.00148)	(0.00177)
Constant	5.322	4.409***
	(.)	(0.140)
Province Characteristics	Yes	Yes
Province Dummies	Yes	Yes
Time Dummies	Yes	Yes
N	458,762	755,970
R^2	0.128	0.116

Source: Authors' calculation

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Workers' characteristics also affect their work hours. On average, male workers tend to have longer working hours in formal and informal sectors than female workers. Higher work experience of workers in the formal sector tends to reduce their working hours in the formal sector, but on the other hand, it tends to increase their working hours in the informal sector. Education level is associated with shorter working hours in both the formal and informal sectors, with a more pronounced effect for workers with higher levels of education. Similarly, disability is associated with shorter working hours in both the formal and informal sectors, and the more severe the disability the shorter the working hours.

There are also other workers' attributes that affect their working hours. Workers who have attended training tend to have shorter working hours than workers who never attended training, except for informal workers who received training for the unemployed. The remote work-related indicators point in different directions. Workers who use the internet for work have longer working hours in both the formal and informal sectors. However, workers who work from home have shorter working hours in both the formal and informal sectors. As expected, workers who work in the essential sectors have longer working hours in both the formal and informal sectors. Probably it owes to the fact that the job providers in such sectors continued to operate during the pandemic compared to those in other sectors which must close due to the mobility restrictions. Finally, in both the formal and informal sectors, workers in urban areas tend to work longer hours compared to workers in rural areas.

4.4.3 Total Earnings

The estimation results on total earnings in Table 5 show that work mobility has positive and significant coefficients in both the formal and informal sectors, indicating that COVID-19 adversely affected the total earnings of workers in both the formal and informal sectors alike. Meanwhile, e-commerce growth has a negative and statistically significant coefficient for the formal sector and an insignificant coefficient for the informal sector. This indicates that the growth of e-commerce suppressed the earnings of workers in the formal sector, but it did not affect the earnings of informal sector workers.

The total earnings earned by workers are also affected by labor demand and supply conditions. The employment rate variable has positive and significant coefficients for both the formal and informal sectors. This indicates that when the economic condition is favorable, workers reap the benefits in the form of higher earnings. Similarly, the labor force growth variable also has positive and significant coefficients for formal and informal sectors. This means that workers in both the formal and informal sectors earn more when the labor supply grows.

Table 5 Estimation Results of Total Earnings Using OLS, August 2019 - February 2021

	(1)	(2)
	Formal	Informal
Work mobility	0.00156***	0.00101*
	(0.000454)	(0.000613)
E-commerce growth	-0.0127**	-0.00788
	(0.00529)	(0.00688)
Labor Demand and Supply Shifters:		
Employment rate	0.903***	0.524**
	(0.172)	(0.231)
Labor force growth	0.270***	0.229***
	(0.0576)	(0.0729)
Worker Characteristics:		
Male	0.428***	0.535***
	(0.00247)	(0.00294)
Work experience	0.0137***	0.00141***
	(0.000106)	(0.000119)
Secondary education	0.326***	0.121***
	(0.00324)	(0.00328)
Tertiary education	0.713***	0.375***
	(0.00442)	(0.00918)
On the job training	0.178***	-0.0388***
	(0.00314)	(0.00621)
Training for unemployed	0.0271***	0.00772
	(0.00705)	(0.00953)
Using internet for work	0.262***	0.228***
	(0.00259)	(0.00430)
Work from home	0.0284***	-0.0352**
	(0.00522)	(0.0147)
Moderate disability	-0.135***	-0.198***
	(0.00658)	(0.00541)
Severe disability	-0.188***	-0.412***
	(0.0344)	(0.0270)
Essential sector	0.221***	0.318***
	(0.00260)	(0.00293)
Urban	0.113***	0.114***
	(0.00241)	(0.00301)
Constant	8.274***	8.839***
	(0.191)	(1.295)
Province Characteristics	Yes	Yes
Province Dummies	Yes	Yes
Time Dummies	Yes	Yes
N	429,120	364,205
R^2	0.288	0.193

Source: Authors' calculation

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The total earnings of workers are also affected by their characteristics. Both in the formal and informal sectors, male workers earned much higher than female workers. Work experience is also associated with higher earnings for workers, both in the formal and informal sectors. Higher education attainment proves to boost workers' total earnings in both the formal and informal sectors. The higher the education level, the higher the earnings premium. On the other hand, having a disability reduces workers' earnings both in the formal and informal sectors. The more severe the disability, the lower the total earnings.

Other workers' attributes also affect their total earnings. We see strong evidence of positive effects of training, both on-the-job training and training for the unemployed, on total earnings in the formal sector. On the other hand, on-the-job training is associated with lower total earnings in the informal sector, while training for the unemployed has no clear effect. Workers who use the internet for work have higher total earnings in formal and informal sectors than workers who do not use the internet in their work. Workers in the formal sector who could work from home earn higher earnings than those who could not. However, workers in the informal sector who work from home earn lower earnings than those who work outside the home. Workers who work in the essential sectors have higher total earnings than those in other sectors. This is expected since there is less reduction of working hours and labor demand in the essential sectors, which means there is less tendency for an excess labor supply buildup and less downward pressure on the existing wage level. Finally, on average, workers in urban areas have significantly higher earnings than rural workers.

4.4.4 Earnings per Hour

The estimation results on earnings per hour in Table 6 show that work mobility has positive and significant coefficients in both the formal and informal sectors, which means that COVID-19 reduced the earnings per hour of workers in both the formal and informal sectors. Similarly, e-commerce growth also suppressed the earnings per hour of workers in the formal and informal sectors. This means that during the pandemic period, workers in both the formal and informal sectors suffered from lower earnings per hour, which indicates declining labor productivity, due to restrictions in work mobility and the growth of e-commerce.

Table 6 Estimation Results of Earnings per Hour Using OLS, August 2019 - February 2021

	(1) Formal	(2) Informal
Work mobility	0.00108**	0.00114*
	(0.000461)	(0.000641)
E-commerce growth	-0.0122**	-0.0281***
	(0.00526)	(0.00710)
Labor Demand and Supply Shifters:		
Employment rate	1.295***	0.281
	(0.171)	(0.244)
Labor force growth	0.412***	0.261***
	(0.0582)	(0.0770)
Worker Characteristics:		
Male	0.292***	0.315***
	(0.00240)	(0.00307)
Work experience	0.0160***	0.00364***
	(0.000103)	(0.000122)
Secondary education	0.349***	0.142***
	(0.00319)	(0.00343)
Tertiary education	0.817***	0.455***
	(0.00435)	(0.0102)
On the job training	0.200***	0.0516***
	(0.00307)	(0.00667)
Training for unemployed	0.0414***	0.0128
	(0.00712)	(0.0104)
Using internet for work	0.223***	0.293***
	(0.00256)	(0.00460)
Work from home	0.276***	0.0419***
	(0.00539)	(0.0157)
Moderate disability	-0.0806***	-0.108***
	(0.00650)	(0.00573)
Severe disability	-0.120***	-0.216***
	(0.0365)	(0.0289)
Essential sector	0.0801***	0.0193***
	(0.00252)	(0.00305)
Urban	0.0337***	0.0640***
	(0.00237)	(0.00311)
Constant	2.801***	4.789
	(0.190)	(.)
Province Characteristics	Yes	Yes
Province Dummies	Yes	Yes
Time Dummies	Yes	Yes
N	418179	355637
R^2	0.296	0.103

Source: Authors' calculation

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Labor demand and supply conditions significantly affect the hourly earnings earned by workers. The employment rate variable has a positive and significant coefficient for the formal sector, but not significant for informal sectors. This means that a favorable economic condition only increases earnings per hour of workers in the formal sector, but not the hourly earnings in

the informal sector. Meanwhile, the labor force growth variable has positive and significant coefficients for both the formal and informal sectors, which indicates that, contrary to expectation, growing labor supply increases the earnings per hour of workers in both the formal and informal sectors.

Workers' characteristics affect their hourly earnings. On average, male workers received higher earnings per hour than female workers in the formal sector and more so in the informal sector. This could indicate that male workers, on average, have higher productivity than female workers, but to some extent, it could also be due to gender wage discrimination. Every additional year of working experience led to higher earnings per hour for workers in formal and informal sectors. However, the hourly earnings premium from experience is much higher in the formal sector than in the informal sector. The effect of education on increasing the earnings per hour is evident in the results of our analysis for workers in both the formal and informal sectors. Like experience, the hourly earnings premium of education is much higher in the formal than in the informal sector. As expected, workers with a disability are associated with lower earnings per hour in formal and informal sectors. More severe disability is associated with a greater hourly earnings penalty, with the penalty substantially greater in the informal sector than in the formal sector.

There are other workers' attributes that also affect their hourly earnings. On-the-job training increased the earnings per hour of workers, especially those in the formal sector, indicating that training increases workers' productivity. Training for the unemployed also increased the earnings per hour of workers in the formal sector. Workers who use the internet and those who work from home have higher earnings per hour than those who do not use the internet for work and those who cannot work from home in both the formal and informal sectors. Workers who work in the essential sectors earn higher hourly earnings than workers in other sectors. Finally, workers in urban areas receive higher earnings per hour than their peers in rural areas. Interestingly, the premium is higher in the informal sector than in the formal sector.

4.5 Robustness Test

To check for the robustness of our results, we conduct two robustness tests. First, our main results on the probability to work are obtained from a linear probability model (LPM) estimation. To test the robustness of the results regarding the estimation method, we re-estimate the model using logistic regression. The results in marginal effect form are presented in Table Table 7 Compared to the main results in Table 1, the results from logistic regression are

qualitatively similar. Hence, the results of our analysis are robust to the method of estimation used.

Table 7 Estimation Results of Probability to Work Using Logit in Marginal Effect, 2019 - February 2021

	(1) Formal	(2) Informal
Work mobility	0.000503***	-0.000455***
	(0.000128)	(0.000160)
E-commerce growth	-0.00212	0.00942***
	(0.00153)	(0.00192)
Labor Demand and Supply Shifters:		
Employment rate	0.0925*	-0.474***
	(0.0494)	(0.0650)
Labor force growth	0.0482***	0.0327*
	(0.0152)	(0.0192)
Worker Characteristics:		
Male	0.121***	0.117***
	(0.000600)	(0.000764)
Work experience	-0.000774***	0.00623***
	(0.0000202)	(0.0000269)
Secondary education	0.0267***	-0.102***
	(0.000807)	(0.000958)
Tertiary education	0.220***	-0.313***
	(0.00121)	(0.00203)
On the job training	0.0651***	-0.0827***
	(0.000939)	(0.00159)
Training for unemployed	0.0341***	-0.00565**
	(0.00201)	(0.00271)
Using internet for work	0.215***	-0.0945***
	(0.000870)	(0.00141)
Work from home	0.189***	-0.0708***
	(0.00224)	(0.00357)
Moderate disability	-0.0634***	-0.168***
	(0.00135)	(0.00147)
Severe disability	-0.229***	-0.634***
	(0.00582)	(0.00540)
Essential sector	0.201***	0.279***
	(0.000630)	(0.000947)
Urban	0.0189***	-0.193***
	(0.000636)	(0.000840)
Province Characteristics	Yes	Yes
Province Dummies	Yes	Yes
Time Dummies	Yes	Yes
N	1982956	1982956

Source: Authors' calculation

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Second, as shown previously, e-commerce growth in Indonesia is dominated by six provinces. To test whether our results are driven by those six provinces, we re-estimate the probability to work model by excluding the six provinces. The results of this estimation are

presented in Table 8 in the .Compared to the main results in Table 1, there are a couple of differences in the coefficients of work mobility and labor force growth variables. However, the coefficients of the e-commerce growth variable remain the same. Hence, the conclusion that e-commerce growth increased the employment prospects of workers only in the informal sector remains the same. Furthermore, the results for other dependent variables are also qualitatively similar.

Table 8 Estimation Results of Probability to Work Using Linear Probability Model and Data from Outside of Six Provinces with the Highest E-Commerce Transactions, August 2019 - February 2021

	(1) Formal	(2) Informal
Work mobility	0.000413***	-0.000361**
	(0.000119)	(0.000160)
E-commerce growth	-0.00625**	0.00860**
	(0.00265)	(0.00338)
Labor Demand and Supply Shifters:		
Employment rate	0.249***	-0.438***
	(0.0517)	(0.0633)
Labor force growth	0.0825***	0.0576***
	(0.0140)	(0.0184)
Worker Characteristics:		
Male	0.106***	0.114***
	(0.000610)	(0.000799)
Work experience	-0.000198***	0.00533***
	(0.0000196)	(0.0000285)
Secondary education	0.0227***	-0.0982***
	(0.000804)	(0.00108)
Tertiary education	0.254***	-0.227***
	(0.00164)	(0.00166)
On the job training	0.0752***	-0.0659***
	(0.00127)	(0.00134)
Training for unemployed	0.0191***	0.00495*
	(0.00229)	(0.00269)
Using internet for work	0.354***	-0.119***
	(0.00145)	(0.00146)
Work from home	0.174***	-0.0114***
	(0.00257)	(0.00250)
Moderate disability	-0.0360***	-0.141***
	(0.000977)	(0.00158)
Severe disability	-0.0676***	-0.459***
	(0.00138)	(0.00273)
Essential sector	0.193***	0.224***
	(0.000876)	(0.000980)
Urban	0.000721	-0.154***
	(0.000716)	(0.000853)
Constant	-0.186***	0.869***
	(0.0573)	(0.0702)
Province Characteristics	Yes	Yes
Province Dummies	Yes	Yes

Time Dummies	Yes	Yes
N	1254703	1254703
R^2	0.349	0.191

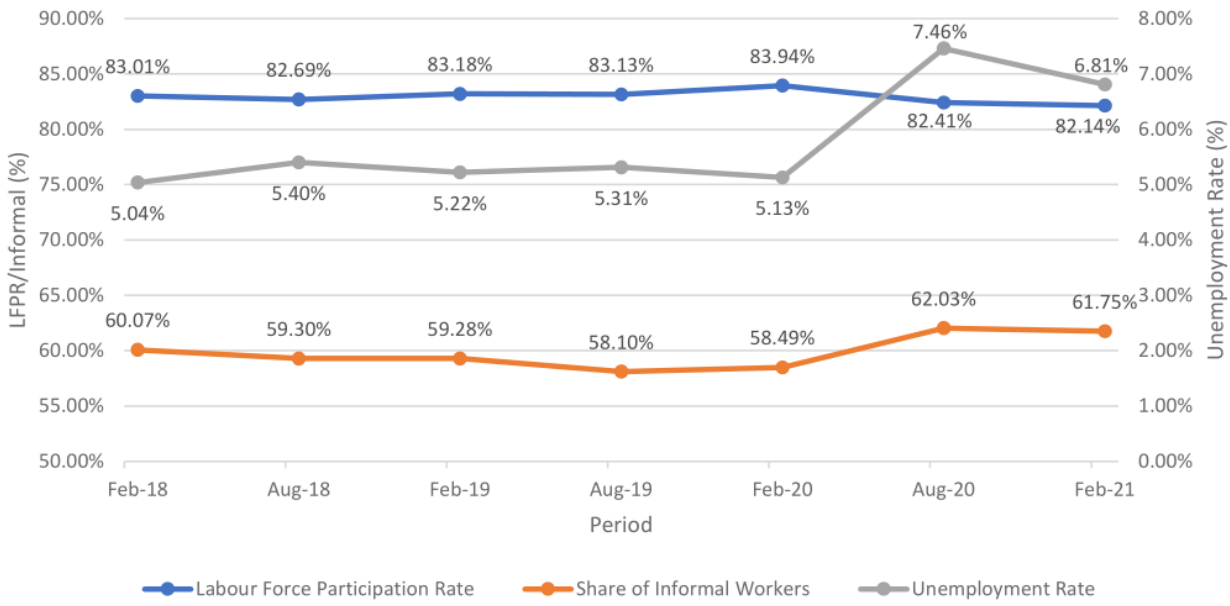
Source: Authors' calculation

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.6 Heterogeneity Analysis

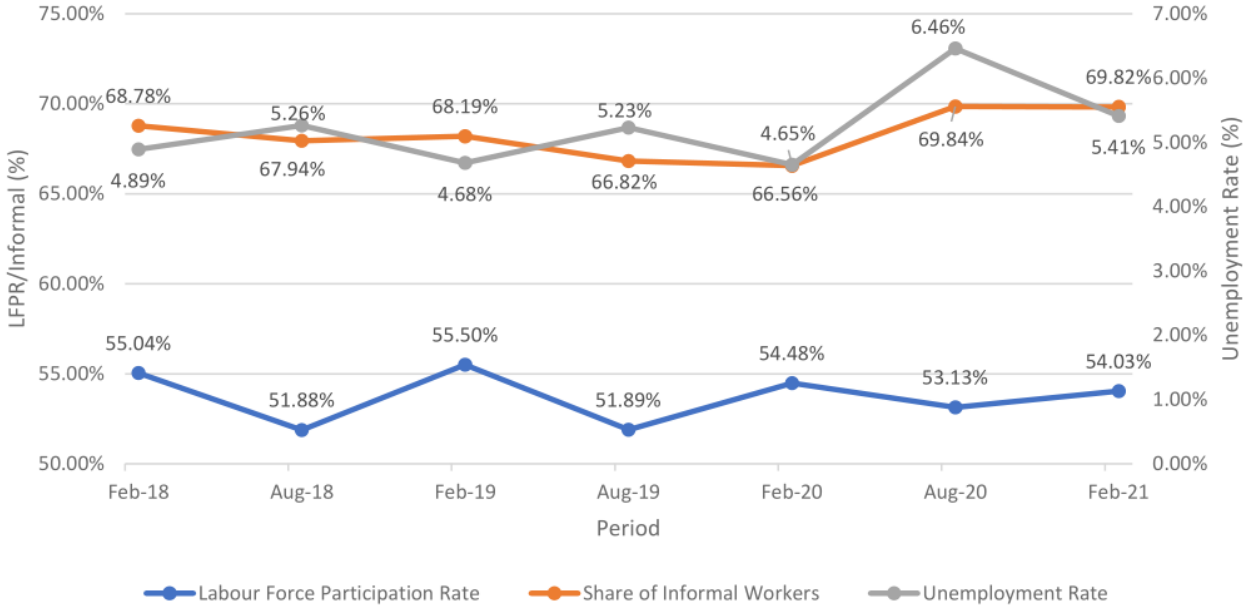
4.6.1 Heterogeneity by Gender

Labor market outcomes are known to be different for male and female workers. Figure 9 in the Appendix presents the labor market indicators disaggregated by gender. Indeed, there is a marked difference in the labor force participation rates between males and females, where the rate for males is more than 80% while for females less than 55%. On the other hand, the share of informal workers is slightly higher for females than males, with the share among females being more than 65% while among males around 60%. Finally, the unemployment rates among males and females are around the same at around 5%. The changes in these labor market indicators during the COVID-19 pandemic across gender are similar, where the labor participation rates slightly decreased, while the share of informal workers and unemployment rates increased.



Source: Authors' calculation

Figure 9 Market Indicators by Gender, February 2018 - February 2021
a) Male workers



Source: Authors' calculation

Figure 9 Market Indicators by Gender, February 2018 - February 2021
(b) female Workers

The results of estimations of the four labor market outcomes for the main independent variables, i.e., work mobility and e-commerce growth, disaggregated by gender, are shown in Table 9 . For probability to work, the results indicate that COVID-19 reduced the employment prospects in the formal sector for both male and female workers. However, COVID-19 increased the probability of female workers working in the informal sector, but not for male workers. Meanwhile, e-commerce growth has similar effects for male and female workers in increasing their probability to work in the informal sector, but no significant effect on their employment prospects in the formal sector.

Table 9 Labor Market Outcome Effects of Mobility Restrictions and E-Commerce Growth by Gender, August 2019 - February 2021

	Work Mobility		E-Commerce Growth	
	(1) Formal	(2) Informal	(3) Formal	(4) Informal
Probability to Work				
Male	0.000407**	-0.000248	0.00175	0.00762***
	(0.000160)	(0.000193)	(0.00206)	(0.00238)
Female	0.000589***	-0.000555***	-0.00251	0.00930***
	(0.000126)	(0.000176)	(0.00156)	(0.00213)
Log Hours Worked				
Male	-0.000138	-0.00160***	-0.00187	0.0366***

	(0.000341)	(0.000370)	(0.00396)	(0.00437)
Female	0.000697	-0.00305***	0.00440	0.0302***
	(0.000522)	(0.000470)	(0.00602)	(0.00549)
Log Total Earnings				
Male	0.000317	0.000594	-0.00881	-0.00255
	(0.000541)	(0.000755)	(0.00617)	(0.00825)
Female	0.00345***	0.00181*	-0.0184*	-0.0170
	(0.000785)	(0.00104)	(0.00944)	(0.0121)
Log Earning per Hour				
Male	0.0000746	0.000548	-0.00699	-0.0279***
	(0.000561)	(0.000789)	(0.00630)	(0.00856)
Female	0.00263***	0.00242**	-0.0214**	-0.0263**
	(0.000786)	(0.00108)	(0.00917)	(0.0124)

Source: Authors' calculation

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

For work hours, there are no differences in the effects of both COVID-19 and e-commerce growth for male and female workers. COVID-19 increased the work hours of male and female workers in the informal sector but had no significant effect on work hours in the formal sector. Similarly, e-commerce growth also increased the work hours of male and female workers in the informal sector but had no significant effect on work hours in the formal sector.

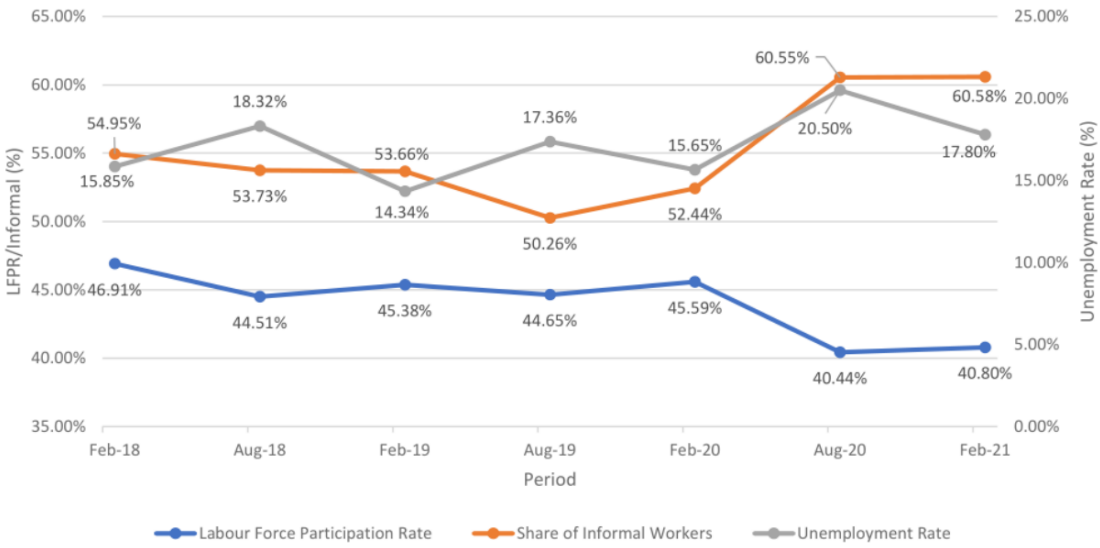
For total earnings, both COVID-19 and e-commerce growth have notable differences in their effects on male and female workers. COVID-19 did not have significant effects on the total earnings of male workers in both the formal and informal sectors. However, it significantly reduced the total earnings of female workers in both the formal and informal sectors. Similarly, e-commerce growth did not have significant effects on the total earnings of male workers in both the formal and informal sectors. However, it has a significant negative effect on the total earnings of female workers in the formal sector, but no significant effect in the informal sector.

For hourly earnings, COVID-19 and e-commerce growth also have significant differences in their effects on male and female workers. COVID-19 did not have significant effects on earnings per hour of male workers in both the formal and informal sectors. However, it significantly reduced the hourly earnings of female workers in both the formal and informal sectors. Meanwhile, e-commerce growth did not have an effect on the earnings per hour of male workers in the formal sector but significantly reduced it in the informal sectors. For female workers, e-commerce growth significantly suppressed their hourly earnings in both the formal and informal sectors.

4.6.2 Heterogeneity by Age Group

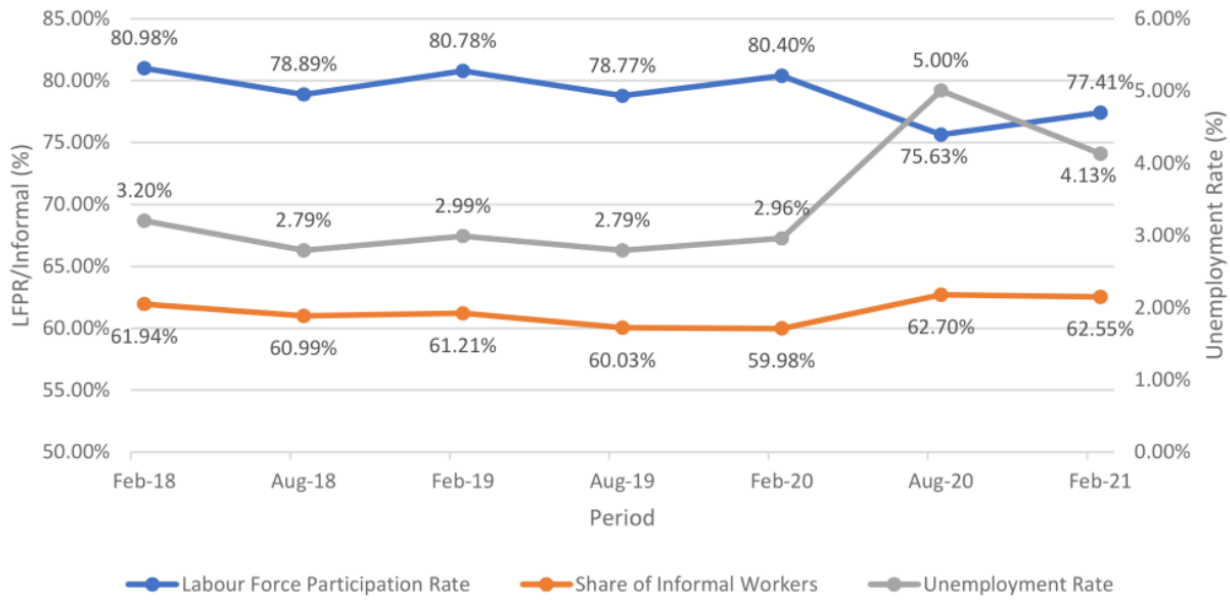
Labor market outcomes are also different for workers in different age brackets. Figure A2 in the Appendix shows the labor market indicators for youth workers (15-24 years old), adult

workers (25-59 years old), and older workers (60+ years old). The labor force participation rate is highest among adult workers with around 80%, while among youth workers and older workers they are much lower at around 45% and 50%, respectively. Slightly over a half of youth workers work in the informal sector, while the share of informal workers among adult workers is significantly higher at around 60%, but the highest share of informal workers is among older workers at more than 85%. The highest unemployment rate is found among youth workers at around 15%, while the unemployment rates among adult and older workers are much lower at only around 3% and 1%, respectively.



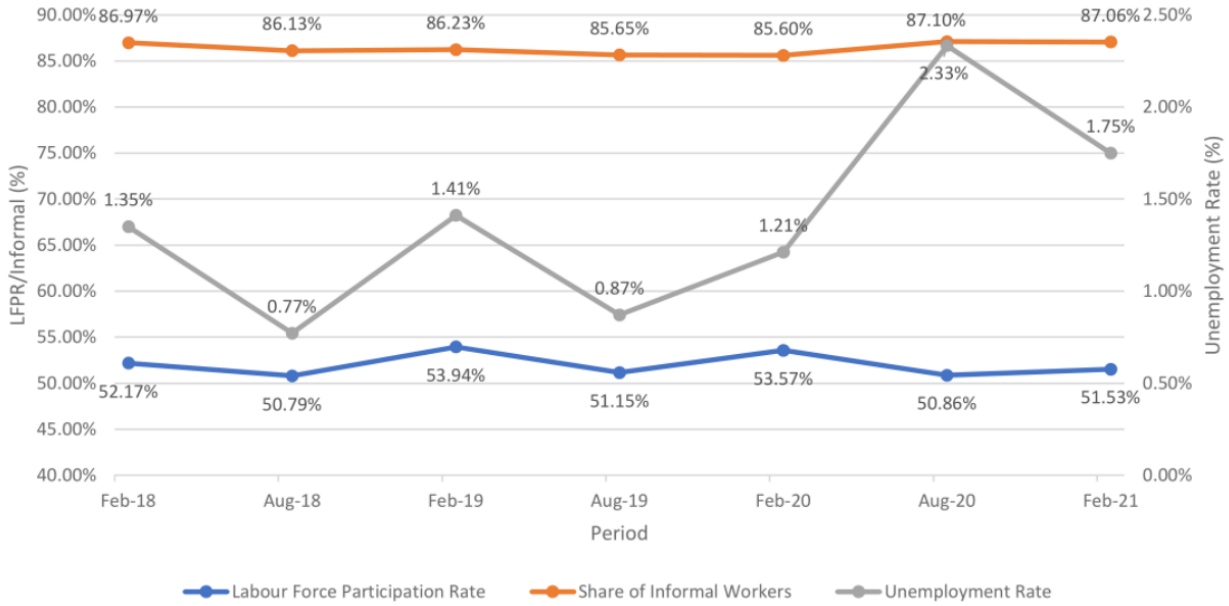
Source: Authors' calculation

Figure 10 Labor Market Indicators by Age Group, February 2018 - February 2021 (a) Youth workers (15-24 years old)



Source: Authors' calculation

Figure 10 Labor Market Indicators by Age Group, February 2018 - February 2021 (b) Adult workers (25-59 years old)



Source: Authors' calculation

Figure 10 Labor Market Indicators by Age Group, February 2018 – February (c) Older workers (60+ years old)

The changes in labor market indicators during the COVID-19 pandemic across age groups seem similar, where the labor force participation rates decreased, while the share of informal workers and unemployment rates increased. However, the effects seem more pronounced among youth workers. The older workforce participation in the labor force does not seem to be much impacted. The young workforce has seen a different trend from other categories in terms of informality. Their group underwent a hike in the share of informal workers and has remained at that level. Other categories only saw a small upward nudge. Lastly, the unemployment trend seems similar across the three categories. All the trend displays a significant spike in late 2020 and partial recovery in the next semester. While recovery of employment happens throughout all categories, the participation rate only improves among adult workers. The trends of the young workforce, which experienced a decline in the participation rate and saw no recovery, might indicate that they will be out of the labor force for the time being. Some young individuals still have the option to attain higher education to delay their entry into the labor market in this difficult situation.

The results of estimations of the four labor market outcomes for the main independent variables, i.e., work mobility and e-commerce growth, disaggregated by age group are shown in Table 10. For probability to work, the results indicate that COVID-19 reduced the employment prospects in the formal sector for youth and adult workers, but it had no effect on older workers. However, COVID-19 increased the probability of adult workers working in the informal sector, but not for youth and older workers. This means that the employment prospects of older workers in both the formal and informal sectors were not affected by COVID-19. Meanwhile, e-commerce growth only significantly increased the employment prospects of adult workers in the informal sector, but not in the formal sector. Furthermore, e-commerce growth had no significant effects on the employment prospects of youth and older workers in both the formal and informal sectors.

Table 10 Labor Market Outcome Effects of Mobility Restrictions and E-Commerce Growth by Age Groups, August 2019 - February 2021

	Work Mobility		E-Commerce Growth	
	(1)	(1)	(3)	(4)
	Formal	Informal	Formal	Informal
Probability to Work				
Youth (15-24)	0.000415**	0.0000913	0.00168	-0.000326
	(0.000179)	(0.000234)	(0.00227)	(0.00292)
Adult (25-60)	0.000635***	-0.000524***	-0.000619	0.0126***
	(0.000141)	(0.000171)	(0.00176)	(0.00208)
Older (60+)	0.000187	-0.000250	-0.00311	0.00353
	(0.000172)	(0.000336)	(0.00236)	(0.00419)

Log Hours Worked				
Youth (15-24)	0.000184	-0.00352***	-0.00357	0.0340***
	(0.000746)	(0.00110)	(0.00866)	(0.0118)
Adult (25-60)	0.000158	-0.00211***	0.000651	0.0291***
	(0.000315)	(0.000324)	(0.00360)	(0.00380)
Older (60+)	0.00122	-0.00125*	0.00900	0.0421***
	(0.00210)	(0.000728)	(0.0233)	(0.00894)
Log Total Earnings				
Youth (15-24)	0.00116	-0.000302	-0.0138	-0.0411
	(0.00104)	(0.00227)	(0.0118)	(0.0259)
Adult (25-60)	0.00147***	0.00102	-0.0151***	-0.0143*
	(0.000498)	(0.000670)	(0.00585)	(0.00749)
Older (60+)	0.00331	0.000706	0.0209	0.0422**
	(0.00320)	(0.00172)	(0.0319)	(0.0196)
Log Earning per Hour				
Youth (15-24)	0.000672	0.00108	-0.0107	-0.0506**
	(0.00106)	(0.00227)	(0.0120)	(0.0256)
Adult (25-60)	0.000981*	0.00147**	-0.0146**	-0.0321***
	(0.000510)	(0.000712)	(0.00583)	(0.00784)
Older (60+)	0.00443	-0.000710	0.000797	0.00434
	(0.00324)	(0.00182)	(0.0328)	(0.0209)

Source: Authors' calculation

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

For work hours, COVID-19 unanimously increased the work hours of all categories of workers in the informal sector but had no significant effect on their work hours in the formal sector. Similarly, e-commerce growth also increased the work hours of all categories of workers in the informal sector with no significant effect on their work hours in the formal sector.

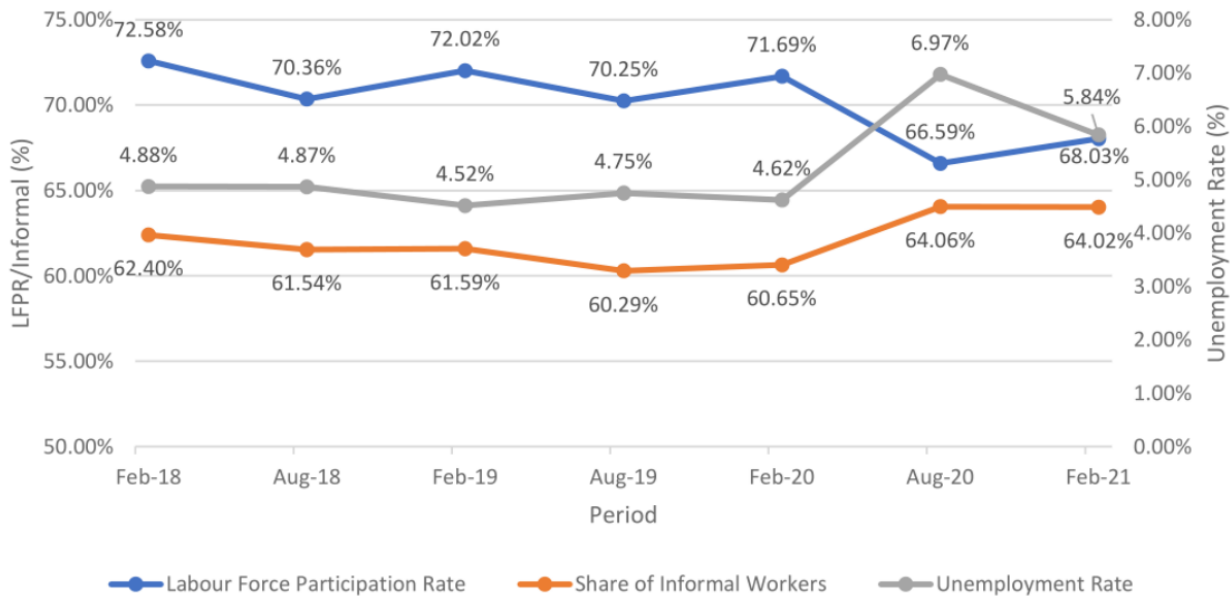
For total earnings, both COVID-19 and e-commerce growth have notable differences in their effects on different age categories of workers. COVID-19 only had a significant effect on reducing the total earnings of adult workers in the formal sector, but no effect in the informal sectors. It did not have significant effects on the total earnings of youth and older workers in both the formal and informal sectors. Meanwhile, e-commerce growth significantly reduced the total earnings of adult workers in both the formal and informal sectors. However, it increased the total earnings of older workers in the informal sector but had no significant effect in the formal sector. The total earnings of youth workers in both the formal and informal sectors were not affected by e-commerce growth.

For hourly earnings, COVID-19 and e-commerce growth also have significant differences in their effects on different age categories of workers. COVID-19 significantly reduced the hourly earnings of adult workers in both the formal and informal sectors. However, it did not have any effect on the hourly earnings of youth and older workers in both the formal and informal sectors. Similarly, e-commerce growth also significantly reduced the hourly earnings of adult workers in both the formal and informal sectors. In addition, it also significantly reduced

the hourly earnings of youth workers in the informal sector, but not in the formal sector. For older workers, e-commerce growth did not have significant effects on their hourly earnings in both the formal and informal sectors.

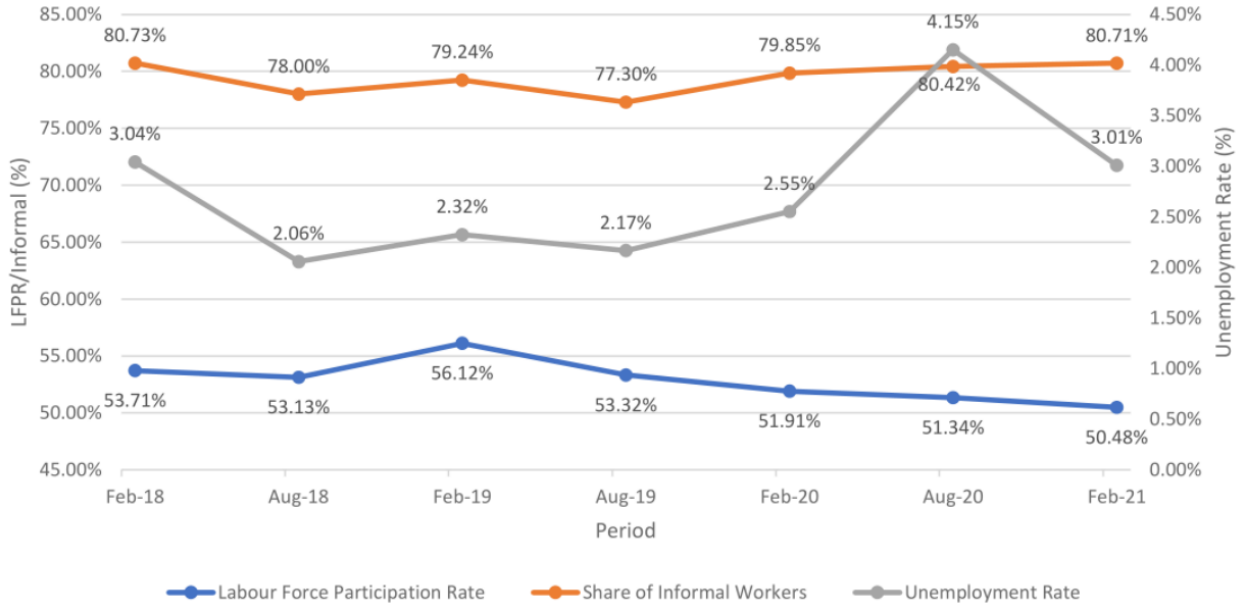
4.6.3 Heterogeneity by Disability Status

Workers with disabilities face various challenges in the labor market, resulting in lower labor market outcomes for this group of workers. Figure 11 in the shows the labor market indicators for groups of workers based on their disability status: non-disability, moderate disability, and severe disability. While the non-disability workers have a labor force participation rate of around 70%, workers with moderate disability have a significantly lower labor force participation rate of around 50%, and workers with severe disability have a much lower labor force participation rate of only around 12%. On the other hand, while the share of informal workers among non-disability workers is around 60%, the share of informal workers among workers with both moderate and severe disabilities is much higher at around 80%. Interestingly, while the unemployment rate among non-disability workers is around 5%, the unemployment rate among workers with a moderate disability is significantly lower at around 2.5%, but the unemployment rate among workers with a severe disability is much higher at around 10%.



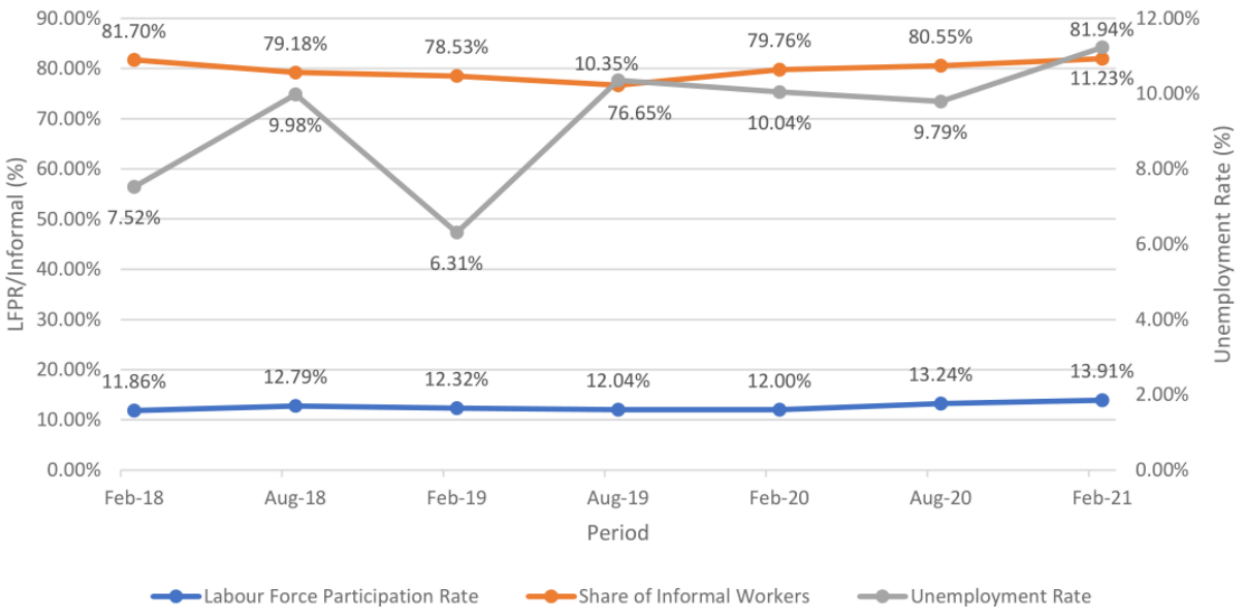
Source: Authors' calculation

Figure 11 Labor Market Indicators by Disability Status, February 2018 - February 2021 (a) non-disability workers



Source: Authors' calculation

Figure 11 Labor Market Indicators by Disability Status, February 2018 - February 2021 (b) Moderate disability workers



Source: Authors' calculation

Figure 11 Labor Market Indicators by Disability Status, February 2018 - February 2021 (c) Severe disability workers

The changes in these labor market indicators during the COVID-19 pandemic across disability groups are visibly different. For the non-disability workers, the effects of COVID-19 where labor force participation rates decreased and the share of informal workers and unemployment rates increased are observed. Similar effects are also observed for workers with moderate disability, although less pronounced. However, workers with severe disabilities have a different pattern of effects, i.e., none of the labor market indicators changed significantly. Hence, the more severe the disability, the less impact experienced by the workforce due to the pandemic.

The results of estimations of the four labor market outcomes for the main independent variables, i.e., work mobility and e-commerce growth, disaggregated by disability group are shown in Table 11 in the Appendix. For probability to work, the results indicate that for non-disability workers and workers with moderate disability, COVID-19 reduced their employment prospects in the formal sector, but it increased their probability to work in the informal sector. For workers with severe disabilities, however, COVID-19 only increased their probability to work in the informal sector, but it had no effect on the employment prospects in the formal sector. Meanwhile, e-commerce growth only significantly increased the employment prospects of non-disability workers in the informal sector but had no effect in the formal sector. For workers with moderate disabilities, on the other hand, e-commerce growth significantly reduced their employment prospects in the formal sector but had no effect in the informal sector. For workers with severe disabilities, e-commerce growth did not have any effect on their probability to work both in the formal and informal sectors, indicating that they are excluded from e-commerce development.

Table 11 Labor Market Outcome Effects of Mobility Restrictions and E-Commerce Growth by Disability Status, August 2019 - February 2021

	Work Mobility		E-Commerce Growth	
	(1)	(2)	(3)	(4)
	Formal	Informal	Formal	Informal
Probability to Work				
Non-Disability	0.000499***	-0.000392***	0.000433	0.00829***
	(0.000111)	(0.000139)	(0.00140)	(0.00170)
Moderate Disability	0.000517**	-0.000777*	-0.0104***	0.00778
	(0.000252)	(0.000461)	(0.00332)	(0.00567)
Severe Disability	0.000516	-0.00145**	0.00222	0.00738
	(0.000353)	(0.000665)	(0.00423)	(0.00808)
Log Hours Worked				
Non-Disability	0.000241	-0.00225***	0.0000421	0.0304***
	(0.000293)	(0.000305)	(0.00335)	(0.00358)
Moderate Disability	-0.000633	-0.00279***	0.00541	0.0675***
	(0.00192)	(0.00106)	(0.0252)	(0.0129)

Severe Disability	-0.0151	0.00550	-0.136	0.0464
	(0.0137)	(0.00683)	(0.196)	(0.0719)
Log Total Earnings				
Non-Disability	0.00160***	0.00118*	-0.0124**	-0.00801
	(0.000459)	(0.000634)	(0.00535)	(0.00709)
Moderate Disability	0.00214	-0.000765	-0.0390	-0.0160
	(0.00282)	(0.00233)	(0.0336)	(0.0274)
Severe Disability	-0.0322**	-0.00960	0.0143	0.284**
	(0.0154)	(0.0112)	(0.194)	(0.129)
Log Earning per Hour				
Non-Disability	0.00111**	0.00121*	-0.0119**	-0.0275***
	(0.000466)	(0.000661)	(0.00531)	(0.00731)
Moderate Disability	0.00134	0.000487	-0.0355	-0.0363
	(0.00297)	(0.00253)	(0.0356)	(0.0290)
Severe Disability	-0.0216	-0.0123	0.115	0.263*
	(0.0183)	(0.0137)	(0.202)	(0.138)

Source: Authors' calculation

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

For work hours, COVID-19 increased the hours worked of non-disability workers and workers with moderate disability in the informal sector but had no significant effect on their work hours in the formal sector. However, among workers with severe disabilities, COVID-19 did not have any significant effect on their work hours both in the formal and informal sectors. Similarly, e-commerce growth had qualitatively the same effects as COVID-19 on the work hours of workers across disability groups in the formal and informal sectors.

For total earnings, COVID-19 reduced the total earnings of non-disability workers in both the formal and informal sectors. However, it increased the total earnings of workers with severe disabilities in the formal sector but had no effect in the informal sectors. For workers with moderate disabilities, COVID-19 did not have significant effects on their total earnings in both the formal and informal sectors. Meanwhile, e-commerce growth reduced the total earnings of non-disability workers in the formal sector but had no effect in the informal sectors. However, it increased the total earnings of workers with severe disabilities in the informal sector but had no effect in the formal sector. For workers with moderate disabilities, e-commerce growth did not have significant effects on their total earnings in both the formal and informal sectors.

For hourly earnings, COVID-19 reduced the hourly earnings of non-disability workers in both the formal and informal sectors. However, it did not have any effect on the hourly earnings of workers with moderate and severe disabilities in both the formal and informal sectors. Similarly, e-commerce growth also significantly reduced the hourly earnings of non-disability workers in both the formal and informal sectors. However, it increased the earnings per hour of

workers with severe disabilities in the informal sector but had no effect in the formal sectors. For workers with moderate disabilities, e-commerce growth did not have significant effects on their earnings per hour in both the formal and informal sectors.

5. Conclusion

COVID-19 pandemic, through its effect on reducing work mobility, adversely affects the labor markets through induced changes in labor supply and demand. At the same time, e-commerce, which grew fast during the COVID-19 period, is expected to increase labor demand, counteracting the effect of COVID-19. At the individual level, both COVID-19 and e-commerce growth affect workers' outcomes in terms of their employment prospects, work hours, total earnings, and earnings per hour.

This study finds that COVID-19 reduced workers' employment prospects in the formal sectors, causing them to flock to the informal sector, and hence increased the probability to work in the informal sector. Meanwhile, the growth of e-commerce did not have a significant effect on the employment prospects in the formal sector. However, it increased the employment prospects in the informal sector, indicating that the jobs created by the growth of e-commerce are mainly in the form of self-employment. This means that both COVID-19 and e-commerce growth increased the employment prospects in the informal sector.

In terms of work hours, this study finds that COVID-19 did not significantly affect the work hours of workers in the formal sector. However, it increased the work hours of informal sector workers. Similarly, e-commerce growth did not have a significant effect on the work hours of workers in the formal sector, but it increased the work hours of informal sector workers. Hence, both COVID-19 and e-commerce growth increased the work hours in the informal sector.

Meanwhile, in terms of total earnings, this study finds that COVID-19 reduced the earnings of workers in both the formal and informal sectors, but the magnitude is proportionally larger for the reduction of earnings in the formal sector. Similarly, e-commerce growth also has a negative effect on the total earnings of workers in the formal sector. However, it did not have a significant effect on the earnings of workers in the informal sector. This means that workers in the formal sector suffered from lowered earnings due to COVID-19 and e-commerce growth. Similarly, workers in the informal sector also suffered from lower earnings due to COVID-19, but their earnings were not significantly affected by e-commerce growth.

The effects of both COVID-19 and e-commerce growth on work hours and total earnings caused workers in both the formal and informal sectors to unanimously suffer from lower earnings per hour, which indicates declining labor productivity. In the formal sector, both

COVID-19 and e-commerce growth caused a reduction in total earnings, while not affect work hours, hence earnings per hour declines. Meanwhile, COVID-19 lowered the total earnings in the informal sector while e-commerce growth did not affect total earnings, but both increased work hours, resulting in lower earnings per hour for workers.

We find there are heterogeneous effects of COVID-19 and e-commerce growth on workers' outcomes based on gender. In terms of employment prospects, there are differences in the effect of e-commerce growth on increasing the probability of working in the informal sector, which is only significant for females but not for male workers. This implies that women mostly reap the self-employment jobs created by the growth of e-commerce. In terms of total earnings, the effects observed for all workers turn out to be significant only for female workers, but not for male workers. Similarly, for earnings per hour, the effects that are significant for all workers are also significant for female workers, while for male workers, only the negative effect of e-commerce growth on earnings per hour in the informal sector is significant.

There are also heterogeneous effects based on the age groups of workers. In terms of employment prospects, the effects observed for all workers are also observed for adult workers. In contrast, for youth workers only the effect of COVID-19 on reducing the probability to work in the formal sector is significant. For older workers, none of the effects are significant, indicating that the employment prospects of older workers are insulated from both COVID-19 and e-commerce growth. For total earnings, both COVID-19 and e-commerce growth have no significant effects on the total earnings of youth workers. Still, they reduced the total earnings of adult workers in both sectors except for the effect of COVID-19 on the total earnings of informal sector workers.

On the other hand, the total earnings of older workers in the informal sector are positively affected by e-commerce growth. For earnings per hour, the negative effects of COVID-19 and e-commerce growth on earnings per hour of workers in both the formal and informal sectors are also observed for adult workers. In contrast, for youth workers only the negative effect of e-commerce growth on earnings per hour for workers in the informal sector which is significant, and none of the effects are significant for older workers.

Finally, we assess the heterogeneous impact of COVID-19 and e-commerce growth based on disability status. For employment prospects, the effects of COVID-19 and e-commerce growth observed for all workers, are also observed for the non-disabled workers. In contrast, for workers with a moderate disability, the effects of COVID-19 are also observed. Still, we find that e-commerce growth reduces the probability of working in the formal sector. For workers with a severe disability, only the effect of COVID-19 on increasing the probability of working

in the informal sector is significant. In terms of work hours, the effects of COVID-19 and e-commerce growth on increasing work hours in the informal sector are also observed for the non-disable and light disability workers. Still, none are significant for workers with severe disabilities. For total earnings, the effects of COVID-19 on reducing earnings in both formal and informal sectors and the effect of e-commerce growth on reducing earnings in the formal sector are also observed for non-disabled workers. Still, none of the effects are significant for moderate disability workers, while for workers with a severe disability the effect of COVID - 19 is increasing earnings in the formal sector and the effect of e-commerce growth is increasing earnings in the informal sector.

The findings of this study confirm that COVID-19 has adverse effects on the labor market and individual workers' outcomes. However, this study finds that e-commerce growth does not counteract the adverse effects of COVID-19. While indeed e-commerce growth creates jobs, those jobs created are mostly in the forms of self-employment, strengthening the effect of COVID-19 on the informalization of the economy. This indicates that e-commerce played a role as an employment buffer during the COVID-19 crisis. However, e-commerce growth tends to suppress the earnings of workers, which did not help the efforts to maintain people's welfare during the crisis.

In addition to e-commerce, this study also finds that another aspect of digitalization, i.e., the use of the internet for work, also affects the outcomes of workers. Workers who use the internet for work have higher prospects to work in the formal sector and a lower probability of working in the informal sector. Moreover, in both the formal and informal sectors, workers who use the internet for work have longer hours worked and earn higher total earnings and earnings per hour compared to workers who do not use the internet for work.

There are several policy implications from the findings of this study. First, since e-commerce growth does not counteract the adverse effects of COVID-19 on the labor market, this means that e-commerce cannot be used as a policy tool to assist workers who are adversely impacted by COVID-19. Second, to realize the potential of e-commerce developments to contribute to improving labor market indicators beyond jobs creation in the informal sector, efforts are needed to increase the productivity of those involved in e-commerce activities, such as through skills enhancement and capacity building programs. Third, considering the heterogeneous effects of COVID-19 on workers, specific assistance for female workers, youth workers, and workers with disability are needed. Fourth, since workers who use the internet for work have better outcomes, improving internet literacy will improve their productivity and work performance.

References

Abraham, Rosa, Amit Basole, and Surbhi Kesar. 2021. 'Down and out? The Gendered Impact of the COVID-19 Pandemic on India's labor Market'. *Economia Politica*, no. 0123456789. https://doi.org/10.1007/s40888-021-00234-8.

Acemoglu, Daron, and Pascual Restrepo. 2018. 'Artificial Intelligence, Automation and Work'. *NBER Working Paper Series*. https://doi.org/10.2139/ssrn.3098384.

Anderton, Robert, Vasco Botelho, Agostino Consolo, António Dias da Silva, Claudia Foroni, Matthias Mohr, and Lara Vivian. 2020. 'The Impact of the Pandemic on the labor Market'. *Economic Bulletin*. https://doi.org/10.46914/1562-2959-2021-1-1-186-190.

Autor, D, and Elisabeth Reynolds. 2020. 'The Nature of Work after the COVID Crisis: Too Few Low Wage Jobs'. *The Hamilton Project*, no. July: 1–13. https://www.hamiltonproject.org/papers/the_nature_of_work_after_the_COVID_crisis_too_few_low_wage_jobs.

Bachtiar, Palmira Permata, Rendy A. Diningrat, Ahmad Zuhdi Dwi Kusuma, Ridho Al Izzati, and Abella Diandra. 2020. '*Ekonomi Digital untuk Siapa? Menuju Ekonomi Digital yang Inklusif di Indonesia*' [Who is Digital Economy for? Toward an Inclusive Digital Economy in Indonesia]. SMERU Research Report. SMERU Research Institute. Jakarta.

Balde, Racky, Mohamed Boly, and Elvis Avenyo. 2020. 'Labor Market Effects of COVID-19 in Sub-Saharan Africa: An Informality Lens from Burkina Faso, Mali and Senegal'. UNU-MERIT Working Paper No. 2020-022. Maastricht Economic and Social Research Institute on Innovation and Technology. Maastricht University.

Balsmeier, Benjamin, and Martin Woerter. 2019. 'Is This Time Different? How Digitalization Influences Job Creation and Destruction'. *Research Policy* 48 (8): 103765. https://doi.org/10.1016/j.respol.2019.03.010.

Barrot, Jean-Noel, Basile Grassi, and Julien Sauvagnat. 2020. 'Sectoral Effects of Social Distancing'. *COVID Economics*, no. 3: 85–102.

Béland, Louis- Philippe, Abel Brodeur, and Taylor Wright. 2020. 'The Short-Term Economic Consequences of COVID-19: Exposure to Disease, Remote Work and Government Response'. IZA DP No. 13159. Bonn.

Bell, David N.F., and David G. Blanchflower. 2020. 'US and UK labor Markets Before and During the COVID-19 Crash'. *National Institute Economic Review* 252 (252): R52–69. https://doi.org/10.1017/nie.2020.14.

Borland, Jeff, and Andrew Charlton. 2020. 'The Australian labor Market and the Early Impact of COVID-19: An Assessment'. *Australian Economic Review* 53 (3): 297–324. https://doi.org/10.1111/1467-8462.12386.

Boukar, Ali Madai, Olivier Mbock, and Jean Marc Malambwe Kilolo. 2021. 'The Impacts of the COVID-19 Pandemic on Employment in Cameroon: A General Equilibrium Analysis'. *African Development Review* 33 (S1): S88–101. https://doi.org/10.1111/1467-8268.12512.

Brochu, Pierre, Jonathan Créchet, and Deng Zechuan. 2020. 'labor Market Flows and Worker Trajectories in Canada during COVID-19'. 32. Canadian labor Economics Forum (CLEF) Working Paper Series. Waterloo.

Byrne, Stephen, Dermot Coates, and Tara Mcindoe-calder. 2020. 'The Initial labor Market Impact of COVID-19'. 4. Vol. 2020. Central Bank of Ireland Economic Letter.

Casarico, Alessandra, and Salvatore Lattanzio. 2020. 'The Heterogeneous Effects of COVID-19 on Labor Market Flows: Evidence from Administrative Data The Heterogeneous Effects of COVID-19 on Labor Market Flows: Evidence from Administrative Data *'. *COVID Economics*, no. 52: 152–74. https://www.researchgate.net/publication/344582457.

Churchill, Brendan. 2021. 'COVID-19 and the Immediate Impact on Young People and Employment in Australia: A Gendered Analysis'. *Gender, Work and Organization* 28 (2): 783–94. https://doi.org/10.1111/gwao.12563.

Coibion, Olivier, Yuriy Gorodnichenko, and Michael Weber. 2020. 'Labor Markets During the COVID-19 Crisis: A Preliminary View'. 27017. *NBER Working Paper Series*. NBER Working Paper Series. Cambridge, MA. https://doi.org/10.2139/ssrn.3574736.

Crossley, Thomas F., Paul Fisher, and Hamish Low. 2021. 'The Heterogeneous and Regressive Consequences of COVID-19: Evidence from High Quality Panel Data'. *Journal of Public Economics* 193: 104334. https://doi.org/10.1016/j.jpubeco.2020.104334.

Das, Kaushik, Michael Gryseels, Priyanka Sudhir, dan Khoon Tee Tan. 2016. 'Unlocking Indonesia's Digital Opportunity.' Jakarta: McKinsey Indonesia Office.

https://www.mckinsey.com/~/media/McKinsey/Locations/Asia/Indonesia/Our%20Insights/Unlocking%20Indonesias%20digital%20opportunity/Unlocking_Indonesias_digital_opportunity.ashx

Das, Kaushik, Toshan Tamhane, Ben Vatterott, Phillia Wibowo, dan Simon Wintels. 2018. 'The Digital Archipelago: How Online Commerce Is Driving Indonesia's Economic Development.' McKinsey & Company Report.

https://www.mckinsey.com/featured-insights/asia-pacific/the-digital-archipelago-how-online-commerce-is-driving-indonesias-economic-development

Dingel, Jonathan I., and Brent Neiman. 2020. 'How Many Jobs Can Be Done at Home?' *Journal of Public Economics* 189: 104235. https://doi.org/10.1016/j.jpubeco.2020.104235.

Diskominfotik DKI Jakarta. 2020. 'Siaran Pers: Dinkes DKI Jakarta Imbau Warga Waspada Wabah Pneumonia Berat Dari Tiongkok'. https://corona.jakarta.go.id/storage/documents/siaran-pers-no-1032-dinkes-dki-jakarta-imbau-warga-waspada-wabah-pneumonia-berat-dari-tiongkok-5e9833ac5000f.pdf.

Eichenbaum, Martin S., Sergio Rebelo, and Mathias Trabandt. 2020. 'The Macroeconomics of Epidemics'. 26882. *NBER Working Paper Series*. Vol. 53. NBER Working Paper Series. Cambridge, MA.

Elder, Sara, Phu Huynh, Steven Kapsos, Sher Verick, and Christian Viegelahn. 2021. 'COVID-19, labor Market Slack and What It Means for Recovery'. https://www.ilo.org/wcmsp5/groups/public/---asia/---ro-bangkok/documents/briefingnote/wcms_771915.pdf.

Google, Temasek, and Bain & Company. 2021. 'Roaring 20s: The SEA Digital Decade. Indonesia'. e-Conomy SEA 2021. https://economysea.withgoogle.com/

Guerrieri, Veronica, Guido Lorenzoni, Ludwig Straub, and Iván Werning. 2020. 'Macroeconomic Implications of COVID-19: Can Negative Supply Shocks Cause Demand Shortages?' 26918. NBER Working Paper Series. Cambridge.

Hassink, Wolter H. J., Guyonne Kalb, and Jordy Meekes. 2020. 'The Dutch labor Market Early on in the COVID-19 Outbreak: Regional Coronavirus Hotspots and the National Lockdown'. 2020–22. Life Course Centre Working Paper Series.

Hausmann, Ricardo. 2020. 'Flattening the COVID-19 Curve in Developing Countries'. *Project Syndicate*, 2020. https://www.project-syndicate.org/commentary/flattening-COVID19-curve-in-developing-countries-by-ricardo-hausmann-2020-03.

Hensvik, Lena, Thomas Le Barbanchon, and Roland Rathelot. 2021. 'Job Search during the COVID-19 Crisis'. *Journal of Public Economics* 194 (April 2020): 104349. https://doi.org/10.1016/j.jpubeco.2020.104349.

Ikhsan, Mohamad, and I Gede Sthitaprajna Virananda. 2021. 'How COVID-19 Affects Food Security in Indonesia'. *Lembaga Penyelidikan Ekonomi Dan Masyarakat - Fakultas Ekonomi Dan Bisnis - Universitas Indonesia*, no. June: 13. https://www.lpem.org/wp-content/uploads/2021/07/WP-LPEM-061_How_COVID-19_Affects_Food_Security_in_Indonesia.pdf.

Inanc, Hande. 2020. ‘Breaking down the Numbers : What Does COVID-19 Mean for Youth Unemployment ?’ *Mathematica*. https://www.mathematica.org/our-publications-and-findings/publications/breaking-down-the-numbers-what-does-COVID-19-mean-for-youth-unemployment.

Kusumawardhani, Niken, Rezanti Pramana, Nurmala Saputri, and Daniel Suryadarma. 2021. ‘Heterogeneous Impact of Internet Availability on Female Labour Market Outcomes in an Emerging Economy: Evidence from Indonesia’. WIDER Working Paper No. 2021/49. United Nations University World Institute for Development Economics Research.

Lee, Sangheon, Dorothea Schmidt-Klau, and Sher Verick. 2020. ‘The labor Market Impacts of the COVID-19: A Global Perspective’. *Indian Journal of Labor Economics* 63 (s1): 11–15. https://doi.org/10.1007/s41027-020-00249-y.

Lemieux, Thomas, Kevin Milligan, Tammy Schirle, and Mikal Skuterud. 2020. ‘Initial Impacts of the COVID-19 Pandemic on the Canadian labor Market’. *Canadian Public Policy* 46 (1): S55–65. https://doi.org/10.3138/CPP.2020-049.

Leontief, Wassily. 1952. ‘MACHINES AND MAN’. *Scientific American* 187 (3): 150–64. http://www.jstor.org/stable/24950787.

Lin, Zhixian, and Christopher M. Meissner. 2020. ‘Health Vs. Wealth? Public Health Policies and the Economy During COVID-19’. 27099. *NBER Working Paper Series*. NBER Working Paper Series. Cambridge, MA.

Manning, Chris. 2021a. ‘The labor Market Shock and Policy Responses to the Coronavirus Pandemic’. In Blane D. Lewis and Firman Witoelar (eds.). *Economic Dimensions of COVID-19 in Indonesia: Responding to the Crisis*. ISEAS - Yusof Ishak Institute, Singapore.

Manning, Chris. 2021b. ‘COVID-19 and Jobs: Implications for Indonesia’s On-going Rural Transformation’. Presentation at The 2021 Mubyarto Public Policy Forum, April 2021, Gadjah Mada University, Yogyakarta.

Olivia, Susan, John Gibson, and Rus’an Nasrudin. 2020. ‘Indonesia in the Time of COVID-19’. *Bulletin of Indonesian Economic Studies* 56 (2): 143–74. https://doi.org/10.1080/00074918.2020.1798581.

Park, Cyn-Young, and Ancilla Marie Inocencio. 2020. ‘COVID-19, Technology, and Polarizing Jobs’. *ADB Briefs*. Manila, Philippines. https://doi.org/10.22617/BRF200217-2.

Pedauga, Luis, Francisco Sáez, and Blanca L. Delgado-Márquez. 2021. ‘Macroeconomic Lockdown and SMEs: The Impact of the COVID-19 Pandemic in Spain’. *Small Business Economics*. https://doi.org/10.1007/s11187-021-00476-7.

Pouliakas, Konstantinos, and Jiri Branka. 2020. ‘EU Jobs at Highest Risk of COVID-19 Social Distancing: Will the Pandemic Exacerbate labor Market Divide?’ IZA DP No. 13281. *Discussion Paper Series*. Discussion Paper Series.

Ranchhod, Vimal, and Reza C Daniels. 2020. ‘labor Market Dynamics in South Africa in the Time of COVID-19: Evidence from Wave 1 of the NIDS-CRAM Survey’. *SALDRU Working Paper No. 265*, no. 2.

Ridhwan, Masagus M., Jahen F. Rezki, Asep Suryahadi, and Arief Ramayandi. 2021. ‘The Impact of COVID-19 Lockdowns on Household Income, Consumption, and Expectation: Evidence from High-Frequency Data in Indonesia’. Bank Indonesia Working Paper, *forthcoming*. Jakarta.

Schotte, Simone, Michael Danquah, Robert Darko Osei, and Kunal Sen. 2021. ‘The labor Market Impact of COVID-19 Lockdowns: Evidence from Ghana’. IZA DP No. 14692. Discussion Paper Series.

Sparrow, Robert, Teguh Dartanto, and Renate Hartwig. 2020. ‘Indonesia Under the New Normal: Challenges and the Way Ahead’. *Bulletin of Indonesian Economic Studies* 56(3): 269–99. https://doi.org/10.1080/00074918.2020.1854079.

Suryahadi, Asep, Ridho Al Izzati, and Athia Yumna. 2021. ‘The Impact of COVID-19 and Social Protection Programs on Poverty in Indonesia’. *Bulletin of Indonesian Economic Studies*, 57(3), forthcoming.

Suryahadi, Asep, Ridho Al Izzati, and Daniel Suryadarma. 2020. ‘Estimating the Impact of COVID-19 on Poverty in Indonesia’. *Bulletin of Indonesian Economic Studies*, 56(2): 175–92. https://doi.org/10.1080/00074918.2020.1779390.

Temenggung, Della, Adhi Saputro, Rullan Rinaldi, and Deasy Pane. 2021. ‘Managing Recovery and Seizing Reform Opportunities’. *Bulletin of Indonesian Economic Studies* 57(1): 1–28. https://doi.org/10.1080/00074918.2021.1908207.

World Bank. 2020. ‘Towards A Secure and Fast Recovery - Indonesia Economic Prospects December 2020’. The World Bank. Jakarta.

World Bank. 2021a. ‘Beyond Unicorns: Harnessing Digital Technologies for Inclusion in Indonesia’. The World Bank. Jakarta.

World Bank. 2021b. ‘Boosting the Recovery - Indonesia Economic Prospects June 2021’. The World Bank. Jakarta.