Journal of Indonesian Economy and Business
Volume 39, Number 2, 2024, 143– 159

UNVEILING THE COVID-19 RECESSION: THE EFFECT OF SECTORAL EXPOSURE ON THE ECONOMY AND LABOR MARKET

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ABSTRACT

Introduction/Main Objectives: The impacts of the COVID-19 pandemic on economic and labor market conditions still need further research. This is because the pandemic had different and more extensive impacts than the 2008 global financial crisis. **Background Problems:** The lack of studies that explore the sectoral exposure of the economic and labor market to COVID-19 motivates this study to examine the problems and determine the impacts of the pandemic on the economy and labor market heterogeneity. **Novelty:** The sectoral exposure classification was based on sectoral risk and teleworkability indicators. Furthermore, input-output tables are used to analyze the interregional economic linkages based on economic activities in terms of sectoral exposure. To the best of the author's knowledge, this is the first study to explore the topic in Indonesia. **Research Methods:** The data used are a cross-section of 34 provinces in 2020. This study uses input-output tables to examine the relationship between sectoral exposure and the economy. In addition, regression analysis is used to examine the effect on the labor market. **Finding/Results:** The industry categorized as having medium-high sectoral exposure is the key sector in Indonesia because the forward and backward linkage has a value of more than 1. It means medium-high sectoral exposure greatly affects other industries' input and output. According to the OLS result, sectoral exposure significantly impacts short-time workers and the unemployment rate. **Conclusion:** This study implies that sectoral exposure to COVID-19 was significant for Indonesia's economic and labor market.

ARTICLE INFO

Article information:

Received: 22 November 2022. Received in revised version: 20 May 2023. Received in revised version: 17 June 2023. Accepted: 26 June 2023

Keywords:

sectoral exposure, labor market, economy, pandemic, input-output table

JEL Code:

I15, J40, R10, R15

ISSN:

ISSN 2085-8272 (print)
ISSN 2338-5847 (online)

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https://doi.org/10.22146/jieb.v39i2.6219 https://journal.ugm.ac.id/v3/jieb

INTRODUCTION

The COVID-19 pandemic struck in 2020 and caused macroeconomic instability in almost all countries worldwide. The consequences were worse than those of the global financial crisis caused by credit issues in the property sector (subprime mortgages) in 2008 (Li et al., 2021). According to data from the World Bank (2020), global economic growth in 2009 decreased by 1.31 percent. A more profound decline of 3.36 percent occurred in 2020, the year of the pandemic year. The significant difference between these two crises was that the pandemic affected both the economy and public health. Policies to reduce the spread of the virus by requiring social distancing, such as mobility controls, and closing businesses and schools, exacerbated the crisis. Policy dilemmas also occurred in making the right decisions so that there would be a balance between the economy and public health.

Various studies, both qualitative and quantitative, have been carried out to understand the impacts of the pandemic and solutions to the crisis. Some of these studies analyze the effects of the pandemic on macroeconomic conditions, especially economic growth and the labor market (Jain et al., 2020; Chitiga-Mabugu et al., 2021; Aduhene & Osei-Assibey, 2021). Dash & Sethi (2022) demonstrated the negative effect of COVID-19 cases and mortality on economic growth in the economies of South and Southeast Asia (SSEA) using panel data regression. Apergis & Apergis (2021) also observed COVID-19 cases and found that there was a strong negative effect on production activities in OECD countries using the Bayesian Panel Vector Autoregressive method. Most previous studies focused on the effect of COVID-19 on the economy using total cases and mortality as proxies. In fact, it is important to sort these effects based on the risk level of each business sector to clarify the impact on the economy. This study differs from previous research because it observes economic effects based on sectoral exposure while considering the risk of exposure and ease of teleworkability. Besides, this study uses input-output tables to present a broader analysis of forward, backward and multiplier economic effects during the pandemic.

Besides the economic impact, this study also investigates the impact of COVID-19 on the labor market because this crisis has had long-lasting negative implications for the labor force (Orlowski, 2020). Studies on the pandemic's impact on the labor market were also important in helping policymakers design more appropriate policies (Karim & Kasnawi, 2021; Bahasoan et al., 2021; Indayani & Hartono, 2020).Most of the studies that examine the effects of COVID-19 on the labor market using inferential analysis demonstrate that this pandemic has negatively impacted the labor market (Djoumessi, 2021; Dreger & Gros, 2021; Raimo et al., 2021). Su et al. (2022) investigated the effect of COVID-19 cases on the labor market by comparing unemployment rates before and during the pandemic in five European countries. The results of his research emphasize the adverse effects of the pandemic on increasing the employment rate. Huang et al. (2020) observed the effect of COVID-19 on the labor market in the hospitality sector and showed negative results similar to other studies. In contrast to previous research, this study explores the effects of the pandemic based on the exposure of the pandemic in the sector to the labor market. As other studies explore the labor market focusing on unemployment rates, this study uses not only unemployment but also short-time workers.

The condition of the labor market was in the spotlight during the pandemic because it was deeply affected. This was because of the limits placed on activities and social distancing rules

imposed by the government. Many companies had to reduce the working hours of their employees or even lay them off. This decrease in activity also impacted their production, which caused their income to decrease. One of the solutions amid the crisis was to lay off their employees, which increased the unemployment rate. According to World Bank (2020) data, the world unemployment rate in 2020 was 6.47 percent, with a loss of 114 million jobs around the world. The unemployment rate reached the highest in a decade. As for gender, job losses for women were 5.0 percent higher than for men, and job losses for young workers were 8.7 percent higher than for older workers (ILO, 2021). The labor force participation rate also decreased to 58.65 percent, whereas this figure had previously always been above 60 percent. The region that experienced the highest employment losses was North America, while the lowest was in Europe and Central America, where the most widely-applied pandemic management scheme reduced working hours (ILO, 2021).

In the case of Indonesia, the unemployment rate in August 2020 reached 7.07 percent, an increase of 1.84 percent compared to 2019 (BPS Statistics Indonesia, 2021). Typically, the unemployment rate varies across the provinces of Indonesia. DKI Jakarta, the nation's capital, had the highest unemployment rate of 10.95 percent. From2019 to 2020, DKI Jakarta's unemployment rate saw the highest increase nationally with 4.41 percent. The next most significant increases were seen in Bali and the Riau Islands at 4.06 and 2.84 percent respectively. Meanwhile, the lowest increase occurred in North Maluku where it rose by only 0.34 percent. More specifically, the impact of COVID-19 on the labor market can be seen in the number of jobs that had reduced working hours. In August 2020, 24.03 million people experienced reduced working hours. Unlike the unemployment rate, the province with the highest population that experienced reduced working hours was West Java with 5.1 million people.

Knowing the factors that influence the heterogeneity of the pandemic's impact on labor market conditions in each province is essential. Analyzing these factors can be used as input into the government's process of policy planning to reduce the negative consequences of a future pandemic for Indonesian workers and to accelerate economic recovery. Considering that the future spread of the COVID-19 virus was still uncertain, and there was an assumption that another peak wave would occur, it was crucial to anticipate the factors causing the decline in the workforce by analyzing regional characteristics. According to Meinen et al. (2021), the regional economic structure needed to be considered in terms of its heterogeneity. In their paper, Meinen et al. (2021) used sectoral exposure classification to describe the structure of a region by considering its exposure to viruses. The novelty of this paper is that, with reference to Meinen et al. (2021), it uses a calculation of sectoral exposure scores to explain labor market heterogeneity in Indonesia.

Meinen et al. (2021) discovered that the spread of economic damage across regions could not be explained just by the transmission of illnesses across those regions. Instead, the economic structure of a place is a vital determinant of the observed variability. This statement is also supported by research by Orlowski (2020) which found that the pandemic crisis had prompted significant structural changes in the labor market, with job growth bolstered in health care, information technology, and various types of online services. Meanwhile, it was reported that there were enormous job losses in travel, manufacturing, retail sales,

recreation, and various other industries. In addition, differences in sectoral structure across regions were also expected to explain the effects on supply and demand chains and production levels. These supply and demand chains can be seen in the Indonesian input-output table last released by BPS Statistics Indonesia based on data from 2016. The analysis used to ascertain the magnitude of the impact is forward and backward linkage analysis. From this analysis, it can be seen which sectoral exposure classification negatively affects the economy. Thus, another objective of this paper is to analyze the interregional economic linkages based on economic activities in terms of sectoral exposure classifications.

Based on the above background, this paper aims to complement the literature by documenting facts and analyzing the determinants of heterogeneous impacts on the labor market and economy in developing countries, especially Indonesia. The author will review the factors that affected the diversity of conditions in the economy using an input-output table analysis and will use cross-sectional data to analyze the factors that affected the labor market. The main factor expected to have influenced the economy and labor market is sectoral exposure across regions, with the control variables being the number of COVID-19 cases and GRDP. Before testing this, it is necessary to establish a sectoral exposure classification. Furthermore, to determine the classification of sectors in each province, the jobs with the greatest number of workers are used as a reference. The sectoral exposure score will be used to determine the economic impacts seen from the forward and backward linkage analysis and then used in a regression analysis to determine its effect on the labor market across regions. This paper differs from previous studies in several ways. First, other studies have only focused on the number of COVID-19 cases and mortality in terms of their economic impact (Dash & Sethi, 2022; Apergis & Apergis, 2021), while the author has used sectoral exposure to investigate the economic impact in a more detailed way. Second, in examining the economic impact, this study uses an analysis based on input-output tables which is an approach that has not yet been used by other studies. Finally, previous studies have used the unemployment rate or the total number of employed people to explore the impact of the pandemic on the labor market (Su et al., 2022; Zhang et al., 2021), whereas this study has added an analysis of the impact through the number of short-time workers.

LITERATURE REVIEW

Various government policies and assistance were implemented during the COVID-19 pandemic to mitigate the more severe economic impacts and reduce disruption to the labor market (Casarico & Lattanzio, 2022). This is because the pandemic, accompanied by massive restrictions on activities outside the home, had an extreme effect on the economy and workforce. However, the effects felt in each region could differ depending on the regional economic structure (Meinen et al., 2021). The shocks caused by the pandemic also impacted the labor market (Kikuchi et al., 2021). The employment of people of various ages, genders, work types, educational levels, industries, and occupations had significant differences. Workers in non-flexible occupations in the social sector were the worst hit, while those in flexible occupations saw little change. The different impacts on the labor market also affected teleworkable and essential jobs had been less severe; however, social jobs were significantly impacted (Shibata, 2020; Hou et al., 2021).

Meinen et al. (2021) have described sectoral exposure as the risk of the virus seen from two

perspectives: the limitations of engaging in social activities and the ease or difficulty of being able to engage in remote work (telework-able jobs). The indicators used to establish a classification of sectoral exposure and a score for each one were the vulnerability to the transmission of any economic activity by INAIL (2020) and teleworkability by Dingel & Neiman (2020). The classification carried out by INAIL (2020)was then given a sectoral-risk score based on the extent to which workers were directly exposed to the virus, the possibility of social distancing in the workplace, and how likely the workers' activities were to be in contact with third parties. Then, the teleworkability indicator obtained from Dingel & Neiman (2020) was added to complement the classification of sectoral exposure by taking into account activities that could be carried out remotely.

According to Shibata (2020), a teleworkable job is one where individuals can work at home. Telework, often known as teleworking, is a work flexibility arrangement whereby a person performs the tasks and obligations of their position and any authorized activities from a location other than where they would typically work (Hou et al., 2021). Teleworkability, that is to say, whether a worker's job can be teleworked, is critical in the significant transition to telework during a pandemic, as it is part of the fight against widespread pandemic-induced job losses. Telework can help workers maintain their productivity and keep their employment while preventing virus transmission in the office or on their commute to work. As a result, telework-ability can support worker resilience for the following reasons. Firms can use teleworkability to ensure work continuity throughout the pandemic and hence are less likely to resort to automation as a solution for teleworkable jobs. Workers in non-teleworkable jobs, on the other hand, are at a higher risk of workplace outbreaks and they will be less productive than teleworkers during the pandemic. Given the important differences between the degrees of sectoral risk and teleworkability during the COVID-19 crisis, this study explores the effects on the economy and labor market in Indonesia.

METHOD, DATA, AND ANALYSIS

Cross-sectional data from 34 provinces in Indonesia were used in the study. This paper used the labor market as the dependent variable, namely short-time workers and unemployment. The data on short-time workers were released by the BPS Statistics Indonesia, specifically the component “working residents experiencing reduced working hours due to COVID-19”. The data on unemployment referred to the open unemployment rate. In order to ascertain the factors that affected the heterogeneity across provinces during the pandemic, a sectoral-exposure score was established using data on the number of workers by sector by region. The control variables used were the number of COVID-19 cases per inhabitant and GRDP per capita. All data were sourced from the BPS Statistics Indonesia, except for the data on COVID-19 cases which were obtained from the website of katadata.co.id. The data were from 2020, and the employment data used were specifically from August 2020. Furthermore, to see the impact on the economy through the supply and demand chain, the recently released input-output table from the BPS Statistics Indonesia (2016) was used.

1. Sectoral Exposure Scores

The indicators obtained—both those for sectoral risk from INAIL and the teleworkability indicators—were converted into an ordinal scale with three categories (low, medium, high) according to the distribution of variables, with the sector allocation as shown in Table 1. The

"high" classification according to the INAIL sectoral risk indicators indicates higher exposure to the virus in that sector. Meanwhile, the "high" classification for teleworkability indicates the increased usage of telework; the higher the classification, the lower the sector's exposure to the virus. According to Table 3, the economic activities with high exposure are those with high sectoral risk and low teleworkability, namely retail and wholesale, accommodation and food services, transportation and warehousing, health care, and social assistance.

In order for them to be used in the subsequent regression analysis, the averages for the two indicators were calculated. Then the sectoral-exposure score was determined as shown in Table 2. Furthermore, the sectoral-exposure level in each province was determined based on the predominance of the number of workers according to their economic activities.

Table 1. Measure of sectoral exposure to the COVID-19 shock

Classification		Degree of Teleworkability		
		Low	**Medium**	**High**
INAIL sectoral risk	**Low**	Agriculture; Construction; Mining, quarrying, and oil and gas extraction	Federal, State, and Local Government; Electricity and gas	Financial and insurance; Real estate;
	Medium	Manufacturing	Professional services; Water supply, sewerage, waste management and remediation activities	Information and communication
	High	Retail and wholesale; Accommodation and food services; Transportation and warehousing; Health care and social assistance	Art, sport and entertainment	Educational services

Source: Meinen et al. (2021:7), combined with author's calculation using indicators by INAIL (2020) and Dingel & Neiman (2020)

Table2. Measures of sectoral exposure to the pandemic

Sectoral	INAIL sectoral risk		Degree of Teleworkability		Sectoral Exposure	
	Classification	**Score Ordinal**	**Classification**	**Score Ordinal**	**Classification**	**Average Score Ordinal**
Agriculture	Low	1.0	Low	3.0	Medium	2.0
Mining, quarrying, and oil and gas extraction	Low	1.0	Low	3.0	Medium	2.0
Manufacturing	Medium	2.0	Low	3.0	Medium-High	2.5
Electricity and gas	Low	1.0	Medium	2.0	Medium-Low	1.5
Water supply, sewerage, waste management and remediation activities	Medium	2.0	Medium	2.0	Medium	2.0
Construction	Low	1.0	Low	3.0	Medium	2.0
Retail and wholesale	High	3.0	Low	3.0	High	3.0
Transportation and warehousing	High	3.0	Low	3.0	High	3.0

Sectoral	INAIL sectoral risk		Degree of Teleworkability		Sectoral Exposure	
	Classification	Score Ordinal	Classification	Score Ordinal	Classification	Average Score Ordinal
Accommodation and food services	High	3.0	Low	3.0	High	3.0
Information and communication	Medium	2.0	High	1.0	Medium-Low	1.5
Financial and insurance	Low	1.0	High	1.0	Low	1.0
Real estate	Low	1.0	High	1.0	Low	1.0
Professional services	Medium	2.0	Medium	2.0	Medium	2.0
Federal, state, and local government	Low	1.0	Medium	2.0	Medium-Low	1.5
Educational services	High	3.0	High	1.0	Medium	2.0
Health care and social assistance	High	3.0	Low	3.0	High	3.0
Art, sport and entertainment	High	3.0	Medium	2.0	Medium-High	2.5

Source: Meinen et al. (2021:7), combined with author's calculation using indicators by INAIL (2020) and Dingel & Neiman (2020)

2. Input-Output Analysis

After the sectoral exposure to COVID-19 was identified, the next step was to explore the impact on the economy. This study used an input-output table to analyze the effects of the pandemic on Indonesia's economy. The chosen method refers to research by Giammetti et al. (2020) which analyzed the impact of the COVID-19 pandemic on the economy in Italy with a scenario in which a lockdown policy was implemented in several risky sectors. Mikulić et al. (2023) also observed the effect of the pandemic using the same method, namely the input-output table, focusing on the tourism sector in Adriatic and Continental Croatia. The advantages of this method were that it was able to capture the interdependencies among different sectors of an economy and it was comprehensive in terms of its sector-specific analysis (Kim & Kim, 2015). These advantages make it valuable for policy formulation and decision-making.

The input-output method analyzes a region's economy and aims to see the linkages between economic sectors in a region as a whole. The assumptions of input-output tables are homogeneity, proportionality, and additivity (Cahyono & Sumargo2, 2005). The usefulness of the input-output table is to examine the degree of the interrelationship among various sectors in an economy. In addition, the input-output table can provide an overview of the contribution of an economic sector to the economy as a whole or the growth potential of a particular economic sector.

From the input-output table, it can be ascertained that the linkage analysis is divided into two, namely backward linkage and forward linkage. Backward linkage calculates an increase in the output of specific sectors, which will encourage an increase in the output of other sectors. This backward linkage is obtained from the sum of all rows of a Leontief Inverse Matrix ($(I - A^d)^{-1}$) in a column. Forward linkage calculates the total output created by increasing an industrial sector's output through the economy's output distribution mechanism. It is obtained from the sum of all the columns of a Leontief Inverse Matrix in a row.

3. Regression Analysis

Multiple regression analysis allows us to adjust explicitly for a variety of additional variables that affect the dependent variable simultaneously. This can be used when we rely on non experimental data to test economic theories and evaluate policy consequences. We can infer

causation in circumstances where simple regression analysis might be deceptive since multiple regression models can include various explanatory factors that may be connected (Wooldrige, 2013). The method used to obtain estimates from multiple regression analysis is called ordinary least squares (OLS). OLS is a method used to estimate the classical regression coefficient by minimizing the squared vertical distance ($\sum(y_i - \beta_0 - \beta_1 x_i)^2$) from the point to the regression line (Leng et al., 2007). The model used in this study is as follows.

$$Labormarket_i = \beta_0 + \beta_1 exposure_i + \beta_2 covidcase_i + \beta_3 GRDP_i + u_i \quad (1)$$

Labor market data here are divided into short-time workers and unemployment rate.

RESULT AND DISCUSSION

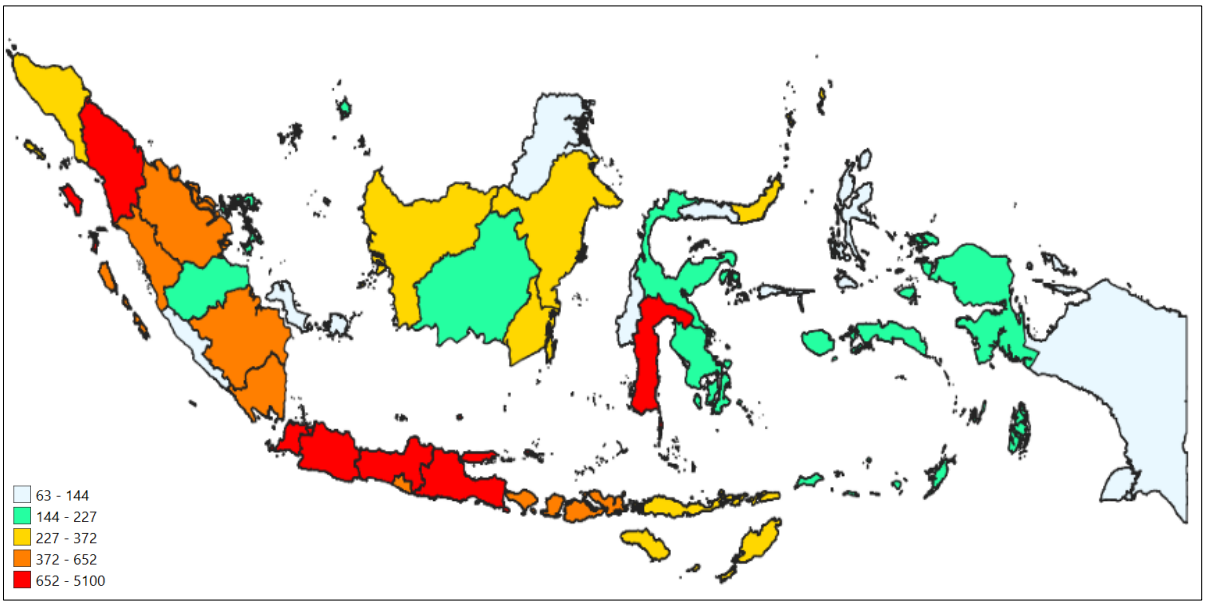
1. Labor market condition in Indonesia

The impact of COVID-19 was felt almost everywhere in the world, including Indonesia, but it lead to heterogeneous conditions in each region. In this paper, the examination of COVID-19 is focused on its impact on the labor market. The dependent variables of interest in the labor market are short-time workers and unemployment. The COVID-19 pandemic caused many companies to implement policies to reduce employee working hours and some even implemented layoffs.

Nationally, the number of employees experiencing reduced working hours was 24.03 million people or almost 9 percent of the total population in Indonesia. According to the ILO (2021), reducing working hours due to COVID-19 had an impact that was four times greater than the 2008 global financial crisis. The impact on the labor market, as seen by the number of short-time workers, varied between provinces. The island of Java was the area that experienced the most reductions in working hours during the pandemic, reaching 15.47 million people or 10 percent of the total population. West Java was the most affected province with 5.1 million people, East Java with 3.5 million people, and Central Java with 3.2 million people. Meanwhile, the regions that experienced the lowest level of reduced working hours were North Kalimantan with 17.3 thousand people, Bangka Belitung Islands with 76.4 thousand people, and North Maluku with 87.8 thousand people.

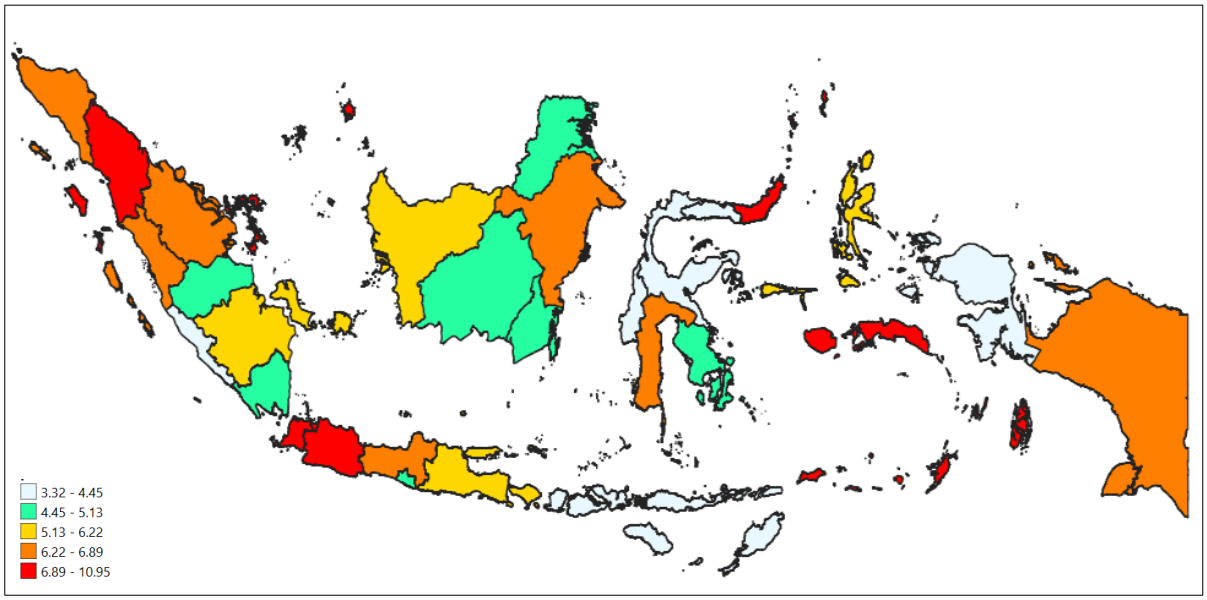
Indonesia's national unemployment rate, which reached 7.07 percent in the year of the pandemic, was the highest it had been in a decade. This condition varied in each province in Indonesia. As seen in Figure 2, the areas with the highest unemployment rate were in provinces spread across several islands, namely DKI Jakarta, West Java, Banten, Riau Islands, North Maluku, and North Sulawesi. The average unemployment rate in the group of provinces where it was highest was 9.15 percent, whereas DKI Jakarta had the worst unemployment rate which reached 10.95 percent. Meanwhile, the lowest levels of unemployment occurred in West Sulawesi, Central Sulawesi, and Bengkulu, at 3.32 percent, 3.77 percent, and 4.07 percent, respectively. The labor market indicators, that is to say, short-time workers and unemployment, cannot be said to reflect each other. The distribution of conditions reflected by these two indicators is different. As seen in the provinces on the island of Java, on average, short-time workers were in the group with the highest unemployment compared to other regions. In contrast, the unemployment rate on the island of Java varied between the groups with the middle and highest ranges.

Figure 1. Short-time worker by province in Indonesia, 2020



Source: Author

Figure 2. Unemployment rate by province in Indonesia, 2020



Source: Author

2. Sectoral exposure

One of the factors that can possibly explain the heterogeneity of the labor market in Indonesia was the risk of being infected with a virus according to each economic activity. The risk level is described in the sectoral-exposure scores that have been calculated previously. The province's risk level in terms of the pandemic's impact was measured by the predominance of workers in each province based on the type of business field. Figure 3 shows the distribution of sectoral exposure to COVID-19 in each province.

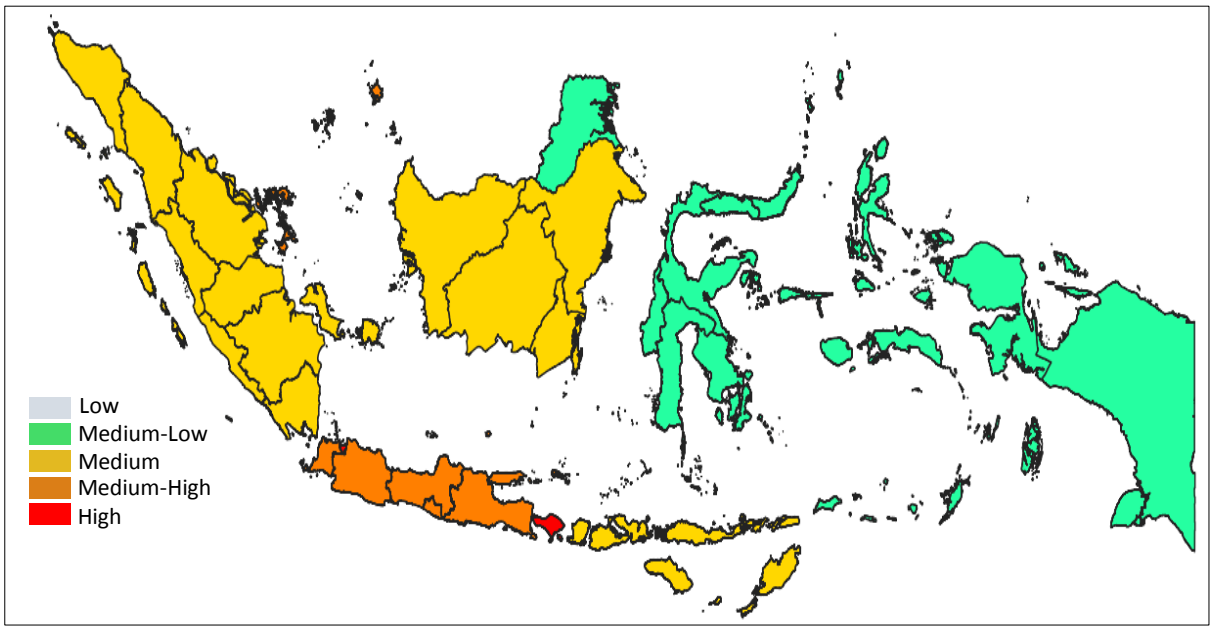
Provinces categorized as having the highest sectoral risk were DKI Jakarta and Bali. This is because the workforce in each of these provinces was predominantly engaged in economic activities that had high sectoral exposure to

COVID-19, namely retail and wholesale for DKI Jakarta and accommodation and food services for Bali. Meanwhile, the Sumatra and Kalimantan regions were in the medium category, with their workforces predominantly engaged in agriculture, and mining, quarrying, and oil and gas extraction. The Nusa Tenggara region was also included in the medium category, but its workforce was predominantly engaged in a different economic activity from the Sumatra and Kalimantan regions, namely educational services. The Java region was in the medium-high category with its workforce predominantly engaged in manufacturing. Furthermore, North Kalimantan and most of eastern Indonesia were in the medium-low group, where jobs in federal, provincial, and local governments dominated the number of workers in those two regions.

3. Economic impact using input-output analysis

By determining sectoral exposure classifications and using the input-output table, the economic impact on activities exposed to the pandemic could also be examined according to the classification. According to the subsequent analysis, the sector categories—with their levels of risk—have a large and small impacts on the economic outputs in Indonesia. The first step was to aggregate the 17 business fields in the 2016 Indonesian input-output table into the sectoral classifications of COVID-19 exposure. Furthermore, analysis was carried out to display both the forward and backward economic linkages. A forward linkage is a sector's linkage with other sectors that are users of the sector's output. In comparison, a backward linkage is a sector's linkage with other sectors that are inputs for that sector. The results obtained can be seen in Table 3.

Figure 3. Sectoral exposure by province in Indonesia, 2020



Source: Author

Table 3. Forward and backward linkage by sectoral exposure in Indonesia

Classification	Forward Linkage	Forward Linkage Index	Backward Linkage	Backward Linkage Index
Low	1.2507	0.7610	1.3700	0.8336
Medium-Low	1.5175	0.9233	1.8639	1.1340
Medium	1.8938	1.1523	1.5917	0.9684
Medium-High	1.9518	1.1876	1.7708	1.0774
High	1.6040	0.9759	1.6215	0.9866

Source: Author

The above table shows that the sectors with the highest forward linkages are those in the medium-high category. This means that an increase (decrease) of IDR 1 billion in the output of the medium-high classification sector will lead to an IDR 1.95 billion increase (decrease) in Indonesia's overall economic output. This occurs through increasing (decreasing) the outputs of the medium-high exposure sector used as inputs by other sectors. Meanwhile, the lowest forward linkage is low sectoral exposure, an increase (decrease) of IDR 1 billion in sector output with low classification will cause an IDR 1.25 billion increase (decrease) in Indonesia's overall economic output through an increase (decrease) in the sector's outputs with low exposure used as inputs by other sectors.

Furthermore, analysis of the backward linkages reveals that the sector with medium-low sectoral exposure has the highest value, namely 1.86. An increase (decrease) of IDR 1 billion in the sector's output with a medium-low classification will lead to an IDR 1.86 billion increase (decrease) in Indonesia's overall economic output. This occurs through an increase (decrease) in outputs produced by other sectors to be used as inputs in the production process sector with medium-low sectoral exposure. Similarly with forward linkages, sectors with low classification have the lowest backward linkages with a value of 1.37. The value indicates that an increase (decrease) of IDR 1 billion in the output of a low-class sector will lead to an IDR 1.37 billion increase (decrease) in Indonesia's overall economic output. This happens through an increase (decrease) in outputs produced by other sectors to be used as inputs in the production process sector with low sectoral exposure.

If viewed from the two sides of the linkage analysis—both the forward and backward linkage indexes—the key sectors will be obtained that can drive the Indonesian economy. These sectors are determined using the forward and backward linkage index and are valued at more than 1. According to Table 3, the sectors with a forward and backward linkage index higher than 1 are those with medium-high sector exposure. To summarize, the sector with medium-high sectoral exposure is a key sector in driving the Indonesian economy. More details on which economic activities are drivers in each sectoral exposure classification can be seen in Table 4.

If we analyze the types of economic activity in the medium-high sector, which is the key sector, then manufacturing is the economic activity with an important role. Manufacturing has forward and backward linkage indexes of more than 1, that is 2.36 and 1.04, respectively. The forward linkage of manufacturing is 3.93, which can be interpreted as meaning that an increase (decrease) of IDR 1 billion in manufacturing output will lead to an IDR3.93 billion increase (decrease) in Indonesia's overall economic output. This occurs through an

Table 4. Forward and backward linkages by economic activities and sectoral exposure in Indonesia

Sectoral Exposure	Industries	Forward Linkage	Forward Linkage Index	Backward Linkage	Backward Linkage Index
Low	Financial and insurance	1.6575	0.9942	1.3896	0.834
Low	Real estate	1.2615	0.7567	1.3633	0.818
Med-Low	Electricity and gas	2.5367	1.5216	2.9522	1.771
Med-Low	Information and communication	1.6928	1.0154	1.5903	0.954
Med-Low	Federal, state, and local government	1.1155	0.6691	1.7037	1.022
Medium	Mining, quarrying, and oil and gas extraction	2.0228	1.2133	1.4670	0.880
Medium	Agriculture	1.8054	1.0829	1.2854	0.771
Medium	Professional services	1.7169	1.0298	1.5961	0.957
Medium	Construction	1.3379	0.8025	1.8207	1.092
Medium	Educational services	1.0507	0.6303	1.5151	0.909
Medium	Water supply, sewerage, waste management and remediation activities	1.0426	0.6254	1.6390	0.983
Med-High	Manufacturing	3.9309	2.3578	1.7389	1.043
Med-High	Art, sport and entertainment	1.1602	0.6959	1.5632	0.938
High	Transportation and warehousing	1.7873	1.0720	1.7852	1.071
High	Retail and wholesale	1.9310	1.1583	1.4367	0.862
High	Accommodation and food services	1.2356	0.7411	1.7575	1.054
High	Health care and social assistance	1.0564	0.6337	1.7376	1.042

Source: Author

increase (decrease) in manufacturing outputs that are used as inputs by other economic activities. For the backward linkage manufacturing, which is 1.74, it can be shown that an increase (decrease) of IDR 1 billion in manufacturing output will lead to an IDR 1.74 billion increase (decrease) in Indonesia's overall economic output. This occurs through an increase (decrease) in outputs generated by other economic activities that are used as inputs in the manufacturing process.

In the sector with low sectoral exposure, the economic activity in Indonesia is financial and insurance, with forward and backward linkage values of 1.66 and 1.39, respectively. If we look at the sector with a medium-low classification, electricity and gas is the economic activity that dominates in economic movements in that classification. However, electricity and gas dominated the medium-low classification and are one of the key sectors in the national economic movement. This is because the economic activity has forward and backward linkage indexes of more than 1, namely 1.52 and 1.77. Furthermore, mining, quarrying, and oil and gas extraction are economic activities that have the largest forward and backward linkages in the medium sectoral exposure classification. The linkage values are 2.02 and 1.47, respectively.

In the high sectoral exposure classification, the economic activity that had a dominant impact in terms of the forward and backward linkage index, i.e. more than 1, was transportation and warehousing. The forward linkage of transportation and warehousing is 1.79, where this value indicates that an increase (decrease) of IDR 1 billion in the output of this activity will lead to an increase (decrease) in Indonesia's overall economic output of IDR 1.79

billion. This occurs through an increase (decrease) in transportation and warehousing outputs used as inputs by other economic activities. The value of the backward linkage of transportation and warehousing, which is 1.78, indicates that an increase (decrease) of IDR 1 billion in transportation and warehousing output will lead to an increase (decrease) in Indonesia's overall economic output of IDR 1.78 billion. This happens because the increasing (decreasing) outputs produced by other economic activities are used as inputs in the transportation and warehousing production process.

4. Role of sectoral exposure on labor market heterogeneity in Indonesia

The following analysis uses ordinary least squares (OLS) to determine the effect of sectoral exposure to COVID-19 on labor market heterogeneity, with the control variables being the number of COVID-19 cases per inhabitant and GRDP per capita. Table 5 shows the descriptive statistics for all the variables used in this study. The ratio between short-time workers and total population is, on average, 0.08, with maximum and minimum values of 0.16 and 0.05, respectively. The unemployment rates in the provinces in Indonesia range from 3.32 percent to 10.95 percent. The average sectoral exposure score is 1.98, with a maximum and minimum value of 1.50 and 3.00, respectively. The mean value of COVID-19 cases per inhabitant is 0.31, ranging from 0.04 to 1.74. The average value of GRDP per capita in logarithmic form is IDR 10,470 ranging from IDR 9,430 to IDR 12,030. In addition, the standard deviation of short-time workers per total population, unemployment rate, sectoral exposure, COVID-19 cases per inhabitant, and GRDP per capita are indicated as being 0.03, 2.01, 0.43, 0.30, and 0.54, respectively.

Factors affecting the labor market's heterogeneity due to a pandemic can be seen in the results of the analysis presented in Table 6. The labor market variables analyzed were short-time workers and unemployment. In the model where the short-time worker was the dependent variable, exposure based on the regions' sectoral structure had a positive and significant effect on the labor market. This means that the higher the sectoral exposure to the virus, the larger the proportion of activities that are difficult to carry out with social distancing and teleworking within the provincial sectoral structure, and the greater the increase in the number of short-time workers. The coefficient's value being 0.030 indicates that the higher the province's exposure to COVID-19, the more short-time workers in the region, with an increase in the ratio of short-time workers to the total population of 3.0 percent.

Table 5. Descriptive Statistics

Variables	Minimum	Maximum	Mean	Standard Deviation
Short-time worker per population	0.05	0.16	0.08	0.03
Unemployment rate	3.32	10.95	6.03	2.01
Exposure	1.50	3.00	1.98	0.43
COVID-19cases per inhabitant	0.04	1.74	0.31	0.30
Log GRDP per capita	9.43	12.03	10.47	0.54

Source: Author

Table 6. Result of regression analysis of labor market impact

Independent Variables	Dependent Variables	
	Short-time Worker	**Unemployment Rate**
Intercept	0.083	-7.611
	(0.084)	(8.029)
	[0.328]	[0.351]
Exposure	0.030***	1.884**
	(0.007)	(0.700)
	[0.000]	[0.012]
COVID-19 cases per inhabitant	0.052***	0.940
	(0.015)	(1.457)
	[0.002]	[0.524]
Log GRDP per capita	-0.007	0.918
	(0.008)	(0.788)
	[0.384]	[0.254]
R^2	0.780	0.611

Notes: () standard error; [] p.value; *** p value < 0.01; ** p value < 0.05; * p value < 0.10
Source: Author

Similar to the model with the short-time workers as the dependent variable, sectoral exposure also positively and significantly impacts the unemployment rate. Table 6 shows that the higher a province's exposure to COVID-19, the higher its unemployment rate (i.e. it increases by 1.88 percent). This shows that the employment structure related to the level of virus transmission risk can explain the pandemic's impact on the labor market heterogeneity in each province in Indonesia. This result is similar to the research conducted by Meinen et al. (2021) in the four largest euro zone economies. Ranđelović (2021) also proved in his study that trade, travel, and tourism were the sectors most heavily affected by the pandemic. Those sectors, in this paper, are categorized as having a high risk of exposure to the virus. Thus, the impact of sectoral exposure is also supported by the results research of Ranđelović (2021). Likewise, the results of research conducted by Shibata (2020), comparing labor market conditions during the 2008 global financial crisis and the 2020 pandemic, also strengthen the relationship between sectoral exposure and the labor market. Shibata's paper demonstrated that workers, in terms of unemployment and average hours worked in teleworkable occupations, are less affected during any recession, where teleworkable occupations are an indicator of the sectoral exposure classification.

In the model with short-time workers as the dependent variable, the coefficient of COVID-19cases per inhabitant positively and significantly affects the number of short-time workers. An increase of 1 percent in cases of COVID-19 in a province's population will cause an increase in the number of short-time workers by 5.2 percent. The significance of the COVID-

19 cases for short-time workers is the same as the results obtained in the paper by Meinen et al. (2021). Unlike the case with previous labor market indicators, the number of COVID-19 cases in a province's population does not have a significant relationship with the unemployment rate. This result is in line with the study on the labor market by Su et al. (2022)which found this insignificant relationship in France and Spain. The higher the number of positive cases of COVID-19, the more that companies prefer to reduce the working hours of their employees compared to layoffs which increase the unemployment rate. Another control variable, namely GDRP per capita, indicates no significant relationship between the province's wealth measured using GRDP per capita and the impact of the pandemic on the labor market. This shows that the impact of the pandemic on the labor market occurs not only in provinces with large economies but also evenly in provinces with lower incomes.

CONCLUSION AND SUGGESTION

This study aimed to examine the impact of the COVID-19 pandemic on the economy and the labor market. The results show that the provinces with the highest sectoral risk are DKI Jakarta and Bali. By comparison, the Java region is in the medium-high category with its workforce predominantly in manufacturing. Sumatra and Kalimantan are included in the medium category. Furthermore, North Kalimantan and most of eastern Indonesia are in the medium-low category. The input-output table indicated that areas with medium-high sectoral risk in Indonesia experience a greater impact on the economy via supply and demand chains. The medium-high category is also said to be a key sector.

The regression analysis indicated that sectoral exposure is a factor that affects the heterogeneity of the labor market. It can be seen from the sectoral exposure coefficient which yielded positive and significant results in the model with the dependent variables of short-time workers and unemployment rate. The higher a province's exposure to COVID-19, the more short-time workers it had and the higher the unemployment rate was.

Given these results, policymakers need to evaluate the exposure of the economic structure in order to reduce the impact on the economy and the labor market of the crisis caused by the pandemic. The policies considered must reach the most vulnerable and severely affected sectors and regions. In addition, teleworkability is one of the indicators that determine the sectoral exposure classification and it needs to be considered. Thus, the government should consider financing broadband infrastructure investment and regulating the cost of high-speed internet connection in economically vulnerable regions to mitigate the effects of a potential digital divide caused by disparities in terms of internet access. Firms should also consider the diversity of needs for flexibility and telework. Workers should be given the opportunity to engage in telework and additional training on how to do this effectively. Future research is expected to add indicators forming sectoral exposure classifications and other variables likely to support the diversity of impacts that occur, both on the economy and the labor market.

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