THE UTILITY OF 'COVID-19 MOBILITY REPORT' AND 'GOOGLE TREND' FOR ANALYSING ECONOMIC ACTIVITIES

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Abstract
WHO urged the world population to practice social distancing to prevent transmission of the COVID-19. Social distancing leads the policy to limit mobility of people to work, school and other social activities. Restricting population mobility makes people start to look for other alternatives to do economic activities. The use of the internet is optimized in carrying out economic activities. This research aims to describe the economic activity using internet during COVID-19 pandemic. The research also aimed to show the relationship between the people mobility during COVID-19 with economic activity using internet. Descriptive analysis and inference analysis are applied to analyse the economic activities. Data source are provided by google trend and google COVID-19 community mobility report. Google trend data are used to represent the economic activities by deriving the queries of keywords related to economic activities. The People mobility to retail, grocery, parks, transit station, workplace and residential are obtained from Google COVID-19 mobility report. Data from COVID-19 mobility report treated as independent variables. As for dependent variables, data from google trend are applied with the keyword 'jual' and 'beli'. Two multiple linear regression models are applied to show the relationship between independent variables and dependent variables. The result showed that mobility to workplace and residential are significantly affecting economic activity during pandemic time for both models.

Keywords: google trend; covid-19 mobility report; regression

Introduction

The coronavirus COVID-19 cases first time appeared in Wuhan, China. The coronavirus COVID-19 is affecting 213 countries and territories around the world and 2 international conveyances. WHO urged the world population to practice social distancing to prevent transmission of the COVID-19. Until May 16, 2020, the number of cases of COVID-19 infection in Indonesia was 17,025 and the number of patients who died from COVID-19 was 1089. The average number of cases found per day was more than 400 cases per day. Indonesia make critical decision to combat the spread of the Covid-19 virus, by implementing a Large-Scale Social Restriction (Pembatasan Sosial Berskala Besar) or known as PSBB. PSBB is a limitation of certain activities in an area suspected of being infected with COVID-19. An area can apply a PSBB, if the province / district / city region meets two criteria. First, the number of cases or deaths due to disease has increased and spread significantly to several regions. Second, the area

where the disease is present also has epidemiological links with similar events that occur in other regions or countries. If both criteria are fulfilled, the Indonesian Ministry of Health will determine the region to apply the PSBB.

PSBB is explained by Minister of Health Regulation No. 9 of 2020 article 2. In Indonesia, there are 18 provinces and districts / cities that apply the PSBB after it is approved by the Indonesian Ministry of Health. The PSBB was first implemented by DKI Jakarta Province on April 10, 2020. Through its leadership, local government has a significant role to play in working across sectors and with civil society partners to support and accelerate action to address the social determinants of health and the causes of health inequalities (Organization, 2012)

Coronavirus COVID-19 outbreak affecting economy activity. Restricting population mobility makes people start to look for other alternatives to do economic activities. The use of the internet is optimized in carrying out economic activities. Badan Pusat Statistik released that 73,75 percent of household used internet in the last 3 months. Internet use for economic activity by the household is confirmed by looking at data that 47,69 percent of population age 5 years and over ever accessing internet for the last 3 months. 50,50 percent of male population use internet for the last 3 months, while 44,86 of female population use internet for the last 3 months. Jakarta is the biggest internet user in Indonesia, 73,46 percent of Jakarta population age 5 years and over ever accessing internet for the last 3 months (Badan Pusat Statistika, 2020).

Economic activities that use the internet include trading transactions using application for marketplace. The use of internet search engines is getting popular for doing business and other economic activity. People look for information through search engines to sell or buy. The most searches are done through the Google search engine. Google is the most popular search engine in the world with a market share of more than 70%. In addition, Google also controls the search market share via mobile devices with a market share of more than 85%.

Google provides data to find out the most searched keywords through the Google Trend feature. Google Trends can be used for comparative keyword research and to discover event-triggered spikes in keyword search volume. During the pandemic, google release Community Mobility Reports to provide insights into what has changed in response to policies aimed at combating COVID-19.

The purpose of this research is to describe the economic activity that using internet during COVID-19 pandemic. The research also showed the relationship between the people mobility during COVID-19 with the economic activity that use internet search on google.

The utility of google trend by using keyword provide not only number but also geographic location of searches (Support.google.com, 2020). This make data from google trend can be utilize for research. Epidemiological research use data from google trend as valuable future implication in aiding surveillance of broad range of diseases (Seifter, Schwarzwalder, Geis, & Aucott, 2010). Another use of google trend by financial research as an approach to portfolio diversification. The diversification is used

based on the popularity of stock measured by search queries from google trend (Kristoufek, 2013).

Mobility of people to do their activity in their everyday life is recorded to google maps. The google location history browser is a minute-by-minute map of our life. It happened when we have device that carry any google-filled gear like android phone or tablet (Techcrunch.com, 2020). This is the data that is collected to make COVID-19 Mobility Report.

During pandemic where people practice social distancing, mobility become a constraint in human development. A paper extends recent research on the economics of human development and social mobility (Heckman & Mosso, 2014). It presents economic models that rationalize the evidence of social mobility and unify the treatment effect and family influence literatures. The study of people's mobility in pandemic era also delivered by (Junghwan Kim & Kwan, 2021) the finding suggested that the restricting people's mobility to control the pandemic may be effective only for a short period, especially in liberal democratic societies. Data mobility report by Google can be used to show the effects of mobility and highlight the importance of appropriate mobility restrictions in terms of the pandemic (Kartal, Depren, & Depren, 2021).

Economic activities that involve the use of internet search engines such as google search require the trust of its users. The meta-analytic structural equation modelling analysis indicated that online trust mediates the effect of various antecedents on behavioural intention (Yeolib Kim, 2015). Sometimes people influence other to buy or sell on internet, especially in e-commerce. To maximize the influence power in e-commerce, enhancing opinion leaders' credibility is crucial (Wu et al., 2018).

The relationship between population mobility and economic activity has been done a long time ago by economist. The approach taken was to look at the relationship between migration and economic development. This type of analysis should take into account the following interrelated dimensions: social agents, global context, regional integration, national environment, and local levels (Wise & Covarrubias, 2009). This research gives another perspective on how to apply free-access-data in internet to analyse economic activities.

Research Methods

This paper makes use of open access data provided by Google namely google trend and community mobility report. Google Trends provides keyword-related data including search volume index and geographical information about search engine users. The numbers represent the search interest relative to the highest point on the chart for the selected region and time. A value of 100 is the peak popularity of the term, whilst a value of 50 means that the term is half as popular.

COVID-19 Community Mobility Reports released globally, initially covering 131 countries and regions. The reports use aggregated, anonymized data to chart movement trends over time by geography, across different high-level categories of places such as retail and recreation, groceries and pharmacies, parks, transit stations, workplaces, and residential. These reports show how visits and length of stay at different places change

compared to a baseline. Google calculate these changes using the same kind of aggregated and anonymized data used to show popular times for places in Google Maps. For each category in a region, reports show in 2 different ways, headline number dan trend graph. The headline number compares mobility for the report date to the baseline day. A baseline day represents a normal value for that day of the week. The baseline day is the median value from the 5-week period Jan 3 – Feb 6, 2020. Trend graph is a graph that represent the percent changes in the 6 weeks before the report date.

Google assured that no personally identifiable information, such as an individual's location, contacts or movement, will be made available at any point. These reports are created with aggregated, anonymized sets of data from users who have turned on the Location History setting, which is off by default (Support.google.com, 2020).

Data used in this research is the mobility to retail, grocery, parks, transit station, workplace and residential. Data from COVID-19 mobility report treated as independent variables. As for dependent variables, data from google trend are applied with the keyword 'jual' and 'beli'. The keyword 'jual' and 'beli' are used to describe the economy activity. The scope of this paper is Indonesia with time series data taken from February 15th – May 16th.

The key purpose of any research report is to offer a clear description of what has been done in the various stages of the research process (Sekaran & Bougie, 2016). Hence descriptive analysis and inference analysis are used to report the research. Descriptive analysis using tables and graphs was developed to give understanding about what is going on with the Indonesian economy during COVID-19 pandemic. Inference analysis is used to show the relationship between the mobility of the people to the economy activity by using linear regression. Two equations are built to show the relationship of independent variables with dependent variables. The model applied to the data as follows:

$$jual_t = \alpha_0 + \alpha_1 retail_t + \alpha_2 grocery_t + \alpha_3 parks_t + \alpha_4 transit_t + \alpha_5 workplace_t + \alpha_5 residential_t + \varepsilon_1$$

$$beli_t = \beta_0 + \beta_1 retail_t + \beta_2 grocery_t + \beta_3 parks_t + \beta_4 transit_t + \alpha_5 workplace_t + \alpha_5 residential_t + \varepsilon_1$$

Where $jual_t$ and $beli_t$ denotes the popularity of keyword 'jual' an 'beli' searched by people in google from Feb 15 to May 16 2020. $Retail_t$ represents people's mobility to retail and recreation, measured by retail and recreation percent change from baseline. $Grocery_t$ is people's mobility to grocery and pharmacy, measured by grocery and pharmacy percent change from baseline. $Parks_t$ is people's mobility to parks, measured as parks percent change from baseline. $Transit_t$ is people's mobility to transit station, measured as transit station percent change from baseline. $Workplace_t$ is people's mobility to workplace, measured as workplace percent change from baseline. $Residential_t$ is people's mobility to residential, measured as residential percent change from baseline. α_i and β_i where i=0, …, 5 is the regression coefficient for the independent

variables of both equations. t is the data period used for research from 15 February 2020 to 16 May 2020.

Ordinary Least Square method is applied to estimate the parameter. The method required assumption that must be met. There are five assumptions: linearity and additivity of the relationship between dependent and independent variables, the error term is normally distributed, homoscedastic, no correlation between consecutive error and non-multicollinearity. The residual obtained by the model must meet the assumption to get BLUE estimator (Gujarati, 2004). BLUE stands for Best Linear Unbiased Estimator that assure us that the estimator obtained is the best one to explain the relationship between independent variable and dependent variable.

The steps to get the best estimator required several tests to check the assumption. To check the linearity, usually the researcher used a plot of observed versus predicted values or a plot of residuals versus predicted values, which are a part of standard regression output. The points should be symmetrically distributed around a diagonal line in the former plot or around horizontal line in the latter plot, with a roughly constant variance. A "bowed" pattern, indicating that the model makes systematic errors whenever it is making unusually large or small predictions.

The normal distribution of error term is tested using Jarque-Bera test. The idea of Jarque-Bera test is using the kurtosis and skewness of the error term. The null hypothesis is the residual is normally distributed. It means if we reject the null hypothesis means the residual is not normally distributed.

The next assumption that must be met is homoscedasticity. Homoscedasticity explained a situation in which the error term the same across all values of the independent variables. The violation of homoscedasticity named heteroscedasticity will lead to inconsistent estimation of the parameter. The test for homoscedasticity is Breusch-Pagan test. The null hypothesis is the error term is homoscedastic.

Autocorrelation refers to the correlation between the values of the same variables across different observations in the data. Autocorrelation often occur in regression using time series data. A common method of testing for autocorrelation is the Durbin-Watson test. A rule of thumb is that test statistic values in the range of 1.5 to 2.5 are relatively normal. Values outside of this range could be cause for concern.

Multicollinearity occurs when independent variables in a regression model are correlated. Result and Discussion. To test the multicollinearity, we can use Variance Inflation Factor (VIF). A VIF above 10 indicates high correlation and is cause for concern.

Results and Discussion

Google trend provide the search of keyword 'jual' and 'beli'. The ' jual ' keyword used in this paper related to other words and they often appear on the search. Google provides 'jual' queries. There are 25 other words that are related to the word 'jual'. Figure 1 below shows related queries for all categories. From Figure 1 we can see the related query for the word 'jual'. The word jual means sell usually related to producut. From related queries search on google, there are product names that follow the

keyword. The bigger space means a lot of people searched for the keyword and related queries. From Figure 1, we can see 'jual beli' as most used keyword related to 'jual' keyword. The 'jual beli' keyword means buy and sell.

When people want to get or sell a product, they will used this keyword on internet search. Products that related to 'jual' keyword are cars (mobil), houses (rumah), land (tanah), used cars (mobil bekas), hp (cellphones), motor (motorcycle), laptop and masks (masker). We can see that products following 'jual' keyword is items that related to assets belong to household. During the COVID-19 pandemic, many people sold their assets because of limited economic activity to fulfill their lives. There are interesting product related to 'jual' queries, namely 'jual vape', 'jual anjing', 'jual kucing' or sell vape, sell dogs, sell cats. In pandemic conditions, it is rare to see that sell or want to buy vape, dogs, cats. Pandemic condition may cause people to look for these things. Related queries for 'jual' keyword give us description what people will search on internet using google search engine. Google searches related to buying and selling are signals of economic activity.
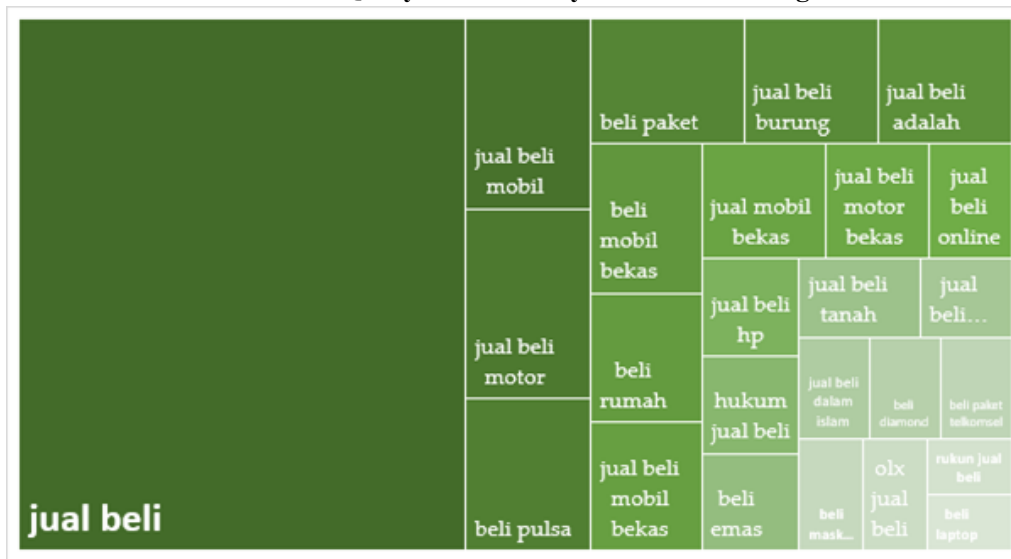
Figure 1
Related Query for 'jual' Keyword for All Categories
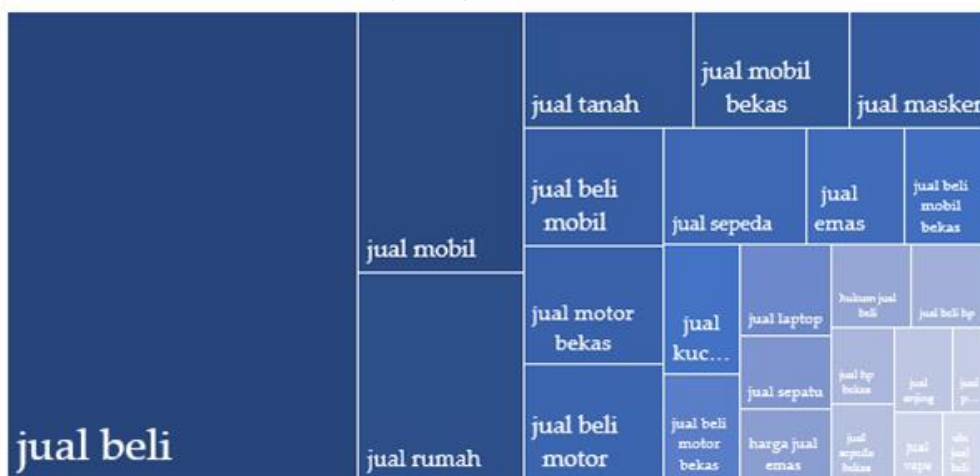
Source: Google Trend Feb 15 – May 16 2020

Meanwhile, almost the same as the word 'jual', the Google search engine also notes that the word buying and selling most related to the word 'beli' or buy. Figure 2 shows a related query with the word 'beli'. From the picture, it can be seen that many people search on Google to buy cars, motorcycles, pulses, data packages, used cars, cellphones, gold. People want to buy items related to online activities such as cellphones, prepaid credit, data packages. This is due to the pandemic conditions where many people who work from home and need these products. What is interesting is the related query 'beli emas' or 'buy gold', because at the pandemic time, the price of gold experienced a significant increase. It is possible that people want to save the value of their money in gold.

Figure 2
Related Query for 'beli' Keyword for All Categories
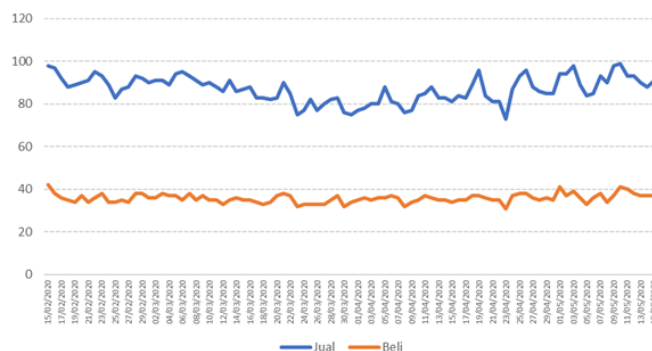

Source: Google Trend Feb 15 – May 16 2020

The popularity or 'jual' and 'beli' keyword can be seen from Figure 3. The figure showed how many times the keyword is popular in web search day by day. From Google's trend it is seen that people always use the keywords 'sell' and 'buy' every day on Google search. This can be seen from the non-zero curve shape. Since the figure showed constantly exist every day, we can conclude that the keyword is good enough to represent the economic activity. Although derived from an internet search, the use of keywords 'jual' and 'beli' indicates the beginning of economic activity. This is a signal for transactions that are part of economic activity.

From Figure 3. we can see 'jual' is about 8.6 times in average more popular than 'beli' in web search. we can say that people more often use keyword selling (jual) to start their economic activities on the internet. The top related query for 'jual' and 'beli' is the same, that is 'jual beli', and the product that have been search through the web are quite similar. It showed that there are no differences for those keywords to capture the beginning of economic activity.
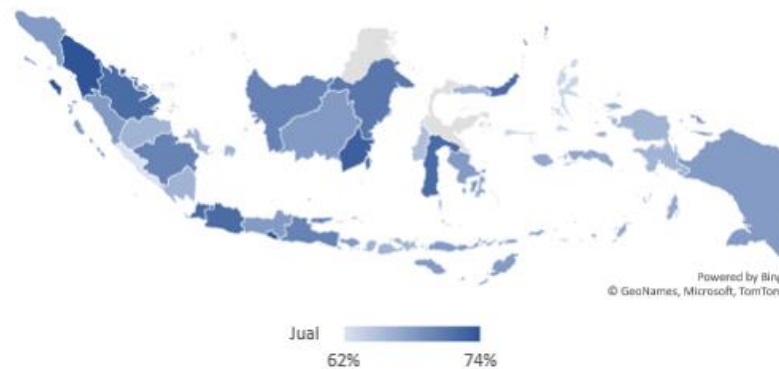
Figure 3
Search Popularity of 'jual' and 'beli' Keyword for All Categories

Source: Google Trend Feb 15 – May 16 2020

Google Trend also gives access to find out where internet searches come from. To show the source of the search location, we can see it based on the province where the search was conducted. Google maps the search by making an average of search origin each day by provinces in Indonesia. The figure 4 showed location where the web search launched. A darker color indicates that in that location the keyword 'jual' was the most searched for, while the lighter color showed the opposite, the keyword 'jual' at that location was the least searched. This comparison was made between provinces in Indonesia in research period. It can be seen from the picture that the keyword 'jual' is the most widely used in Google search in North Sumatra Province. The keyword 'jual' was used the least in the South Sumatra Province during research period.

Figure 4
Geomap For Keyword Jual (Feb 15 – May 16)

Source: Google Trend Feb 15 – May 16 2020 (data processed)

Compared to the keyword 'sell', the keyword 'buy' is the most widely used in South Sumatra, while this keyword is the least searched in North Sumatra. From figure 5, we can see that 'beli' keyword in Sumatra Utara has the lightest colour among provinces in Indonesia. From this fact we can say that the two keywords are complements.

Figure 5.
**Geomap For Keyword Jual (Feb 15 – May 16)**
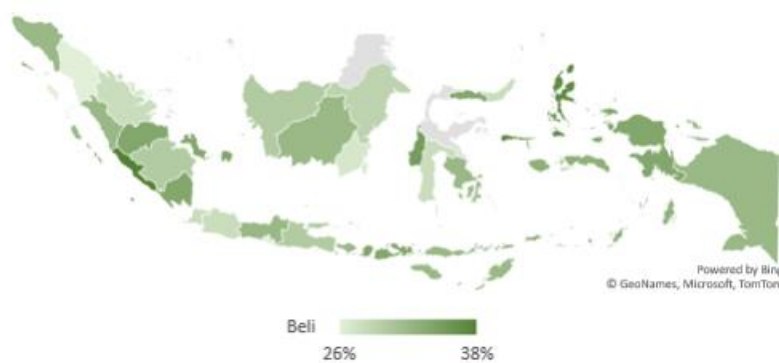
Source: Google Trend Feb 15 – May 16 2020 (data processed)

As the literature review says, population mobility will affect economic activity in a region. Population mobility associated with socioeconomic activities includes mobility to parks, transit station, workplace, retail, grocery and residential. The mobility data of people compared to baseline can be seen from figure over time. When the mobility data showed positive sign, it means population mobility from baseline to the destination such as parks, transit station, workplace, retail, grocery, residential are high or show rise. Negative sign showed decreased mobility from baseline.

There is a significant decrease in mobility on March 14. The mobility to Transit Station experienced the most decrease number. It is followed with mobility to parks, workplace, retail and grocery due to the closure of many attractions, museum and malls. It is also due to the policy of working from home and study from home. But mobility to residential showed the opposite way. More people go out to residential. The reason that many people go out to residential is due to the closure of offices and school. Another reason is people from big cities go back to their hometown due to uncertainty of the economic activity. Until May 16, the mobility to transit station, parks grocery, retail and workplace are relative the same. Mobility to workplace showed cyclical trend. It gives the signal that the office may have policy to limit of the presence of the worker. Mobility to grocery start to rebound to normal at the end of research period due to holiday preparations for moslem (Idul Fitri day).

Figure 6
Population Mobility Compared to Baseline
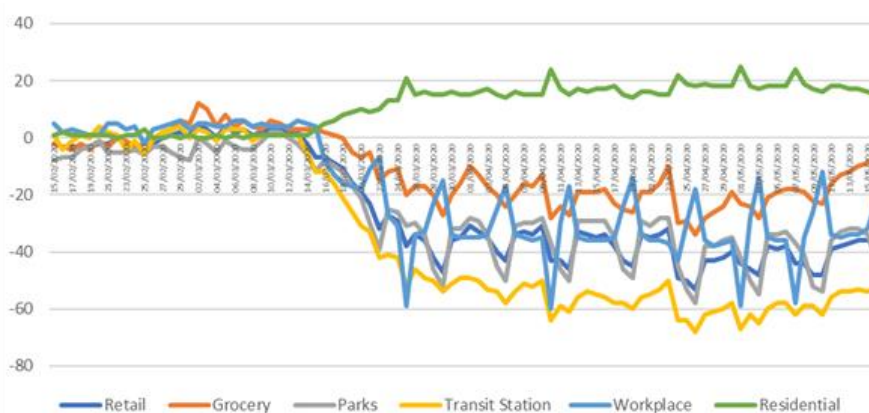
Source: COVID-19 Google Mobility Report Feb 15 – May 16 2020

It is interesting to see how the mobility of the people effect economic activity. In order to do so, we make regression model as we write before. The first equation showed how mobility from baseline effect the economic activity that represent by 'jual' keyword. Table 1 showed that mobility to transit station, workplace, and residential have significant effect to economic activity. a positive sign on the regression coefficient of a variable that has a significant effect indicates that if the variable changes by one unit which means that mobility from the baseline is increasing then economic activity will show an increase. The R squared for this model is 0.54 that mean all independent variables explained 54% about the dependent variable. In this case, the economic

activity that measured by the popularity of 'jual' keyword. Simultaneously, all the independent variables influence the dependent variables. Anova from model 1 showed that the F test is significantly reject the null hypothesis. It is most often used when comparing statistical models that have been fitted to a data set, in order to identify the model that best fits the population.

Table 1
Model Result, Dependent Variable: Popularity of 'jual' Keyword

Independent Variables	Coefficients	Standard Error	t Stat	P-value
Intercept*	81,85814	1,296925	63,11709	0,00
retail	0,363501	0,35951	1,0111	0,31
grocery	0,01491	0,137637	0,10833	0,91
parks	-0,19461	0,215226	-0,90423	0,37
Transit*	0,522073	0,156825	3,329027	0,00
Workplace*	0,904037	0,155568	5,811213	0,00
Residential*	4,108752	0,652391	6,297993	0,00

Sources: Data Processed by Author

The result for the second equation is presented in Table 2. It is showed the effect of mobility from baseline to economic activity that represent by the popularity of 'beli' keyword on google search. The result showed that mobility to retail, parks, workplace, and residential have significant effect to economic activity. The interesting thing is the sign for the mobility variable from the baseline to the park is negative. As for the other variables that significantly influence the dependent variable is positive. The intercept in the model is the expected mean value of dependent variable when all independent variables are assumed zero. In this case, the expected mean value of the popularity of keyword 'beli' is 33.328 or we can interpret that the expected mean of popularity 'beli' keyword is 33.328 percent.

Table 2
Model Result, Dependent Variable: Beli

Independent Variables	Coefficients	Standard Error	t Stat	P-value
Intercept*	33,328	0,506719	65,77213	0,00
Retail*	0,335756	0,140464	2,39034	0,02
grocery	0,012179	0,053776	0,226484	0,82
Parks*	-0,22402	0,084091	-2,66399	0,01
transit	0,06998	0,061273	1,142101	0,26
Workplace*	0,185704	0,060782	3,055274	0,00
Residential*	1,028775	0,254894	4,036084	0,00

Sources: Data Processed by Author

The result from two equations showed that mobility to workplace and residential are significantly effect economic activity that measured by the popularity google search using 'jual' and 'beli' keyword. It is confirmed that mobility to workplace and residential have positive impact to economic activity. Positive signs of the workplace and residential coefficients indicate that the more mobile people to workplace and residential the greater the popularity of search 'jual' and 'beli' keywords on Google

search. It means during COVID-19 pandemic, the mobility to workplace and residential increase economic activity on internet. Assumption tests have been applied to both models. The test results can be seen in the following table.

Table 3
Model Assumption Test

Assumption	Test	Result
Linearity	Plot	Linear
Error term normally distributed	Jarque-Berra Test	Error term normally distributed
Homoscedasticity	Breusch-Pagan Test	Error term homoscedastic
Autocorrelation	Durbin Watson	No autocorrelation between error term
Multicollinearity	VIF	No multicollinearity

Sources: Data Processed by Author

The utility of open access data such as Google Trend and Google Mobility Data is a breakthrough for researchers. But in statistics, sampling is a methodology that reflects the representation of the population. The use of new data sources that do not pay attention to the sampling rules will produce a biased analysis. But for academics' needs, studies using open data sources can be a signal for research that can eliminate sampling bias.

Conclusion

The use of google trend data and COVID-19 mobility report can explained how mobility of the people from baseline effect economic activity. During pandemic time there is decreased mobility from baseline to parks, transit station, workplace, retail, grocery, but not to residential. Population mobility from baseline to residential increased during the pandemic. The proxy variables for economic activity using google trend data is by taken 'jual' and 'beli' keyword that showed that the keyword are complements. Products related to the keyword that often searched on internet mostly related to the need of communication, because during pandemic people need to stay at home and they need communication. There is a product search related to the keyword because of the price, namely gold. To capture the relationship between mobility and economic activity, multiple linear regression is applied. From two model, we can say there is relationship between mobility of people to economic activity. Model 1 showed that mobility to transit station, workplace, and residential have significant effect to economic activity. Model 2 showed that mobility to retail, parks, workplace, and residential have significant effect to economic activity. But the sign for the mobility variable from the baseline to the park is negative. It means the increase mobility to parks will slow the economic activity. From both models showed that mobility to workplace and residential are significantly affecting economic activity during pandemic time. It means the increase in mobility to workplace and residential will also increase economic activity.

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