Pandemic Impacts on Gig Economy by Occupations – Base on Online Labour Index

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Abstract. Gig economy has attracted people's attention and aroused a widely discussion in recent years. Online gig economy market plays an important role in gig economy due to its unique characteristics, which provides more conveniences and availabilities to workers. In 2020, COVID-19 influenced the whole world in many aspects, where not only the people's health is in danger, but also the world economy is retailed. On this occasion, we investigate the relationship between gig online economy and COVID-19 by Online Labour Index (OLI) and VAR model. OLI tracks the number of online projects and works in different countries and various occupations. On this basis, the study chooses two occupations, Professional services and Software development and technology, to analyse precisely and specifically. The original hypothesis is that COVID-19 is supposed to have a positive effect on online gig economy since it provides a contactless working environment. However, the study shows that COVID-19 do not have an obvious impact on these two occupations, and people are supposed to find other influence factors out of this result to poromote markets' further development from various aspects.

Keywords: Gig economy; COVID-19; VAR model.

1. Introduction

Contemporarily, the world has been strongly affected by a global pandemic known as coronavirus disease 2019 (COVID-19). It is a contagious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). As a consequence, it can spread between people that are in close contact through small droplets and aerosols containing the virus, which is unavoidable if a person that carrying the virus sneezes or coughs. After the exposure to the virus, about 80% of the patients will develop noticeable symptoms (e.g., fever, coughing, loss of smell and taste), while suffer from hypoxia, respiratory failure and multiorgan dysfunction in some severe cases. After its first outbreak in China, it has been found in other parts of the world. As for the United States, according to WHO, the World Health Organization, there has been more than 30 million accumulated cases and 550,000 deaths due to COVID-19 since March 2021. In 2020, Jie-Ming Qu, Bin Cao, and Rong-Chang Chen (three senior physicians specializing in respiratory/pulmonary diseases and critical care medicine) wrote their insights about the prevention and treatment to the disease, which is considered as one of the most important first-hand information and guideline [1]. Following the guidelines, economists Ozili and Arun (2020) found that coronavirus stifled economic activities in two main mechanisms [2]. On the one hand, the fast spreading of the virus enlarges the social distances, which discourages any social and economic activities required close contact with others, i.e., leads to the collapse of markets, businesses and events. During the pandemic, over 100,000 businesses in the United States shut down permanently, while a large amount of businesses were closed temporarily in September, 2020. Loss of businesses also increased the unemployment ratio, which reached its highest peak of 14.7% in April 2020 [3]. On the other hand, the exponential rate of spreading of such virus brings uncertainty to the customers, employers and investors of the market future [2].

Although the world market has been brought to a trough, the gig economy has shown to be thriving. It refers to a free market in the economy that consists independent contractors who performs

temporarily and flexible jobs through online platforms. Since social distance becomes an essential criterion during COVID-19 to evaluate the safety of work place, working online while staying home has replaced many traditional jobs. According to a Stanford economist, Nickolas Bloom, who stated that from 1980 to 2010, the home working population has tripled in 30 years from 0.75% to 2.4% [4]. Apart from this, COVID-19 has pushed the trend going much forward. Specifically, only about 20% of the working force works online before the outbreak. However, the number reaches about 42% compare to 26% of the workers not in 2020.

2. Literature review

Base on former discussion, the great influence of COVID-19 existed on the society has been clearly shown. People are asked to follow strict controls of movement and social distancing rules in order to limit the transmission of coronavirus. Douglas et al. (2020) demonstrated that these limitations will cause profound consequences, including steep reductions in business and panic buying in shops [5].

Gig economy, as a part of whole economy, has also been affected by these new measures with its unique characteristics. The gig economy is basically defined as individuals offer their services to other individuals or firms within available part-times. According to statistics of gig economy, one finds that the data are surprising. For example, "36% of U.S. workers participate in the gig economy through either their primary or secondary jobs" [6], and "1 in 6 workers in traditional jobs would like to become a primary independent earner" [7].

In 2019, Kost et al. claims that there is a distinct difference between work that performed in online and offline [8]. Specifically, one is finished via online platforms without contacting with people, the other one need to be performed with direct contact with customers. Due to COVID-19, contactless online working mode is more completed and welcomed since people are supposed to stay at home. Chawla (2020) found that Zoom, an innovative video conferencing platform, has 200 million users in March 2020 compared with 10 million users in December 2019 [9]. The result indicates the great market capacity of online working, including various occupations of online gig economy as well. Besides, Blanchard in 2021 analyzed that employees may continue to work remotely for a substantial amount even after pandemic is ended [10]. Connecting online work with developing gig economy market, it forms a completely innovative and potential topic to be analyzed and studied.

Muhammad et al. (2020) analyzed the impact of COVID-19 on the whole gig economy market based on Online Labor Index (OLI) a and daily record of new cases and deaths of patients [11]. The study mainly utilizes GARCH and VAR model to find and interpret the relationship, which shows that the number of online jobs has increased after the spread of pandemic. Similarly, Stephany et al. investigates the impact of COVID-19 existed on all online freelancers in 2020 [12]. However, they notice that online job positions are increasing scarce as more and more people are seeking freelance work. In another study by Sung (2020) also inspects the impact of COVID-19 on the gig economy in both Short and long term focusing on global data [13]. With analyzing different variables about gender, locations, ages, and occupations, the research believes that tracking data becomes much more difficult in pandemic and the nature of gig work also affects the result. The data and resources are not up-to-date and one of the tables still remains in 2016, which leads to less convincing and lack of renewal conclusion for the result.

Other studies analyzing specific information and data instead of model also have their perspectives. Zorzoli studies the relationship between COVID-19 and Brazil and Latin America's gig economy [14]. The research is built on the premise that "lockdown generation" do not have protective equipment in their unemployed period. Zorzoli only studies the condition of offline gig market, which could be concluded as not guaranteed temporary work. Therefore, he believes people will become trapped in gig economy. In 2020, Spurk et al. concludes that workers' experiences during the pandemic will highlight the risks and opportunities of flexible employment relationships [15]. Moreover, people in freelance working mode will be supported by new policies and rules [15].

Polkowska (2020) studies the impact of the COVID-19 pandemic on the gig economy sector by applying the research in a particular occupation, bicycle couriers in Poland [16]. After Polkowska analyzed over 1300 posts on forums, he draws a conclusion that couriers generally are unable to feel the negative impact of COVID-19 on their occupational situation.

With concluding and analyzing the above discussions, the drawbacks (e.g., lacking valid resources, incorrect variables, improper modeling, etc.) are shown, which need to be addressed. Shifting the topic to the research question, this study chooses to study the impact of COVID-19 on America online gig market. We mainly focus on two specific and representative occupations, which are software development and technology, and professional services to make the conclusion be more precise. According to Andrew (2016), the number of applications to join the network of independent consultants handled by Eden McCallum has doubled in the past five years to 1,058 [17]. Beisdes, more and more business advisers are seeking the flexibility and creativity of working for themselves independent of the big brands [17]. In 2019, Jeff concludes that computer and information technology jobs are the driving forces of gig work [18]. Over 40% of company state that they are having trouble filling all the in-demand technology jobs and trying to hire high-skilled employees to finish the task as independent contractors. Online freelance workers, become favor options for both individual employers and large corporations and the trend of online gig economy particiapes in the mainstream in recent years.

Under the situation of COVID-19, the study believes that contactless online gig economy is still potential with lots of markets and demands, especially in the high-tech and professional services industries that lack of professional staffs. With analyzing the existing influence of COVID-19 had on gig economy, one is able to find more useful and credible methods and solutions on the way of developing gig market. Through using differnet models and controlling various factors, the research aim to discover possible relationship between the pandemic and the market.

After Sims put forward VAR model since 1980, many scholars have applied the model into analyzing time-series variables [19]. Stock and Watson (2001) assess the validation of VARs in macro-econometric tasks and find that VarS could capture co-movements that cannot be detected in univariate or bivariate models [20]. Aiming at figuring out the effects of exchange rates and import prices on domestic inflation, McCarthy (2007) uses a VAR model that incorporated a distribution, which found the effect was limited [21].

In 2018, Otto and Vili produce Online Labour Index, which is a milestone measured the supply and demand of labour on online platform and a plenty of scholars applied the index into researches since then [22]. In order to find out the trends of online labour demand in times of covid-19, Stephany et al (2020) choose Online Labour Index to analyze [12]. Besides that, they conclude the changes of online labour demand from United States, Germany and South Korea and compare the online labour demand of different occupations in America from February to May. Combining Garch model with VAR model, Muhammad et al (2020) find the pandemic has more effects on supply of jobs than demand of jobs by Online Labour Index as well [11].

3. Methodology

3.1 Research design

We suppose that covid-19 has a positive effect on gig economy and take the occupations of professional services and software development and technology for instance. In order to find whether our hypothesis is correct or not, the different regression models are adopted to time series. Besides, a VAR model to find the relationship between the pandemic and covid-19. If the hypothesis can be confirmed by using E-Views to analyze the data, the study can conclude that pandemic actually has a positive effect on professional service and software development and technology in gig economy. Besides, this paper can also find the relationship among three variables from the outcome above by VAR Model. Therefore, the study can explain the main reason that causes growth in different occupations and contributes to the sustainable development of gig economy during the duration of

the pandemic. Nevertheless, it should be pointed out that only situation of United States are investigated, which means it is not attached to global situation. Aiming at two certain occupations in gig economy, it will be a correlational research with quantitative analysis.

3.2 Methods and sources

3.2.1 Data

We adopt Online Labour index (OLI), which is the first economic indicator that provides an online gig economy equivalent of conventional labor market statistics presented by Otto and Vili in 2018 in order to measure the utilization of online labor [22]. The index is based on all the projects and tasks from 40 English-language online labor platforms and contains 6 types of occupations (Professional services, Clerical and data entry, Creative and multimedia, Sales and marketing support, Software development and technology, Writing and translation) from April 1st ,2020 to April 1st, 2021). In addition, new cases of covid-19 in U.S has been obtained from Johns Hopkins Coronavirus Resource Center from April 1st ,2020 to April 1st, 2021.

3.2.2 Models

For time-series data, VAR (Vactor Autoregression Model) is adopted to investigate the the pandemic impact on OLI.

3.2.2.1 Model design

The model is constructed as follow:

$$ln\,\boldsymbol{Y}_{1t} = C_1 + \beta_1 X_t + \nu_{1t} \tag{1}$$

$$ln\,\boldsymbol{Y}_{2t} = C_2 + \beta_2 X_t + \nu_{2t} \tag{2}$$

where Y_{1t} is OLI of occupation of professional services; Y_{2t} is OLI of occupation of software development and technology and X_t is Cumulative cases of covid-19 in the U.S. To sum up, $Y_{1t,}$ $Y_{2t,}$ X_t are all time-series data.

3.2.2.2 VAR Fundamental expression

In order to analyze the interaction among different time-series economic system and indicators, Sims (1980) built Vector Autoregression Model to indicate all kinds of impacts on economic variables.

$$ln\,\boldsymbol{Y}_t = \boldsymbol{\mu} + \boldsymbol{A}_1 Y_{t-1} + \cdots + \boldsymbol{A}_p Y_{t-p} + \boldsymbol{\varepsilon_t}, \quad t = 1,2,\ldots,T \tag{3}$$

$$\boldsymbol{Y_{t-i}} = \begin{pmatrix} Y_{1_{t-i}} \\ Y_{2_{t-i}} \\ \vdots \\ Y_{k_{t-i}} \end{pmatrix}, i = 1,2,\ldots,p \tag{4}$$

$$\boldsymbol{A_j} = \begin{bmatrix} \alpha_{11.j} & \alpha_{12.j} & \ldots & \alpha_{1k.j} \\ \alpha_{21.j} & \alpha_{22.j} & \ldots & \alpha_{2k.j} \\ \vdots & \vdots & \ldots & \vdots \\ \alpha_{k1.j} & \alpha_{k2.j} & \ldots & \alpha_{kk.j} \end{bmatrix} \tag{5}$$

$$\boldsymbol{\mu} = (u_1, \ldots \mu_k)', \boldsymbol{\varepsilon}_t = (\varepsilon_{1t}, \varepsilon_{2t}, \ldots \varepsilon_{kt})' \tag{6}$$

4. Results and discussion

4.1 Results

For the Vactor Autoregression Model, we use lots of measures to analyze, e.g., Unit Root Test, Johansen Test Granger test of causality, Granger test of causality, Impulse response analysis, Variance Partitioning Analysis etc.

4.1.1 Stationary test

In order to judge whether the series are stationary or not and ensure the white noise of random jamming, we adopt Augmented Dickey-Fuller (ADF) test to analyze. The following results show that all the variables are all integration of order one. Therefore, we adopt the forms of first difference to ensure the series is stationary.

Table 1. Unit Root Test Based on ADF

Variable	Prob.*	Outcome
LNX	0.0866	Nonstationary
LNY1	0.2757	Nonstationary
LNY2	0.5331	Nonstationary
DLNX	0.0000	Stationary*
DLNY1	0.0000	Stationary*
DLNY2	0.0000	Stationary*

* Stationary after Difference first difference.

4.1.2 Cointegration test

Because of the integration of order one and the 3-variebles VAR model, we adopt Unrestricted Cointegration Rank Test (Trace) in Johansen Test instead of Engle-Granger Test for examination. Trace test indicates 1 cointegrating eqn(s) at the 0.05 level.

Table 2. Johansen Test for LNY1, LNY2, LNX

No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.0639	30.106	29.797	0.0003
At most 1	0.0171	7.4378	15.494	0.0276
At most 2	0.0043	1.5026	3.8414	0.1159

4.1.3 Lag order test

In order to find out the lag order, we calculate sequential modified LR test statistic (each test at 5% level), Final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC) and Hannan-Quinn information criterion (HQ) through Lag Order Selection Criteria shown in Table 4.

4.1.4 Granger test of causality

Table 3. VAR Granger Causality Tests

Dependent variable: DX			
Excluded	Chi-sq	df	Prob.
DY1	4.622868	8	0.7970
DY2	5.330015	8	0.7218
All	11.74080	16	0.7616

Dependent variable: DY1			
Excluded	Chi-sq	df	Prob.
DX	2.999610	8	0.9344

DY2	17.51243	8	0.0252
All	19.82899	16	0.2280

Dependent variable: DY2

Excluded	Chi-sq	df	Prob.
DX	2.570247	8	0.9584
DY1	9.091692	8	0.3346
All	11.99185	16	0.7445

The consequences indicate that only DY2 has a significant influence on DY1 while DX does not have a significant influence on DY2. In this case, we fail at building the model between explanatory variable and predicted variable

Therefore, we can conclude that the lag order is 8 from the table.

Table 4. VAR Lag Order Selection under Different Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	139.5226	NA	9.05e-05	-0.796050	-0.762484	-0.782680
1	2570.393	4805.045	6.67e-11	-14.91775	-14.78348	-14.86426
2	2658.150	171.9312	4.21e-11	-15.37697	-15.14200	-15.28337
3	2689.249	60.38392	3.70e-11	-15.50582	-15.17016	-15.37212
4	2708.728	37.48174	3.48e-11	-15.56693	-15.13057	-15.39311
5	2777.795	131.6903	2.45e-11	-15.91717	-15.38011	-15.70324
6	2811.171	63.05463	2.13e-11*	-16.05930*	-15.42155*	-15.80527*
7	2817.935	12.66105	2.16e-11	-16.04627	-15.30781	-15.75212
8	2828.717	19.99174*	2.14e-11	-16.05666	-15.21750	-15.72240

*Best lag order under different criteria

4.1.5 Model stationary test

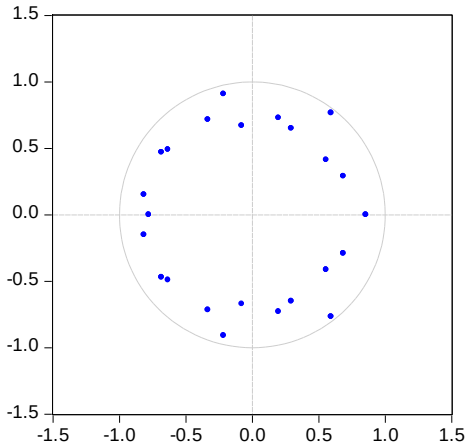

Fig. 1. Inverse Roots of **AR** Characteristic Polynomial

As shown in Fig. 1, the Model is stationary since all unit roots are included in the unit circle.

4.1.6 Impulse response analysis

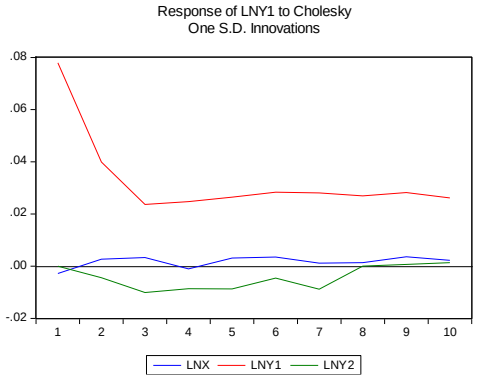

Fig. 2. Impulse Response of Y1 to Y1, Y2, X

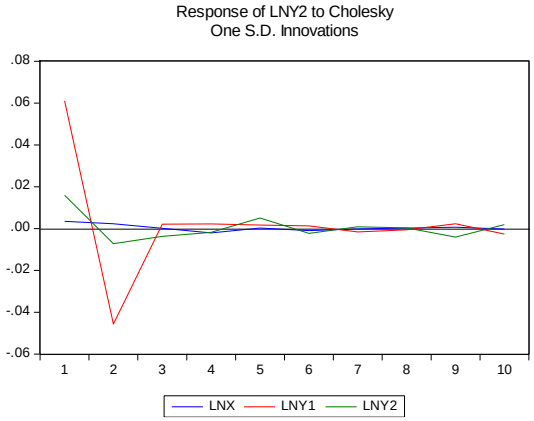

Fig. 3. Impulse Response of Y2 to Y1, Y2, X

In order to ensure the economic meaning of Impulse, origin data is adopted to analyze. In the Impulse Response of Y1 to Y1, Y2, X (figure 3) and Impulse Response of Y2 to Y1, Y2, X (figure 4), we can find that the effects from DLNX, DLNY1, DLNY2 are rather small, which means that pandemic makes a slight influence on professional services and software development and technology. Besides, we still find the pandemic has a positive impact on them though the effects are fluctuant and little. However, software development and technology can have an adverse impact on professional services. In addition, there is a time-lag for the effects of almost 4 period.

4.1.7 Variance Partitioning Analysis

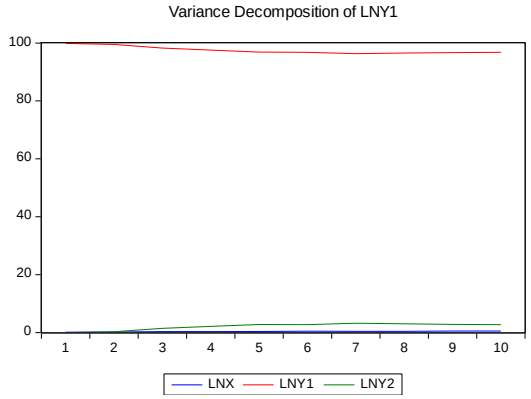

Fig. 4. Variance Decomposition of LYN1

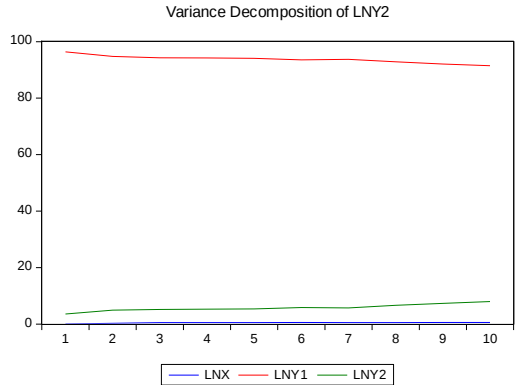

Fig. 5. Variance Decomposition of LYN2

In the figure 4, Variance Decomposition of LYN1, nearly 100% changes of LNY1 can be explained by LNY1 and the other influences are less than 10% while nearly 95% changes of LNY2 can be explained by LNY1 through Variance Decomposition of LYN1 (figure 5). Thus, the influence from another occupation has higher contribution than itself and covid-19.

To sum up, the effect of Covid-19 on gig economy is generally positive but a modest one instead of a considerable one. The result is off the expectation from the past literature.

4.2 Discussion

Based on the effectiveness and reliability of the models used in this study, one possible reason for this result is the imperfect design of the research. In order to further investigate the problem, we looked at several aspects of the research design.

Generally, gig economy is a labor market that covers hundreds of distinct jobs. The OLI divided into six main categories, from which we picked two out of. Professional services, which include occupations that require special training in arts and sciences or some even require holding certain degrees and licenses. Some common examples of these areas are doctors, lawyers, and accountants. These types of jobs often require high level of trust and communications between the service providers and clients. In this case, COVID-19 has little influence on it, as the pandemic does not raise the trust between individuals. All in all, the proportion of professional services in the total gig market is only 2%. The other category that was picked out is the software development and technology. It includes the process of writing and maintaining the source codes, activities result in software products and the overall process of invention, innovation and diffusion of technology, which has a proportion of about 37% (Kässi and Lehdonvirta 2018). However, possessing a larger percentage in the gig market does not mean it will be affected by large as well. In fact, it is already the biggest portion in the market, the space of its grow has also limited. Additionally, one notices that both categories require the service provider having a certain degree of higher education. Nevertheless, under the pandemic circumstance, the education system is highly affected, which adds another uncertainty to this research.

Furthermore, another finding, which reveals the effect of the two categories on each other is much greater than the effect of COVID-19 on the two categories, leaves another unsolved question to this research. From the result, about 80% of the fluctuant in professional services during Covid-19 time is caused by the change of software development and technology. Such outcome may be brought about by the incompletion in research design, e.g., the use of existing models, the data obtained from sources and the chosen time frames.

5. Conclusion

In summary, the effect of COVID-19 on gig economy is generally positive but not so significant, particularly on the two categories selected. Although the corona virus has brought huge damage to the world economy, the positive effect has shown the thriving vitality of gig economy even under the

situation. For policy makers and business owners, this beneficial effect is most likely to provide them with some profound insights, e.g., coping with similar situations and limiting the damage from future disasters. Moreover, with regard to the interest of individual workers, the result may also provide them information about their career planning under post-pandemic condition. Whereas, for the result of the study, it is different from the expectation that we inferred from other literature references. Specifically, the COVID-19 has little effect on the two sectors of the gig economy, the effect of each classification on the other one is stronger. The results of the study suggest that there are several possible factors contributed to the difference. In this case, since the study only chose two classifications out of six in total, the variations between classifications can be used to explain the difference. Besides, another factor should also be discussed, which is the chosen region of the study. We selected the United States as the region to collect data, but choosing one country instead of studying the world as a whole can bring divergence in the results. Moreover, U.S. is one of the most developed countries and the percentage of people using online platforms is higher than the average rate of other countries. In order to be more accurate, the future studies should focus on improving the models and complementing the research design with broader categories and regions.

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