THE IMPACT OF COVID-19 ON THE PRODUCTIVITY OF LARGE COMPANIES IN TAIWAN

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Abstract

The outbreak of COVID-19 at the end of 2019 spread over the world extensively and quickly. The daily lives are affected by lockdowns, work-from-home, and travel bans. The economic growth is stagnated. To investigate the impact of this pandemic on the productivity of the industries in Taiwan, samples of the top 1000 manufacturing companies and the top 500 service companies before the pandemic, in the period of 2016-2019, and during the pandemic, in the year of 2020, are studied. The results show that the overall productivity of all companies in 2020 has not decreased. By classifying the sampled companies into different industries, there are four industries, including textile, automobile, tourism, and electronic products distribution, showing a decrease in productivity. There are also five industries, including electronic parts/components, optoelectronic, electrical and cable, rubber, and oil, gas and electricity, whose productivities are unexpectedly increased. The reasons that the productivities of these industries are affected by COVID-19 are discussed. They shed some light on how the government can help these industries to overcome the crisis and to recover the country's economy.

Keywords: *COVID-19, manufacturing industries, service industries, productivity*

1. INTRODUCTION

Since the outbreak of the novel coronavirus disease (COVID-19) in Wuhan, China in December 2019, more than two hundred countries and territories have been infected. At the beginning of 2022, there were approximately 380 million cases of this disease and 5.7 million deaths in the world (Johns Hopkins University, JHU CSSE website). To avoid the spread of this disease, cities are locked down, restaurants are shut down, employees are requested to work from home, and students are studying on line. The daily lives of people are badly affected.

Many studies show that work-from-home reduces employee productivity (Morikawa, 2021a; Farooq and Sultana, 2021; Baakeel, 2021). Lockdowns also affect several industries. Tourism and the related industries are prominent examples (de Vries et al., 2021; Hao et al., 2021; Kim et al., 2021). The costs caused by COVID-19 lead to productivity lost (López-Valcárcel and Vallejo-Torres, 2021; Salas-Fumás, 2021). Studies also indicate that agriculture is an industry affected by lockdowns due to delayed harvesting (Mohanty et al., 2020; Golban and Golban, 2021). Other industries being reported include construction (Alsharef et al., 2021; Nguyen et al., 2021), automobile (Nayak et al., 2020), and textile (Cho and Saki, 2021; Nguyen and Vu, 2021). Coyle et al. (2021) found that measured health output in the UK declined sharply during the COVID-19 pandemic, despite the large increase in some National Health Service (NHS) activities such as critical care, test, trace, and vaccination programs. The economies of the world are severely affected by the COVID-19 pandemic due to immobility of labor, reduction in productivity, disruption of the supply chain, decline in exports, etc. (Usman et al., 2020). Many countries use relief policies to revitalize the economy (Morikawa, 2021b).

Compared to other countries, the infection of COVID-19 in Taiwan is mild. With a population of twenty-three million, there were approximately eighteen thousand cases in the beginning of 2022, which was ranked 178th in the world (JHU CSSE website). If the population is taken into account, the ranking would be even lower. This result is mainly attributed to the containment and zero-case-clearing policies of the Central Epidemic Command Center for COVID-19 of Taiwan. All persons entering Taiwan are, in general, required to be quarantined in quarantine hotels for fourteen days and

isolated at home subsequently for seven days. Those with a positive PCR test upon arrival are sent to Collective Quarantine Centers for collective quarantine. Social distancing in closed spaces such as restaurants, trains, and offices are kept by assigning seats properly. Facial mask is mandatory in public places. Whenever a case appears, the footprint of the infectee is traced to find all persons who have contacts with the infectee. PCR tests are made to these persons to make sure there are no potential infectors in communities. These measures, on the one hand, effectively control the number of COVID-19 cases. On the other hand, the businesses of many stores and companies are affected.

To investigate what industries in Taiwan have been significantly affected by COVID-19, we compare the productivities of companies of different industries before and after the outbreak of the pandemic. The companies selected for the study are top 1000 manufacturing and top 500 service companies. The four-year period of 2016-2019 and the year of 2020 are chosen to represent the periods before and after the outbreak of the pandemic, respectively. The sampled top 1000 manufacturing and top 500 service companies are of different industries. The productivity changes of the companies of an industry between the two periods show how severe is this industry being affected by COVID-19. Certainly, the productivity of a company is affected by many factors. Since the appearance of COVID-19 is the most prominent change of the operating conditions of companies in 2020, we believe the change is mainly due to COVID-19. Even if it is not entirely, the results of this study still shed some light on how productivities of the industries in Taiwan are affected by COVID-19.

In the following sections, we first introduce the measurement of productivity. We then discuss the productivity change of large companies in Taiwan. The discussion is separated into two levels, the aggregate industry level and the individual industry level. Finally, some conclusions are drawn based on the discussions in the preceding sections.

2. PRODUCTIVITY MEASUREMENT

Productivity is a measure of efficiency, with which a production activity converts inputs into outputs. It is generally defined as the ratio of the aggregate output to the aggregate input (Bitran and Chang, 1984). Since different inputs and outputs have different units, which make the aggregation difficult, the monetary values of the inputs and outputs are usually used in the aggregation. In this case, a ratio of greater than one implies that the corresponding production activity is making a profit.

A firm usually produces several products or services. To make the calculation simple, productivity is calculated as the ratio of added value to the sum of labor inputs and capital inputs (Craig and Harris, 1973; Kurosawa, 1991). Different ways for calculating added value and the two types of inputs have been reported in the literature (Taylor and Davis, 1977; Coelli et al., 1998). Combining the ideas of different studies and taking the items shown in the company financial statements into consideration, the productivity is calculated as the ratio of sales plus inventory to operating costs plus operating expenses that occur in a period of time (usually one year) in this study:

$$\text{Productivity} = \frac{\text{Sales} + \text{Inventory}}{\text{Operating Costs} + \text{Operating Expenses}}$$

The difference between operating costs and operating expenses is that the former refers to the cost occurred in the process of production or providing services, while the latter refers to the expenses indirectly related to producing the products, such as marketing, management, and R&D. Inventory includes the finished products ready for sale, work in process, and the material consumed in the process of production. The Table of Business Account Items published by Department of Commerce, Ministry of Economic Affairs of Taiwan (DOC, MOEA website) has detailed description of these terms. Some studies (Kao et al., 2013) also include non-operating revenue in the output part and non-operating expenses in the input part to calculate the overall productivity of a company. In this study, the non-operating revenue and non-operating expenses are excluded to reflect the productivity of the main business of a company.

The productivity of a company in a period is usually compared to that of other similar companies in the same period (a cross-sectional comparison) to examine the relative performance of this company in a group of companies. Sometimes it is compared to that of the same company in a different period (a time-series comparison) to understand how the performance of this company is changed over time. This study focuses on the time series comparison, although the results also show how a company has performed as compared to other companies.

The target of this study is the top 1000 manufacturing companies (CommonWealth, 2020a) and top 500 service companies (CommonWealth, 2020b) ranked by the CommonWealth Magazine published in Taiwan. One reason for choosing these companies is because most of them are listed companies (TWSE, Taiwan Stock Exchange), with their financial statements revealed in the Market Observation Post System, TWSE website (MOPS, TWSE website). In the five years of 2016 to 2020, the top 1000 manufacturing companies and the top 500 service companies are not the same every year. In order to compare productivity changes, the companies to be considered must be the top 1000 or top 500 ranked companies for all five years. In addition, these companies must be listed companies so their financial statements are readily available for calculating productivities. Excluding the companies whose data are incomplete, there are 755 manufacturing companies and 319 service companies, with a total of 1,074, that satisfy these conditions. The productivities of these companies in years 2016 to 2020 are calculated for analyses.

In the following two sections, we discuss productivity changes from the aggregate industry level and individual industry level separately. At the aggregate industry level, the discussion is focused on the whole industry represented by all 1,074 companies, the manufacturing industry represented by the 755 manufacturing companies, and the service industry represented by the 319 service companies. At the individual industry level, we discuss productivity changes of different industry sectors within the manufacturing and service industries.

3. AGGREGATE-INDUSTRY LEVEL ANALYSES

The first row of Table 1 shows the average productivities of the 1,074 companies in years 2016-2020. They are also depicted in Figure 1 shown by solid circles connected by solid lines. Here, the average is a weighted average, which is the average of the productivities of the companies weighted by their sizes, in terms of the input value. Larger companies in this case have larger effect on the average productivity. The purpose for using a weighted average, instead of the simple arithmetic average, is to avoid the extreme values of small companies from distorting the overall productivity of all companies.

From 2019 to 2020 the productivity has increased, with values of 1.2096 versus 1.2383. This result contradicts to our expectation. To find the reason, we note that productivity is the ratio of the output value to the input value. In 2020, many companies noticed that the demand for their products and services was declining. The employees and workers did not have much work to do. To avoid from losing profit, employees were furloughed and the wages of workers were cut. The owners tried all their best to reduce the cost to compensate the decrease in revenue. It might be that the reduction in input values outweighed the decrease in output values. By comparing the total output values of the 1,074 companies in 2019 and 2020, we find they are indeed decreased, from 36.7551 trillion Taiwan dollars (1 USD $\cong$ 28 TD) to 36.6458 trillion Taiwan dollars (MOPS, TWSE website). Each company has decreased, on average, an amount of 101.77 million Taiwan dollars. At the same time, the input value of each company is reduced, on average, by 736.73 million Taiwan dollars. The larger extent of reduction in input values caused the increase in productivity.

The productivities in the four years before the pandemic, as shown in Figure 1, fluctuate up and down. The productivity of the year 2019 alone may not be representative for the productivity before the pandemic. In order to eliminate the fluctuation and to obtain a value that is more representative for the productivity before the pandemic, the productivity over the four-year period of 2016-2019 is used to represent the productivity before the pandemic in this study. The four-year-period productivity of 2016-2019 is compared with the productivity of 2020 to discuss the impact of COVID-19 on the productivity of Taiwanese companies.

The average productivity of the 1,074 companies before the pandemic is 1.4296, and that of the year 2020 is 1.4447. Here, the average is the simple average because the statistic used in the *t*-test is simple averages. Using simple averages gives a general idea of the result of the *t*-test. The simple average in this case is higher than the weighted average shown in Table 1. The reason is that several small companies have very high productivities. The average productivity of the year 2020 is greater than that of the period of 2016-2019. To examine whether the increase in productivity is significantly greater than zero, a one-sided paired *t*-test is conducted, and a *t*-value of 0.71 is obtained. The corresponding *p*-value is 0.24, which indicates that the increase in productivity is not greater than zero in a statistical sense.

Table 1. Average productivities of all, manufacturing, and service companies.

Company type	(sample)	2016	2017	2018	2019	2020
All	(1,074)	1.2216	1.3147	1.2276	1.2096	1.2383
Manufacturing	(755)	1.2073	1.3183	1.2159	1.1924	1.2226
Service	(319)	1.2854	1.2993	1.2822	1.2900	1.3084

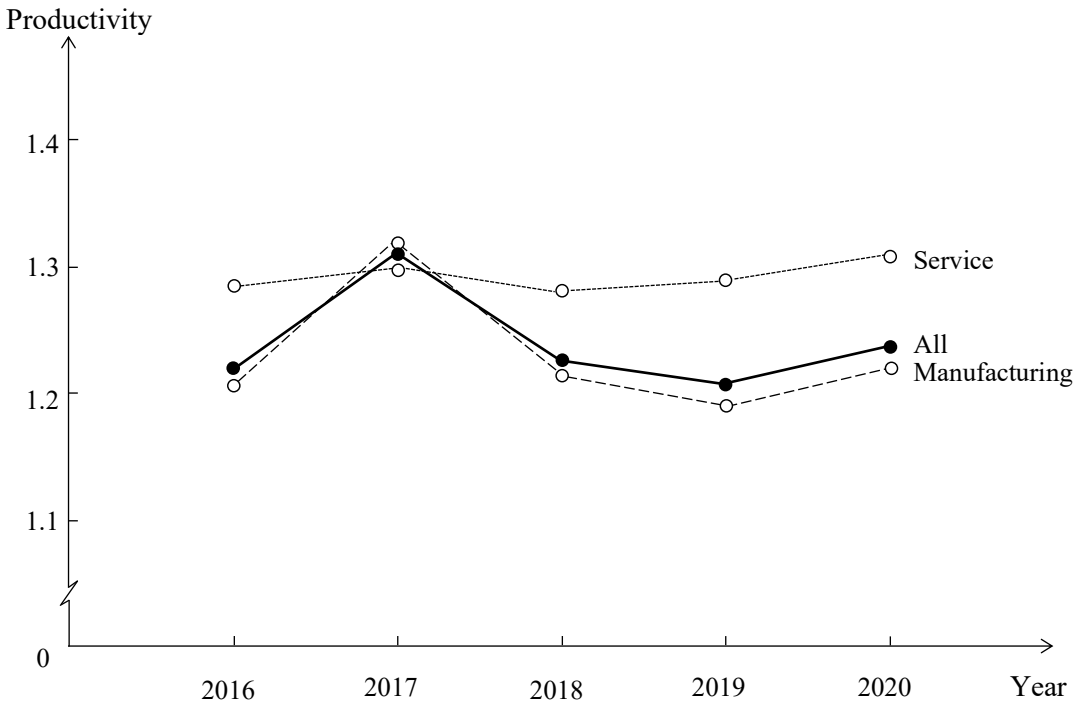


Figure 1. Average productivities of all companies in five years, 2016-2020.

Although the increase in productivity in 2020 is not significantly greater than zero, it still contradicts to our expectation that the productivity should have decreased. One conjecture is that only service companies are affected by the pandemic since they are directly related to daily life. The large number of manufacturing companies dilutes the behavior of service companies. The manufacturing and service companies are thus examined separately.

Of the 1,074 companies, 755 are manufacturing companies and 319 are service companies. The productivities of these two types of companies are calculated for the five years of 2016-2020. The second and third rows of Table 1 show the weighted averages of the manufacturing and service companies, respectively. They are also depicted in Figure 1 in hollow circles connected by dash and

dot lines. Over the five years, the average productivities of the service companies are quite stable. Those of the manufacturing companies are also stable, except a hump in 2017. Service companies generally have higher average productivities than manufacturing companies. To investigate whether the service companies are more affected by COVID-19, we follow the same procedure for investigating all 1,074 companies.

For manufacturing companies, the simple average productivities of the 2016-2019 and 2020 periods are 1.3057 and 1.3132, respectively. The average productivity is increased by 0.0075. For service companies, they are 1.7227 and 1.7558, and an increase of 0.0331 is observed. The productivity change for service companies is higher than that for manufacturing companies. A two-sided *t*-test for whether the productivity change in manufacturing companies is different from that in service companies shows that the productivity changes in these two types of companies are not significantly different, with a *t*-value of □0.36 and the corresponding *p*-value of 0.720. In other words, our conjecture that service companies suffer more severely from COVID-19 than manufacturing companies is not justified.

What we have observed that the productivities of both the manufacturing companies and the service companies have not declined is disappointing. A possibility for this phenomenon may be that while companies of some industry sectors are affected by the pandemic, companies of some other industry sectors are unexpectedly benefited from the pandemic. If the industry sectors benefited from the pandemic are more than those suffered from the pandemic, then the overall productivity of all companies may increase. In the next section, we examine which industries are benefited from the pandemic and which industries are suffered from the pandemic.

4. INDIVIDUAL-INDUSTRY LEVEL ANALYSES

Companies are broadly classified as manufacturing and service companies based on their business types. Taiwan Stock Exchange Inc. classifies the manufacturing companies further into twenty-four industry sectors (hereafter simply referred to as industries) and the service companies into sixteen industries (MOPS, TWSE website). The 1,074 sampled companies, with their financial statements shown in the website of MOPS TWSE, are classified into appropriate industries.

The names of the manufacturing industries and the corresponding numbers of sampled companies being classified into are: automobile (23), biotechnology and medical care (32), building material and construction (1), cement (5), chemical (30), communications and internet (33), computer and peripheral equipment (95), electric machinery (53), electrical and cable (15), electronic parts/components (126), electronic products distribution (3), food (23), glass, ceramics (3), information service (1), iron and steel (38), oil, gas and electricity (1), optoelectronic (59), other electronic (34), paper, pulp (3), plastics (21), rubber (9), semiconductor (69), textile (28), and others (50). Similarly, those of the service industries are: biotechnology and medical care (16), building material and construction (51), communications and internet (11), computer and peripheral equipment (3), culture and creative industries (9), e-commerce (3), electronic parts/components (7), electronic products distribution (30), financial and insurance (1), information service (33), oil, gas and electricity (15), other electronic (16), shipping and transportation (25), trading and consumers' goods (25), tourism (32), and others (42).

Some manufacturing industries and service industries share the same name; for example, computer and peripheral equipment. The difference is that manufacturing companies are manufacturing products of its type while service companies are selling products of its type or providing service to customers. We discuss the manufacturing and service industries separately in the following two subsections.

4.1. Manufacturing industries

Some industries are small, in terms of the number of companies. The extreme performance of one company may distort the general performance of all companies in these industries. To avoid the small sample effect, only the industries with more than five companies are analyzed. There are sixteen

manufacturing industries that satisfy this criterion, and they are listed in Table 2. The industry sector "others" is not included because it is not a specific industry.

For sample sizes of thirty or larger, the conventional one-sided paired *t*-test is applied to examine whether the productivity of 2020 is lower than that of the 2016-2019 period. For sample sizes smaller than thirty, the Wilcoxon matched-pairs signed-ranks nonparametric test is applied. Columns three and four of Table 2 show the average productivities of the period of 2016-2019 and the year 2020, respectively, and Column five is the difference of the latter minus the former. The last column shows the *p*-value of the statistical test of the corresponding industry. If the *p*-value is less than 0.05, then we conclude that the decline in productivity in 2020 is significantly greater than zero at the 5% significance level. If the *p*-value is greater than 0.95, then we conclude that the productivity has actually increased. The *p*-value is greater than 0.5 if the productivity change is positive. However, this is not necessarily true for the Wilcoxon nonparametric test; for example, the food and plastics industries, because nonparametric tests do not dependent on averages.

Table 2. The average productivity changes between 2016-2019 and 2020 for manufacturing industries.

Industries	(Sample)	2016-19	2020	Change	*p*-value
Electronic parts/components	126	337121	395560	0.0159	0.975*
Semiconductor	95	482122	540927	0.0161	0.847
Computer and peripheral equipment	69	227183	241062	0.0038	0.630
Optoelectronic	59	147559	230105	0.0226	0.953*
Electric machinery	53	932467	997844	0.0179	0.806
Iron and steel	38	532526	475913	-0.0155	0.210
Other electronic	34	432815	437563	0.0012	0.521
Communications and internet	33	178971	203443	0.0067	0.628
Biotechnology and medical care	32	851747	838965	-0.0035	0.446
Chemical	30	384237	403960	0.0054	0.637
Textile	28	393003	288179	-0.0288	0.005*
Automobile	23	739983	531795	-0.0570	0.016*
Food	23	201251	188467	-0.0035	0.542
Plastics	21	164726	142082	–0.0063	0.583
Electrical and cable	15	247272	392273	0.0397	0.975*
Rubber	9	639907	1095000	0.1246	0.951*

The *p*-values in Table 2 indicate that only two industries, textile and automobile, have their productivities significantly decreased in 2020. It is worthwhile to note that four industries, electronic parts/components, optoelectronic, electrical and cable, and rubber, in contrast, have their productivities increased. The changes in productivity for other industries are not significantly different from zero.

Of the two industries whose productivities have decreased, textile firms suffer sharp declines in demand for clothes in the global market during the pandemic. Many clothes stores were shut down, which caused cancellation of orders or postponed shipments of the orders. According to Industrial Development Bureau of Taiwan (Industrial Development Bureau website), the output of the textile industry in Taiwan dropped 19.9% in 2020. The study of Nguyen and Vu (2021) showed that the

business performance of the textile and garment enterprises in Vietnam was greatly affected by the COVID-19 pandemic. Cho and Saki (2021) also found that textile and apparel firms experienced sharp declines in firm performance following the COVID-19 outbreak. The productivity decrease of the textile industry in Taiwan is clearly due to COVID-19.

Regarding the automobile industry, the pandemic has severe impact on the automobile markets in the world. The reason is that people are staying at home whenever possible. There is almost no need for people to buy cars. As a matter of fact, the total number of cars sold in the whole world dropped down to 77.97 million in 2020, which is 13.8% lower than that of 2019 (Department of Statistics, MOEA website *a*). Nayak et al. (2020) reported that new sales of vehicles in China fell by 92% in February 2020 and the total vehicle sales in Europe were dropped by 7.4%. The productivity decrease of the automobile industry is obviously the effect of COVID-19.

One of the products that is unexpectedly benefited from the pandemic is electronic games. As people are staying at home during the pandemic, playing electronic games becomes the major activity for people to spend time. The demand for electronic games drives the demand for electronic parts/components. The output value of this industry reaches the historical high in single quarters in 2020, and the annual output value is increased by 8.79% (Department of Statistics, MOEA website *b*). The productivity of the electronic parts/components industry is thus increased in 2020.

Why the productivity of the optoelectronic industry is increased in 2020 is not clear. The output value of this industry in 2020 was actually decreased by a small amount of 0.0908 billion Taiwan dollars per company, from 22.8972 billion dollars in 2019 to 22.8064 billion Taiwan dollars in 2020. The input value, however, was decreased in a larger extent, from 20.5037 billion Taiwan dollars in 2019 to 19.5162 billion Taiwan dollars in 2020. The reduction is 0.9875 billion Taiwan dollars. The larger decrease in input value caused the increase in productivity. The productivity increase of this industry might be an artefact of the definition of productivity.

The situation of the electrical and cable industry is similar to the optoelectronic industry. Starting from 2019, the demand for electric wire and cable in the Chinese market is declining, which results in the shrinking of the demand in 2020 in the world by 5~6% (Forward-The Economist website). The output value of this industry in Taiwan decreased from 19.0636 billion Taiwan dollars per company in 2019 to 17.2866 billion Taiwan dollars in 2020. The input value was also decreased due to furlough and wage cut. However, since the decrease in the input value, from 15.6626 billion Taiwan dollars in 2019 to 13.5735 billion Taiwan dollars in 2020, is greater than that in the output value, the productivity is increased. The increase in productivity is also an artefact of the definition of productivity.

The rubber industry that has its productivity increased is unexpected because this industry is highly related to the automobile industry. As the productivity of the automobile industry is decreased, the productivity of the rubber industry should have been decreased accordingly. Examining the output and input values of this industry in 2019 and 2020, it is noted that the output value is actually decreased from 30.7744 billion Taiwan dollars per company in 2019 to 28.1046 billion Taiwan dollars in 2020. Since the input value was also decreased, and in a larger extent (from 23.9763 billion Taiwan dollars to 20.6125 billion Taiwan dollars), the productivity is increased. The increase in productivity of this industry is, again, an artefact effect.

4.2. Service industries

Of the sixteen service industries, excluding the industry sector “others”, twelve have a sample size greater than five. Similar to the case of manufacturing industries discussed in the preceding subsection, a one-sided paired *t*-test is applied to industries with a sample size greater than or equal to thirty and a Wilcoxon matched-pairs signed-ranks nonparametric test is applied to industries with sample sizes smaller than thirty. Table 3 shows the average productivities of the twelve industries in the period of 2016-19 and 2020. The differences between the average productivities of the year 2020 and the period of 2016-19 are shown in the second-to-last column of Table 3, and the last column shows the *p*-value of the corresponding test of each industry.

There are two industries, tourism and electrical products distribution, whose *p*-values are less than 0.05, indicating that their productivities were decreased significantly in 2020 at the 5% significance level. In contrast, there is also one industry, oil, gas and electricity, whose *p*-value is greater than 0.95, indicating that its productivity was actually increased in 2020. Similar to the case of manufacturing industries, a minus change in productivity leads to a *p*-value less than 0.5. However, this may not be true for samples of smaller than thirty, in which case a nonparametric test is used.

Tourism is probably the most severely affected industry by COVID-19. Travel bans, stay-at-home restrictions, and quarantine requirements have largely reduced the output value of this industry. According to a report of World Travel & Tourism Council (website), the travel bans in 2020 caused losses of 87 million jobs and 1.4 trillion US dollars in tourism in Asia. Data from the Taiwan Tourism Bureau, Ministry of Transportation and Communications (Taiwan Tourism Bureau, MOTC website) shows that 11,864,105 travelers entered Taiwan in 2019. The number dropped down to 1,377,861 in 2020. The number shrinks by 88.4%. The decrease in the productivity of the tourism industry coincides with our expectation.

Another industry whose productivity has significantly declined is electronic products distribution. This result is different from our expectation. During the pandemic, distance learning and work from home are common (Taiwan Stock Exchange website) which cause an increase in the demand for notebooks, servers, smart phones, etc. The productivity of this industry should have increased. By examining the input and output values, it is noted that the output value has increased, as expected, from 67.0797 billion Taiwan dollars in 2019 to 72.6689 billion Taiwan dollars in 2020. However, the cost of distribution during the pandemic is extraordinarily high, which brings the input value from 59.0630 billion Taiwan dollars in 2019 to 64.7507 billion Taiwan dollars in 2020. The increase in the output value does not outweigh the increase in the input value. The productivity of this industry is thus decreased.

Table 3. The average productivity changes between 2016-2019 and 2020 for service industries.

Industries	(Sample)	2016-19	2020	Change	*p*-value
Building material and construction	51	4.1817	830654	0.2357	0.701
Information service	33	1.1517	1.1701	0.0184	0.815
Tourism	32	6211	1.1331	-0.0586	0.016*
Electronic products distribution	30	1.1370	1.1226	-0.0144	0.007*
Shipping and transportation	25	1.1505	1.1554	0.0049	0.714
Trading and consumers' goods	25	181162	1.1877	-0.0519	0.373
Biotechnology and medical care	16	345522	144638	-0.0549	0.276
Other electronic	16	58076	55154	-0.0008	0.510
Oil, gas and electricity	15	1.1611	77068	0.0500	0.999*
Communications and internet	11	112496	86565	-0.0071	0.378
Culture and creative industries	9	71225	195042	0.0340	0.723
Electronic parts/components	7	878775	1520507	0.1757	0.466

Oil, gas and electricity is the only service industry whose productivity is significantly increased in 2020. During the pandemic, cities are locked down and people are staying at home. The demand for gas is largely reduced. The total output value of this industry in Taiwan dropped from 6.0151 billion Taiwan dollars in 2019 to 5.3664 billion Taiwan dollars in 2020. The output value is indeed decreased.

However, at the same time, Saudi Arabia increased the production of crude oil. Accompanied with the price war between Saudi Arabia and Russia, the price of gasoline dropped sharply. The price of 95 unleaded gasoline in April 2020 in Taiwan reached a historical low of 17.5 Taiwan dollars per liter (Bureau of Energy, MOEA website). This decreased the total input value of this industry in a larger extent, from 5.5010 billion Taiwan dollars in 2019 to 4.7779 billion Taiwan dollars in 2020. The productivity is thus increased in 2020, which is an artefact.

5. CONCLUSIONS

The outbreak of COVID-19 has not only harmed people's health, but also affected the economy. Protecting people's health and maintaining proper economic activities are two conflicting views. The policy of most countries is to sacrifice economy in exchange of the health of people. This paper investigates the impact of COVID-19 on the productivity of the industries in Taiwan in 2020. The industries considered are those covered by the top 1000 manufacturing and the top 500 service companies.

Since the COVID-19 pandemic is relatively mild in Taiwan, the productivities of large companies, in general, are not much affected. The results show that the average productivity has actually increased, although the increase is not significantly different from zero. However, the total output value of the sampled companies was decreased. The increase in productivity is probably due to a larger extent of decrease in the total input value due to furlough and wage cut. For individual industries, the results show that only two out of the twenty-four manufacturing industries and two out of the sixteen service industries had their productivities decreased in 2020. The two manufacturing industries are textile and automobile and the two service industries are tourism and electronic products distribution. The decreases in productivity for these industries are expected, except the electronic products distribution industry. As work-from-home and learning on-line were common, distribution of the related electronic products was in urgent need. However, since the cost of distribution was relatively higher during the pandemic than in normal time, the productivity was decreased.

There are also four manufacturing industries and one service industries whose productivities have increased. The four manufacturing industries are electronic parts/components, optoelectronic, electrical and cable, and rubber. The only service industry is oil, gas and electricity. Of these five industries whose productivities have increased, only the electronic parts/components industry is really benefited from the pandemic due to increased demand for electronic game devices. The increases in productivity for other industries are artefacts.

The investigation of this study is focused on large companies due to availability of data. Although smaller companies are not included, the results still provide a general picture of the economy in Taiwan after the outbreak of COVID-19. Since stores and small companies, especially those related to daily life, seem to be more affected by the pandemic, measuring the productivity change of small companies is a topic for future study. The aggregate results of large and small companies will then give a whole picture of the economy in Taiwan after COVID-19.

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