



The Impact of COVID-19 on the Urban Spatial Distribution of the Sales and Use of Online Education Courses: The Case of the Taipei Area

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Keywords

COVID-19
Online education
Digital development
Geographical location

Abstract.

The COVID-19 pandemic broke out in December 2019 and began to spread globally in 2020. The final analysis of 124, 564 valid observations pointed out that before and after the COVID-19, online education courses had an absolute increase in the total purchase amount or total purchase amount. Because of the control of COVID-19 in Taiwan, there is no significant difference between the validity and the time point of the purchase amount and the use of the course. The geographic location is defined by the digital development level of the administrative area, and the higher the digital development of the administrative area, the better the amount of courses purchased and the use of courses, compared with other types of courses, the life category has more purchase amount and course use time; the education level of course users has a considerable degree of positive influence on the purchase amount and course using.

1. Introduction

COVID-19 broke out in December 2019. In February 2020, COVID-19 caused city closures or closed management in more than 80 cities in China, resulting in difficulties in transportation, logistics, warehousing and retail, resulting in material shortage and worker shortage in production in the upstream, and inability to ship in the downstream. Economically, COVID-19 will reduce the global economic growth rate by about 4% in 2020, which is much higher than the low point of the global financial tsunami in 2009 OECD [19].

The impact of pandemic on the education system is mainly due to the substantial suspension or closure of schools and adult education systems at all levels. According to the statistics of the World Economic Forum 2020, 1.2 billion students at all levels of schools around the world have lost the opportunity of face-to-face education due to the impact of the pandemic. At the same time, with the remarkable rise of e-learning, the

education system's response to the impact of the pandemic has led to great changes in the modes of learning and education, especially the rise of digital platforms and distance teaching. (see Dhawan [8]) pointed out that online learning shows more opportunities to retain information and knowledge, but correspondingly, students spend less time in learning than the formal hours given by the formal education system, which means that more time is needed to observe the correlation between learning effect and learning mode.

However, online learning or online education did not begin in the pandemic era. (see Singh and Thurman [25]) study, based on a meta-analysis of a large number of literature reviews on different groups, pointed out that, in fact, with the rise of adult education, continuing education is not only a requirement for skill renewal in the labor market, but also an important indicator of active aging in the age of aged society. At the same time, in the face of the collapse of the formal education system and the rise of the theory that academic qualifications are useless, the interest and skills of self-learning, coupled with the requirements of new atypical or non-standard work, another group's learning motivation and the momentum driving the development of the industry all point to the focus of online courses of vocational training. The spread of novel coronavirus pandemic just makes online learning and online education present the momentum of accelerating development and the trend of upward enhancement (see Saxena [22]). In the trend of online learning, a variety of courses with different objectives and market segments have been launched constantly. However, online courses are not designed in the same way as traditional courses. If teachers are asked to teach traditional courses online at once, the quality may be compromised. As a result, more people in the formal education system are beginning to integrate existing online courses and learning modes (see Basilaia et al. [7]). It can be imagined that the market of online education and learning courses will have more opportunities to flourish because of the investment in formal education. Schools at all levels, which used to practice the education system in a fixed space within the city, reformed their learning mode in a way with more social network effect, and at the same time developed the existing adult education, technical and vocational education, and sustainable education. The spatial distribution of online learning has more different features and development opportunities than before by diverging the abstract cyberspace which is different from the concrete urban development model.

The researchers took Taiwan, which is relatively safe under the severe pandemic situation, as the research scope, and took the sale and use of an online course in Greater Taipei area as an example to explore the relevant connotation of the online course database before and after the COVID-19 pandemic, including information on course category, course sale, course use, as well as the spatial distribution of buyers and users, and discuss the learning modes and usage of online courses in Taiwan, as well as the specific landscape of their spatial geography distribution.

2. Literature Review

2.1. Impact of the COVID-19 pandemic

2.1.1. Responses of political and economic systems

After the outbreak of COVID-19 in December 2019, there was a shortage of medical supplies in all countries around the world for in the first two quarters of 2020 (see

Solomon, Wynia and Gostin [24]), and because of the situation of anti-epidemic in cities, the local economy stopped and general supplies were in short supply (see Ascani, Faggian and Montresor [2]). First and foremost, governments have to deal with the shortage of medical supplies. After the third quarter of 2020, the first wave of pandemic increased, so economic stagnation and declining labor market demand persisted (see Brouder [6]). Some scholars believed that such a situation has led to continuous doubts about economic globalization and the structure of the global supply chain. In other words, the anti-globalists at that time (see Manshur and Husni [14]) blamed the “globalization of the pandemic” on the “globalization of the economy”, and the consequence of this rethinking was the emergence of the idea of de-globalization of re-shoring production. In fact, the process of globalization has slowed down even before the COVID-19 pandemic. Due to the internal gap between rich and poor, the failure of governance, or the perceived risk of geopolitical conflicts between the United States and China and other major powers, various countries have all taken the actions of de-globalization governance to some extent. The global pandemic has only accelerated the speed of political intervention in the process of globalization. For example, in May 2020, Trump, the former president of the United States, issued a statement pointing out that the global pandemic reflects the fact that the US relies too much on imports. Therefore, the U.S. government carries out the strategic national inventory mechanism see Strategic National Stockpile, SNS (U.S.). Related products will be localized to improve production capacity and reduce dependence on imported goods. In the relevant executive order, the former President, Trump, invested USD 25 billion and authorized the United States International Development Finance Corporation (DFC) to undertake strategic actions to enhance the productive energy of strategic resources for national defence, including strengthening the establishment of relevant supply chains in the United States and its territories, and providing the necessary capital loans for related industries to establish, maintain, protect, expand and restore basic manufacturing capabilities in relevant industries in the United States and reduce dependence on imported products (see Saldinger [23]). The decision of Hon Hai or TSMC to invest in the US, as well as the various preferential measures provided by the US government, can be regarded as the result of the active operation of the relevant strategic mechanism.

2.1.2. Responses of education system and market to the impact of pandemic

The aforementioned effects of de-liberalization and de-globalization are accompanied by the closure of many university campuses around the world, as well as the suspension of courses, research, examinations, and international conferences and even infection and death of students and faculty members under the ravages of COVID-19 in 2020, showing the predicament of the global higher education system and the situation of restriction of commodity flow in the education market (see Neuwirth, Jovi and Mukherji [18]). In addition, Law’s literature also pointed out that the Severe Acute Respiratory Syndrome (SARS) pandemic from 2002 to 2003 was also a serious infectious disease, leading to the closure of schools and the suspension of classes in mainland China, Hong Kong and Taiwan, which were severely affected at that time. Some universities and other higher education began to try the teaching mode of online education, which means that courses, teaching and research are not necessarily “completely” shut down because of the spread of the global pandemic. Stavropoulos’s study argued that even if it had an impact

on the education system, groups within the education system would still be divided along the sociological boundaries of population groups, including classes, races, and even genders, allowing the pandemic to have some unequal learning resources, unequal access to networks, and digital drops such as poor information equipment, exacerbated by the impact of the pandemic.

These preparations include risk analysis and contingency planning in the event of war, economic crisis or natural disasters, the improvement of digital equipment, the establishment of online education model, and the cultivation of students' self-learning ability. In addition, most of the higher education quality assurance mechanisms have insufficient assessment of the online education model, and the vast majority of quality assurance standards are only applicable to face-to-face courses in the past. Moreover, the public does not trust online education, and teachers of relevant courses are not familiar with the software and hardware of remote online courses, which will make it difficult for global higher education institutions to play their due role in the face of the challenges brought by the pandemic (see Salmi [21]). Then, (see Salmi [21]) study pointed out that online education is merely an "additional" interest of teachers with innovative teaching models in the higher education system. However, this model, which is considered to be dominated by media publicity and enters the curriculum through informal channels, has become the mainstream of the teaching field under the influence of the pandemic in 2020. With such a change, Salmi pointed out that higher education institutions should (1) construct the correctness of network connections before the online education model begins; (2) learning management system (LMS); (3) teaching materials used in digital online learning (including authorization and copyright processing); (4) establish the online teaching ability of teachers; (5) cultivate students' online learning ability, and (6) confirm the assessment tools. Otherwise, the digital drop will exacerbate educational inequality. In terms of the response of Taiwan's education system to the pandemic, the Central Ministry of Education made various responses uniformly in combination with the contingency strategy of the Central Epidemic Command Center. At the same time, the hardware of schools at all levels was disinfected, and epidemic prevention centers or epidemic prevention committees in schools at all levels were established to be responsible for the epidemic prevention of schools at all levels. Then, it mainly followed the recommendations of the Central Epidemic Command Center, including temperature measurement at the entrance of school, entrance and exit control, the suspension of large-scale activities, and the advocacy of the use of masks, alcohol and other supplies. After the pandemic in Taiwan was controlled to a considerable extent, there was no large-scale suspension of classes in schools at all levels. However, for higher education institutions, in addition to the original correspondence courses for part-time credits, all departments have also invited teachers to be ready to use Zoom or Google and other systems, so that when classes are suspended or teachers are under quarantine at home, they can use online teaching methods to carry out courses and protect students' learning rights. While the impact of the pandemic was not as high as in other countries, the pandemic control in Taiwan gave higher education more time to prepare for the impact of the epidemic. However, the in-service education and adult education courses offered by schools at all levels were under-registered due to public concerns about the pandemic, or some units offering courses announced the suspension of classes, making the intervention of learning and teaching model of online courses deeper and wider than the formal degree education.

Then, the researchers discuss the market size and related usage of online education in Taiwan before and after the pandemic.

2.2. Industry analysis of online education

2.2.1. Industrial overview of online education

Therefore, the connotation and curriculum of professional practical education have led to online courses that are not limited by time, place and number of people gradually becoming a new trend of in-service education and adult education, because the educational content of traditional schools does not meet the needs of the labor market. More and more professional lecturers have begun to seek relevant curriculum platforms, and those who want to be more competitive than their peers have flocked to the online education market. An American market research company, released a market trend and forecast report on online courses in Research, which predicted that the global online education market would reach USD 350 billion by 2025.

In Taiwan, TutorABC, a foreign language learning platform founded in 1998, was the first online learning platform to enter the market. With its early entry and strong business sales, it has so far accounted for 25% of the total value of foreign language online education in Taiwan the Industrial Development . Other platforms, such as Hahow, YOTTA, HiSKIO, TibaMe and Voicetube, began to appear after 2015 one after another. In recent years, as the gap between production and education has widened, more and more people have begun to look for resources to invest in themselves. At the same time, enterprises also often carry out shifts, so that employees can use flexible time to study in accordance with the layout planning of human resources in the industry. According to the report of Smart M, an online education and enterprise solution platform, about 18-25% of the budget for education and training of enterprises has directly invested in the “online courses” within the enterprises, whose customers include industries as diverse as real estate, manufacturing, technology, and insurance. At present, 52 well-known enterprises have joined the enterprise online courses of Smart M platform, among which, “enterprise video and audio course procurement” accounts for 58%, and “enterprise video and audio course customization” accounts for 42%. It can be seen that enterprises are paying more and more attention to the demand for online courses.

2.2.2. Development of online education after the COVID-19 pandemic

In order to prevent the spread of COVID-19 pandemic, schools from primary schools to universities around the world have been forced to start a wave of non-stop online learning, which unexpectedly triggered a huge demand for information and communication technology in education, and also extended the focus of attention to the related education technology start-up industry. According to the report of the Industrial Development, among the innovation energy of education technology in Taiwan, 63% of the smart learning industry is still focused on hardware infrastructure. However, since 2019, there have also been innovations on the content side and the platform side. By 2020, textbook publishers have invested in the development of digital teaching materials, APPs and cloud platforms to cope with the spread and development of the pandemic. The research report on tutorial education of the Ministry of Education [16]also pointed out that the tutorial system aimed at strengthening after-class review and examination

has also invested considerable efforts in the construction of platform and software. The overall market size of supplementary education has reached NTD 150 billion by the end of 2020. Therefore, the wave of education technology caused by the unexpected outbreak of COVID-19 pandemic is different from the integration of science and technology into the teaching scene that was valued in the past, but is expected to change more from the nature of education (see Martin [15]). In the profit-oriented online education industry market, the huge capital investment and the comprehensive teaching platform of language and tool classes constructed in a monopolistic way are the norm in the industry (see Tull and Dabner [31]). According to the industrialization and profit-making inference, after the pandemic, because of the increase of market demand and the updating frequency of the content supplied by the industry, the online education industry is likely to carry out mutual support and coordination of technology and content in various ways, as well as the integration of platform and capital (see Affouneh, Salha and Khlaif [1]).

2.3. Spatial distribution of online education: from the perspective of spatial geography

2.3.1. Impact of COVID-19 pandemic on urban development

The impact of the COVID-19 pandemic on urban development was mainly due to restrictions on population movement, including the isolation of individuals at high risk, the closure of affected sites and areas, and restrictions on the movement of people from non-affected areas. While preventing the spread of the pandemic, restrictions on population movement also have a relatively high degree of negative impact on urban development, for example, increasing the cost of pandemic control and management, increasing the psychological pressure of isolated people, affecting family income, easily causing social conflicts, and hindering social and economic development (see Tian, Huang [28]). Scholars believe that the city is the core space for human survival and economic development. However, if there is a huge risk of pandemic infection and life threats in the city, when the risk is higher than the income brought about, whether the public's willingness to enter the city will be reduced, whether the urbanization process will be hindered, and whether the urban density will be reduced, resulting in "anti-urbanization" and entering the suburbanization stage (see Avetisyan [3]). However, since the development of the pandemic is still in the short-term stage, long-term data is needed to support the corresponding degree of urbanization or suburbanization in the livable areas. Therefore, there is still great uncertainty at present. Objectively speaking, a high-density city will indeed accelerate the spatial spread of infectious diseases due to its developed traffic network and frequent mobility of people. However, some scholars believe that there is no direct link between high-density cities and outbreaks of infectious diseases. Cities with high density are usually economically developed cities, such as Seoul, Tokyo, New York, Shanghai and Beijing. They also have top-level medical resources and facilities, which are conducive to the control and treatment of infectious diseases and enhance the resilience of cities to deal with the pandemic (see Shih, Chang and Wu [27]).

In addition, taking urban economic development as an example, before the outbreak of the pandemic, the Global Value Chain Development Report 2019 published by the World Bank pointed out that the global production network and manufacturing process began to shrink from 2016 to 2019, with the phenomenon of "local production and short

chain adjustment”. The COVID-19 pandemic, once again highlighting the fragility of supply chains and the lack of resilience of the urban economy World Bank [33]. Taking Honda Automobile as an example for regional concentration problem, three of its five factories in China are located in Hubei, accounting for nearly 50% of its total production capacity, which has become the foreign-invested automobile factory with the biggest impact this time, which also highlights the problem of insufficient urban economic resilience(see Wang and Li [34]). In the face of the continuous arrival of local production, the US-China trade war and the COVID-19 pandemic, the above-mentioned defects of structural resilience have been increasingly highlighted. Therefore, strengthening supply chain risk control ability and supply chain “resilience” has become a key economic reform focus for enterprises and even an important city. The corresponding reform is that public health, major disaster risk assessment, sustainable development and social impact assessment all need to be embedded in urban development planning(see Yang, Zhu and Liu [36]).

2.3.2. Urban development and spatial distribution of education system

Issues related to education are closely related to geography, mainly because of the roles of education and related institutions in society, and these roles can all correspond to geographical or spatial distribution. In other words, they are closely related to location. Traditionally, education has been regarded to have the functions of teaching, imparting knowledge and resolving doubts, but now education has been entrusted with the continuation and revitalization of the overall economic development, promoting social integration, developing the post-industrial knowledge economy, enhancing national competitiveness and other more diversified and far-reaching tasks (see Bulter and THamnett [6]; Thiem and Xie [30]). However, after the spread of COVID-19, the spatial distribution of the education system, while changing itself, also changed the landscape of the city, as well as the associated economic, social and cultural activities (see BagolySimó, Hartmann and Verena [5]). This suggests that cities whose main epidemic prevention measures are to limit population mobility have greater impact on systems or institutions that are less resilient OECD [20]. Therefore, the teaching mode of online Differences in different levels of urbanization and educational location, including differences in the degree of e-localization based on geographic location Executive Yuan Research, Evaluation and Development Committee [9], has also become a source of difference in the locating of online education teaching mode.

3. Research Framework and Methodology

3.1. Research framework and variable definition

Most of the studies related to the behavioral patterns of online education and online learning take the Technology Acceptance Model (TAM) as the main theoretical model. Among them, based on individual data, the behavioral pattern of individual use of online courses is constructed, including the usefulness of online courses, the ease of use of the interface, the attitude of use and the external point of view, which further affect the generation of behavioral intentions and real behaviors(see Granić, Marangunić [10]; Tao et al. [29]). For the research aimed at enterprise management or business strategy, if

the behavioral intention of consumers does not become real “consumption” in the end, then the marketing practice strategy guided by relevant research is equivalent to failure. Therefore, this study takes the course usage and individual course purchase amount as dependent variables affected by various factors. In addition, according to the literature review, the researchers defined the independent variables in the research framework, including time points, geographical location, personal education level, and the types of courses on the online platform. Detailed research framework inference and variable definition are as follows.

3.1.1. Independent variables

1. Time Points

As discussed in the literature review, no matter for the rapid construction of software caused by the degree of informatization, the hardware construction, and the marketization of emerging technologies, or for the social, political and economic system response caused by major infectious disease, the overall structure often reveals differences in major social mechanisms, cultural shifts, and economic changes before and after time points. However, from the perspective of research methodology, the origin of differences to the generation of observability usually goes through the window period of institutional response of delay. The researchers took the beginning point of the COVID-19 pandemic announced by the World Health Organization, the end of December 2019, as the dividing point, and the time notes of data selection were mainly in 2019 and 2020. The first data marker is dated from January 1, 2019 to December 31, 2019; the second data marker is dated from January 1, 2020 to December 31, 2020.

2. Geographical Location

The geographic scope of the data used by the researchers includes Taipei City and New Taipei City, which are collectively known as Greater Taipei. Therefore, the geographical location distribution of the specified variable can be seen by using the division of administrative regions in the set map of geographic information system. What is highly correlated to online education is the degree of digital development of the location itself. Therefore, the researchers further used the digital development degree indicators of the Executive Yuan Research, Evaluation and Development Committee [9] to define the geographical location. This study measured a relatively wide range of dimensions, including human resource structure, social and economic development, educational and cultural development, transportation dynamics development, living environment development, and information infrastructure construction. Finally, the digital development degree of Taiwan's towns and cities was divided into five levels. In this study, Songshan District, Xinyi District, Daan District, Zhongshan District, Zhongzheng District, Wenshan District, Neihu District, Shilin District, Beitou District in Taipei City and Banqiao District, Sanchong District, Zhonghe District Xinzhuang District, Xindian District in New Taipei City belong to the first level; Datong District, Wanhua District and Nangang District in Taipei City and Yonghe District, Shulin District, Yingge District Sanxia District, Tamsui District, Xizhi District Tucheng District, Luzhou District, Wugu Taishan District, Linkou District, Shenkeng District, Bali District in New Taipei City belong to the second level; Ruifang District, Sanzhi District, Jinshan District Wanli District,

Wulai District in New Taipei City belongs to the third level; Shiding District belongs to the fourth level; Pingxi District, Shuangxi District, Gongliao District belongs to the fifth level.

3. Educational Level

Educational level is a basic demographic variable. In the study of the use and purchase of digital courses, educational level is highly correlated with the behaviors of purchasing and using courses (see Speily, Kardan [26]; Li and Tsai [13]). There is a considerable difference in the educational level of population groups captured by different online education platforms or different massive open course platforms, which means that educational level is relatively correlated with specific educational platforms (see Khanlarian, Rahua [12]). In this study, the researchers defined the educational level as the number of years of education, and converted the educational level into the number of years of education according to Taiwan's national compulsory education, secondary education, vocational education and higher education system.

4. Types of Courses

Speily, Kardan [26] pointed out that different online course usage behaviors can be traced back to the types of courses selected by users. According to (see Jordan [11]) study, if users pick courses that take longer to complete (usually basic subjects), they will have lower completion rates. However, Tao et al. [29] findings showed that consumers' intention to use online courses is relatively high for courses with high cognitive usefulness. Based on the classification of courses selected from an online education platform, the researchers categorized the courses into life, design, business, language, and science and technology. In addition, each individual user may purchase more than one course category in the year, and the researchers use the method of repeated counting to calculate.

3.1.2. Dependent variables

1. Course Usage

However, the low completion rate is the biggest challenge for MOOCs. According to a study conducted by (see Jordan [11]), the average completion rate of MOOCs is only 15%. In other words, it only lasts about 2.34 hours. Udacity, the first MOOC platform created by Sebastian Thrun, the father of online education, has a completion rate of just 7% (see Bonhardt [4]). Jordan's study also indicated that only about 20-35% of MOOC students complete the course in the first week, and the completion rate drops sharply by the fifth week of the course.

Therefore, the continuation of student participation is the key factor affecting the completion rate. In this study, the main operation of the course usage is the total time that the course purchasers used the purchased course in the year. The researcher wanted to know the percentage of changes in course usage, so the logarithm of this variable was taken and then the model was analyzed.

2. Individual Course Purchase Amount

In terms of the mechanism of the online education market, different course purchase mechanisms feedback different course purchase costs. In the database adopted in this study, the corresponding information is mainly expressed by the purchase amount of

courses. In this variable, the researchers defined the individual course purchase amount as the total amount of online courses purchased on the platform by the course purchaser during the year. Similarly, the researcher wanted to know the percentage of changes in course usage, so the logarithm of this variable was taken and then the model was analyzed.

3.2. Data Collection and Analysis Methods

According to Kusika's metrological study guidelines, from the perspective of enterprise management, if an organization or a profit-making unit intends to become a data-driven unit as the basis of operation, it should not only collect and regularly review the operation or customer relationship management data. This study belongs to the basic research of management and behavior science with the data-driven model, which means that the research purpose derived from the research motivation, in the context of a wide range of research background, must find the corresponding database and operationalization-able variable, and finally present the answer to the research question in the way of modeling Wooldridge [32]. As a result, the researchers used the background database of an online course platform to extract the required variables for data cleaning after removing or transferring the personal privacy data of online course platform purchasers including columns that can identify personal identity, such as e-mail address, bill address and personal phone number, and the bill address is transferred to the geographic coordinates that the geographic information system can handle). In the part of data analysis method, the researchers analyzed the geographical location, made a set map of geographical location by descriptive statistics, and illustrated the geographical location distribution of online education course purchase in the two periods before and after the time point of the outbreak of the pandemic set by World Health Organization by GIS distribution map. In addition, in the part of the statistical model construction, the researchers used a multiple regression model to illustrate the difference between the two periods before and after the time point of the outbreak of the pandemic that affected online education course purchase and course usage.

4. Data Analysis and Discussion

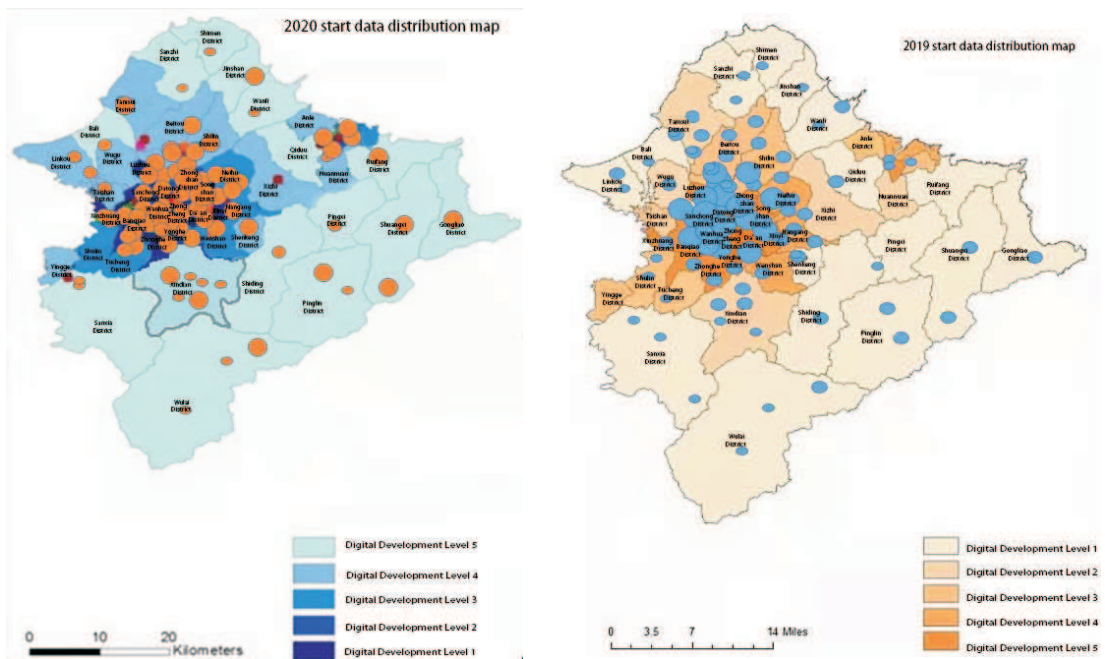
4.1. Data description and geographical location analysis

After cleaning the data collected from the database, the researchers obtained a total of 66, 342 course purchase data in 2019 and 76, 434 course purchase data in 2020. After cross-comparison of customer number and purchase number of personal data, a total of 34, 453 personal data in 2019 and 39, 424 personal data in 2020 were generated. In other words, each purchaser purchased an average of 1.925 online courses in 2019 and an average of 1.938 in 2020. If the average unit price of courses in the database is NTD 2, 615 yuan, the total trading volume of 2019 would be NTD 173.48 million, with the average consumption amount of each customer of NTD 5, 033; the total trading volume of 2020 would be NTD 199.87 million, with the average consumption amount of each customer of NTD 5, 067.

Among 66, 342 course purchase data in 2019 and 76, 434 course purchase data in 2020, the category of life courses accounted for 30% (19, 876) of the courses purchased in

2019, followed by the category of language courses accounting for about 20% (13, 371), and the categories of design, business and science and technology respectively accounted for 19.6% (12, 987), 14.9% (9, 874) and 15.4% (10, 234). The category of life courses accounted for more than 36% (23, 985) of the courses purchased in 2020, followed by the category of language courses accounting for about 23% (15, 349), and the categories of design, business and science and technology respectively accounted for 20.9% (13, 928), 15.5% (10, 298) and 19.4% (12, 874). In terms of personal education level of individual users, the average number of years of education for purchasers in 2019 was 17.23 years, and the average number of years of education for purchasers in 2020 was 16.19 years. In terms of the educational system in Taiwan, the average educational level is university and college.

In terms of the number of course purchases in 2019, 39, 930 (60.2%) were at the first level of digital development in geographical location; 10, 123 (15.3%) were at the second level; 7, 984 (12.0%) were at the third level; 5, 109 (7.7%) were at the fourth level; 3, 196 (4.8%) were at the fifth level. In terms of the number of course purchases in 2020, 44, 938 (58.8%) were at the first level of digital development in geographical location; 11, 837 (15.5%) were at the second level; 9, 984 (13.0%) were at the third level; 6, 252 (8.2%) were at the fourth level; 3, 423 (4.4%) were at the fifth level. The detailed set map of geographic information system is shown below:



Source: Researcher's own drawing

Figure 1: Geographic distribution of online course purchase data in 2019 and 2020.

4.2. Research model validation

4.2.1. Model validation for predicting the course sales amount

The model validation for predicting the course sales amount took the logarithm of the course sales amount as the dependent variable, and time point (virtual variable), geographical location, years of education, and course category (virtual variable) were used to predict the course sales amount. After the conversion of virtual variables, the data was processed according to the steps of general multiple regression analysis. Because the course items are categorical variables, it is necessary to make four dummy variables and run regression. These four dummy variables originally have collinearity. In the regression formula, the collinearity of the dummy variables will not be considered, because the degree of autocorrelation of these dummy variables is very high, because they are fictitious from the same variable, so there were 124, 564 final observations. As shown in Table 1, the tolerance, the coefficient of variation expansion, and the conditional index of predictor variables are all within a reasonable range except for the case that the course categories are collinear. The influence coefficient of course category variable on the course sales amount may not reach a statistically significant level, but it will not affect the overall explanatory power or fitness degree of the regression model. The results of the multiple regression analysis show that in the overall regression equation, all the predictor variables have explanatory power of 18.68% on the course sales amount. In the regression model, the time point did not reach the statistically significant level. The β values of geographical location and years of education were 12.5644 and 0.9482. Table 1. Multi-collinearity diagnostic indicators for predictive variables respectively, indicating that the degree of digital development represented by geographical location has a positive impact on the course sales amount by 12.56% for each unit increase, and each year of increase in the number of years of education has a positive impact on the course sales amount by 0.94%. In terms of course category, the β values of the four virtual variables were all negative, indicating that the courses of the life category had a small impact on the course sales amount, but they all had a statistically significant impact.

Table 1: Multi-collinearity diagnostic indicators for predictive variables.

Variable	Tolerance	VIF	CI
Dummy variable at point in time	0.9342	1.4985	1.0918
Geographical location	0.9452	1.5873	1.1008
Education years	0.9482	1.0938	1.1857
Virtual variable of course category 1	0.7326	17.0948	1.3536
Virtual variable of course category 2	0.7385	92.3958	1.4642
Virtual variable of course category 3	0.7867	75.0938	1.9385
Virtual variable of course category 4	0.7492	34.6235	19.4982

Table 2: Summary table of multiple stepwise regression analysis of predicting the amount of lessons sold log ($n = 142, 776$).

Variable	β	t	SEb
intercept	0	3.78***	0.8376
Dummy variable at point in time	0.0143	1.04	0.0876
Geographical location	12.5644	3.53***	0.0398
Education years	0.9482	2.38**	0.0987
Virtual variable of course category 1	-3.4646	2.12**	0.0736
Virtual variable of course category 2	-2.7345	2.14**	0.0673
Virtual variable of course category 3	-2.4823	2.17**	0.8751
Virtual variable of course category 4	-1.4662	2.60**	0.8763
$F = 8.43 * **$	$R^2 = 18.68$	Adj. $R^2 = 14.32$	

$p < .001 * **$; $p < .01 * *20$.

4.2.2. Model validation for predicting course usage

The results of the multiple regression analysis indicate that in the overall regression equation, all the predictor variables have explanatory power of 16.33% on the course usage. In the regression model, the time point did not reach the statistically significant level. The β values of geographical location and years of education were 10.3412 and 2.6473 respectively, indicating that the degree of digital development represented by geographical location has a positive impact on the course usage (total hours) by 10.34%

Table 3: Summary table of multiple stepwise regression analysis for predicting course usage log ($n = 142, 776$).

Variable	β	t	SEb
intercept	0	3.62***	0.5839
Dummy variable at point in time	0.0024	0.93	0.0847
Geographical location	10.3412	3.37***	0.0472
Education years	2.6473	3.61***	0.0683
Virtual variable of course category 1	-2.6456	2.01**	0.5572
Virtual variable of course category 2	-2.4821	1.92**	0.6347
Virtual variable of course category 3	-2.3478	2.03**	0.8034
Virtual variable of course category 4	-1.5561	2.31**	0.8577
$F = 9.21 * **$	$R^2 = 16.33$	Adj. $R^2 = 13.17$	

$p < .001 * **$; $p < .01 * *21$.

for each unit increase, and each year of increase in the number of years of education has a positive impact on the course usage (total hours) by 2.64%. In terms of course category, the β values of the four virtual variables were all negative, indicating that the courses of the life category had a small impact on the course usage (total hours), but they all had a statistically significant impact.

5. Conclusions and Practical Implication

5.1. Conclusions

The researchers took the beginning point of the COVID-19 pandemic announced by World Health Organization, the end of December 2019, as the dividing point, to conduct online course purchase analysis of geographical location based on the theory of geographical diffusion. Before and after the COVID-19 pandemic, both the total number of courses purchased and the total purchase amount for online education had an absolute value increase. However, in the research model, there was no significant difference in consumers' purchasing behavior, including course purchase amount and course usage, between the two periods separated by the time point. In addition, with other conditions unchanged, if the geographical locations are defined by the degree of digital development of administrative districts, the administrative district with better digital development will have higher course purchase amount and better course usage. This partly echoes Stavropoulos's research conclusions that even though the pandemic in Taiwan is relatively mild compared with other countries, the initial anti-epidemic measures such as suspending classes and parties may be a shock to the education system, the groups within the education system will still have varying degrees of influence along the sociological boundary of population groups. Digital drops such as uneven learning resources, uneven Internet access and backward information equipment are relatively reflected in geographical locations defined by the degree of digital development.

In terms of course category, compared with other categories of courses, the life category has more purchase amount and use time of courses, which reflects the research conclusions of Speily and Tao to a certain extent, except that the type of courses selected by users will produce different online course usage behaviors. Finally, the educational level of course users has a considerable positive impact on the course purchase amount and the course usage. In principle, the higher the number of years of education, the higher the course purchase amount, and the longer the time to use the courses.

5.2. Practical implication

The foundation of course sales comes from the possession of digital products and digital infrastructure. It is obvious that the distribution of sales in geographical locations shows no significant image difference between two different periods due to the restriction of the pandemic, but there is a significant correlation between the distribution of sales and the administrative region based on digital development. This means that precise promotion and marketing strategies can be conservatively targeted at areas with higher digital development to maintain the current high sales volume of courses; for the areas with medium digital development, it should take active marketing strategy to increase the current medium sales volume of courses; for the areas with low digital

development, more public free marketing means should be adopted, including promotion and cooperation with various MOOCs, and marketing should be carried out according to the characteristics of the local population.

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