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The effect of online meeting and health screening on business travel: A stated preference case study in Hong Kong

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ABSTRACT

This study quantifies the effects of health control measures at the airport on passenger behaviour related to business travel. A stated preference survey was conducted over potential air travellers in Hong Kong in the context of COVID-19 pandemic. Panel latent class models were estimated to understand passenger preference toward new travel requirements given the applicability of online meeting. Online meeting is applicable in cases where it is a good substitute of air travel and achieves the same outcomes of a trip, and inapplicable otherwise. Empirical results indicate that traveller subgroups are affected in different ways. When an online meeting is inapplicable, nearly 75% of the respondents prefer to travel for business and undertake health screenings. These passengers (identified as “captive” business travellers) perceive such measures necessary to lower health related risks during air travel. As such, they are willing to spend up to 21 to 38 min on the health control measures such as vaccination record requirements and test involving sample collection. When an online meeting is applicable, the share of “choice” business travellers is about 45%, among whom the attitudes towards health control measures become more averse. The average weighted willingness-to-pay for the time saved at health checkpoints increase significantly. The aviation industry thus faces a “double-hit” problem: operation costs will increase due to pandemic control measures, and the resultant inconvenience, extra time and costs further reduces travel demand. Unlike previous short pandemics, business travel is likely to suffer with an extended decline until the pandemic is fully controlled. These identified challenges call for financial and operational support to help the aviation industry reach a sustainable “new normal”. The high value of time saved at check points also justifies investments that make the pandemic control and health measures efficient and smooth. Travellers’ time spent on airport health control should be within 20 min to avoid substantial negative impacts on business travel demand.

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1. Introduction

The outbreak of COVID-19 has brought catastrophic impacts to the aviation industry and the global economy. Substantial changes introduced to air travel, such as health control measures at airports, are expected to be retained at least in the coming few years. Back to the mid-1990s, air travel used to be very easy. Then, the 9/11 terrorist attack happened, which has caused long-lasting changes to the air travel experience not only in the U.S., but also in other countries around the world. In the following 20 years, airport security protocols became more sophisticated and ever-more-elaborate. From the experience of 9/11, we can see that the airlines and airports were at the beginning hesitant to introduce security measures when the Transportation Security Agency (TSA) system was first established. Air travellers had to accept those security measures as normal features at airports. Indeed, the history of airport security suggests that security attacks often prompted new security measures, such as metal detector, body scan for passengers and X-ray for bags. Similar to the case of security screenings, it is likely that airports may introduce health screening procedures as routine operations based on the lesson learnt during the COVID-19 pandemic.

Meanwhile, online meeting platforms have become a crucial instrument of business communication extensively used during the pandemic. The significant changes in travel arrangements and the prevalence of online meeting may together impose significant impacts on air travel. These are important issues to be quantified, because a decline in transport demand could lead to network downsizing and connectivity loss, which reduce the attractiveness of aviation services and thus lead to further negative feedback effects on demand. It is therefore essential to quantify the impacts brought by the COVID-19 pandemic on airport safety protocol and the resulting passenger travel behaviour, so that the right policy and managerial strategy can be identified to help the aviation industry reach a sustainable “new normal”.

This study aims to investigate the effects on air travel choice of the following factors: (a) health control services/passenger health screening at the airport; and (b) the increased use of online meetings. For this purpose, the choice to fly is examined as a function of different factors such as severity levels of the pandemic, travel characteristics, and health control measures. Attitudes towards online meetings, travel cost, travel time, type of business communication, and travel-associated health risk are examined through the attitudinal questions and rating scales. Then, a stated preference (SP) experiment is employed to investigate how different health control strategies and disease information may affect the choice to travel internationally for business purpose. The survey is conducted over Hong Kong residents who had recent business travel experiences. Hong Kong has been a major international hub, with a competitive aviation industry that contributes significantly to the city's other key economic sectors such as tourism, trade, and logistics (Tsui et al., 2021, 2022). The safety and security operations have been rigorous and complying with international standards. Study on this well-developed market is expected to contribute to the design of supportive policies that could facilitate the recovery of the aviation industries, and help improve the service offering to passengers especially business travellers.

The rest of the paper is organized as follows: Section 2 provides a literature review. Section 3 describes the methodology used for data collection and for our analysis. Section 4 provides a description of the sample used in the study. Section 5 presents and interprets the results. Section 6 concludes the paper with a summary of the findings and recommendations.

2. Literature review

Since Jan 2020, the aviation industry around the world has been in the doldrums due to the outbreak of COVID-19 and its resulting entry restriction policies imposed by different countries and regions (Li et al., 2021). The number of passengers and flight movements handled by Hong Kong International Airport in April 2020 recorded a year-on-year decrease of 99.5% and 73.5%, respectively. Visitor and transfer/transit traffic dropped by nearly 100%, while Hong Kong residents' travel reduced by 99%, compared to the same month before the outbreak (HKIA, 2020). It was estimated that the overall revenue passenger kilometers would reduce by 38% in 2020 as compared with that in 2019, leading to a revenue loss of US\$252 billion (IATA, 2020a).

It is not the first time that a disease outbreak causes a remarkably negative impact on the aviation industry. For example, the SARS epidemic in 2003 caused serious impacts on the tourism, hotel, and aviation industry in China (Dombey, 2004, Hai et al., 2004, Zeng et al., 2005). Similarly, negative impacts of pandemic influenza H1N1 2009 and MERS Flu 2015 on the tourism and aviation industry were also revealed (Chung, 2015). With the prevalence of viral epidemic events associated with environmental pollution and climate change (Gössling et al., 2020; Hendryx and Luo, 2020), the aviation industry has to adapt to and withstand pandemics. Undoubtedly, the aviation industry does not wish to introduce excessive inconvenience to passengers, which would reduce travel demand and revenue. However, there is a significant chance that COVID-19 would introduce some lasting or even permanent changes to the safety protocol of air travel. For example, it is expected that health declaration, vaccination and virus test requirements will be kept at least in the coming several years (Murray, 2022; International Civil Aviation Organization (ICAO), 2021). This would introduce significant monetary costs related to the provision of travel services, and passenger disutility related to inconvenience, extra time, and regulatory compliances. All these costs and inconveniences would discourage passenger travel desire and thus aviation demand, eventually loss in connectivity. This could create negative feedback to the travel demand and traffic volumes.

The intention of air travel would decrease with higher risk perception in the presence of the COVID-19 pandemic (Neuburger and Egger, 2020). Lamb et al., (2020) indicated that passenger's willingness to fly for a business trip during the COVID-19 pandemic decreases due to the increase in risk perception, which could be influenced by the effectiveness of the control measures and the features of disease (Lau et al., 2005). Passengers tend to perceive higher health risk when the disease is of a higher infection rate or/and mortality rate (Ibuka et al., 2010). Implementing health control measures provides passengers with reassurance, thereby reducing their perceived travel risk (Cohen, 2016). A report released by IATA indicated that travellers show preferences for COVID-19 screening at airport, compulsory mask wearing, and social distancing measures on aircraft which can provide health protection (IATA, 2020c).

Health control measures commonly used in the aviation industry include flight cancellation, temperature screening at airport to identify potential virus carriers, mask wearing requirements, health declaration, social distancing measures, and on-site virus testing. In particular, a health declaration form requiring personal information, travel history and possible syndromes is currently used by many regulators, and international certificates or mobile applications of vaccination are being developed to enable passengers to travel across borders.

On the other hand, previous research revealed that air passengers have reservations about the advanced security screening procedures, expressing concerns about the privacy invasion (Beck et al., 2018; Patil et al., 2016). Recent studies also found some negative public attitudes towards the restrictive governmental measures against COVID-19. For example, one study conducted in Germany found that about 20% of the respondents showed an unwillingness to wear a mask during the COVID-19 pandemic, partly due to the social prejudice and peer pressure (Rieger, 2020). In addition, people questioned the policy of mandatory vaccination and worried about disclosing their travel history to COVID-19 contact tracing apps (Graeber et al., 2021; O'Callaghan et al., 2021).

In summary, the COVID-19 pandemic has caused a significant decline in travel intention and traffic volume. Whereas many passengers indicated positive support to restrictive measures, there are substantial concerns over such measures' economic implications and effectiveness. Whereas all these measures will impose extra time and inconveniences, few studies have examined their implications to passenger travel intention and demand. As such measures are likely to be introduced as permanent routines (i.e., new safety protocols) after this global health crisis, studies on the attitudes of air travellers towards passenger health screenings are urgently needed in order to understand the related implications on travel demand and aviation operations.

Although business travellers account for a smaller proportion than leisure travellers¹, they contribute to a high percentage of airline's revenue and an even higher percentage of profit. This can be attributed to the difference in travel preferences between business and leisure travellers. In particular, business travellers tend to plan less prior to travel and assign more importance to convenient flight schedules, while being less sensitive to ticket price (Milioti et al., 2015; Seetaram et al., 2018; Talluri and Van Ryzin, 2006). Despite that business travellers are considered highly profitable before the pandemic, IATA holds a more pessimistic attitude towards the outlook for the recovery of business travel, as online meeting appears to have made significant inroads as a substitute for face-to-face meetings (IATA, 2020b). Online meeting platforms enable people in different locations to have a real-time communication through audio and video imaging (Gough and Rosenfeld, 2006). Compared to traditional in-person meetings, online meetings (or, interactive video conferencing) offer many advantages such as the flexibility, convenience, time and cost savings (Lehmann, 2003; Gray et al., 2020). On the other hand, online platforms are also often exposed to various challenges including inaccessibility to reliable internet services, server outages, hardware failures, hackers' attacks, privacy invasion, and other network security issues (D'Anna et al., 2020; Gupta and Perera, 2021). More importantly, online meetings may fail to contribute to personal interaction and social networking especially where people have never met face to face. In the past decades, researchers in sociology have emphasized the centrality of face-to-face relationships in global business life (Miller, 2003). For instance, an effective face-to-face communication would be more desired when negotiating conflicts of interest in business, rather than using a medium (Mason and Leek, 2012).

Some industry observers argue that the online meeting applications offer a good substitute to face-to-face meeting, and thus will significantly reduce travel demand. However, similar predictions were made for technologies such as telephone, fax, and email. Contrary to such predictions, these IT technologies facilitated contacts of people far apart, building globally more dispersed networks and supply chains which could have increased, instead of replaced, the desire for face-to-face meeting. IT technologies may serve as complements rather than substitutes for travel. In summary, the significant changes in travel requirements and online meetings may have significant effects on travel demand, with such effects yet to be quantified. As aforementioned, a decline in transport demand could lead to network downsizing and connectivity loss, which reduce the attractiveness of aviation services and thus lead to a further negative feedback effect on demand. Therefore, it is worth studying the preferences of travellers in the presence of pandemic control related travel requirements, and examining the impact of the use of online meetings on travel choices.

3. Methodology

We aim to quantify passenger preference changes in the presence of health control and declaration measures related to air travel, and increased use of online meetings. The choice to fly is examined as a function of different factors such as severity levels of the pandemic, travel characteristics, and health control measures. Attitudes towards online meetings, travel cost, travel time, type of business communication, and travel-associated health risk are examined through attitudinal questions and rating scales. Then, a stated preference (SP) experiment is employed to investigate how different health control strategies and disease information may affect the choice to travel internationally for business purpose. Consideration is also given to the effect of online meetings on the choice to travel.

The questionnaire has three sections: (1) Travel experience, perception and attitudes, (2) SP questions regarding travel choices, and (3) Demographics and employment characteristics of business travellers. The first section collects the information on the business travel, online meeting, and work from home (WFH) experiences before and after the COVID-19 pandemic. In addition, some attitudinal questions are presented. The second section is the SP instrument (detailed discussion in the following sections). The third section collects information on passenger demographics (i.e., gender, age, education, marital status, and income) and employment characteristics (i.e., type of employment and industrial classification).

¹ In the aviation industry travelers are often classified as business travelers, leisure travelers (mainly tourists), and visiting friends and relatives (VFR) travelers. Here we use the term of leisure traveler to broadly refer to passengers travel for non-business purpose.

3.1. Attitudinal questions

There is a total of 10 questions where respondents are required to rate their level of agreement with each statement on an 11-point scale (0 = strongly disagree; 10 = strongly agree). The items and the corresponding statements are selected and refined based on previous travel behavior research (Aguilera, 2008; Demir et al., 2020; Lavieri and Bhat, 2019; Neuburger and Egger, 2020). The latent constructs considered in this study include the technology acceptance of online meeting, preference for face-to-face communication, and perceived higher risk of health for traveling in the context of the pandemic (as shown in Table 1). Earlier studies, such as those referenced above, suggest that these factors are important in the choice of travel especially for business trips.

A latent factor analysis is applied to identify the key descriptors summarising the attitudinal responses, using software SPSS 24. Factor analysis is a commonly used statistical method to reduce a large number of observed and correlated variables into fewer unobserved variables. For example, it is possible that variations in the first five measured statements mainly reflect the variation in one unobserved variable - "Technology Acceptance of Online Meeting". Performing factor analysis consists of two steps - factor extraction and factor rotation. In this study, principal component analysis (PCA) is used for factor extraction and Kaiser's rule (i.e., eigenvalues > 1, see Kaiser, 1960) is used to determine the number of extracted factors. To interpret factor loadings, a factor rotation that aims to achieve simple structure to improve interpretability is required. The two categories of factor rotation include orthogonal rotation (e.g., varimax, quartimax, and equimax rotation) and oblique rotation (assuming that the extracted factors are correlated, e.g., direct oblimin and promax rotation). Note that Varimax is used in this study to generate uncorrelated factors. To assess the degree of internal consistency among the measurement items for each latent factor, the reliability analysis is performed using Cronbach's alpha as the diagnostic indicator. Measures of the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity indicate how suited the data is for factor analysis. As a rule of thumb, KMO values close to 1 (e.g., >0.7) indicate that the sampling is adequate for factor analysis. A p-value lower than the chosen significance level (e.g., 0.10, 0.05, 0.01) from Bartlett's Test of Sphericity indicates that the observed variables are not orthogonal (i.e., the data is suitable for factor analysis).

3.2. Stated preference design

In this study, respondents' perceptions towards the severity levels of the pandemic, travel characteristics, and preferences for different health control measures are gauged through a stated choice to travel internationally by air in an SP survey. SP surveys have been widely applied to evaluate the effects of passenger screening strategies on the propensity for domestic or international travel by measuring the passenger's response under hypothetically constructed conditions (Beck et al., 2018; Patil et al., 2016; Potoglou et al., 2010). The SP questions in this study are based on the scenario with various travel restrictions in the context of the COVID-19 pandemic. The respondents are asked to imagine that they were planning to have an international business trip by air. For each question, three choices (two unlabelled alternatives and a 'no choice' alternative) are presented as three ways in which respondents might make this journey. The two alternatives are described by attributes representing disease information, travel characteristics, and health control measures. There is also a 'no choice' alternative which provides a no-travel option for a choice scenario task. For each SP scenario presented, the respondent makes a choice given two preconditions, thus providing two choices. The two preconditions are defined as follows: (1) online meeting inapplicable, (in this case, the term "inapplicable" is interpreted as the situations that online meeting is not a good substitute of air travel to achieve the same trip outcomes, for example, the situations where reliable internet/technical supports are not available, where hand-on work are needed (e.g., installation of new equipment and systems, maintenance and repair, audit of original files and receipts), and where business conflicts exist so better to discuss face to face, etc. In this experiment, we have not clearly referred to specific situations in order to gauge a general perception), and (2) online meeting applicable (referring to the situations that online meeting is a good substitute of air travel).

In each of the SP questions presented to respondents, the choice context is characterized by eight attributes: (1) Daily confirmed cases at the current city, (2) Daily confirmed cases at the destination city, (3) Global average case fatality rate (CFR_a), (4) Average time

Table 1
Attitudinal Questions.

Items and Statements
Technology Acceptance of Online Meeting
The online meeting tool allows me to organize meetings any time (24/7).
The online meeting tool is very user friendly.
It is easy to prepare an online meeting.
I will recommend my colleagues and friends to use online meeting tool.
In general, I consider online meeting platforms/applications as very useful.
Preference for Face-to-Face Communication
I prefer face-to-face communication rather than online communication.
I like meeting new people in different locations.
Instead of sitting at home or office, I prefer to go and meet people.
I'm interested in experiencing different cultures, languages, food, and customs.
Perceived Higher Risk of Health
The health risk associated with the air travel during the pandemic is very high.
To me, traveling during the pandemic is a very risky behavior that leads to disease infection.
Taking actions against important health risks (e.g., disease infection) is a must.

to pass through the health and security checks, (5) Increased cost of ticket (e.g., to cover the extra costs of health control measures), (6) Health declaration requirements, (7) Mask wearing requirement, and (8) Onsite health checks at airport. Fig. 1 provides a screenshot of the content and format of a sample SP question.

The levels of the first and second attributes - Daily confirmed cases - are set based on the actual situation of COVID-19 cases in Hong Kong (Department of Health, 2021). The Hong Kong residents had experienced four waves of the epidemic since the first reported case on 23rd January 2020. The survey was conducted near the end of the fourth wave in late March 2021, when the daily confirmed cases were below ten. To achieve a more realistic perception, three levels of 10, 50, 100 daily confirmed cases are adopted to reflect low, common, and serious pandemic situations respectively. Despite that there may be a need to consider the COVID situation in global cities, HKIA's most important markets are East Asia and Southeast Asia (Tsui and Fung, 2016), where the pandemic situation is similar to Hong Kong during the survey period. Using the same levels for daily confirmed cases at current city and destination city should avoid introducing additional effects of a specific destination. Specifically, the effects of the perceived possible destination city may include respondent's attitudes towards varied government response strategies and respondent's concern over the insurance availability, etc, which are not the focuses of the current research.

The levels of the third attribute - CFR_a - are also set based on the reported statistics regarding the CFRs of COVID-19 by country or region (varied from less than 0.1% to 25%, see WHO, 2020). CFR is defined as the ratio between confirmed deaths and confirmed cases. The CFR of COVID-19 in Hong Kong was around 1.4% in March 2021 (Department of Health, 2021a). On the other hand, CFRs of the COVID-19 epidemic in European countries could reach over 10% (Rosser et al., 2020). As CFR is also affected by many factors such as age, gender, smoke habit, etc., a global average CFR is considered in this study to measure an overall risk level or perception. Therefore, three levels of CFR_a, i.e., 0.1%, 1%, and 10%, corresponding to a low, common, and high risk of death from COVID-19.

The levels of the fourth attribute are set with reference to previous studies on the passenger screening process at airports (Beck et al., 2018; Veisten and Flügel, 2011; Blalock et al., 2007), with 20, 40, and 60 min adopted as the average time to pass through health and security checks. Three levels of the fifth attribute associated with the increased ticket cost are considered: HK\$500, HK\$1,000, and HK\$3,000. They are set with reference to the suggested testing fee of COVID-19 for departure passengers in Hong Kong International Airport (HKIA, 2021), in the context of airfares quoted at travelling websites. Finally, three levels, for each of the sixth to eighth attributes associated with the health control measures, are set in accordance with the boarding and quarantine arrangements for entry via airport (i.e., HKIA) (Department of Health, 2021b; The Government of HKSAR, 2021).

In the pilot survey, the levels for each of the attributes were examined to ensure that they are within reasonable ranges. To summarize, the SP experiments have eight factors, each with three levels. If the full factorial design were considered, there would be a very large number (i.e., 3⁸ × 3⁸) of choice scenarios, which are not practical nor efficient to present to respondents. An efficient design which enables us to estimate the main effects and two-way interaction effects of attributes is adopted to reduce the number of choice

Scenario 3/6:

Despite the widespread outbreak, business travel has not come to an absolute standstill. People are still undertaking essential business trips. However, online meetings have become popular and widely used in business collaborations. Therefore, travelers are often faced with the dilemma of whether to proceed with their plans or not.

Imagine that the travel restrictions are lifted now, and you plan to make an international business trip by air. We would like you then to consider three ways in which you might make this journey.

Please select one option considering the following descriptions.

	Option A	Option B	Option C
Disease Information			
Daily confirmed cases of current city	10	100	I would choose not to fly under these conditions
Daily confirmed cases of the destination city	100	10	
Global average case fatality rate (CFR _a)	10% (there is one death among 10 confirmed cases)	0.1% (there is one death among 1000 confirmed cases)	
Travel characteristics			
Average time to pass through the health and security checks	20 minutes	40 minutes	
Increased cost of ticket to cover the health control measures	3,000 HKD	500 HKD	
Health Control Measures			
Health declaration	Provide personal information, self-reported travel history, symptoms	No requirements	
Mask requirement	Compulsory mask-wearing during flight and airport	Compulsory at the airport, but no requirements during flight	
Onsite Health Check	No requirements	Temperature screening	
When an online meeting is not applicable for this business negotiation:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
When an online meeting is applicable:	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Fig. 1. Sample of Choice Scenario for the SP Game.

scenarios (Beck et al., 2018; Hensher and Rose, 2007; Ho et al., 2018; Rose et al., 2008). Orthogonal designs focus on minimizing the correlations in the data for estimation purpose. The efficient designs aim to yield data that enable estimation of parameters with as small as possible standard errors. Specifically, efficient design aims to minimize the asymptotic standard errors of the parameter estimates. This objective can be achieved by obtaining the asymptotic variance–covariance matrix of the parameters when there is some information about the priors. To assess the efficiency of an experiment design, D-error is a widely used measure of efficiency error (or, can be interpreted as a measure of inefficiency). Therefore, a D-efficient design refers to the design that is generated by minimizing the D-error.

This study applies a Bayesian efficient design to obtain the choice situations for the stated preference experiment by minimizing the D_b -error. The Bayesian approach requires the use of simulation to randomly draw different prior distributions to calculate the D_b -error for each design. In this study, 250 draws using Halton sequences are performed. Prior parameters for the attributes are obtained from the pilot study, which is constructed through an orthogonal design. The parameter estimates of the preliminary model are subsequently used as priors to generate the D_b -efficient design. The software package *Ngene 1.2* (ChoiceMetrics, 2018) is used to determine the final design based on the assumption of a Multinomial Logit model and normally distributed priors. Table 2 shows the considered attributes and their levels. The design has 24 choice situations, which are divided into 4 blocks. Each participant was randomly given one of the four blocks of six SP scenarios in the survey.

3.3. Model specification

In this paper, we formulate a panel latent class model (LCM) for the travel choices of respondents. Similar to the mixed multinomial logit (MMNL) model, the LCM formulation accommodates unobserved preference heterogeneity. However, there are differences in applying these two models. Random parameters with a continuous distribution assumption are used in MMNL model to account for the unobserved heterogeneity across observations (see Chen et al., 2020), whereas LCM addresses the unobserved heterogeneity across groups using a discrete distribution (see Beck et al., 2018, Greene and Hensher 2003; Greene and Hensher, 2013; Hensher, Rose and Greene, 2015). Compared to MMNL, LCM has the advantage of linking the heterogeneity to attitudinal indicators and socio-demographic factors, while identifying the presence and number of the segments in the sample. The panel nature of the data also requires a recognition of the correlations among the responses coming from the same individual. The model structure is discussed in the following paragraph. For notation, index i ($i = 1, 2, \dots, I$) for the decision-makers, j for the alternative ($j = 1, 2, \dots, J$), and s for the SP choice scenarios ($s = 1, 2, \dots, S$) are used. In this study, $J = 3$ (as indicated earlier, two unlabelled alternatives and a 'no choice' alternative) for all i . Within each of the six SP choice sets presented, the respondents are required to state their travel choice in two preconditions – online meeting inapplicable and online meeting applicable.

In the traditional framework of utility-maximizing models of choice, the utility that an individual i associates with the alternative j in choice scenario s is specified as follows:

Table 2
Attributes and Levels for SP Games.

Attributes considered	Levels
Disease information	
Daily confirmed cases at current city	100 50 10
Daily confirmed cases at destination city	100 50 10
The global average case fatality rate (CFR _a)	10% (one death among 10 confirmed cases) 1% (one death among 100 confirmed cases) 0.1% (one death among 1000 confirmed cases)
Travel characteristics	
Average time to pass through the health and security checks	20 min 40 min 60 min
Increased cost of ticket to cover the health control measures	500 HKD 1,000 HKD 3,000 HKD
Health control measures	
Health declaration	Provide vaccination record Provide personal information, self-reported travel history, symptoms No need to declare your health condition
Mask requirement	No mask requirements Compulsory at the airport, but no requirements during flight
Onsite Health Check	Compulsory mask-wearing during flight and airport Temperature screening Tests involving sample collection No requirements

$$U_{ijs} = \beta x_{ijs} + \varepsilon_{ijs} \tag{1}$$

where x_{ijs} is a vector affecting the valuation of individual i for alternative j in the s^{th} choice scenario, and that includes eight attributes ($Q = 8$) in the SP experiment. β is a vector of the average marginal (dis)utility of the attributes. ε_{ijs} denotes an idiosyncratic random error term specific to the choice scenario. ε_{ijs} is assumed to be identically and independently standard Gumbel distributed (extreme value type I distribution, see [McFadden, 1981](#)), and independent of x_{ijs} .

Given that the LCM accounts for the unobserved preference heterogeneity through the estimation of parameters that vary across groups, we assume that there exists C distinct classes within the sample. The determination of the number of classes (i.e., value of C) is based on the goodness-of-fit of the models, using the Bayesian information criterion (BIC). For a given class c , the probability that individual i will choose alternative j on the s^{th} choice occasion can be written as follows:

$$P_{isj|c} = \frac{\exp\left(\sum_{q=1}^Q \beta_{q|c} x_{isjq}\right)}{\sum_{n=1}^J \exp\left(\sum_{q=1}^Q \beta_{q|c} x_{isnq}\right)} \tag{2}$$

where β_{ijs} denotes the coefficient associated with the q^{th} attribute in class c .

The probability of individual i being in class c can be associated with the observable individual-specific variables such as socio-demographic and employment characteristics, travel experience, as well as the latent constructs (i.e., the technology acceptance of online meeting, travel cost sensitive, preference for face-to-face communication, perceived risk of health, and travel time sensitive).

$$P_{ic} = \frac{\exp\left(\sum \gamma_c Z_i\right)}{\sum_{c=1}^C \exp\left(\sum \gamma_c Z_i\right)} \tag{3}$$

where γ are coefficients associated with observable characteristics Z on the classification of individuals into one of the classes.

The parameters to be estimated in the model are β vectors in the class-specific choice model (Equation (2)) and γ vectors for the class membership model (Equation (3)). These two vectors are estimated simultaneously using the likelihood function in (4).

$$\ln L = \sum_i \ln \left[\sum_c P_{ic} \left(\prod_s P_{isj|c} \right) \right] \tag{4}$$

γ are estimated for $(C - 1)$ latent classes. The remaining class is set to be the reference group, where the coefficients are normalized to zero. The software package *NLOGIT 5.0* is used to estimate the panel LCM model.

3.4. Willingness to pay and trade-offs

Willingness to Pay (WTP) indicates the monetary value that the respondent has to sacrifice to obtain one unit of a relevant travel attribute while maintaining the same utility level ([Hensher et al., 2015](#); [Lavieri and Bhat, 2019](#); [Chen et al., 2019](#); [Chiambaretto, 2021](#); [Li et al., 2010](#)). WTP estimates are computed as the ratio between two coefficients of travel attribute and cost. In this study, the WTP of the individuals in class c for the q^{th} attribute is given as:

$$WTP_{q|c} = \frac{\beta_{q|c}}{\beta_{cost|c}} \tag{6}$$

The standard error for a $WTP_{q|c}$ ratio is defined as ([Hensher et al., 2015](#)):

$$S.E.(WTP_{q|c}) = \sqrt{\frac{1}{\beta_{cost|c}^2} \left[Var(\beta_{q|c}) - \frac{2\beta_{q|c}}{\beta_{cost|c}} \cdot Cov(\beta_{q|c}, \beta_{cost|c}) + \left(\frac{\beta_{q|c}}{\beta_{cost|c}}\right)^2 Var(\beta_{cost|c}) \right]} \tag{7}$$

Importantly, these WTP estimates within class are dependent on the probability of class membership. Thus, a weighted average WTP (WTP_{wa}) across all classes, where weights are the probabilities (i.e., P_{ic} the probability of individual i being in class c), is needed and specified as:

$$WTP_{wa,q} = \sum_c (P_{ic} * WTP_{q|c}) \tag{8}$$

In addition, the health control versus time trade-off of air travellers can be gauged through the computation of the ratio between two coefficients of health control measures and time ([Veisten and Flügél, 2011](#); [Mouter et al., 2017](#); [Zhu et al., 2021](#)). This trade-off can also refer to “risk-return rate” (RR). For example, [Zhu et al. \(2021\)](#) found that the risk-return rate of the pedestrians in Hong Kong ranges from 0.5 to 1.5 (% per second), suggesting that they would bear 15–44% increase in their safety risk in order to save the waiting time by 30 s at signalized intersections. In this study, the “risk” is associated with not undertaking the health control procedures, while the “return” is the time saved at airport checkpoints. In other words, RR indicates the amount of time that the respondents are willing to spend in order to cooperate with the implementation of relevant health screening procedures, which helps reduce the health-related travel risk during the pandemic. In this study, the trade-offs between health screening and the time spent of the individuals in class c for the q^{th} attribute is given as:

$$RR_{q|c} = \frac{\beta_{q|c}}{\beta_{time|c}} \tag{9}$$

Similarly, the standard error for a $RR_{q|c}$ is defined as:

$$S.E.(RR_{q|c}) = \sqrt{\frac{1}{\beta_{time|c}^2} \left[Var(\beta_{q|c}) - \frac{2\beta_{q|c}}{\beta_{time|c}} \cdot Cov(\beta_{q|c}, \beta_{time|c}) + \left(\frac{\beta_{q|c}}{\beta_{time|c}}\right)^2 Var(\beta_{time|c}) \right]} \tag{10}$$

Also, a weighted average trade-off between health screening and time (i.e., RR_{wa}) across all classes is specified as:

$$RR_{wa,q} = \sum_c (P_{ic} * RR_{q|c}) \tag{11}$$

4. Data and sample description

The total sample size is set at 400, representing 4,800 (400 respondents × 6 scenarios × 2 preconditions) valid choice observations. The data used in the current analysis is drawn from an online survey conducted in April 2021 from online samples of Hong Kong residents, organized by a professional data collection company (Credamo.com). The inclusion criteria of the respondents are (1) must have international business trip before COVID-19 pandemic (in recent 2 years), and (2) aged 18 and above. After ethical approval more than 400 respondents were approached. Two criteria are set to automatically exclude invalid responses (see Li et al., 2017): (1) The time spent for completing the questionnaire. Based on our pilot study, the attitudinal questions in Section one are supposed to be finished in about two to three minutes. If the respondents finished the questionnaire in less than one and a half minute, the responses will be rejected. In addition, the SP parts in Section two (six choice sets) are expected to be finished in about four to five minutes. Those finished in less than two minutes are excluded as invalid responses. (2) Additional screening questions. In the process of answering the questionnaire, respondents are randomly given two questions, e.g., “Please select six as the answer for this question”. The respondents who fail to provide the right answer are considered as unserious.

Fig. 2 presents the participants’ yearly business trips by air before and during the COVID-19 epidemic. It shows that 35.5% of the participants undertook no international business trips during the COVID-19 epidemic. Moreover, the proportion of the respondents who travelled at least 4 times a year decreased dramatically from 61% before COVID-19 to about 16% during the pandemic. In this study, 95 respondents who travelled at least 7 times a year before the epidemic are marked as frequent travellers before COVID-19, and 63 respondents who travelled at least 4 times a year during the epidemic are identified as frequent travellers amid COVID-19. In terms of online meeting experience, as shown in Fig. 3, 64% of the respondents in our sample have at least four online business meetings per week during COVID-19, compared with 25% before COVID-19. Of the 400 respondents, 255 who have online business meetings at least four times a week during the epidemic are considered as frequent online meeting users during COVID-19. Fig. 4 demonstrates diversity regarding the number of days working from home (WFH), either at the extreme of no work or almost all work being done from home, or some days ranging from one to four. Before COVID-19, 32% of the respondents did not work from home at all (zero days). Respondents

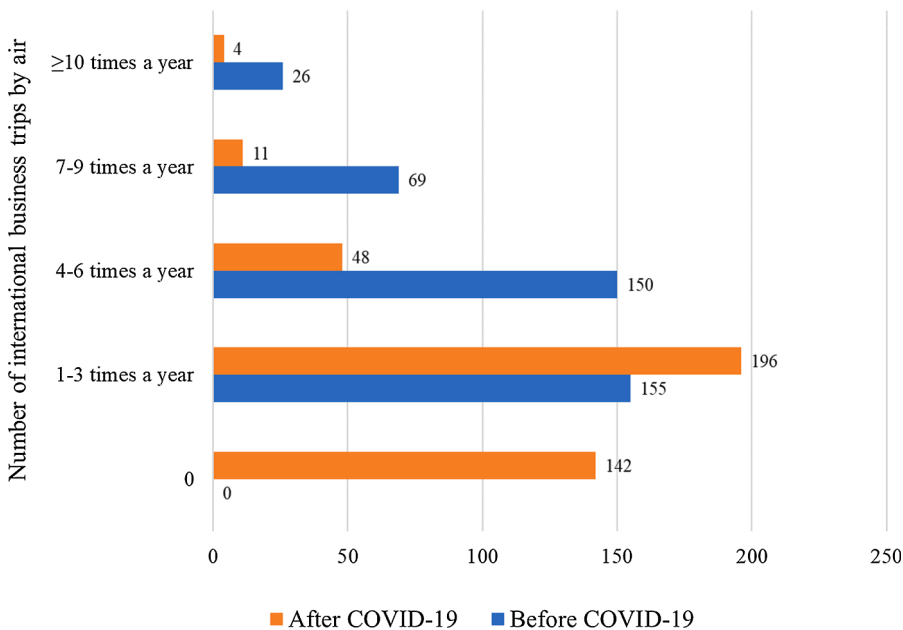


Fig. 2. The Average Number of International Business Trips by Air Per Year.

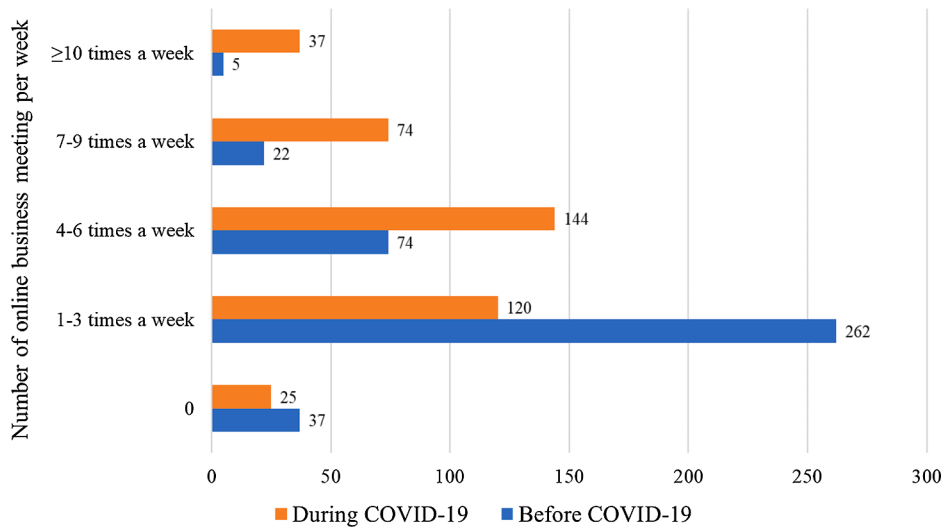


Fig. 3. The Average Number of Online Meeting for Business Purpose Per Week.

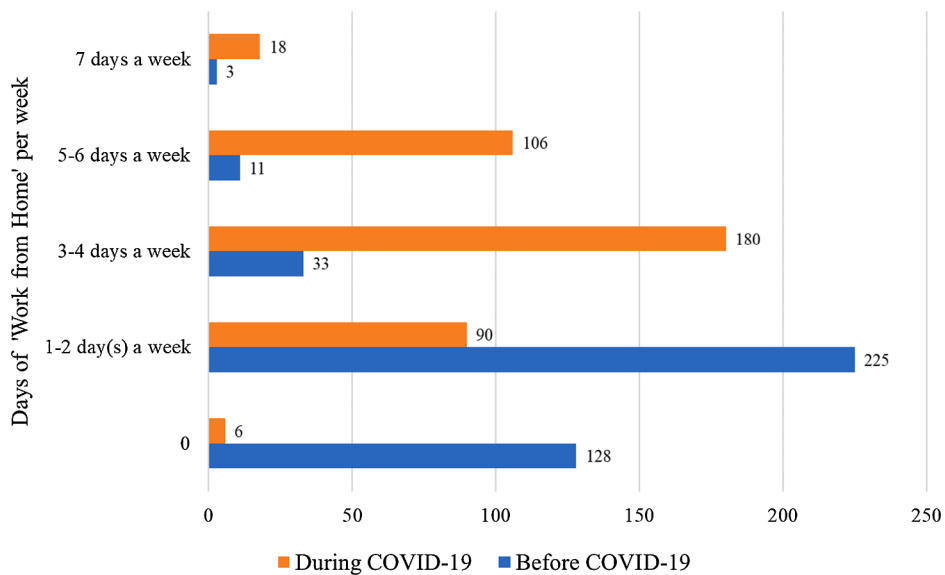


Fig. 4. Number of Days Working from Home.

tend to WFH more frequently during COVID-19. For example, the proportion of those who work five or more days reached 31% during the pandemic. This could be attributed to the social distancing policy implemented by the government, or the changes in company’s operating mode in order to reduce the infection risk and minimize closeness within office space.

Table 3 presents the demographic and employment characteristics of the 400 respondents. 54% of the participants are male (46% female). Although the information on the age distribution of business travellers in Hong Kong is not available, the age groups of 26–35 and 36–45 seem to be the main business travellers based on statistics reported in previous studies of the local markets. For example, Hsu and Kang (2007) reported that 54.7% of interviewed air travellers were aged between 26 and 45; Liu and Mc Kercher (2016) found that the share of business travellers aged between 26 and 55 was about 77% in 2012. Despite that the age distribution of our sample should be close to that of the sample in earlier research, a potential limitation of sample bias (i.e., underrepresentation of older business travellers) might still exist due to the internet-based nature of the survey (Iragüen and de Dios Ortúzar, 2004). Furthermore, almost all the respondents in our sample have attained tertiary education, and 78.5% are married or cohabiting. The latest statistics indicate that about 62% and 55% of the males and females in Hong Kong are married (Census and Statistic Department, 2018). Interestingly, all respondents provided their monthly income values. A little over 20% of the respondents have a monthly gross income below HK\$ 20,000 (US\$ 2,575) and a little over 34% of the sample earn over HK\$ 40,000 (US\$ 5,150). Official statistics regarding the monthly income of business travellers from official reports are not available. The closest possible comparison is the latest monthly wage of all

Table 3
Profile of Respondents (N = 400).

Variable	Count	Percentage
Demographics		
Gender		
Male	216	54%
Female	184	46%
Age		
18–25	27	6.75%
26–35	278	69.5%
36–45	88	22.0%
46–55	7	1.75%
Education		
Tertiary	396	99%
Secondary or below	4	1%
Marital status		
Married or Cohabiting	314	78.5%
Single	86	21.5%
Monthly income		
HK\$ 10,000 – 19,999	82	20.5%
HK\$ 20,000 – 29,999	93	23.2%
HK\$ 30,000 – 39,999	87	21.75%
HK\$ 40,000 – 49,999	59	14.75%
HK\$ 50,000 – 59,999	43	10.8%
HK\$ 60,000 and above	36	9.0%
Employment characteristics		
Employment status		
Full-time employee	230	57.5%
Employer or manager	110	27.5%
Self-employed	55	13.75%
Part-time employee	4	1.0%
Others	1	0.25%
Industrial Classification		
Financing, insurance, real estate, and business services	109	27.25%
Wholesale, retail and import/export trades, restaurants, and hotels	107	26.75%
Manufacturing	98	24.5%
Construction	30	7.5%
Others	56	14.0%

employees in Hong Kong. In 2020, the 25th, 50th, and 75th percentile of the monthly wage of all full-time employees with tertiary education was HK\$ 19,000, HK\$29,200, and HK\$ 44,700, respectively (Census and Statistic Department, 2020). Overall, respondents' incomes are slightly higher than Hong Kong's averages.

The respondent's employment characteristics are presented in the next set of rows in Table 3. The employment status of respondents is stratified into five categories: (i) full-time employee (57.5% of the sample), (ii) Employer or manager (27.5%), (iii) Self-employed (13.8%), (iv) part-time employee (1.0%), and (v) others (0.3%). The self-employed respondents include freelancers who

Table 4
Factor Analysis of Travel-Related Values (N = 400).

Latent Variables	Mean	S.D.	Factor 1	Factor 2	Factor 3
Technology Acceptance of Online Meeting					
The online meeting tool allows me to organize meetings any time (24/7).	8.52	1.06	0.712		
The online meeting tool is very user friendly.	8.62	1.00	0.800		
It is easy to prepare an online meeting.	8.06	1.57	0.668		
I will recommend my colleagues and friends to use online meeting tool.	8.64	1.12	0.754		
In general, I consider online meeting platforms/applications as very useful.	8.76	1.04	0.810		
Preference for Face-to-Face Communication					
I prefer face-to-face communication rather than online communication.	7.37	1.62		0.885	
I like meeting new people in different locations.	8.21	1.28		0.624	
Instead of sitting at home or office, I prefer to go and meet people.	7.69	1.59		0.901	
Perceived Higher Risk of Health					
The health risk associated with the air travel during the pandemic is very high.	8.10	1.64			0.922
To me, traveling during the pandemic is a very risky behavior that leads to disease infection.	8.37	1.45			0.922
Eigenvalues					
% of variance explained			29.10%	20.23%	17.92%
Cronbach's alpha					
			0.79	0.75	0.85

Note: zero-to-ten measurement scale.

Cumulative % of variance explained by five factors = 67.24%.

travel occasionally for business purpose, while category (ii) refers to those who own or run a company or organization. There are five categories for the respondent’s industrial classification: from (i) Finance, insurance, real estate, and business services (27.3% of the sample), (ii) Wholesale, retail and import/export trades, restaurants, and hotels (26.8%), (iii) Manufacturing industry (24.5%), (iv) Construction industry (7.5%), and (v) others (14.0%).

5. Estimation results and discussion

In the following sections we present the results of the two stages – namely the factor analysis used to obtain the latent variables for use in the latent class choice models.

5.1. Factor analysis

Table 4 presents the results of factor analysis. Two items (i.e., ‘experiencing different cultures, languages, food, and customs’, and ‘taking actions against important health risks’) are excluded to improve the internal consistency of the scale. Three factors are identified, which explain 67.24% of the variance. The results of Bartlett’s test of sphericity (p less than 0.000) and KMO Test (0.726) indicate that the data is suitable for factor analysis. Also, the three extracted factors show a Cronbach’s alpha of 0.79, 0.75, and 0.85 respectively, indicating a satisfactory internal consistency (Chen et al., 2019).

Recent studies have applied perceived usefulness and perceived ease of use to better understand students’ acceptance of using online meeting applications or e-learning systems during the COVID-19 pandemic (Alfadda and Mahdi, 2021; Al-Okaily et al., 2020). As shown in Table 4, factor 1 contains five items measuring the perceived usefulness and perceived ease of use of the online meeting applications, labelled as “Technology Acceptance in Online Meeting”. Factor 2 has three items investigating respondent’s “Preference for Face-to-Face Communication”. The third factor (with two items) is labelled as “Perceived Higher Risk of Health”.

5.2. The choice to travel when an online meeting is inapplicable

Three panel LCM specifications are estimated for the choice to travel on business when an online meeting is not applicable. In deciding on the final model form, BIC was used to as measures of fit for models with two to four classes, see Table 5 (Louviere et al., 2000). Our results suggest that the model with two latent classes is superior to the two other counterparts, given its lowest BIC value, the consideration of model application, practicable specification of the number of classes, and interpretable class membership (Beck et al., 2013, 2018). In addition, the likelihood-ratio test is applied to compare the overall statistical fit of the panel LCM and MNL models. Based on the results, we can safely reject the MNL model in favour of the LCM (Greene and Hensher, 2003).

Table 6 presents the parameter estimates for each of the two latent classes, the class probabilities, and the coefficients for characteristics that determine class probabilities. The characteristics of travel experience and extracted latent factors were used to predict class membership, where only the factors significant at the 10% level are included. In addition, the socio-demographic variables of (i) younger (below 35), (ii) male, (iii) married, (iv) employer, manager, or self-employed, (v) higher monthly income (HK\$ 50,000 and above), and (vi) lower monthly income (below HK\$ 20,000) were entered into the utility function of “no travel” choice alternative. In this case, parameters of socio-demographic variables will be interpreted relative to the travel choice alternatives (Hensher et al., 2015).

The respondents who show a preference for face-to-face communication or/and have experience in frequent travel before COVID-19 are more likely to belong to class 1. Respondents in this group are less likely to have a business trip by air due to the increase in CFR, while they are less sensitive to daily confirmed cases of the destination. They prefer providing a vaccination record for health declaration, having compulsory mask-wearing, and having onsite health checks such as tests involving sample collection at the airport. Nevertheless, the two-way interaction effects for class 1 further indicate that they tend to reject the tests involving sample collection at the airport when daily confirmed cases of the destination decrease. While 74.5% of the individuals are classified into class 1, the remaining 25.5% belongs to class 2. In particular, respondents in class 2 are also likely to be deterred from a relatively severe epidemic situation (i.e., high CFR or/and daily confirmed cases of the destination/current location). Also, class 1 travellers have a significant disutility towards the requirements of providing personal information, travel history, and symptoms for health declaration. However, both class 1 and class 2 travellers are willing to provide personal information, self-reported travel history, and symptoms for health declaration if such procedures do not take much of their time at the checkpoint.

Table 5
Model Fit Statistics for Different Numbers of Classes.

Class selection	Online meeting inapplicable			Online meeting applicable		
	2 classes	3 classes	4 classes	2 classes	3 classes	4 classes
ln L (LCM), number of parameters	-1902.16 (K = 37)	-1826.03 (K = 57)	-1770.59 (K = 77)	-1402.45 (K = 40)	-1326.03 (K = 62)	-1296.35 (K = 84)
BIC	4092.30	4095.70	4140.49	3116.22	3134.62	3246.49
No. of observations	2400			2400		
ln L (MNL)	-2287.53			-2308.99		
ln L (LCM)	-1902.16			-1402.45		
G ² (LCM vs. MNL), χ^2 (df), p value	770.74 (20), 0.000			1813.08 (22), 0.000		

Table 6
Results of Panel Latent Class Choice Model (Online Meeting Inapplicable).

Class specific Choice Model	Latent Class 1		Latent Class 2	
	Coeff.	Z value	Coeff.	Z value
ASC _{no travel option}	-2.515***	-4.33	1.066	1.08
Daily confirmed cases of current location (CCL)	-0.009***	-3.08	-0.009***	-3.08
Daily confirmed cases of destination (Cdes)	0.000	0.32	-0.009**	-2.44
Case fatality rate (CFR)	-0.007***	-8.13	-0.007**	-2.56
Average time to pass through the health and security checks	-0.018***	-4.30	-0.019**	-2.13
Increased cost of ticket to cover the health control measures	-0.004	-0.70	-0.025*	-1.85
Health Declaration				
<i>No declare requirements</i>	(Reference)		(Reference)	
Provide vaccination record	0.354***	2.95	0.440	1.64
Provide personal information, self-reported travel history, symptoms	-1.221***	-4.05	-0.724	-1.28
Mask Requirement				
<i>No mask requirements</i>	(Reference)		(Reference)	
Compulsory mask-wearing during flight and airport	0.555***	4.51	-0.185	-0.61
Compulsory at the airport, but no requirements during flight	0.722***	5.29	0.209	0.75
Onsite Health Check				
<i>No requirements</i>	(Reference)		(Reference)	
Tests involving sample collection	0.697***	3.03	0.693*	1.89
Temperature screening	0.083	0.73	0.241	0.88
Two-way Interaction Effect				
Cdes × Sample Collection ^a	-0.011***	-2.97	-0.004	-0.77
Time × Self-reported Health ^b	0.041***	5.68	0.034***	2.74
Socio-demographic Characteristics				
Married	-0.802*	-1.89	-1.380***	-4.58
Lower monthly income (below HK\$ 20,000)	-1.004	-1.39	-1.138***	-4.27
Higher monthly income (≥HK\$ 50,000)	-0.520	-1.07	1.428***	2.95
Class Membership Model			(Reference: Class 2)	
Constant	0.925***	6.02		
Preference for face-to-face communication	0.335**	2.47		
Frequent international travel before COVID-19	0.878**	2.43		
Average Probability	0.745		0.255	

Note: ***, **, * Significance at 1%, 5%, 10% level.

n.s. Not statistically significant (removed from the model).

^a Daily confirmed cases of destination × Tests involving sample collection.

^b Average time to pass through the health and security checks × Provide personal information, self-reported travel history, symptoms.

More importantly, although the two classes of passengers show significant disutility for the increase in “time” (i.e., “average time to pass through the health and security checks”), they perceive the “price” attribute (i.e., “increased cost of ticket to cover the health control measures”) differently. Specifically, class 1 travellers are less sensitive to the increase in ticket cost, as they may regard “price” as indicators of health protection and quality of passenger screening services when traveling during the pandemic, or deem as justifiable costs for travel safety. As mentioned above, class 1 respondents are those who prefer face-to-face communication and have frequent international travel before the COVID-19 epidemic. Therefore, they tend to have a higher intention to travel, which is confirmed by the significant negative constant for the “no travel” option. In contrast, class 2 respondents perceive higher risk of traveling during the pandemic, and are more reserved toward travel. Their utility or valuation of travel decreases with the increased ticket cost and time spent at the airport checkpoint. Moreover, class 2 travellers who are married or lower-income are less likely to choose ‘no travel’ option, while those having higher monthly income are more likely to choose not travelling relative to the travel options (i.e., the two unlabelled alternatives). Such results could be partially explained by the increased family responsibility of married people and financial incentives of the low-income earners.

Overall, negative effects of increased severity of the epidemic situation on the choice to fly are found for both groups. Different from class 2, class 1 respondents show preferences for some health control measures, and have no significant disutility for the increased ticket cost needed for health control services. Consistently, previous studies suggest that some travellers tend to avoid travel inconvenience, while others favour security and safety measures. For example, Patil et al. (2016) found that respondents in France prefer having CCTV cameras, security personnel at the station, and stringent physical security checks. Such preference can be attributed to the experience from terrorist attacks on rail/metro facilities in France, and therefore the respondents are likely to be more supportive of safety measures. Molin et al. (2017) also revealed positive attitudes towards the safety improvements in passenger air travel. Specific to airport security processes, Beck et al. (2018) found 47% of the passengers prefer X-ray with luggage opened random and passport with finger and retinal scans, while 21% are against these measures. This could be attributed to the differences in privacy concerns, trust in authorities, and overall safety perception.

5.3. The choice to travel when an online meeting is applicable

For the scenario where an online meeting is applicable, three panel LCM specifications are estimated for the choice of business travel. Similar to the procedure described in section 5.1.2, the model with two latent classes is selected as the final model given its lowest BIC value. Table 7 presents the coefficient estimates for the class-specific choice model, class probabilities, and the parameters for class membership model.

Respondents who perceive higher risk of traveling during the pandemic and/or have experience in frequent online meeting amid COVID-19 epidemic are more likely to belong to class 1. On the other hand, those who have experience in frequent travel amid COVID-19 epidemic are less likely to belong to class 1. When the online meeting is applicable, respondents in class 1 are discouraged from flying for business purposes due to the increases in CFR or/and daily confirmed cases of the destination. The results of alternative-specific constant show that they have a strong intention to call off their business travel by air. Yet, male travellers in class 1 and those who are employer, manager, and self-employed people are less likely to choose 'no travel' option relative to the travel options. Class 1 travellers also consider compulsory requirement of mask-wearing and tests involving sample collection are acceptable. While 54.7% of the individuals are classified into class 1, the other 45.3% belonged to class 2. Respondents in class 2 show a strong intention to have their business travel, especially for the younger, male, married, and employers, managers, and self-employed people. In contrast, higher-income people in class 2 tend to choose not travelling relative to the travel options. Class 2 respondents also exhibit disutility for the requirements of providing vaccination record, compulsory mask wearing at airport (but no requirements during flight), and onsite health checks. Yet, the two-way interaction effect for both classes indicate that respondents are more likely to accept the requirements of providing vaccination record when daily confirmed cases of the destination increase.

Indeed, Palamenghi et al. (2020) revealed that middle-aged persons were less inclined to be vaccinated than the younger group (i.e., 18–34-year-olds), and a higher level of apprehension to COVID vaccine among those elderly and female individuals were also reported (Troiano and Nardi, 2021). In particular, Townsel et al. (2021) revealed that women's hesitancy or concerns about vaccinating against COVID-19 stem primarily from the safety and efficacy of the vaccine, especially for those who are pregnant, planning pregnancy, or breastfeeding. In this case, if government agencies implement a vaccine passport policy for air travel, a medical

Table 7
Results of Panel Latent Class Choice Model (Online Meeting Applicable).

Class specific Choice Model	Latent Class 1		Latent Class 2	
	Coeff.	Z value	Coeff.	Z value
ASC _{no travel option}	6.255***	4.00	-2.929***	-4.29
Daily confirmed cases of current location (CCL)	-0.000	-0.07	-0.009***	-8.13
Daily confirmed cases of destination (Cdes)	-0.015**	-2.18	-0.006***	-3.26
Case fatality rate (CFR)	-0.014***	-3.22	-0.007***	-6.66
Average time to pass through the health and security checks	-0.004	-0.39	-0.008*	-1.94
Increased cost of ticket to cover the health control measures	0.024	1.22	-0.009	-1.52
Health Declaration				
No declare requirements	(Reference)		(Reference)	
Provide vaccination record	0.087	0.16	-0.711***	-2.58
Provide personal information, self-reported travel history, symptoms	0.389	0.91	-0.105	-0.68
Mask Requirement				
No mask requirements	(Reference)		(Reference)	
Compulsory mask-wearing during flight and airport	1.316***	2.67	-0.169	-1.08
Compulsory at the airport, but no requirements during flight	0.207	0.44	-0.521***	-3.45
Onsite Health Check				
No requirements	(Reference)		(Reference)	
Tests involving sample collection	0.965**	2.25	-0.626***	-4.15
Temperature screening	0.787	1.62	-0.951***	-6.68
Two-way Interaction Effect				
Daily confirmed cases of destination × Vaccination ^d	0.018*	1.76	0.016***	3.50
Socio-demographic Characteristics				
Younger	-0.401	-1.17	-0.641**	-2.03
Male	-0.526*	-1.79	-0.537*	-1.94
Married	-0.607	-1.64	-0.722**	-2.39
Employer, Manager, or Self-employed	-1.402***	-4.84	-0.474*	-1.68
Higher monthly income (≥HK\$ 50,000)	0.763	1.54	0.809***	2.82
Class Membership Model			(Reference: Class 2)	
Constant	-0.122	-0.65		
Perceived higher risk of health	0.395***	3.43		
Frequent international travel amid COVID-19	-0.770**	-2.29		
Frequent online meeting amid COVID-19	0.685***	2.98		
Average Probability	0.547		0.453	

Note: ***, **, * Significance at 1%, 5%, 10% level.

n.s. Not statistically significant (removed from the model).

^d Daily confirmed cases of destination × Provide vaccination record.

exemption certificate for COVID-19 vaccination should be accepted in exceptional circumstances (e.g., elderly or female travellers who are not eligible for vaccination). Moreover, employees, compared with business owners and managers, were less inclined to take their business trip with those additional travel requirements if an online meeting is available. This may be due to differences in the desire and willingness to invest in long-term mutually beneficial relationships. Owners or managers are dedicated to cultivating intimate relationships with their business partners or clients, while employees shall be encouraged to improve the closeness of these relationships (e.g., rewarded by the company for the face-to-face business interactions), which further enhance the B2B (business to business) trust (Fleming et al., 2016).

Similarly, the two classes perceive the “time” and “price” attributes in a different way. As shown in the class membership model, class 1 respondents have experience in frequent online meeting amid COVID-19 epidemic and perceive higher risk of health. Thus, they tend to have a strong intention to choose “not to fly” when an online meeting is applicable. In this context, they seem to be no longer sensitive to the “time” and “price” attributes. In contrast, those who have the experience in frequent international travel (at least 4 times per year) amid COVID-19 epidemic are more likely to belong to class 2. Respondents in this group show a higher intention to have a business trip by air in the context of COVID-19 epidemic, while their utility of travel decreases significantly when the ticket cost and time spent at the airport checkpoint increase.

This study revealed a moderating effect of online meetings on the association between health screening procedures and travel intention. When comparing the air travel choices under the two pre-conditions, we found that the signs of the coefficients of health control measures are opposite, for the traveller class that shows higher intention to have their business trip. In other words, the way how travellers perceive health control measures has changed (i.e., as necessary operations for safe travel when an online meeting is inapplicable vs. as travel inconveniences when an online meeting is applicable). This could be attributed to the advantages such as the flexibility, convenience, time and cost savings, offered by online meetings as an alternative to air travel (Gray et al., 2020). Therefore, it is not hard to explain why these travellers become more sensitive to the cost of air tickets when an online meeting is applicable. In this context, introducing passenger health screenings as a permanent feature of the Hong Kong airport may face more challenges due to the prevalence of online meetings.

5.4. Willingness to pay and Trade-offs

Based on the results of the latent class models, we calculated business travellers’ willingness to pay (WTP) for specific service features in the context of the COVID-19 pandemic, as well as the trade-offs between health-risk-based screening and the time spent. Tables 8 and 9 report the weighted average WTP (WTP_{wa}) and the trade-offs across all classes under two preconditions (online meeting inapplicable/applicable). We also conducted the WALD tests for standard errors of WTP and trade-off estimates, where the z values given are used to assess the significance level of the test. The mean estimates of WTP and trade-off statistically different from zero at the 90% confidence level are reported below.

Overall, the results of WTP_{wa} in Table 8 suggest that when an online meeting is applicable, the WTP_{wa} for the time saved at the checkpoint increases from HK\$19.32/min to HK\$38.51/min, as passengers become more averse (less supportive) to health control measures. The WTP estimates for the time saved and for the elements of the airport health control measures seem relatively high. Because our study is among the first of relevant quantitative analysis, we reviewed previous estimates of other safety and security features, and found our empirical results are overall consistent with previous studies. Veisten and Flügel (2011) conducted a stated preference survey pre-COVID in Norway. Their estimated WTP for the travel time saving in air travel was about 47.9 NOK/min (approx. HK\$45/min). Patil et al. (2016) conducted a pan-European study to assess the public’s preference for security and surveillance measures in train station. The estimation for the “time to go through security checks” and “security surcharge on top of ticket cost” indicated a WTP of 5.45 Euro/min (approx. HK\$54/min) for the high-income travellers. Merkert and Beck (2017) revealed that the WTP of business travellers for air travel was two times higher than that of leisure travellers. Without including the attribute of security check at the airport in the choice scenario, the value of time saved can reach AU\$312/hr (approx. HK\$31/min) for business travellers. Later, Beck et al. (2018) estimated passengers’ preference towards the elements of the airport security process, and found a median WTP of AU\$ 7.83/min (approx. HK\$47/min) for the time saving at security checkpoint.

When an online meeting becomes applicable, traveller’s willingness to pay to avoid the travel inconveniences increases. In other words, the monetary value to compensate potential business travellers for the health screenings increases due to the applicability of online meetings. For example, the WTP_{wa} to avoid the requirements of compulsory mask-wearing and testing at airport are HK\$2,488 and HK\$2,989, respectively. For policymakers, this implies a possible reduction in air ticket prices in order to compensate for the utility ascribed to online meetings (e.g., timesaving, flexibility, and convenience). Despite that the compensation values for health control measures are fairly high, our estimates seem to be within reasonable ranges, and are comparable to estimates obtained by

Table 8

Wald Test for the Weighted Average WTP (WTP_{wa}).

Attributes	Online meeting inapplicable		Online meeting applicable	
	WTP_{wa} (HK\$)	Z value	WTP_{wa} (HK\$)	Z value
Time taken in health and security checks	19.32*	1.91	38.51**	2.09
Compulsory mask wearing at the airport, but no requirements during flight	n.s.	–	2487.92*	1.94
Tests involving sample collection	n.s.	–	2988.92*	1.79

Note: **, *Significance at 5%, 10% level respectively.

Table 9Wald Test for the Weighted Average Trade-offs (RR_{wa}) between Health Control Measures and Time when online meeting is inapplicable.

Attributes	Coefficient	Z value
Provide vaccination record	20.6**	2.28
Provide personal information, self-reported travel history, symptoms	-60.5***	-5.59
Tests involving sample collection	38.3***	2.78
Temperature screening	n.s.	-

Note: ***, **Significance at 1%, 5% level respectively.

limited previous studies. For example, [Jonas et al. \(2010\)](#) found a WTP of US\$ 263 (approx. HK\$2,065) to avoid the time spent and discomfort associated with health screening.

Overall, the results of weighted average trade-offs between health screening procedure and time in [Table 9](#) suggest that when an online meeting is inapplicable, the coefficient of the trade-off (RR_{wa}) between providing vaccination record and time is 20.6. Thus, travellers are willing to spend up to 20.6 mins to undertake this health screening procedure. That is, considering the improved health safety vs. the extra time involved, a traveller would be indifferent if the vaccination record check takes 20.6 mins to finish, otherwise the traveler will be better off (worse off) if the time involved is less (more) than 20.6 mins. Similarly, travellers are willing to spend up to 38 mins to undertake the onsite tests involving sample collection. On the other hand, the extra burden of providing personal information, self-reporting travel history and symptoms need to be compensated by a reduction of 60 min' processing time at airport checkpoints to make the traveler indifferent. These results seem to be in line with other estimations. For example, [Veisten and Flügel \(2011\)](#) estimated the trade-off between risk-based screening and the time use, and found that air travellers will accept a new risk-based screening control if it helps reduce the processing time by about 20 min. Hence, more efficient methods for self-reported health declarations are recommended, such as filling out personal health information online 24 h prior to boarding, rather than providing paper materials for manual check on-site. We also conducted a WALD test for the trade-offs between different health screening procedures and time when online meeting is applicable. However, no statistically significant results were found. As such, it should be noted that the amount of time that travellers are willing to spend on health screening procedures may be overestimated, as their tolerance for extra time decreases when an online meeting becomes available.

6. Conclusion and recommendations

To study the pandemic's implications for business travel, a stated preference survey was conducted over potential air travellers in Hong Kong. Our analysis suggests that there are different traveller subgroups as classified by their preferences for the pandemic control and health related measures, with their attitudes significantly affected by the availability of online meetings.

When an online meeting is inapplicable, nearly 75% of the respondents prefer to travel abroad for business and favour health control measures. These measures, and the associated high cost/fare, are perceived as valuable and necessary to lower the risks of infection during air travel. In this context, these passengers were identified as "captive" users of air transport. Based on the previous definitions of "captive" and "choice" transit riders ([Beimborn et al., 2003](#); [Krizek and El-Geneidy, 2007](#); [Srinivasan et al., 2007](#)), this study defines captive business travellers as those who must have the air travel to make a desired business trip, and choice business travellers as those who have the online meeting option to achieve the same trip outcomes, yet for certain reasons, they prefer to have a business trip by air. When the online meeting is applicable, the share of "choice" business passengers accounts for 45.3%. Compared to the other class, these business travellers are characterized with stronger preference for face-to-face meeting, lower risk perception, richer travel experience before and amid the pandemic, and less extensive use of online meeting. More importantly, they become more sensitive to the increased price and time associated with health control measures. Also, they are averse to the requirements of providing a vaccination record, mandatory mask-wearing at the airport, and onsite health checks, when an online meeting is applicable.

When online meeting is inapplicable, it is recommended that the procedures for providing vaccination records and performing onsite testing should be completed in less than 21 min and 38 min, respectively, to allow for a more pleasant air travel experience. On the other hand, travellers are willing to accept the screening control of providing personal information, self-reported travel history, symptoms as long as the time spent at airport checkpoint can be reduced by about 60 min. As discussed earlier, the amount of time that travellers are willing to spend on health screening procedures may be overestimated, as their tolerance for time reduces when an online meeting becomes available. Overall, it seems reasonable to conclude that business travel demand will not be significantly reduced if airport health control measures can be finished within 20 min or so.

Our findings are generally consistent with those of previous transit research and analysis, suggesting that changes in service influence the transit ridership of both captive and choice users, while choice users tend to be more sensitive towards the service quality as they can choose not to use the system given the existence of the alternative mode ([Jin et al., 2005](#)). As the motivation of this study, the history of airport security suggests that security attacks often prompted new security measures. Therefore, new bio-security measures (i.e., passenger health screening) based on the lesson learnt during the COVID-19 pandemic are likely to be introduced as normal features at airports. Findings from this research are expected to provide insights into potential changes in passenger demand due to the introduction of health control services for air travel in the New Normal and the inevitable era of online meetings.

These results suggest a relatively positive outlook for business travel demand from captive business travellers. The key to the recovery of business travel lies in the demand from those choice business travellers, i.e., 45.3% of the sample identified in this study.

Although they still show a higher intention to undertake air travel when an online meeting is applicable, they are averse to the health screening procedures (e.g., providing vaccination record, onsite health checks) and need to be compensated to sustain the same travel demand. Also, these choice business travellers are more likely to cancel air travel if they are older or female, possibly stemming from concerns about vaccine safety. Therefore, medical exemption certificates for COVID-19 vaccinations should be accepted for international air travel in certain instances. As such, it is important and justified for government agencies to make the pandemic control and health measures efficient and smooth, even if this would involve extra costs and investment, because the value of time saved at check points is very high. For health screening operations, it is important for stakeholders in different countries to cooperate in order to facilitate seamless control and pleasant travel experiences. Moreover, targeted promotion and discounts for the choice business travellers have merit based on customer characteristics (e.g., male, younger, married, personality, etc.) and travel experience. Furthermore, governments should consider sharing the costs associated with pandemic control, or to provide direct financial support to the aviation industry to facilitate the recovery, as the aviation industry will face a “double-hit” problem (i.e., operation costs and processing time will increase due to control measures; the resultant inconvenience, extra time and costs will further reduce travel demand). Airlines should also consider cooperative arrangements more favorably. The extra time and inconvenience associated with health control reduces travel demand and traffic volume, resulting in reduced flight frequency. This would increase travelers’ average “schedule delay” and thus reduce service quality (Richard 2003; Wang et al. 2014; Zhang et al. 2017). Cooperative arrangements such as code-sharing would partially address the schedule delay issue in addition to enhancing airline capacity utilization.

Although our conclusions are obtained with updated data and rigorous analysis, it should be noted that the passenger preference analysis focused on business travel based on survey over respondents in Hong Kong. More in-depth analysis focusing on specific markets is needed for the optimal design of policies and strategies (Czerny et al., 2021). It would be also useful to conduct in depth investigation using a larger sample, although such an extension is beyond the scope of the current study. In future studies, it will be worthwhile to apply some behavioural theories such as the theory of planned behaviour (TPB; Ajzen, 1991) and protection motivation theory (PMT; Rogers, 1983), to better link preference heterogeneity to attitudinal indicators, which could be investigated using a hybrid logit model (Balbontin et al., 2022).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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