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Covid-19 vaccines, rules, deaths, and tourism recovery

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Article info

Abstract

This study explores whether vaccination coverage, social distancing rules, and COVID-19 death rate affect tourism recovery using data from 249 countries/territories. We used panel data regression techniques—namely Fixed-effects, Hausman-Taylor, and Instrumental Variables regressions for the empirical analysis. Results show that a higher vaccination coverage is not necessarily accompanied by a higher tourism recovery. Similarly, a higher level of stringency restriction hinders tourism recovery. Results also indicate that a lower death rate helps to promote tourism recovery in developed economies. These results suggest that vaccination coverage alone is not the magic bullet for restarting the tourism industry. Policymakers should consider a mix of effective vaccination administration accompanied by the use of therapeutics to lower the COVID-19 death rate.

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Introduction

Prior to the outbreak of COVID-19, the tourism industry had become one of the crucial sectors in a world of increasingly economic interconnections. It contributed about 10% of world gross domestic product (GDP) and at least 320 million jobs globally (Behsudi, 2020). The tourism industry also helped to stimulate economic activities through its multiplier effects on affiliated sectors in the economy (Okafor, Adeola, & Folarin, 2021). Following the COVID-19 outbreak, and the introduction of restrictions on international travel by most countries as well as restrictions on domestic mobility through social distancing rules, the tourism industry is virtually at a standstill.

The introduction of international travel restrictions has caused severe disruptions in the global tourism industry. As of February 2021, around 32% of all destinations globally closed their borders completely for international tourism. Partial closure of borders—either one or a mixture of borders are closed: air, land, or sea, but not all—are implemented in about 34% of all destinations, while around 2% of destinations have removed all COVID-19 induced restrictions (UNWTO, 2021). On the domestic front, many countries imposed different degrees of social distancing measures—such as stay-at-home policies and curfews, to limit the spread of COVID-19 and help to reduce the burden on the healthcare providers (Milani, 2021). These measures have also brought almost a halt to domestic tourism flows.

Evidence from a recent study suggests that the negative effect of COVID-19 pandemic on the tourism sector will be unmatched by impacts of past pandemic events. Under the best-case scenario, the pandemic is projected to cause a fall of around −2.93 to −7.82 percentage points on average in the travel and tourism total contribution to GDP. Employment is projected to drop by about −2.44 to −6.55 percentage points (Skare et al., 2021).

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Given the destructive impacts of the COVID-19 pandemic, it is important to investigate factors that could help to revive or delay the recovery of the tourism sector from the pandemic. One of such factors is the level of vaccination coverage across countries. The potential effect of vaccination coverage on tourism recovery seems ambiguous. On the one hand, the return of tourism activities is more likely to depend on the success of the COVID-19 vaccination campaign within and across countries (Williams et al., 2021). For example, Harris (2021) finds that higher vaccination coverage is related to smaller COVID-19 incidence and hospitalizations per 100 cases in a case study of most populous US counties. This suggests that vaccination is more likely to lower the risk of exposure to COVID-19 and in turn may help to revive the tourism industry.

On the other hand, the uneven distribution of COVID-19 vaccines across countries (Trotsenburg, 2021), as well as different levels of efficacy of vaccines (Rotshild et al., 2021), used in different countries may affect the impact of vaccination coverage on COVID-19 risks. In the presence of high COVID-19 risk, vaccination coverage may not help to jumpstart the tourism industry, at least in the short term. While vaccination has been advocated as one of the possible ways for jumpstarting the tourism industry, little is known about the influence of vaccination coverage on tourism recovery.

The COVID-19 death rate is a potential determinant of tourism recovery. A significant number of tourists are less likely to demand tourism services when the death rate from COVID-19 is high. This is in line with a finding from a recent study showing that tourists’ travel risk and management perception is highly associated with evading overcrowded locations due to COVID-19 pandemic (Rahman et al., 2021). In addition, the impact of death toll on tourism recovery depends on whether the price effect or the income effect of the pandemic dominates. The influence of the COVID-19 death rate on tourism recovery has not been explored in the extant literature. A few studies, however, have considered why COVID-19 fatality rates differ across countries or the link between COVID-19 death rate and international tourism flows. For instance, Banik et al. (2020) find that the main determinants of fatality rates across countries include population age structure, poverty, public health infrastructure, among others.

The stringency of lockdown measures may be an important determinant of tourism recovery, though its impact appears to be ambiguous. On the one hand, high levels of stringent measures may lower the number of COVID-19 cases, as well as infections and mortality rates (Violato et al., 2021), but may not help to promote tourism recovery. It is likely that the higher the level of stringency measures, the lower the demand and supply of tourism services. On the other hand, a high level of stringent measures may lower COVID-19 risk through its dampening effect on infections and mortality rates and thus may help to revive the tourism industry. Analogous to vaccination coverage and COVID-19 death rate, little is known about the influence of stringency measures on tourism recovery.

In view of the foregoing, this study investigates whether vaccination coverage, social distancing rules, and COVID-19 death rate affect the recovery of the tourism industry using cross-country dataset. This includes examining if the effects of vaccination coverage, social distancing rules, and death rate vary for developed and less developed economies or more vaccinated and less vaccinated economies. We used panel data regression techniques—namely Fixed-effects, Hausman-Taylor, and Instrumental Variables regressions for the empirical analysis. We also present a theoretical model explaining the possible links between vaccination coverage, social distancing rules, COVID-19 death rate, and tourism recovery.

This study contributes to the literature by showing that a higher vaccination coverage is not necessarily accompanied by a higher tourism recovery. This implies that vaccination coverage would have a lag effect in terms of tourism recovery. Vaccination needs to substantially dampen the death rate from COVID-19 for it to propel tourism recovery. Furthermore, it contributes by showing that COVID-19 death rate has a significant negative impact on tourism recovery in developed economies and economies with high vaccination coverage especially when the overall index is used to capture tourism recovery. In contrast, the impact of death toll on tourism recovery is insignificant in less developed economies and economies with low vaccination coverage regardless of the measure used to capture tourism recovery. This suggests that a lower death rate is very important for the recovery of the tourism industry in developed economies and economies with high vaccination coverage.

The findings also indicate that a higher level of stringency restriction hinders tourism recovery. Additionally, this study contributes to the literature by developing a theoretical model that rationalizes the influence of vaccination coverage, stringency measures, and COVID-19 death rate on tourism recovery from the pandemic. The theoretical model suggests that COVID-19 death toll, stringency index, and vaccination coverage have ambiguous effects on tourism recovery. The impacts depend on whether the income effect or the price effect of the pandemic dominates.

The remainder of the study is arranged as follows. The review of related literature is presented in the second section. The theoretical model is developed in Section three. Section four discusses the data sources and variables used in the empirical analysis, while section five describes the methodology. Section six discusses the preliminary evidence using Figures, while section seven discusses the results of the empirical analysis. The final section concludes with theoretical and empirical policy implications of the study.

**Review of related literature**

There are replete of studies in the strand of literature that deals with the impact of the COVID-19 pandemic on the tourism sector (Foo et al., 2020; Gössling et al., 2021; Milani, 2021). For instance, international tourism flow has been identified as one of the major channels for the transmission of COVID-19 across national borders. A recent study found that countries with a high level of connectedness in terms of international tourist flows registered a higher number of confirmed COVID-19 cases and death tolls (Farzanegan et al., 2021).

To prevent the spread of COVID-19, many countries introduced strong restrictive measures. The restrictive measures in turn have led to a dramatic fall in socio-economic activities in both developing and developed countries (Kawohl & Nordt, 2020). A
fall in socio-economic activities, in turn, leads to rising unemployment and poverty rates in many countries, especially in developing countries. This is consistent with the estimate from the ILO (2020), that around 25 million jobs could be wiped out by the COVID-19 pandemic. This implies that millions of individuals could be pushed into unemployment, underemployment, and poverty.

Similarly, another estimate indicates that in the worst-case scenario, global unemployment would rise from 4.94% to 5.64%, which in turn results in an increase in suicides of around 9570 annually. In the best-case scenario, unemployment would rise by around 5.01%, whereas suicides would rise by 2135 (Kawohl & Nordt, 2020). Moreover, the sharp fall in tourism activities due to COVID-19 and resultant unemployment is likely to be more pronounced in low-income economies. This is consistent with the evidence that pandemics dampen tourist arrivals, but this effect holds in low-income economies (Karabulut et al., 2020).

While some studies have explored the interplay between stringency restriction and stock returns or mental health, the link between stringency restriction and tourism recovery has not been explored in the existing literature. For example, Chen et al. (2020) find that stringency of government restrictions has a depressing effect on stock returns using data from listed companies in the U.S. There is also some evidence that higher levels of stringent measures are associated with increased feelings of depression or mental health issues among older individuals using survey data from Europe and Israel (Voss et al., 2021).

Given the devastating impact of the COVID-19 pandemic on different sectors of the economy, especially the tourism sector, emerging literature focuses on the determinants of tourism recovery from the pandemic. The emerging evidence is mixed and inconclusive (Gulati, 2021). For instance, there is some evidence that COVID-19 vaccination may lead to the emergence of vaccine tourism. Positive sentiments in favour of vaccine tourism accounts for 28.14% of 12,258 emotions that were captured, that dominate the recovery of the tourism industry from the pandemic has not been explored. This includes examining if the impacts of vaccination, stringency of lockdown measures and death rate differ by stage of development and level of vaccination coverage. This study attempts to cover these gaps in the extant literature.

Model

There is a representative household, whose head has the endowments of time and money. The monetary endowment is allocated between leisure and consumption of commodity. The time endowment is allocated for work or leisure, while the remaining time is idle—neither utilized for work or leisure due to the influence of COVID-19 pandemic. We can capture the idle time as the unemployment in the economy. The time not used for work or leisure turns into a loss of productivity/welfare. Let \( t \) denote the time endowment of the household; \( t \) is the work time, \( t \) is the leisure time and \( w \) the wage rate. We can express the monetary loss due to the reduction of working time as \( z = w(l-t)-t \). Our model shares a similar setup with Larson and Shaikh (2004) in terms of the assumptions of time and monetary constraints. Furthermore, we resolve the optimization of household indirect utility function like the authors. However, we additionally take account of the monetary loss due to the reduction of working time in the household head’s time constraint.

While the household head’s working time decreases with the spread of the COVID-19, it is also affected by the use of vaccination coverage (denoted by \( \theta \)) and the policy of social distancing (denoted by \( \Omega \)). We define \( t \) as a negative function of the number of COVID-19 deaths (denoted by \( D \)). Although, we consider vaccination coverage and social distancing policy as determinants of working time, we do not specify their influences on working time. This is because while a social distancing policy has a direct negative effect on working time, it may also lead to the recovery of working time possible by mitigating the impact of the COVID-19 pandemic. Based on the above discussion, we define \( t = t(D(\theta,\Omega),\theta,\Omega) \), where \( \frac{\partial t}{\partial \theta} \leq 0 \), but the influences of \( \theta \) and \( \Omega \) on \( t \) are not specified.
Variables influencing the household head’s utility (denoted by $U$), include his or her consumption (denoted by $\chi$), the monetary loss due to the reduction of working time, $t$, and COVID-19 deaths, $D$, leisure time, $\lambda$, and working time, $t$, which as noted is affected by vaccination coverage, $\theta$, and social distancing policy, $\Omega$. We express $U$ as $U(x, t, \lambda, D)$. Household utility decreases with $D$ due to the harm resulting from COVID-19 deaths. It increases with $x$ due to consumption satiation and $t$ due to the enjoyment of leisure. It decreases with working time, $t$, that requires the household head to bear the boredom and triviality of work while sacrificing his/her leisure time.

It is worthwhile to note that the influence of $D$ on $U$ is presumed in our study. The assumption of damage on an individual’s utility is commonly used in the literature on the environment and resource (See, Bazhanov, 2012). Differently, the influence of COVID-19 deaths, $D$, on work time, $t$, is derived from the Roy’s inequalities obtained using the first-order conditions for the representative individual’s utility function. The derived result implies that an individual’s health may influence his/her work time and thus leisure demand. Nevertheless, the influences of $\theta$ and $\Omega$ on $U$ are not clear due to the earlier discussed unclear effects on working time, say $t = t(D(\theta, \Omega), \theta, \Omega)$.

The household’s wage income is expressed as $wt$. Let $p$ denote the price of commodity and $v$ the price of leisure per unit of time. We express the budget of the household as $w=px+tv$. Additionally, we express the indirect utility function as $U(p,w,v,z,\theta,\Omega)$. The optimization of the household head can be written as the following function of $p$, $w$, $v$, $z$, $\theta$, and $\Omega$:

$$U(p,v,w,z,\theta,\Omega) + \lambda(wt−px−tv) + N[w((l−t)−t)−z]$$

(1)

Define $\epsilon_{wU} = \frac{\partial U}{\partial p}$ as the household head’s responsiveness of welfare to one percentage increase in wage rate, $\epsilon_{wU} = \frac{\partial U}{\partial w}$ as the household head’s responsiveness of welfare to one percentage increase in the monetary loss due to the reduction of working time, $\epsilon_{tu} = \frac{\partial U}{\partial t}$ as the household head’s responsiveness of welfare to one percentage increase in the price of leisure, and $\epsilon_{pU} = \frac{\partial U}{\partial p}$ as the household head’s responsiveness of welfare to one percentage increase in commodity price. We assume $\epsilon_{wU} > 0$ and $\epsilon_{wU} > 0$ to reflect the positive influence of higher wage on utility, $\epsilon_{tu} > 0$ and $\epsilon_{tu} > 0$ to reflect the negative influence of monetary loss on utility, $\epsilon_{tu} > 0$ and $\epsilon_{tu} > 0$ to reflect the negative influence from a higher price of leisure on utility, and $\epsilon_{pU} > 0$ and $\epsilon_{pU} > 0$ to reflect the negative influence from a higher commodity price on utility. While the negative influence of COVID-19 deaths on health is reflected in $U_D = \frac{\partial U}{\partial D} > 0$, an increase in $D$ is assumed to further aggravate the negative influences of $v$, $p$, and $z$, making the negative values of $U_t$, $U_p$, and $U_v$ even smaller, that is, $U_{tD} = \frac{\partial U}{\partial D} > 0$, $U_{pD} = \frac{\partial U}{\partial D} > 0$, and $U_{vD} = \frac{\partial U}{\partial D} > 0$. For this reason, $\frac{\partial U}{\partial U_t} = \frac{\partial U}{\partial D} > 0$, $\frac{\partial U}{\partial U_p} = \frac{\partial U}{\partial D} > 0$, and $\frac{\partial U}{\partial U_v} = \frac{\partial U}{\partial D} > 0$. That is, an increase in the number of COVID-19 deaths would make monetary loss, $z$, and the high prices of commodity and leisure, that is, $p$ and $v$, that the household head disturbs to be less distasteful. In contrast, a higher income level allows the household head to enjoy better healthcare during the COVID-19 pandemic and thus brings him/her a higher marginal utility. That is, $U_{wD} = \frac{\partial U}{\partial D} > 0$. Thus, $\frac{\partial U}{\partial U_t} = \frac{\partial U}{\partial U_v} = \frac{\partial U}{\partial U_p} > 0$. That is, an increase in the number of COVID-19 deaths would make a higher wage pursued by the household head more valuable to him/her.

Using the first-order conditions for Eq. (1), we can derive that

$$t = At$$

where $A = \frac{\epsilon_{wU}(\epsilon_{tu}+\epsilon_{vU})}{\epsilon_{tu}^2} \frac{V}{W}$

(2)

The determinants of this Equation are $\epsilon_{wU}$, $\epsilon_{tu}$, and $\epsilon_{vU}$ that reflect the response of household utility, $U$, to changes in $z$, $v$, and $w$.

Eq. (2) implies that the utility of the household head is more responsive to the increase in wage growth than the growth of monetary loss, $z$, that is, $\epsilon_{wU} > \epsilon_{zU}$. Given that $t \geq 0$, $t \geq 0$, $\epsilon_{wU} \geq 0$, $\epsilon_{tu} \leq 0$, and $\epsilon_{vU} \leq 0$, Eq. (2) implies that $\frac{\partial U}{\partial t} = -1$, that is, $\epsilon_{wU} \geq 1$ $\epsilon_{zU}$. We can express $A$ as $A = A(p,v,w,z,\theta,\Omega)$, given that the indirect utility function of the household head is written as $U(p,v,w,z,\theta,\Omega)$. Then, Eq. (2) also manifests the importance of vaccination coverage, $\theta$, and social distancing policy, $\Omega$, in the determination of working time, $t$, at given leisure time, $\lambda$. Furthermore, assume constants, $w$ and $v$ (due to wage and nominal rigidities) and constants, $\epsilon_{wU}$, $\epsilon_{tu}$, and $\epsilon_{vU}$ (due to changeless household preference), Eq. (2) implies a linear relationship between working time, $t$, and leisure time, $\lambda$. Thus, even though $t$ and $\lambda$ do not add up to 1, a change in COVID-19 deaths would simultaneously affect both. It is worthwhile to note that the assumptions of wage and nominal rigidities and changeless household preference holds throughout this article and are crucial for deriving our theoretical findings.

Using Eq. (2) and the first-order conditions for Eq. (1) with respect to $p$ and $v$, we obtain that

$$\frac{px}{Wt} = -\frac{\epsilon_{pU}}{\epsilon_{tu}} \left(\frac{\epsilon_{tu}}{\epsilon_{tu}} + \frac{\epsilon_{vU}}{\epsilon_{tu}}\right)^{-1}$$

(3)

This Equation suggests a constant ratio of household consumption to its total wage income in equilibrium. The determinants of this ratio are the household head’s responsiveness of welfare to changes by one percentage in commodity price, $p$, wage rate, $w$, and the monetary loss of the time spent not working, $z$.

Since $l$ is the household head’s time endowment, the product of $w$ and $l$ can be considered as the household head’s earning capacity under an intertemporal framework. The concept of ‘earning capacity’ is in line with the definition of Horner and
Slesnick (2016) about the anticipated earnings of an employee that opts to maximize the projected present value (PV) of actual earnings in the future period. Taking into account monetary loss, \( z \), we can further derive the household head’s earning capacity during the COVID-19 pandemic, (denoted by \( y \)) as:
\[
y = \left( w - \frac{\epsilon_{dU} + \epsilon_{wU}}{\epsilon_{U}} \right) \bar{t}, \text{ where } y = wI - z
\]
where \( \frac{\epsilon_{dU} + \epsilon_{wU}}{\epsilon_{U}} \) reflects the responsiveness of the household head’s utility with respect to the changes in monetary loss, \( z \), wage rate, \( w \), and the price of leisure, \( v \), during the COVID-19 pandemic. This composite effect determines the post-COVID-19 price of leisure, changing it from \( v \) to \( \frac{\epsilon_{dU} + \epsilon_{wU}}{\epsilon_{U}} v \). The difference between \( w \) and \( \frac{\epsilon_{dU} + \epsilon_{wU}}{\epsilon_{U}} v \) is considered as the wage rate received by the household that can be used for the satiation of consumption other than leisure. Thus, the product of \( \left( w - \frac{\epsilon_{dU} + \epsilon_{wU}}{\epsilon_{U}} v \right) \bar{t} \) is the household’s income available for consumption other than leisure. The equality between \( y \) and \( \left( w - \frac{\epsilon_{dU} + \epsilon_{wU}}{\epsilon_{U}} v \right) \bar{t} \) means that the outbreak of COVID-19 pandemic is at the price of leisure, while the household tries to make its commodity expenditure less affected by the disease.

Given earning capacity \( y \), we can express leisure time \( \bar{t} \) as follows using Eq. (4):
\[
\bar{t} = \left( w - B(D; \theta, \Omega) v \right)^{-1} y, \text{ where } B(D; \theta, \Omega) = \frac{\epsilon_{dU} + \epsilon_{wU}}{\epsilon_{dU}}.
\]
In this Equation, \( B(D; \theta, \Omega) = \frac{\epsilon_{dU} + \epsilon_{wU}}{\epsilon_{dU}} \) is an explicit function of \( D \) because \( \epsilon_{dU}, \epsilon_{vU}, \text{ and } \epsilon_{wU} \) are derived from utility function, \( U(D, \cdot) \); however, it is an implicit function of \( \theta \) and \( \Omega \) because we derive \( \epsilon_{dU}, \epsilon_{vU}, \text{ and } \epsilon_{wU} \) from indirect utility function, \( U(p, v, w, z, \theta, \Omega) \). (Note that, \( \epsilon_{wU} + \epsilon_{dU} > 0 \) as discussed for Eq. (2).)

The recovery of COVID-19 arises alongside the decrease of COVID-19 deaths, \( D \), or vaccination coverage, \( \theta \). While vaccination coverage, \( \theta \), helps to reduce COVID-19 deaths, \( D \), we look at their influences separately. Taking the derivative of \( \bar{t} = \left( w - \frac{\epsilon_{dU} + \epsilon_{wU}}{\epsilon_{dU}} v \right)^{-1} y \) with respect to \( D \) gives that
\[
\frac{d}{dD} \bar{t} \equiv \frac{\left( \frac{d}{dD} \epsilon_{dU} + \frac{d}{dD} \epsilon_{wU} \right)}{\left( y \right)^{2}} - \frac{\left( \frac{d}{dD} \epsilon_{wU} \right)}{\left( y \right)^{3}} - \frac{\epsilon_{dU} \epsilon_{wU} \left( \frac{d}{dD} \epsilon_{wU} \right)}{\left( y \right)^{2}}
\]
According to Eq. (5), \( \frac{d}{dD} \bar{t} > 0 \) only if \( \frac{d}{dD} \epsilon_{dU} + \frac{d}{dD} \epsilon_{wU} < 0 \). Because \( \frac{d}{dD} \epsilon_{wU} \geq 0 \) and \( \frac{d}{dD} \epsilon_{dU} \leq 0 \), this means that leisure time decreases with a decline in COVID-19 deaths only if a change in COVID-19 deaths enhances the household head’s valuation of a higher wage to a higher degree than his/her distaste for the monetary loss due to the pandemic. Under this circumstance, the household head may increase his/her work time but spend less time for leisure.

Moreover, \( \frac{d}{dD} \epsilon_{dU} + \frac{d}{dD} \epsilon_{wU} > 0 \), guarantees the holding of \( \frac{d}{dD} \bar{t} < 0 \). This means that, if a decline in COVID-19 is followed by more leisure time, a change in COVID-19 deaths enhances the household head’s distaste for the monetary loss due to the pandemic to a higher degree than his/her valuation of a higher wage.

Eq. (5) suggests that the link between COVID-19 death toll and tourism recovery is ambiguous. It reflects the importance of income effect and price effect of the pandemic on the link between death toll and tourism recovery. The effect of COVID-19 death depends on whether the income effect or the price effect of the pandemic dominates. For instance, even if the death rate from COVID-19 decreases, people may not necessarily spend more time for travel. This can be explained by either higher price of tourism and travel services during and/or post-COVID-19 pandemic or job losses induced by the pandemic.

Analogously, the link between vaccination coverage or stringency index and tourism recovery is also ambiguous. This is realized if we take the derivative of \( \bar{t} \) with respect to \( \theta \) and with respect to \( \Omega \) respectively. This suggests that the impact of vaccination coverage, or stringency index on tourism recovery depends on whether the income effect or the price effect of the pandemic dominates. Furthermore, empirical estimations would allow us to capture the effects of variables of interest. Eq. (6) below is therefore specified in such a way that tourism recovery is a function of death toll, vaccination coverage, stringency index, and relevant control variables.

**Data sources and descriptions of variables**

The dependent variable for the empirical analysis is leisure demand during the COVID-19 pandemic. We denote the leisure demand of country \( i \) on day \( t \) by Leisure Demand\(_{it} \). This variable is analogous to the leisure time, \( \bar{t} \), from the theoretical model. We used two proxies to capture leisure demand—hotel revenue and COVID19 tourism index. Hotel revenue is measured as the log value of country \( i \)’s revenue per available room on day \( t \) (denoted by Hotel\(_{it} \)). The other proxy for leisure demand is the log value of country \( i \)’s COVID19 tourism index on day \( t \) (denoted by Overall\(_{it} \)). COVID19 tourism index captures the recovery level of the tourism and travel industry from the COVID-19 pandemic compared to the non-crisis period without COVID-19 (Yang et al., 2021). The data for theCOVID19 tourism index and hotel sub-index are for the period 1 February 2020 and 10 April 2021. The data for both variables are made available by Yang et al. (2021).

The COVID19 tourism index is specifically designed to monitor the recovery level of the tourism industry from the impact of the pandemic. By construction, the index is comparable across countries depending on the number of countries in the sample.
Statistical descriptions of all data used for the construction of the overall index and sub-indices did not change over the duration of the study and across countries. The COVID19tourism index, (overall index), is derived using the geometric mean of three sub-indices—aviation, pandemic, and hotel. The hotel and aviation sub-indices capture the level of performance in two key sub-sectors of the tourism industry (Yang et al., 2021). This suggests that the overall index and hotel sub-index can be used as proxy to capture the recovery level of tourism demand or leisure time during the pandemic. Hotel index is useful for capturing mainly domestic tourism demand in the presence of international travel restrictions. The revival of the tourism industry in most countries is likely to driven largely by the recovery of the domestic tourism industry at least at the initial stage of recovery, which would be reflected in hotel revenue. Analogously, the revival of both domestic and international tourism demand is captured by the overall index—the COVID19tourism index.

In line with the theoretical model, we used three explanatory variables that have potential influence on tourism recovery from the pandemic. One of the explanatory variables is log value of country i’s total COVID-19 deaths per million population on day t. Higher number of COVID-19 deaths is more likely to delay tourism recovery. Amidst a high risk of death from COVID-19, most tourists are more likely to postpone or cancel their travel plans and this would act to hinder tourism recovery.

The second explanatory variable is the log number of country i’s vaccinated people per million population on day t. The potential impact of vaccination coverage on tourism recovery is ambiguous. On the one hand, a higher vaccination coverage may help to jumpstart the tourism industry. This is in line with evidence that higher vaccination coverage helps to lower COVID-19 incidence and hospitalizations (Harris, 2021). A lower COVID-19 incidence and hospitalizations would be associated with lower risk perception by tourists and in turn the revival of tourism activities. On the other hand, the different levels of efficacy of vaccines used in different countries as well as the uneven distribution of vaccines across countries (Trotsenburg, 2021; Rotshild et al., 2021), may dampen the impact of vaccination coverage on tourism recovery. Assuming that the vaccination coverage lags COVID-19 deaths due to uneven distribution of vaccines and/or different levels of efficacy of vaccines, the impact of higher vaccination may be negative at least in the short term.

The third explanatory variable is the log of country i’s stringency index value on day t, Stringencyt. The level of stringency measures is likely to influence tourism recovery, though the impact on tourism recovery may be ambiguous. On the one hand, a higher level of stringency measures would help to lower infection and mortality rates (Violato et al., 2021), but may not create an enabling environment for tourism recovery. On the other hand, a higher level of stringency measures may help to lower infection and mortality rates and thus act to promote tourism recovery.

The data for the explanatory variables are collected from Our World Data (https://ourworldindata.org/coronavirus). These variables are time-variant. The data for these variables are for the period 1 January 2020 to 17 September 2021. We also control for all countries’ GDP per capita in 2017 in the Hausman-Taylor Specification. This is because richer countries are more likely to devote more resources to contain the spread of COVID-19 compared to poorer countries. We denote country i’s GDP per capita by GDPpci, The data for GDPpc are collected from the World Bank (https://databank.worldbank.org/). It is worthwhile to note that GDPpc data after 2017 are also available in the World Bank’s dataset. However, the 2017 data are more comprehensive. After merging the data from different sources as discussed above, the sample consists of 249 countries/territories. Summary statistics of all the variables are presented in Table 1.

### Table 1
Summary statistics.

| Variable       | Mean    | STD    |
|----------------|---------|--------|
| Overall        | −85.990 | 66.691 |
| Hotel          | −81.336 | 67.902 |
| Death          | −51.655 | 68.093 |
| Vaccinated     | −124.225| 36.678 |
| Stringency     | −46.930 | 67.294 |
| GDPpc          | 8.755   | 1.483  |

Note: All variables are log transformed. STD denotes standard deviation.
In line with the theoretical framework, the FE model for estimating impacts of death rate, stringency measures, and vaccination coverage on tourism recovery from the pandemic can be specified as follows:

\[
\text{Leisure Demand}_{it} = \alpha_0 + \alpha_1 \text{Stringency}_{it} + \alpha_2 R_{it} + \varnothing_i + \epsilon_{it}
\]  

(6)

where Leisure Demand_{it} is captured using Hotel_{it} or Overall_{it} (COVID19Tourism Index), R is either Death_{it} or Vaccinated_{it} (included separately in the estimations), \varnothing_i is country-specific effects, \epsilon_i is the error term.

In addition to estimating the models for countries in the sample, we also estimated for sub-samples of developed and less developed as well as for more vaccinated and less vaccinated economies. We follow this approach to gain further insights into whether the impacts of vaccination coverage, stringency measures, and death rate on tourism recovery differ by level of development or level of vaccination coverage. To capture the influence of the level of development, we used the Human Development Index (HDI) to classify the sample into two groups.

In general, the HDI captures the level of a country’s human development with the use of three composite indicators—life expectancy, education, and per capita income. Countries are ranked on a scale of 0 to 1—least developed to most developed with the use of the index. The four thresholds used for the classification include—low human development for countries with HDI between 0 and 0.55, medium human development for countries with HDI between 0.55 and 0.70, high human development for countries with HDI between 0.70 and 0.80, and very high human development for countries with HDI between 0.80 and 1.00 (https://worldpopulationreview.com/country-rankings/underdeveloped-countries). In the context of this study, the more developed economies are those with HDI scores no lower than 0.55, while those with scores lower than 0.55 are considered less developed.

We also divided the sample into two groups using the level of vaccination coverage. An economy with a larger average value of vaccination coverage than the average for all the sample economies is considered as more vaccinated, otherwise, it is considered as less vaccinated. More specifically, this classification is derived by comparing a country’s average vaccinated people per million population over the period between 1 January 2020 to 17 September 2021 with average vaccinated people per million for all the countries covered in the sample for the same period.

**Preliminary evidence**

Preliminary evidence from Fig. 1, which plots the COVID19tourism index on the vertical axis and time on the horizontal axis, suggests that the tourism industry is yet to rebound significantly from the impact of the COVID-19 pandemic. In general, COVID19tourism index gauges the potential recovery level of the travel and tourism industry across countries and regions (Yang et al., 2021). As shown in Fig. 1, there was a sharp drop in the demand and supply of tourism services as of the beginning of 2020, and a slight rebound around March 2020. Over the period of March 2020 to April 2021, the recovery level of the travel and tourism industry hovers around 15% to 32% compared to a full recovery level of 100%.

Vaccination coverage alone may not be sufficient to jumpstart the travel and industry if there is no substantial reduction in the COVID-19 death rate. Preliminary evidence from Figs. 2 and 3 suggests that vaccination coverage has not substantially dampened the COVID-19 death rate. The number of vaccinated people per million population lags the total COVID-19 deaths per million population.
population. In addition, different degrees of travel and social distancing rules are likely to be maintained in countries with a high COVID-19 death rate.

Furthermore, the uneven distribution of vaccines poses a serious problem for the recovery of the tourism sector. For instance, while the Africa population accounts for around 17.51% of the global population, merely 2.5% of the 6.4 billion vaccine doses administered worldwide as of October 2021 have been in African countries (Trotsenburg, 2021). Several factors account for the uneven distribution of available vaccine doses globally, such as vaccine production problems, a high level of competition for the limited available doses, and inadequate support from rich countries, among others. This suggests that the effects of vaccination coverage, stringency restrictions, and death rate may differ between developed and less developed economies or more vaccinated and less vaccinated economies.

**Discussion of results**

Table 2 presents the parameter estimates of the link between death rate, stringency measures, vaccination coverage, and tourism recovery from the pandemic for the whole sample in Panels A and B. Parameter estimates obtained with the use of Fixed-effects estimator (FE) are reported in Columns 1 and 3, whereas those obtained with Hausman-Taylor estimator (HT) are presented in Columns 2 and 4. Overall, the parameter estimates from the two estimators are relatively similar.
This resiliency helps to spur tourism recovery from the pandemic (Khalid et al., 2021; Okafor, Khalid, & Burzynska, 2021). A high level of economic stimulus package accompanied by a high level of fiscal and monetary policy interventions to mitigate the impact of the COVID-19 pandemic. In addition, richer economies are found to be more resilient to shocks than poorer economies. This is in line with the evidence that richer economies introduced larger economic stimulus packages in terms of GDPpc (Chen et al., 2020), but it also inhibits tourism recovery from the pandemic.

Table 2: The link between death rate, stringency measures, vaccination coverage and tourism recovery from the pandemic (whole sample).

| Panel A | Dependent variable: Hotel | Dependent variable: Overall |
|---------|---------------------------|---------------------------|
|         | (1)                       | (2)                       | (3)                       | (4)                       |
| Death   | -0.0198***                | -0.0193***                | -0.0281***                | -0.0284***                |
|         | (0.00297)                 | (0.00348)                 | (0.00276)                 | (0.00330)                 |
| Stringency | -0.0494***                | -0.0542***                | -0.0366***                | -0.0400***                |
|         | (0.00373)                 | (0.00443)                 | (0.00347)                 | (0.00420)                 |
| GDPpc   | 15.57***                  | 2.836***                  | 15.09***                  | 2.888***                  |
| Observations | 108,315                  | 81,780                    | 108,315                  | 81,780                    |
| R-squared (within) | 0.005                    | 0.005                     | 0.005                    | 0.4922                    |
| Chi-squared | 489.5                    | 81,780                    | 489.5                    | 4922.2                    |

| Panel B | Dependent variable: Hotel | Dependent variable: Overall |
|---------|---------------------------|---------------------------|
|         | (1)                       | (2)                       | (3)                       | (4)                       |
| Vaccinated | -0.292***                 | -0.318***                 | -0.270***                 | -0.299***                 |
|         | (0.00244)                 | (0.00287)                 | (0.00227)                 | (0.00273)                 |
| Stringency | -0.0324***                | -0.0340***                | -0.0286***                | -0.0297***                |
|         | (0.00272)                 | (0.00317)                 | (0.00254)                 | (0.00301)                 |
| GDPpc   | 17.02***                  | 2.861***                  | 16.45***                  | 2.911***                  |
| Observations | 108,315                  | 81,780                    | 108,315                  | 81,780                    |
| R-squared (within) | 0.121                    | 0.12                      | 0.12                     | 12,461.7                  |
| Chi-squared | 81,780                   | 12,819.3                  | 12,819.3                 | 12,461.7                  |

Notes: (1) Standard errors are in parentheses, country-specific effects are controlled for in all FE estimations; significance levels: * p < 0.05, ** p < 0.01, *** p < 0.001. (2) All variables are log transformed. Basically speaking, we report coefficients of estimates and their standard errors to the third decimal digit. However, for variables which have much smaller absolute values of coefficients and standard errors than other variables, it is reported to the first three significant figures. The accuracy of this mixing way of presentation can be found in Cole (2014) introduction to the rule of rounding number. (3) R-squared values are not large in this table. This is acceptable. A detailed discussion about this issue is provided by Frost (2020), p.131, and can be seen in Frost’s (2020) blog at https://statisticsbyjim.com/regression/interpret-r-squared-regression/.

As shown in Columns 1–4 of Panel A, death rate has a negative impact on tourism recovery, as captured using either the hotel index or COVID19 tourism index. A one percentage change in death rate results in around a 0.02% to 0.03% lower tourism recovery. This implies that a lower COVID-19 death rate is accompanied by a higher tourism recovery. The demand for tourism services—such as hotels, leisure travel—is higher with a lower COVID-19 death toll. In the presence of a high COVID-19 death rate, most individuals are likely to avoid domestic and/or international travel for tourism purposes even if there are no travel bans.

In addition, in the presence of high death rate, most individuals would likely refrain from participating in other forms of recreational activities where maintenance of social distancing is difficult, if not impossible. The finding of this study is supportive of the introduction of travel and mobility restrictions across countries as a tool to prevent the spread of COVID-19 (Gursoy & Chi, 2020). The prevention of the spread of the disease in turn helps to reduce the number of cases and deaths from the disease. This is partly in line with the evidence that a high level of global connectedness in terms of travel is associated with a higher COVID-19 cases and death toll (Farzanegan et al., 2021). This implies that most individuals would prefer not to take part in leisure activities and/or activities that involve crowds—such as tourism activities— at home or abroad to reduce the risk of contracting the disease and/or death from it.

Consistent with expectation, social distancing policy, as captured using stringency index, has a negative impact on tourism recovery. A one percentage change in stringency index results in around a 0.02% to 0.03% lower tourism recovery (Columns 1–4, Panel A). This suggests that strict stringent policies dampen the demand for tourism services, and in turn tourism recovery. This finding shows that the stringency of government restrictions does not only lead to lower stock returns for leisure and travel companies (Chen et al., 2020), but it also inhibits tourism recovery from the pandemic.

As shown in Columns 2 and 4, one percentage change in GDP per capita results in around a 15% to 16% increase in tourism recovery. This suggests that richer economies are better placed to recover faster from the COVID-19 pandemic compared to poorer economies. This is in line with the evidence that richer economies introduced larger economic stimulus packages in terms of fiscal and monetary policy interventions to mitigate the impact of the COVID-19 pandemic. In addition, richer economies are found to be more resilient to shocks than poorer economies. A high level of economic stimulus package accompanied by a high level of resiliency helps to spur tourism recovery from the pandemic (Khalid et al., 2021; Okafor, Khalid, & Burzynska, 2021).

Regarding the parameter estimates reported in Panel B, we used vaccination coverage in lieu of death rate, while other variables are the same as in Panel A. As shown in Columns 1–4 of Panel B, vaccination coverage has a negative impact on tourism recovery. A one percentage change in vaccination coverage results in about a 0.27% to 0.32% decrease in tourism recovery. This finding suggests that vaccination coverage is still not high enough in most countries for vaccines to help to jumpstart the recovery of the tourism industry. Vaccination coverage is yet to catch up with the pace of COVID-19 death. In general, vaccination coverage needs to reduce the risk of COVID-19 death substantially for most tourism activities to commence. This is still not the case, as the
number of vaccinated people per million lags the COVID-19 deaths per million as discussed earlier. This implies that the risk of
death from COVID-19 is still high and this acts to delay the recovery of the tourism industry. Moreover, different levels of efficacy
of vaccines used in different countries suggest that a higher vaccination coverage would not necessarily correspond to a higher
level of tourism recovery. The wide availability of highly efficacious and safe vaccines accompanied by higher vaccination cover-
ages in most countries is needed for the tourism sector to rebound.
Furthermore, vaccine hesitancy, uneven distribution, and/or limited availability of vaccines, especially in developing countries,
limit the influence of vaccination as the main tool to restart the tourism industry. This is partially in line with the evidence that a
key factor that is essential for restarting the tourism industry is the willingness to travel instead of vaccination as discussed pre-
viously (Ram et al., 2021; Williams et al., 2021). This is consistent with the notion that vaccination coverage alone is not enough
to restart the tourism industry, especially in the short run. This implies that the growth rate of vaccination coverage needs to be
higher than the COVID-19 death toll, for vaccination to promote tourism revival, assuming that the vaccines are highly effective
against COVID-19. The parameter estimates of stringency and GDP per capita as reported in Panel B are relatively similar to those
reported in Panel A in terms of both signs and magnitudes.

Table 3 reports the coefficients of the link between death rate, stringency measures, and tourism recovery from the pandemic
by subsamples. As shown in Columns 1, 3, 5, and 7 of Panels A and B, the COVID-19 death rate has a significant negative impact
on tourism recovery in developed economies, whereas its impact is insignificant in less developed economies. Information about
the number of deaths from COVID-19 and other medical complications resulting from the disease is more accessible in developed
economies compared to less developed economies. This suggests that the COVID-19 death toll is more likely to hinder tourism
recovery in developed economies than in less developed economies.

As reported in Columns 2 and 4 of Panels A and B, death rate has an insignificant or a minor negative impact on the hotel
index in more vaccinated economies (indicated by vaccinated = 1), whereas its impact is negative and statistically significant
in less vaccinated economies (indicated by vaccinated = 0). The influence of the death rate is relatively similar when the
COVID19tourism index is used as the dependent variable. In general, tourism recovery, especially in terms of hotel occupancy
appears to be rebounding in more vaccinated economies relative to less vaccinated economies.

As reported in Columns 1, 3, 5, and 7 of Panels A and B, a higher level of stringency restriction hinders tourism recovery more
in less developed economies compared to developed economies. This result holds regardless of whether the hotel index or
COVID19tourism index is used to capture tourism recovery. A high level of digital connectivity in developed economies can
help to mitigate the influence of stringent restrictions on socioeconomic activities compared to less developed economies with
a lower level of digital connectivity. As expected, a higher level of GDP per capita helps to promote tourism recovery in both
developed and less developed economies.

| Table 3 |
The link between death rate, stringency measures and tourism recovery from the pandemic (sub-samples). |

| Panel A. | Developed = 1 | Vaccinated = 1 | Developed = 0 | Vaccinated = 0 | Developed = 1 | Vaccinated = 1 | Developed = 0 | Vaccinated = 0 |
|---------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|
| Death   | -0.0211***    | -0.00984       | -0.00978      | -0.0223***     | -0.0332***    | -0.0279***     | -0.00503      | -0.0274***     |
|         | (0.00392)     | (0.00571)      | (0.00761)     | (0.00431)      | (0.00373)     | (0.00484)      | (0.00713)     | (0.00420)      |
| Stringency | -0.0505***    | -0.0393***     | -0.0684***    | -0.0603***     | -0.0319***    | -0.0160**      | -0.00727***   | -0.0505***     |
|         | (0.00509)     | (0.00702)      | (0.00918)     | (0.00555)      | (0.00484)     | (0.00595)      | (0.00860)     | (0.00541)      |
| GDPpc   | 17.51***      | 18.93***       | 29.80*        | 13.00***       | 15.73***      | 13.62**        | 23.96*        | 15.20***       |
|         | (3.491)       | (4.200)        | (12.90)       | (3.580)        | (3.611)       | (4.486)        | (11.94)       | (3.564)        |
| Number of countries | 210 | 249 | 39 | 249 | 210 | 249 | 39 | 249 |
| Observations | 64,815 | 22,620 | 16,965 | 59,160 | 64,815 | 22,620 | 16,965 | 59,160 |
| Chi-squared | 326.5 | 88.23 | 177.3 | 407.4 | 322 | 95.5 | 197.4 | 396.3 |
| Model   | HT            | HT             | HT            | HT             | HT            | HT             | HT            | HT             |

| Panel B. | Developed = 1 | Vaccinated = 1 | Developed = 0 | Vaccinated = 0 | Developed = 1 | Vaccinated = 1 | Developed = 0 | Vaccinated = 0 |
|---------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|
| Death   | -0.0213***    | -0.00964*      | -0.00978      | -0.0227***     | -0.0320***    | -0.0262***     | -0.00501      | -0.0274***     |
|         | (0.00323)     | (0.00392)      | (0.00761)     | (0.00413)      | (0.00300)     | (0.00321)      | (0.00713)     | (0.00397)      |
| Stringency | -0.0448***    | -0.0342***     | -0.0684***    | -0.0561***     | -0.0284***    | -0.0141***     | -0.0727***    | -0.0470***     |
|         | (0.00412)     | (0.00473)      | (0.00918)     | (0.00528)      | (0.00383)     | (0.00387)      | (0.00860)     | (0.00508)      |
| Number of countries | 210 | 249 | 39 | 249 | 210 | 249 | 39 | 249 |
| Observations | 91.350 | 46.110 | 16.965 | 62.205 | 91.350 | 46.110 | 16.965 | 62.205 |
| R-squared | 0.004 | 0.003 | 0.01 | 0.006 | 0.004 | 0.004 | 0.011 | 0.006 |
| Model   | FE            | FE             | FE            | FE             | FE            | FE             | FE            | FE             |

Notes: See notes under Table 2.
Table 4

The link between vaccination coverage, stringency measures, and tourism recovery from the pandemic (sub-samples).

Panel A. Dependent variable: Hotel

| Developed | Vaccinated | Developed | Vaccinated |
|-----------|------------|-----------|------------|
| 1         | 1          | 0         | 0          |

| Vaccinated | Stringency | GDPpc | Number of countries | Observations | Chi-squared | Model |
|------------|------------|-------|---------------------|--------------|-------------|-------|
| -0.311*** | -0.0241*** | 18.86* | (3.514)             | 64,815       | 10,436      | HT    |
| (0.00309)  | (0.00380)  | (20.50**| (4.218)             | (22,620)     | (2449.9)    | HT    |

Panel B. Dependent variable: Hotel

| Developed | Vaccinated | Developed | Vaccinated |
|-----------|------------|-----------|------------|
| 1         | 1          | 0         | 0          |

| Vaccinated | Stringency | GDPpc | Number of countries | Observations | Chi-squared | Model |
|------------|------------|-------|---------------------|--------------|-------------|-------|
| -0.282*** | -0.0227*** | 19.20* | (2.814)             | 10,436       | 10,230      | HT    |
| (0.00254)  | (0.00314)  | (20.50**| (4.218)             | (22,620)     | (2449.9)    | HT    |

Note: See notes under Table 2.

**Table 4** reports the parameter estimates of the link between vaccination coverage, stringency measures, and tourism recovery from the pandemic by subsamples. The results show that the negative impact of vaccination coverage is lower in developed economies compared to less developed economies when the hotel index is used as the dependent variable (Columns 1 and 3 of Panels A and B; Columns 5 and 7 of Panel B). An exception is observed from the contrast between Columns 5 and 7 of Panel A as the negative influence of vaccination coverage is relatively stronger in developed economies when the COVID19 tourism index is used as a proxy for tourism recovery. This is consistent with the notion that larger vaccination coverage is not necessarily accompanied by tourism recovery. This is because vaccination coverage has not substantially dampened the death rate from COVID-19, as illustrated in Figs. 2 and 3.

Overall, our findings suggest a weaker negative effect on tourism recovery in developed economies compared to less developed economies. The differential negative effects as reported in Columns 5 and 7 of Panel A can be explained by higher exposure to cross-border activities in developed economies compared to less developed economies in the presence of low or modest vaccination coverage. It is worthwhile to point out that the COVID19 tourism index which is used as a proxy for leisure demand captures the influence of cross-border activities heavily—based on an economy’s air flight departure data—compared to a hotel index.

Consistent with expectation, the results indicate that the negative impact of vaccination coverage is lower in more vaccinated economies compared to less vaccinated economies regardless of whether hotel index or COVID19 tourism index is used as the proxy for tourism recovery (Columns 2, 4, 6, and 8 of Panels A and B). Furthermore, the parameter estimates of stringency policy or GDP per capita on tourism recovery are relatively similar to those reported in Table 3 in terms of signs and magnitudes. We carried out several robustness checks. The discussion about the robustness checks and the results of re-estimated models are available in the supplementary materials. For instance, to check the robustness of the estimates, we addressed potential endogeneity issues with the use of instrumental variables estimation approach. We performed several checks to find out if we have a structural break problem. We performed diagnostic checks and found the dataset to be skewedly distributed, serially correlated, and heteroscedastic. To confirm the robustness of the parameter, we re-estimated the models using Fixed-effects regressions with Driscoll-Kraay standard errors.

**Conclusion**

The COVID-19 pandemic has led to a collapse of both domestic and international tourism flows. Restarting the tourism sector may depend largely on the successful rollout of COVID-19 vaccines within and across countries. Vaccination rollout across countries faces problems resulting from vaccine hesitancy, uneven distribution and/or limited availability of vaccines—especially in less developed countries—and different levels of efficacies of different vaccines. This suggests that vaccination alone may not be the magic bullet for restarting the tourism industry.
While COVID-19 vaccines may help to jumpstart the tourism sector, little is known about the link between vaccination coverage and tourism recovery. Furthermore, the influence of the COVID-19 death rate or stringency on tourism recovery has not been explored in the extant literature. Vaccination coverage alone may not be enough for the tourism sector to rebound if the number of deaths per million population outpaces the number of vaccinated people per million population. Additionally, the link between stringency restrictions and tourism recovery has not been explored in the existing literature. This is an important issue as a higher level of stringency restrictions may not be compatible with tourism recovery.

To cover the gaps in the extant literature, this study explores whether vaccination coverage, social distancing rules, and COVID-19 death rate affect the recovery of the tourism industry using cross-country data. This includes examining if the impacts of vaccination coverage, social distancing rules, and COVID-19 death rate on tourism recovery differ by developed and less developed economies or by more vaccinated and less vaccinated economies. We also build a theoretical model that explains the possible links between vaccination coverage, social distancing rules, COVID-19 death rate, and tourism recovery.

The predictions from the theoretical model indicate that COVID-19 death toll, social distancing rules, and vaccination coverage have ambiguous effects on tourism recovery. These predictions have important theoretical implications. For instance, these predictions imply that vaccination coverage alone is not sufficient for the tourism industry to rebound from the pandemic. Effective vaccination rollout is needed to substantially lower the COVID-19 death rate. Lower risk of COVID-19 infection and death is essential for the tourism industry to rebound. Furthermore, social distancing rules are useful for preventing the spread of COVID-19, but the revival of the tourism industry with strict social distancing rules is unlikely.

The empirical results show that a lower COVID-19 death rate helps to enhance tourism recovery from the pandemic in developed economies and economies with high level of vaccination coverage. Results also show that higher vaccination coverage is not necessarily accompanied by a higher tourism recovery. The impact of vaccination coverage on tourism recovery holds regardless of the stage of development. Similarly, a higher level of stringency restriction hinders tourism recovery.

The empirical results have important policy implications. First, vaccination coverage is not the magic bullet for restarting the tourism industry. Vaccination coverage would have a lag effect in terms of jumpstarting the tourism industry. This is because vaccination needs to substantially dampen the COVID-19 death rate for vaccination coverage to propel tourism recovery. Policymakers should consider a mix of effective vaccination coverage accompanied by the use of therapeutics to lower the COVID-19 death rate. Lower risk of infection and death from COVID-19 is necessary for the tourism industry to rebound. In addition, policymakers should use targeted common sense social distancing rules to prevent the spread of COVID-19. A one-size-fits-all social distancing rule for an entire country is more likely to be counterproductive in terms of creating an environment for the resumption of domestic and/or international tourism activities. This implies that social distancing rules should be relaxed as the risk of infection and death decreases. Additionally, the level of stringency for different states or regions in a country should be contingent on the level of risk of infection and death.

Data statement

The tourism recovery data used in this analysis are not publicly available. The data are available from Dr. Yang Yang (for details, see: https://sites.temple.edu/yangyang/ and Yang, Yang, Benjamin Altschuler, Zhengkang Liang, and Xiang Li. 2020. “Monitoring the global COVID-19 impact on tourism: The COVID19tourism index.” Annals of Tourism Research:103120. doi: https://doi.org/10.1016/j.annals.2020.103120).

CRediT authorship contribution statement

Luke Okafor: Conceptualization, Methodology, Formal analysis, Investigation, Writing- Original draft preparation, Writing - Review and Editing. Eric Yan: Data curation, Modelling, Methodology, Formal analysis, Investigation, Writing- Original draft preparation.

Data availability

The authors do not have permission to share data.

Declaration of competing interest

None.

Appendix A

Derivation of Eq. (2)

The household’s optimization problem is written as

\[
U(p, v, w, z) + \lambda (wt - px - \tilde{tv}) + \lambda' [w(\ell - t) - \tilde{t} - z].
\]
From its first-order derivatives with respect to $p, v, w,$ and $z$, we have that

\[ U_p = \lambda x \quad (A - 1) \]
\[ U_v = \lambda \dot{t} \quad (A - 2) \]
\[ U_w = -\lambda t - \lambda v (l - t - \tilde{t}) \quad (A - 3) \]
\[ U_z = \lambda v \quad (A - 4) \]

Plugging Eqs. (A-2) and (A-4) into Eq. (A-3) gives that

\[ U_w = -t \frac{U_v}{\dot{t}} - U_z l + U_z (t + \tilde{t}) \]
\[ \Rightarrow U_w + U_z l = -t \frac{U_v}{\dot{t}} + U_z (t + \tilde{t}) \]

Rewrite $w((l - t) - \tilde{t}) = z$ as $+\tilde{t} = l - \frac{w}{w}$, and plug it into the above Equation. Thus, we have that

\[ t = \frac{\tilde{t}}{U_v} \left( -1 - \frac{wU_w}{2U_z} \right) \tilde{t} \quad (A - 5) \]

Given that $\epsilon_{wU} = \frac{wU_v}{\partial U_v}, \epsilon_{sU} = \frac{sU_v}{\partial U_v},$ and $\epsilon_{vU} = \frac{wU_z}{\partial U_z},$ we further reduce Eq. (A-5) to

\[ t = \frac{\epsilon_{sU}}{\epsilon_{vU}} \left( -1 - \frac{\epsilon_{wU}}{\epsilon_{vU}} \right) \frac{v}{w} \tilde{t} \]

The derivation of Eq. (A-5) is as follows:

\[ U_w + U_z l = -t \frac{U_v}{\dot{t}} + U_z \left( \frac{w l - z}{w} \right) \]
\[ \Rightarrow -U_v t = \left( U_w + U_z l - U_z \left( \frac{w l - z}{w} \right) \right) \tilde{t} \]
\[ \Rightarrow t = \frac{U_z}{U_v} \left( \frac{w l - z}{w} \right) - \frac{U_w + U_z l}{U_v} \tilde{t} \]
\[ \Rightarrow t = \frac{U_z}{U_v} \left( \frac{w l - z}{w} \right) - \frac{U_w}{U_v} \tilde{t} = \frac{U_z}{U_v} \left( \frac{w}{w} - \frac{U_w}{U_v} \right) \tilde{t} = \frac{2U_z}{U_v} \left( \frac{w}{w} - \frac{U_w}{U_v} \right) \tilde{t} \]

The derivation of Eq. (A-5) is as follows:

\[ U_w + U_z l = -t \frac{U_v}{\dot{t}} + U_z \left( \frac{w l - z}{w} \right) \]
\[ \Rightarrow -U_v t = \left( U_w + U_z l - U_z \left( \frac{w l - z}{w} \right) \right) \tilde{t} \]
\[ \Rightarrow t = \frac{U_z}{U_v} \left( \frac{w l - z}{w} \right) - \frac{U_w + U_z l}{U_v} \tilde{t} \]
\[ t = \frac{U_z}{U_v} \left( \frac{wU_z - U_{wz} - t}{w} \right), \quad \dot{t} = \frac{U_z}{U_v} \left( -\frac{z - U_{wz}}{w} \right) \]

### Derivation of Eq. (3)

Eqs. (A-1) and (A-2) imply that \( x = \frac{U_z}{U_p} \dot{t} \). Plugging this into Eq. (2) gives that

\[ t = \frac{\epsilon_{zt}}{\epsilon_{zt}} \left( -1 - \frac{\epsilon_{zt} \epsilon_{zt}}{\epsilon_{zt}} \right) \frac{U_z}{U_p} x \]

\[ \Rightarrow wt = \frac{\epsilon_{zt}}{\epsilon_{zt}} \left( -1 - \frac{\epsilon_{zt} \epsilon_{zt}}{\epsilon_{zt}} \right) \frac{U_z}{U_p} px \]

\[ \Rightarrow px \frac{wt}{w} = - \frac{\epsilon_{zt}}{\epsilon_{zt}} \left( \frac{\epsilon_{zt} + \epsilon_{zt}}{\epsilon_{zt}} \right)^{-1}. \]

### Derivation of Eq. (4)

The welfare loss due to the reduction of working time is \( w(\ell - t) - \dot{t} = z \). Plugging Eq. (2) into it gives that

\[ wt + \left( \frac{\epsilon_{zt} + \epsilon_{zt}}{\epsilon_{zt}} \right) \dot{w} = z \]

That is,

\[ w - z = \left( \frac{\epsilon_{zt} + \epsilon_{zt}}{\epsilon_{zt}} \right) \dot{w}. \]

### Derivation of Eq. (5)

Given that \( \dot{t} = \left( w - \left( \frac{\epsilon_{zt} + \epsilon_{zt}}{\epsilon_{zt}} \right) \right)^{-1} \), we obtain the derivative of \( \dot{t} \) with respect to \( D \) as follows:

\[ \frac{d}{dD} \left( w - \left( \frac{\epsilon_{zt} + \epsilon_{zt}}{\epsilon_{zt}} \right) \right)^{-1} = \left( w - \left( \frac{\epsilon_{zt} + \epsilon_{zt}}{\epsilon_{zt}} \right) \right)^{-2} \frac{d}{dD} \left( \frac{\epsilon_{zt} + \epsilon_{zt}}{\epsilon_{zt}} \right) \]

\[ \Rightarrow \frac{d}{dD} \left( \frac{\epsilon_{zt} + \epsilon_{zt}}{\epsilon_{zt}} \right)^{-1} = \left( \frac{d}{dD} \right) \left( \frac{\epsilon_{zt} + \epsilon_{zt}}{\epsilon_{zt}} \right)^{-1} - \left( \frac{\epsilon_{zt} + \epsilon_{zt}}{\epsilon_{zt}} \right)^{-2} \frac{d}{dD} \left( \frac{\epsilon_{zt} + \epsilon_{zt}}{\epsilon_{zt}} \right) \]

### Appendix B. Supplementary materials

Supplementary materials to this article can be found online at [https://doi.org/10.1016/j.annals.2022.103424](https://doi.org/10.1016/j.annals.2022.103424).

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