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Time Effectiveness of the COVID-19 State Emergency Decree: Evidence from the Non-Experimental Design and the Interrupted-Time Series Analysis

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COVID-19 pandemic is one of the most severe epidemics that depress the regional and the global economy. The government of many countries has implemented a wide range of COVID-19 containment policies to enclose the spread of the virus, particularly the state emergency decree. The state emergency consists of multiple measurements that affect economic activities, for instance, lockdown, curfew, social distancing, and information censoring. Since the policy maintains costs and benefits, thus this study aimed to answer whether the COVID-19 state emergency decree of Thailand and China was time-effective. The study was designed to find the pre-post mean variation of the interested group after being affected by the policy intervention. The experimental design was based on the non-experimental approach, together with the Interrupted-Time Series (ITS) analysis. Our estimation based on the Ordinary Least Square (OLS) and the Prais-Winsten estimation. Empirical results found a significant policy effect of the COVID-19 state emergency decree in both Thailand and China. Evidence from the Prais-Winsten estimation exhibited a longer policy delay time relative to OLS. This paper suggested that the faster policy implemented, the shorter policy-delay time.

Key words: *COVID-19; Policy Evaluation; Non-experimental Design; The Interrupted-Time Series; Prais-Winsten Estimation*

Introduction

The epidemic of the coronavirus (COVID-19) has started when the first case was discovered on January 22, 2020, in Wuhan, the capital city of Hubei Province. In the same year, the World Health Organization (WHO) officially announced that the world is coping with the major viral pandemic situation. This pandemic is strongly severe as the virus can be transmitted from person to person through the contact with aerosols (droplets) or infectious secretions. Together with touching the affected areas in the body such as the mouth and nose. Empirically, many countries have been impacted by such disease.

The government of many countries has implemented a wide range of COVID-19 containment policies to enclose the spread of the virus, particularly the "state emergency decree". Most of the state emergency consists of multiple measurements that harmfully affect economic activities, for example, lockdown, curfew, social distancing, information censoring, etc. These measurements discontinue economic activities such as international production, trading, traveling and logistics, investment, and more. Since we know that government policies involve and impact to everyone in the country and each policy has its economic costs and benefits, thus government needs to carefully implement such policies in the best optimal efficient manner. To ensure that emergency decree was worth implementing, this study aimed to answer if such decree effectively and statistically lower a quantity of new case infection.

Explicitly, the main objective of this study was to set up the nonexperimental design to ensure that 1) the state of the emergency decree does significantly lower the COVID-19 infection in the case of Thailand and China; 2) the state of emergency is time-effective in case of Thailand and China during the first wave of COVID-19 pandemic.

Literature Review

Policy Evaluation Techniques

When considering the effectiveness of the government-funded program, many economists adopted many policy evaluation techniques. One of the widely-used methodologies is to conduct a random assignment (or experimental evaluation) to capture the response of control groups (based on random criteria) to the policy intervention (Bernal, Cummins, & Gasparrini, 2017). Theoretically, there are three types of policy evaluation by the experimental design methodology as briefly summarized below.

First, the *random assignment* or *experimental design*, this methodology was appropriate for the policy that is particularly implemented to a certain amount of population, i.e., the government-funded training programs. The conduction of the experiment can help to measure the policy effect (or treatment effect) within the short-range of sample groups. The results of this methodology relied heavily on the experimental results and specifically to a certain group of the population at the certain time (Bassi, 1983; Freedman, Bryan, and Cave, 1988; Cave et al., 1993; Quint et al., 1994; Orr et al., 1996; Zambrowski and Gordon, 1993).

Second, the *Quasi-experimental design*, this evaluation aims at finding a cause-effect of policy variables on the control group. This policy evaluation is similar to the experimental design excepted that the control group came from non-random criteria. As this approach is time and cost-consuming, thus it needed to be well-designed before conducting an experiment.

Third, *Non-experimental design*, this evaluation was appropriate for such policy implemented universally and subjected to everyone in the country (Ashenfelt, 1978; Ashenfelter and Card, 1985; Bassi, 1983; Bell and Orr, 1994; Bloom, 1987; Gay and Borus, 1980; Kiefer, 1979; Nightingale et al., 1991). The results of the non-experimental design were sometimes equivalent to experimental design. Also, the variation of policy effects among the experimental and non-experimental design are insignificant (Greenberg, D., Michalopoulos, C., & Robins, P.,2006). Therefore, to reach our research objectives and due to time limitation, we adopted the non-experimental design to evaluate the pre-pose mean variation of the COVID-19 new cases as the resulted of a government state emergency.

Experimental Design

The methodology of this study employed a "Non-Experimental Design" to evaluate the pre-post mean variation. This was because of two reasons; firstly, the experimental design or Randomized Controlled Trials (RCTs) is not applicable for a policy that was implemented universally and applied widely to everyone in the country. Even though the RCTs were the ideal approach for assessing the effectiveness of the intervention, it was time consumption and cost ineffective (Kontopantelis E, et al., 2015). Secondly, the treatment group (or control group) was considered as the overall population in the country which was difficult to identify the randomize controlled trials. Therefore, at the macro-level evaluation, the non- experimental would guarantee the most appropriate degree of fit and would promptly provide the answer to our research questions. The control group of this study were the citizen in Thailand and China who had impacted by the COVID-19 pandemic, whilst the policy intervention came from the state emergency decree of each country.

Interrupted Time-Series (ITS) analysis was statically method to estimate a treatment effects based on the pre and post mean variation of the interested group (St. Clair, T., Hallberg, K., & Cook, T., 2016; Kisely, S., & Lawrence, D., 2016) that resulted from the policy. The ITS was an alternative tool when the RCTs was not the option. This paper also provided multiples strengths, i.e., the study provided the time-varying confounders or the study controlled external influence or set of influences in the policy intervention. The results from ITS was ineffective by the typical confounding variables such as socioeconomic variables, and population age distribution (Bernal, L., Cummins, S., & Gasparrini, A., 2017). The basic idea behind the ITS was to find the pre-post mean- difference and observe whether or not the post-mean changed.

If the policy was effective, this paper clearly and statically observed the post-mean changing, otherwise the policy was not effective (see figure 1).

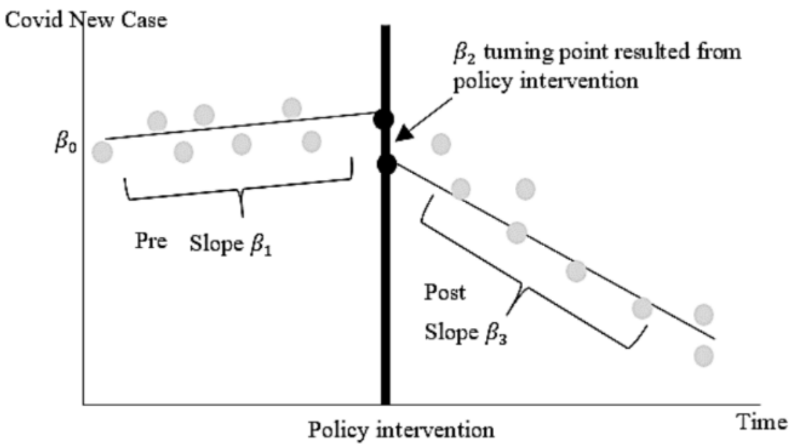


Figure 1 The impact model with Interrupted Time-Series (ITS)

From figure 1, we assumed that the policy effect significantly generates the changes around the turning point. Statistically speaking, if $\beta2$ was significant, then it can ensure that the policy strictly lower number of the COVID-19 infection effectively.

Data and Estimation

In this study, the variable of interest was the number of daily COVID-19 new confirmed cases from the1st January – 30th September 2020 (N=273) retrieved from the Ministry of Public Health of Thailand and China. The regression model follows Bernal, Cummins, & Gasparrini, (2017). Three variables of interest consist of time, intervention, and the outcome. Our interrupted-time series model was expressed as:

$$NC_t = \beta_0 + \beta_1 T + \beta_2 SE + \beta_3 Postslope + \varepsilon_t \quad (1)$$
$$NC_t = \gamma_0 + \gamma_1 Preslope + \gamma_2 SE + \gamma_3 Postslope + \varepsilon_t \quad (2)$$

Where NC_t was the number of the daily new case at time t, T was time elapsed since the start of the study in a daily basis, SE was the dummy for the state of emergency (or the policy intervention), $Preslope$ was the slope of pre-intervention, $Postslope$ was the slope or post-intervention, and ε was a residual. Where β_0 represents the baseline level at T=0, β_1 is interpreted as the change in outcome associated with a time unit increase (underlying the pre-intervention trend).

The limitation of this idea was that we ignore the non-stationarity, structural breaks, trends, seasonality, and the delay of the policy effect. Also, we did not consider socioeconomic, or locational factors. Then the results could be somehow imperfect. However, to allow the methodology to measure the policy effects based on the mentioned limitation, we conduct the estimation by varying the delay time of policy effect by 5, 10, 15, and 20 days respectively to observe the existence of the policy effect during each delay periods.

For the estimation, this paper compared the results from both classical OLS and Prais-Winsten estimation, which was believed to give more efficient results for time-series data, particularly with autocorrelation problems (Prais and Winsten, 1954; Choudhury, Hubata, & Louis, 1999; Branger, Quirion, & Chevallier,2016; Kreisle, 2015).

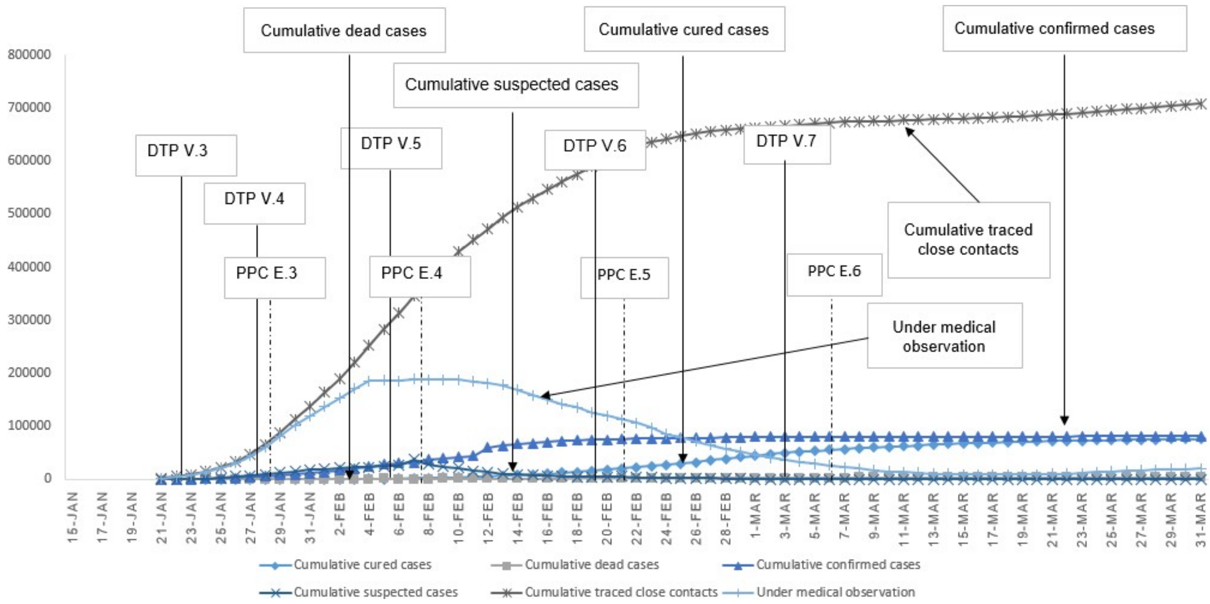
Results

A. China's Essential Policy in Response to the COVID-19 Epidemic

The organizations that the Chinese government mainly relied on when controlling the novel coronavirus pneumonia epidemic, namely the China National Health Commission and the Joint Prevention and Control Mechanism of the State Council. Under the leadership of these two institutions, the Chinese government had issued two main policies to deal with the novel coronavirus pneumonia, namely, the Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia and the Protocol on Prevention and Control of Novel Coronavirus Pneumonia.

Chinese officials have divided the action against the COVID-19 epidemic as of May 31, 2020 into 5 stages (SCIO, 2020): The stage 1 was the emergency response from the discovery of a case of unknown caused pneumonia (December 27, 2019 - January 19, 2020). The stage 2 was as of the first time that the number of newly cured and discharged cases in Wuhan, Hubei province was greater than the number of newly confirmed cases (January 20-February 20, 2020). The stage 3 was the number of new cases in China decline to single digits (February 21 - March 17, 2020). The stage 4 was that the spread of the epidemic in China was basically blocked, and the traffic blockade measures in Hubei Province were lifted (March 18 - April 28, 2020). The stage 5 was the normalization of epidemic prevention and control across China (since April 29, 2020). As mentioned above, the NHC has formulated and revised 6 versions of the Diagnosis and Treatment Protocol, and 7 editions of the Protocol on Prevention and Control of Novel Coronavirus Pneumonia, during the first to third phases (see figures 2)

Figure 2: Timeline of major COVID-19 policy in China



Note: DTP: Diagnosis and Treatment Protocol, PPC: Protocol on Prevention and Control of Novel Coronavirus Pneumonia

Source: The State Council the People's Republic of China. Retrieved 10 Nov. 2020 from http://www.gov.cn/fuwu/zt/yqfwzq/yqfkblt.htm

The Protocol on Prevention and Control of Novel Coronavirus Pneumonia

The Protocol on Prevention and Control of Novel Coronavirus Pneumonia was a policy document issued by the Joint Prevention and Control Mechanism of the State Council of China to guide country in the prevention and control of novel coronavirus pneumonia. According to the characteristics of the epidemic of novel coronavirus in different periods, the protocol would make corresponding update, as said by the notice on the issuance of the Protocol on Prevention and Control of Novel Coronavirus Pneumonia (Edition 7) (NHC, 2020). Some of the main prevention and control measures included: the organizational structure of the prevention and control work, the detection and reporting of cases and emergencies, epidemiological investigation, case treatment and nosocomial infection prevention and control, close contact tracking and management, training of professionals in medical and health institutions, prevention and control measures targeting at key settings, institutions and populations, disinfection measures for specific places, public education and risk communication, prevention and control of overseas epidemic import. Both of the Diagnosis and Treatment Protocol issued by NHC, and Protocol on Prevention and Control of Novel Coronavirus Pneumonia by JPCMSC, had timeline as follows:

Table 1: Timeline of protocol issued by China's NHC and the JPCMSC

Issued Time	Diagnosis and Treatment Protocol(NHC)	Protocol on Prevention and Control of NCP (JPCMSC)
Jan 15	Version 1	Edition 1
Jan 18	Version 2	
Jan 20		Edition 2
Jan 22	Version 3	
Jan 27	Version 4	
Jan 28		Edition 3
Feb 5	Version 5	
Feb 7		Edition 4
Feb 19	Version 6	
Feb 21		Edition 5
Mar 3	Version 7	
Mar 7		Edition 6

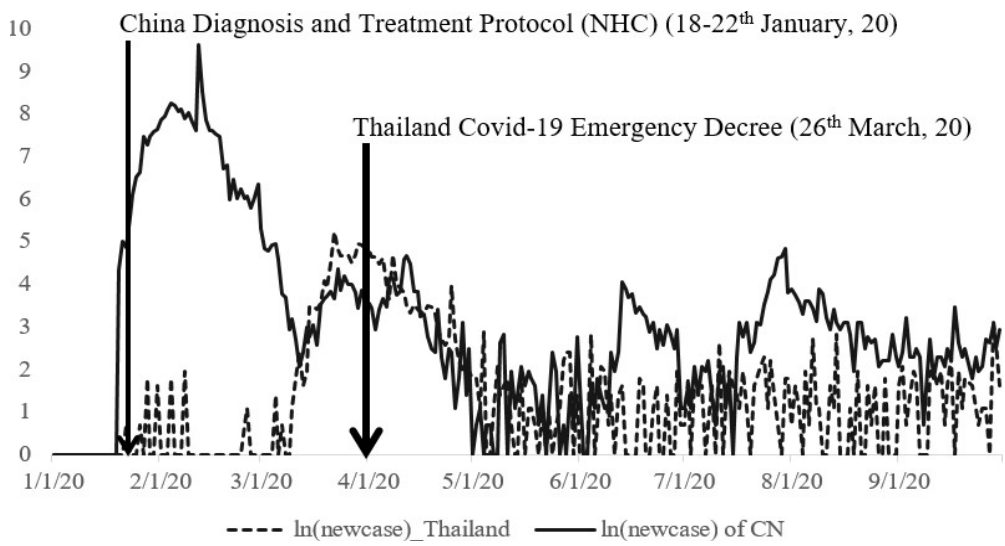
Source: China's NHC and the JPCMSC

When this paper was analyzed, the time of the Diagnosis and Treatment Protocol and the epidemic data, this paper could find that the cumulative cure rate had increased significantly since the 6th version of the Diagnosis and Treatment Protocol, and gradually moved closer to the cumulative number of confirmed cases. Starting from the 7th version of the Diagnosis and Treatment Protocol, the cumulative cure rate and cumulative diagnosis rate continued to be moved closer and gradually approached. The cumulative number of deaths was constantly increasing, but a gentle trend had been maintained, with the number remaining between hundreds of people per day. The cumulative number of confirmed cases had increased since the 3rd version of the Diagnosis and Treatment Protocol, and the magnitude was not too much. From the 5th version to the 6th version, the number of confirmed cases tended to be flat until after the 7th version. Whilst this paper could find the renewal of the Diagnosis and Treatment Protocol, the study found it was important in reducing mortality. (Liu & Sun, 2020)

B. Thailand's potential policy in response to COVID-19 pandemic

In case of Thailand, government announced the first COVID-19 emergency decree during the peak of the first wave around March of 2020. Regulation is involving lockdown, curfew, social distancing, strictly public places closing was first imposed nationwide on 26 March 2020. Prime Minister Prayut Chan-o-cha had decided to exercise his power under Section 9 of the Emergency Situation and Section 11 of the State Administration Regulation to issue following regulations; no entry to areas deemed at risk of coronavirus infection; closure of areas at risk of infection; a ban on gatherings or illegal assembly in crowded areas or any activities that would incite unrest; strict screening of the movement of migrant workers by health authorities. The number of new infection and timeline of policy were shown in the figure 3.

Figure 3: COVID-19 New Case of Thailand and China



Source: Thailand: Ministry of Public Health, China: National Health Commission (complied by CEIC)

C. Time Effectiveness of COVID-19 containment policies in Thailand

The results from Prais-Winsten AR (1) regression - iterated estimates (model 6-10) claimed that the emergency decree (policy intervention) in Thailand that was exercised on 26th March 2020 did lower number of COVID-19 new cases significantly, but only when this study allowed the delay time after the announcement by 15-20 days. This paper concluded that the COVID-19 state emergency could control the spread of virus after 15-20 days approximately. Rationales behind this were because 1) the State Emergency involved wide rages of strong containment policy such as curfew, lockdown, public places closing, censoring media, and activity prohibition (public health ministry,2020; Burton,2020), in which legal effects strictly force people to follow, and 2) its extension provided power to the government to strictly control the spread of disease through others measurement such as state and self-quarantine, social transfer, and empowerment of local authorities. On the other hand, the result from OLS found the shorter delay time, which was approximately 5-20 days. This paper observed the policy had effects since the 5th day delay time (see model 2 in table 1)

Table 1: OLS and Prais-Winsten AR (1) regression - iterated estimates (Case of Thailand)

	OLS_TH					Prais-Winsten _TH				
COVIDNewcase	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Time	0.657***	-0.207***	1.078***	1.065***	0.955***	-0.273**	-0.240**	-0.273**	-0.202*	-0.190
	(0.172)	(0.0402)	(0.140)	(0.120)	(0.110)	(0.110)	(0.109)	(0.122)	(0.108)	(0.117)
Intervention	1.765					3.548				
	(11.44)					(11.13)				
Postslope	-0.936***									
	(0.178)									
Intervention date delays by 5 days										
Intervention		-28.11**					-13.16			
		(11.27)					(10.99)			
preslope		1.137***					0.974***			
		(0.170)					(0.319)			
Intervention date delays by 10 days										
Intervention			-52.39***					0.445		
			(9.775)					(11.18)		
presplope			-1.208***							
			(0.143)							
Intervention date delays by 15 days										
Intervention				-63.67***					-19.50*	
				(8.688)					(10.78)	
postslope				-1.141***					0.808***	
				(0.122)					(0.273)	
Intervention date delays by 20 days										
Intervention					-64.72***					-18.85*
					(8.503)					(10.88)
postslope					-1.004***					0.707**
					(0.111)					(0.276)
Constant	-17.27***	-25.37***	-29.98***	-29.53***	-25.72***	-14.38	-17.77	-10.80	-12.58	-9.040
	(5.081)	(5.347)	(4.998)	(4.534)	(4.078)	(17.01)	(16.00)	(17.02)	(14.28)	(14.65)
Observations	273	273	273	273	273	273	273	273	273	273
R-squared	0.288	0.335	0.447	0.512	0.495	0.027	0.035	0.022	0.038	0.031

Note: Omitted variables because of collinearity; Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

D. Time effectiveness of COVID-19 containment policy in China

From table 2, the Prais-Winsten AR(1) regression - iterated estimates found the negative impact of COVID-19 containment measured significantly and the policy started to be effective after 15-20 days of implementation (see model 9 and 10). The delay time of the policy effect of Thailand and China were similar. Whereas, the results from OLS (model 1 to 5) encountered strong multicollinearity amongst the independent variables, which caused this study to omit the policy intervention variables.

Table 2: OLS and Prais-Winsten AR(1) regression - iterated estimates (case of China)

	OLS_CN					Prais-Winsten_CN				
COVIDNewcase	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Time	**-969.1*** **	**-178.8**	**1,031*** **	**2,216*** **	**4,213*** **	**-5.94*** **	**-5.98*** **	**-5.57*** **	**-4.48*** **	**-1.68** **
	(241.4)	**(324.3)**	**(365.5)**	**(350.9)**	**(1,011)**	**(1.551)**	**(1.608)**	**(1.625)**	**(1.506)**	**(0.841)**
Intervention	-					727.2				
						(692.1)				
Preslope	**978.6*** **					27.22				
	(240.7)					(47.48)				
postslope	**963.0*** **									
	(240.2)									
Intervention date delays by 5 days										
Intervention		-					189.0			
							(653.9)			
Preslope		222.2					47.28			
		(317.7)					(37.06)			
postslope		172.8								
		(323.2)								
Intervention date delays by 10 days										
Intervention			-					-606.0		
								(613.2)		
Preslope			**-952.5*** **					**66.51** **		
			(357.7)					**(29.47)**		
postslope			**-1,036*** **							
			(364.5)							
Intervention date delays by 15 days										
Intervention				-					**-1,712*** **	
									(542.5)	
Preslope				**-2,116*** **					**85.46*** **	
				(344.9)					**(22.44)**	
postslope				**-2,220*** **						
				(349.8)						
Intervention date delays by 20 days										
Intervention					-					**-4,158*** **
										(303.5)
Preslope					**-4,079*** **					**134.2*** **
					(977.5)					**(10.88)**
postslope					**-4,215*** **					
					(1,011)					
Constant	**-74.46** **	**-393.2*** **	**-781.5*** **	**-1,032*** **	**-1,558*** **	-158.4	-349.8	-546.5	-756	**-1,512*** **
	(31.28)	**(123.1)**	**(185.9)**	**(203.7)**	**(544.5)**	(721.3)	(670.6)	(616.6)	(528.6)	**(281.1)**
Observations	288	288	288	288	288	288	288	288	288	288
R-squared	0.157	0.150	0.166	0.238	0.542	0.051	0.049	0.052	0.085	0.455

Note: Omitted variables because of collinearity; Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Conclusion and Suggestion

Empirically, the policy effect was found in both Thailand and China. Time was the significant variable when making decision toward emergency decree. The faster policy was implemented, the shorter the policy effect delays. Furthermore, the study found the insignificant differences between the delay of policy effect of the two countries. The delay of the policy effect of the two countries was between 10-20 days, which could imply that policy effectively works quite well in terms of spreading prevention for both countries. The results were not unforeseen as because the COVID-19 emergency decree involved multiples strong containment measures. For instance, the curfew and the lockdown policy.

For experimental design and technical estimation, the non-experimental design got along well with the interrupted time series analysis in estimating the policy effect. Using only historical data of the COVID-19 new confirmed cases was adequate to measure the pre-post mean difference evaluation.

For the future study, the study could have better contribution by strengthening ITS with additional vectors of policy exposures, household, and area characteristics into the model. Then, allowed time-series analysis to find the response of policy outcomes such as Impulse Response from Vector Auto Regressive (VAR) or to find a causal relationship based on other cointegration methods. To overcome the seasonality, autocorrelation, and over-dispersion issue, the study could be better if designing more complex model to extend the ITS designs. Also, the study should incorporate cost-benefit analysis to guarantee that such policy was implemented in the most efficient way.

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