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Highlights

(1) A quantitative analysis of Covid-19 pandemic shocks on economic stimulus policies in 156 economies.

(2) Check both the short-term effects and middle-term cumulative effects.

(3) Discuss the heterogeneity in responses to pandemic by developed economies and developing countries.

(4) Use quasi-natural experiment to investigate the causal relationship between shocks and policies.

COVID-19 Pandemic and economic stimulus policy inequality: evidence from quasi-natural experiments

Abstract: This paper investigates the impact of the COVID-19 pandemic on economic stimulus policies. Using the standard DID and continuous variable DID methods with data from 156 economies, empirical results show that, deaths tolls have a greater impact on economic stimulus policies than confirmed cases; the cumulative effect is more influential to economic stimulus than the short-term effect. Among other additional socio-economic determinants, economic development level is robustly positively correlated with the economic stimulus intensity, while the medical condition is negatively correlated. Population density and proportion of aging population are positively correlated with the intensity of fiscal policies. Heterogeneity tests show that while economic policies are used in developed economies more often, restrictive measures in developing countries are likely used as a substitute for economic stimulus. Our results show that the impact of the epidemic may have increased economic inequality to some extent due to the impact of policy capabilities, requiring international coordination and assistance to low - and middle-income countries.

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Introduction

Covid-19 pandemic has had a huge impact on the world economy. For the first time since the Great Depression both advanced economies and developing economies are in recession.（Benmelech & Tzur-Ilan, 2020）. The impact has the following remarkable characteristics: first, the shock is unprecedented and very quick; Second, the impact appears to be contagious, spreading in time and space as the epidemic itself spreads. Third, there is no precedent for the response to such a sudden and contagious shock. It is now more than a year since the outbreak began, and it is important to reflect on how countries have responded to the shock with a view to responding more calmly and effectively.

How do governments respond to specific external shocks, such as a pandemic? Policies government took can roughly be divided into two categories, that is, economic intervention and non-economic intervention. The former mainly includes classical macroeconomic measures, such as traditional fiscal policy and monetary policy, which are conventional measures to deal with general economic shocks. The latter is mainly administrative measures taken in response to the infectious nature of the epidemic, such as restricting the movement of people and quarantining confirmed patients and their close contacts.

Since the impact of the pandemic is unprecedented and there is no good frame of reference, it creates considerable economic uncertainty. This leads to a series of issues, including at least (1) Which one has the priority in response to the pandemic，economic policy or non-economic policy? whether there is a complementary or substitution effect between the two? (2) For economic policies，which one has the priority, fiscal policy or monetary policy? How to coordinate the two; (3) How should the intensity of economic stimulus policies be adjusted according to the development of the pandemic? Should stimulus be stepped up as the epidemic worsens?

Many researches discussed the role of fiscal stimulus and monetary policy (e.g., Carroll et al.,2020; Coibion et al., 2020; Faria-E-Castro, 2020; Ganong et al., 2020). At the same time, policy makers have put forward the largest stimulus package in history. Some focus on the household side, for example, U.S. announced an amount to $2 trillion, a quarter of which is earmarked for transfer payments to households (Bayer et al., 2020), and others pay more attention on corporations such as corporate debt markets (Elenev et al., 2020).

From the perspective of restrictive policies, countries often take different measures according to the stage of their own epidemic development and their own characteristics of management. （e.g. Bajardi et al., 2011;Chinazzi et al.,2020; Fang et al., 2020; Ng, 2020）.From the beginning of the pandemic to about six months later, some countries with earlier outbreak experience tightening - loosening - tightening stages. Others experienced a gradual tightening and gradual loosening. Some countries tighten the restrictive policies fast and keep restrictive, as in the US, while some others are becoming more restrictive as they may still in the developmental stage.

The possible contributions of this paper are mainly reflected in several aspects: First, with data from 156 economies, we hold a quantitative analysis of the impact of sudden external shocks on

economic stimulus policies. Second, we both check the short-term effects and a middle-term cumulative effects and describe a relatively dynamic process. Third, we discuss the heterogeneity in responses to pandemic by developed economies and developing countries. Fourth, a quasi-natural experiment was used to investigate the causal relationship between the Covid-19 pandemic shock and economic stimulus policies.

Literature review

Governments and central banks have responded to the Covid-19 pandemic and the economic crisis using both fiscal and monetary tools on a scale that the world has not witnessed before. Theoretically, the stimulus effects of different economic policies could be heterogeneous. Some argue that standard fiscal stimulus can be less effective than usual because the fact that some sectors are shut down mutes the Keynesian multiplier feedback. Monetary policy, as long as it is unimpeded by the zero lower bound, can have magnified effects, by preventing firm exits (Guerrieri et al., 2020). However, using standard closed and open-economy New Keynesian models, Farhi（2016）show that self-financed multipliers are small. Further, other factor such as inequality may diminish the effects of demand-side fiscal stimulus（Auerbach et al., 2020）.

Other studies have shown that stimulus policies in developed and developing countries are heterogeneous in response to an epidemic. For example, high-income countries announced larger fiscal policies than lower-income countries and entered the crisis with historically low interest rates and as a result were more likely to use nonconventional monetary policy tools（Benmelech & Tzur-Ilan, 2020）. Since developing economies have more younger populations, much larger informal economies, and less fiscal capacity than developed economies. Age-specific policies as well as school closures are more effective (Alon et al., 2020).

However, there is less research on developing countries than on developed ones. Zhao（2020）argues that monetary policy is effective because it provides enough liquidity for households to buffer health risks and monetary stimulus is more effective in an economy with greater health risks and consumption uncertainty. Djurovic et al. （2020） assesses appropriate macroeconomic policy responses to the outbreak of COVID-19 in Montenegrin in various pandemic scenarios.

Travel-related controls are seen as one of the non-economic measure during the early stage of the outbreak of 2009 H1N1 pandemic (Bajardi et al., 2011). Similar measures are also effective for Covid-19. For example, according to Chinazzi et al. (2020), the travel quarantine of Wuhan delayed the overall epidemic progression by 3 to 5 days in Mainland China, and has a more marked effect at the international scale, where case importations were reduced by nearly 80% until mid-February. Fang et al (2020) conducted an empirical study using the difference-in-differences method and found that the blockade policy reduced the flow into Wuhan, the outflow and the internal flow of Wuhan by 76.64%, 56.35% and 54.15% respectively without which would have resulted in an increase of 52.64 percent in 16 other cities in Hubei province and 64.81 percent in 347 cities outside

the province.

Lockdown policy is also being widely discussed and it alone may be ineffective in controlling the epidemic and the most effective policy is a hybrid policy with lockdown and broadening testing（Ng, 2020）. Comparing different strategies of weak restrictions on the activity of many (UK) versus strict restrictions on a targeted few (SK), Aum et al.（2020）shows that quarantine enforcement more important than asymptomatic test-and-tracing. Different strategies may have different effects at different stage of the pandemic, for example, earlier, stricter and shorter lockdowns can minimize overall losses. A 'go-slow' approach to lifting restrictions may reduce overall damages if it avoids the need for further lockdowns（Guan et al., 2020）.

Both economic and non-economic policies face a common problem: the uncertainty caused by the COVID-19 pandemic. The existence of this new type of uncertainty brings major challenges to policy responses and choices. Some scholars try to depict this uncertainty through various methods. Caggiano et al.（2020）estimate a VAR with world-level variables to simulate the effects of the Covid-19 outbreak-related uncertainty shock and find a peak negative response of world output of 1.6% and a cumulative negative response of 14% over one year. Baker et al.（2020）identify three indicators – stock market volatility, newspaper-based economic uncertainty, and subjective uncertainty in business expectation surveys – that provide real-time forward-looking uncertainty measures and imply a year-on-year contraction in U.S. real GDP of nearly 11 percent as of 2020 Q4. Amid all the uncertainty, this article focuses on the particular case of policy choices in response to the impact of a pandemic.

The rest of the paper is organized as follows: firstly, we introduce the methodology, data and variables. Secondly, we present the empirical findings, including baseline results, heterogeneity and robustness check. Finally, conclusions and policy implications are presented.

Methodology

Empirical model

The impact of the pandemic itself is exogenous, so theoretically, there should no reverse causality between the pandemic and the economic stimulus policies. However, the factors that affect the economic stimulus policy are very complex, and there may be interrelationship between different policy choices. Therefore, we use a quasi-natural experimental method to characterize the impact of the epidemic on economic stimulus policy choice.

Since the type of economic stimulus used and the degree of stimulus chosen vary over time, the shock of the pandemic on policies are classified as short-term effects and cumulative effects. For the short-term effect of the pandemic, we adopted the standard DID model and divided it into the experimental group (countries where the epidemic is still worsening) and the control group (countries where the epidemic is getting better) to investigate the impact of pandemic on economic stimulus. With regard to the different criteria, we further distinguish between an increase in new

confirmed cases and an increase in deaths tolls. Therefore, we adopt the following model:

$$ESpolicy_{i,t} = \alpha_0 + \beta_1 TTC + \beta_2 post + \beta_3 TTC * post + \theta X_{i,t} + \varepsilon_{i,t} \quad (1)$$

$$ESpolicy_{i,t} = \alpha_0 + \beta_1 TTD + \beta_2 post + \beta_3 TTD * post + \theta X_{i,t} + \varepsilon_{i,t} \quad (2)$$

Where $ESpolicy_{i,t}$ stands for economic stimulus policies. TTC is the change in the number of new confirmed cases, TTD is the change of death tolls, $\theta X_{i,t}$ are the control variables, $\varepsilon_{i,t}$ is the random term.

Considering the dynamic changes of economic stimulus policies caused by the pandemic, we used the continuous variable DID model to investigate the cumulative effect of the pandemic on economic stimulus policies. Thus, we adopt the following model:

$$ESpolicy_{i,t} = \alpha_0 + \beta_1 TTCC + \beta_2 post + \beta_3 TTCC * post + \theta X_{i,t} + \varepsilon_{i,t} \quad (3)$$

$$ESpolicy_{i,t} = \alpha_0 + \beta_1 TTCD + \beta_2 post + \beta_3 TTCD * post + \theta X_{i,t} + \varepsilon_{i,t} \quad (4)$$

Where $ESpolicy_{i,t}$ stands for economic stimulus policies. $TTCC$ is the cumulative number of confirmed cases, $TTDC$ is the cumulative number of death cases, $\theta X_{i,t}$ are the control variables, $\varepsilon_{i,t}$ is the random term.

Data and variables

The key explained variable in the paper are the different types of economic stimulus policies. Classical macroeconomic theoretical framework argues that when the economy faces exogenous shocks, macroeconomic policies need to respond. There are usually two categories: fiscal policy and monetary policy. Both categories are discussed in this article and the source of the data is Elgin et al. (2020)[1]. Based on the availability and comparability of data, we take the ratio of increased government spending to GDP as a variable of fiscal policy, and interest rate cut as a variable of monetary policy.

The treatment variable is the impact caused by the COVID-19 pandemic, which can be divided into two categories: short-term effects and cumulative effects. The former investigates the short-term impact of the pandemic on the economic stimulus policy during about five weeks from March 31, 2020 to May 7, 2020; The later depict the cumulative impact in the med-term, examining the cumulative impact in each country between the outbreak to 7 May 2020.

Specifically, the new cases number and the deaths tolls at two points (on March 31 and May 7) were used as the comparison standard, and the sample countries were divided into treatment group and control group. In order to reduce the influence of other random factors, March 31 and May 7 were taken as the benchmark, and the previous and the following three days were included respectively. That is, the average value of 7 days from March 28 to April 3, (hereinafter referred to as the earlier week, post=0） and the average value of 7 days from May 4 to May 10, 2020

[1] Stimulus data is reported on March 31, 2020, and updated on May 7, 2020. There are still irregular updates.

(hereinafter referred to as the later week, post=1) are as a benchmark for comparison.

As for Short-term effects:(1) If the average number of newly confirmed cases in the later week of country I is greater than that in the earlier week, it is classified as case treatment group ($TTC = 1$); otherwise, it is classified as case control group ($TTC = 0$). (2) If the average number of new deaths in the later week of country I was greater than that in the earlier week, it was classified as death treatment group ($TTD = 1$); otherwise, it was classified as death control group ($TTD = 0$).

As for Cumulative effects: The number of confirmed cases per million population ($TTCC$) and deaths per million population ($TTDC$) as of 7 May 2020 were used as continuous variables for the treatment effect.

For the full sample, with either new cases or the deaths tolls criteria, there is no significant difference of economic stimulus policies between the experimental group and the control group. However, if we divided the sample into developed countries and developing countries, there are significant differences in both fiscal policies and monetary policies, as shown in Figure 1.

Figure 1 is about here

For Control variables, to some extent, the economic development reflects the comprehensive ability of an economy to withstand external emergency shocks and the potential capacity of stimulus. Therefore, we use logarithmic GDP per capita (LGDPPC) and expected growth expectation (EG2020) to measure.

After an outbreak and spread of the pandemic, most countries have put in place restrictive measures, albeit with varying degrees of severity and timing. We using the Oxford COVID-19 Government Response Tracker Stringency Index, which is a composite measure based on nine response indicators including school closures, workplace closures, and travel bans, as Restrictive measures (Pstringency). This index rescaled to a value from 0 to 100 (100 = strictest). It is worth noting that the restrictions adopted by different countries at different stages of the pandemic have varied considerably. With the spread of the epidemic, restrictions are generally strengthened, but it could also be released when a country's epidemic is well controlled at a certain period of time, as shown in Figure 2.

Figure 2 is about here

As demographic characteristics and medical conditions are also important factors to economic policies during the pandemic, in line with Alon et al. (2020), we used population density (mpopdensity), proportion of population over 65 years old reflecting the degree of aging (mpop65), diabetes prevalence (mdiabetes), hospital beds per thousand (mhospital_beds), and life expectancy (mlife_expectancy).

The daily number of confirmed cases and deaths comes from the European Centre for Disease Prevention and Control (ECDC). Other variables are collected from a variety of sources (United

Nations, World Bank, Global Burden of Disease, Blavatnik School of Government).

Descriptive statistics

From the perspective of fiscal policy, the average proportion of fiscal expenditure in last year's GDP is about 3%. The minimum is negative which means the reducing of fiscal expenditure while the maximum value is 17.8%, and the variance is large. From the perspective of monetary policy, the average rate cut of the full sample countries and regions is about 15.3 basis points, and the median was about 3.6 basis points, far less than the mean value. The maximum was 88.9 basis points, and the variance is much larger，as shown in Panel A Table 1.

By the comparison between developed countries and developing countries, we find for both fiscal policy and monetary policy, the intensity of economic stimulus policy in developed countries is significantly higher than that in developing countries. Fiscal expenditure in developed countries accounted for 4.712% of GDP, about 3.4 percentage points higher than that in developing countries. Developed countries interest rates cut by an average of about 19 basis points, nearly 7.6 percentage points more than developing countries. From the perspective of restrictive policy measures, developing countries are higher than developed countries. Other variables, including economic development, population density, population aging, diabetes incidence and the number of hospital beds, were significantly higher in developed countries than in developing countries，as shown in Panel B Table 1.

By the comparison of the earlier week and later week, the fiscal stimulus policies in developed countries were significant, while the interest rate cut was not significant. In developing countries, fiscal stimulus and interest rate cut are both significant, but fiscal stimulus is less intense and interest rate cut is larger, as shown in Panel C Table 1.

Table 1 is about here

Empirical results

Figure 3 shows the difference in the distribution of economic stimulus policies between developed and developing countries. (a) and (b) show the changes in the intensity of fiscal policy stimulus in developed and developing countries in the earlier week and later weeks, respectively, and (c) and (d) show the changes in the intensity of monetary policy stimulus in developed and developing countries in the earlier week and later weeks, respectively. The results show that fiscal stimulus is more aggressive in developed countries, while monetary policy, namely interest rate cuts, is more preferred in developing countries.

Figure 3 is about here

Figure 4 shows changes in pandemic and economic stimulus policies in developed and developing countries over the earlier week and later weeks. (a) shows the change in the intensity of fiscal policy stimulus in developed and developing countries over the earlier and later weeks,(b) Indicates changes in the intensity of monetary policy stimulus in both developed and developing

countries over the earlier and later weeks,(c) and (d) show changes in the cumulative number of confirmed cases and cumulative number of deaths in the earlier and later weeks, respectively, in developed and developing countries.

Figure 4 is about here

Baseline regression

Within the sample interval, columns (1) and (2) of Table 2 show that the increase in the number of confirmed cases are negatively correlated with fiscal policy stimulus and monetary policy stimulus, but both are not significant at the significance level of 10%. Column (3) and (4) of Table 2 shows that the change of deaths tolls is positively correlated with fiscal policy stimulus and monetary policy stimulus, which are also not significant at the significance level of 10%. Thus, putting together, the impact of the epidemic on short-term economic policy is generally not significant. This may indicate that the response to the exogenous shock of the COVID-19 pandemic, which is quite large, are not sensitive in the short term.

For control variables, the correlation between restrictive measures and economic stimulus policies is not significant. In theory, restrictions could have a negative impact on the economy, which could be hedged by aggressive fiscal policy and extended monetary policy. However, empirical results show that, in fact, the response of economic stimulus policies to restrictive measures, or the "compensation" in a sense, is not significant. Similarly, in most cases, the impact of economic expectations on stimulus policies is not significant[1].

In all cases, the level of economic development was significantly positively correlated with fiscal policy and monetary policy at the 1% level, which is consistent with Alon et al. (2020). This shows that countries with higher levels of economic development have taken more measures to stimulate the economy. This may indicate that, on the one hand, developed economies with relatively strong economic development strength have the foundation to stimulate their economy; on the other hand, developed economies may have richer experience in coping with sudden exogenous shocks.

From the perspective of demographic characteristics, for both the number of new confirmed cases and the number of new deaths, population density and the proportion of people over 65 years old are positively correlated with fiscal stimulus at the 1% level, but not significantly correlated with monetary policy stimulus. The proportion of diabetic patients is negatively correlated with fiscal stimulus at the 1% level, but not significantly correlated with monetary policy stimulus. The medical conditions expressed by the number of hospital beds were significantly negatively correlated with the economic policy stimulus (1%). Life expectancy was not correlated with economic stimulus policies.

In summary, the baseline regression results indicate that in the short term (about 5 weeks), both

[1] The only exception is the significant negative correlation between new deaths and fiscal stimulus, as shown in column (3).

new cases and new deaths increased have no significant impact on economic stimulus policies. In the countries with relatively lower level of medical conditions, the economic stimulus policies, including fiscal policies and monetary policies, are significantly more positive. However, the influence of demographic factors on economic stimulus policies is asymmetric: the higher the population density, the higher the proportion of aging and the lower the proportion of diabetes, the greater the stimulus intensity of fiscal policy. These social welfare, medical and other public expenditures are closely linked. In general, restrictions on population movement, expectations of economic development and life expectancy have no significant effect on economic stimulus in the short term.

Table 2 is about here

Next, we have an analysis of the cumulative impact of the pandemic on economic stimulus policies. Table 3 shows that there is significant heterogeneity in the impact of cumulative confirmed cases and cumulative deaths tolls on economic stimulus policies in the full sample the deaths tolls is significantly positively correlated with fiscal policy stimulus and monetary policy stimulus, while the number of cumulative confirmed cases is not significantly correlated with either. This indicates that as the impact of exogenous shocks gradually accumulates by death criteria, the response of stimulus policies gradually strengthens.

From the point of view of the control variables, they show a strong robustness. In all cases, the level of economic development is positively correlated with economic stimulus policies (at 1% significance), while hospital beds are negatively correlated with economic stimulus policies (at 1% significance). The influence of demographic factors on economic stimulus policies is asymmetric: the higher the population density, the higher the proportion of aging and the lower the proportion of diabetes, the greater the stimulus intensity of fiscal policy. These social welfare, medical and other public expenditures are closely linked. In general, restrictions on population movement, expectations of economic development and life expectancy have no significant effect on economic stimulus.

Table 3 is about here

Heterogeneity

As mentioned above in statistical descriptive part, there is significant heterogeneity in the choice of economic stimulus policies between developed and developing countries. For high-income countries, no matter the short-term increase in new cases or deaths, the stimulus of fiscal policy or monetary policy is not statistically significant, indicating that for high-income economies, the substitution effect of restrictive measures on economic stimulus is not significant, which is consistent with the baseline regression results. Similarly, restrictive measures and economic expectations are not statistically significant related to stimulus policies; Economic development level, aging degree and fiscal stimulus are statistically significantly positive correlation; The

proportion of diabetes and life expectancy were significantly positively correlated with monetary policy stimulus.

Table 4 is about here

For low- and middle-income countries, the stimulus from fiscal and monetary policies is not statistically significant, either because of a short-term increase in the number of new cases or deaths. In contrast to the baseline regression results, there is a statistically significant positive correlation between curbs and stimulus policies, suggesting that for developing countries, curbs may be somewhat complementary to stimulus policies. From the perspective of other control variables, most variables are not statistically correlated with economic stimulus measures, and only the level of economic development is statistically positively correlated with monetary policy stimulus (at significance level of 1%).

Table 5 is about here

For the developed economies, increased confirmed cases have no significant cumulative influence on economic stimulus policies, and increase with the deaths tolls have, which is positively correlated with stimulus policies significantly. Comparing with the benchmark regression, the coefficient is larger, and the significance level is higher, showing that for developed economies, the cumulative impact of the outbreak shock on policy stimulus is higher.

From the results of control variables, the level of economic development and the proportion of elderly population are significantly positively correlated with fiscal policy stimulus (1% level), but not with monetary policy stimulus. The proportion of diabetes and life expectancy were significantly positively correlated with monetary policy stimulus. This is consistent with the short-term impact of the epidemic on advanced economies.

Table 6 is about here

The impact of new confirmed cases on economic stimulus policies in low - and middle-income countries is not significant, consistent with baseline regression and developed economies. The increase in the number of new deaths was not related to economic stimulus policies, which was inconsistent with the baseline regression and the results of developed economies, indicating that the corresponding degree of economic stimulus was lower in low - and middle-income countries than in developed economies.

Unlike the baseline regression results, there is a statistically significant positive correlation between curbs and fiscal policy, suggesting that for developing countries, curbs may be somewhat complementary to fiscal stimulus. Similar to the situation in the case of short-term shocks, from the perspective of other control variables, most of the variables are not statistically correlated with economic stimulus measures, and only the level of economic development is statistically positively

correlated with monetary policy stimulus (1% significance level).

Table 7 is about here

In conclusion, when comparing high income and low - and middle-income economies, the short-term stimulus policies are similar, that is, the worsening of the epidemic, including the number of new diagnoses and deaths, is not statistically significant on the stimulus effects of fiscal and monetary policies; There are two differences: first, the correlation between restrictive measures and economic stimulus is not significant in developed economies, while it is significantly positive in developing countries, indicating that developing countries may use restrictive measures as a supplement to economic stimulus policies; Second, the variables of economic development level and demographic characteristics have different degrees of influence on developed countries, while the influence on developing countries is not significant in most cases.

Robustness test

In order to test the robustness of the empirical results, we carried out the following checks. Firstly, we check the short-term impact as shown in Panel A table 8, using PSM method for the experimental group and control group with kernel matching and the nearest neighbor matching methods as well as covariate matching. Compared with baseline regression, the results were robust. Then a similar method was used to test the robustness of cumulative effects, and the results were robust, as shown in Panel B table 8. In short, similar to the benchmark results, the short-term pandemic shock has no significant influence on economic stimulus policies, and cumulative impact shock measured in deaths have significant influence on economic stimulus policies, including fiscal policy and monetary policy.

Table 8 is about here

Conclusion and implications

The COVID-19 pandemic has caused enormous uncertainty and real shocks to the world's economy, and the influence are still ongoing. In order to cope with the shock, countries have taken both economic measures and non-economic measures, but the choice of policy varies a lot in different countries. This paper investigated the impact of the epidemic and the dynamic change process on economic stimulus policies. Using the standard DID and continuous variable DID methods with data from 156 economies.

We found that, deaths tolls have a greater impact on economic stimulus policies than new cases; the cumulative effect of a pandemic is more influential to economic stimulus than the short-term effect. Other economic and social factors such as economic development is positively correlated with the economic stimulus intensity, while the medical condition is negatively correlated with the

economic stimulus intensity. Population density and proportion of aging population are positively correlated with the intensity of fiscal stimulus. Heterogeneity tests show that while economic policies are more often used in developed economies, restrictive measures in developing countries may be used as a substitute for economic stimulus.

Our research shows that governments of different countries adopt different measures in response to sudden exogenous shocks, typically the trade-off between economic policies and non-economic policies, which may be comprehensively affected by a country's economic development level, demographic characteristics, medical conditions and other factors. There are also studies that show that social networks, which could influence the effect of restrictive measures, differ in different countries and have either a positive or negative impact on economic growth because of that networks diffuse both ideas and disease（Fogli and Veldkamp，2020）.

Our research suggests that the impact of the pandemic and the adoption of response measures may deepen inequality. The impact of the epidemic may have increased economic inequality due to the impact of policy capabilities, requiring international coordination and assistance to low - and middle-income countries. Furthermore, some studies have shown that the pandemic can also affect individual behavior and choice. For example, Buso et al. (2020) shows that the participants are more selfish in the ultimatum bargaining and cooperation function when lockdown is longer. This suggests that more humanitarian concern is needed for developing countries, which are more inclined to adopt restrictive measures.

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Figure and tables

Figure 1 Pandemic and economic stimulus policies

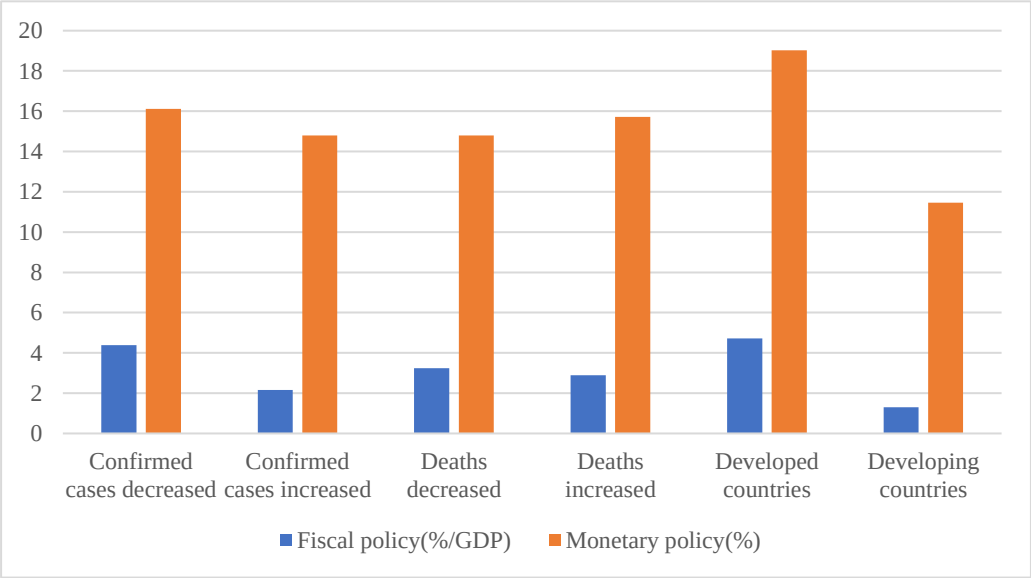


Figure 2 Pandemic and containment policies

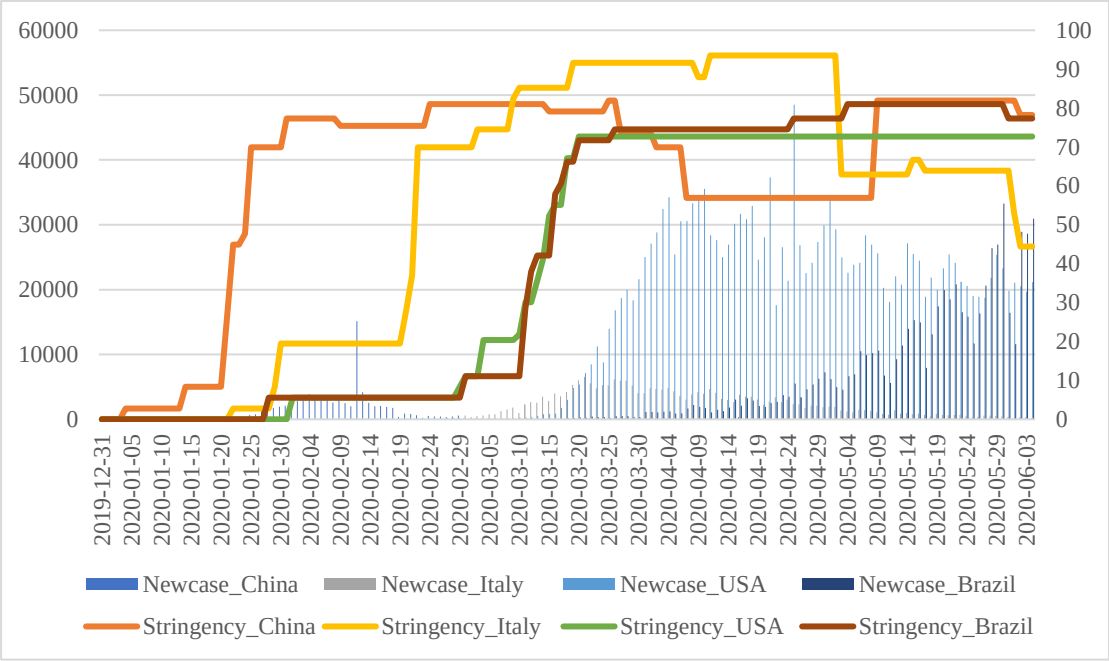
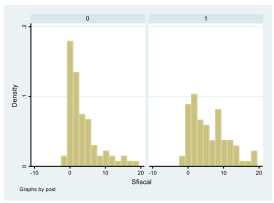
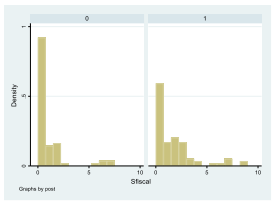


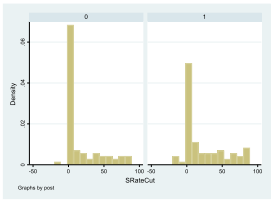
Figure 3 The heterogeneity of economic stimulus policies



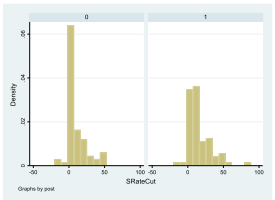
(a)



(b)



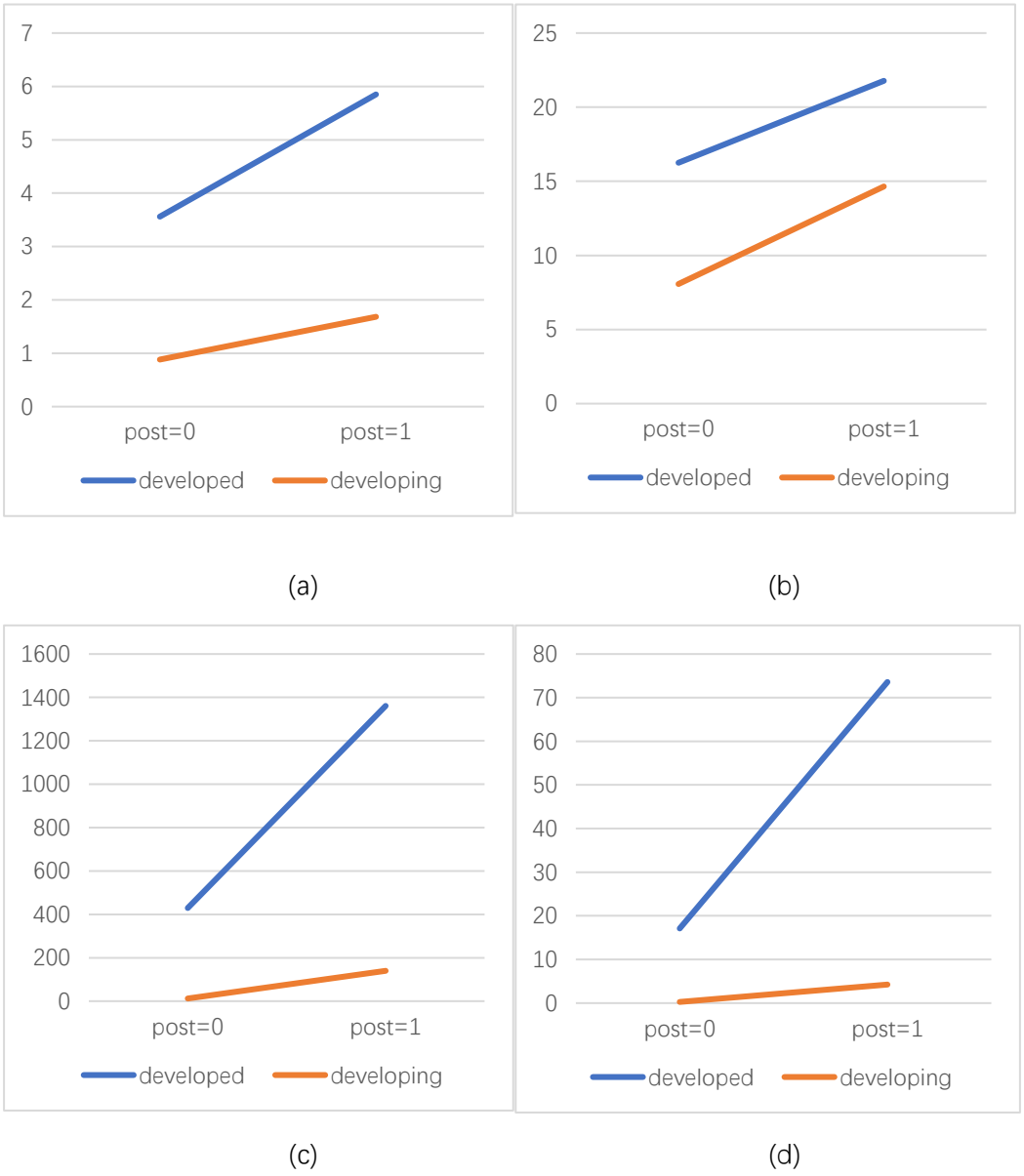
(c)



(d)

Note: (a) and (b) show the changes in the intensity of fiscal policy stimulus in developed and developing countries in the earlier week and later weeks, respectively, and (c) and (d) show the changes in the intensity of monetary policy stimulus in developed and developing countries in the earlier week, respectively.

Figure 4 The heterogeneity of pandemic shock and average economic stimulus policies



Note: (a) shows the change in the intensity of fiscal policy stimulus in developed and developing countries over the earlier and later weeks,(b) Indicates changes in the intensity of monetary policy stimulus in both developed and developing countries over the earlier and later weeks,(c) and (d) show changes in the cumulative number of confirmed cases and cumulative number of deaths in the earlier and later weeks, respectively, in developed and developing countries.

Table 1 Descriptive Statistics

Panel A: Full sample

VarName	*Obs*	*Mean*	*SD*	*Min*	*Median*	*Max*
sfiscal	312	3.037	4.125	-2.500	1.400	17.800
sratecut	312	15.321	23.480	-20.000	3.590	88.889
TTCC	312	495.909	1063.411	0.200	74.011	6151.993
TTDC	312	24.340	83.596	0.000	1.225	557.590
pstringency	298	77.542	15.918	13.890	80.560	100.000
eg2020	312	-0.102	4.498	-10.835	1.223	7.445
lgdppc	312	9.307	1.207	6.624	9.501	11.454
mpopdensity	312	168.113	299.313	3.078	80.080	1935.907
mpop65	308	8.944	6.323	1.307	6.336	23.021
mdiabetes	310	7.567	3.798	1.820	7.090	17.720
mhospital_beds	283	2.964	2.404	0.200	2.300	12.270
mlife_expectancy	310	72.949	7.593	54.240	74.530	4.630

Panel B: Developed and developing countries

VarName	*Mean*	*SD*	*Mean*	*SD*	*MEANDIFF*
	Developed countries		Developing countries		
sfiscal	4.712	4.910	1.296	1.941	3.417***
sratecut	19.031	28.377	11.466	16.174	7.565***
TTCC	897.954	1355.873	78.097	240.839	819.858***
TTDC	45.523	112.950	2.326	8.940	43.197***
pstringency	75.743	14.661	79.341	16.942	-3.598*
eg2020	-1.597	4.497	1.451	3.951	-3.048***
lgdppc	10.292	0.513	8.284	0.799	2.009***
mpopdensity	216.451	378.614	117.879	171.204	98.572***
mpop65	12.890	6.225	4.842	2.879	8.047***
mdiabetes	8.462	3.635	6.625	3.748	1.838***
mhospital_beds	4.041	2.391	1.622	1.620	2.419***
mlife_expectancy	78.282	4.376	67.334	6.058	10.948***

Panel C: Developed and developing countries

Variables	*Post=0*	*Post=1*	*MeanDiff*	*Post=0*	*Post=1*	*MeanDiff*
	Developed countries			Developing countries		
sfiscal	3.56	5.85	2.290***	0.882	1.683	0.800**
sratecut	16.251	21.776	5.526	8.069	14.648	6.579**
ancase	188.15	185.086	-3.064	144.137	135.72	-8.417
andeath	21.392	21.082	-0.31	5.264	4.964	-0.301
ctotalm	429.213	1360.837	931.624***	12.221	139.803	127.581***
dtotalm	17.104	73.586	56.482***	0.271	4.25	3.979***

Note: ***, **, * indicate statistical significance at the level of 1%, 5% and 10%, respectively.

Table 2 Short-term effects

	(1)	*(3)*	*(2)*	*(4)*
	Fiscal policy	Monetary policy	Fiscal policy	Monetary policy
	Confirmed cases	Confirmed cases	Deaths	Deaths
*TTC *post*	-0.162	-1.682		
	(-0.19)	(-0.28)		
TTC	-0.279	3.900		
	(-0.44)	(0.93)		
*TTD *post*			0.867	1.944
			(1.04)	(0.34)
TTD			-1.060*	0.214
			(-1.69)	(0.06)
post	1.130	5.808	0.431	3.609
	(1.39)	(0.97)	(0.62)	(0.68)
pstringency	-0.005	0.045	-0.006	0.055
	(-0.45)	(0.56)	(-0.55)	(0.70)
eg2020	-0.105	-0.245	-0.119*	-0.253
	(-1.52)	(-0.47)	(-1.71)	(-0.49)
lgdppc	1.221***	6.768***	1.255***	6.770***
	(3.45)	(2.85)	(3.51)	(2.84)
mpopdensity	0.002***	-0.005	0.002***	-0.004
	(2.78)	(-0.79)	(2.64)	(-0.72)
mpop65	0.218***	-0.046	0.228***	-0.131
	(3.12)	(-0.09)	(3.28)	(-0.28)
mdiabetes	-0.167**	0.552	-0.166**	0.535
	(-2.13)	(1.18)	(-2.13)	(1.14)
mhospital_beds	-0.237*	-2.199**	-0.242*	-2.124**
	(-1.83)	(-2.22)	(-1.86)	(-2.23)
mlife_expectancy	0.011	0.241	0.003	0.221
	(0.18)	(0.59)	(0.04)	(0.54)
constant	-9.370***	-70.052***	-8.577***	-66.490***
	(-2.96)	(-3.31)	(-2.75)	(-3.15)
observations	271	271	271	271
R^2	0.419	0.160	0.425	0.157
Adj R^2	0.39	0.12	0.40	0.12

Note: ***, **, * indicate statistical significance at the level of 1%, 5% and 10%, respectively.

Table 3 Cumulative effects

	(1)	*(3)*	*(2)*	*(4)*
	Fiscal policy	Monetary policy	Fiscal policy	Monetary policy
	Confirmed cases	Confirmed cases	Deaths	Deaths
*TTCC*post*	-0.000	0.003		
	(-0.37)	(0.56)		
TTCC	0.002*	-0.005		
	(1.68)	(-1.05)		
*TTDC*post*			0.029***	0.077*
			(3.24)	(1.82)
TTDC			-0.025**	-0.118**
			(-2.55)	(-2.08)
post	0.590	5.309	0.817*	4.859
	(1.36)	(1.41)	(1.76)	(1.30)
pstringency	-0.003	0.053	-0.007	0.067
	(-0.28)	(0.65)	(-0.59)	(0.86)
eg2020	-0.068	-0.292	-0.087	-0.376
	(-1.03)	(-0.57)	(-1.25)	(-0.73)
lgdppc	0.602**	8.076***	1.173***	7.368***
	(2.04)	(3.15)	(3.41)	(3.07)
mpopdensity	0.001*	-0.004	0.002***	-0.004
	(1.84)	(-0.60)	(2.68)	(-0.66)
mpop65	0.214***	-0.082	0.234***	0.113
	(3.34)	(-0.17)	(3.29)	(0.23)
mdiabetes	-0.069	0.336	-0.154*	0.362
	(-0.95)	(0.70)	(-1.96)	(0.78)
mhospital_beds	-0.108	-2.398**	-0.255**	-2.595***
	(-0.77)	(-2.49)	(-1.97)	(-2.61)
mlife_expectancy	-0.001	0.241	0.018	0.221
	(-0.02)	(0.58)	(0.30)	(0.54)
constant	-4.438	-77.043***	-9.627***	-71.432***
	(-1.55)	(-3.48)	(-3.02)	(-3.44)
observations	271	271	271	271
R^2	0.477	0.163	0.439	0.169
Adj R^2	0.45	0.13	0.42	0.13

Note: ***, **, * indicate statistical significance at the level of 1%, 5% and 10%, respectively.

Table 4 Short-term effects on developed countries

	(1)	*(3)*	*(2)*	*(4)*
	Fiscal policy	Monetary policy	Fiscal policy	Monetary policy
	Confirmed cases	Confirmed cases	Deaths	Deaths
*TTC*post*	-0.003	-1.852		
	(-0.00)	(-0.21)		
TTC	-0.516	12.773**		
	(-0.54)	(2.05)		
*TTD*post*			1.446	5.092
			(1.07)	(0.55)
TTD			-1.635	7.440
			(-1.56)	(1.20)
post	0.859	0.071	-0.148	-4.352
	(0.51)	(0.01)	(-0.09)	(-0.37)
pstringency	0.011	0.002	0.010	-0.014
	(0.48)	(0.01)	(0.45)	(-0.09)
eg2020	-0.220	-0.890	-0.239	-0.957
	(-1.26)	(-0.80)	(-1.45)	(-0.84)
lgdppc	3.134***	4.482	3.226***	4.191
	(3.84)	(0.85)	(3.92)	(0.76)
mpopdensity	0.001	-0.013	0.001	-0.010
	(1.30)	(-1.58)	(0.97)	(-1.16)
mpop65	0.170*	0.077	0.178*	-0.246
	(1.69)	(0.11)	(1.83)	(-0.37)
mdiabetes	-0.139	2.161***	-0.146	2.110***
	(-0.99)	(2.81)	(-1.08)	(2.69)
mhospital_beds	-0.026	-1.916	-0.021	-1.879
	(-0.13)	(-1.36)	(-0.10)	(-1.34)
mlife_expectancy	0.129	1.898**	0.113	1.855**
	(1.02)	(2.12)	(0.90)	(2.08)
constant	-39.992***	-190.604***	-38.901***	-177.229***
	(-4.25)	(-3.00)	(-4.21)	(-2.83)
observations	147	147	147	147
R^2	0.414	0.194	0.424	0.187
Adj R^2	0.37	0.13	0.38	0.12

Note: ***, **, * indicate statistical significance at the level of 1%, 5% and 10%, respectively.

Table 5 Short-term effects on developing countries

	(1)	*(3)*	*(2)*	*(4)*
	Fiscal policy	Monetary policy	Fiscal policy	Monetary policy
	Confirmed cases	Confirmed cases	Deaths	Deaths
*TTC*post*	0.535	-0.522		
	(0.76)	(-0.08)		
TTC	-0.114	-8.970*		
	(-0.23)	(-1.97)		
*TTD*post*			-0.025	-0.701
			(-0.04)	(-0.13)
TTD			-0.048	-7.886**
			(-0.11)	(-2.10)
post	0.174	5.018	0.601	4.103
	(0.28)	(0.79)	(1.18)	(0.83)
pstringency	0.019*	0.148**	0.020**	0.105*
	(1.86)	(2.46)	(2.26)	(1.84)
eg2020	-0.036	-0.419	-0.031	-0.614
	(-0.63)	(-0.82)	(-0.53)	(-1.26)
lgdppc	0.182	9.209***	0.192	9.696***
	(0.56)	(4.03)	(0.58)	(4.21)
mpopdensity	-0.000	0.004	-0.000	0.006
	(-0.33)	(0.86)	(-0.25)	(1.16)
mpop65	-0.013	0.525	-0.010	0.703
	(-0.17)	(0.69)	(-0.13)	(0.91)
mdiabetes	0.076	-0.367	0.077	-0.302
	(0.97)	(-0.66)	(0.98)	(-0.53)
mhospital_beds	-0.046	-0.703	-0.040	-1.103
	(-0.35)	(-0.61)	(-0.30)	(-0.97)
mlife_expectancy	0.015	-0.495	0.011	-0.545
	(0.24)	(-1.27)	(0.18)	(-1.37)
constant	-3.336	-38.139	-3.416	-37.382
	(-1.01)	(-1.48)	(-1.02)	(-1.49)
observations	124	124	124	124
R^2	0.159	0.253	0.153	0.254
Adj R^2	0.08	0.18	0.07	0.18

Note: ***, **, * indicate statistical significance at the level of 1%, 5% and 10%, respectively.

Table 6 Cumulative effects on developed countries

	(1)	*(3)*	*(2)*	*(4)*
	Fiscal policy	Monetary policy	Fiscal policy	Monetary policy
	Confirmed cases	Confirmed cases	Deaths	Deaths
*TTCC*post*	-0.000	0.003		
	(-0.17)	(0.64)		
TTCC	0.001	-0.008		
	(1.03)	(-1.40)		
*TTDC*post*			0.033***	0.097**
			(3.93)	(2.18)
TTDC			-0.034***	-0.146**
			(-3.73)	(-2.28)
post	0.219	3.823	0.404	1.359
	(0.18)	(0.39)	(0.31)	(0.14)
pstringency	0.008	0.026	0.016	0.051
	(0.33)	(0.16)	(0.69)	(0.32)
eg2020	-0.204	-0.685	-0.232	-0.829
	(-1.31)	(-0.58)	(-1.39)	(-0.70)
lgdppc	2.193***	10.710	3.113***	7.036
	(2.88)	(1.64)	(3.78)	(1.26)
mpopdensity	0.001	-0.011	0.001	-0.012
	(1.10)	(-1.37)	(1.31)	(-1.40)
mpop65	0.186**	-0.220	0.213**	0.062
	(1.99)	(-0.34)	(2.15)	(0.09)
mdiabetes	-0.077	1.645**	-0.135	1.791**
	(-0.56)	(2.03)	(-0.94)	(2.28)
mhospital_beds	0.022	-2.052	-0.090	-2.257*
	(0.11)	(-1.60)	(-0.47)	(-1.68)
mlife_expectancy	0.101	1.872**	0.160	1.741*
	(0.81)	(2.11)	(1.30)	(1.93)
constant	-29.424***	-237.702***	-42.737***	-196.398***
	(-2.92)	(-3.22)	(-4.31)	(-3.08)
observations	147	147	147	147
R^2	0.437	0.183	0.437	0.181
Adj R^2	0.39	0.12	0.39	0.11

Note: ***, **, * indicate statistical significance at the level of 1%, 5% and 10%, respectively.

Table 7 Cumulative effects on developing countries

	(1)	*(3)*	*(2)*	*(4)*
	Fiscal policy	Monetary policy	Fiscal policy	Monetary policy
	Confirmed cases	Confirmed cases	Deaths	Deaths
*TTCC*post*	-0.003	-0.150		
	(-0.38)	(-0.77)		
TTCC	0.004	0.163		
	(0.49)	(0.83)		
*TTDC*post*			0.024	-4.625
			(0.14)	(-1.03)
TTDC			-0.016	4.775
			(-0.10)	(1.06)
post	0.577	5.464	0.576	5.530
	(1.59)	(1.48)	(1.63)	(1.63)
pstringency	0.019**	0.054	0.020**	0.079
	(2.19)	(0.78)	(2.31)	(1.22)
eg2020	-0.018	-0.286	-0.025	-0.405
	(-0.33)	(-0.58)	(-0.45)	(-0.84)
lgdppc	0.172	8.844***	0.178	8.807***
	(0.54)	(4.04)	(0.56)	(4.05)
mpopdensity	-0.000	0.004	-0.000	0.003
	(-0.14)	(0.78)	(-0.26)	(0.66)
mpop65	-0.021	0.244	-0.012	0.286
	(-0.26)	(0.31)	(-0.16)	(0.38)
mdiabetes	0.093	-0.078	0.082	-0.192
	(1.29)	(-0.15)	(1.13)	(-0.37)
mhospital_beds	-0.035	-0.947	-0.037	-0.729
	(-0.26)	(-0.91)	(-0.28)	(-0.66)
mlife_expectancy	0.002	-0.559	0.009	-0.535
	(0.04)	(-1.53)	(0.17)	(-1.44)
constant	-2.733	-32.235	-3.238	-34.455
	(-0.97)	(-1.57)	(-1.12)	(-1.61)
observations	124	124	124	124
R^2	0.163	0.235	0.154	0.221
Adj R^2	0.08	0.16	0.07	0.14

Note: ***, **, * indicate statistical significance at the level of 1%, 5% and 10%, respectively.

Table 8 Robustness test

Panel A: Short-term impact

	(1)	*(3)*	*(2)*	*(4)*
	Fiscal policy	Monetary policy	Fiscal policy	Monetary policy
	Confirmed cases	Confirmed cases	Deaths	Deaths
PSM Neighbor				
*TTC *post/ TTD *post*	-0.174	-1.509	0.871	2.465
	(-0.20)	(-0.25)	(1.03)	(0.43)
PSM kernel				
*TTC *post/ TTD *post*	-0.162	-1.682	0.867	1.944
	(-0.19)	(-0.28)	(1.04)	(0.34)
covariate Matching				
*TTC *post/ TTD *post*	-0.059	-2.025	0.980	1.891
	(-0.07)	(-0.32)	(1.14)	(0.32)
Control variables	Yes	Yes	Yes	Yes

Panel B: Cumulative impact

	(1)	*(3)*	*(2)*	*(4)*
	Fiscal policy	Monetary policy	Fiscal policy	Monetary policy
	Confirmed cases	Confirmed cases	Deaths	Deaths
PSM Neighbor				
*TTCC*post/ TTDC*post*	-0.000	0.002	0.029***	0.076*
	(-0.42)	(0.50)	(3.19)	(1.83)
PSM kernel				
*TTC *post/ TTD *post*	-0.000	0.003	0.029***	0.077*
	(-0.37)	(0.56)	(3.24)	(1.82)
covariate Matching				
*TTC *post/ TTD *post*	-0.000	0.003	0.029***	0.076*
	(-0.35)	(0.59)	(3.30)	(1.80)
Control variables	Yes	Yes	Yes	Yes

Note: ***, **, * indicate statistical significance at the level of 1%, 5% and 10%, respectively.