

Online Prices and Stay-at-home Economy: Evidence from Prices of 107 Chinese Websites during the COVID-19 Quarantine Period

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Outline

- Part 1: Introduction
- Part 2: Data and Methodology
- Part 3: Impacts of the COVID-19 Pandemic on Inflation
- Part 4: Impacts of the COVID-19 Pandemic on Price Stickiness
- Part 5: Conclusions and Implications

Part 1: Introduction

□ Motivation

- The outbreak of the COVID-19 pandemic brings huge consequences on the global economy and health.
- Diverse restrictive policies have been enforced to prevent the novel Coronavirus from spreading, for example, wearing masks and keeping social distance.



Motivation

- During the quarantine period, the “stay-at-home” (“Zhai” economy) is developing rapidly, while the offline economy is seriously impacted (almost frozen).

Industry that Stay-at-home Economy Involves

Online Shopping



Online Entertainment



Home-delivery Service



Online Medical Service



Online Education



Remote Working



Online Recruitment



Online House-purchase



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Motivation

- ❑ Online prices receive more and more attention.
 - ✓ BPP(Billion Price Project) , Refer to: Cavallo & Rigobon, 2016; Cavallo, 2017)
 - ✓ iCPI (Internet-based CPI) in China, <http://www.bdecon.com/chartsEnglishIndex> . (Refer to: Liu et al., 2019; Jiang et al., 2020)
- ❑ Online prices are different from offline prices
 - ✓ low search costs/low costs of monitoring competitors' prices/ low costs of nominal price adjustment
- ❑ Online prices provide new possibilities for analyzing impacts of the pandemic on prices during the COVID-19 quarantine period.

Literature Review

- ❑ For the impacts of COVID-19 pandemic on the macroeconomics, e.g. McKibbin & Fernando (2020) , Coibion et al. (2020), Chen et al. (2020)
- ❑ For the impacts of COVID-19 pandemic on the financial markets, e.g. Fernandes (2020) , Guravl & Kotrappa (2020), Albulescu(2020).
- ❑ For the impacts of disasters on prices, e.g. Cavallo et al. (2014), Gagnon & López-Salido(2014).
- ❑ For online prices, e.g. Cavallo(2017), Gorodnichenko et al.(2018), Jiang et al.(2020).

Main Findings

- We use **online prices** and the **DiD** method to analyze the impact of the epidemic on the overall price adjustment behavior and inflation of various types of goods and services.
- **First**, we show that the pandemic leads to a 0.6% surge in overall price index, but a 20% decrease in the price change frequency, and 1% drop in the absolute price change size.
- **Second**, significant differences show up among various sectors as the pandemic has heterogeneous impacts on their demand and supply sides, including pure online products, online-to-offline (O2O) products and pure offline products.

Part 2: Data and Methodology

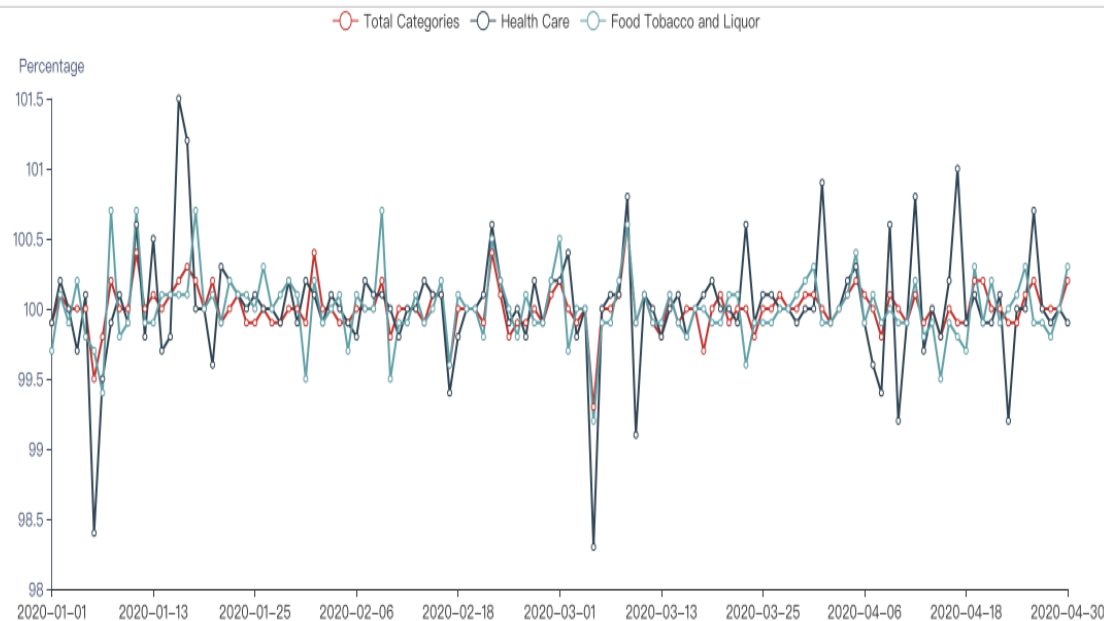
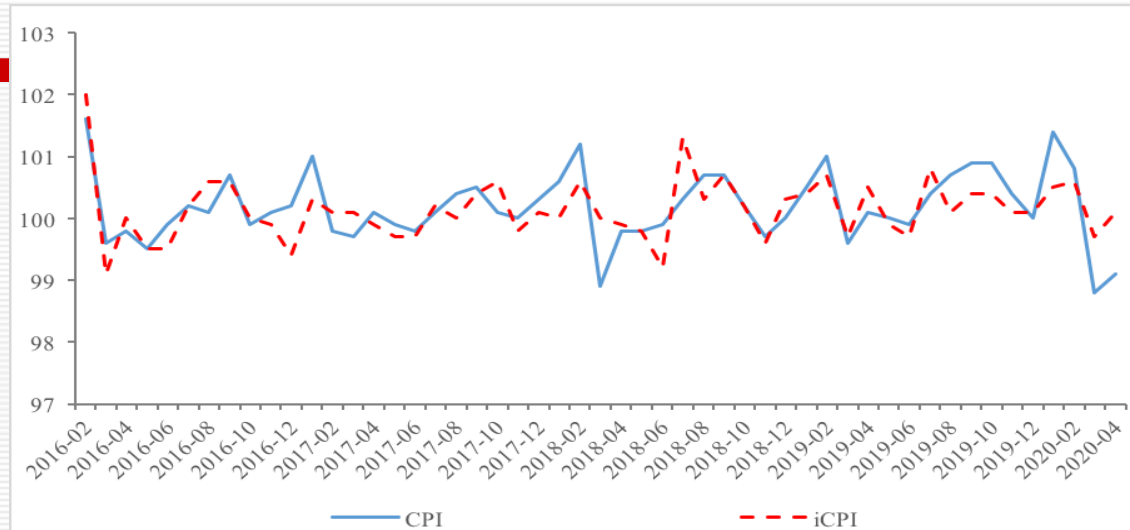
□ 2.1 Data

□ iCPI (Internet-based Consumer Price Index) , <http://www.bdecon.com/chartsEnglishIndex>

- ✓ The goods basket of iCPI follows the latest CPI basket of the National Bureau of Statistics of the People's Republic of China, which consists of the main index, 8 divisions, 46 groups and 262 classes.
- ✓ We directly collect price data from China's main E-commerce platforms and price-searching websites (107 platforms in total).
- ✓ iCPI is generated in automatic computation procedures including data collection, data cleaning, and final processing to online publishing, which avoids human intervention and improves its validity.
- ✓ iCPI published through our website is updated every day including daily, weekly and monthly indices.

2.1 Data: iCPI

- The correlation coefficient of the main monthly iCPI and CPI is 0.65 significant at 1% significance level.
- Daily, weekly and monthly iCPI can be downloaded in some databases, e.g. Bloomberg, CEIC and Wind et al.



2.2 Methodology

- On January 20, 2020, Zhong Nanshan, a renowned Chinese respiratory expert, first revealed the possibility of human-to-human transmission of the COVID-19, causing the panic. Thus, we take the day of January 20, 2020 as the outbreak point of COVID-19.
- Considering the outbreak is close to the *Chinese New Year* (Spring Festival; abbreviated as *CNY*) on January 25, 2020, we use the difference-in-differences (*DiD*) regression approach to evaluate the impact of COVID-19 on prices.

2.2 Methodology

- ❑ To capture the counterfactual price change pattern, we adopt the same data from a similar period of 2019 as the control group (benchmark), aiming to remove the impact of *CNY*.
- ✓ The sample period of treatment group is from January 1, 2020 to February 20, 2020 with January 20, 2020 (5 days before *CNY* of 2020) as the outbreak point;
- ✓ The sample period of control group is from January 12, 2019 to February 27, 2019 with the January 31, 2019 (5 days before *CNY* of 2019) as the assumptive “outbreak” point.

2.2 Methodology

- For the price change/increase/decrease probability analysis, we adopt the panel logit DiD model with product-level panel data:

$$\ln\left(\frac{Prob_{it}}{1-Prob_{it}}\right) = \alpha + \beta_{did} year_t * ncov_t + \beta_1 year_t + \beta_2 ncov_t + Z'_{it} \delta + u_{it}$$

$Prob_{it}$ is the price change/increase/decrease probability of goods i at day t

$$year_t = \begin{cases} 1, & t \text{ is from January 1, 2020 to February 20, 2020; the treatment group} \\ 0, & t \text{ is from January 12, 2019 to February 27, 2019; the control group} \end{cases}$$

$$ncov_t = \begin{cases} 1, & t \text{ is after the outbreak point (January 20, 2020 or January 31, 2019)} \\ 0, & t \text{ is before the outbreak point (January 20, 2020 or January 31, 2019)} \end{cases}$$

β_{did} is the DiD coefficient, indicating the impact of the COVID-19 on the probability of price adjustment after excluding the effect of CNY.

2.2 Methodology

- For the price change size analysis, we adopt the fixed-effect DiD model with product-level panel data:

$$pcsize_{it} = \alpha + \beta_{did} year_t * ncov_t + \beta_1 year_t + \beta_2 ncov_t + Z'_{it} \delta + u_{it}$$

$pcsize_{it}$ is the price change/increase/decrease size of goods i at day t , and

$$pcsize_{it} = \frac{P_{it} - P_{it-1}}{P_{it-1}} * 100\%$$

Part 3: Impacts of the COVID-19 Pandemic on Inflation

□ 3.1 Impacts of the COVID-19 pandemic on the overall inflation rate

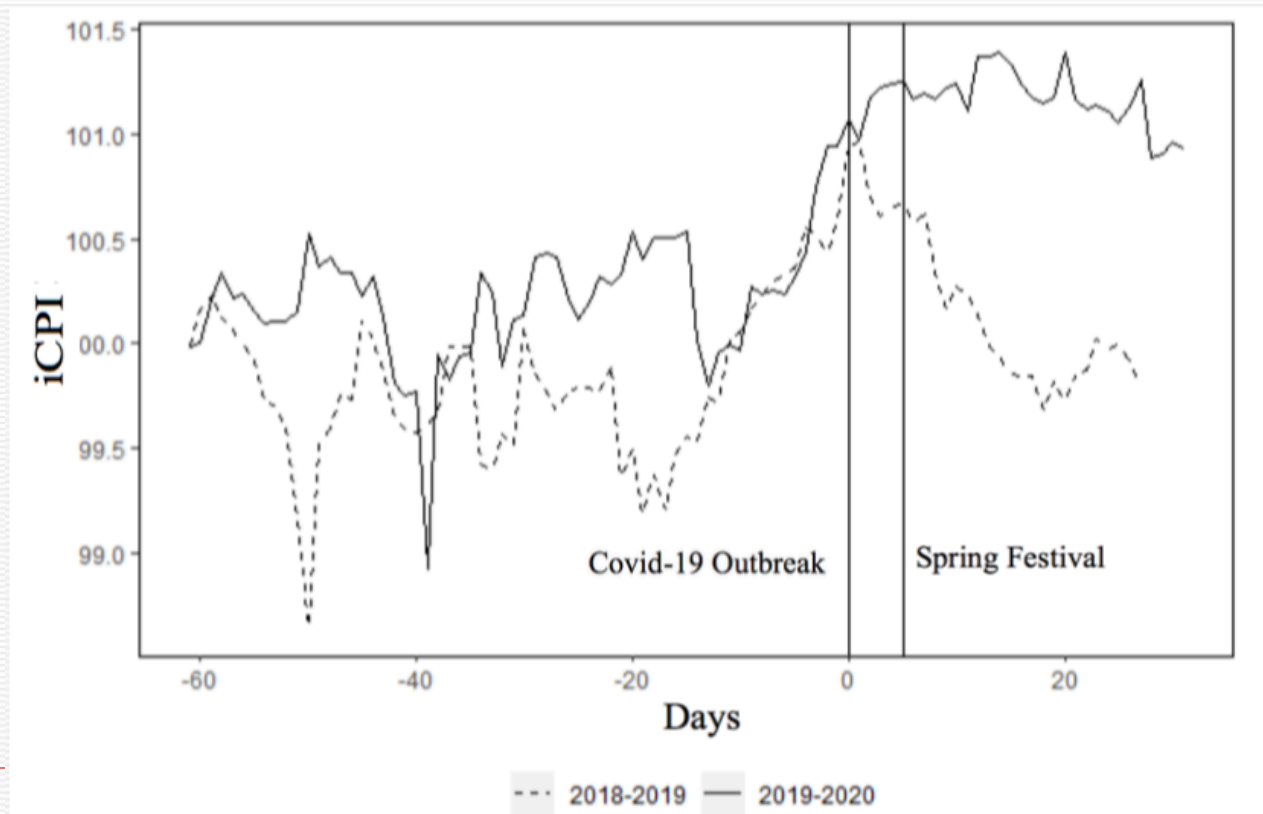


Figure 1. Daily overall online inflation rate before and after the outbreak of COVID-19

3.1 Impacts of the COVID-19 Pandemic on the overall inflation rate

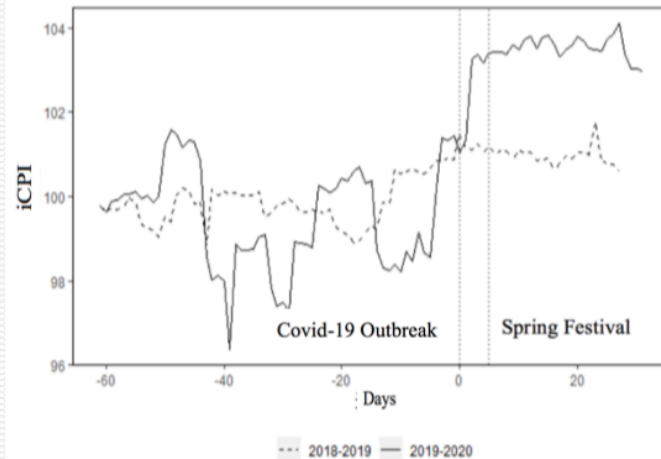
- The pandemic leads to a 0.6% surge in overall price index at 1% significance level.

Table 1. Impacts of the COVID-19 pandemic on inflation (iCPI)

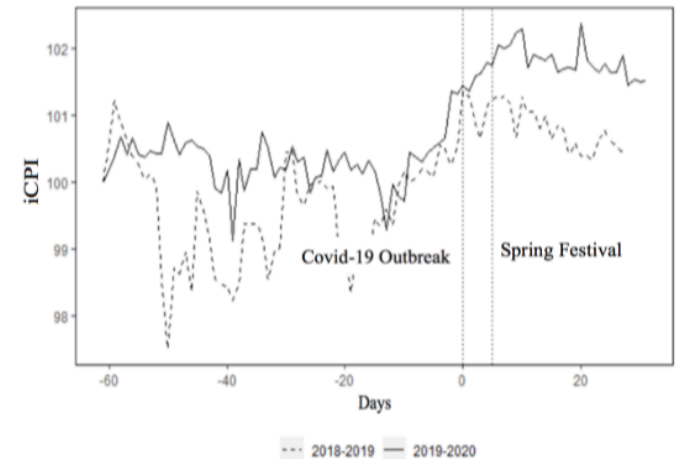
	2019 (the control group)			2020 (the treatment group)			
	before the “outbreak”	after the “outbreak”	difference 1 (the impact of <i>Spring Festival</i>)	before the outbreak	after the outbreak	difference 2	Diff-in-Diff (the impact of <i>COVID-19</i>)
The whole basket	99.965 (0.474)	100.179 (0.388)	0.214 (1.64)	100.346 (0.323)	101.167 (0.135)	0.821*** (12.70)	0.607*** (3.99)
The whole basket excluding <i>health care</i>	100.774 (0.457)	100.933 (0.414)	0.159 (1.22)	100.001 (0.261)	100.577 (0.129)	0.576*** (10.55)	0.417*** (2.88)

Notes: (1) the sample period of treatment group is from January 1, 2020 to February 20, 2020 with January 20, 2020 (5 days before the Spring Festival of 2020) as the outbreak point; the sample period of control group is from January 12, 2019 to February 27, 2019 with the January 31, 2019 (5 days before the Spring Festival of 2019) as the assumptive “outbreak” point; (2) The values not in parentheses are the average price index; t-statistics are shown in parentheses; (3) *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$; (4) Diff-in-Diff= difference 2-difference 1.

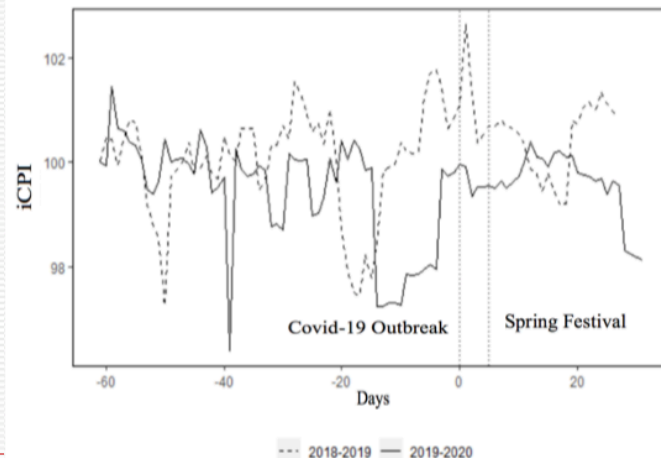
3.2 Impacts of the COVID-19 Pandemic on the price index on different divisions



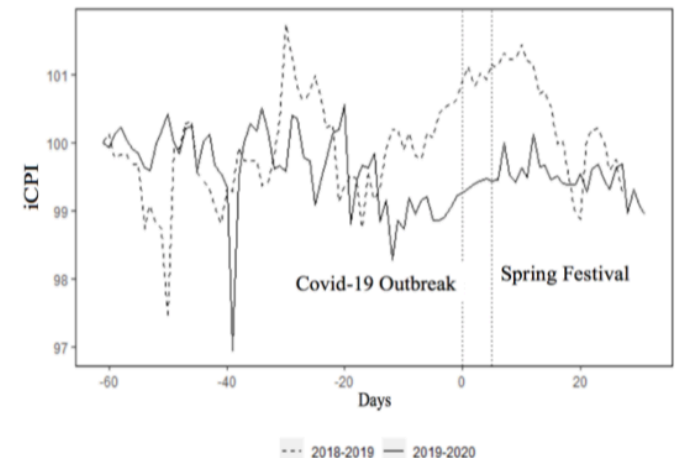
(a) Price Index of Health Care



(b) Price Index of Food, Tobacco and Liquor



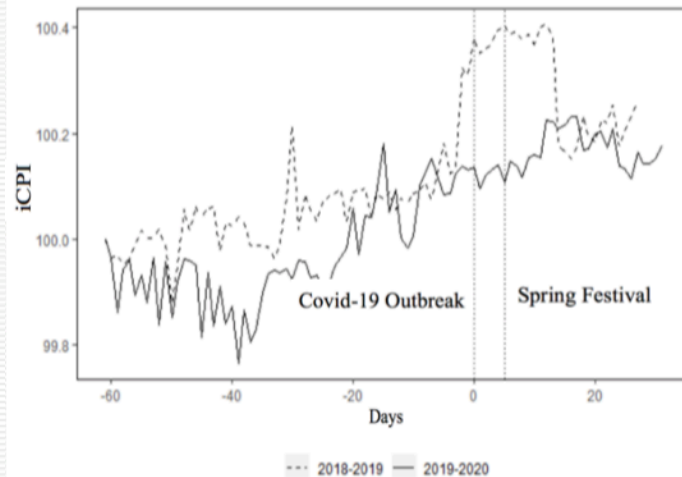
(c) Price Index of Clothing



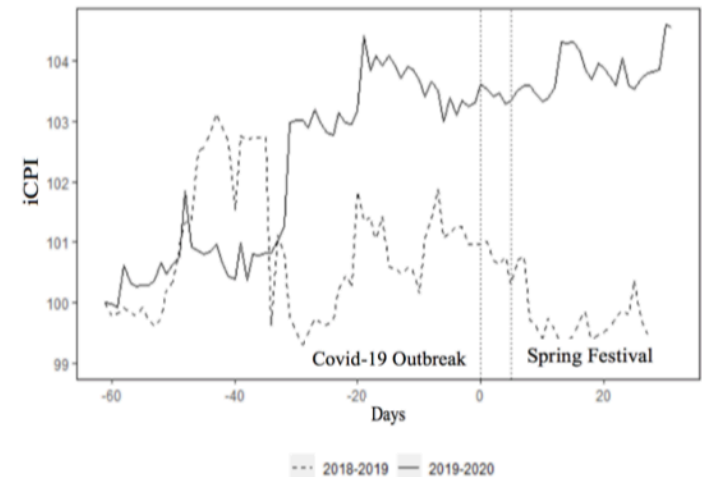
(d) Price Index of Household Articles and Service

Figure 2-1. Daily online inflation rates of 8 divisions before and after the outbreak of COVID-19

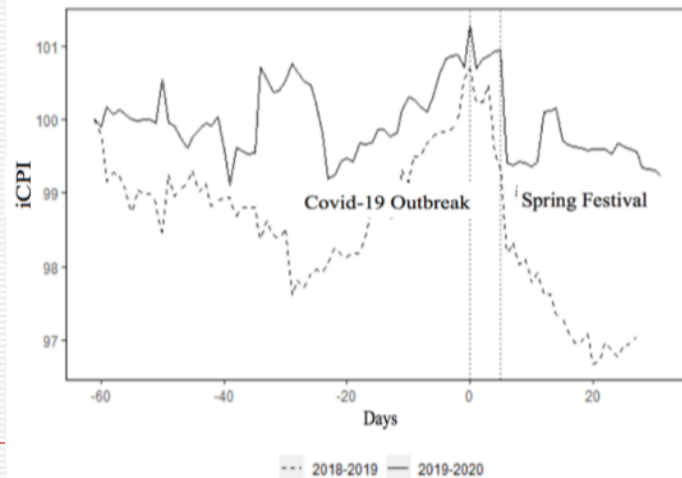
3.2 Impacts of the COVID-19 Pandemic on the price index on different divisions



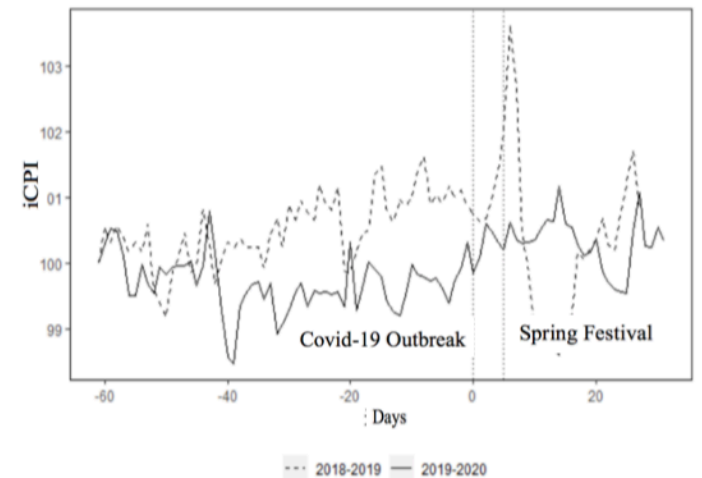
(e) Price Index of Residence



(f) Price Index of Education, Culture and Recreation



(g) Price Index of Transportation and Communication



(h) Price Index of Other Articles and Services

Figure 2-2. Daily online inflation rates of 8 divisions before and after the outbreak of COVID-19

3.2 Impacts of the COVID-19 Pandemic on the price index on different divisions

- The pandemic leads to a 2.87% and 0.4% surge in the price index of *Health Care* and *Food, Tobacco and Liquor*, respectively.

Table 2. Impacts of the COVID-19 epidemic on the price index of different divisions

	2019 (the control group)			2020 (the treatment group)			Diff-in-Diff (the impact of COVID-19)
	before the “outbreak”	after the “outbreak”	difference 1 (the impact of <i>Spring Festival</i>)	before the outbreak	after the outbreak	difference 2	
Health Care	100.109 (0.757)	101.009 (0.236)	0.899*** (5.05)	99.589 (1.194)	103.357 (0.624)	3.768*** (14.82)	2.869*** (8.34)
Food, Tobacco and Liquor	99.737 (0.652)	100.834 (0.330)	1.096*** (6.79)	100.294 (0.498)	101.767 (0.244)	1.472*** (14.17)	0.376* (1.86)
Clothing	99.760 (1.446)	100.567 (0.755)	0.808** (2.25)	98.616 (1.235)	99.591 (0.591)	0.976*** (3.81)	0.168 (0.36)
Residence	100.118 (0.0762)	100.293 (0.0952)	0.175*** (6.98)	100.080 (0.0596)	100.163 (0.0387)	0.0828*** (6.02)	-0.0920*** (-3.14)
Household Articles and Service	99.900 (0.510)	100.464 (0.760)	0.564*** (3.05)	99.091 (0.371)	99.463 (0.242)	0.372*** (4.34)	-0.192 (-0.92)
Transportation and Communication	99.248 (0.670)	97.920 (1.265)	-1.328*** (-4.67)	100.159 (0.457)	99.831 (0.582)	-0.327** (-2.10)	1.001*** (3.13)
Education, Culture and Recreation	101.007 (0.428)	99.947 (0.552)	-1.060*** (-7.41)	103.653 (0.373)	103.763 (0.356)	0.110 (1.05)	1.170*** (6.57)
Other Articles and Services	100.953 (0.358)	100.412 (1.220)	-0.542** (-2.21)	99.691 (0.289)	100.305 (0.385)	0.615*** (6.02)	1.156*** (4.40)

Notes: Refer to the notes of table 1.

Part 4: Impacts of the COVID-19 Pandemic on Price Stickiness

□ Price Change Frequency

$$pcf_t = \frac{npc_t}{obs_t}$$

□ Price Change Size

$$pcsize_t = \frac{P_t - P_{t-1}}{P_{t-1}} * 100\%$$

□ Absolute Price Change Size

$$abspcsize_t = \left| \frac{P_t - P_{t-1}}{P_{t-1}} \right| * 100\%$$

4.1 Impacts of the COVID-19 Pandemic on price change frequency

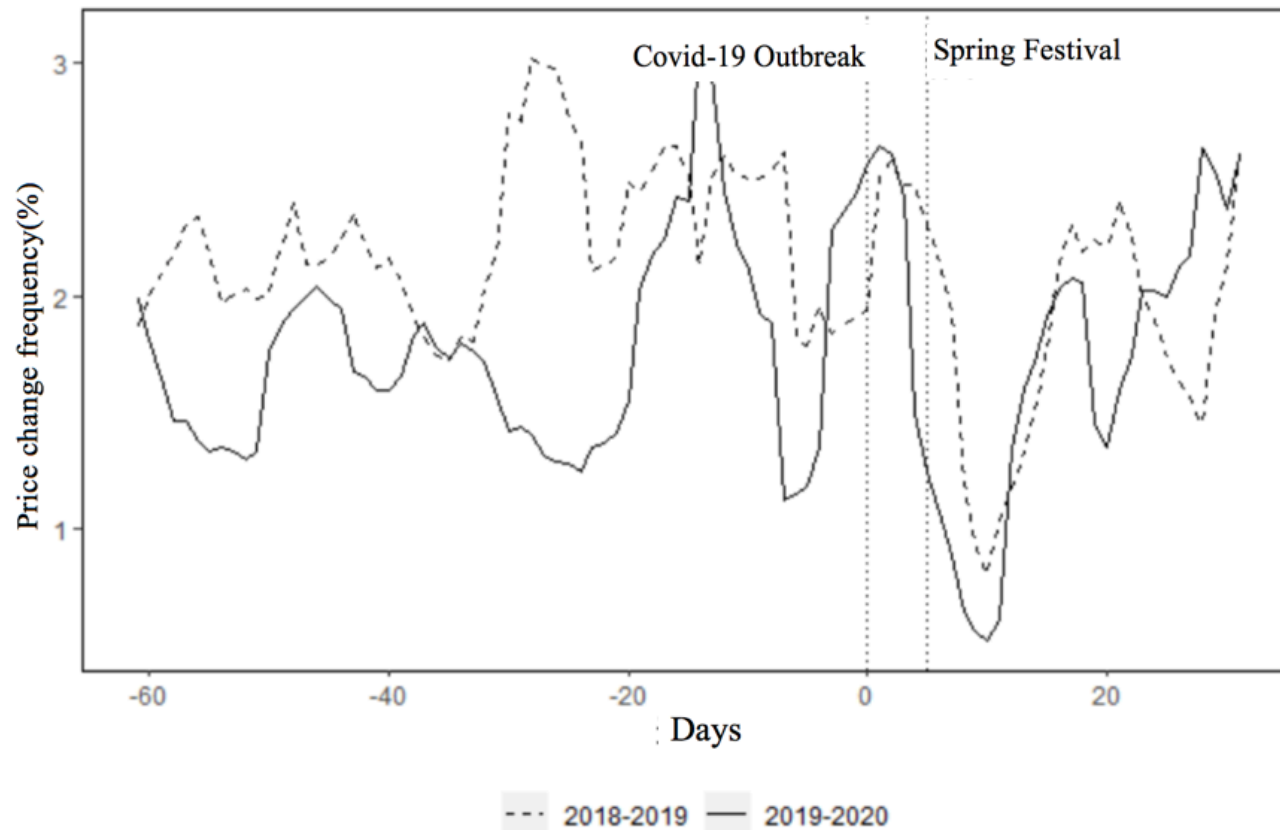


Figure 3. Price change frequency before and after the outbreak of COVID-19

Descriptive statistics of variables

Table 3. Descriptive statistics of variables

Variables	Obs	Mean	Min	Max	S.D.
Dependent Variables					
Price Change	3104546	0.02	0	1	0.14
Price Increase	3104546	0.01	0	1	0.10
Price Decrease	3104546	0.01	0	1	0.10
Price Change Size	61957	3.17	-50	100	24.25
Absolute Price Change Size	61957	16.51	0	100	18.04
Price Increase Size	31548	19.32	0	100	21.91
Price Decrease Size	30409	13.58	0	50	12.18
Independent Variables					
year(in 2019=0, in 2020=1)	3104546	0.60	0	1	0.49
ncov(before outbreak=0, after outbreak=1)	3104546	0.62	0	1	0.49
year* ncov	3104546	0.37	0	1	0.48
Control Variables					
Ln(Price)	3104546	4.81	-4.61	17.73	1.83
Food, Tobacco and Liquor	3104546	0.33	0	1	
Clothing	3104546	0.18	0	1	
Residence	3104546	0.04	0	1	
Household Articles and Service	3104546	0.24	0	1	
Transportation and Communication	3104546	0.06	0	1	
Education, Culture and Recreation	3104546	0.08			
Health Care	3104546	0.05	0	1	
Other Articles and Services	3104546	0.02	0	1	
Monday	3104546	0.14	0	1	
Tuesday	3104546	0.14	0	1	
Wednesday	3104546	0.15	0	1	
Thursday	3104546	0.15	0	1	
Friday	3104546	0.14	0	1	
Saturday	3104546	0.15	0	1	
Sunday	3104546	0.14	0	1	

Notes: There are seven dummy variables for divisions, and six dummy variables for weekdays.

Sources: Tsinghua University iCPI.

Impacts of the COVID-19 Pandemic on price change probability

- The DiD Coefficients in three models(price changes, price increases and price decreases) are -0.226, -0.276 and -0.227, respectively. The corresponding odds ratios decrease by about 20%, 24% and 20%, respectively.
- These show that the pandemic leads to a decrease in price change probability.

Table 4. Impacts of the COVID-19 epidemic on the price adjustment probability

Models	Model 1	Model 2	Model 3
Indep Var\ Dep Var	Price Change	Price Increase	Price Decrease
year*ncov	-0.226*** (0.017)	-0.276*** (0.023)	-0.227*** (0.025)
year	0.073*** (0.013)	-0.144*** (0.017)	0.333*** (0.020)
ncov	-0.040*** (0.013)	-0.144*** (0.017)	0.092*** (0.020)
Ln(Price)	0.103*** (0.002)	0.130*** (0.003)	0.072*** (0.003)
Food, Tobacco and Liquor	0.139*** (0.019)	0.175*** (0.026)	0.111*** (0.029)
Clothing	-0.131*** (0.020)	-0.235*** (0.028)	-0.013 (0.029)
Residence	-0.955*** (0.039)	-1.082*** (0.056)	-0.805*** (0.055)
Household Articles and Service	0.139*** (0.019)	0.031 (0.025)	0.259*** (0.028)
Education, Culture and Recreation	0.175*** (0.021)	0.106*** (0.029)	0.255*** (0.032)
Health Care	-0.135*** (0.028)	-0.014 (0.036)	-0.272*** (0.042)
Other Articles and Services	0.784*** (0.024)	0.817*** (0.032)	0.723*** (0.037)
Monday	0.339*** (0.015)	0.050** (0.024)	0.523*** (0.020)
Wednesday	-0.007 (0.016)	-0.016 (0.024)	-0.0002 (0.022)
Thursday	-0.054*** (0.016)	0.014 (0.024)	-0.114*** (0.022)
Friday	0.421*** (0.015)	0.819*** (0.021)	-0.103*** (0.023)
Saturday	0.212*** (0.015)	0.468*** (0.022)	-0.073*** (0.022)
Sunday	-0.223*** (0.017)	-0.040* (0.024)	-0.400*** (0.024)
Constant	-4.541*** (0.027)	-5.257*** (0.037)	-5.279*** (0.038)
Number of Obs	3,104,546	3,104,546	3,104,546
Number of Events	61957	31548	30409
Log Likelihood	-299,178	-171,668	-168,517.
Akaike Inf. Crit.	598,392	343,373	337,070

Notes: (1) Standard errors are shown in parentheses;(2) *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$.

4.2 Impacts of the COVID-19 Pandemic on price change size

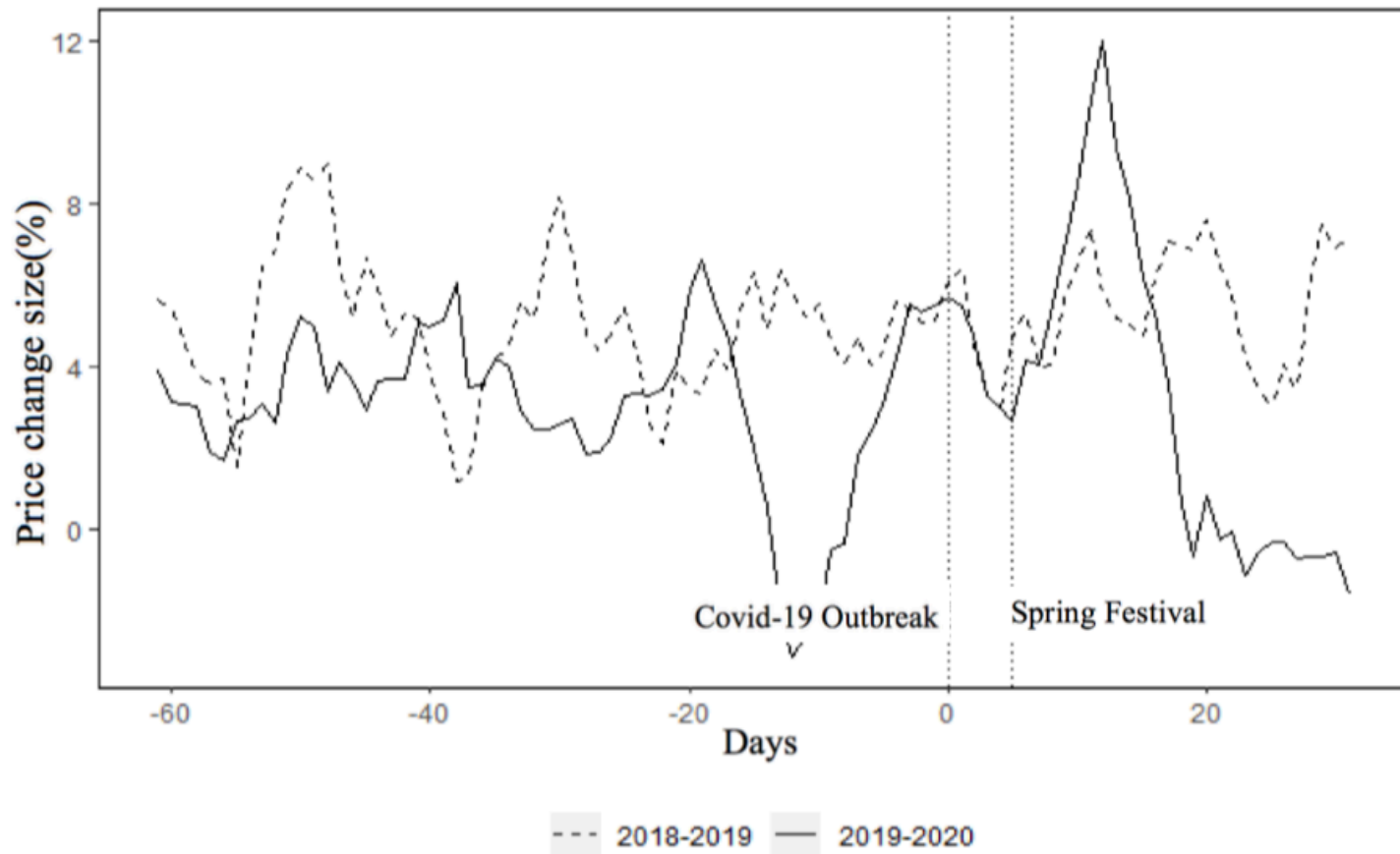


Figure 4. Price change size before and after the outbreak of COVID-19

4.2 Impacts of the COVID-19 Pandemic on price change size

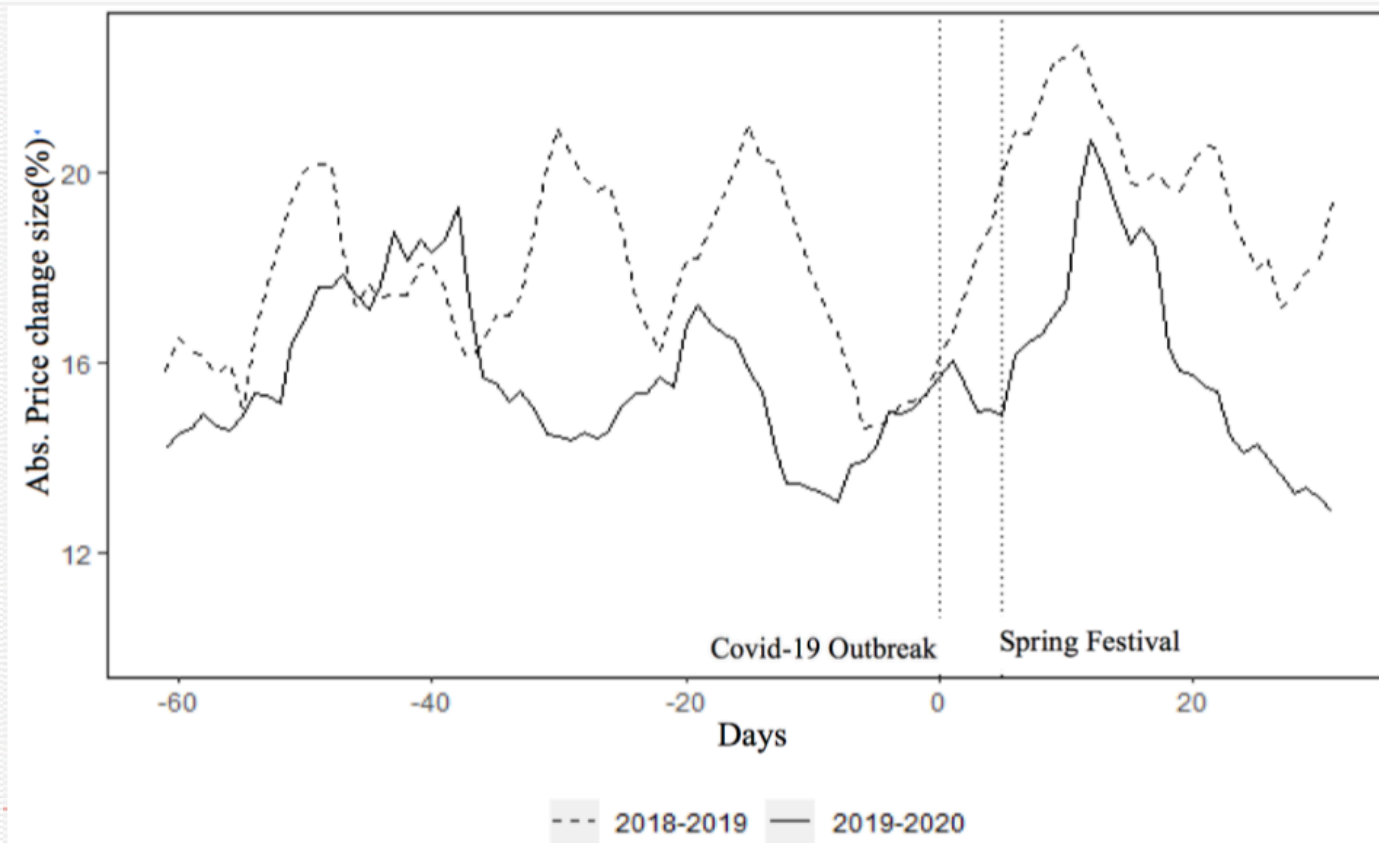


Figure 5. Absolute Price change size before and after the outbreak of COVID-19

4.2 Impacts of the COVID-19 Pandemic on price change size

- The DiD Coefficient in model 2 (absolute price change size) is -1% and significant at 1% significance level.
- These show that the pandemic leads to a decrease in absolute price change size.

Table 5. Impacts of the COVID-19 epidemic on the price change size

Models	Model 1	Model 2	Model 3	Model 4
Indep Var\ Dep Var	price change size(%)	absolute price change size(%)	price increase size(%)	price decrease size(%)
year*ncov	-0.116	-1.009***	0.006	-1.120***
	(0.403)	(0.297)	(0.498)	(0.294)
year	-3.978***	-3.869***	-4.021***	-2.450***
	(0.308)	(0.226)	(0.369)	(0.231)
ncov	-0.234	2.454***	3.603***	1.356***
	(0.013)	(0.017)	(0.020)	(0.236)
Ln(Price)	1.146***	-0.143***	0.262***	-0.848***
	(0.062)	(0.046)	(0.077)	(0.044)
Food, Tobacco and Liquor	3.390***	2.844***	4.726***	-0.678**
	(0.454)	(0.334)	(0.540)	(0.339)
Clothing	1.777***	8.162***	11.571***	4.373***
	(0.476)	(0.350)	(0.580)	(0.347)
Residence	2.683***	8.360***	13.104***	3.352***
	(0.931)	(0.685)	(1.190)	(0.641)
Household Articles and Service	-0.832	3.289***	4.624***	1.279***
	(0.445)	(0.328)	(0.540)	(0.325)
Education, Culture and Recreation	1.511***	0.846**	2.202***	-1.629***
	(0.509)	(0.374)	(0.618)	(0.370)
Health Care	5.899***	4.916***	7.160***	0.934*
	(0.650)	(0.478)	(0.762)	(0.762)
Other Articles and Services	-0.832	-4.682***	-5.803***	-4.431***
	(0.576)	(0.424)	(0.688)	(0.427)
Monday	-1.402***	-1.510***	1.225**	-2.154***
	(0.364)	(0.268)	(0.514)	(0.234)
Wednesday	0.519	0.733***	2.152***	-0.100
	(0.384)	(0.283)	(0.515)	(0.253)
Thursday	-0.378	0.318	-0.392	0.924***
	(0.361)	(0.266)	(0.448)	(0.270)
Friday	5.699***	0.425	-0.875*	0.166
	(0.361)	(0.266)	(0.448)	(0.270)
Saturday	3.170***	0.721***	-1.014**	1.131***
	(0.368)	(0.270)	(0.463)	(0.263)
Sunday	2.464***	1.925***	1.205**	1.764***
	(0.408)	(0.300)	(0.515)	(0.285)
Constant	-3.627***	14.996***	13.355***	18.573***
	(0.630)	(0.464)	(0.755)	(0.470)
Number of Obs	61,957	61,957	31,548	30,409
Adjusted R ²	0.025	0.046	0.050	0.072
F Statistic	95	179	98	140
P value	0.0000	0.0000	0.0000	0.0000

Notes: (1) Standard errors are shown in parentheses; (2) *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.10$.

4.3 Dynamic Impacts of the COVID-19 Pandemic on price change frequency

- For the treatment group, the period before the outbreak of COVID-19 is from January 1, 2020 to January 19, 2020 (6 days before the Spring Festival of 2020); the period after the outbreak is from January 20, 2020 to time t , where t is changing from January 20, 2020 to March 31, 2020.
- For the control group, the period before the outbreak of COVID-19 is from January 12, 2019 to January 30, 2019 (5 days before the Spring Festival of 2019); the period after the outbreak of COVID-19 is from January 31, 2019 to time t , where t is changing from January 31, 2019 to April 11, 2019.

4.3 Dynamic Impacts of the COVID-19 Pandemic on price change frequency

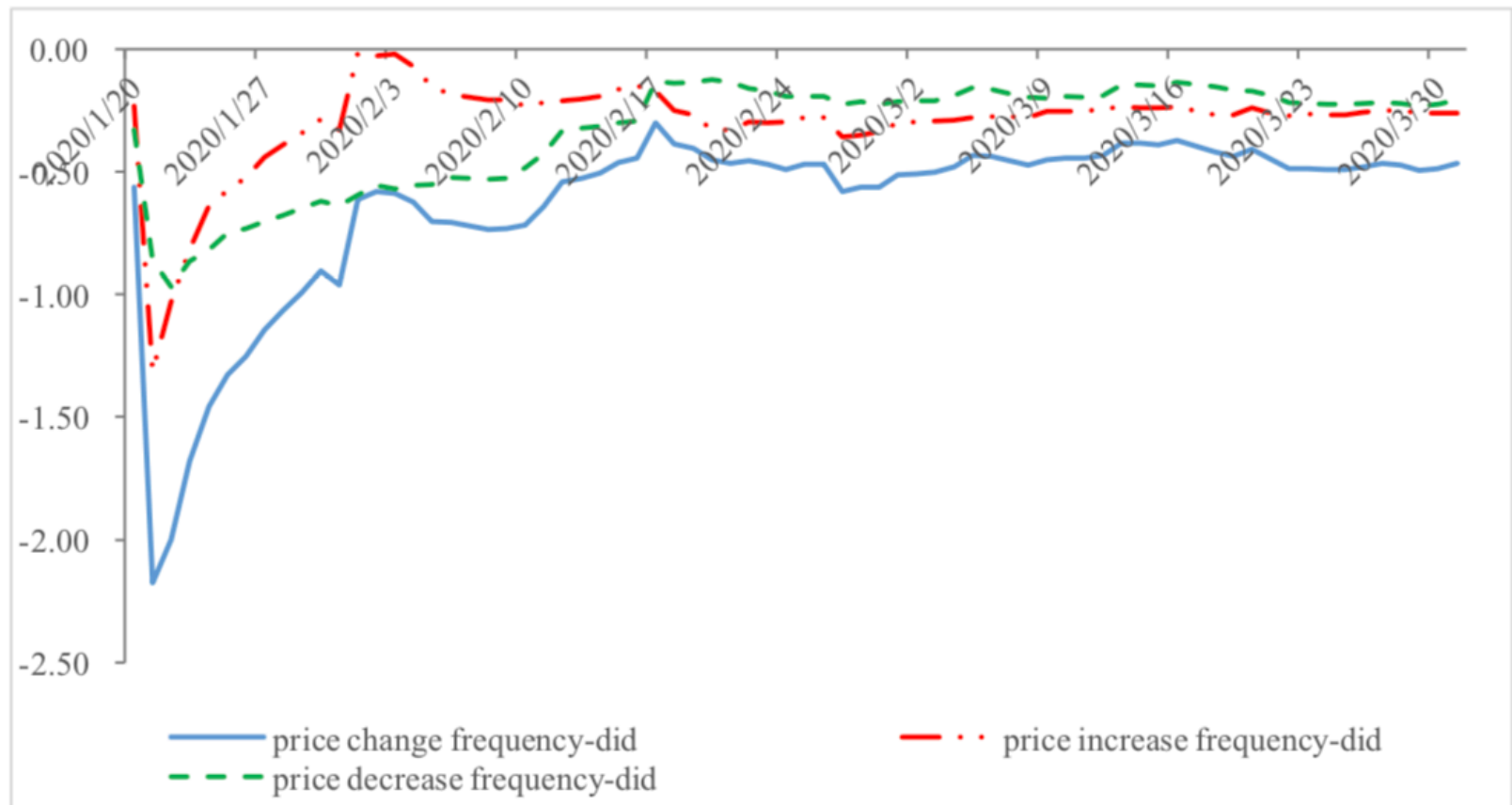


Figure 6. Dynamic impacts (DiD) of COVID-19 pandemic on the overall price change frequency(%)

4.3 Dynamic Impacts of the COVID-19 Pandemic on price change frequency

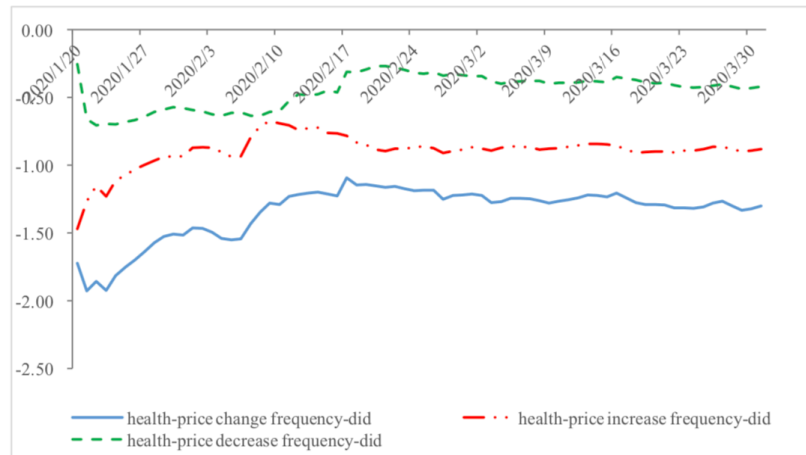


Figure 7. Dynamic impacts (DiD) of COVID-19 pandemic on the price change frequency of Health Care (%)

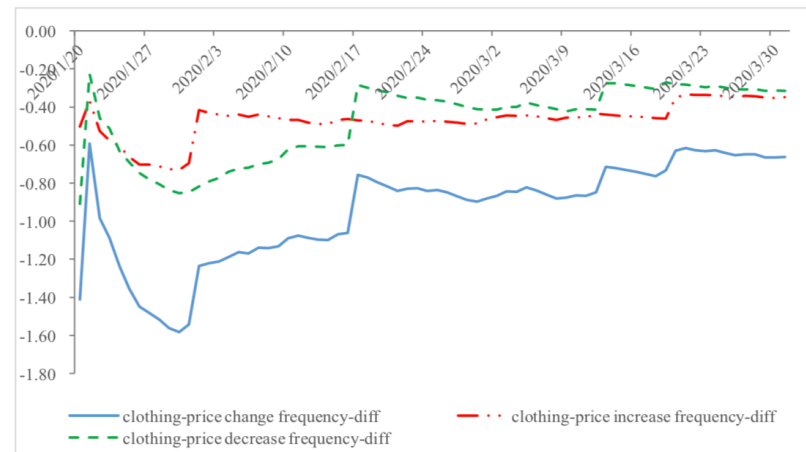


Figure 9. Dynamic impacts (DiD) of COVID-19 pandemic on the price change frequency of Clothing (%)

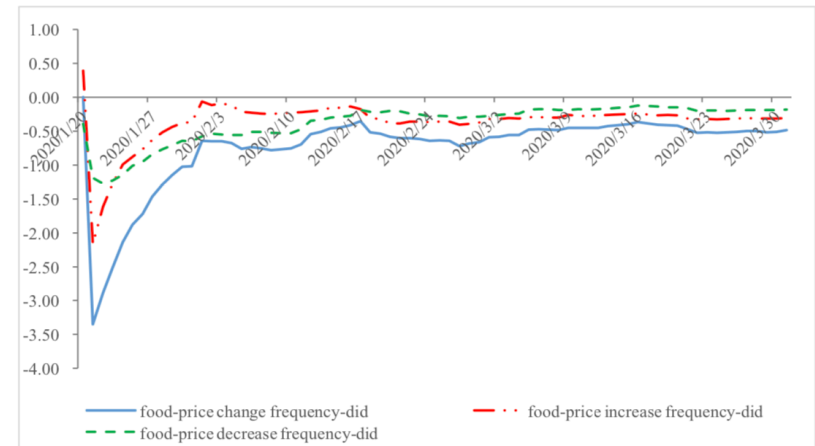


Figure 8. Dynamic impacts (DiD) of COVID-19 pandemic on the price change frequency of Food, Tobacco and Liquor (%)

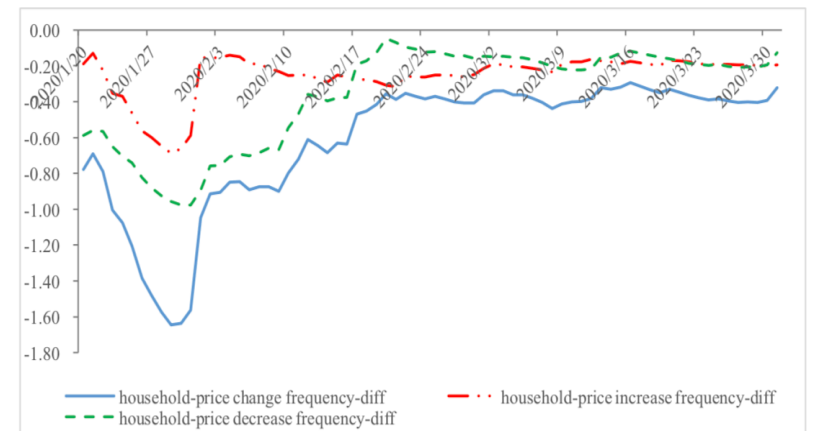


Figure 10. Dynamic impacts (DiD) of COVID-19 pandemic on the price change frequency of Household Articles and Service (%)

4.3 Dynamic Impacts of the COVID-19 Pandemic on price change frequency

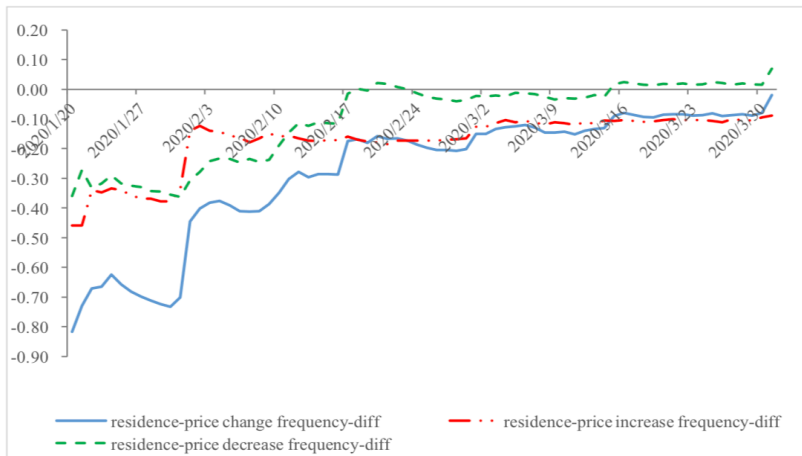


Figure 11. Dynamic impacts (DiD) of COVID-19 pandemic on the price change frequency of Residence (%)

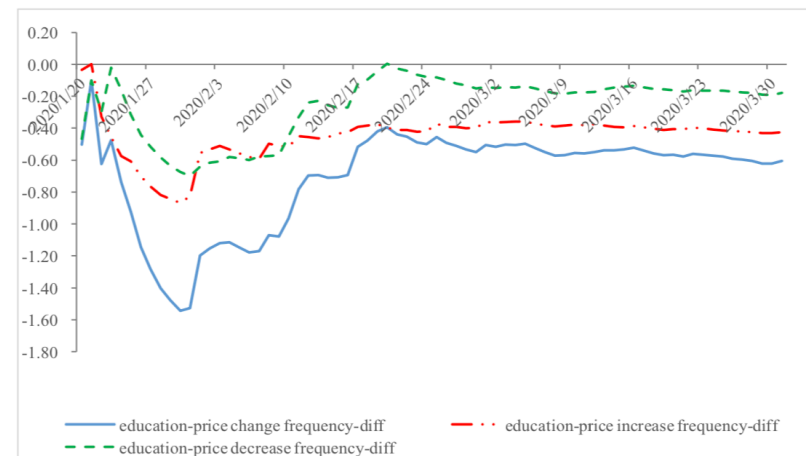


Figure 12. Dynamic impacts (DiD) of COVID-19 pandemic on the price change frequency of Education, Culture and Recreation (%)

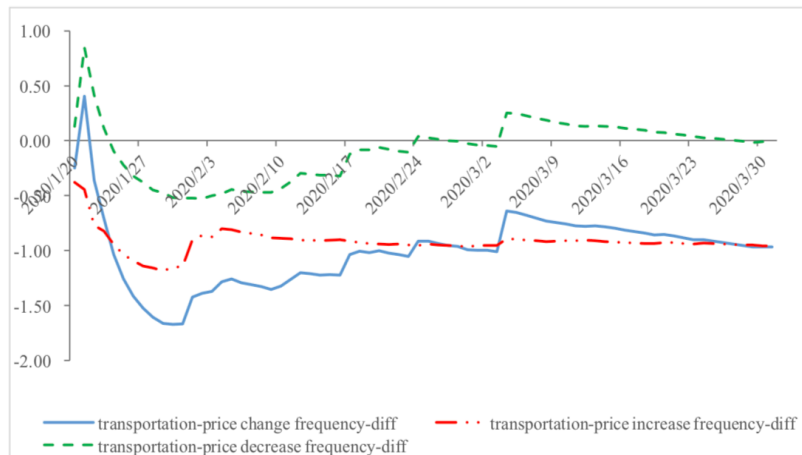


Figure 13. Dynamic impacts (DiD) of COVID-19 pandemic on the price change frequency of Transportation and Communication (%)

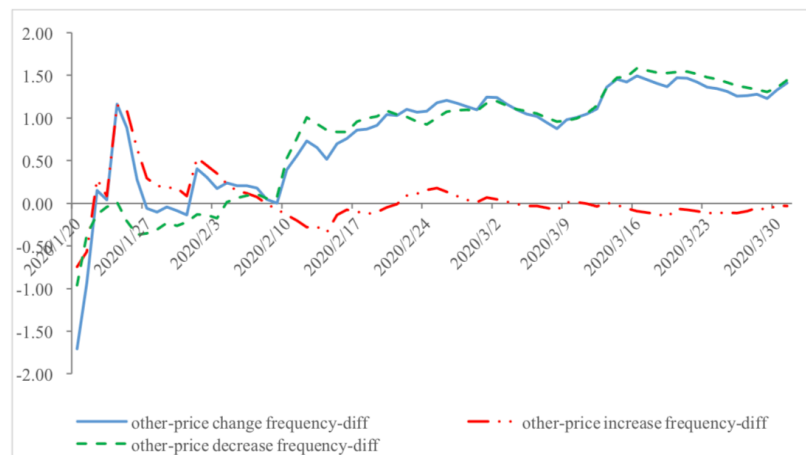
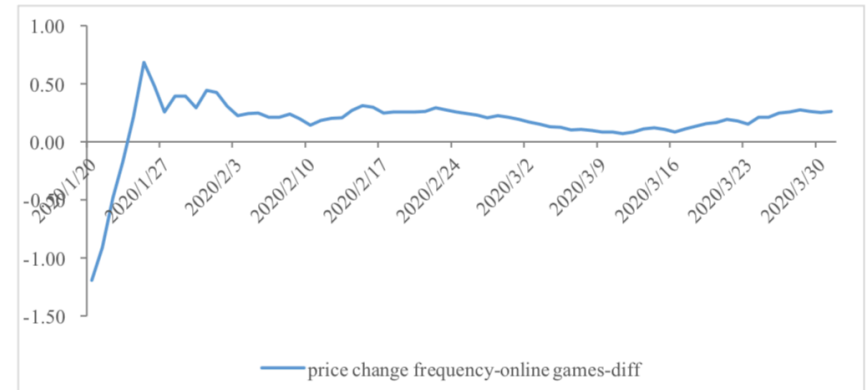


Figure 14. Dynamic impacts (DiD) of COVID-19 pandemic on the price change frequency of Other Articles and Services (%)

Dynamic Impacts of the COVID-19 Pandemic on online games prices

- From January 1, 2020 to February 20, 2020 with January 20, 2020 (5 days before the Spring Festival of 2020) as the outbreak point, the price index of online games increases by 121% after the COVID-19 outbreak, together with an 18% rise of the price change frequency.



Notes: Since we don't have the price data of online games in 2019, we only calculate the difference instead of DiD. The period before the outbreak of COVID-19 is from January 1, 2020 to January 19, 2020 (6 days before the Spring Festival of 2020); the period after the outbreak is from January 20, 2020 to time t , where t is changing from January 20, 2020 to March 31, 2020.

Figure 15. Dynamic difference of the price change frequency of online games before and after the outbreak of COVID-19 pandemic (%)

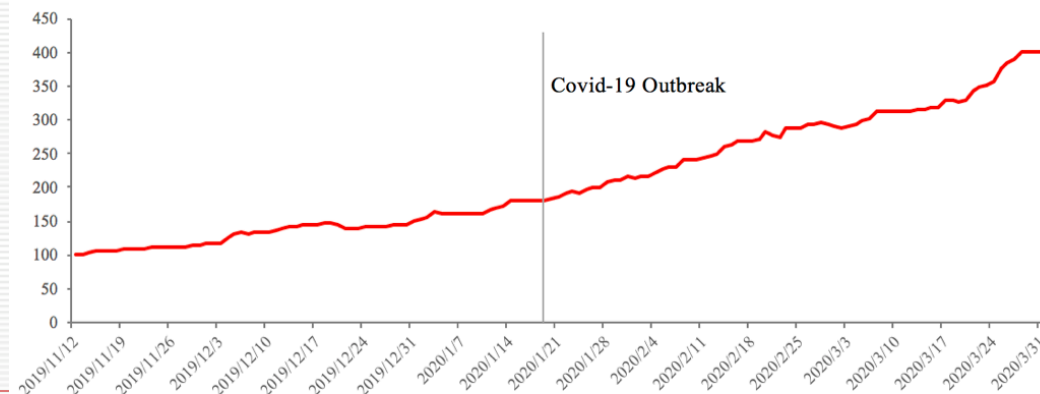


Figure 16. the price index of online games before and after the outbreak of COVID-19 (%)

Part 5: Conclusions and Implications

□ Main Conclusions

- **First**, we show that the pandemic leads to a 0.6% surge in overall price index, but a 20% decrease in the price change frequency, and 1% drop in the absolute price change size.
- **Second**, significant differences show up among various sectors as the pandemic has heterogeneous impacts on their demand and supply sides, including pure online products, online-to-offline (O2O) products and pure offline products.

Implications

- **First**, the heterogeneous impacts call for different policies for various sectors to alleviate the damage of the COVID-19 pandemic. (Anti-inflation, Anti-deflation, and flexible handling)
- **Second**, in the future, more importance should be attached to the development of stay-at-home economy, and the high-frequency inflation indicators based on online prices. In particular, the impacts of digital economy on the macroeconomics and monetary policy should not be ignored.

Thank you!

Your questions are welcome!

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