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ORIGINAL RESEARCH

Government Intervention and the Price of KF94 Masks in the Covid-19 Era

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Background: To control the surging prices of KF94 masks amid the Covid-19 pandemic in South Korea, the government mandated 80% of medical masks to be sold as "public masks" at a fixed price. The mask prices came down quickly, ensuring public health and suppressing the spread of the pandemic, and the sales of KF94 masks reverted to the free market system on July 12, 2020. This paper aims to evaluate the unintended consequence of public masks to mitigate any negative effects for future deployment.

Methods: The relationship between the offline and online prices of KF94 masks and the production quantity of medical masks was estimated using the data after July 12, 2020 (the "free market" period), and, given the regression results, counterfactual analyses were conducted to predict what the offline and online prices of KF94 masks would have been before July 12, 2020 (the "public masks" period) had the sales of medical masks reverted to the free market system a month earlier than July 12, 2020.

Results: The prolonged deployment of public masks distorted the ratio of offline and online prices of KF94 masks and kept the prices artificially high at its later stage. How much higher? The online price of privately sold KF94 masks would have been roughly thirty to forty percent lower and the offline price roughly three to four percent lower if public masks ended four weeks earlier.

Conclusion: The government intervention achieved its intended consequence of controlling the surging prices of KF94 masks at the early days of Covid-19, but the prolonged use of public masks had the unintended consequence of distorting market outcomes. The lesson? The government intervention should be kept brief, and the free market system should return as soon as the crisis subsides.

Keywords: government intervention, price control, masks, Covid-19

Introduction

Governments have used price controls to set maximum or minimum prices for food,[1] drug,[2,3] gasoline,[4,5] and grain[6] as well as rent[7] and wage.[8,9] The opponents of price control cite the unintended consequences such as shortage or oversupply and price distortions.[10–12] They argue that the price control of prescription drugs hurts public health[12] and the rent control in San Francisco limits the mobility of renters by 20%.[11] Yet others argue that the harmful effect of price controls is overstated[13,14] and price controls may be effective in some situations.[6] For example, the rise in New Jersey's minimum wage on April 1, 1992 did not reduce employment that year.[14] Despite the diverging views, price controls may be necessary or even desirable when extraordinary events cause the failure of the free market system, hampering the price-finding mechanism. This paper aims to

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evaluate the unintended consequence of "public masks" in South Korea to mitigate any negative effects for future deployment.

Public masks are the government intervention in South Korea to suppress the surging prices of face masks in the early days of the Covid-19 pandemic. Mask wearing has been shown to prevent respiratory virus transmission, even the Covid-19 virus,[15,16] and there was a heightened awareness of mask-wearing among South Koreans from the prior exposure to SARS-CoV in 2003 and MERS-CoV in 2015. Within a month of the first diagnosed case of Covid-19, the price of KF94 masks nearly quadrupled from the limited production capacity, the market manipulation by some sellers and the subsequent supply shortage.[17] The public outcry against price gouging and supply shortage prompted the government to step in and handle the crisis.

The South Korean government took full control of face mask supply, including production, logistics and distribution, mandating 80% of the daily production of medical masks to be sold as "public masks" through local pharmacies, post offices and stores operated by the National Agriculture Cooperative Federation (NongHyup) at a fixed price of 1500 South Korean Won (KRW).[18] (Medical masks refer to KF80 and KF94 masks, which offer similar high-level protection as N95 masks.[19]) The remaining 20% of the daily production was sold privately at other venues. The rationing of public masks was also implemented: Each person could buy up to two masks per week and, a few months later, up to ten masks per week. The intervention calmed the market quickly, lowering the offline price of KF94 masks by 35% within a month and the online price by 26% within two months, and after returning to the free market system, mask prices remained stable.[20] But is there any unintended consequence of public masks? Do price controls, as critics point out, distort the prices? This paper addresses these questions.

The Timeline of "Public Masks" in South Korea

In South Korea, the first diagnosed case of Covid-19 occurred on January 19, 2020. The virus did not spread right away, taking thirty days to infect one hundred patients on February 20, 2020, but since then the case count doubled up every few days to almost one thousand patients on February 25, 2020. In just four days, the case count tripled to over three thousand by the end of the month.[21]

Following the rise in the case count for Covid-19 patients, the demand for face masks rose sharply. South Koreans experienced a series of respiratory infections, SARS-CoV in 2003 and MERS-CoV in 2015, so there was a heightened awareness of the need for mask-wearing to combat respiratory diseases. Some sellers held onto their stockpiles or even canceled prior orders, anticipating higher prices to come, further exacerbating the supply shortage, which was a common problem in many developing countries at the early stage of Covid-19.[22] Panic buying, coupled with the limited production capacity, led to a sudden spike in mask prices: The price of single-use masks nearly quadrupled in a remarkably short period, resulting in the export ban of face masks.[17]

The public outrage against the price gouging and hoarding of masks prompted the government to intervene. The timeline of "public masks" in this section is quoted from the press releases by the Ministry of Food and Drug Safety, Republic of Korea.[20] From early February, the government cracked down on the unlawful transaction of masks and disinfectants, catching a reseller who hid away one million face masks in a remote warehouse on February 10 and another with four million face masks on February 13, about forty percent of the daily production capacity back then. The hoarding of masks can take place even in non-pandemic times, but the mask shortage and its threat to public health led to tougher penalties of up to two years of a prison sentence or a maximum fine of 50 million KRW, roughly $42,000, against those who hoard face masks.[23] On February 26, 2020, the government mandated 50% of the daily production of medical masks to be sold as "public masks" at the designated places for a fixed price of 1500 KRW, banning the export of face masks by resellers and forbidding the export of more than 10% of daily production by producers.

The mask shortage persisted, and, on March 6, 2020, the government mandated 80% of the daily production to be sold as public masks and began the rationing of medical masks, where each person could buy up to two KF94 (or KF80) masks a week. To ease the congestion of buyers, the 5-day rotation system was implemented, where people could buy masks on one of the five weekdays based on the year of birth and everyone could buy masks on weekends. The government relaxed these strict restrictions, as the production capacity increased and the early panic-buying fazed. On April 17, 2020, each person could buy up to three KF94 masks a week, and on May 7, 2020, the government permitted the export of face masks for humanitarian purposes,

citing that the supply shortage of masks eased quite a bit. By early June, the 5-day rotation system ended, and only 60% of the daily production was to be sold as public masks.

From June 16, 2020, each person could buy up to ten KF94 (or KF80) masks a week, and the government further reduced the proportion of public masks to 50% of the daily production and eased the export restriction to 30% of the daily production. It was a clear and visible sign that the shortage of masks was largely eradicated. On July 12, 2020, the government declared that it would revert to the free market system for the sales of face masks, ending the policy of public masks.

Data

The data come from two sources. The Ministry of Food and Drug Safety publishes the price and production quantity of masks in South Korea monthly from February 2020 to May 2020 and then weekly from June 2020 through the press releases on its website.[20] The price of KF94 masks are collected from a sample of offline and online sellers and averaged separately for offline and online, and the production quantity of masks is available separately for medical, surgical and KF-AD (KF Anti Droplet) masks. (See Korean-English glossary for Korea's response to COVID-19 by the Ministry of Foreign Affairs for the terminologies used herein.[24]) The production quantity of medical masks is relevant to this study and thus used. Humanitarian Data Exchange publishes the daily confirmed Covid-19 cases for South Korea on its website.[21] The sample period ends at January 7, 2021, as there is not much variation in the price and production quantity of masks thenceforth.

Figure 1 shows the offline and online prices of KF94 masks starting on February 27, 2020. There is a noticeable difference in how offline and online prices fell. Whereas the offline price of KF94 masks fell sharply within a few weeks of "public masks" and stayed relatively flat throughout the year, the online price of KF94 masks remained stubbornly high for at least a few months. There is a crossing of offline and online prices sometime in the summer, and thenceforth the online price stayed much lower than the offline price. Note that the crossing of offline and online prices coincides with the return to the free market system from the price control by the government.

Figure 2 shows the production quantity of medical masks and the daily confirmed Covid-19 cases, which are intended to represent the supply of and demand for KF94 masks, respectively. But it is doubtful that the daily Covid-19 case count truly represents the demand for KF94 masks, as it is somehow negatively correlated with the price of KF94 masks, so it should be seen in a much more nuanced light. To flatten the infection curve, the South Korean government regulated mask-wearing throughout the year. For example, May 26, 2020 and onward, Central Disaster and Safety Countermeasures Headquarters mandated the use of face masks in public transportations such as buses and subways, and, on November 13, 2020, the city of Seoul began fining mask-non-wearers in public places 100,000 KRW.[25] The mandatory mask-wearing had been unprecedented even in

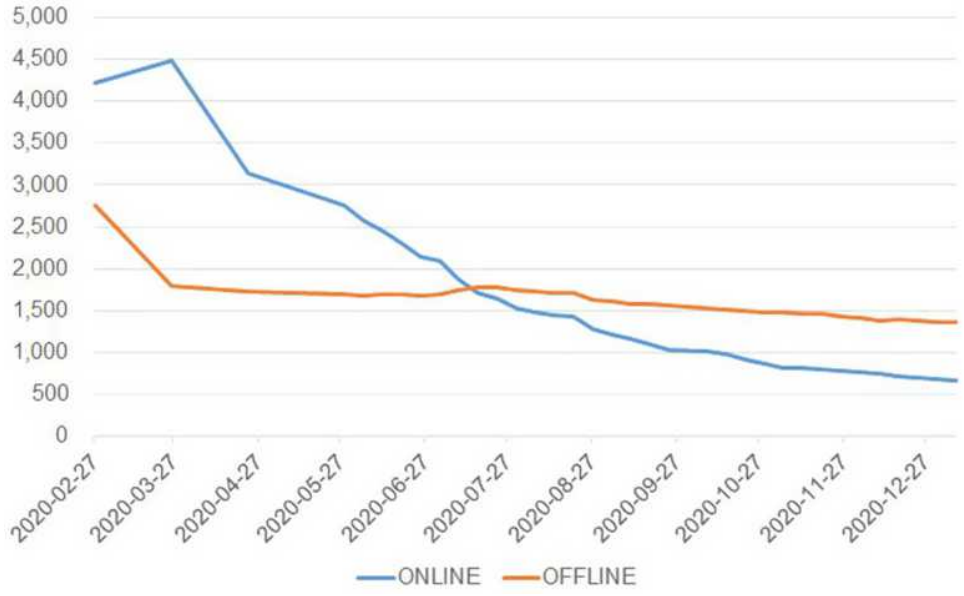

Figure 1 The offline and online prices of KF94 masks after February 27, 2020.

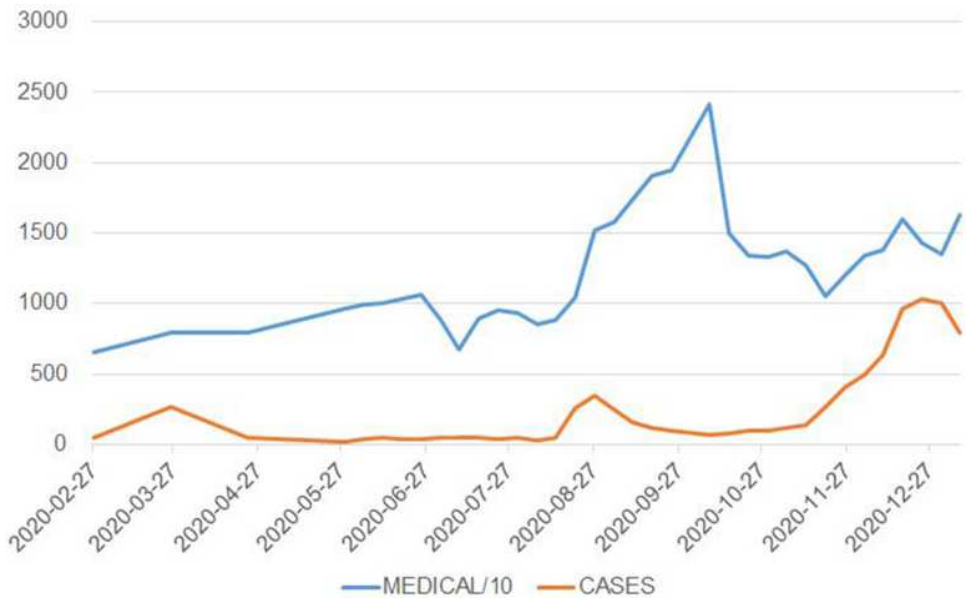

Figure 2 The production quantity of medical masks and the daily confirmed Covid-19 cases after February 27, 2020.

the flu seasons, during which time an average of 2900 Influenza-associated deaths occurred every year from the years 2003 to 2013.[26] This example offers a glimpse into the extraordinary nature of the Covid-19 pandemic.

Table 1 shows the correlations between the variables used in the analyses using the data from the entire sample period. The correlations in this table seem mostly intuitive. Offline and online prices, denoted by OFFLINE and ONLINE, respectively, are positively correlated with each other but negatively with the production quantity of medical masks in ten thousand, denoted by MEDICAL. But the negative correlation between the prices and the daily confirmed cases, denoted by CASES, is puzzling. The problem seems to be that the daily confirmed cases do not represent the demand for masks for the reasons cited earlier. Furthermore, the daily confirmed cases and the total mask production are positively correlated and also with the mask price.

Table 2 shows the correlations between the variables used in the analyses but this time using the data from the "free market" period only, that is, after July 12, 2020. Similar results are seen in this table, but there is one critical difference. The correlation between offline and online prices is much higher in Table 2, quite close to 1, as opposed to 0.78 in Table 1. So, after the free market system returned, offline and online prices moved in unison by the same invisible hand, but under the price control, the grip of the invisible hand relaxed with some other forces at play. The difference in the correlations between offline and online prices before and after the free market system indicates that the early days of Covid-19 were quite extraordinary as the fear of the Covid-19 pandemic, coupled with the supply shortage, triggered the breakdown of the price-finding mechanism.

The next section estimates the relationship between the offline and online prices of KF94 masks and the production quantity of medical masks using the data after July 12, 2020 (the "free market" period) and conducts counterfactual analyses to predict what the offline and online prices of KF94 masks would have been before July 12, 2020 (the

Table 1 Correlations Using the Entire Data After February 27, 2020

	Online	Offline	Medical	Cases
ONLINE	1			
OFFLINE	0.7753	1		
MEDICAL	−0.6163	−0.5341	1	
CASES	−0.4346	−0.4997	0.3044	1

Note: No. of observations = 35.

Table 2 Correlations Using the "Free Market" Data After July 12, 2020

	Online	Offline	Medical	Cases
ONLINE	1			
OFFLINE	0.9918	1		
MEDICAL	−0.4256	−0.4029	1	
CASES	−0.6274	−0.6934	0.1368	1

Note: No. of observations = 25.

"public masks" period) had the sales of medical masks reverted to the free market system a month earlier than July 12, 2020.

Results

A cursory look at the price movement of KF94 masks in Figure 1 shows that the government intervention was undoubtedly successful in bringing down the price of KF94 masks. Within a month of selling public masks, the offline price of KF94 masks dropped from 2751 to 1792 KRW, roughly a 35% drop. It took an extra month for the online price to drop from 4221 to 3140 KRW, roughly a 26% drop. So the government intervention achieved its intended goal, and the necessity of price controls is evident during a sudden and turbulent event that caused the temporary confusion in the price-finding mechanism of the free market system. But is there any unintended consequence of public masks? This question arises from the observation that the shortage of KF94 masks seems to have been resolved by June 16, 2020 with the daily rationing of 10 masks a week or even a way back on April 27, 2020 with 3 masks a week, as some people reuse their masks for a few days to save money. Should public masks have ended sooner than July 12, 2020 or even at around April 27, 2020?

Counterfactual analyses were conducted to answer this question by predicting what the offline and online prices of KF94 masks would have been had the sales of KF94 masks reverted to the free market system earlier than July 12, 2020. To put it more precisely, the regression analyses were run with the offline and online prices of KF94 masks as the dependent variables and the quadratic function of the production quantity as the independent variables using only the data from July 12, 2020 (the "free market" period), and, given the regression results, the offline and online prices of KF94 masks before July 12, 2020 (the "public masks" period) were predicted.

Admittedly, the sample size of twenty-five observations is quite small, so only a few regressors can be included in the regressions to ensure the precision of parameter estimates. A minimum of 10 observations is required for every regressor in regression analyses,[27,28] which implies that the sample of twenty five observations supports at most two regressors. From the correlations in Tables 1 and 2, it seems reasonable to infer that the production quantity of medical masks is a suitable explanatory variable to explain the variation in offline and online prices of KF94 masks. Several functional forms of this variable were used in the regression, and the quadratic function with two regressors was chosen as it yielded the highest adjusted R-squared in the regressions.

Table 3 shows the regression results with the online price of KF94 masks as the dependent variable using the data from July 12, 2020. The quadratic function of MEDICAL yielded the highest adjusted R-squared of 0.4355. The regression results were then used to predict what the online price of KF94 masks would have been four weeks before July 12, 2020 under the free market system. The online prices of KF94 masks were 2310, 2143, 2100 and 1883 KRW, but they would have been 1289, 1458, 1211 and 1248, had public masks ended earlier. This result may not be entirely surprising. The government rerouted medical masks from private online sales to public offline sales, causing an artificial supply shortage in the online market. Nevertheless, just how much more expensive KF94 masks were online is still a surprise. The artificially high online prices would hurt those who cannot travel easily to pharmacies and post offices or around whom pharmacies and post offices are sparse.

Table 4 shows the regression results with the offline price of KF94 masks as the dependent variable using the data from July 12, 2020. The quadratic function of MEDICAL yielded the highest adjusted R-squared of

Table 3 The Regression Results with the Online Price of KF94 Masks as the Dependent Variable Using the "Free Market" Data After July 12, 2020

	Model 1	Model 2	Model 3
MEDICAL	−0.037229*		−0.313242**
$MEDICAL^2$			9.11E-06**
LOG (MEDICAL)		−640.6075**	
Constant	1564.298**	7134.854**	3513.636**
Adjusted R-squared	0.1455	0.2407	0.4355

Note: **Sig. at 1%, *Sig. at 5%, no. of observations = 25.

Table 4 The Regression Results with the Offline Price of KF94 Masks as the Dependent Variable Using the "Free Market" Data After July 12, 2020

	Model 1	Model 2	Model 3
MEDICAL	−0.0148677*		−0.1353851**
$MEDICAL^2$			3.98E-06**
LOG (MEDICAL)		−260.1935**	
Constant	1746.918**	4012.988**	2598.07**
Adjusted R-squared	0.1259	0.2199	0.4383

Note: **Sig. at 1%, *Sig. at 5%, no. of observations = 25.

0.4383. The regression results were then used to predict what the offline price of KF94 masks would have been four weeks before July 12, 2020 under the free market system. The offline prices of KF94 masks were 1688, 1683, 1694 and 1741 KRW, but they would have been 1623, 1607, 1713 and 1864, had public masks ended earlier. The predicted prices are similar to the actual prices, but it is surprising to see that three and four weeks before public masks ended, the predicted prices are somewhat lower than the actual prices.

The counterfactuals stopped the prediction of online and offline prices at the four-week mark for the fear of extrapolating too far in time but extrapolating further back shows that the actual offline prices in the first and second week of June, 1685 and 1700 KRW, are still higher than the predicted prices of 1644 and 1640. Recall from the earlier discussion that the mask production increased quite a bit by the middle of June to enable the rationing of ten public masks a week. One can also argue that the supply of KF94 masks was plentiful as far back as early May when the government resumed the export of face masks for humanitarian purposes on the ground that the supply shortage of masks was no longer an issue or the mid-April when people could buy up to three public masks a week. Why did the offline price remain so high then? Should not it have dropped further? A troubling but plausible explanation emerges here. The mandated price of 1500 KRW for public masks acted as an anchor, artificially raising the offline prices of privately-sold KF94 masks. People would have been willing to pay the high offline price because the online price was far higher as well. So, the prolonged price control of KF94 masks ended up hurting consumer welfare at its late stage.

Conclusion

Extraordinary times call for extraordinary measures. The outbreak of Covid-19 and the subsequent shortage of face masks called for government intervention in South Korea using public masks. The government invention lowered the price of KF94 masks quickly, ensuring public health and suppressing the spread of Covid-19. But it also had its pitfalls. The counterfactuals demonstrate that the government intervention lasted a bit too long, distorting the balance of offline and online prices of KF94 masks, and even more surprisingly, keeping the offline price higher than what it would have been under the free market system. The government intervention should end as soon as the price-finding mechanism regains its function.

Disclosure

The author reports no conflicts of interest in this work.

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