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Measuring “Fearonomic Effects” in Valuing Therapies: An Application to COVID-19 in China



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ABSTRACT

Objectives: To develop a checklist that helps quantify the economic impact associated with fear of contagion and to illustrate how one might use the checklist by presenting a case study featuring China during the coronavirus disease 2019 (COVID-19) outbreak.

Methods: Based on “fearonomic effects,” a qualitative framework that conceptualizes the direct and indirect economic effects caused by the fear of contagion, we created a checklist to facilitate empirical estimation. As a case study, we first identified relevant sectors affected by China’s lockdown policies implemented just before the Lunar New Year (LNY) week. To quantify the immediate impact, we then estimated the projected spending levels in 2020 in the absence of COVID-19 and compared these projections with actual spending during the LNY week. Data sources used include Chinese and global websites. To characterize uncertainty, we reported upper and lower bound estimates and calculated midpoints for each range.

Results: The COVID-19 epidemic is estimated to cost China’s economy \$283 billion (\$196–369 billion), that is, ¥2.0 trillion renminbi (¥1.4–¥2.6 trillion), during the LNY week. Reduced restaurant and movie theater business (\$106 [\$103–\$109] billion, 37.5% [36.4%–38.5%]) and reduced public transportation utilization (\$96 [\$13–\$179] billion dollars, 33.9% [4.6%–63.3%]) explain most of this loss, followed by travel restrictions and the resulting loss of hotel business and tourism (\$80.36 billion, 28.4%).

Conclusion: Our checklist can help quantify the immediate and near-term impact of COVID-19 on a country’s economy. It can also help researchers and policy makers consider the broader economic and social consequences when valuing future vaccines and treatments.

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Introduction

Vaccines are among the most cost-effective public health interventions for preventing diseases and death.¹ Still, the broader social and economic impacts of vaccines, such as productivity gains and community risk protection, are not routinely incorporated into the conventional value assessments.² A recent International Society for Pharmacoeconomics and Outcomes Research special task force report has suggested that the fear associated with the spread of disease, sometimes called the “fear of contagion,” can be an important element to consider when assessing the value of vaccination and other interventions and is also often omitted.³

Fearonomic Effects

Fearonomic effects, a term coined by Bali et al, conceptualizes the direct and indirect economic effects caused by the fear of

contagion during an outbreak or an epidemic.⁴ The fearonomic effects framework categorized these consequences into behavioral impacts on business (stigma, change in consumption behavior, and life disruptions), impacts on business continuity (operational disruptions, restricted travel, and delays in project delivery), financial impacts on business (job loss, loss of revenue, and higher costs for businesses), and impacts on the health sector (changes in health-seeking behavior, health outcomes of other diseases, and collateral loss of lives).⁴ Although Bali et al describe a qualitative framework, quantifying the actual impacts for each category can be challenging. To facilitate empirical estimation, we developed a checklist that includes examples for each framework category, further classifying the categories based on their timing. To illustrate how one might use the checklist to quantify the economic impact of fear of contagion, we present a case study featuring China during the COVID-19 outbreak.

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A Checklist for Estimating the Economic Impact Due to the Fear of Contagion

Our checklist includes specific behavioral responses to the fear of contagion by individuals, businesses, and government. For example, under the change in consumption behavior category, we list “avoidance of crowded areas (eg, restaurants and cinemas).” For operational disruptions, we include the cancellation or postponement of professional sporting events (eg, contests played in the National Basketball Association in the United States or the Premier League in the United Kingdom) owing to COVID-19 (Table 1). We also divide our checklist into 2 periods: the immediate period during the outbreak, when governments implement interventions to mitigate the outbreak; and a near-term (1-year) period, accounting for most of the epidemic’s economic impact, because most recent epidemics have come under control within this period (eg, severe acute respiratory syndrome [SARS], Ebola).^{5,6}

Estimating the Economic Impact of COVID-19 in China

As of May 12, 2020, 4 088 848 cumulative COVID-19 cases were confirmed globally, with 84 451 (2%) of those cases reported in China.⁷ To slow the outbreak, China’s government imposed a lockdown and travel ban just before the Lunar New Year (LNY) week, January 25 to February 2, 2020. As the mass quarantine approach slowed the spread of COVID-19 within China, we sought to use this checklist to estimate the immediate economic impact of the fear of contagion. We first identified the sectors affected by the lockdown policies, including restaurants and cinemas, public transportation, and hotels and tourism. We then estimated, for these sectors, what revenue levels would have been in 2020 in the absence of COVID-19, using projected gross domestic product (GDP) growth (6%), and then compared these projections with actual revenues during the LNY week. When detailed sales volume data were available (eg, for public transportation), we estimated revenue loss as the product of the volume reduction and unit price. We assumed a 3% annual inflation rate and that ¥1 renminbi (RMB) is worth \$0.14 to convert all costs to 2020 US dollars. To characterize uncertainty, we reported upper and lower bound estimates and calculated midpoints for each range.

Although the pandemic continues to evolve and data collection is fragmented and ongoing, we attempted to quantify the immediate economic impact. Data sources used included Chinese (ie, xinhuanet, qq news) and global websites (ie, CNN, New York Times), the Chinese National Bureau of Statistics, Ministry of Transport, International Air Transport Association, and various other sources (Travel China Guide, Lonely Planet, China economy). We used search terms such as “restaurant revenue 2019,” “cinema revenue 2019,” “Lunar New Year tourism 2019,” “Lunar New Year tourism 2020,” “Lunar New Year public transportation 2019,” “lockdown restaurant revenue,” “lockdown cinema revenue,” and “lockdown public transportation,” and searched in both English and Chinese.

During the lockdown period, 78% of all restaurants were closed and lost all of their revenue, 16% lost 70% to 90%, and the rest (5%) lost less than 70%.⁸ For cinemas, although the 2019 LNY vacation week revenue was \$0.89 billion, the revenues from the same week this year was less than 0.1% of the 2019 revenue.^{9,10} Similar to our assumptions for cinemas, we assumed that the tourism industry lost all of its revenue.¹¹ The influence of the lockdown on public transportation includes its impact on trains, buses, flights, and ferries.^{12,13} We estimated the revenue loss for trains, buses, and

Table 1. Checklist for measuring economic impact owing to the fear of contagion*

	Immediate (over first week)	Near-term (over 1 year)
Behavioral impact on business		
Stigma	✓	✓
Change in consumption behaviour	✓	✓
Avoidance of crowded areas (ie, restaurants, cinemas)		
Life disruptions	✓	✓
School closures		
Decreased public transportation utilization (ie, train, flights, ferry)		
Impact on business continuity		
Operational disruptions	✓	✓
Cancelled events (ie, conferences, major professional sports leagues, such as National Basketball Association, Premier League)		
Restricted travel (ie, tourism, hotel occupancy)	✓	✓
Delays in project delivery		✓
Financial impact on business		
Higher costs for business (ie, protection items for workers, such as masks, sanitizers, gowns)	✓	✓
Revenue loss (ie, automobile production) [†]		✓
Job loss		✓
Market share loss		✓
Increase in commodity/food prices (ie, oil and gas, [‡] retail market [§])		✓
Impact on health sector		
Change in health-seeking behaviour		✓
Health outcomes of other diseases		✓
Collateral loss of lives		✓
Health service interruptions (ie, auxiliary departments in hospitals shutdown)		✓
Impact on health systems		✓

*This checklist is adopted from the “fearonomic framework.”

[†]Hubei province accounts for 9% of total Chinese auto production.

[‡]China is the second largest oil consumer and largest importer of liquefied natural gas.

[§]Retailers with thin margins face severe drops in demand, and threats to liquidity.

ferries from changes in volume, which decreased by half during the LNY week 2020. The revenue loss for airlines came directly from the International Air Transport Association.¹²

Economic Impact Breakdown

The COVID-19 epidemic is estimated to have cost China’s economy \$283 billion (\$196–\$369 billion), that is, ¥2.0 trillion

Table 2. Quantifying the short-term economic impact of fear of contagion on China's economy using the checklist.

(in billions)	Economic impact			Data sources
	Estimates	Lower bound	Upper bound	
Behavioral impact on business				
Change in consumption behavior	(\$105.94)	(\$102.73)	(\$109.14)	
Restaurant revenue change		(\$101.84)	(\$108.25)	8
Cinema revenue change		(\$0.89)	(\$0.89)	9,10
Life disruptions	(\$96.27)	(\$13.36)	(\$179.17)	
Decreased public transportation utilization				
Train revenue change		(\$0.92)	(\$28.29)	13
Long-distance bus revenue change		(\$2.08)	(\$63.95)	
Ferry revenue change		(\$2.57)	(\$79.14)	
Air revenue change		(\$7.78)	(\$7.78)	12
Impact on business continuity				
restricted travel	(\$80.36)	(\$80.36)	(\$80.36)	
Tourism (including hotels)		(\$80.36)	(\$80.36)	
Total				
in US dollars	(\$282.56)	(\$196.45)	(\$368.66)	
in RMB	(¥ 2018.26)	(¥1,403.2)	(¥2633.31)	

RMB indicates Renminbi.

Renminbi (¥1.4–¥2.6 trillion) during the LNY week (immediate impact). Reduced restaurant and movie theater business (\$106 [\$103–\$109] billion, 37.5% [36.4%–38.5%]) and reduced public transportation use (\$96 [\$13–\$179] billion dollars, 33.9% [4.6%–63.3%]) explain most of this loss, followed by travel restrictions and the resulting loss of hotel business and tourism (\$80.36 billion, 28.4%) (Table 2).

The estimated \$283 billion loss during the LNY week represents 1.9% of China's 2019 GDP.¹⁴ If we were to include other short-term impacts that we could not quantify owing to data limitations (eg, lost retail sales), our estimates would be much larger. Although the long-term effects on the manufacturing, oil and gas, and healthcare sectors remain unclear, they are undoubtedly substantial. During the SARS epidemic in 2003, China's economic growth decreased by 3%.¹⁵ With China now the world's second largest economy,¹⁶ and COVID-19 affecting far more countries and causing far more deaths than SARS, we anticipate that the long-term impact of COVID-19 will substantially exceed previously reported estimates of lost economic activity (1.9% loss as of China's 2019 GDP).

Limitations

Because our article focused on the economic impact during the pandemic, our checklist does not include the psychological effects associated with the fear of contagion. In a qualitative study, patients ranked the anxiety associated with spreading a chronic infection as more important than the actual physical symptoms.¹⁷ Particularly for chronic diseases, for which vaccines and treatments are available, considering psychological effects would be important to properly capturing the fear of contagion. Moreover, we could not itemize all affected sectors in detail, and we excluded health effects. A recent commentary has offered a modified "impact inventory" to highlight the importance of capturing broader health and societal consequences for evaluating policy responses to the COVID-19 pandemic.¹⁸ Finally, because of data limitations that may have compromised the accuracy of our estimates, our case study did not include all checked items in the immediate impact column. Our estimate of the fearonomic effects of COVID-19 would have been greater had we been able to include all affected sectors.

Looking Forward

As the COVID-19 outbreak continues to spread worldwide, many countries will likely fall into recession. Supply chain disruptions, reduced demand in China and elsewhere, financial market volatility, and bankruptcies can cause economic losses across multiple countries, including the United States. Despite optimistic long-term forecasts that the economic impact of COVID-19 will be limited because economic confidence should quickly return once the pandemic subsides, the ultimate impact remains largely unknown.¹⁹ Our checklist can help quantify the immediate and near-term impact of COVID-19 on a country's economy. As more data become available, the checklist can help refine estimates. It can also help researchers and policy makers consider the broader economic and social consequences when valuing future vaccines, treatments, and other strategies to address COVID-19 and other infectious diseases.

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REFERENCES

1. Remy V, Langeron N, Quilici S, Carroll S. The economic value of vaccination: why prevention is wealth. *Value Health*. 2014;17:A450.
2. Bärnighausen T, Bloom DE, Cafiero-Fonseca ET, O'Brien JC. Valuing vaccination. *Proc Natl Acad Sci U S A*. 2014;111(34):12313–12319.
3. Lakdawalla DN, Doshi JA, Garrison Jr LP, Phelps CE, Basu A, Danzon PM. Defining elements of value in health care—a health economics approach: an ISPOR Special Task Force report [3]. *Value Health*. 2018;21:131–139.
4. Bali S, Stewart KA, Pate MA. Long shadow of fear in an epidemic: fearonomic effects of Ebola on the private sector in Nigeria. *BMJ Global Health*. 2016;1(3):e000111.
5. World Health Organization. Update 87—World Health Organization changes last remaining travel recommendation—for Beijing China. June 24, 2020.
6. Cooper C, Fisher D, Gupta N, MacCauley R, Pessoa-Silva CL. Infection prevention and control of the Ebola outbreak in Liberia, 2014–2015: key challenges and successes. *BMC Med*. 2016;14:2.
7. World Health Organization. Coronavirus disease 2019 (COVID-19): situation report – 113. 2020. https://www.who.int/docs/default-source/coronavirus/situation-reports/20200512-covid-19-sitrep-113.pdf?sfvrsn=feac3b6d_2. Accessed July 22, 2020.
8. Day Visions. Take away and flow support, AB side of food and beverage industry recovery. Accessed March 14, 2020.
9. Xinhua Headlines: Lunar New Year consumption mirrors China's economic strength. February 11, 2019. http://www.xinhuanet.com/english/2019-02/11/c_137813517.htm.
10. At the New Year's Day, the national movie box office only received 1.81 billion and the same period last year was 1.485 billion. <http://finance.eastmoney.com/a/202001261367928320.html>. Accessed July 22, 2020.
11. Chinese tourists ignore bumpy economy for Lunar New Year travel plans. 2020. <https://www.scmp.com/news/china/society/article/3044037/chinese-tourists-ignore-bumpy-economy-lunar-new-year-travel>. Accessed July 22, 2020.
12. International Air Transport Association. New coronary pneumonia epidemic causes demand and income of aviation industry to decrease. 2020. <https://www.iata.org/contentassets/33c7a94b015419787d15bbb1fffb6ac/2020-02-20-01-cn.pdf>. Accessed July 22, 2020.
13. Impact of New Coronavirus on transportation and automotive industry. 2020. <https://cn.weforum.org/agenda/2020/02/xin-guan-bing-du-dui-jiao-tong-he-qi-che-hang-ye-de-ying-xiang-96d32b284c/>. Accessed July 22, 2020.
14. Commentary: a milestone for China and world economy. January 17, 2020. http://www.xinhuanet.com/english/2020-01/17/c_138714013.htm.
15. Keogh-Brown MR, Smith RD. The economic impact of SARS: how does the reality match the predictions? *Health Policy*. 2008;88:110–120.
16. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention [e-pub ahead of print]. *JAMA*. 2020 Feb 24. <https://doi.org/10.1001/jama.2020.2648>. Accessed July 22, 2020.
17. Mattingly TJ, Slejko JF, Perfetto EM, Kottitil S, Mullins CD. What matters most for treatment decisions in hepatitis C: effectiveness, costs, and altruism. *Patient*. 2019;12(6):631–638.
18. Kim DD, Neumann PJ. Analyzing the cost-effectiveness of policy responses for COVID-19: the importance of capturing social consequences. *Med Decision Making*. 2020;40(3):251–253.
19. Anderson K. Morningstar's view: the impact of coronavirus on the economy. March 10, 2020. https://www.morningstar.com/articles/971254/morning-stars-view-the-impact-of-coronavirus-on-the-economy?utm_medium=referral&utm_campaign=linkshare&utm_source=link.