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Was There a Better Way to Contain COVID-19?

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Many countries resorted to social distancing as a first response to contain the spread of COVID-19. Arguably, social distancing measures caused major disruptions of the economy. Targeted interventions — such as more effective quarantine, contact tracing and random testing — may have had less harmful economic outcomes and more effective containment of COVID-19.

From March to April 2020, after many states introduced stay-at-home orders in response to the emerging COVID-19 pandemic, U.S. employment declined by about 14 percent. Upon relaxing the stay-at-home orders, employment recovered to within 6 percent of pre-pandemic levels by late summer. Following the introduction and eventual loosening of stay-at-home orders, deaths due to COVID-19 declined from more than 2,000 per day in April to about 500 per day in the summer of 2020, before increasing to about 3,000 per day by the end of the year. Total 2020 deaths due to COVID-19 were near 430,000, or about 0.1 percent of the U.S. population.

The decline in work-related contacts and social contacts associated with the stay-at-home orders arguably helped contain the pandemic and the number of disease-related deaths but came at the cost of lost output. Could a more targeted approach — such as improved quarantine, contact tracing and random testing — have attained similar or better disease-related outcomes while avoiding the sharp decline in output and employment?

A simulation study in a standard infectious disease model modified to account for known features of the spread of COVID-19 suggests that modest improvements in quarantine measures — augmented by contact tracing and random testing — would have resulted in far fewer deaths while not being too costly to implement.

Furthermore, evaluating the reduction in COVID-19-related deaths at values used by U.S. federal agencies in cost-benefit studies of regulations suggests that the benefits from reduced deaths far exceed the benefits from increased output.[1]

Examining an Alternative Method for Combating COVID-19

Indiscriminate social distancing limits the spread of COVID-19 because it reduces contact rates for all individuals, whether or not they are infectious. Quarantine is less disruptive because it only removes known infectious individuals.

Clearly, infectious individuals who display symptoms can be quarantined, but a feature of COVID-19 is that even individuals who do not display symptoms can be infectious. In the model, I distinguish between asymptomatic and symptomatic infectious individuals to study the potential effects of not only quarantine, but also contact tracing and random testing as alternative policy tools to generalized social distancing measures. Contact tracing can work backwards from newly identified symptomatic individuals to identify individuals who may have been infected but do not yet display any symptoms. Random testing of the population provides another means to identify and subsequently quarantine asymptomatic individuals.

For this study, I use a modified SIR model. An SIR-model is a standard epidemiological model, in which susceptible individuals (S) become infected (I) after meeting already infectious individuals. Over time, infected individuals either recover or die (R).

I extend the basic SIR model of a pandemic to explore the relative merits of various policy interventions — in this case, social distancing, quarantine, contact tracing and random testing — in a unified framework. Social distancing is modeled as a uniform reduction in the contact rates at which individuals meet each other, independent of their health status.

The modified SIR model is calibrated to the known characteristics of COVID-19 and is then used to infer the transmission rate of COVID-19 from data on daily deaths for the year 2020. The transmission rate can in turn be used to calculate the model-implied effective reproduction rate for COVID-19. Information on employment and social mobility indexes is then used to separate out the impact of work contacts on the transmission rate.

The simulation study also proposes an alternative employment path that smoothly transitions to the fall employment values — thus avoiding the sharp decline (and subsequent rebound) of employment and the output losses associated with the employment contraction. This path then generates a counterfactual path for transmission rates. In particular, increased work contacts through higher employment increases the transmission rate and the number of infected individuals and cumulative deaths.

The Potential Benefits of Targeted Interventions

The output gains of this alternative employment path are estimated to be nearly $0.5 trillion, about 2.5 percent of 2019 GDP. But this path without targeted interventions — that is, quarantine, contact tracing and random testing — implies a higher overall transmission rate and about twice the fatalities by the end of 2020.

But with targeted interventions, fatalities decline. The study's baseline simulations assume that 50 percent of symptomatic individuals self-quarantine, consistent with other estimates of quarantine effectiveness.[2] Further simulations suggest that a permanent increase of the quarantine rate to 70 percent would have contained cumulative deaths over the second half of 2020. This increase in the quarantine rate initially is not as effective as the steep but temporary actual employment reductions in the first part of the year. But it prevents the surge of infections and deaths at the end of the year, and thus reduces cumulative deaths in 2020 to about 0.063 percent of the U.S. population, a third less than the actual 2020 outcome.

Adding a contact-tracing program that captures 50 percent of asymptomatic individuals infected by a newly symptomatic individual reduces cumulative deaths to about 0.058 percent. Finally, adding a program that randomly tests 0.1 percent of the population every day reduces cumulative deaths to about 0.042 percent.

And the benefits do not include the values from reduced loss of life. The value of a statistical life (VSL) represents a person's willingness to pay for a reduced probability of death and is a concept used by U.S. federal agencies in the cost-benefit analysis of regulations.[3]

For example, the Environmental Protection Agency uses an inflation-adjusted 2020 VSL for an adult U.S. citizen of $11.5 million. Rescaling the VSL for the long-term negative health effects of survivors who suffered severe infections, a death is valued at $24 million.

Using this VSL measure, the benefits from reduced mortality on the alternative employment path with increased quarantine, contact tracing and random testing are up to $5 trillion, a multiple of the economic benefits from higher employment and output.

How Much Would an Alternative Path Have Cost?

The simulations suggest that the proposed policies yield better economic and health outcomes, but obviously these policies are not costless. Regarding the potential costs of such policies, we assume:

- Each infected individual going into quarantine is paid $4,400.
- A working contact-tracing program can be established for $25 billion.
- The cost of a random test is $100.

These rough estimates suggest a cost of about $0.1 trillion, about one fifth of the economic benefits from the reduced employment and output losses.

Conclusion

The proposed alternative policies affect the transmission of the virus by reducing the pool of infected individuals that interact with susceptible individuals. In turn, this reduces the number of total transmissions, infected individuals and cumulative deaths.

Simulations of a stylized pandemic model suggest that alternative COVID-19 containment policies such as improved quarantine, contact tracing and random testing could have led to improved economic outcomes and reduced cumulative deaths. The net economic benefit from a policy that avoided the sharp economic slowdown is calculated to be nearly $0.4 trillion, about 2 percent of 2019 GDP. In addition, using the VSL concept the benefit from reduced deaths is estimated to be up to $5 trillion, about 24 percent of 2019 GDP.

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[1] *Andreas Hornstein, "Quarantine, Contact Tracing, and Testing: Implications of an Augmented SEIR Model." Federal Reserve Bank of Richmond Working Paper No. 21-08, April 2021.*

[2] *The particular values cited in this article are motivated in Hornstein (2021).*

[3] *For a recent survey of the VSL concept, see Thomas J. Kniesner and W. Kip Viscusi, "The Value of a Statistical Life," Vanderbilt Law Research Paper No. 19-15, May 16, 2019.*

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