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**A REVISED ECONOMIC ANALYSIS
FOR OSHA'S COVID-19 VACCINATION
AND TESTING EMERGENCY
TEMPORARY STANDARD**

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ABSTRACT

In November 2021, the Occupational Safety and Health Administration (OSHA) issued a COVID-19 Vaccination and Testing Emergency Temporary Standard (ETS) mandating that employers with 100 or more employees require their workers to vaccinate or telework. OSHA performed an economic feasibility analysis that estimated the ETS would impose \$5.2 billion in costs, including testing costs for exempt workers. This paper reviews and revises OSHA’s calculations to present a more thorough regulatory impact analysis than OSHA’s economic feasibility analysis. We find that, had the regulation gone into effect, OSHA’s ETS could have been expected to impose societal costs closer to \$10.1 billion (excluding the healthcare sector), roughly double OSHA’s total cost estimate. OSHA could improve its regulatory impact analysis substantially by expanding it beyond economic feasibility to include both societal costs and benefits.

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A Revised Economic Analysis for OSHA's COVID-19 Vaccination and Testing Emergency Temporary Standard

1. INTRODUCTION

In November of 2021, the Occupational Safety and Health Administration (OSHA) issued a COVID-19 Vaccination and Testing Emergency Temporary Standard (ETS).¹ The regulation never went into effect as a result of a Supreme Court ruling. Had it been enacted, it would have mandated that employers with 100 or more employees require their workers to vaccinate or telework. Employers could seek an exemption if they established a system in which their unvaccinated employees submitted to weekly testing for COVID-19 and ensured they wore masks. Employees could receive an exemption and choose the testing option regardless of their employer's policy if they had a medical or religious reason why they could not vaccinate.²

OSHA's rule required employers to establish a COVID-19 vaccine policy, determine their workforce's vaccination status, provide paid time off for vaccination and recovery, enforce their unvaccinated employees' weekly testing and masking requirements, and record their employees' vaccination and testing status. Employees who did not fully vaccinate needed to use a Food and Drug Administration (FDA) "cleared, approved, or authorized" test that could detect a current infection. Although employees could administer their own tests, a test could not be self-administered and self-read except under supervision. OSHA's ETS did not require employers to pay for their employees' vaccination or testing, but OSHA noted that other statutes might require employers to cover vaccine-exempt workers' testing costs.

Because the regulation was economically significant, a regulatory impact analysis would normally be required under prevailing presidential executive orders. Usually such circumstances entail a cost-benefit analysis. However, OSHA performed only an economic "feasibility analysis" for the ETS, because OSHA asserts "the Supreme Court has conclusively ruled that economic feasibility [under the OSH Act] does not involve a cost-benefit analysis."³ OSHA's economic feasibility analysis accounts only for employers' costs and employees' direct health benefits, unlike a cost-benefit analysis, which should address broader societal costs and benefits. OSHA acknowledges that such "costs would be attributable to the ETS in a regulatory impact analysis."⁴ Despite these limitations, OSHA still estimated that over six months, its ETS would impose \$5.2 billion in costs (including exempt workers' testing costs) and prevent 6,830 fatalities,

¹ COVID-19 Vaccination and Testing; Emergency Temporary Standard, 86 Fed. Reg. 61,402 (Nov. 5, 2021).

² OSHA's ETS excluded certain workplaces if they are covered by a previous ETS relating to healthcare employees (Occupational Exposure to COVID-19; Emergency Temporary Standard. 86 Fed. Reg. 32,376 (June 21, 2021)) or by an executive order and subsequent guidance related to COVID-19 workplace safety for federal contractors and subcontractors (Exec. Order No. 14042, 86 Fed. Reg. 50,985 (Sept. 14, 2021); Safer Federal Workforce Task Force (2021). It also excluded workplaces where workers did not have physical contact with other humans, work from home, or work outdoors.

³ COVID-19 Vaccination and Testing; Emergency Temporary Standard, 86 Fed. Reg. at 61,459.

⁴ COVID-19 Vaccination and Testing; Emergency Temporary Standard, 86 Fed. Reg. at 61,459.

277,736 hospitalizations, and 830,533 COVID-19 infections for workers 18 to 64 years old that are not federal contractors and not employed in the healthcare sector.⁵

OSHA's regulatory analysis deserves a comprehensive re-evaluation both because economic feasibility analysis generally has been criticized in the academic literature (Graham and Noe 2020) and because this particular ETS had substantial uncertainties, such that the regulation could even potentially increase rather than decrease risk (Broughel and Baxter 2022). Here, we review and revise OSHA's calculations to provide a more complete regulatory impact analysis. We find that, had the regulation not been prevented from going into effect by a court ruling, OSHA's ETS could be expected to impose societal costs closer to \$10.1 billion, excluding the healthcare sector, roughly double OSHA's total cost estimate. Moreover, despite including more workers in our health benefit calculations than OSHA accounted for, we find that the ETS would have produced only \$7.2 billion in cost savings by preventing 739,802 COVID-19 cases, 36,674 hospitalizations, and 6,003 fatalities for non-healthcare workers ages 18 to 74. We, therefore, estimate that OSHA's ETS would have imposed \$2.9 billion in net regulatory costs, had the regulation been enacted.⁶

2. REVIEWING OSHA'S ASSUMPTIONS AND METHODOLOGY

This section walks through how OSHA's economic analysis arrived at its main conclusions and its key assumptions. Section 3 revises OSHA's main estimates based on more realistic assumptions. Section 4 estimates the rule's total regulatory costs and benefits, which OSHA's feasibility analysis failed to do. Section 5 concludes by discussing how OSHA could improve its future regulatory analysis by making it more comprehensive.

2.1 Affected Population

OSHA's ETS covered 84.2 million employees across the non-healthcare (74.3 million) and healthcare sectors (9.9 million) (OSHA 2021a). OSHA separated covered employees into non-healthcare and healthcare industries because the vaccine ETS, if implemented in a timely fashion, covered healthcare workers for only the last four months that the vaccine ETS would be in effect, because they were already covered by a prior ETS.⁷ Additionally, on the same day as the vaccine ETS, the Centers for Medicare & Medicaid Services (CMS) published a regulation that established vaccination requirements for staff at Medicare- and Medicaid-certified providers and suppliers (CMS 2021a). Unlike OSHA's vaccine ETS, CMS's rule covered all Medicare- and Medicaid-certified providers and suppliers regardless of the number of people they employed.

⁵ OSHA's cost estimates include healthcare sector costs, but the agency does not include healthcare workers in its main health estimates, partly to avoid double counting benefits from other regulations. Thus, OSHA claims its cost estimate is an upper bound, while its health estimate is a lower bound. The rule imposes \$4.6 billion in costs on the non-healthcare sector.

⁶ While neither our analysis nor OSHA's main health analysis captured vaccination's ancillary benefits, we believe that these benefits are somewhat offset by the fact that OSHA appears to assume a baseline whereby no additional workers would have vaccinated absent the ETS.

⁷ Occupational Exposure to COVID-19; Emergency Temporary Standard. 86 Fed. Reg. 32,376 (June 21, 2021).

2.2 Affected Population's Vaccination Rate

OSHA's cost estimates relied on age-specific vaccination rates and the age distribution of the labor force. OSHA found that 61.3 percent of covered non-healthcare workers were fully vaccinated or received one dose of the vaccine within the last two weeks at the time of their calculations. OSHA considered this group fully vaccinated, given that they had either already fully vaccinated or indicated that they would vaccinate by recently taking a COVID-19 vaccine. OSHA's vaccination estimate implies that the ETS covered 28.7 million unvaccinated and 45.6 million vaccinated workers. Additionally, OSHA found that among those they considered unvaccinated, 6.5 million (8.75 percent) had taken at least one dose of the vaccine, though not in the past two weeks (OSHA 2021a).

2.3 Vaccine-Hesitant Workers

OSHA relied on Centers for Disease Control and Prevention (CDC) COVID-19 vaccine confidence data to separate unvaccinated workers into two categories: unvaccinated but not hesitant and vaccine hesitant (CDC 2021a). The CDC survey asked adult respondents (18+) to identify as: vaccinated, at least one dose;⁸ definitely will get vaccinated; probably will get vaccinated or are unsure; or probably or definitely will not get vaccinated. OSHA based the number of workers who are "vaccine hesitant" on the 13.8 percent of CDC respondents who answered that they probably or definitely will not get the vaccine. Otherwise, OSHA assumed that unvaccinated workers are not vaccine hesitant. OSHA estimated that 1 percent of employees would receive a medical exemption and 4 percent would receive a religious exemption.

2.4 Firm Vaccine Policies

OSHA estimated that before the ETS went into effect, 25 percent of employers had vaccine mandates that required all non-teleworking employees to get vaccinated absent religious or medical exemptions. After the ETS, OSHA estimated that 60 percent of employers would have employer mandates requiring vaccination, termination, or telework because of the ETS. OSHA assumed that the remaining firms would opt for voluntary employer policies that allowed masking and weekly testing as an alternative to vaccination. OSHA anticipated that nonexempt employees who do not telework would vaccinate under an employer mandate, and that employees who are not vaccine hesitant or teleworking would choose to vaccinate under voluntary employer policies instead of opting to test weekly and wear masks.

2.5 Costs and Health Benefits

OSHA estimated its ETS would impose \$2.6 billion in costs on non-healthcare employers, excluding testing costs (OSHA 2021a), and that the testing and masking costs for religious or medical exempt workers would be roughly \$2 billion (OSHA 2021a). OSHA noted that the ETS could increase absenteeism because it required employers to provide time off to workers who receive vaccinations and bars employees from working if they receive a positive COVID-19 test. However, OSHA believed productivity gains from reducing the spread of COVID-19

⁸ The CDC's survey defined the vaccinated population differently than did OSHA. Whereas OSHA excluded individuals who had taken one dose of the vaccine more than two weeks ago, the CDC included these individuals in its vaccinated population.

in the workplace would offset increases in absenteeism.⁹ Thus, OSHA did not estimate any economic losses from increased employee turnover nor economic benefits from reduced absenteeism from healthier workers. OSHA’s main health estimate finds that the ETS would prevent 830,533 COVID-19 cases, 277,736 hospitalizations, and 6,830 fatalities for non-healthcare nonfederal contractors between 18 and 64 years old. (If OSHA includes 65- to 74-year-olds, then prevented hospitalizations rise to 563,102 and prevented deaths to 13,847.)

3. REVISITING OSHA’S ASSUMPTIONS AND METHODOLOGY

This section reviews OSHA’s assumptions regarding the number of employees likely to vaccinate, the number of employers likely to impose employer mandates instead of voluntary policies (vaccinate or test), and OSHA’s health benefit estimates.

3.1 Making Costs and Benefits Comparable

OSHA’s cost estimates included healthcare sector costs but did not include healthcare workers in its main health estimates, partly to avoid double counting benefits from other regulations. Thus, OSHA claimed its cost estimate is an upper bound, while its health estimate is a lower bound. Given the ETS’s overlapping impacts with other regulations, our analysis focuses on the costs and benefits that accrue to non-healthcare workers. These impacts represent 89 percent of OSHA’s costs and 100 percent of OSHA’s estimated benefits. We believe this approach is appropriate as it allows costs and benefits to be compared in an apples-to-apples manner.

3.2 Employees Likely to Vaccinate

As stated previously, OSHA used the CDC’s COVID-19 vaccine confidence survey to separate unvaccinated workers into two categories: unvaccinated but not hesitant and vaccine hesitant. In the CDC vaccine confidence survey, 13.8 percent of respondents answered that they probably or definitely would not get vaccinated. These respondents represented 54.8 percent of CDC’s unvaccinated survey population, whom the CDC defines as individuals who have taken zero doses. Using CDC’s estimate, OSHA inferred that by multiplying its rule’s total affected population of 74.3 million non-healthcare workers by 13.8 percent, there are approximately 10.2 million vaccine-hesitant workers covered by its rule.

However, as mentioned earlier, the CDC survey defined “vaccinated” as those who have taken at least one dose, whereas OSHA defined “vaccinated” as those who were fully vaccinated or who had received one dose within the past two weeks. Because of this difference, when OSHA multiplied the affected population by 13.8 percent, it undercounted the number of vaccine-hesitant workers. To match the CDC survey’s results, OSHA should have multiplied its unvaccinated worker population—less than one dose¹⁰—by 54.8 percent (the share of the unvaccinated population, defined by the CDC as those who have taken zero doses, found to be vaccine hesitant in CDC’s

⁹ COVID-19 Vaccination and Testing: Emergency Temporary Standard, 86 Fed. Reg. 61,402.

¹⁰ 28.7 million unvaccinated workers minus 6.5 million unvaccinated workers who took at least one dose but not in the last two weeks equals 22.2 million unvaccinated workers who have never taken a dose of the vaccine. Multiplying these 22.2 million unvaccinated workers by the CDC’s share of vaccine-hesitant respondents among those who have taken zero doses of the vaccine (54.8 percent) aligns OSHA’s estimates of vaccine-hesitant workers with the CDC survey. It also increases the number of vaccine-hesitant workers in OSHA’s affected population.

survey). Applying CDC’s survey results correctly indicates that 12.2 million workers probably or definitely will not get vaccinated, 7.7 million workers probably will get vaccinated or are unsure, and 2.4 million workers definitely will get vaccinated (see table 1). This suggests that OSHA underestimated the number of vaccine-hesitant workers by 1.9 million, or roughly 20 percent.

TABLE 1. Affected Population by Vaccination Status

Baseline Vaccination Status	OSHA’s Calculations		Adjusted Calculations	
	Employees (percent)	Employees (millions)	Employees (percent)	Employees (millions)
All covered employees	100.0	74.3	100.0	74.3
Fully vaccinated	61.3	45.6	61.3	45.6
Unvaccinated	38.7	28.7	38.7	28.7
Unvaccinated and vaccine hesitant	13.8	10.2	16.4	12.2
Medical exemption	1.0	0.7	1.0	0.7
Religious exemption	4.0	3.0	4.0	3.0
Hesitant for other reasons	8.8	6.5	11.4	8.4
Sought exemption but was rejected	3.0	2.2	3.0	2.2
Unvaccinated but not vaccine hesitant	24.9	18.5	22.3	16.5
At least one dose	8.75	6.5	8.75	6.5
Other—CDC survey categories	16.1	12.0	13.5	10.0
Definitely will get vaccinated*	—	—	3.2	2.4
Probably will get vaccinated or unsure*	—	—	10.3	7.7

Sources: OSHA’s Analytical Spreadsheets in Support of the COVID-19 Vaccination and Testing ETS, CDC Surveys, and authors’ calculations.

Notes: OSHA does not break down their “unvaccinated but not vaccine-hesitant” group into the same categories as the CDC.

3.3 Adjusting the Employer Mandate Baseline

OSHA cited three surveys—Mishra and Hartstein (2021), Willis Towers Watson (2021a), and Arizona State University (n.d.)—when it estimated how many firms had employer mandates in place before the ETS. OSHA stated that these surveys show “approximately 13–45 percent of employers currently requiring or planning to require vaccination among employees,”¹¹ providing some support for using a 25 percent pre-ETS baseline of firms with a vaccine mandate. We review these surveys here.

Mishra and Hartstein (2021) administered and published their survey in August 2021. The survey asked respondents: “Which of the following statements best describes your organization’s [current] approach to COVID-19 vaccinations?” Nine percent of firms responded that they currently mandate vaccines for some (4 percent) or all workers (5 percent). Twelve percent said

¹¹ COVID-19 Vaccination and Testing; Emergency Temporary Standard, 86 Fed. Reg. at 61,472.

they *may* implement a vaccine mandate for either some (4 percent) or all workers (8 percent). These responses indicate that 21 percent of surveyed firms currently have or plan to have vaccine mandates.

Mishra and Hartstein asked firms with vaccine mandates: “Which of the following best describes how your organization currently defines, or plans to define, its vaccination policy for those who do not have a medical or religious exemption?” Thirty-three percent of respondents stated that workers will be terminated if they refuse to be vaccinated. Fourteen percent responded that workers must be fully vaccinated or regularly tested for COVID-19, otherwise they will be terminated. Thirty-five percent said workers must be fully vaccinated or regularly tested for COVID-19, otherwise they will not be permitted to return to in-person and/or on-site work. Multiplying the 21 percent of surveyed firms that currently have or plan to have vaccine mandates by the 33 percent that say they would terminate workers if they refused vaccination implies that 6.9 percent of firms have vaccine mandates that meet OSHA’s employer mandate definition.

Willis Towers Watson (2021a) surveyed US employers in May 2021. This survey found that out of the 28 percent of employers requiring or planning to require employees to vaccinate to enter the workplace, only 56 percent would require proof of vaccination. The survey does not discuss how respondents define their vaccination policies nor the consequences of noncompliance, which gives us limited insight into how many firms had employer mandates that meet OSHA’s definition. If we assume that requiring proof of vaccination implies employees will be terminated absent providing such proof, multiplying the 28 percent of surveyed firms who require or are considering requiring vaccinations by the 56 percent of firms within this group that would require proof of vaccination suggests that a maximum of 16 percent of firms *may* have had vaccine mandates that meet OSHA’s employer mandate definition.

The Arizona State University (ASU) COVID-19 spring 2021 report (n.d.) surveys US firms of varying sizes. It asks three questions of relevance:

1. “What are your companies’ policies for employees regarding COVID-19 vaccination?”
2. Is “proof of vaccination from employees . . . encouraged or required?”
3. “What are the consequences for lack of compliance with vaccination policy?”

Forty-four percent of firms require all employees to be vaccinated against COVID-19. Another 14 percent require some employees to be vaccinated against COVID-19. Among all firms, 63 percent require proof of vaccination.¹² Within firms with COVID-19 policies—including the 31 percent who only encourage vaccination—35 percent said that they would impose disciplinary action up to termination, 29 percent said they would change employees’ work responsibilities, 42 percent said the worker would not be allowed to return to the physical work environment, and 14 percent said they would impose no consequences.

From the ASU survey, unlike the previous surveys, we cannot deduce how many firms had vaccine mandates that met OSHA’s employer mandate definition, because when the surveyors asked firms about the consequences for noncompliance, the respondents included firms with vaccine mandates as well as firms that only encourage vaccinations. None of the three surveys OSHA cited asked how firms plan to respond to OSHA’s vaccine mandate.

¹² The number of firms asking for proof of vaccination could be higher than the percent of firms requiring vaccination since some firms may provide benefits, such as allowing an exemption from a mask mandate for vaccinated workers despite not requiring vaccination.

Overall, it is unclear how OSHA decided that 25 percent of firms had vaccine mandates before the ETS. Averaging the two surveys that ask firms with vaccine mandates about the consequences of noncompliance or proof of vaccination suggests that perhaps 11.5 percent of firms *could* have had vaccine mandates that met OSHA’s employer mandate definition before the ETS.

3.4 Adjusting the Employer Mandate Post-Implementation

OSHA assumed that 60 percent of firms would have employer mandates after the ETS’s implementation, an increase of 45 percentage points relative to their baseline. OSHA appears to rely mainly on the ASU fall 2021 survey to justify its estimate, as this survey provides the most evidence for OSHA’s 60 percent figure (Arizona State University n.d.). However, like the Spring 2021 survey, the ASU fall survey also finds that firms with vaccination requirements have varying consequences for noncompliance. For the same reasons discussed in the previous section, the ASU fall survey does not allow us to deduce how many firms had vaccine mandates that met OSHA’s employer mandate definition.

In November 2021, an updated Willis Towers Watson survey (2021b) asked respondents whether their organization will require their employees to vaccinate and specifically mentioned the OSHA mandates.¹³ Thirty-two percent of firms stated they plan to require vaccination only if OSHA’s rule takes effect. However, the surveyors did not ask respondents what the consequences of noncompliance are, so it is unclear how many of these firms would have met OSHA’s employer mandate definition. If we generously assume that all 32 percent of these firms would implement a vaccine mandate that meets OSHA’s employer mandate definition, then our post-implementation estimate of employer mandates equals 43.5 percent (32 percent plus 11.5 percent).

3.5 Adjusting Workers Likely to Get Vaccinated

We believe that respondents in the CDC’s vaccine confidence survey who expressed any uncertainty about getting vaccinated may better represent the vaccine-hesitant population than just those who say they probably will not get vaccinated. One fact supporting this position is that those who say they probably will get vaccinated and those who say they probably will not get vaccinated likely hold similar concerns about the vaccine. For example, when the COVID-19 Consortium asked unvaccinated respondents who are willing to get vaccinated and who are not getting the COVID-19 vaccine “which, if any, of the following concerns do have regarding the COVID-19 vaccine?” 92 percent of those not getting the COVID-19 vaccine were concerned about side effects and 88 percent of those willing to get vaccinated shared the same concern, suggesting similarity among the groups (Uslu et al. 2021).

Additionally, as the unvaccinated population falls, the remaining unvaccinated population seems to comprise increasingly of the vaccine hesitant. In CDC’s April 25–May 1 survey (CDC 2021b), 44.3 percent of respondents were unvaccinated (less than one dose). In CDC’s September 5–September 11 survey (CDC 2021a), only 25.2 percent were unvaccinated. Compared with the earlier survey’s unvaccinated population, 13.5 percentage points more respondents stated that they probably or definitely will not get vaccinated, and 3.6 percentage

¹³ It is important to note that 28 percent of firms in this survey are federal contractors that already had to comply with a federal vaccine mandate.

points fewer respondents stated that they would probably get vaccinated or are unsure. Moreover, in the September survey, respondents who expressed any uncertainty about getting vaccinated comprised 89.3 percent of the unvaccinated population.

The Kaiser Family Foundation’s October survey (Hamel et al. 2021) found that 46 percent of unvaccinated respondents would choose to test instead of vaccinate. The survey also found that 37 percent of unvaccinated respondents would likely leave their job if their employer required them to either get the COVID-19 vaccine or undergo weekly COVID-19 testing (Hamel et al. 2021). While it would have been surprising if 37 percent of unvaccinated workers left their job, these surveys indicate that OSHA’s assumption that all nonvaccine-hesitant workers would vaccinate and no workers would quit in response to the ETS may have been unrealistic.

To reiterate, OSHA assumed that vaccine-hesitant workers under voluntary employer policies would opt to test and wear masks rather than vaccinate but that, unless given an exemption, all other workers would vaccinate. Under employer mandates, OSHA assumed that even vaccine-hesitant workers would vaccinate or telework but not quit. We maintain OSHA’s strong assumption that all employees at firms with employer mandates would get vaccinated instead of quitting unless they qualify for an exemption or telework. However, we amend OSHA’s assumptions for workers at firms with the voluntary testing option. Specifically, for workers who probably would get vaccinated or are unsure, and work for employers with voluntary employer policies, we assume that 40 percent would opt for weekly testing or teleworking.

Our estimate is about half the percentage of unvaccinated workers the Kaiser Family Foundation survey implied would choose to test or quit if their employer required the COVID-19 vaccine. We believe our estimate is reasonable because refusing vaccination would cost employees time and money relative to vaccination and because quitting seems unlikely for unsure workers. However, our position is still deferential to OSHA’s assumptions. Relative to OSHA’s estimates, our change implies that roughly 2.0 million more workers at firms with voluntary employer policies would not vaccinate (see table 2).

TABLE 2. Workers by Employer Vaccine Policy

Category	Adjusted			OSHA
	Employer Mandates	Voluntary Employer Policies	Total	Total
Total unvaccinated employees under ETS	10,377,640	18,323,021	28,700,661	28,700,661
Employees vaccinated under ETS	8,106,672	8,601,496	16,708,168	20,822,580
Vaccine-exempt employees who test	1,043,131	1,841,778	2,884,909	2,884,909
Other vaccine-hesitant or unsure employees who test	assumed vaccinated	5,711,847	5,711,847	2,707,968
Religious/medical-exempt employees, telework	299,380	528,593	827,973	827,973
Other vaccine-hesitant or unsure employees who return to telework	928,457	1,639,307	2,567,764	1,457,232

Sources: OSHA’s Analytical Spreadsheets in Support of the COVID-19 Vaccination and Testing ETS and authors’ calculations.

3.6 Adjusting Hospitalizations

OSHA's health estimates imply that 33.4 percent of COVID-19 cases among unvaccinated workers between the ages 18 to 64 result in hospitalization, which seems high given the hospitalization data available. For instance, Washington State Department of Health (2022) provides unvaccinated case and hospitalization data by age group between February and November 2021, which suggests that 4.9 percent of unvaccinated individuals with COVID-19 between the ages 12 to 64 were hospitalized. Similarly, Heather M. Scobie et al. (2021) found that 4.6 percent of unvaccinated individuals between the ages 18 to 64 required hospitalization. Moreover, it is unclear whether all prevented infections are symptomatic.¹⁴ If OSHA's estimates of prevented infections included asymptomatic cases, then the ratio of infections to hospitalizations becomes more problematic.

OSHA estimated hospitalizations using CDC data by dividing the 6,830 fatalities their rule would have prevented (18 to 64) by the proportion of in-hospital COVID-19 fatalities for individuals between the ages 18 to 49 (2.4 percent) and subtracting fatalities (OSHA 2021b).¹⁵ This method overstates prevented hospitalizations because of COVID-19's differential impact on age groups. When we re-estimate prevented hospitalizations using the same CDC data but using more age-appropriate in-hospitalization death rates, hospitalizations fall from 277,736 to 133,201 (CDC 2021c). However, OSHA also likely overstates its hospitalization estimate for another reason. Specifically, it divides unvaccinated fatalities by the fraction of total in-hospital deaths including vaccinated persons, which inflates hospitalizations. Correcting for both age and vaccination status using data from Scobie et al. (2021) reduces the number of prevented hospitalizations to 42,558.¹⁶ We take this approach in our health estimates.

3.7 Adjusting OSHA's Health Benefits, Unvaccinated Age Distribution

To calculate health benefits, OSHA started with the affected population derived from their cost estimates and removed non-healthcare workers, federal contractors, and roughly 1.9 million workers ages 65 to 74 (OSHA 2021b). OSHA then estimated these remaining workers' age distribution using the age distribution of the US population.

OSHA's health estimates imply that unvaccinated workers ages 18 to 64 have the following age distribution: 26.7 percent (18 to 29), 42.0 percent (30 to 49), and 31.3 percent (50 to 64).¹⁷ However, OSHA's cost estimates imply a younger age distribution: 29.3 percent (18 to 29), 47.9 percent (30 to 49), and 21.8 percent (50 to 64). The two distributions should be identical because they relate to the same population of workers. OSHA should not have reweighted its health benefits by the age distribution of the US population since its cost estimate was already weighted appropriately. This error overstates OSHA's health benefits.

¹⁴ We assume that every prevented COVID-19 case is a symptomatic infection. In that sense, infections equal reported cases. To the extent that OSHA counts asymptomatic COVID-19 infections as prevented infections, our following cost savings are overstated, given that asymptomatic infections may not result in any costs to the infected.

¹⁵ $277,736 \text{ hospitalizations} \approx 6,830 \text{ fatalities ages } 18\text{--}64 / 2.4 \text{ percent (the proportion of in-hospital COVID-19 fatalities for vaccinated and unvaccinated individuals ages } 18\text{--}49) - 6,830 \text{ fatalities ages } 18\text{--}64.$

¹⁶ Because OSHA estimates that its ETS would prevent 830,533 COVID-19 infections for workers ages 18–64, its estimate of 277,736 prevented hospitalizations suggests a hospitalization rate of 33.3 percent. Using OSHA's prevented COVID-19 infections estimate, our hospitalization figure suggests a hospitalization rate of about 5.1 percent for the unvaccinated.

¹⁷ COVID-19 Vaccination and Testing; Emergency Temporary Standard, 86 Fed. Reg. 61,402.

Re-estimating OSHA’s health benefits using OSHA’s cost estimate age distribution reduces OSHA’s fatality and hospitalization estimates by roughly 18 percent. Because our analysis relies on the age distribution from OSHA’s cost estimates, we also re-include older unvaccinated workers that OSHA’s health estimates drop, which increases our health benefits relative to OSHA’s method (see table 3).

TABLE 3. Vaccination Rate for Covered Employees, Based on OSHA’s Cost Estimate’s Age Distribution

Age	US Population		Labor Force				Unvaccinated Distribution (18–64)*
	Vaccination Rate	Population	Percent	Vaccinated	Unvaccinated	Unvaccinated Distribution*	
18–29*	53.0%	36.5	23.4%	12.4%	11.0%	28.4%	29.3%
18–24	52.0%	18.1	—	—	—	—	—
25–39	54.3%	54.1	—	—	—	—	—
30–39*	54.3%	35.8	23.0%	12.5%	10.5%	27.1%	27.9%
40–49	62.3%	32.5	20.9%	13.0%	7.9%	20.4%	21.0%
50–64	69.9%	42.4	27.2%	19.0%	8.2%	21.2%	21.8%
65–74	79.7%	8.6	5.5%	4.4%	1.1%	2.9%	
Total	63.2%	156.0	100.0%	61.3%	38.7%	100.0%	100.0%

Sources: OSHA’s Current Vaccination Rate for Covered Employees, Table IV.B.6; CPS; and authors’ calculations.

Notes: We calculate the two variables and columns with an asterisk. We rely on population data from OSHA’s Analytical Spreadsheets in Support of the COVID-19 Vaccination and Testing ETS. We extract the rest of the table from OSHA’s Current Vaccination Rate for Covered Employees, Table IV.B.6.

4. ESTIMATING COST AND BENEFITS

We revise OSHA’s cost estimates by including costs that OSHA excluded from its economic feasibility analysis, including testing and vaccine administration costs. We then calculate health benefits and the cost savings associated with prevented deaths and hospitalizations. Finally, we subtract these benefits from gross costs to estimate net regulatory costs.

4.1 Costs

We use OSHA’s analytical spreadsheets, which OSHA used to calculate their cost estimates, to estimate the ETS’s costs after making four adjustments (OSHA 2021a). First, we increase the number of vaccine-hesitant workers in the unvaccinated population from 10.2 million to 12.2 million to remedy OSHA’s misapplication of the CDC’s vaccine confidence survey. Second, we estimate that the number of firms with employer mandates before the ETS is 11.5 percent, based on our review of OSHA’s cited surveys. We also assume that the number of firms with employer mandates after the ETS is 43.5 percent based on the updated Willis Towers Watson (2021b) survey. Third, we assume that only 60 percent of unsure workers at firms with voluntary

employer policies would have gotten vaccinated based on the relative vaccine hesitancy of the unvaccinated population. Fourth, we adjust OSHA’s workbook to capture all employees’ testing costs. Additionally, we calculate payments to medical providers and the vaccine’s production costs, which OSHA excludes from its feasibility analysis.

We estimate vaccine administration costs using CMS Medicare rates of \$40 per dose (CMS 2021b).¹⁸ This figure reflects payments to medical providers for the administration of the vaccine; however, it does not include the vaccine’s production costs. We estimate the vaccine’s production costs using the following prices: Pfizer/BioNTech (\$19.50 per dose), Moderna (\$15 per dose), and J&J (\$10 per dose) (Kaplan and Wehrwein 2021). We then separate unvaccinated workers into three groups. The first group is workers who already received one dose (8.75 percent). The second group is equal to the percentage of the vaccinated population (5 percent) who took J&J before the ETS, according to OSHA. We assume the same percentage of the unvaccinated would have taken J&J after the ETS.¹⁹ The third group is workers who would take two doses of Moderna or Pfizer/BioNTech. We assume that 50 percent of workers who would take two doses take Moderna and 50 percent take Pfizer/BioNTech. In total, we estimate that the ETS would impose \$1.8 billion in vaccination costs and \$10.1 billion in total costs (see table 4).

TABLE 4. ETS Costs for Non-Healthcare Employers

Category	\$ Millions, 2020		
	Estimated	OSHA	Difference
Familiarization and vaccine and testing policy	137.0	120.0	17.1
Support for employee vaccine	1,389.4	1,731.6	(342.1)
Communication with employees	4.2	4.2	—
Determining employee vaccination status	276.5	276.5	—
Recordkeeping cost	814.4	531.1	283.2
Recording all test results	810.6	527.3	283.2
Reporting fatalities	3.8	3.8	—
Recordkeeping cost for vaccine exemption requests	117.0	117.0	—
Unvaccinated testing cost—exempt and nonexempt*	5,320.0	1,785.3	3,534.7
Masking cost	206.3	69.2	137.1
Cost of the COVID-19 vaccine and administration*	1,827.2	—	1,827.2
Total cost	10,092.1	4,635.0	5,457.2

Sources: OSHA’s Analytical Spreadsheets in Support of the COVID-19 Vaccination and Testing ETS and authors’ calculations.

Note: Line items with asterisk are authors’ calculations. We do not re-estimate the adjusted cost of reporting fatalities. Note: Sums may not be exact because of rounding.

¹⁸ This value is in 2021 dollars, deflated to 2020 dollars; using the implicit price deflator increases vaccine administration costs to \$41.7 per dose in 2021.

¹⁹ Given CDC advisements, this assumption would likely no longer hold. To the extent that fewer individuals take the J&J vaccine, our vaccination costs would increase.

4.2 Benefits

After making our employer mandates and vaccination adjustments discussed above, the number of non-healthcare workers who would vaccinate drops from 20.8 million to 16.7 million. In our final health analysis, we find that the ETS would have prevented 739,802 COVID-19 cases, 36,674 hospitalizations, and 6,003 fatalities for non-healthcare workers between the ages of 18 and 74 (see table 5). We constructed our hospitalization estimates using data from Scobie et al. (2021) and the age distribution from OSHA’s cost estimates. Otherwise, we follow OSHA’s main health estimates approach and make the same geographic and community spread reductions.

TABLE 5. Estimated COVID-19 Cases, Fatalities, and Hospitalizations of Non-Healthcare Workers Averted

Category	18–29	30–49	50–64	65–74	Total
Age distribution based on labor force	28.4%	47.5%	21.2%	2.9%	100%
Workers that vaccinate	4,746,243	7,933,799	3,541,899	486,227	16,708,168
COVID-19 case rate per 100k, unvaccinated	302.1	330.4	280.6	265.7	309.9
Total cases, unvaccinated	372,786	681,576	258,383	33,595	1,346,340
Total cases averted after adjustments	205,571	372,904	142,625	18,701	739,802
Death rate per 100k, unvaccinated	0.25	1.51	6.17	18.08	2.6
Total deaths	314	3,124	5,686	2,286	11,410
Total deaths averted after adjustments	170	1,663	2,982	1,187	6,003
Case/hospitalizations, unvaccinated	3.2%	3.2%	9.9%	21.3%	5.0%
Estimated hospitalizations	6,624	12,016	14,050	3,983	36,674

Sources: OSHA 2021b, CDC 2021c, Scobie et al. 2021, and authors’ calculations.

Note: We use hospitalization estimates for the unvaccinated population from Scobie et al. (2021). The hospitalization estimate for those ages 65 to 74 is based on the hospitalization rate for those 65+.

4.3 Monetized Benefits

We calculate the cost savings associated with reductions in medical services and lost work following a similar approach found in Broughel and Baxter (2021). We use the remaining lifetime contributions estimates based on Broughel and Kotrous (2021) to estimate the cost of fatalities.²⁰ We find the average present value of remaining lifetime production for a COVID-19 death among the working-age population is approximately \$841,398 (2020 dollars) and that this value is \$1.26 million (2020 dollars) for a non-COVID-19 death when discounted at a 5.6 percent discount rate. The expected COVID-19 value is lower than the average value of remaining lifetime production because the average COVID-19 victim is older.

²⁰ We adjust these estimates to account for different discount rates.

We estimate the cost savings from reductions in medical services using Amin and Cox’s hospitalization cost estimates (2021), which finds that an average COVID-19 hospitalization costs roughly \$20,000. Finally, we use Broughel and Kotrous (2021) to estimate that a nonhospitalized symptomatic infection costs \$1,900, assuming two weeks of lost work.²¹ Based on these values, we find that the rule would generate roughly \$5.1 billion in cost savings due to prevented lost output. When medical and economic cost savings are included, we find that this rule would produce cost savings of \$7.2 billion (see table 6), which also takes into account countervailing risk increases from lost income (i.e., regulatory expenditures) in the initial period (Broughel and Baxter 2022). Subtracting cost savings from the ETS’s regulatory costs yields net costs of \$2.9 billion.

TABLE 6. Regulatory Costs, Cost Savings, and Net Costs

Category	Estimate	Value per Person (\$, 2020)	Total Value (\$ millions, 2020)
Net reduction in mortality	5,964	—	—
Prevented COVID-19 deaths (18–74)	6,003	841,398	5,051
Deaths from lost income (net regulatory cost/cost per life cutoff)	39	1,258,108	49
COVID-19 infections prevented (excluding COVID-19 deaths prevented)	733,800	1,900	1,394
Hospitalizations prevented (including COVID-19 deaths prevented)	36,674	20,000	733
Regulatory cost savings	—	—	7,178
Regulatory costs	—	—	10,092
Net regulatory costs	—	—	2,914
Net regulatory costs + costs from indirect deaths	—	—	2,963
Cost per life saved (net regulatory costs/gross mortality reduction)	—	—	0.489

Sources: Broughel and Kotrous 2021; Amin and Cox 2021; authors’ calculations.

Note: Sums may not be exact because of rounding.

²¹ This two-week output reduction represents CDC guidance in November 2021.

4.4 Comment about the Value of Statistical Life

Using a value of a statistical life (VSL) of \$10 million per saved life, OSHA's ETS passes a cost-benefit analysis. However, the VSL is calculated by summing individuals' willingness to pay for risk reductions until that sum equals one statistical life saved (Kniesner and Viscusi 2019). Applying the VSL, in this case, seems inappropriate because when OSHA issued the ETS, the vaccine was freely available and widely accessible, indicating that unvaccinated workers' willingness to pay for the vaccine was near or below zero. For this reason, an alternative value of life estimate, such as the one used earlier, appears more appropriate for this regulation. We believe that this may be why OSHA didn't use the VSL to monetize its ETS's health benefits, despite doing so in its previous Healthcare ETS.²²

4.5 Uncertainty and Sensitivity Analysis

We find that three assumptions—the number of workers who would have vaccinated due to the ETS, the number of firms that would have implemented employer mandates under the ETS, and the number of workers who would have quit instead of vaccinating—are the most uncertain and impact the ETS's cost and benefits the most. Though we discussed our approach to these issues throughout this paper, it is important to discuss these assumptions' directional impact on cost and benefits.

The number of workers who would have vaccinated due to the ETS is uncertain and may potentially have generated overestimated regulatory benefit estimates for two reasons. First, OSHA's and our analyses, which followed OSHA's baseline and estimation methods, implicitly assume that no additional workers would have vaccinated in the absence of the ETS as we both attribute health benefit estimates from all vaccinations that occur during the ETS to the ETS. Second, OSHA's categorization of vaccine-hesitant workers assumes that many workers at firms with voluntary mandates who appear to be vaccine-hesitant would have vaccinated. Though we altered OSHA's categorization of vaccine-hesitant workers and the behavior of these workers at firms with voluntary policies based on the survey data we reviewed, it is possible that fewer workers would have vaccinated than we predicted based on the survey data we reviewed. In the future, we recommend that OSHA perform sensitivity analysis regarding assumptions regarding vaccination uptake.

Similarly, the number of firms that would have adopted mandatory policies is also uncertain, and this assumption could have overstated the ETS's benefits and lowered its costs. Though we revised our mandatory policy estimates downward, we were deferential to OSHA's estimates and believe that even fewer firms would have had mandatory policies that conformed to OSHA's standards. We believe the same is true for OSHA's post-ETS assumptions regarding the number of employer mandates that firms would adopt. To the extent that fewer firms had employer mandates before the ETS or adopted employer mandates after the ETS, fewer workers would have vaccinated and more workers would have tested. In other words, health benefits would have fallen and costs would have increased if fewer firms had employer mandates.

Finally, OSHA's treatment of vaccine-hesitant workers at firms with employer mandates and zero attrition assumption may have overestimated the ETS's benefits and reduced its costs. These two assumptions, in combination with OSHA's estimate of firms with employer mandates, significantly increased the number of vaccine-hesitant workers that would test. Moreover,

²² Occupational Exposure to COVID-19; Emergency Temporary Standard. 86 Fed. Reg. 32,376.

OSHA’s assumption that its ETS would generate zero attrition seems optimistic, given that the KFF survey, discussed earlier, found that 37 percent of unvaccinated respondents said they would likely leave their job if their employer required them to either get the COVID-19 vaccine or undergo weekly COVID-19 testing (Hamel et al. 2021).

Altogether, we find that these issues would likely generate fewer benefits than OSHA, or we, estimated. For these reasons, we encourage OSHA to include a more robust sensitivity analysis in regulations that face significant areas of uncertainty.²³

5. CONCLUSION

OSHA’s economic feasibility analysis finds that, had the regulation gone into effect, the vaccine ETS would have imposed \$5.2 billion in costs, including exempt workers’ testing costs, and prevented 830,533 COVID-19 infections, 277,736 hospitalizations, and 6,830 fatalities for non-healthcare workers ages 18 to 64. However, we find that the ETS’s costs, excluding the healthcare sector, were roughly \$10.1 billion, or almost double OSHA’s total cost estimates. Moreover, we find that OSHA’s ETS would have prevented only 739,802 COVID-19 infections, 36,674 hospitalizations, and 6,003 fatalities for non-healthcare workers ages 18 to 74. Because the ETS would have generated only \$7.2 billion in cost savings by reducing medical expenditures and lost economic output, we find that the ETS would have imposed net societal costs of roughly \$2.9 billion. Our results suggest that OSHA’s ETS does not pass a cost-benefit analysis.

Although the Supreme Court overturned OSHA’s ETS before it went into effect, we find that OSHA could use this ETS to improve future economic analysis. We believe that our paper demonstrates that the scope of regulatory analysis can significantly alter an agency’s cost-benefit estimates. For this reason, we hold that OSHA’s regulations deserve comprehensive evaluations that better align with *Circular A-4* guidelines. Even if OSHA continues to use economic feasibility analysis to determine its regulation’s viability, we suggest that OSHA provide supplemental analysis that includes societal impacts as that would provide significantly greater context to the agency and external stakeholders.

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²³ Neither OSHA’s nor our analysis examines the impact of new variants, such as Omicron, on the ETS’s costs and benefits.

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