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A cost-benefit assessment of covid-19 strategies:

The case of Norway

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Abstract

This study evaluates the costs and benefits of alternative COVID-19 strategies for Norway, drawing on ex-post evidence from countries that pursued markedly different approaches. We argue that an elimination strategy—combining strict infection control with stringent border measures until a vaccine becomes available—delivers the greatest net benefits when a successful vaccine is expected within a short timeframe. Under vaccine uncertainty, both elimination and mitigation, the latter allowing gradual community spread, remain viable options. Norway adopted a suppression approach based on extensive TTIQ measures. Our findings suggest that this strategy was inferior compared to both elimination and mitigation. Finally, we compare ex-post assessments of costs and benefits with those emphasized in ex-ante evaluations, highlighting key discrepancies.

Keywords: COVID-19, Strategies, Cost-benefit analysis

JEL classification: H51, I18

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Sammendrag

I etterkant av pandemien har det vært betydelig interesse for å evaluere hvor hensiktsmessige ulike smitteverntiltak har vært. Denne studien bidrar til debatten ved å gjennomføre en nytte-kostnadsanalyse av ulike strategier, basert på faktiske utfall i land som valgte forskjellige tilnærminger. Analysen inkluderer konsekvenser for både helse og økonomi.

Tidligere forskning har ofte fokusert på effekten av enkeltstående tiltak, men har i mindre grad vurdert helheten i en nasjonal strategi og dens optimale timing. Denne studien søker å fylle det tomrommet ved å vurdere de samlede konsekvensene av ulike strategivalg, med særlig søkelys på hva som kunne vært relevant for Norge. I motsetning til analyser som bygger på modellering, baserer denne studien seg på faktiske utfall i ulike land.

Studien identifiserer også hvilke faktorer som viste seg å være avgjørende for strategivalget, og hvilke som viste seg å være mindre viktige. Metodisk behandles de ulike nasjonale strategiene som et slags naturlig eksperiment, der landene valgte ulike tilnærminger. Tre hovedkategorier av strategier identifiseres:

1. **Mitigering («Brems»)** – valgt av blant annet Sverige, Brasil, Storbritannia og USA. Tiltak begrenses til beskyttelse av spesielt eldre og syke og andre utsatte grupper. Viruset får spre seg gradvis og gjør befolkningen immun.
2. **Suppression («Slå ned»)** – valgt av Norge og de fleste EU-land. Harde tiltak hver gang spredningen fører til at R-tallet blir større enn 1 («slå ned og hold nede»).
3. **Eliminering («Eliminer»)** – valgt av Kina, Taiwan, New Zealand og Vietnam. Her er målet å utrydde viruset gjennom strenge tiltak, kombinert med svært streng grensekontroll fram til en effektiv vaksine er tilgjengelig.

Ved å sammenligne utfallene i disse landene, samt korrigere for faktorer som er spesifikke for det norske samfunnet, gir studien grunnlag for en normativ vurdering av hvilke strategier som ville vært mest hensiktsmessige. Konklusjonene er også relevante dersom lignende pandemier dukker opp igjen.

Vår konklusjon er at en elimineringsstrategi er å foretrekke når det er rimelig å forvente at en vaksine vil lykkes i løpet av ikke for lang tid. Dersom dette er tilstrekkelig usikkert, kan Brems strategien fungere like godt som Eliminer. Slå ned-strategien, som Norge valgte, gir da et dårligere utfall enn begge disse strategiene. I visse tilfeller fører imidlertid Brems til et dårligere utfall enn Slå ned.

1. Introduction

In the aftermath of the pandemic, considerable efforts have been made to assess the appropriateness of various infection control strategies. This study contributes to this discourse by conducting a cost-benefit analysis of strategies, based on ex-post outcomes from countries that adopted different strategies. The Norwegian strategy is compared with different strategies implemented by countries with similar characteristics, and the analysis considers impacts on health, mortality, and economic performance.

While several studies have examined the effects of specific infection control measures, they often fall short in evaluating whether a comprehensive COVID-19 strategy – comprising a suite of measures and their optimal timing – is successful. A holistic assessment is essential to gauge the overall impact of different infection control strategies. This study aims to evaluate the overall impact of COVID-19 strategy choices available to Norwegian society by conducting a cost-benefit analysis of these strategies. The Norwegian case is particularly noteworthy, as Norway shares key characteristics with countries that adopted alternative strategies. This enables the analysis to incorporate post-pandemic insights, linking strategy choices to real-world outcomes across nations that pursued different approaches.

Several studies have primarily assessed overall strategy choices through model-based simulations of outcomes, see section 2. This study advances the literature by evaluating infection control strategies based on real world outcomes, thereby enhancing empirical relevance compared to simulation-based approaches. The study finds that an elimination strategy – involving the eradication of the virus through stringent infection control measures combined with tight border restrictions until a vaccine is available – is preferable when the availability of an effective vaccine can be expected. Conversely, when vaccine efficacy or availability is uncertain, both elimination and mitigation strategies – wherein the virus is permitted to spread gradually within the population – remain desirable policy options. In certain cases, however, mitigation leads to a worse outcome than suppression – strict measures whenever the spread causes the reproduction number to exceed 1. Additionally, the study identifies key factors that were critical to the desired choice of infection control strategy, as well as those that proved less influential.

Our approach treats the choice of COVID-19 strategies as a form of “natural experiment", where different countries adopted different strategies. Although no country implemented a strategy in its pure form, the differences are sufficiently systematic to allow for a meaningful categorization. We distinguish between three main strategies: (i) Mitigation (M), chosen by countries such as Sweden, Brazil, the UK, and the US; (ii) Suppression (S), adopted by Norway and most EU countries; and (iii) Elimination (E), pursued by China, Taiwan, New Zealand, and Vietnam. The core idea of the study is that comparing actual outcomes across these countries, while accounting for country specific factors, provides insight into the consequences of strategic choices. While this natural experiment offers valuable insights, it remains inherently imperfect. Outcomes across countries during the pandemic may have been shaped by factors unrelated to the pandemic itself, and the effects observed in certain contexts may not be generalizable to others. Consequently, the costs and benefits incorporated in the analysis are subject to considerable uncertainty. These limitations are mitigated by comparing outcomes in countries with similar characteristics but different strategy choices – specifically, by contrasting Norway with Sweden and New Zealand. Limitations are discussed throughout the study.

Section 2 outlines the paper's contribution to the literature. Section 3 presents the strategies considered. Section 4 provides a cost-benefit analysis based on ex-post outcomes across countries that adopted different infection control strategies. Section 5 extends the analysis to a setting where the success of vaccination is uncertain. Section 6 discusses key caveats and limitations, and section 7 concludes.

2. Contribution to the literature

The COVID-19 pandemic confronted countries with a spectrum of strategic choices, effectively constituting a global natural experiment in public health policy. Broadly, national responses can be grouped into three principal categories: Mitigation (M), Suppression (S), and Elimination (E). Mitigation was adopted by countries like Sweden, Brazil, and the UK. It minimizes interference with daily activities, accepting a degree of viral spread as inevitable. Measures focus on protecting particularly vulnerable people. Suppression was pursued by Norway and many EU countries. This strategy sought to reduce the spread of the virus to a low, manageable level through targeted interventions. Elimination, as implemented by China, Taiwan, New Zealand, and Vietnam, sought to eradicate the virus entirely, followed by strict border controls to prevent further infections.

Empirical evidence suggests that early and stringent interventions were associated with more favorable outcomes in the short run, particularly among wealthy high-income countries (Caselli et al. (2022); Demirguc-Kunt et al. (2020)). Nations such as New Zealand and Taiwan employed comprehensive testing, contact tracing, and strict border controls, resulting in markedly lower infection and mortality rates (Baker et al. (2020a) (2020b); Summers et al. (2020); Jefferies et al. (2020)). These outcomes underscore the relative success of the Elimination strategy, not only in curbing viral transmission, but also in facilitating economic recovery by reducing the need for prolonged lockdowns and restrictions (Lewis (2022); Helliwell et al. (2021)).

Several studies have demonstrated that the economic costs associated with shutting down parts of the economy to contain the spread of COVID-19 are justified by the public health benefits. For instance, Eichenbaum et al. (2021), Alvarez et al. (2021), Jones et al. (2020), Farboody et al. (2020) and Garriga et al. (2020) employ integrated epidemiological-economic models to show that timely and targeted containment measures can significantly reduce mortality while mitigating long-term economic damage. These findings are consistent with simulation-based analyses conducted by Giordano et al. (2020) and Bethune et al. (2020), which also conclude that proactive containment strategies yield net societal benefits.

Taken together, this body of research supports the view that the costs of containment are outweighed by the benefits in terms of lives saved and economic resilience. However, different strategies call for different degrees of social distancing, see Acemoglu et al. (2021) for a literature review. Greenstone and Nigam (2020) find that reducing the number of infected saves costs, but this study accounts only for health expenses and the number of sick and dead. Bethune et al. (2020) argue that policy should aim to eliminate both the virus and the disease, a view echoed by Baker et al. (2020). In contrast, Miles et al. (2020) contend that the costs of maintaining severe restrictions in the UK may outweigh the benefits, advocating for a substantial easing of measures. A more controversial perspective in this respect is offered by Epstein (2020a, 2020b), whose analysis of U.S. policy responses argued that the economic and social costs of total lockdowns may outweigh their public health benefits.

Despite the success of aggressive strategies in some nations, global consensus on the optimal public health strategy remains elusive. The complexity of pandemics, influenced by factors such as virus characteristics, population density, pre-existing health conditions, and public trust in government decisions complicates policy decisions. Non-pharmaceutical interventions (NPIs) have proven effective (Flaxman et al. (2020); Nader et al. (2021); Deb et al. (2020)), but the lack of clear guidelines underscores the need for adaptable strategies. The integration of epidemic and economic models (epi-econ) is increasingly used to analyze strategies, helping to balance health, economic, and societal impacts (Alvarez et al. (2021); Acemoglu et al. (2021)); Holden et al. (2024).

To be empirically relevant, any normative analysis of intervention strategies must be based on an accurate description of country specific conditions. For our purposes, the analysis by Holden et al. (2024) is particularly pertinent, since it explores the effects of broad types of intervention strategies in Norway. Based on an age-stratified SEIR model of the Norwegian population, their study finds that the optimal policy will typically be an all-or-nothing strategy, where costly interventions are either applied with high intensity or not used at all. This conclusion is consistent with the results found in the present paper, although we apply a different approach. In our view, the fact that basically similar conclusions are reached from rather different methodological angles strengthens their credibility and robustness.

Holden et al. (2024) also contribute several insights that merit further discussion. First, they highlight the interaction between voluntary behavioral adaptation and formal policy interventions, suggesting that fear-induced behavior may substitute for some policy measures. However, their model does not support strategies relying solely on voluntary adaptation. Second, their assumption that test-trace-isolate-quarantine (TTIQ) measures can reduce the reproduction number (R) by up to 90% suggest that the elimination strategy is feasible. A detailed presentation of intervention policies within the elimination strategy, beyond TTIQ, is omitted, however. Third, the lack of specification of individual policy instruments in their model limits its applicability for real-time policy design. Fourth, they offer a nuanced and highly relevant discussion of the political economy-challenges associated with sustaining strict interventions over time, an issue that is often under communicated in formal models. Finally, their estimates of lockdown-related costs provide a useful benchmark for comparisons.

Several studies have continued to explore the effectiveness of elimination strategies. Lin et al. (2020) examine Taiwan's early and adaptive pandemic response, emphasizing the role of public compliance supported by transparent and consistent communication. Their analysis highlights how a coordinated public health system and people-centered approach contributed to successful containment without widespread lockdowns. Complementing this, Hoang (2022) analyzes Vietnam's shift from early containment through strict public health measures to a vaccination-driven strategy during the Delta wave. He introduces a threshold-based framework to explain when traditional measures become ineffective and when herd immunity enables transition to endemicity.

Wu et al. (2021) provide a comparative analysis of aggressive containment, suppression, and mitigation strategies across eight countries, concluding that aggressive containment - closely aligned with the Elimination strategy - is most effective in minimizing loss of lives and livelihoods, particularly in the absence of vaccines and effective therapies. Their findings underscore the importance of early, coordinated public health interventions, supported by strong political leadership, community engagement and scientific input. Seale et al. (2020) complement these findings by showing that public trust and perceived effectiveness of measures significantly influenced compliance in Australia, underscoring the importance of transparent communication and community engagement in successful containment. These findings highlight that transparent communication and public trust in government are critical for the success of containment strategies.

More recent studies further support these conclusions: Chan et al. (2022) demonstrate that Taiwan's soft lockdown and targeted community screening effectively reduced transmission without full economic shutdowns, while Chiou (2023) finds that Taiwan's elimination strategy led to the lowest health impact and least disruption in daily life, though a later shift away from elimination in 2022 resulted in a sharp rise in mortality. Hsieh et al. (2025) confirm that Taiwan's early containment efforts delayed the epidemic curve and enabled proactive responses, while also highlighting challenges such as the lack of a clear transition plan and vulnerabilities among the elderly population. Together, these studies illustrate how elimination strategies can succeed when embedded in responsive, well-coordinated systems that adapt to changing epidemiological conditions. While the Elimination strategy has proven effective in certain contexts, its success hinges on several factors: early implementation, adaptability of measures, and sustained public compliance (van der Meer & Jin, (2020)). Thus, a multifaceted approach – combining decisive policy action with strategic communication – is essential for effective pandemic management.

From the outset of the pandemic, Norway's COVID-19 policy was accompanied by ambitious reporting on macroeconomic developments, social and distributional impacts, and public health outcomes. A government-appointed expert group, hereinafter the Holden-committee, was established. Its first report (Holden et al. 2020) compared the fiscal costs of various covid19 strategies with the estimated value of lives saved. The analysis concluded that a Mitigation strategy was preferable**.** However, this recommendation appeared to be heavily influenced by a questionable attempt to avoid long-term effects on unemployment. The present study finds no support for such adverse employment effects.

Bjertnæs et al. (2020), on the other hand, concluded in favor of the Elimination-strategy, provided there was a sufficiently high probability of developing an effective vaccine within two years. If this condition was not met, the Mitigation-strategy would work better than both suppression and elimination. Thus, this early *ex ante* study reached broadly similar conclusions to those presented in the current paper. In contrast, the Norwegian Corona Commission recommended a shift to the Suppression-strategy in their second report, explicitly excluding elimination as a viable option in both reports.

The present study contributes to the literature by conducting a cost-benefit analysis of COVID-19 strategies, using empirical outcomes from countries that adopted different approaches. This approach links the outcomes of different strategies to real-world results in the countries that adopted them, thereby reducing the limitations associated with relying solely on simulated outcomes. The advantage is improved empirical relevance. However, this approach has its limitations, which we discuss in Section 6.

3. Scenarios in more detail

Throughout the pandemic, the Norwegian government implemented the Suppression strategy, which serves as the reference scenario for comparisons in our study. Norway's pandemic outcomes thus reflect the consequences of this strategic choice and form the baseline for comparison with the Mitigation and Elimination strategy scenarios. We assess the differences between the scenarios using standard cost-benefit analysis (CB) methods. Specifically, we weigh the benefits of i) lives saved, or more accurately: life years preserved, and ii) reductions in patient numbers, against the costs associated with iii) increased hospital admissions, iv) higher rates of layoffs, unemployment and national income loss, v) more individuals in quarantine and isolation, and vi) stricter border control. We discuss the significance of covid19 mortality, the appreciation of several life years and the role of vaccine development - factors that were both crucial and highly uncertain at the onset of the pandemic. The valuation of lives and life years saved by covid19 measures is based on the cost-benefit framework outlined by the Ministry of Finance (2014). The percentage increase in the number of deaths during the pandemic compared to the estimated number of deaths in the absence of the pandemic, indicates both the magnitude of health costs and the number of deaths due to the pandemic. Similarly, the percentage difference in GDP during the pandemic compared to a trend without the pandemic indicates how the economy was affected.

Importantly, the pandemic also triggered global effects that were not directly tied to specific COVID-19 strategies – such as reduced life expectancy and fluctuations in energy prices. These broader impacts are factored into all our COVID-19 strategy scenarios. Hence, the cost-benefit analyses, which focus on differences in outcomes between the scenarios, are not affected by such common impacts.

Suppress (S)

In the S-scenario, the primary objective is to keep the infection rate (R) below 1. Achieving this requires extensive TTIQ measures. As a result, far fewer individuals acquire natural immunity compared to the M-scenario, which in turn necessitates prolonged infection control efforts until vaccines can be administered to those who remain susceptible.

On March 12, 2020, Norway implemented strict infection control measures to curb the spread of the virus. These measures were gradually relaxed over the summer of 2020 as infection rates approached zero. Throughout the pandemic, the Norwegian society faced several waves of infections, which led to the reintroduction of various control measures. Additionally, extensive policy initiatives were launched to mitigate the pandemic's economic fallout. This development also influenced health-related issues and the number of additional deaths.

Mitigation (M)

The M-strategy aims to gradually build immunity within the population by allowing controlled transmission of the virus. It involves implementing infection control measures to protect particularly vulnerable groups and to limit the spread of infection. Compared to the S-strategy, these measures are generally less intrusive for individuals and businesses, resulting in more moderate economic impacts. However, some of the differences in outcomes between the strategies may be offset by voluntary protective behavior. The less stringent nature of the M-strategy also allows for a more aggressive spread of the virus, initially leading to higher numbers of infections and deaths relative to the S-strategy.

The M-strategy is exemplified by the approaches taken in Sweden, Brazil, the UK and the United States. However, the effects observed in these countries are not directly transferrable to the Norwegian context. Factors such as population density, voluntary protective behaviors, mobility, and production sectors are likely to influence outcomes. Among these countries, Sweden shares the greatest economic and societal similarities with Norway. Thus, we assume that implementing the M-strategy in Norway would yield outcomes broadly comparable to those observed in Sweden. Adjustments are made for differences in production sectors, as well as for population size and GDP between Norway and Sweden. We consider the percentage change in key variables compared to a pre-pandemic trend in both countries. The percentage change in each key variable from switching from the S- to the M-strategy is attributed to differences in outcomes between Norway and Sweden. Note that the UK case is included in the analysis to shed light on the impacts of the M-strategy when country characteristics differ from those of Norway.

Elimination (E)

The E-strategy seeks to eradicate the virus within the first few months through stringent infection control measures. This includes severe restrictions on social contact and extensive use TTIQ. Early implementation of border controls at an initial stage, such as those adopted by Taiwan, is a key component. If successful, all intrusive domestic control measures can then be lifted. However, because only a small share of the population acquires immunity under this strategy, the risk of imported infections remains high. Until effective mass vaccination becomes possible, the strategy therefore requires continued strict border controls and quarantine for incoming travelers.

Additional tools may include using an infection tracking app combined with geographic isolation measures.

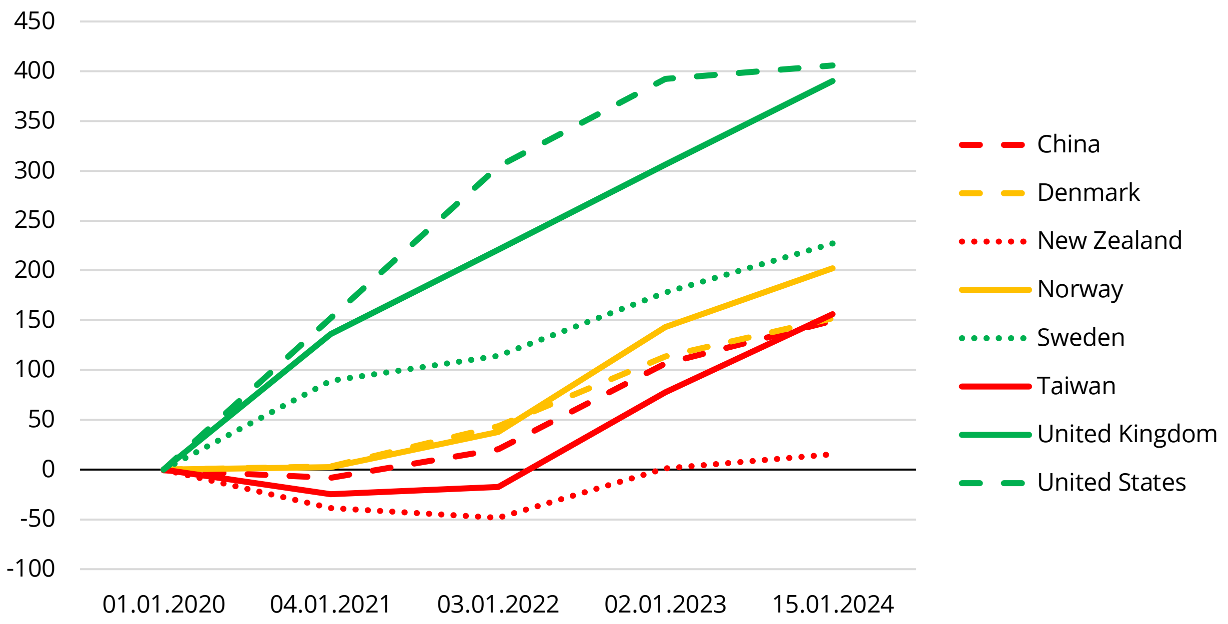
The E-strategies were followed by China, Taiwan, Vietnam, and New Zealand. However, the effects observed in these countries may not directly apply to Norway due to differences in border control requirements, population density, voluntary protective behaviors, mobility, composition of production, and trust in the legal authorities. The initial phase of this strategy resembles the initial phase of the S-strategy when strict border control is not employed at an early stage. By June 2020, the spread of the virus in Norway was nearly eliminated. Adopting the E-strategy in Norway would most likely resemble the strategies practiced in Taiwan, and particularly New Zealand. Norway and New Zealand share key characteristics. They are rich countries with low population densities. Their populations are highly educated. They share a similar parliamentary democratic system and a relatively strong trust in the government. Taiwan is less similar to Norway (and New Zealand) for two reasons mainly: It is more densely populated, and its population is probably more disciplined due earlier pandemics combined with an Asian culture that places less emphasis on individual freedom. Based on these similarities, it is reasonable to anticipate that the implementation of the E-strategy in Norway may yield outcomes analogous to those observed in New Zealand. Notably, New Zealand introduced strict border control measures at a later stage than Taiwan. The inclusion of Taiwan in the analysis thus serves to illustrate the potential effects of early intervention policies. Adjustments are made to account for the higher logistical and economic costs of maintaining strict border controls in Norway, which, unlike Taiwan and New Zealand, does not benefit from natural geographic isolation. As an open, non-island economy with extensive land borders and cross-border mobility, Norway faces greater challenges in preventing imported infections. We also account for differences in production sector developments. The semiconductor industry boost during the pandemic was arguably specific to Taiwan and should not be extrapolated to the Norwegian economy. Finally, we adjust for differences in population size and GDP to ensure comparability.

4. Cost- benefit components based on ex-post outcomes

4.1. Benefit of saved lives

The pandemic caused severe direct health effects in terms of sickness, suffering and deaths. More indirect health effects include fear and stress, as well as adverse psychological effects of isolation. The percentage increase in the number of deaths during the pandemic compared to the estimated number of deaths in the absence of the pandemic indicates both the magnitude of such health-related costs and the number of deaths due to the pandemic, see figure 1.

Figure 1. Accumulated excess deaths per 100,000, based on a pre-pandemic counterfactual trend intended to represent mortality in the absence of the pandemic, selected countries



Source: Our World in Data, From the Economist (2024).

Figure 1 shows accumulated excess deaths per 100,000 in selected countries, calculated as the difference between observed deaths and a counterfactual trend estimating mortality in the absence of the pandemic. The figure illustrates that, in the early stages of the pandemic, countries following the E-strategy (China, Taiwan, and New Zealand) experienced significantly fewer excess deaths than those following the S-strategy, and markedly fewer than countries following the M-strategy. It also shows that excess mortality in S-strategy countries was substantially lower than in M-strategy countries during the same period.

This pattern changed somewhat over the course of the pandemic. Toward the later stages, countries following the E-strategy saw an increase in excess deaths, while M-countries experienced a more modest rise. However, when considering the full period from 2020 to 2023, countries that followed the E-strategy still outperformed those that adopted the S- or M-strategies in terms of cumulative excess mortality. The largest overall increase in the number of deaths emerged in countries following the M-strategy.

The number of life years lost compared to the S-strategy consists of both accelerated covid-related deaths and additional covid-related deaths. Life-years lost due to additional covid-related deaths consists of additional accumulated deaths multiplied with life-years saved per death. Life-years lost due to accelerated covid-related deaths include life-years lost as individuals die younger than in the S-scenario. Our CB analysis evaluates the loss of extra quality adjusted life years (QUALY), according to established guidelines. This approach aligns with the prioritization practice in the Norwegian public health service.

According to our general plan for comparisons of strategies, we assume that implementing the M-strategy in Norway would have resulted in excess mortality rates similar to those observed in Sweden during the pandemic. We start by assessing the number of life years lost due to accelerated covid-related deaths during the pandemic. We assume that the virus becomes less lethal as the pandemic evolves. Hence, postponing covid-related deaths translates to saved life-years as older and more vulnerable people die due to infection. Figure 1 shows that the majority of covid-related deaths in Norway occurred toward the end of the pandemic, whereas in Sweden, the majority occurred early on. These earlier deaths in Sweden, compared to Norway, amounts to the number of life years lost due to accelerated covid-related deaths during the pandemic. The number of life years lost due to higher accumulated deaths at the end of the pandemic is found by calculating the life expectancy of additional covid-19 related deaths in Sweden compared to Norway. Knudsen et al. (2023) find that the average age of covid related deaths in Norway was 85,5 years in 2022, which was the year with most covid related deaths. The life expectancy of an 86-year-old in Norway was approximately 6 years in 2023. Based on this, we assume that the number of life years lost per additional covid-related death at the end of the pandemic is estimated to be 6. We acknowledge that there are both strengths and weaknesses associated with the chosen approach, but it provides a consistent basis for comparison across strategies.

Accelerated covid-related deaths during the pandemic would cause an increase in lost life years equal to 11 378 if Norway had chosen the M- instead of the S-strategy. Life years lost due to additional covid-related deaths at the end of the pandemic by choosing the M- over the S-strategy amounts to 8 100. Hence, the total number of life years lost amounts to 19 478. The number of life years lost by choosing a UK based M-strategy over the S-strategy chosen by Norway amounts to

91 957. The substantial difference in outcomes between the UK and Sweden illustrates differences between countries following the M-strategy. Hence, results should be evaluated based on such uncertainties with respect to outcomes.

The number of life years gained by choosing the E-strategy over the S-strategy includes both postponed covid-related deaths during the pandemic and a lower number of covid-related deaths at the end of the pandemic. In this scenario, we assume that mortality outcomes in Norway under the E-strategy would mirror those observed in New Zealand. A separate scenario based on Taiwan is also included to illustrate the potential impact of early border control measures. The number of life years gained due to postponed deaths is found by summing the temporal differences in mortality between the two scenarios. The number of life years gained due to lower accumulated deaths at the end of the pandemic is found by calculating the life expectancy of these gained lives.

Based on comparisons with New Zealand, we estimate that Norway could have gained 19 544 life years due to postponed covid-related deaths during the pandemic by choosing the E- instead of the S-strategy. In addition, 60 039 life years would have been gained due to avoided covid-related deaths at the end of the pandemic. Hence, the number of life years gained by choosing the E- over the S-strategy totals 80 039. In a separate scenario based on Taiwan, the estimated number of life years gained by choosing a Taiwan-based E-strategy over Norway's S-strategy amounts to 24 100. Taiwan experienced an increase in the number of deaths toward the end of the pandemic. One important factor contributing to this outcome was a weakening of border control measures during the middle phase of the pandemic, which led to a substantial rise in infections and, consequently, in mortality.

Our adjusted valuation of saved life-years follows the official Norwegian guidelines (Ministry of Finance, 2014). The economic value of a statistical life was set at NOK 30 million in 2012. The economic value of a statistical life should be adjusted upwards, corresponding to the growth in GDP per capita in the latest available Perspective Report from the Ministry of Finance. The valuation of a year of life is assessed by the Norwegian Directorate of Health (2017) and Magnusen et al. (2015). Estimates range from 0.275 to 1.3 million in 2015. Holden et al. (2024) sets the value of life years gained at NOK 1.5 million, which equals the inflated valuation in Holden (2020). The lack of an unambiguous basis has led us to include calculations for two estimates, NOK 0.7 and NOK 1.4 million, respectively. When a life year is valued at NOK 0.7 million, the loss of choosing the M- over the S strategy amounts to a present value of about NOK 13.635 billion. With NOK 1.4 million per extra life year, this loss increases to approximately NOK 27.270 billion. The loss of choosing a UK based M strategy amounts to NOK 64,370 billion and 128,740 billion, respectively. The monetary benefit of choosing the E- over the S strategy will be approximately NOK 56,027 billion when the life-year value is set at NOK 0.7 million, and NOK 112,055 billion when the life-year value is set at 1.4 million. The gain of choosing a Taiwan-based E strategy amounts to NOK 16,870 billion and NOK 33,740 billion, respectively; see Table 3.

The cost of being afraid of becoming infected and dying is likely to differ between scenarios. Such costs are challenging to quantify. The likelihood of exposure to viruses at different degrees of immunity are plausible factors determining the cost for society. We assume that such fear, and hence such costs, can be inferred from the number of additional deaths within each strategy. Cost estimates of saved life-years are based on individual's willingness to pay to avoid the risk of dying, see TØI rapport 1692/2019. Hence, one may argue that costs associated with fear of being infected and dying are included in cost estimates of dying from covid. On the other hand, one may argue that costs of a covid-related death exceed cost estimates of saved lives as a covid-related death are more horrific. Such additional costs are not included in this analysis, however. Fear of becoming infected and dying may also deteriorate mental and physical health. The cost of reduced production due to sick leave associated with such health issues is included in cost estimates in section 4.4.

4.2. Costs due to hospitalizations

Estimates of costs due to hospitalizations warrant assessments, contingent on the chosen strategies. According to on FHI report (Folkehelsen etter covid-19[1]) 1,15 persons were given intensive care per person who died from covid19 in Norway. The corresponding ratio of hospitalized people was 6.06. We assume that these ratios can be interpreted as structural parameters that are valid also when we consider counterfactual numbers of deaths caused by covid19.

The number of covid-related deaths in Norway at the end of the pandemic, defined as January 2024, amounts to 10 913 persons. The above-mentioned ratios imply that 12 540 Norwegians were given intensive care, and 66 133 were hospitalized. If Norway had chosen the M-strategy, we estimate 12 263,4 covid-related deaths at the end of the pandemic. The corresponding counter factual number of hospitalized and given intensive care amounts to 74 316 and 14 103, respectively. If the E-strategy had been chosen, Norway would have seen 831 covid-related deaths, 5 036 hospitalized and 956 given intensive care at the end of the pandemic.

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[1] https://www.fhi.no/ss/korona/koronavirus/folkehelserapporten-temautgave-2021/del-1-9/pandemiens-viktigste-helsekonsekvenser/?term=

Thus, choosing the M-strategy over the S-strategy imply an 8 183 increase in the number of hospitalized Norwegians. The corresponding increase in Norwegians given intensive care equals 1 563. If Norway had chosen the E- instead of the S strategy, the reductions in the numbers of persons hospitalized and given intensive care amounts to 61 097 and 11 584, respectively.

The price of intensive care amounts to approximately NOK 60,000 per day, according to The Norwegian Directorate of Health. With an average length of stay of 10 days, the M-scenario implies an extra cost related to intensive care of NOK 0,94 billion compared with the S-scenario. Choosing the E- rather than the S-strategy implies a reduction in these costs of NOK 6,95 billion. With a daily price of ordinary hospital admissions of NOK 40,000 and 2 days in hospital, choosing the M- instead of the S-strategy implies an increase in the costs related to hospitalization of NOK 0,65 billion. The corresponding cost saving from choosing the E- instead of the S-strategy is NOK 4,89 billion. The cost increase from choosing the M- instead of the S- strategy amounts to NOK 1,59 billion. Cost increases related to choosing the UK M-strategy are assumed to be twice as high. The corresponding cost saving by choosing E- instead of the M-strategy is NOK 11,84 billion. Hence, cost savings by choosing the E- rather than the S- scenario amount to NOK 10.2 billion, see Table 3. We assess the cost savings compared to the Taiwan E-scenario to be half of the saving of choosing the New Zealand E-scenario.

4.3. Costs due to discomfort of illness

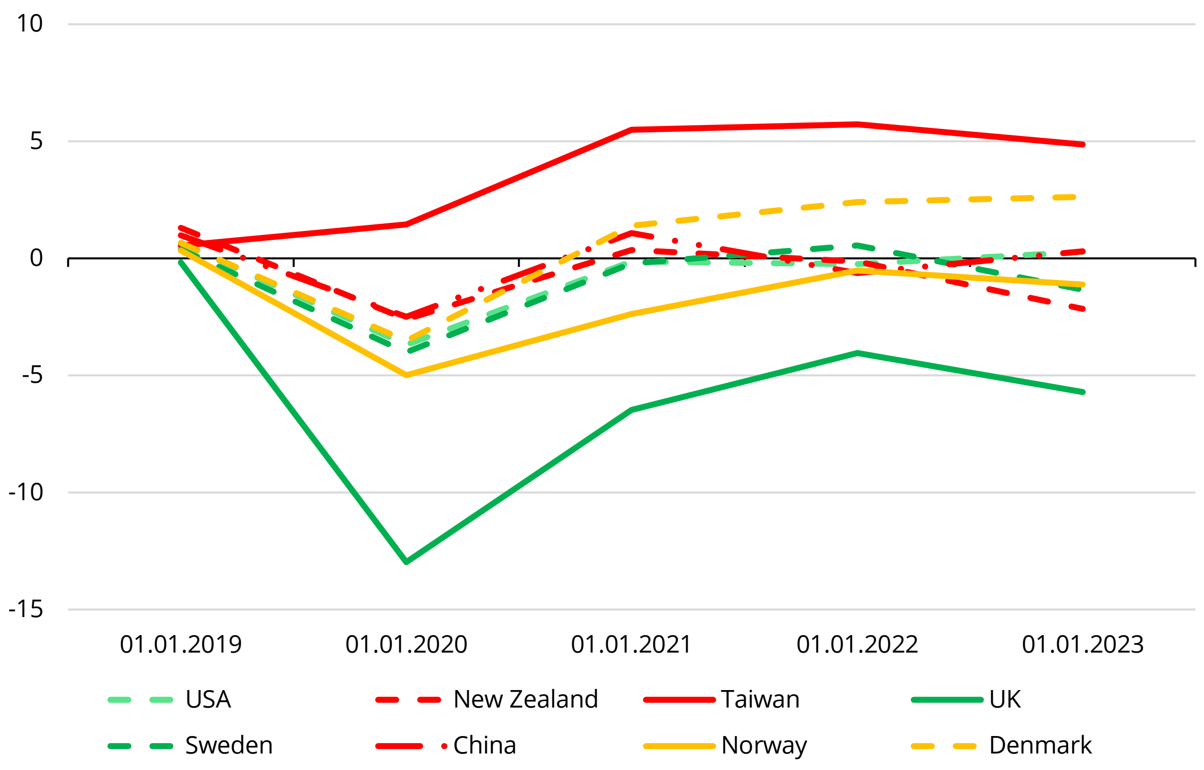
Illness means discomfort for the person affected, as well as for the close relatives. It is difficult to quantify the value of this discomfort. Both ill and vaccinated people suffer from long-covid. The number suffering from long-covid is modest, and impacts are on average more severe for infected and ill persons than for those vaccinated, see e.g. Català et al. (2024). We assume that the number of infected persons would be approximately 700 000 higher under the M-strategy compared to situation under both the S- and E strategy. Assuming the average additional cost per additional infected amounts to be NOK 10.000, the gain from choosing the S- or the E-, rather than the M-strategy, amounts to about NOK 7 billion.

On average, approximately 100,000 seek medical attention each year due to a flu infection. The S- and E-strategies will reduce the extent of such and other diseases. The benefit compared to the M-scenario is therefore estimated at about NOK 2 billion in both the S- and E-strategies. Hence, more discomfort of illness generates an additional loss of NOK 9 billion if Norway had chosen the M- instead of the S- strategy. The loss associated with the UK M-scenario is assumed to be twice as high. Choosing the E-strategy offers no additional gain compared to the S-strategy, see Table 3.

4.4. Costs due to layoffs

The economy is affected through both infection control measures and layoffs due to voluntary behavior to avoid infection. We calculate the costs based on how the pandemic affected GDP within selected countries which followed different infection control strategies. Hence, costs of both infection control measures and voluntary behavior are included. Figure 2 shows the percentage deviation of actual GDP during the pandemic from an estimated trend-GDP in a selection of countries that adopted differing COVID-19 strategies. The trend-GDP is calculated based on pre-pandemic data, representing the expected economic trajectory had the pandemic not occurred. The figure shows that the slowdown in GDP growth following the pandemic outbreak in 2020 was weaker in our selected E-countries (China, Taiwan and New Zealand) than in the selected S- and M-countries. The figure also shows that recovery was quite rapid for S- and M-countries, except for the UK. When considering the full period from 2020 to 2023, the E-countries outperformed the others in terms of GDP growth.

Figure 2. Percentage difference between GDP during the pandemic and trend-GDP without the pandemic in selected countries



Source: Macrobond, Gross Domestic Product; U.S. Bureau of Economic Analysis (BEA), Statistics New Zealand, Taiwan Directorate-General of Budget, Accounting & Statistics, Vietnamese General Statistics Office, Bank of Korea (BOK), U.K. Office for National Statistics (ONS), Statistics Sweden (SCB), China National Bureau of Statistics (NBS), Australian Bureau of Statistics, Statistics Norway.

One may argue that other factors than the covid-19 strategy contributed to the favorable GDP outcome within some of the E-countries. An example is the boost in the semiconductor industry in Taiwan during the pandemic. One may also argue that some of the negative impacts in the UK were due to Brexit, which was implemented at the same time as the pandemic emerged. This should be considered when results are evaluated.

Since the shut-down of companies due to infection control measures took place very quickly and in large numbers, we assume that alternative use of real capital of affected companies was limited. The use of intermediate goods is on the other hand assumed to be scaled down proportionally to production. We therefore measure the cost of lost man-years by the reduction in GDP.

This measure is likely to underestimate the costs of layoffs as the marginal willingness to pay for rationed goods will exceed their market value. However, this bias is counteracted by an increase in leisure time, which contributes to reducing the cost of layoffs. There are two reasons for this: Firstly, most of the layoffs were known to be temporary, also for the individual laid off, because most of them were entitled to return to their jobs when these restrictions were removed. Secondly, the unemployment benefit to the temporarily dismissed in Norway were raised to provide almost full compensation for the lost wage income. Thus, their situation had more in common with a temporary vacation paid for by the government than typical unemployment.

Admittedly, restrictions on social interaction and travelling reduced the value of the increased leisure time compared with an extension of a normal vacation. We nevertheless make the simplifying assumption that the two effects cancel out. Thus, the GDP-effect captures both the loss of output and the increased leisure time. Note that the GDP-effect also incorporates that low-income earners were hurt to a greater extent by the covid19 crises compared to high-income earners.

The monetary cost of layoffs by choosing the M- over the S strategy would have been approximately NOK -33,0 billion in 2020, NOK -71,4 billion in 2021, NOK -37,3 billion in 2022 and NOK 8,0 billion in 2023. Hence, the total cost amounts to NOK -133,7 billion, i.e. a gain of NOK 133,7 billion; see Table 3. Bougroug et al. (2021) compare forecasts made prior to the outbreak of the pandemic with GDP outcomes and find that GDP was between 4 and 5 percent lower the initial year of the pandemic, with the outcome in Sweden being approximately ¼ to ¾ percentage points better than in Denmark and Mainland Norway. This result suggests that the decline triggered by the pandemic itself was substantially greater than any additional decline that may have resulted from stricter infection control measures. This finding is consistent with the findings in the present study. The total cost of choosing a UK based M-strategy amounts to a total cost of NOK 687 billion. This outcome suggests that the costs of choosing an M-strategy might be substantial. Hence, these findings suggest that the outcome of choosing the M- instead of the S-strategy is highly uncertain.

The monetary gain of fewer layoffs by choosing the E- rather than the S-strategy will be approximately NOK 83,4 billion in 2020, NOK 93,2 billion in 2021, NOK 13,8 billion in 2022 and NOK -35,7 billion in 2023. Hence, the total gain amounts to NOK 154,7 billion. The total gain of choosing a Taiwan variant of the E-strategy amounts to a total gain of NOK 908,6 billion. Hence, the outcome of choosing the E-strategy over the S-strategy is substantial according to these findings. The differences in outcomes between different E-countries are also substantial, however.

4.5. Costs of school closedowns

The costs of school closure can be decomposed into days of closure and the social cost per day of closure. UNESCO (2022) distinguishes between days *fully* versus *partially* closed, see Table 1. In Norway *partially closure* meant teaching at school, but often outdoor, and physical contact should be avoided. School classes were split into groups, which did not attend school simultaneously. Thus, the time at school was reduced for the average pupil during these periods. Thus, the socialization effect of schooling was purposedly reduced, but the restrictions did not isolate children/youths. They met friends and took part in social interaction, which is regarded as important aspects of schooling in Norway. Costs related to isolation and restrictions on behavior are included in section 4.6. Costs caused by the need for parents to reduce their labor supply to look after their children when they could not attend school, are included in the production costs, section 4.4.

We share the common view, also expressed in e.g. the Holden-4 report, that school closure reduces, *cet par*., learning. However, assuming learning to be zero in periods with full school closure would be an exaggeration of the average effect. In all our selected countries school closure was combined with online distance learning. Moreover, more homework and parental teaching can compensate for parts of the lost schooling time. Most likely such substitution was correlated with parental education and income (Fuchs-Schündeln, 2022).

Table 1. **Number of days in the period 16/02/2020 - 30/04/2022 when schools were fully or partially closed due to COVID-19**

Country	Strategy	Days fully closed	Days partially closed	Total	Closed days equivalents
China	E	66	173	239	153
New Zealand	E	54	135	189	122
Denmark	S	59	185	244	152
Norway	S	34	172	206	120
UK	M	109	80	189	149
Sweden	M	0	167	167	84
USA	M	0	539	539	270

Source: "UNESCO Institute for Statistics based on UNESCO map on school closures (https://en.unesco.org/covid19/educationresponse)"

Table 1 shows that Norwegian schools were fully closed for 34 consecutive days in March and April 2020. In comparison, Norwegian schools are closed for 45 consecutive days net of Saturdays and Sundays in the summertime. In total, the number of holidays for Norwegian school children totals approximately 14 weeks per year.[2]

In addition to full closure, Norwegian schools were partially closed for 172 days when holidays/vacations are excluded.[3] With respect to fully closure, the M-countries Sweden and USA stand out with no such days, whereas the UK is an outlier in the opposite direction. Norway ended up with fewer days of fully closure than the other selected E- and S-countries. Turning to partial closure, the USA is an outlier with 539 days. The number of days with partially closure were rather similar in China, Denmark, Norway and Sweden.

There are several ways to aggregate partial and fully closed schools. Fuchs-Schündeln et al. (2022) avoid this problem by basing their assessment of lost schooling time in the US and Germany on Safegraph data on cell-phone visits at the physical location of a specific school. As a rough indication we assume that 2 days with partial school closure are equivalent to 1 day of full closure with respect to learning and socializing. The last column in Table 1 shows that with this assumption, there is no significant difference between countries choosing different strategies with respect to the loss of schooling time. The two M-countries, Sweden and the US, stands out with the lowest and the highest loss. Moreover, the loss in the S-country Norway was approximately the same as in the E-country New Zealand, and the E-country China experienced the same loss as the S-countries Denmark and the M-country UK. Consequently, and irrespective of the social cost per day of closure, we conclude

[2] Skolerute, skoleferie og skolestart hele Norge

[3] Norwegian schools were partially closed in two periods of consecutive days: 24.03-28.04 2020 and 17.08-21.09 2021.

that the difference in total costs related to school closure between countries choosing different strategies will be zero.

The robustness of this conclusion decreases as the cost of school closures increases. More precisely, if different strategies were to result in different numbers of school closure days, then the impact of an erroneous conclusion on the overall cost assessment will be smaller when the cost of school closure is lower. By combining the estimated 0.95 percent loss of life cycle income in Fuchs-Schündelen et al. (2022), with the estimated life cycle income of 11 million 2015-NOK in Bhuller et al. (2017), the Holden-4 report computes a cost per month of school closure equal to NOK 15 billion. Though large, this assessment would be much higher if the estimated loss of life cycle income in Fuchs-Schündelen et al. (2022), were replaced by the cost estimates of, respectively, school strikes in Argentina (Jaume and Willen, 2019) and snowstorms in the US (Goodman, 2014). However, the Holden-4 report points to several reasons for regarding NOK 15 billion as strongly upwards biased. Firstly, it relies on a linear relationship between the loss of human capital and days of school closure. Most likely, this cost increases progressively with the days closed, so that the cost of one day without schooling is much smaller than the corresponding average daily cost of 100 consecutive days. Secondly, ordinary schooling was replaced by on-line digital schooling and, to some extent, by parents teaching at home, when schools were closed under the pandemic. Such a substitution of teaching efforts is probably less likely when schools close because of strikes. In fact, the Holden-4 report argues that the school closure in Norway had no significant effect on human capital formation. This surprising conclusion is based on the average results from National Exams for pupils in classes 5, 8 and 9. These results are basically the same in 2020 and 2021 as they were in the pre-pandemic years. Note that these National Exams in Norway are constructed to make the results in different years comparable.

4.6. Social costs due to quarantine and restrictions on behavior

Research indicates that individuals subjected to quarantine and isolation during the COVID-19 pandemic experienced elevated levels of psychological distress, including anxiety, sleep disorders, anger, depression, poor concentration, as well as post-traumatic stress symptoms (Santomauro et al., 2021). One could in principle value such costs related to quarantine/ isolation by uncovering the willingness to pay to avoid such measures. However, willingness to pay varies widely across populations, and while studies such as Mehranfarda et al. (2024) suggest substantial costs, we lack robust estimates for Norway. As a proxy, we use the subsidiary prison sentence associated with fines to estimate the cost of quarantine and home isolation. We set the cost of 10 days of home isolation at NOK 10,000. This estimate is admittedly crude and open to criticism, but it provides a starting point for discussing the order of magnitude of such costs.

The number of individuals quarantined and isolated during the pandemic includes both mandatory and voluntary cases. Reliable data on the number of people in quarantine and/or isolation at home or in public facilities within each scenario is, however, not available. It is therefore challenging to estimate the number in quarantine and/or isolation within each scenario. We assume that an additional 0.5 million is isolated/ quarantined for 10 days due to nation-specific measures during the pandemic in the scenarios associated by, respectively, the S- and the E- strategies compared to the M-strategy. This choice gives an additional cost of NOK 5 billion in S- and E- compared with the M-scenario.

In the E-scenario, region-specific quarantines – such as those implemented in Hubei province, China – were more prevalent. We assume that region-specific quarantine amounts to 700 000 people for 10 days within the E-scenario. Hence, the additional cost in the E-scenario amounts to NOK 7 billion. The additional cost related to isolation and quarantine compared to the M-scenario amounts to NOK 5 billion for the S- and NOK 12 billion for the E-scenario. Note that such costs add to those caused by layoffs (Section 4.4) and discomfort of illness (Section 4.3). It is important to note that some infection control measures – particularly in China – were inhumane, involving forced isolation and surveillance. However, other countries pursuing E-strategies, such as New Zealand and Taiwan, achieved similar outcomes without resorting to such measures. Therefore, inhumane restrictions are not inherent to the E-strategy.

Beyond quarantine, the pandemic led to widespread behavioural responses – both voluntary and mandated. These restrictions imposed two types of costs: (i) a measurable loss in GDP, addressed in Section 4.4, and (ii) a less tangible welfare loss from reduced social interaction and leisure activities. Quantifying the latter is challenging. As an indirect proxy, we examine the drop in GDP across countries with differing COVID-19 strategies, Figure 2 in Section 4.4. This metric captures both voluntary and involuntary behavioural changes, but is sensitive to factors such as fiscal support, domestic tourism, and structural differences in service sectors.

Figure 2 shows that the initial slowdown in 2020 was most severe in M-countries such as the UK compared to the S- countries. The E-strategy countries experienced a much smaller decline (New Zealand) or an increase (Taiwan) compared to both S- and M- countries. Recovery patterns were heterogeneous: Taiwan and New Zealand rebounded strongly by 2021 and maintained near-baseline levels, while Norway and China recovered moderately. In contrast, the UK remained far below baseline through 2023. These patterns suggest that E-strategies generally imposed fewer lasting restrictions on social and economic activity than M-strategies, while S-strategies fell in between. Assuming an additional welfare cost of NOK 1,000 per individual for the M-scenario compared to the S-scenario yields an estimated extra cost of NOK 5 billion. Assuming an additional welfare cost of NOK 1,000 per individual for the S-scenario compared to the E-scenario yields an estimated extra cost of NOK 5 billion. Hence, the combined impact of quarantine and restrictions on behavior generates no additional costs within the M-scenario compared to the S-scenario. Choosing the E- over the S-scenario generates an additional cost of NOK 2 billion.

4.7. Direct costs due to stricter border control

The strategies require different levels of boarder control. The import of infection was modest in the initial phase in both the S- and E-scenarios. When the extent of infection grows in the M-scenario, there is little to be achieved by limiting imported infection, whereas this is important in both the E- and the S-scenario to keep the infection rate below 1. Therefore, we assume that restrictions on traveling into the country in the initial face of the pandemic are maintained in both these scenarios. When the virus has been eradicated domestically in the E-scenario, it becomes crucial to stop imported infection, and we assume that strict restrictions are maintained on travel into the country throughout the pandemic. Such restrictions entail an additional cost compared to the M-scenario, but it is challenging to quantify.

We assume that the required control measures resemble boarder control measures implemented in Norway in the first half of 2021. In the first half of 2021, Norway implemented a comprehensive set of border control measures to mitigate the spread of COVID-19 through international travel. Entry was restricted to Norwegian citizens and individuals with essential purposes, effectively suspending non-essential travel. Travelers arriving from high-risk regions were mandated to stay in quarantine hotels for up to ten days, during which they were subject to periodic testing. All incoming travelers were required to complete a digital registration prior to arrival. Furthermore, mandatory PCR tests or rapid antigen testing were enforced at the border, supported by the establishment of testing facilities at major airports and land crossings. Numerous smaller border checkpoints were temporarily closed, consolidating traffic through larger, controlled entry points. These measures were reinforced by increased police and customs presence to ensure compliance. The financial implications of these interventions were substantial. The quarantine hotel program alone incurred costs amounting to several hundred million Norwegian kroner according to the Ministry of Justice and Public Security. The establishment and operation of border testing facilities added tens of millions in expenditures according to the Norwegian Directorate of Health. Additionally, the expansion of law enforcement and customs personnel, along with the development of digital infrastructure for entry registration and monitoring, contributed further to the overall fiscal burden. We assume that additional operating costs of boarder control measures in the S- compared to the M-scenario amount to NOK 3 billion, and that additional costs in the E- compared to the S-scenario amount to 5 billion.

The flow of goods in and out of the country was limited by the fact that the Covid-19 crisis was global. Entry restrictions could have led to practical problems with the transportation of goods. Creative transportation solutions might have solved many of these problems at a modest cost. Restrictions on entry and fear of infection would primarily have affected tourism to and from the country, as well as labor immigration and cross-border commuting in this case. Tourism into Norway dropped drastically in 2020 and 2021 according to Statistics Norway. Holidays abroad also dropped drastically. Many Norwegians went on holiday in Norway, however. This contributed to maintain activity in the Norwegian tourism industry. However, many did not get their holiday wishes fulfilled. If fear of infection and restrictions implemented abroad prevent holidays abroad, tourism-related costs created by entry restrictions domestically will be modest. On the other hand, costs can be significant if entry restrictions domestically prevent holidays abroad.

Direct comparisons of holidays and labor migration between Norway and Sweden are challenging, as Norwegians tend to spend holidays in Sweden to a greater extent, while Swedes are more likely to migrate to Norway for work. Norwegians went on 7,4 million holiday trips abroad in 2019 according to Statistics Norway. Fears of infection, restrictions on entry and restrictions abroad meant that traveling abroad was reduced by approximately 90 percent in 2020. Swedes experienced a similar drop in holiday trips abroad. The reduction was somewhat more modest, however. We assume that the consumer surplus associated with being able to travel abroad during the pandemic is NOK 10.000 per trip, and that restrictions on entries in the S-scenario were accountable for reducing travel abroad by 0.5 million trips in 2020 compared to the M-scenario. This implies an additional yearly cost of NOK 5 billion in the S- compared to the M-scenario. The corresponding total cost difference during the pandemic is NOK 10 billion. We also assume that more strict and permanent restrictions on entry in the E-scenario would have reduced traveling abroad by 1 million trips per year compared to the M-scenario. Compared to the M-scenario, this results in an additional cost in the E-scenario of NOK 10 billion per year, and a total cost of NOK 20 billion during the pandemic.

Labor immigration and commuting into Norway were limited by entry restrictions. Some of these foreign workers were replaced with Norwegians. Some tasks were arguable postponed, such as painting buildings. Some work tasks require expertise from abroad. Some tasks were solved with information technology, e.g. Teams meetings, and some required that labor was imported from abroad. These cases imply additional costs when labor was quarantined. Statistics Norway report that approximately 100,000 people had work-related short-term stays in Norway in 2019. This includes people who commute to work in Norway. The number went down to approximately 60,000 people during 2020 and stabilized at that level for the initial part of 2021. We lack good data on how many man-years they work and how many man-years that were replaced by Norwegians.

We assume that stricter restrictions on entry in the S- than in the M-scenario entailed a yearly reduction of approximately 15,000 imported man-years that was not replaced. These lost man-years would have generated profits and tax revenues for Norway, at the same time as this workforce would have accumulated social security rights in Norway. It is assumed that the net gain for Norway amounts to NOK 200,000 per man-year. Hence, the additional cost in S- compared to the M-scenario amounts to NOK 3 billion per year, and a total of NOK 6 billion during the pandemic.

We assume that stricter restrictions on entry in the E-scenario would reduce the imported work effort that is not replaced by natives by 30,000 man-years compared to the M-scenario. The additional cost in E- compared to the M-scenario amounts to NOK 6 billion per year, and a total of NOK 12 billion during the pandemic. Hence, compared with the S-scenario, more lenient boarder control in the M-scenario generates a total gain of NOK 19 billion. Stricter boarder control in the E-scenario amounts to a cost of NOK 21 billion compared with the S-scenario, see Table 3.

4.8. Costs due to hysteresis

Parts of the unemployment caused by lockdowns of industries may become persistent. The likelihood of becoming a disability pensioner increases with the length of the period being out of work (Fevang, Markusen and Røed, 2020). Per individual such costs will be substantial, and they were a major concern during the pandemic. Alstadseter et al. (2022) use Norwegian register data until October 2021 to study the long-term effects of unemployment. They compare the dynamics of the employment rate for residents being employed in February 2020 with the dynamics of a corresponding group of employed residents in February 2018. After one month the employment rate of the “2020-group” dropped by 4 percentage points relatively to the “2018-group”. However, this difference vanished completely as both groups approached October in the year after, respectively 2018 and 2020. The same dynamics are found for labour income, but in this case a small difference remained at the end of the period. These findings suggest that job losses during the pandemic are basically different from job losses caused by normal recessions.

Our assessment of expected costs of persistent long-run unemployment is based on a comparison of unemployment rates in December 2019 and December 2023 in selected countries. The comparison uncovers a modest reduction in the unemployment rate within most of these countries, se Table 2. We are not able to identify traces of hysteresis due to the pandemic or the choice of strategy. Consequently, costs are set to zero. Holden et al. (2020), on the other hand, assumed substantial costs generated by hysteresis due to both the pandemic and choice of infection control strategy.

Table 2 Unemployment rates before and after the pandemic (ILO numbers if no asterisk)[1]

Country	December 2019	December 2023
Norway	4.1	3.6
Denmark	5.1	6.0
Sweden	6.8	8.2
Finland	6.7	7.7
EU2	6.4	5.9
Germany	3.1	3.2
Italy	9.7	7.2
Spain	13.8	11.9
France	8.2	7.5
USA	3.6	3.7
UK	4.1	4.1
Brazil*	11.1	7.4
Australia*	5.2	3.9
Japan	6.7	7.7
Israel*	3.1	3.2
China*	3.2	3.2
Taiwan*	3.7	3.4
New Zealand*	4.1	4.1
Vietnam*	1.7	0.8
South Korea*	3.5	3.2
Mexico*	3.1	2.8

Macrobond
Euro area 27 countries

5. Cost- benefit analysis based on ex-post outcomes

Section 5.1 presents a cost-benefit analysis based on the ex-post outcome components discussed in Section 4. Section 5.2 addresses vaccine uncertainty.

5.1. Total costs and benefits

Table 3 shows the net benefits of choosing the M- or E strategy instead of the S-strategy. The net benefit of choosing the E-strategy exceeds the net benefit of choosing the S- or the M-strategy. The table further shows that the Swedish M-strategy performed better than the Norwegian S-strategy, mainly due to a smaller impact on the economy. The British M-strategy performed way worse than the Norwegian S-strategy, however. The table further shows that the E-strategy in both New Zealand and Taiwan performed better than both the Norwegian S-strategy and the Swedish M-strategy. In fact, the E-strategy performed better due to both saved life-years and impacts on the economy.

Table 3. Benefits of choosing the M- or E-strategy instead of the S-strategy when the value of a saved year of life equals NOK 0.7 million (NOK 1.4 million in parentheses). Deviations from the S-scenario measured in billion 2020 NOK.

Cost- benefit components	M Sweden	M UK	E New Zealand	E Taiwan
Saved life-years	-13,6 (-27.2)	-64,4 (-128.8)	56,0 (112)	16,9 (33.8)
Fewer layoffs	133,7	-687	154,7	908,6
Fewer in hospitals	-1,6	-3,2	10.2	5,1
Discomfort of sick	-9	-18	0	0
School close downs	0	0	0	0
Hysteresis	0	0	0	0
Restrictions on behavior	-5	-5	5	5
Quarantine	5	5	-7	-7
Border control	19	19	-21	-21
Net utility, total	128.5 (114.9)	-753,6 (-818)	197.9 (253.9)	907,6 (924,5)

The net benefit of saved life-years doubles when the value of a saved life-year equals NOK 1.4 million. Hence, the net loss of the Swedish and the UK M-strategies increases by NOK 13.6 and 64.4 billion, respectively. The net benefit within the E-scenarios in New Zealand and Taiwan increases by NOK 56.0 and 16.9 billion, respectively.

5.2. Cost-benefit and vaccine uncertainty

There is a probability that a vaccine may either succeed or fail in conferring protection. This affects the tradeoff between the strategies because gains of postponing the spread of the disease are reduced when vaccines do not lead to immunity. It is therefore necessary to calculate differences in costs and benefits between the different scenarios when a vaccine is successful and when vaccines are not successful.

The outcome of scenarios with perfectly effective and ineffective vaccines is not observed as vaccination during the pandemic is best described as partially successful. Assumptions about outcomes are required. We assume that observed outcomes in 2020 and 2021 are not affected by the probability of discovering an effective vaccine. Hence, we use the observed outcomes within countries with different infection control strategies for 2020 and 2021. We also assume that the outcomes from 2022 and onwards will depend on the success of vaccination and on the strategy chosen. We assume that the economy returns to the trend growth prior to the pandemic and that additional excess mortality equal zero when a successful vaccine is administered to a large majority of the population at the beginning of 2022. This outcome is assumed to emerge even though infection control strategies differ between countries.

We also assume that countries which chose the S- or the E-strategy in 2020 and 2021 implement a M-strategy in 2022 if vaccination is not successful. We further assume that the impact on the economies is identical to the impact on the Swedish economy at the beginning of the pandemic, i.e. that their percentage deviation from trend-GDP in 2022 and 2023 equals the percentage deviation from trend-GDP in Sweden in 2020 and 2021. We also assume that excess deaths in S- and E-countries are catching up with excess deaths in M-countries. This pattern is observed in data. Hence, we simplify by assuming that observed excess deaths within countries with different strategies follow observed patterns until the beginning of 2024. It is reasonable to expect that accumulated excess deaths in different countries will converge when vaccination is completely ineffective. We assume complete convergence from 2024 and onwards. Hence, compared to the M-strategy, the S- and the E- strategy save life-years, but not lives after 2024. The Norwegian S-strategy is as mentioned compared to the Swedish M-strategy and the New Zealand E-strategy as these countries share comparable characteristics in terms of both population density and form of government.

Table 4 shows the costs and benefits of choosing the M- or the E-strategy over the S-strategy. The E-strategy should be chosen when a successful vaccine is expected within 2 years after the outbreak of the pandemic. The explanation is that this strategy both saves more life-years and jobs during the first half of the pandemic. A Swedish M-strategy performs better than the New Zealand E-strategy and the Norwegian S strategy when vaccination is expected to fail. The explanation is that M-strategy measures are implemented in the last half of the pandemic in both the Norwegian S- and the New Zealand E-scenarios in this case. The cost of implementing such measures exceeds the net gain generated by the E-strategy within the first half of the pandemic. Hence, the Norwegian S-strategy is outperformed by both the Swedish M- and the New Zealand E-strategy in this case.

Table 4. Benefits of choosing the M- or E-strategy instead of the S-strategy when the probability of a successful vaccine equals p and the value of a saved year of life equals NOK 0.7 million. Deviations from the S-scenario measured in billion 2020 NOK.

Cost- benefit components:	M Sweden	E New Zealand
Saved life-years	-22,1p-8,0(1-p)	22,7p+13,7(1-p)
Fewer layoffs	104,5p +225,1(1-p)	176,6p +176,6(1-p)
Fewer in hospitals	-1.6p	10.2
Discomfort, sick	-9p	0
Behavior	-5p	5
Quarantine	5	-7
Border control	19	-21
Net utility	241,1-150,3p	177,5+9p

* p is the probability that one will be able to develop a successful vaccine against the coronavirus.

6. Caveats

The cost-benefit analysis in this study is based on several simplifying assumptions. First, one may argue that excess deaths emerge due to factors that are not related to the pandemic. The observed excess deaths in Sweden may in part be explained by low all-cause mortality in the previous year according to Juul et al. (2022). Juul et al. (2022) find decreased all-cause mortality in Norway and increased all-cause mortality in Sweden in 2020 mainly due to covid-related deaths, however. Hence, the S-strategy in Norway arguably postponed covid-related excess deaths compared to the M-strategy chosen by Sweden.

Second, one may argue that the choice of strategy should be contingent upon the expected degree of viral mutation. The adopted methodology accounts for the impact of mutations, as real-world outcomes were demonstrably influenced by such developments. Mutations that result in increased transmissibility, but reduced severity are commonly observed. These types of mutations may, in effect, resemble the outcomes associated with successful vaccination campaigns. Consequently, Section 5.2 also sheds light on scenarios where the degree and direction of mutation remain uncertain, and the scope for vaccination is limited. A high probability of mutation towards a less severe variant strengthens the case for adopting the E-strategy. A more lethal virus also strengthens the case for adopting the E-strategy, as this strategy results in a greater number of life-years saved.

Third, differences between countries can as mentioned be due to factors other than the choice of infection control strategy, and factors that are not considered may favor another strategy. Other aspects, such as changed income distribution and inhumane lockdowns, should also be considered.

Fourth, the effectiveness of a given strategy may depend on the choices made by neighbouring countries. For instance, a country might attempt to freeride – benefiting from others' efforts to suppress the pandemic without implementing strict measures itself. However, this option was not feasible for Norway, as Sweden pursued a Mitigation strategy.

Fifth, the financial measures implemented during the pandemic were intended to alleviate liquidity problems among companies and households through various types of cash transfers and loans. Such impacts are not explicitly incorporated into our analysis, however.

Sixth, tax financing costs are not included in our analysis. In cost-benefit analysis, costs are typically multiplied by the Marginal Cost of Public Funds (MCF), to account for the distortionary effects of taxes used to finance public projects. In Norway, economic analyses have applied an MCF of 1,2 for several years. Jacobs (2018), however, argues that the marginal cost of public funds equals one. In the E-scenario, a lower accumulated level of unemployment implies lower tax financing costs. Therefore, excluding tax financing costs does not alter our ranking of the strategies.

7. Conclusion

Several studies have examined the effects of specific infection control measures. They often fall short in evaluating the desirability of a comprehensive COVID-19 strategy. This study assesses the overarching effect of COVID-19 strategy choices available to the Norwegian society by conducting a cost-benefit analysis of potential strategies. The study draws on real-world outcomes from countries that implemented different strategies, allowing for the identification of factors that proved crucial. Calculations show that the E-strategy should be chosen when a successful vaccine is expected. When this is regarded as unrealistic, a Swedish-M strategy should be chosen over the New Zealand E- strategy and the Norwegian S- strategy. The Norwegian S- strategy outperforms the UK M-strategy, however. The winning strategy is the Taiwan E- strategy, which outperforms all other strategies. Results also show that the E-strategy should be chosen when the mortality rate is sufficiently high. The explanation is that health related costs are dominating, and that the E-strategy is the least costly way when a highly lethal virus is spreading around the world.

The point of departure of the analysis in this article is that the government chooses an infection control strategy at the start of a pandemic. However, the results above also serve as a guide when policy is updated during the pandemic. Say that the probability of developing an effective vaccine drops dramatically two years into a pandemic as attempts at developing an effective vaccine have failed. The cost-benefit analysis above suggests that the M- strategy should be chosen in that case when the mortality rate is similar to that of the covid-19 virus. The explanation is that both the S- and the E-strategy just postpone the costs of allowing the virus to gradually spread throughout the population.

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