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Consideration of Trade-offs Regarding COVID-19 Containment Measures in the United States: Implications for Canada

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Abstract

The economic stimulus package in the United States, which totalled US$2.48 trillion, was designed to soften the economic impact of sweeping containment measures including shelter-in-place orders that were put in place to control the COVID-19 pandemic. In health care, interventions are rarely justified simply in terms of the number of lives saved, but also in terms of a myriad of other trade-off factors including value-for-money or cost-effectiveness. The data suggest the incremental costs per life-year gained related to the lockdown can span a wide range, depending on the baseline number of deaths in the absence of any containment measures. The results show that, in the United States, under no scenario for life-years gained does the stimulus package compare favourably to other health care interventions that have had favourable cost-effectiveness profiles. However, when comparing value-of-statistical-life-year threshold measures used in other sectors, it is plausible that the stimulus package could be viewed more favourably in the United States. In Canada, a similar analysis could have been possible if age-sex mortality and other data used for containment strategy decisions were made available as the pandemic unfolded.

Le plan de relance économique des États-Unis, d'un montant de 2,48 billions de dollars, avait été conçu pour atténuer l'impact économique des mesures d'endiguement radicales, y compris les ordres de confinement, qui ont été mises en place pour contrôler la pandémie du virus COVID-19. Dans le secteur des soins de santé, les interventions sont rarement justifiées par le seul nombre de vies sauvées, mais aussi par une myriade d'autres facteurs de compromis, notamment le rapport qualité-prix ou le rapport coût-efficacité. Les données suggèrent que les coûts supplémentaires par année de vie gagnée liés au confinement peuvent varier considérablement en fonction du nombre de décès de référence en l'absence de toute mesure d'endiguement. Nos résultats montrent qu'aux États-Unis, le plan de relance ne soutient pas la comparaison avec d'autres interventions de soins de santé ayant un profil coût-efficacité favorable, quel que soit le scénario envisagé pour les années de vie gagnées. Toutefois, le plan de relance peut être considéré plus favorablement si l'on utilise les mesures de seuil de la valeur statistique de l'année de vie d'autres secteurs. Au Canada, une analyse similaire aurait pu être réalisée si les données de mortalité par âge et par sexe et d'autres données utilisées pour les décisions relatives à la stratégie d'endiguement avaient été disponibles au fur et à mesure du déroulement de la pandémie.

Key Messages

- The stimulus package that was put in place in the United States to counteract the impact of containment measures due to COVID-19 did not demonstrate a favourable cost-effectiveness profile using health care-specific metrics.
- The package, however, could be viewed more favourably when using value of statistical life year threshold standards.
- The analysis highlights the importance of trade-off considerations when implementing containment strategies that impact both the economy and public health.
- The paper highlights the implications of these findings for Canada.

Messages-clés

- *Le plan de relance mis en place aux États-Unis pour contrer l'impact des restrictions imposées par le COVID-19 n'a pas démontré un profil coût-efficacité favorable sur la base de paramètres spécifiques aux soins de santé.*
- *Le programme pourrait toutefois être considéré comme plus favorable si l'on utilise les normes de seuil de la valeur de l'année de vie statistique.*
- *L'analyse souligne l'importance des compromis à faire lors de la mise en œuvre de stratégies d'endiguement ayant un impact à la fois sur l'économie et sur la santé publique.*
- *Le document souligne les implications de ces résultats pour le Canada.*

1 BRIEF DESCRIPTION OF THE HEALTH POLICY

COVID-19 emanates from a family of zoonotic viruses that can lead to severe respiratory symptoms. Past corona virus epidemics have included Severe Acute Respiratory Syndrome or SARS-CoV, in 2003 which resulted in 744 deaths and 8,098 cases worldwide and the Middle Eastern Respiratory Syndrome MERS in 2012 resulting in 862 deaths and 2,506 confirmed cases worldwide (NHS 2014; WHO 2020a). COVID-19 was first documented in China on 31 December 2019, with the first death on 11 January 2020. Since then, it has rapidly spread globally and on 11 March 2020, the World Health organization (WHO) officially declared a pandemic. The last pandemic associated with H1N1 influenza in 2009 resulted in 400,000 deaths. As of 10 March 2023, there were over 676 million cases and 6.9 million deaths worldwide and over 104 million cases and 1.1 million deaths in the United States due to COVID-19.

The highly contagious spread of the virus has been unexpected and has left the global community unprepared. To control the spread, countries have put forward stringent containment measures (e.g., social distancing, travel restrictions, and quarantine provisions) to collectively slow the spread of the contagion. The US federal government put in place mitigation policies in the form of travel warnings and restrictions at the onset of the pandemic, and then elevated this to a national emergency on 13 March 2020. All US states followed and declared a state of emergency by 16 March 2020. At the federal level, this state of emergency was renewed for another three months on 23 July 2020. Other emergency declarations were enacted by individual states, enabling them to close schools, enforce mask mandates, ban large gatherings, close non-essential businesses, enact stay-at-home orders, and impose limits on indoor dining. In early May 2021, the federal government issued a broad framework to assist states and local entities to exit from their own restrictions. Since these policies had adverse impacts on businesses and employment, the government enacted the *Coronavirus Aid, Relief, and Economic Security Act (CARES Act)* on 27 March 2020 to provide economic support to individuals, small businesses, large corporations, states, and local governments.

In addition, all foreign nationals who visited China during the last half of January 2020 were banned from entering the United States as of 31 January 2020. The first US death was reported on 7 February 2020 in California, followed by the more-often reported death in Washington on 29 February 2020. Further travel restrictions were put in place when the United States banned all travellers from 26 European countries on 11 March 2020, and two days later, declared the outbreak a national emergency. By 7 April 2020, 42 states had issued shelter-in-place orders, with nearly 95% of Americans under lockdown. By April 20, 2020, protestors began anti-lockdown rallies throughout the United States and in many other jurisdictions (Mervosh, Lu, and Swales 2020). Since October 2021, the United States put in place requirements that all international visitors had to be fully vaccinated to enter the country. These requirements were due to expire on 9 January 2023, but were extended for another three months to mid-April 2023. These requirements were dropped starting 12

May 2023.

The instituted containment measures included lockdown and shelter-in-place orders, domestic and international travel restrictions, self-isolation, quarantine, closure or restriction of all nonessential businesses, school closures and limits on public gatherings. These have resulted in substantial economic consequences in the United States. The result is best exemplified by the contraction of the US gross domestic product (GDP) by 4.8% during the first three months of 2020 – a contraction not seen since the 1930s Great Depression, when the economy contracted by 13% in the wake of the stock market crash of 1929. US unemployment increased to 14.7% by the end of April 2020, with a total of 33.5 million Americans having filed for unemployment since 13 March 2020, when the state of emergency was declared (US Bureau of Labour Statistics [BLS] 2020) These figures do not include the rise in underemployment owing to a reduction in work hours or increases in job sharing. Many US employees and their families also lost their health insurance coverage along with their employment. There was – and continues to be – a particularly large impact on workers in the hospitality, retail, and transportation sectors and an associated likelihood of permanent job loss due to sudden structural changes in the economy.

The impact was felt beyond the economy, with school closures and their potential effects on students' educational trajectories, and negative health impacts resulting from delayed elective surgeries and routine medical checkups, including a lack of timely access to therapies, diagnostic tests, and vaccinations. Finally, there was a tremendous impact on mental health as the combination of the economic downturn, job losses, social isolation, stress, and anxiety led to possible escalations in anxiety, rates of depression, and unhealthy behaviours such as substance abuse (WHO 2022; Twenge 2020). In addition, those who were treated in ICUs may have experienced some form of post-traumatic stress disorder and other physiological issues (McKie 2020).

2 HISTORY AND CONTEXT

To counteract the negative effects of these containment measures on the economy, the US government put in place a massive, unprecedented stimulus package called the *CARES Act*. The *CARES Act* was signed into law on 27 March 2020, and provided US$2.2 trillion of economic relief to workers, families, small businesses, industry sectors, and other levels of government impacted by COVID-19. The key purpose of the *CARES Act* was to preserve and protect jobs in industries that were adversely impacted by the spread of COVID-19. The *CARES Act* also provided up to US$32 billion of direct financial assistance to passenger and cargo air carriers and respective contractors for their employees' salaries and benefits, $150 billion in direct assistance to states and units of local government and $130 billion for the health care system (Congress H.R.748 - *CARES Act*).

The *CARES Act* is now considered the largest financial rescue package in US history. Previous rescue packages included the 2009 *Recovery Act* which was valued at US$831

billion, the *Consolidated Appropriations Act* of 2021 (CAA), with targeted funds of US$910 billion for stimulus relief from the pandemic, and the *American Rescue Plan Act of 2021 (ARPA)*, valued at US$1.9 trillion. *ARPA* extended several of the benefits of the CARES Act, including rebates to taxpayers, benefits for the unemployed, and tax credits for parents. The *CARES Act*, *CAA*, and *ARPA* were the three major pieces of relief legislation for COVID-19 in the US. *CAA* and *ARPA* were signed into law on 27 December 2020 and 11 March 2021, respectively.

The key recipients of the *CARES Act* extended widely from individuals and families to large industries, including unemployment support, income maintenance, community development, vaccine development and distribution, rent assistance, nutrition and agriculture, employee retention benefits, tax breaks, economic stabilization loans, economic injury disaster loans, as well as hospital and health care assistance.

Notably, the *CARES Act* expanded the eligibility and benefits for those collecting unemployment insurance and further enabled one-time direct cash payments to many US households to help soften the impact of containment strategies, particularly for job and income losses that would have impacted the ability to purchase basic needs. Table 1 provides details of these benefits and their recipients.

Despite the enormous costs of the *CARES Act* packages, they merely provided stabilization rather than long-term stimulus; as a result, there was growing public pressure to reopen the economy even though there was no evidence of a sustained levelling off of the pandemic to that point. Information regarding the magnitude of trade-offs between economic and health effects are crucial to determining the path forward as governments consider strategies to both loosen the current lockdown and to determine further economic measures needed to manage the current crisis. Governments may have succumbed prematurely to pressures to reopen the economy prior to a sustained reduction in new daily cases, and without proper monitoring or testing needed to avoid overwhelming hospital capacity in the coming months.

Trade-off decisions are not new to health care. When it comes to selecting optimal therapy for patients, trade-offs are an explicit part of all levels of decision-making. This includes decision-making at the bedside with or without patient involvement by the physician and decision-making by regulatory agencies to approve new interventions after weighing both efficacy and safety elements (Neumann et al. 2016; US FDA 2019). Internationally, some reimbursement agencies evaluate the cost-effectiveness of interventions to determine whether they provide reasonable value-for-money before making funding decisions on coverage and formulary inclusion.

Table 1: Breakdown of recipients of combined stimulus package (US$ billion)

Recipient	**Description**	**Cost (US$B)**
Individuals	Cash payments to individuals	300.00
Individuals	Additional unemployment benefits	260.00
Individuals	Student loans and others	43.70
Large corporations	Loans	425.00
Large corporations	Airline industry and others	76.85
Local and state governments	COVID-19 response	274.00
Local and state governments	Education/family programs	32.30
Local and state governments	Grants and others	33.50
Local and state governments	COVID-19 testing	25.00
Public services	Hospitals	100.00
Public services	Hospitals (new)	75.00
Public services	Veteran	20.00
Public services	Stockpiled equipment	16.00
Public services	SNAP/child nutrition/food banks	24.75
Public services	Other services	16.90
Small businesses	New loans	350.00
Small businesses	Relief for current loans and grants	27.00
Small businesses	Relief for current loans and grants (new)	384.00
Costs (Total)		**2,484.00**

Source: US Congress (2020a and 2020b)

2.1 Process: methodology and data

The economic impact of the pandemic will be eventually computed in greater detail than offered herein as more complete data becomes available. However, there is merit in assessing the value now as restrictions ease and projections are consequently adjusted upward. One

method of measuring trade-offs could be in the form of a simple cost-effectiveness analysis (CEA), calculated as the cost per life-year gained (Cost/LYG) from the containment measures adopted and in force through the end of April 2020. In this regard, there are no scientifically rigorous standards regarding thresholds that represent good value-for-money from a societal perspective (Garber and Phelps 1997). Though current economic evaluation methods recommend evaluating therapies from a societal perspective, most CEA and associated methodologies have currently focussed on single interventions from a payer-perspective (Drummond et al. 2005). Attempting to conduct these forms of analyses outside clinical trial settings is challenging as the impacts to society are wide-ranging with too many unknowns to model effectively (Weatherly et al. 2009). However, if the model is defined by what is known currently, it is possible to perform a high-level analysis using concepts of cost-effectiveness especially given that the cost outlays and health outcomes are defined within a short time window.

In its basic form, cost-effectiveness is a form of analysis that compares the difference of costs and effects between an intervention and baseline standards. The incremental cost-effectiveness ratio (ICER) is therefore defined as follows:

$$\frac{\text{(health costs after intervention - health costs prior to intervention)}}{\text{(health status after intervention - health status prior to intervention)}}$$

In this paper, the intervention is the American pandemic containment measures collectively in place and the changes in premature mortality due to the lockdown – i.e., the difference between years of life lost relative to life expectancy both under the lockdown and without one in place. Given that men and women have different life expectancies, the analysis calculates premature mortality for men and women by age category.

To determine the costs of the intervention – i.e., the numerator in the cost-effectiveness analysis – we used the budgetary costs of the intervention, as the purpose and scope of this work are to quantify the costs outlays of these interventions in order to determine value-for-money to compare with other health care interventions such as advanced medical devices and drugs that use similar methodologies.

In currently accepted cost-effectiveness methods used for decision-making in health care, incremental cost/quality-adjusted life year (QALY) for health care interventions are measured by the difference in the cost of an intervention – e.g., medical technology costs – over different health outcomes. The paper therefore uses this methodology to focus on cost outlays due to these interventions rather than economic costs, including opportunity costs. This enables comparisons to be made vis-à-vis other health care interventions in terms of cost-effectiveness using similar framework and thresholds for value-for-money. In the United States, the GDP equivalent of these fiscal interventions was estimated to be 11% (Danielli et al. 2021).

The economic costs of pandemic interventions are an important area to understand and investigate. Identifying the scope of these costs and quantifying them accurately can itself be a major undertaking, as the effect on the aggregate total economic costs can be second

order, with the potential of distortionary effects of taxation. In addition, the choice of an appropriate measure of economic costs needs to be determined as there are many potential measures of economic activity such as current GDP and Gross National Income, amongst others. During the pandemic years of 2020 and 2021, US quarterly GDP varied only slightly due to the effectiveness of these fiscal stimuli (ranging from US$20 trillion to $23 trillion) (US Bureau of Economic Analysis [BEA] n.d.). Consideration also needs to be given to the impact of the various waves of COVID-19, dynamic changes over time, the geography of various containment measures, and the severity of these measure in place at different time periods.

To calculate the change in life years, it was assumed that the distribution of deaths across society by age categories would have been similar had there been no lockdown compared to what was observed. In these calculations, the midpoint of each age category is taken as the age of all those who died in that category, except an age of 20 years was assigned for the first age bracket and 85 years for the final bracket. These ages were also attributed to the distribution overlaid on the different projections for a no-lockdown scenario. The reduction in life-years lost between the lockdown and no-lockdown scenarios – based on current remaining life-expectancies for males and females – produced the effects due to the lockdown (i.e., life-years gained under the lockdown).

In this regard, there will be a degree of uncertainty estimating baseline projected deaths in the absence of a lockdown and other containment measures. Deaths from previous pandemics range from 50 million from the 1918 Spanish flu pandemic to 400,000 from the most recent global pandemic, the 2009 H1N1 (WHO 2020c). The Imperial College London epidemiologic model used by the UK government estimated that between 2.18 million to 2.78 million deaths would have occurred in the United States (using $R_0 = 3$) in the absence of any containment measures (Ferguson et al. 2020). Another projection from the University of Nebraska Medical Center estimated 480,000 deaths in the absence of any containment measures (Zoellner 2020). These estimates show the large range in potential mortality in the absence of containment strategies. To reflect a wider possible range given the uncertainty in baseline, the number of potential deaths used for baseline projections in the foregoing analysis ranged from 200,000 to three million. The extreme end cases were used to illustrate other possible scenarios, though these were not based on currently published epidemiologic models.

To estimate premature mortality, projections of mortality under lockdown need to be determined alongside the already-discussed projections in the absence of a lockdown. The Institute of Health Metrics and Evaluation (IHME) projections favoured by the Trump administration originally projected 73,433 deaths by 4 August 2020 (IHME 2020). This projection, made at the end of April 2020, did not account for the announced easing of restrictions and assumed social distancing measures remained in place until R_0[1] fell below

[1] R_0 is the measure of reproduction, i.e., the average number of people who will contract COVID-19 from one infected person.

one. This estimate, with the overlay of age-sex category mortality, will be used as a point estimate in estimating mortality experienced under the lockdown. The model has since been modified to project 134,475 deaths by 4 August 2020 to reflect the relaxation of some of the measures in some US states, including the re-opening of certain businesses and public spaces. Since the number of deaths and cases is continually increasing on a daily basis, this model uses a cut-off point of 4 August 2020, when the IHME model suggested that deaths would have plateaued during the then-current wave, had containment measures remained in place.

The largest impact from these pandemic containment strategies was on the economy. Containment measures have resulted in closures of businesses – both small and large corporations – as well as air and land travel. Quantifying the exact costs of the impact on the economy is challenging, given the pandemic is ongoing and its wide scope. The best proxy for costs associated with pandemic containment measures is therefore the costs of the stimulus package that was put forth by the US government in an attempt to minimize the damage to corporations, small businesses, and recently unemployed individuals. While these measures might still be viewed as insufficient, they are currently the best quantifiable proxy for lost economic productivity.

The stimulus package that was put in place on 27 March 2020 totalled approximately US$2 trillion was the largest emergency relief in US history through the *CARES Act* (US Congress 2020a). A further US$484 billion was passed through the *Paycheck Protection Program and Health Care Enhancement Act* (colloquially known as the COVID 3.5 relief package) on 21 April 2020 (US Congress 2020b). This package can be divided by type of recipient, which includes individuals, small businesses, large corporations, local and state governments and various public services including hospitals, food banks, stockpiled equipment, child nutrition, and veterans (Figure 1). The package also included the one-time US$1,200 cash payment to all qualified Americans, which technically represented a tax credit to offset future income taxes (US Congress 2020a and 2020b). The proportional breakdown of the stimulus package is illustrated in Figure 1.

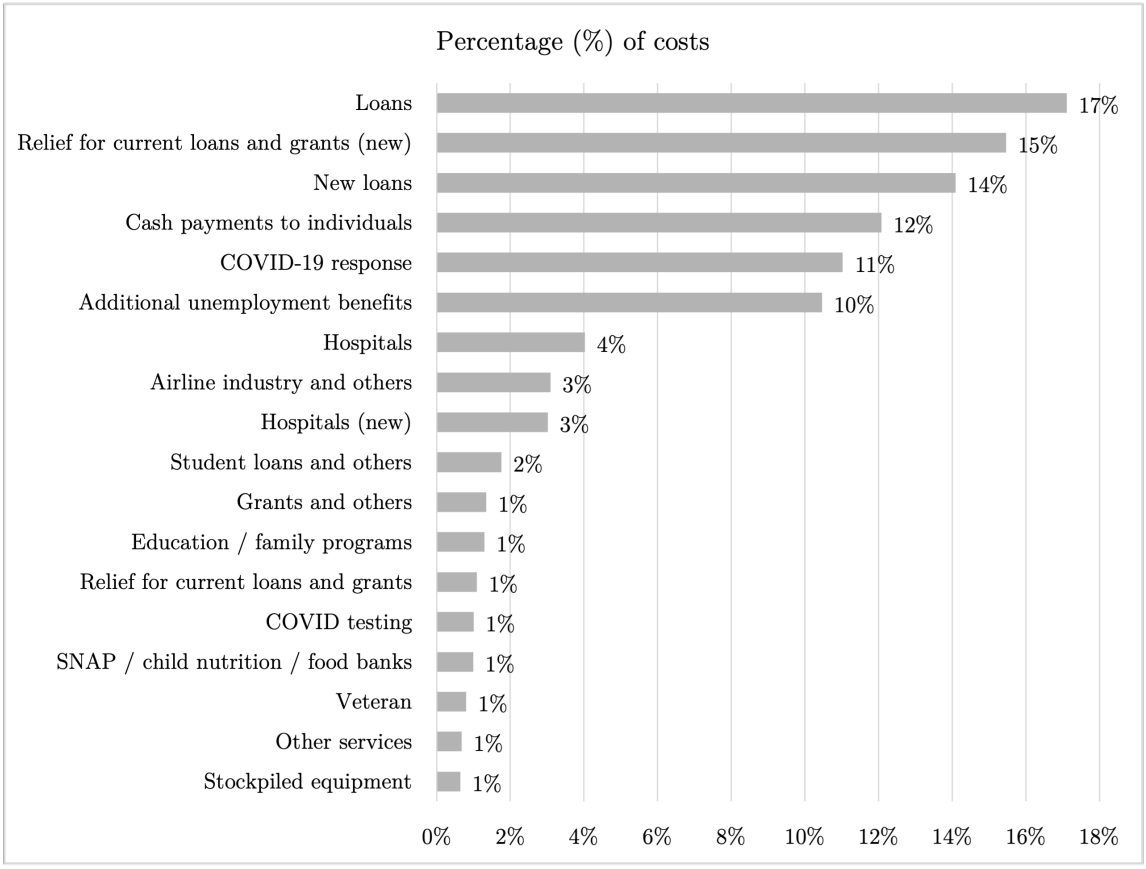

Figure 1: Categories for the combined stimulus package
(*CARES Act* 2020 and COVID 3.5)

Source: US Congress (2020a and 2020b)

Mortality data shows the age distribution of pandemic-associated decedents (Table 2) with a gender distribution of 56.6% male to 43.4% female. The gradient of mortality shows that decedents have primarily fallen in the age 65+ category, with a higher proportion of deaths amongst younger males (NCHS 2020).

Table 2: Demographic distribution at death due to COVID-19

Age (years)	**<1-24**	**25-34**	**35-44**	**45-54**	**55-64**	**65-74**	**75-84**	**>=85**
Male (56.6%)	0.16	0.91	2.42	6.58	14.92	24.01	27.54	23.45
Female (43.4%)	0.10	0.52	1.21	3.34	9.50	18.11	27.06	40.16
All	0.14	0.75	1.90	5.17	12.57	21.45	27.33	30.71

Source: US Congress (2020a and 2020b)

Using these data, we obtain high-level estimates for the cost per LYG based on seven different scenarios with different death projections (Table 3). The results show seven different scenarios that reflect different death projection ranges for the baseline case. The life-years gained from the baseline without containment measures is also shown in the table. The results show that, as the projected number of deaths without restrictions increases, the cost-effectiveness of the containment measures becomes more favourable, i.e., providing better value-for-money for US taxpayers. With cost-effectiveness ranging from US$180,874 per LYG for the high-end projection to US$4,258,780 per LYG for the low-end death projection estimate.

Table 3: Incremental cost per LYG
(Costs set at US$2.48 trillion: cost of the US stimulus package)

Scenarios	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**	**Scenario 6**	**Scenario 7**
Projected deaths	200,000	480,000	750,000	1,000,000	2,180,000	2,780,000	3,000,000
Δ LYG	583,266	1,863,490	3,178,487	4,241,050	9,655,154	12,379,916	13,733,304
Incremental costs / LYG	$4,258,780	$1,332,983	$781,504	$585,704	$257,006	$200,648	$180,874

Note: ΔLYG = change in life-years gained.

The most commonly utilized cost-effectiveness threshold in the US is $50,000, which was the cost-effectiveness of end-stage renal disease that was publicly reimbursed by Medicare in the 1970s (Neumann, Cohen, and Weinstein 2014). Inflating this amount to present times would imply a threshold of US$150,000, which is currently used to set a value-based price in many cases (Neumann, Cohen, and Weinstein 2014). Thresholds of up to US$500,000

have also been referenced for rare diseases (Garrison et al. 2019). Outside the health sector, thresholds may also be substantially higher (Bennan 2016; Hirth 2000).

Using the conventional threshold of US$150,000/LYG in the health care sector to establish favourable cost-effectiveness profiles, the results shown in Table 3 indicate that the lockdown measures were not cost-effective and hence did not represent good value-for-money. This claim is made by comparing the economic lockdown to both health care interventions and to the number of LYG if the estimated number of deaths in the absence of containment measures remained below the high-end estimate of three million. However, experiences in sectors outside of health care should also be considered to make more definitive statements regarding value-for-money of the lockdown.

2.2 Implementation and evaluation

This paper helps to frame the advisability of whether a large economic stabilization program in the wake of a pandemic – such as COVID-19 – represents good value-for-money. Rather than simply looking at the number of lives saved in comparison to what might be predicted in the absence of the lockdown, the framework attempts to compare the cost of the economic stabilization interventions in relation to the number of LYG. For example, a study in California suggests that the state's shelter-in-place orders averted 1.4 COVID-19-related deaths per 100,000 population, resulting in 763 fewer deaths by 20 April 2020 for that state; yet the authors provide no standardized way to compare these results with other initiatives that save lives (Friedson et al. 2020). The hope is that the evaluation undertaken here will add another angle by which to evaluate the success of this enormous undertaking when all the data have been compiled.

While widely used conventional cost-effectiveness thresholds in the health care sector suggest that containment strategies did not represent good value-for-money in the United States, there is an alternative published literature in the value of a statistical life (VSL) or the value of a statistical life year (VSLY). The VSL is a measure of a policy-maker's willingness-to-sacrifice/pay for a small reduction in risk that reduces the number of fatalities by one. As such, the VSL is a valuation of anticipated mortality risk reductions rather than the valuation of a life per se (Treasury Board of Canada Secretariat 2022). The VSLY just extends this framework to examine the valuation of preventing a year of premature mortality – mortality prior to life expectancy. There is a nuanced difference between cost-effectiveness measures such as the cost per QALY and the VSLY, with the former reflecting the replacement cost of an intervention rather than the willingness-to-sacrifice or willingness-to-pay, which may exceed the market price or cost-of-replacement. As a result, interventions dubbed worthwhile when considered in a VSLY framework often have valuations above the thresholds established for cost-effectiveness analyses.

The measured valuation regarding both the VSL and VSLY frameworks largely depends on the sector, with space exploration venues placing extremely high values on risk reductions that preserve life at the level of millions of dollars per life-year to guarantee

the safe return of astronauts (Brennan 2016). More earth-bound estimates from 35 studies associated with heightened job-risks produce median thresholds of VSLY equivalent to US$428,000/QALY (Hirth 2000). Environmental health protection such as the Superfund Program valuate VSLYs equivalent to over US$1 million/QALY. Even higher rates are used by the Consumer Product Safety Commission, which applies a value-per-statistical-life of US$8.7 million (2014 figures) and US$9.6 million (2016 figures) at the US Department of Transportation (CPSC 2018; USDOT 2016). Thus, from the perspective of VSLY, it is entirely possible that the cost-effectiveness profile of the lockdown in the United States was indeed favourable relative to VSLY estimates outside the health sector. Conversely, it might not be possible to say anything conclusive about whether the containment measures and stimulus package were worthwhile, because these measures are often driven by a variety of concerns specific to a particular sector like the level of public visibility, not just the value of lives.

There is also a factor to consider that valuations may differ in times of worldwide emergency like a pandemic from other times in history. There is reason to think that the threshold of US$10 million currently used for VSL is too high with regard to government interventions that affect environmental, health, and safety risks (Robinson et al. 2019). This is especially true when considering that large reductions in income occur alongside widespread mortality among the elderly during pandemics (Hammitt 2020).

In the Canadian context, the VSL was first estimated for public sector decision-making at C$5.2 million as of 1983 with further updates suggesting that this value is now over C$6 million with a VSLY of at least C$276,000 (Meng and Smith 1990; Chestnut and De Civita 2009; Quigley 2018). This is consistent with comparisons made between the United States and Canada in terms of VSL suggesting that Canadian figures are approximately 30-40% lower than VSL values calculated for the United States (Alberini et al. 2009).

There is also evidence that the lockdown may have produced a net cost savings to society rather than involving a trade-off of dollars for lives saved. Nationally, it is estimated that Americans who contract COVID-19 over age 60 could lose an average between 153 and 222 days of life expectancy while those under 40 would lose an average of two weeks, with the total value of statistical lives lost without containment measures in place of between US$8 to US$60 trillion (Wilson 2020). If the estimates of the stimulus package of US$2.48 trillion stand as a good proxy for the costs of the lockdown, then it would appear that this initiative actually produced at least US$5.5 trillion in savings, along with at least 583,000 life-years gained (Table 3); that is, there was not an actual trade-off but a net actual cost savings to society from saving lives. This result is consistent with the results of a recent draft working paper that estimated US$5 trillion in net benefits from current containment initiatives (Thunstrom et al. 2020).

Given both the highly contagious nature of COVID-19 and limits on testing for the virus, the low-end estimate for the total number of deaths may be a vast underestimate with many COVID-19 decedents remaining unidentified; conversely, the high-end estimates may be overestimated as COVID-19 – when listed as a comorbidity – is normally listed as a

COVID-19 death. In addition, beyond the cost of the stimulus package, there may be other cost considerations that include additional investments made by the US federal government not contained in the stimulus package, investments and assistance made by state and municipal governments, non-profit organizations, charitable groups including food banks, other financial investments made directly by corporations, the deployment of the military to build temporary hospitals and other services-in-kind, as well as charitable funding from foundations and private citizens. The analysis also does not take into account the decreases in quality-of-life and morbidity associated with hospitalizations and shelter-in-place orders that likely extend well beyond the time perspective of this analysis and involve extensive often-unmeasured costs to the health care system, particularly near the end of life (Dao, Godbout, and Fortin 2014). There are other ramifications, including mental and physical sequalae, including benefits and costs associated with short- and long-term behavioural changes associated with pandemic shock. Lastly, there is a large degree of uncertainty on the range of death forecasts without a lockdown with an associated wide range of subsequent impacts upon society.

2.3 Implications for Canada

To put this in context, in Canada, as of 10 March 2023, there were approximately 4.6 million reported cases and 51,720 deaths (JHU CSSE COVID-19 Data). Canada also had a similar trajectory in terms of imposing early mitigating policies at the onset of COVID-19. The provision of health care is mostly the responsibility of provinces and territories, hence the federal government focussed mainly on areas that were within its jurisdiction, including restrictions on international travel and border controls. This included mandating the use of the ArriveCan app for all travellers entering Canada and the requirement for all travellers, including fully vaccinated Canadians, to show a negative molecular test (such as the PCR test) done within seventy-two hours of departure flight time, random testing of passengers at arrival and imposing quarantine and stay-at-home orders for travellers. Canada began containment measures on 22 January 2020, when the federal government implemented screening requirements for travellers returning from China. It then expanded screening requirements for travellers returning from affected areas to ten specific airports, and travellers were advised to self-isolate for 14 days. On 18 March 2020, Canada implemented a ban on foreign nationals from all countries and closed the Canada-US border to all non-essential travel. Canada ended all COVID-19 travel restrictions as of 1 October 2022, including no longer needing to show proof of COVID-19 vaccination (which the United States still maintains for international travellers entering the country).

Other areas of federal jurisdiction include vaccine procurement and distribution and additional employment insurance for the newly unemployed due to the lockdown policies. The federal government also initiated Canada's economic stimulus package in response to the pandemic, similar to the US federal government.

The containment measures put in place by provinces and territories included physical

distancing, and the closure of all non-essential businesses and educational institutions. This resulted in massive shrinkage of the economy, including a decrease in manufacturing sales by 9.2% in March, the lowest level since 2016 (Statistics Canada 2020).

The COVID-19 Economic Response Plan was put forward on 18 March 2020 to counteract these economic impacts. By 16 April 2020, the federal government introduced the Canada Emergency Response Benefit, which provided a monthly stipend of C$2,000 to all individuals who were laid off from their jobs due to the pandemic. This program ran until September 2020 and then transitioned to the Emergency Wage Subsidy program.

While a comparison of costs and life-years saved for the American stimulus package is analytically possible, the paucity of reliable age-sex category mortality for COVID-19 in Canada makes it only possible to surmise the value-for-money in Canada based on an analysis of the American package.

In Canada, cost-effectiveness is a consideration in, though not determinative of, decision-making. Given that the Canadian health care system provides universal coverage under a single-payer publicly funded system for hospital and physician services as well as some prescription drug services, decisions based on trade-offs are often made given limits on resources available. Further, decisions regarding initiatives in other sectors are also often subject to the lens of cost-effectiveness, including the area of consumer safety and environmental concerns. The findings from the US (from its *CARES Act* package) contained herein can help set out a framework to perform a similar analysis to determine if the current Canadian economic stimulus package is good value-for-money (Craig 2020; PBO 2020). While this paper is not intended to develop a full comparative framework, this is an area for future consideration.

Canada has been using dynamic epidemiological models to predict how the pandemic unfolded over time. The federal government refers to a model developed by the Public Health Agency of Canada to help inform policy. The model shows that, in the absence of a containment strategy, the projected number of deaths will fall between 311,000 to 355,000 deaths due to the COVID-19 pandemic (Government of Canada 2020). This projection is similar to figures provided by Imperial College London showing 321,565 projected deaths (R_0=3) for Canada under a similar scenario (Ferguson et al. 2020). The latest publicly released figures by the Canadian government at the end of April 2020 showed that, with containment measures in place, the curve would have flattened at 3,883 deaths by 5 May 2020 – a figure that has since been surpassed (Government of Canada 2020). Further, age and sex information for those dying of COVID-19 is incomplete (Cardoso and Weeks 2020). Without these critical publicly available data, it is challenging to conduct similar evidence-based analysis for Canada.

For the purpose of comparing the particulars of the different stimulus packages between the United States and Canada, Appendix 1 provides the particular line items of the Canadian stimulus package. The package totalled approximately C$146 billion over two years, and it contrasts with the *CARES Act* package, by providing more targeted funding and support to individuals, businesses, specific industries, organizations that help individuals,

and to provinces and territories. It is of a similar magnitude relative to national GDP figures for both countries. Yet, with half the case counts and deaths per 100,000 population in comparison to the United States – owing perhaps to higher levels of adherence to social spacing guidelines and staying-at-home – the lockdown in Canada is likely to have produced larger gains in life-years per 100,000 population than in the United States. As a result, the cost-effectiveness of the stimulus package could be ostensibly more favourable than what was calculated in this paper for the United States (WHO 2020b; Google 2020; Leger 2020).

As the R_0 trends downward and more high-quality data becomes available for each jurisdiction, it may be possible to conduct future research that focuses on the development of a population-based, long-term cost-effectiveness analysis from a societal perspective for Canada. A comprehensive analysis will enable the capture of both direct and indirect downstream costs including potential mortality effects of the economic downturn, health outcomes including mental health and quality of life (Ariizumi and Schirle 2012) and the impacts of long COVID. Such forms of analysis can determine whether the sweeping containment measures put in place in Canada resulting in the economic downturn were either sufficient or too broad to achieve optimal value-for-money.

The analysis of the *CARES Act* shows the need for similar real-time data including epidemiological models' projections and assumptions used by Public Health of Canada to recommend containment strategies to be made public. Similar to the United States, Canada did not have a national mandate, but residents were advised to voluntarily stay at home except for needed essential services. Provinces and territories put in place restrictions on public gatherings, travel, visitation to long-term care homes, and closed all educational institutions and government offices and public venues (Unruh et al. 2022).

The transparency and availability of detailed data on COVID-19 mortality and epidemiologic model projections of deaths and cases in Canada would have enabled researchers to go further. They could have performed trade-off analyses and provided real-time input into the development of containment strategies incorporating economic impacts as well as the individuals and businesses affected by the lockdown. This would have enabled a more systematic approach to implement containment strategies tailored to specific populations, geographic areas and time periods. The ability to conduct trade-off analysis can also help design a cost-effective stimulus package that can mitigate the damage to the economy as well as curtail the spread of COVID-19.

In the end, this analysis is focussed on the short-term and therefore not all costs and effects are included in this analysis. The larger question is whether the magnitude of missing effects is larger than the magnitude of missing costs or vice versa. If the former, then it might be possible that the true value-for-money of the stimulus package might be substantially more favourable than what this analysis shows; however, if the latter is true, then the cost-effectiveness profile of the stimulus package may be even more unfavourable than what has been presented.

The economic stimulus package under the US *CARES Act* (2020) and the subsequent US *Paycheck Protection Program and Health Care Enhancement Act* (2020) is unprecedented in

terms of its magnitude, suggesting that the US lockdown was also unprecedented in terms of its cost to the US economy. There are a variety of ways to justify the US lockdown, not least of which was to avoid overwhelming the US hospital sector, which experienced significant pressures in March and April 2020. Other measures of justification are also warranted, based on trying to compare the costs with the benefits in terms of life-years gained from the lockdown compared to a scenario of no containment efforts.

Ultimately, VSL and VSLY are most useful when analyzing a single intervention rather than a collection of interventions. Each of these interventions likely has a separate VSLY with the average VSLY possibly not representing any single intervention in the package. Thus, judgments based on whether the lockdown was worthwhile have a degree of uncertainty attached to them.

Based on these concerns, it is unclear whether the lockdown was a worthy endeavour, depending on whether the lockdown was compared to interventions in the health sector or provisions that have been put in place to protect human life outside this sector. Given the wide-ranging impacts that this pandemic has had on American life, it would seem that the comparisons should be made to experiences in multiple sectors rather than just the health sector, and on this basis, it could be the case that the lockdown may represent good value-for-money if it can be assumed that the VSLY of the different COVID-19 initiatives are similar in value and that the pandemic, in itself, has not substantially lowered VSLY valuations.

In addition, the determination of economic costs is a complex area of investigation that would require identification and quantification of costs at the macro-level from these fiscal interventions. Previous attempts have been made to quantify economic costs at the federal level for other interventions, but key issues have been noted, including the lack of required empirical data (Moodie et al. 2013). For these interventions, the impact of risk-averse behaviour when containment measures are removed – e.g., people avoiding restaurants or theatres – might also need to be considered. In addition, rapidly changing global factors can impact economic costs, such as the supply-chain disruptions that occurred during the pandemic.

Future research in this area may want to focus on identifying the best measures to quantify accurately economic costs due to these fiscal interventions, filling an important missing gap in the literature. This also involves the need to detangle the impacts of different external factors on these costs, considering the nuance of the different waves of the pandemic and the impact of variations in containment strategies in place at different times throughout the pandemic. These include those at the federal, state, and municipal levels as different waves of COVID-19 and its variants have impacted these containment strategies during the course of the pandemic.

In conclusion, a trade-off analysis that considers impacts on both public health and the economy would have helped in the design of effective and targeted containment strategies and ensured that the value and scope of the stimulus packages were comparable to other policy interventions that the government put forth over time. Better publicly available

real-time mortality data alongside assumptions and data used in epidemiological models by Canadian federal public health authorities would make such an analysis possible. It could have enabled recommendations regarding the design of containment measures that were more targeted and focussed. These recommendations might have included a consideration of dynamic changes to the containment measures to take into account impacts and trade-offs on both public health and the economy simultaneously.

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4 Appendix 1: Costs of stimulus package in Canada

Category	**2019-2020 (C$ millions)**	**2020-2021 (C$ millions)**
At home on the land initiative	-	3
Additional international assistance	-	110
Additional lending capacity for Farm Credit Canada	-	-96
COVID response fund: funding for provinces and territories	500	-
COVID response fund: immediate public health response	25	25
COVID response fund: initial funding to the WHO	-	2
COVID response fund: international assistance	-	50
COVID response fund: investing in research	-	275
COVID response fund: personal protective equipment	-	50
COVID response fund: repatriation of Canadians	-	7
COVID response fund: sustained communications and public education	-	50
COVID response fund: funding for preparedness in First Nations and Inuit communities	-	100
COVID response fund: work sharing program	-	125
Canada emergency business account	-	9,106
Canada Emergency Response Benefit	-	35,471
Canada Emergency Wage Subsidy	-	75,975
Canada Student Emergency Benefit	-	5,250
Canada student loan payments	-	159
Canada student loans	-	1,296
Canada student service grant	-	912
Canadian agricultural partnership	-	1
Co-lending program for small and medium-sized enterprises	-	-389
Deferral of sales tax remittance and customs duty payments until June	-	92
Emergency community support fund	-	350

Category	**2019-2020 (C$ millions)**	**2020-2021 (C$ millions)**
Emergency support fund for cultural, heritage, and sports organizations	-	500
Emissions reduction fund for the oil and gas sector	-	94
Enhanced Canada child benefit	-	1,900
Enhanced GST credit	-	5,665
Extended deadlines to file income tax returns and pay income taxes	-	634
Funding for food banks and local food organizations	25	75
Funding for food system firms that hire temporary foreign workers	-	50
Funding for Indigenous businesses and Aboriginal financial institutions	-	307
Funding for orphan and inactive oil and gas wells clean-up, Alberta Orphan Well Association	-	-
Funding for orphan and inactive oil and gas wells clean-up, Government of Alberta	-	1,000
Funding for orphan and inactive oil and gas wells clean-up, Government of British Columbia	-	120
Funding for orphan and inactive oil and gas wells clean-up, Government of Saskatchewan	-	400
Funding for personal protective equipment and supplies	200	1,800
Funding for seniors (United Way Canada)	9	-
Funding for women's shelters and sexual assault centres	-	50
Funding for the air transport sector	14	123
Funding for the community futures network	-	287
Funding to Digital Citizen Initiative's digital citizen contribution program	-	3
Funding to Futurepreneur Canada	-	20
Funding to Nutrition North Canada	-	25
Funding to regional development agencies	-	675
Funding to the Canada Food Inspection Agency	-	20

Category	**2019-2020 (C$ millions)**	**2020-2021 (C$ millions)**
Funding to the Industrial Research Assistance Program	-	250
Funding to the Reaching Home Initiative	-	158
Indigenous community support fund	-	305
Insured Mortgage Purchase Program	-13	-428
Loan guarantee program for small and medium-sized enterprises	-	-3
Lower RRIF minimum withdrawal	-	505
Mental health funding for children and youth (Kids Help Phone)	-	8
National medical and research strategy to combat COVID-19	-	822
Non-repayable support for businesses in the territories	-	15
Temporary business wage subsidy	-	844
Transfers to territorial governments to support health and social services	-	73
Transfers to territorial governments to support northern air carriers	-	17
Waiving Part I broadcasting licence fees and providing equivalent funding to CRTC	-	33
Youth employment and skills development programs	-	728
Total	**760**	**145,997**

Source: PBO (2020)