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Hyperbolic Discounting and COVID-19 Policy Responses

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Abstract

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Keywords

hyperbolic discounting, time preferences, behavioral economics, public policy

Disciplines

Behavioral Economics | Health Policy | Public Policy

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Abstract

Traditional economic theory assumes that policymakers are rational. However, one bias that policymakers may exhibit is hyperbolic discounting, particularly in health and environmental policy. This paper investigated whether a correlation between hyperbolic discounting and COVID-19 policy responses existed. Results showed that rational discounting and hyperbolic discounting both explain the stringency of policy responses across the world, although this effect was not driven by any specific policies. Further research is needed to determine the mechanism behind the relationship.

Introduction

Traditional economic theory assumes that policymakers are rational. Theoretically, they carefully and perfectly weigh costs and benefits. However, evidence from behavioral political economy suggests that policymakers, like other people, are subject to behavioral influences. For example, politicians use heuristics like “starve the beast” to justify tax cuts (Kuehnhanss 2015). Behavioral biases extend beyond politicians. Because they lack external feedback to learn from their mistakes, bureaucrats are also subject to behavioral biases (Cooper and Kovacic 2012).

One bias that policymakers may exhibit is hyperbolic discounting. In theory, discount rates should increase exponentially over time. Hyperbolic discounting is a time-inconsistent model of delay discounting (Rasmusen 2008). Broadly, hyperbolic discounting is an irrational discount on the future. It implies that preferences change as the time period approaches (Rasmusen 2008). In practice, this bias means that people favor short-term gains that entail long-term losses (Gintis 2000). Hyperbolic discounting originally received its name since discount rates as a function of time were hyperbolic instead of exponential. However, the name has since been extended to generally cover non-exponential discounting.

Hyperbolic discounting appears cross-culturally; survey evidence found hyperbolic discounting patterns in 53 countries (Wang et al 2016). The same study found that after controlling for economic factors, Hofstede’s cultural factors including lower levels of uncertainty avoidance, higher levels of individualism, and higher degrees of long-term orientation correlated with less hyperbolic discounting. In the study, less hyperbolic discounting also correlated with positive policy outcomes. After controlling for economic factors, less hyperbolic discounting was associated with more innovation, increased environmental protection, higher credit ratings, and lower body mass index.

Clearly, hyperbolic discounting correlates with policy outcomes. Other studies have more directly tied policy outcomes with hyperbolic discounting. This effect is clearest in environmental policy. To control climate change and maintain natural resources, policymakers must commit to policies that involve short-term costs and long-term benefits. For example, regulating the stock of a natural resource, like fish, requires upfront costs for the future benefit of a plentiful stock. Because of hyperbolic discounting, however, policymakers struggle to enact effective climate policy. Hepburn et al (2010) found that if a planner cannot commit to a policy, future re-evaluation of the policy could lead to a collapse in the stock of a natural resource. Winkler (2006) showed that weak progress in reducing greenhouse gas emissions under the Kyoto protocol could be linked to time-inconsistent preferences.

Lawless et al (2013) also link health policy outcomes to hyperbolic discounting. In health policy, high discount rates can lead to government prioritization of acute, rather than preventative, care. Lower discount rates in a country, as measured by personal savings, correlate with obesity rates.

This investigation aims to extend the existing literature between hyperbolic discounting and government policy. In particular, it will delve into the relationship between levels of hyperbolic discounting internationally and COVID-19 policy responses.

COVID-19 Policy

In response to the COVID-19 pandemic, governments around the world took unprecedented actions to control the spread of the disease. Although the pandemic affected nearly every aspect of life, several areas were particularly changed. First, schools around the world shut down to reduce the spread of the disease. By March 18, half of students were not attending school, a figure that amounted to approximately 862 million people (Viner et al 2020). Similarly, workplaces across the world closed. Additionally, public events, such as concerts and sporting events, were cancelled. Private gatherings were also limited or banned entirely and stay-at-home requirements were instituted. Finally, to enforce limited movement, policymakers restricted internal movement and international travel.

Coronavirus policies, like other policies, involved both short-term and long-term costs and benefits. According to Gros et al., strict policies, those with high short term costs, lead to better health and economic outcomes than hands-off policies. Additionally, strategies formulated in response to case numbers, rather than the epidemic's history, lead to better outcomes. However, because the benefits are in the future and the costs are in the present, policymakers may have been subject to hyperbolic discounting when formulating coronavirus response policy.

School Closures

For school closure policies, the benefits and costs fall into three main categories: health impacts, economic impacts, and educational impacts. The clearest effect is loss of education.

The baseline cost per student due to loss of education was estimated to be $142 per student per week (Lempel et al 2009).

As far as health impacts, school closures have mixed effects. During the swine flu epidemic, closures reduced disease transmission (Mangtani 2014). Another study found that school closures reduced the peak of flu transmission by 29.7% and delayed the peak by 11 days (Nafisah, Sharafaldeen Bin, et al 2018). However, school closures may also worsen health outcomes. Transmission may increase within families (Viner et al 2020). Schools also play an important role in healthcare delivery and nutrition for low-income students (Viner et al 2020). School closures may worsen existing socioeconomic healthcare disparities.

The economic impacts stem from children preventing adults from working. For one, when schools are closed, less healthcare workers are available due to childcare demands (Viner et al 2020). According to Sadique et al, 16% of the British workforce are primary caregivers for children, a level which rises to 30% of health and social care workers. In the US, 29% of healthcare workers face child care obligations (Bayham and Fenichel 2020). A Brookings study found that absenteeism due to school closure in the US would lead to a base estimate of $21.3 billion in economic costs for two weeks, $42.6 billion for 4 weeks, $63.9 billion for 6 weeks, and $127.8 billion for 12 weeks (Lempel et al 2009). In Taiwan, a study found that a one-week school closure led to 27% of families being unable to work in 2009 (Chen et al 2011). If schools are closed, workers with children face a high risk of absenteeism. However, these concerns may be mitigated by the rapid switch to work-from-home.

As far as hyperbolic discounting, the benefit of school closures, a lower peak and quicker return to normal life, lies in the future. However, the costs, such as lost worker productivity and education, lie in the present. Therefore, school closures may correlate with higher levels of hyperbolic discounting.

Stay-At-Home Requirements

Stay-at-home requirements ensure that people only leave the home for essential reasons. They reduce disease transmission, economic activity, and affect health more broadly. One study estimated that stay-at-home orders reduce both disease transmission and economic activity by 5-10% (Allcott et al 2020). However, the same study found that the ratio of health benefits to economic impacts is similar for mandated and voluntary social distancing (Allcott et al 2020).

As far as economic impacts, stay-at-home orders cost significantly more than other public health measures. The United Kingdom recommends medical interventions that cost less than £30,000 per quality-adjusted life year. However, one study estimated that the cost per quality-adjusted life year of stay-at-home orders is about £400,000 (Gøtzsche 2020).

Broader health impacts include mental health and less non-coronavirus-related treatments. As far as mental health, government-ordered lockdowns in Europe and the US have significantly increased Google searches of boredom, loneliness, worry, and sadness (Brodeur et al 2020). Additionally, suicides and infant head trauma increase in periods of economic distress (Gøtzsche 2020). Stay-at-home requirements have also led people with other conditions, such as strokes and heart attacks, to not seek treatment (Gøtzsche 2020).

Like with school closures, the benefits of stay-at-home requirements, a lower peak and quicker return to normal life, lie in the future. However, the costs, such as mental health and economic distress, lie in the present. Therefore, strictness stay-at-home requirements may correlate with increased levels of hyperbolic discounting.

International Travel Controls

International travel controls slow disease spread at an economic cost. The primary benefit is more time to prepare for the arrival of the disease. Before the COVID-19 pandemic, the scientific consensus was that travel bans were “detrimental and ineffective” in stopping disease (Nuttall 2014). Scientists assumed that people desperate to see friends and family or seek better opportunities would travel regardless of bans. For the COVID-19 pandemic, the travel bans also failed to contain the pandemic (Wells et al 2020), but they did slow the spread of the disease. For example, Chinese travel restrictions during the first 3.5 weeks of their implementation decreased the daily rate of exportation by 81.3% (Wells et al 2020).

From an economic standpoint, travel bans decrease productivity in a similar way to a temporary fall in employment (Baldwin and Mauro 2020). One study found that stopping cross-border travel would cause a major disruption of economic activity in the EU (Barua 2020). International travel controls could be subject to hyperbolic discounting because they involve high short-term costs, principally less economic activity, for low future benefits, including more time to prepare for the arrival of the disease. Countries with high rational discount rates may also be more likely to institute travel bans because they value the future benefit of time to prepare more than the short-term economic impacts.

Methodology

To measure hyperbolic discounting, data was used from Wang et al's 2016 estimates of mean β, or degrees of present bias. This study surveyed economics students in 53 countries. Respondents were asked to choose between three hypothetical questions measuring time preferences. The researchers then calculated β for each country using a quasi-hyperbolic discounting model, where δ is the rational discount rate and F is future value.

$$\beta = \frac{100}{\delta F_{1year}}$$

To measure the strength of policy responses, data was used from Our World in Data's Policy Responses to the Coronavirus Pandemic dataset (Roser et al 2020). The September 21st version, which included dates from 12/31/2019 to 9/21/2020, was used. Each observation encodes the severity of the pandemic in a certain country on a given date. After removing observations of countries not listed in Wang's dataset and incomplete observations, this left 5447 observations. To measure stringency of policy restrictions, the dependent variable was stringency index, a measure developed by Oxford University researchers. The index aggregates publicly available data about eight indicators of government responses including: school closures, workplaces closures, cancelation of public events, restrictions on gatherings, closure of public transit, stay-at-home requirements, restrictions on internal movement, and international travel controls. These policy indicators are aggregated into a number between 1 and 100, with 100 representing the strictest possible response ("Codebook for the Oxford Covid-19 Government Response Tracker").

Data was fitted to a linear regression model. Standard errors were clustered by country. Results from the analysis are listed below.

Results

Stringency Index

	Estimate	**Std. Error**	**t value**	**Pr(>|t|)**
(Intercept)	1,473.6	1,797.1	0.82	0.4123
date_value	-0.0298	0.0408	-0.7319	0.4642
new_cases_smoothed_per_million	-0.0858 .	0.0441	-1.9472	0.0516
new_deaths_smoothed_per_million	0.9514	0.6277	1.5157	0.1297
total_cases_per_million	0.0023***	0.0004	6.4524	0.0000
total_deaths_per_million	0.0017	0.0086	0.1961	0.8445
new_tests_smoothed_per_thousand	19.5890***	3.8364	5.1060	0.0000
total_tests_per_thousand	-0.2577***	0.0528	-4.8801	0.0000
positive_rate	83.4710**	29.0890	2.8695	0.0041
mean_discount	28.5950*	12.7580	2.2414	0.0250
mean_beta	-154.9200*	72.0310	-2.1508	0.0315

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Results show a statistically-significant correlation between mean beta and stringency index, as well as mean discount rate and stringency index. In particular, this result means that a

1% increase in mean beta correlates with a 1.54 decrease in stringency index. It also means that a 1% increase in mean discount rate correlates with a 0.29 increase in stringency index.

The negative correlation between mean beta and stringency index means that higher levels of hyperbolic discounting correlate with lower levels of restrictions, even after controlling for pandemic severity and date. This result supports the idea that irrational policymakers may not be appropriately valuing the future benefit of restrictions.

The positive correlation between mean discount rate and stringency index means that higher discount rates correlate with higher levels of restrictions, even after controlling for pandemic severity and date. This result supports the idea that rational policymakers appropriately value the future, since they are willing to sacrifice current freedoms for future benefits.

Specific Indicators

To understand which indicators drove the hyperbolic discounting, correlations between each of the specific variables and hyperbolic discounting were also explored. Each variable was measured on an ordinal scale from 0 to 3 or an ordinal scale from 0 to 3. Detailed descriptions of each variable are found in Appendix 1. The data was used from Oxford University's 9/21/2020 version of their COVID policy responses dataset. Confirmed cases and confirmed deaths were standardized.

Parameter Estimates (Standard Error)	Explanatory Variables		Control Variables		
	Mean Beta	Mean Discount Rate	Confirmed Cases	Confirmed Deaths	Date
C1_School	-5.2440000	0.2707700	-0.0000006**	0.0000193***	0.0024307***

closing					
	(3.4120000)	(0.6583500)	(0.0000002)	(0.0000051)	(0.0005729)
C2_Workplace closing	-0.2105100	0.0795000	-0.0000005 .	0.0000180 **	0.0015364 ***
	(2.6681000)	(0.2983000)	(0.0000003)	(0.0000057)	(0.0000992)
C3_Cancel public events	-1.2744000	-0.0602460	-0.0000003***	0.0000130***	0.0015978***
	(1.6381000)	(0.2612600)	(0.0000001)	(0.0000029)	(0.0001185)
C4_Restrictions on gatherings	-2.9619000	0.2112400	-0.0000006	0.0000235*	0.0032096***
	(3.2766000)	(0.3489800)	(0.0000004)	(0.0000110)	(0.0001371)
C5_Close public transport	-2.5596000	0.1311000	-0.0000002	0.0000073	0.0006578***
	(1.8225000)	(0.2458800)	(0.0000002)	(0.0000054)	(0.0001051)
C6_Stay at home requirements	-2.7918000	-0.1740700	0.0000000	0.0000041	0.0010243***
	(3.3223000)	(0.4238600)	(0.0000003)	(0.0000079)	(0.0001935)
C7_Restrictions on internal movement	-1.3375000	0.1867300	-0.0000002	0.0000099	0.0012147***
	(2.0237000)	(0.2964400)	(0.0000002)	(0.0000059)	(0.0002101)
C8_International travel controls	-3.8632000	0.3124800	0.0000005	-0.0000151	2.2970000***
	(3.8384000)	(0.5857500)	(0.0000005)	(0.0000137)	(0.0002598)

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Results showed that mean beta did not significantly explain any variable. An increase in hyperbolic discounting rates did not correlate with a change in restrictions. Analysis also showed that mean discount rate did not significantly explain any variables meaning that higher value placed on the future did not correlate with more restrictions in the present.

Conclusion

Hyperbolic discounting is a nearly-universal behavioral bias. Prior research has found that the bias affects policymakers, especially when making decisions with long-term benefits and short-term costs. This investigation sought to extend the literature into the domain of pandemic response. In particular, it investigated the correlations between rational and irrational (hyperbolic) discounting and coronavirus policy restrictions.

The investigation found that stringency index, a metric developed by Oxford University researchers, significantly correlated with mean discount rate and mean beta in any given country. The inverse relationship between mean beta and stringency index suggests that hyperbolic policymakers created less-restrictive coronavirus policy. This results supports the idea that hyperbolic policymakers struggle to enact policies with short-term costs and long-term benefits, such as school closures and international travel controls. The positive relationship between mean discount rate and stringency rate suggests that policymakers who value the future more highly instituted stricter restrictions. The correlations between both mean beta and mean discount rate were not driven by any particular indicator.

However, this investigation faced significant limitations. In particular, hyperbolic discounting and rational discount rates strongly correlate with other factors such as Human Development Index, gross domestic product per capita, and Hofstede's cultural dimensions (Wang et al 2016). Further research is necessary to determine whether hyperbolic discounting caused more short-term policies to be enacted, or if other factors were the cause. More research is also needed to determine why the overall stringency index significantly correlated with mean beta and mean discount rate, but no particular factor drove the correlation.

Additionally, the discount rates used in this study only covered 53 countries . Furthermore, the samples from which the researchers imputed discount rates were largely university students, so their external validity is limited (Wang et al 2016). Further research is needed to impute more accurate discount rates for various countries.

Overall, however, this investigation shows that public policies, like other domains, are subject to behavioral biases. As far as social impact, policymakers should be aware of their biases and build controls into decision-making systems to address failures. Especially in a pandemic setting like COVID-19, remedying hyperbolic discounting could be the difference between life and death.

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Appendix 1: Containment and closure policies

Source: Codebook for the Oxford Covid-19 Government Response Tracker

ID	Name	Description	Coding
C1	C1_School closing	Record closings of schools and universities	0 - no measures 1 - recommend closing 2 - require closing (only some levels or categories, eg just high school, or just public schools) 3 - require closing all levels Blank - no data
C2	C2_Workplace closing	Record closings of workplaces	0 - no measures 1 - recommend closing (or recommend work from home) 2 - require closing (or work from home) for some sectors or categories of workers 3 - require closing (or work from home) for all-but-essential workplaces (eg grocery stores, doctors) Blank - no data
C3	C3_Cancel public events	Record cancelling public events	0 - no measures 1 - recommend cancelling 2 - require cancelling Blank - no data
C4	C4_Restrictions on gatherings	Record limits on private gatherings	0 - no restrictions 1 - restrictions on very large gatherings (the limit is above 1000 people) 2 - restrictions on gatherings between 101-1000 people 3 - restrictions on gatherings between 11-100 people 4 - restrictions on gatherings of 10 people or less Blank - no data
C5	C5_Close public	Record closing of	0 - no measures

	transport	public transport	1 - recommend closing (or significantly reduce volume/route/means of transport available) 2 - require closing (or prohibit most citizens from using it) Blank - no data
C6	C6_Stay at home requirements	Record orders to "shelter-in-place"	0 - no measures 1 - recommend not leaving house

		and otherwise confine to the home	2 - require not leaving house with exceptions for daily exercise, grocery shopping, and 'essential' trips 3 - require not leaving house with minimal exceptions (eg allowed to leave once a week, or only one person can leave at a time, etc) Blank - no data
C7	C7_Restrictions on internal movement	Record restrictions on internal movement between cities/regions	0 - no measures 1 - recommend not to travel between regions/cities 2 - internal movement restrictions in place Blank - no data
C8	C8_International travel controls	Record restrictions on international travel Note: this records policy for foreign travellers, not citizens	0 - no restrictions 1 - screening arrivals 2 - quarantine arrivals from some or all regions 3 - ban arrivals from some regions 4 - ban on all regions or total border closure Blank - no data