Optimal COVID Contractions*

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Abstract

In this short note, I show how the standard undergraduate textbook model of monetary policy can be used to uncover back-of-the-envelope estimates for two of the most important policy parameters today, namely the *willingness* and *ability* of countries to forgo current income to reduce the spread of COVID-19. The data are consistent with a social weight on reducing excess deaths over 20 times that of output stabilisation (*willingness*), while a contraction in GDP of 1% helps to reduce excess deaths by around 0.6% of the population (*ability*).

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1 Introduction

Standard undergraduate courses in macroeconomics teach students how, in normal times, the conflicting macroeconomic aims of society may be captured as a trade-off between stabilising output and inflation. These are not normal times and a primary goal of most countries around the world is the treatment and prevention of COVID-19.

Although social priorities have clearly shifted, this short note argues there is no need to reconstruct a theoretical framework for evaluating such policy trade-offs. Indeed, the standard macroeconomic optimal policy framework can be reinterpreted in the context of COVID-19. Using this framework, I uncover rough estimates for two of the most important parameters in the current economic debate: the *willingness* and *ability* of countries to forgo current income, through a contraction in GDP, in order to reduce the spread of COVID-19.[1] I demonstrate how the current data are consistent with a social weight on reducing excess deaths over 20 times that of output stabilisation (*willingness*), while a reduction in GDP of 1% helps to reduce excess deaths by around 0.6% of the population (*ability*).

Concentrating analysis within a tractable model intentionally serves two purposes. Firstly, this clarifies the economic mechanism through which a trade-off between the economy and health arises. Secondly, this enables practitioners to conduct sensitivity analysis as new data are reported. I next present the theoretical model, calibrate this, and then conclude.

2 Theoretical Model

Standard courses in macroeconomics analyse a time inconsistency problem facing monetary policy makers using the Barro and Gordon (1983a,b) model.[2] In this model policy makers face a loss, L, from deviations of output, Y, and inflation, π, from target:

$$L = Y^2 + \beta\pi^2,$$

[1] Though, of course, currently the much quoted "R_0" underlying reproductive rate of the disease may be the single most important parameter.

[2] The Barro-Gordon model was developed from the earlier work of Kydland and Prescott (1977). A standard undergraduate textbook analysis may be found in Carlin and Soskice (2006, 2015) and Walsh (2010), while the issue is also discussed at graduate level in Romer (2018).

where $\beta > 0$ is a welfare parameter. The economy operates subject to a constraint on the comovements of these target variables as presented in the Phillips curve:

$$\pi = \pi^e + \alpha Y,$$

where π^e are pre-set inflationary expectations.

This model may be reinterpreted in the context of the current situation involving COVID-19. Society currently faces a social welfare function where losses are derived from deviations of national income and excess deaths caused by the virus. In this case, one social loss function is given by:

$$L = Y^2 + \beta D^2,$$

where Y represents the output gap and D are excess deaths. Again $\beta > 0$ is a parameter controlling the weight of welfare losses on each argument of the loss function. This parameter is of particular interest as it represents the *willingness* of society to trade-off current income losses, through a contraction in GDP, against additional virus deaths.

In addition to replacing the loss function, a second alteration replaces the Phillips curve with a relationship between the output gap and excess deaths. Excess deaths are assumed to evolve according to:

$$D = D_0 + \alpha Y, \tag{YD}$$

where D_0 is the minimum level of excess deaths introduced by a given outbreak of COVID-19 and αY captures an assumption that greater economic activity increases deaths (through greater social interaction, etc).[3] The parameter α is also of particular interest as this captures the *ability* of policymakers to trade-off additional current income for a reduction in excess deaths (assuming $\alpha > 0$).

[3]This model is not dynamic and so sidesteps the important epidemiological discussion of how current infections influence those in the future.

The social planner's problem is then characterised by:

$$\min_{Y,D} \quad Y^2 + \beta D^2$$
$$\min_{Y} \quad Y^2 + \beta (D_0 + \alpha Y)^2,$$

which is solved with a first order optimal condition given by:

$$0 = Y^* + \alpha\beta D^*,$$
$$Y^* = -\alpha\beta D^*. \tag{1}$$

This states that, assuming $\alpha > 0$, the observed comovement between the two outcome variables, the output gap and excess deaths, should be negative. In particular, given a shock D_0 the outcome variables, under optimal policy, may be calculated as:

$$D^* = D_0 + \alpha\Big(- \alpha\beta D^*\Big),$$
$$D^* = \frac{1}{1+\alpha^2\beta} D_0, \quad \Rightarrow \quad Y^* = -\frac{\alpha\beta}{1+\alpha^2\beta} D_0.$$

3 Calibration

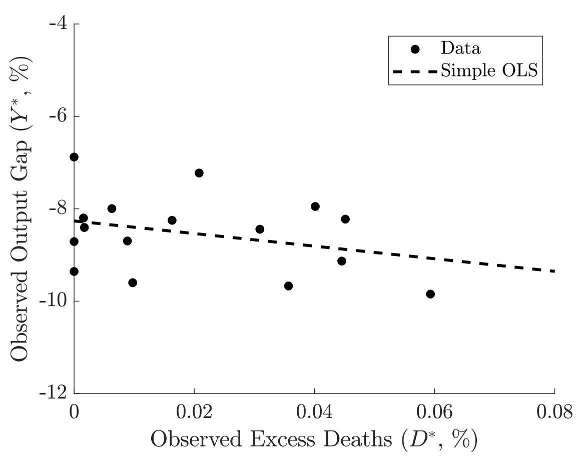
This section of the note firstly outlines how data taken from the Financial Times analysis of mortality and the IMF 2020 World Economic Outlook may be used to uncover the observed comovement between the outcome variables of interest in a cross-country setting. Assuming policymakers reacted optimally to the threat of the shock, this relationship may be used to determine the slope, $\alpha\beta$, given in equation 1. Secondly, I use the Imperial College report, Ferguson et al. (2020), to approximate $\frac{D^*}{D_0}$ for the UK. Combining this with equation 1, I trace out the YD curve and therefore uncover the parameters of interest α and β.

3.1 Observed Responses

Data are taken from the Financial Times analysis of mortality for 16 countries.[4] This is converted to express observed excess deaths, D^*, as a percentage of the 2020 population in each country as given in the IMF's January 2020 World Economic Outlook (WEO) database. Data for the observed output gap, Y^*, use the IMF's forecast revisions between the January and April WEO updates for the same countries.[5] Together these data represent the outcome of both the observed *ability* and *willingness* of countries to offset the COVID-19 shock through contractions in output which limit GDP.

The results are shown in Figure 1 and highlight a negative association between observed output revisions and excess deaths. This is highlighted through the simple OLS regression and its downward sloping trend line. Countries with the largest number of excess deaths are therefore also expected to face the largest incomes drops in 2020, compared to the IMF's January estimate.

Figure 1: Observed Outcomes



Sources: FT analysis of mortality data, IMF 2020 WEO and own calculations.

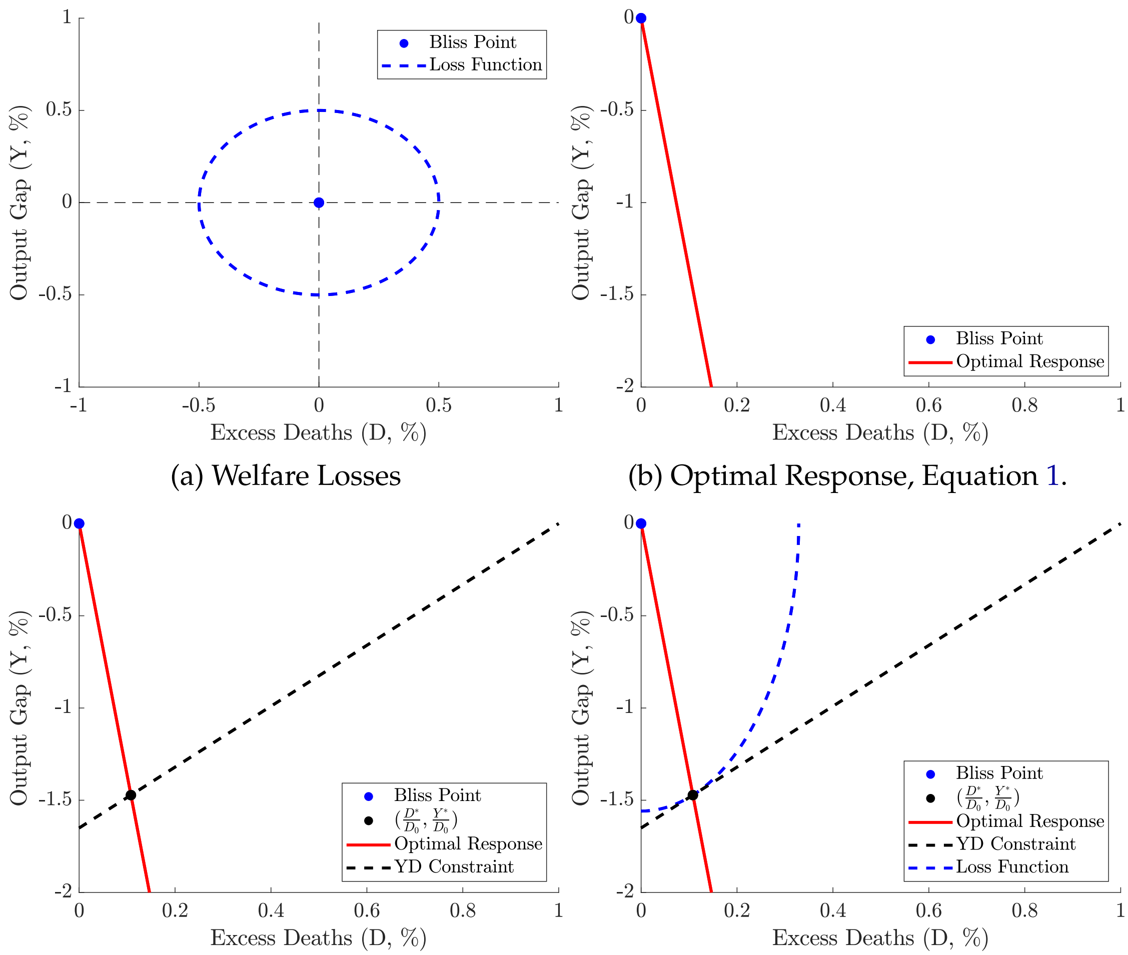
Together these data suggest a reasonable approximation of the slope in equation 1 may be taken to imply $\alpha\beta \approx 13.6$, and enable the optimal response, equa-

[4]Retrieved May 04 from John Burn-Murdock (2020), https://www.ft.com/coronavirus-latest. Although a wider analysis would be possible using data from the WHO, this source is chosen due to the interpretability of these data as the primary target for policymakers.

[5]This may reasonably be assumed approximate to the welfare-relevant income losses faced by each country due to the size of the COVID-19 shock, and the proximity of these forecasts.

tion 1, to be graphed. This initial theoretical situation is outlined in Figure 2a, which shows the policymakers "bliss point" of 0 loss, and a possible curve of constant welfare loss (assuming $\beta = 1$ and $L = 0.5$). The analysis of interest is concentrated in the negative quadrant. The estimate $\alpha\beta \approx 13.6$ is used to construct the optimal response line, as shown in Figure 2b. This line appears steep, as deaths currently remain at a low percentage of the population.

Figure 2: Theoretical Construction



(a) Welfare Losses

(b) Optimal Response, Equation 1.

(c) Constraint, Equation YD.

(d) Loss Function Tangency.

3.2 Observed Shock

The second stage of the calibration uses information about the size of the current COVID-19 shock alongside the observed cross-country responses to identify the

YD constraint. Recall that under optimal policy, the observed number of excess deaths may be written as:

$$D^* = \frac{1}{1+\alpha^2\beta} D_0.$$

The highly influential Imperial College COVID-19 report, Ferguson et al. (2020), provides an estimate for the size of the exogenous shock faced by the UK. This claims that *without action* $D_0 \approx 250,000$.[6] To date, the Financial Times data suggest, UK excess deaths are $D^* \approx 27,000$. This implies:

$$\frac{D^*}{D_0} \approx \frac{27}{250} \approx \frac{1}{1+\alpha^2\beta}. \tag{2}$$

Result 1 (Ability). *A 1% reduction in output reduces excess deaths by c. 0.6% of population.*

Proof. Using the calibration of $\frac{D^*}{D_0}$ in equation 2 above alongside the slope estimate from equation 1, $\alpha\beta \approx 13.6$, imply:

$$\frac{27}{250} = \frac{1}{1+\alpha^2\beta} = \frac{1}{1+13.6\alpha},$$
$$\alpha = \frac{1}{13.6}\left(\frac{250}{27} - 1\right) \approx 0.6.$$

Graphically, this is achieved through knowledge that the points $(\frac{D_0}{D_0}, 0)$ and $(\frac{D^*}{D_0}, \frac{Y^*}{D_0})$ must each arise on the YD constraint. The relative shock $\frac{D^*}{D_0}$ and optimal response, $\frac{Y^*}{D_0}$ are then computed, enabling estimation of the YD constraint slope, α. This is shown in Figure 2c. □

Result 2 (Willingness). *Society values excess deaths* $23\times$ *more than output losses.*

Proof. Result 1 and the estimate of the slope of equation 1, $\alpha\beta \approx 13.6$, together imply:

$$\Rightarrow \beta = \frac{13.6}{\alpha} \approx 22.5.$$

Graphically, the loss function should be tangent to the YD constraint along equation 1. This is shown for the point $(\frac{D^*}{D_0}, \frac{Y^*}{D_0})$ in Figure 2d to finally recover the parameter β. □

[6] This report is thought to have been highly influential in leading to the UK shutdown. There is nothing special about the choice to calibrate the model to the UK value of D_0.

3.3 Sensitivities

The analysis presented above outlines how to uncover estimates for the implied *ability* and *willingness* of society to respond to COVID-19 by reducing economic activity. The simplistic representation is useful not only to illustrate the choices being faced, but also in highlighting the sensitivities of the policy trade-offs being considered in the real world. Altering the size of the initial shock, $\frac{D^*}{D_0}$ or the observed cross-country outcomes experienced, through the slope $\alpha\beta$, can substantially change the parameter estimates obtained.

Two such sensitivities are outlined in Table 1. The first shows that a larger estimate of the level of excess deaths compared to a "do nothing" scenario would roughly halve the implied *ability* of policymakers to react, while doubling their *willingness* to offset such shocks through income reduction. Alternatively, if observed cross-country outcomes showed a greater relationship between lower economic activity and excess deaths, this would have a similar impact in reducing estimates of *ability* to respond by lowering income, while multiplying the implied *willingness* of policymakers to respond by a factor of four.

Table 1: Estimation Sensitivities.

Parameter	Baseline	Double $\frac{D^*}{D_0}$	Double Slope
$\frac{D^*}{D_0}$	0.11	0.22	0.11
Slope	13.6	13.6	27.3
α (*ability*)	0.6	0.3	0.3
β (*willingness*)	22.5	51.2	90.0

4 Conclusion

In this note, I outline how the standard undergraduate theoretical treatment of optimal monetary policy may be used to inform the current debate surrounding a reduction of economic activity to reduce excess deaths from COVID-19. Through this intentionality simplistic framework, I am able to uncover estimates for two of the most important current policy parameters. These show that society places over 20 times the weight on stabilising deaths, than income (*willingness*), while facing the constraint that a 1% reduction in GDP helps to reduce deaths by around 0.6% of the population (*ability*).

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