A BELT AND BRACES APPROACH – THE EFFECT OF SOFT AND HARD LOCKDOWNS AGAINST COVID-19 IN PORTUGAL

Miguel St. Aubyn

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A belt and braces approach – the effect of soft and hard lockdowns against Covid-19 in Portugal

Miguel St Aubyn[1]

Executive member of the Senior Council, CFP - Portuguese Public Finance Council[2]

REM, Research in Economics and Mathematics, Lisbon School of Economics and Management, Universidade de Lisboa

Abstract

The post-Christmas surge of Covid-19 cases in Portugal is empirically estimated using a nonlinear exponential growth equation. The `soft' lockdown, implemented on 15th January is shown to induce an initial inflexion point from which cases decline, and the subsequent `hard' lockdown from the 22nd January reinforces this downwards trend. Taking no action would have led to an estimated 20 000 cases per day in the week ending the 15th February. The effect of the soft lockdown, strengthened by school closures and a harder lockdown, avoided this scenario, and curtailed the number of daily new cases to less than 3000 by week ending the 15th February. It is estimated that without the adoption of school closures and harder lockdown measures, the estimated cases in Portugal would be approximately 9700 per day.

Keywords: COVID-19, lockdown, Portugal, school closures

1 Some very recent history

After the first wave of Covid-19 cases in the spring of 2020, which prompted a strict initial lockdown in Portugal including full school closures, the small number of daily cases meant a relatively `normal' summer ensued. By the autumn, however, similar to other European countries, the rate of new Covid-19 cases started to grow again. At first, the Portuguese government avoided full lockdown measures and only partial curfew-type measures were implemented, including some travel restrictions and stay-at-home rules on weekends and evenings, especially in the most affected parts of the country.

Despite growing concern and the strong recommendations to limit seeing family and other social contacts, Covid-19 restrictions in Portugal were actually lifted during the Christmas holiday, contrary to the approach of other countries, only to be reimposed during the New Years festivities.

<div align="center">Figure 1</div>

<div align="center">Daily new Covid-19 cases in Portugal</div>
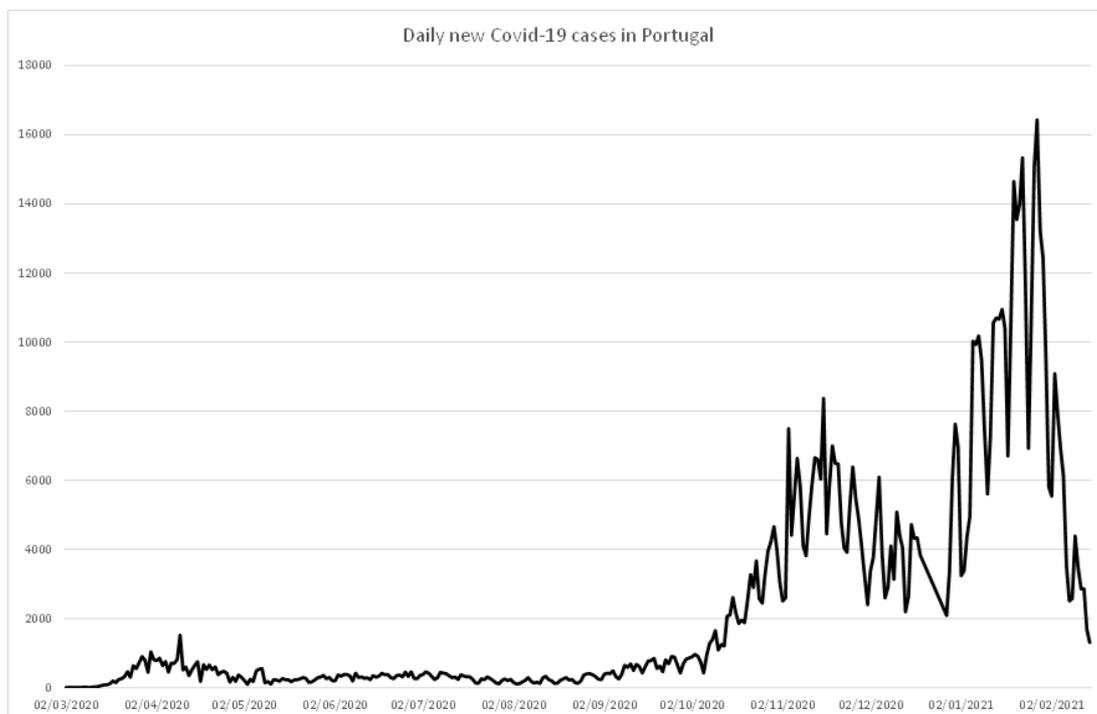
New cases started to grow rapidly from the 28th December, as illustrated in Figure 1, the result of which promptly led to Portugal attaining the top world ranking in the daily rate of Covid-19 cases per inhabitant[3]. The severity of the situation led a previously reluctant president and government to implement a new lockdown from the 15th January. Although working from home was advised wherever possible, this lockdown did not

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[3] Data used in this paper comes from Direção-Geral de Saúde (Directorate-General for Health), and were collected on the Internet via the (excellent) site https://github.com/dssg-pt/covid19pt-data, which is maintained by voluntary individuals.

include any school closures, unlike that which was enforced in March. For clarity, this will be referred to as the `soft' lockdown.

Following debate on the pros and cons of closing schools and considering the advice of experts, the government ultimately decided to close all in-person academic activity from 22nd January onwards, a decision explicitly justified because of the dangers associated with the new British variant. This stricter lockdown will be referred to as the `hard' lockdown.

After wearing a belt, the Portuguese also started using braces. In the next section, econometric evidence is provided that the combined belt and brace approach was effective. In summary, the soft lockdown had the effect of reversing the increasing trend, and the hard measure of closing the schools reinforced this, resulting in a rapid rate of decline of new cases.

2 Econometric results

New Covid-19 case statistics are provided on a daily basis by Direção-Geral de Saúde. As this data is prone to seasonality, namely that Sunday and Monday figures are usually artificially low as laboratory activity is reduced on weekends, it is appropriate to use weekly new cases, such that

$$y_t = x_t - x_{t-7},$$

is the total number of confirmed Covid-19 cases from the beginning of the epidemic until day t.

A lockdown is introduced in the model as a binary variable, equal to zero when the lockdown is not active and becoming one when the latter becomes effective. Therefore, two lockdown variables are necessary, one for the soft lockdown, s_t, and one for the hard lockdown, h_t which are set to one from the 15th and 22nd January respectively. It is assumed that any lockdown takes twelve days to have any visible effect on the recorded data concerning new Covid-19 cases, considering contagion and incubation periods, and subsequent delays in reporting due to time taken for testing, laboratory analysis and data collation[4].

The number of new weekly cases, y_t, is calculated as follows:

$$y_t = \beta_0 + (\beta_1 + \beta_2.s_{t-12} + \beta_3.h_{t-12}).y_{t-1},$$

or, equivalently,

$$y_t = \beta_0 + \rho_t.y_{t-1},$$

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[4] Iwata, Asako and Miyakoshi (2020), with a different methodology, consider a 9 day lag for Japan. In Portugal, and probably due to the overwhelming number of recent cases, it takes three more days.

where $\sigma_t = \beta_1 + \beta_2.s_{t-12} + \beta_3.h_{t-12}$, where the $\beta's$ are coefficients which are estimated using the nonlinear least squares method with data from the 28th December to the 15th January. It is important to note that when $\rho_t > 1$, the process is exponentially growing, and cases grow unbounded. If $\rho_t < 1$, then the process is tamed and new cases decrease with time This study aims to quantify the effectiveness of the two lockdown approaches, if they work at all. The lockdown measures can be called successful if ρ_t become smaller than one.

Results are summarised in the following table[5].

<div align="center">

Nonlinear regression results

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50 daily observations, 28.dec.2020 to 15.feb.2021
Dependent variable, y_t, the homologous changes in daily cases. Adjusted $R^2 = 0.995$

Variable	Coefficient	Standard Error	t-statistic	Probability
β_0	1449.118	674.8507	2.147316	0.0371
β_1	1.012388	0.012315	82.20999	0.0000
β_2, soft lockdown	-0.043484	0.009573	-4.542489	0.0000
β_3, hard lockdown	-0.097491	0.013078	-7.454612	0.0000

Residuals do not display evidence of autocorrelation or of no normality[6].

The interpretation of these results is straightforward:
- Without any lockdown, new covid-19 cases were growing at rate of 1.24 percent, as given by the estimate for $(\beta_1 - 1)$;
- The soft lockdown of 15 January was effective in bringing down this rate to a negative number, estimated at a value of -3.1 percent, as given by the estimate of $(\beta_1 + \beta_2 - 1)$;
- The hard lockdown implemented seven days later brought the declining rate to a much more negative rate, equal to -12.9 percent, as given by the estimate of $(\beta_1 + \beta_1 + \beta_3 - 1)$.

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[5] The econometric results were obtained using the software E-Views 8.1.

[6] Normality and autocorrelation test results are available from the author on request.
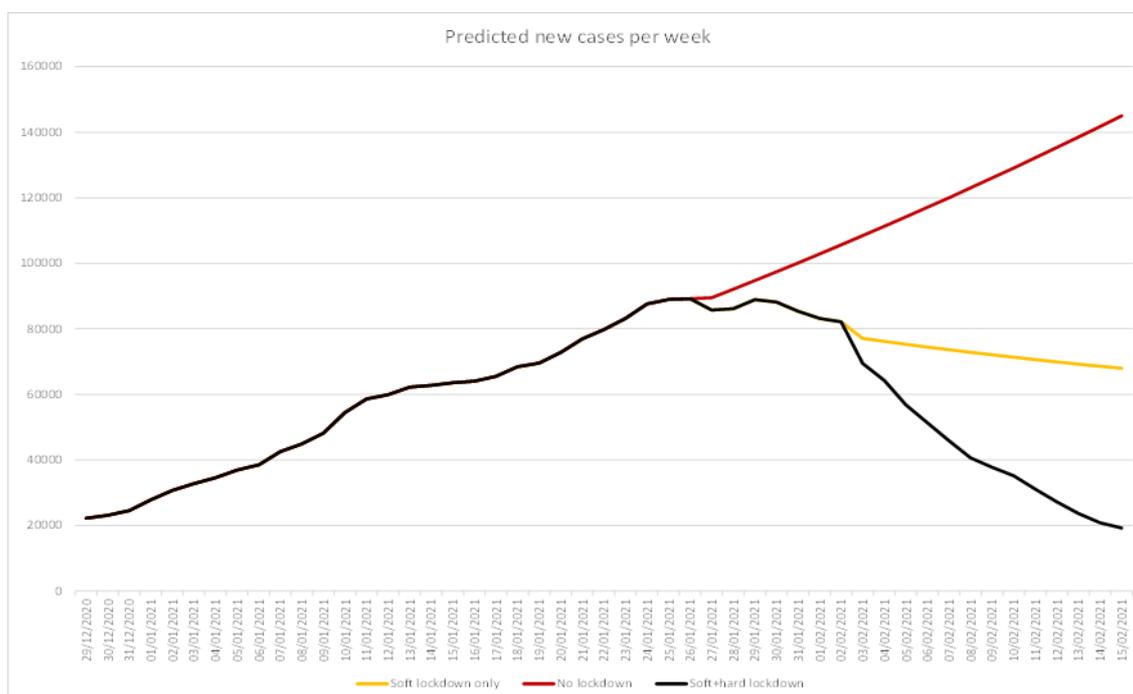
Figure 2

Figure 2 depicts three possible scenarios, predicted using the proposed model. One corresponds to the real world lockdown events, i.e. the one where the soft lockdown started on 15 January, and was reinforced seven days later with school closures. This exhibits a strongly declining number of cases per week and is depicted by the black line.

The yellow line represents the hypothetical situation where the second `hard' lockdown was not introduced, and only the `soft' option was enforced. Following this strategy, the model predicts that new Covid-19 cases would have continued to fall, but clearly at a lower rate than in the previous example.

The red line portrays the worst-case scenario, without lockdown measures and leaving the virus to spread unchecked, extrapolating the exponential growth that was being observed from after Christmas. If the trend was not broken by lockdown, the model predicts that Portugal would be observing more than 140 000 new cases per week at the time of writing, meaning more than 20 000 cases per day. This amount of new cases would likely have resulted in the Portuguese healthcare system being overwhelmed.

The difference between the lockdown lines and the red line may be called "the lockdown gain". Computing this gain gives the following results:

> - The adopted measures of a soft, followed by a hard lockdown, meant that an estimated 227 798 new cases were already avoided up to and including the 15 February.

- If the soft lockdown was not to be followed by the hard one, then this gain would be of 146 849 cases only. The move into a stricter lockdown, including school closures, avoided an extra of 80 949 cases, up to and including the 15 February.

3   Conclusions

Data and econometric results presented in this paper show that Portugal was observing an exponential growth in Covid-19 cases which started after Christmas. If left unchecked, the number of daily cases would have exceeded 20 000 cases per day in the week ending 15th February, completely overstretching the Portuguese health service, and fatally would have led to an unprecedented and impressive number of deaths in early 2021.

The `soft' lockdown, subsequently toughened by school closures and harder lockdown measures, avoided this terrible scenario. The recorded number of cases in the week ending the 15 February is of about 20 000 cases, or less than 3000 cases per day, a sevenfold reduction compared to the aforementioned worst-case scenario.

 If the harder lockdown was not adopted, only following soft lockdown rules, it is estimated cases in Portugal would be approximately 9700 per day. Despite the obvious disadvantages that school closures bring and all the additional costs that come with it, it is surely not worth keeping schools open if the cost is the very high price of illness, loss of work and lives lost, in addition to overwhelming the Portuguese health service.

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