Is A Lockdown Worth It?

Since January 23rd, COVID-19 has forced almost a third of the global population to remain in lockdown (Lifting lockdowns). As ambitious economists, we delved deeper to interpret whether the lockdown measures were worth the cost. To better analyze the ongoing and varying lockdown initiatives taken by countries, linear regression has been conducted in this paper. Linear regression will logically help us answer: Are lockdown measures worth the cost? Does cross-country evidence confirm the success of lockdown measures? This paper will walk through an analysis of the models and clearly conclude that the costs of stricter lockdown measures justify the benefits of that approach.

To form an accurate picture, we must look at both sides of the coin. To represent a non-strict take on lockdown measures, Sweden was fitting. Of its many EU counterparts, Sweden has both taken the most relaxed approach to lockdown (Milne), and rejected the need for masks (Steiner). In contrast to Sweden, Spain, is the most suitable choice. The Guardian recounts it to be "one of the strictest coronavirus lockdowns in Europe," functioning as the perfect opposite (Jones).

To begin, the dependant variable taken is the respective new marginal deaths for each country. From a rational viewpoint, the number of deaths is a clear indicator of whether or not the lockdown measures are protecting the country. We start by regressing new deaths with marginal cases.

```
. regress sweDeathsNew  sweCasesMargin

      Source |       SS           df       MS      Number of obs   =       149
-------------+----------------------------------   F(1, 147)       =    312.34
       Model |  1930.89798         1  1930.89798   Prob > F        =    0.0000
    Residual |  908.767232       147  6.18209001   R-squared       =    0.6800
-------------+----------------------------------   Adj R-squared   =    0.6778
       Total |  2839.66521       148  19.1869271   Root MSE        =    2.4864

------------------------------------------------------------------------------
 sweDeathsNew |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
sweCasesMargin|   .1373587   .0077722    17.67   0.000     .1219991    .1527184
        _cons |  -.3985033   .2726433    -1.46   0.146      -.93731    .1403033
------------------------------------------------------------------------------
```

Sweden

```
. regress espDeathsNew espCasesMargin

      Source |       SS           df       MS      Number of obs   =       148
-------------+----------------------------------   F(1, 146)       =    201.84
       Model |  4151.20795         1  4151.20795   Prob > F        =    0.0000
    Residual |  3002.75955       146  20.5668462   R-squared       =    0.5803
-------------+----------------------------------   Adj R-squared   =    0.5774
       Total |   7153.9675       147  48.6664456   Root MSE        =    4.5351

------------------------------------------------------------------------------
 espDeathsNew |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------+----------------------------------------------------------------
espCasesMargin|   .1041315   .0073296    14.21   0.000     .0896457    .1186173
        _cons |   .3559381    .449291     0.79   0.430    -.5320163    1.243893
------------------------------------------------------------------------------
```

Spain

From the models, we see that both Spain and Sweden have a positive relationship with new marginal cases, as shown by the coefficients. Furthermore, both models' R-squared values are preceding 0.50, affirming that there is a relatively strong relationship between marginal deaths and cases. Lastly, the P-values indicate that marginal cases are a vital variable - 0.0000 tells us with 95% confidence that the coefficients are not 0.

Our model isn't strong enough yet. To paint an accurate picture, we must add more independent variables. Another contributor to new marginal deaths is stringency.

```
. regress sweDeathsNew sweCasesMargin sweStringency
```

Source	SS	df	MS
Model	1969.21688	2	984.60844
Residual	870.448332	146	5.96197488
Total	2839.66521	148	19.1869271

Number of obs	=	149
F(2, 146)	=	165.15
Prob > F	=	0.0000
R-squared	=	0.6935
Adj R-squared	=	0.6893
Root MSE	=	2.4417

sweDeathsNew	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
sweCasesMargin	.183028	.0195644	9.36	0.000	.1443621	.221694
sweStringency	-.0622052	.0245367	-2.54	0.012	-.1106982	-.0137123
_cons	-.1451605	.2857861	-0.51	0.612	-.7099727	.4196517

Sweden

```
. regress espDeathsNew espCasesMargin espStringency
```

Source	SS	df	MS
Model	4253.92735	2	2126.96367
Residual	2900.04015	145	20.0002769
Total	7153.9675	147	48.6664456

Number of obs	=	148
F(2, 145)	=	106.35
Prob > F	=	0.0000
R-squared	=	0.5946
Adj R-squared	=	0.5890
Root MSE	=	4.4722

espDeathsNew	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
espCasesMargin	.0915756	.0091071	10.06	0.000	.0735758	.1095753
espStringency	.0282759	.0124769	2.27	0.025	.0036157	.0529361
_cons	-.4946921	.5806778	-0.85	0.396	-1.642378	.6529941

Spain

The models for both countries now experience an increase in the adjusted R-squared and decrease in root MSE. To avoid the inflated number R-squared provides when variables increase, we will rely on adjusted R-squared. However, the R-squared value is still weak in both the models, so we must add more variables.

Since this data spans over a significant period, a useful addition would be time. This variable successfully captures an essential detail with COVID-19: with every passing day and future day to come, how can our model better predict which measures work better.

```
. regress sweDeathsNew sweCasesMargin sweStringency t
```

Source	SS	df	MS
Model	1972.18642	3	657.395473
Residual	867.478793	145	5.98261237
Total	2839.66521	148	19.1869271

Number of obs	=	149
F(3, 145)	=	109.88
Prob > F	=	0.0000
R-squared	=	0.6945
Adj R-squared	=	0.6882
Root MSE	=	2.4459

sweDeathsNew	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
sweCasesMargin	.1829538	.0195985	9.34	0.000	.1442182	.2216894
sweStringency	-.0455522	.0341005	-1.34	0.184	-.1129504	.021846
t	-.0086926	.0123381	-0.70	0.482	-.0330784	.0156932
_cons	.1642994	.5243007	0.31	0.754	-.8719598	1.200559

Sweden

```
. regress espDeathsNew espCasesMargin espStringency t
```

Source	SS	df	MS
Model	4302.7895	3	1434.26317
Residual	2851.178	144	19.7998472
Total	7153.9675	147	48.6664456

Number of obs	=	148
F(3, 144)	=	72.44
Prob > F	=	0.0000
R-squared	=	0.6015
Adj R-squared	=	0.5932
Root MSE	=	4.4497

espDeathsNew	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
espCasesMargin	.0799193	.0117117	6.82	0.000	.0567702	.1030684
espStringency	.0832108	.037108	2.24	0.026	.0098641	.1565575
t	-.042966	.0273508	-1.57	0.118	-.0970269	.0110949
_cons	.6607854	.9353215	0.71	0.481	-1.187948	2.509518

Spain

With this model, we see improvements in the adjusted R-squared. Let's further examine the coefficients. With Sweden, we witness an inverse and fragile relationship between time and new deaths. The ratio outlines that with each passing day, deaths decrease, but only infinitesimally. On the contrary, Spain - the stricter counterpart - shows that deaths at a better rate. At this point, the models can reasonably demonstrate that Spain outshines Sweden with its more rigorous methods. But have we checked the soundness of our model? Two methods can assure us that our model is sound.

Sweden

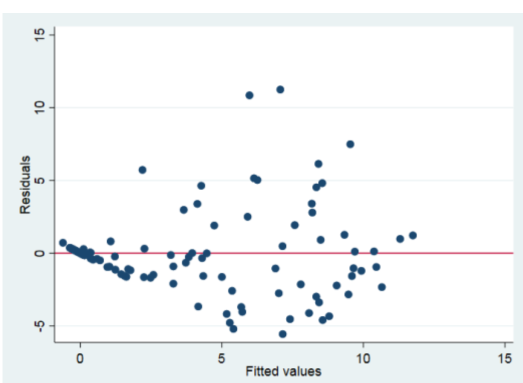
```
. ovtest

Ramsey RESET test using powers of the fitted values of sweDeathsNew
       Ho:  model has no omitted variables
                 F(3, 142) =      1.20
                  Prob > F =      0.3135
```

Spain

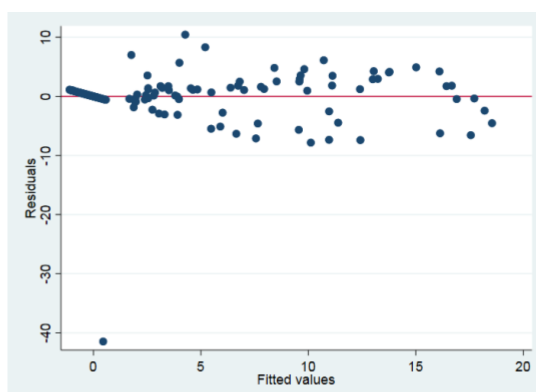
```
. ovtest

Ramsey RESET test using powers of the fitted values of espDeathsNew
       Ho:  model has no omitted variables
                 F(3, 141) =      0.89
                  Prob > F =      0.4489
```

We first can see the soundness of both the models by testing for omitted variables. Both regression models do not reject the null hypothesis of no omitted variables, which confirms the soundness. Secondly, we can solidify that our model is sound by graphing residuals against fitted values. With the graphs we can visually confirm that our model is sound.

Sweden



Spain



To conclude the findings from our model, using the health indicators available, we can see Spain's stricter approach to lockdown saves more people in the long run, and its costs justify the benefits of the path. However, we also need to run a model that looks at economic health. In the next analysis, this paper will probe the economic indicators and show that stricter lockdown measures are justified.

To begin the second model, the dependant variable we chose is inflation for each country. This variable provides us with a comprehensive picture of how a country is doing. Historically, inflation has always shone a light on a country's current standing. We begin by regressing inflation with stringency. The model will show us the direct effects of strictness on the volatility of the economy.

Sweden

```
.
. regress sweINF sweStringency

      Source |       SS           df       MS      Number of obs   =       121
-------------+----------------------------------   F(1, 119)       =    745.25
       Model |  41.5240026         1  41.5240026   Prob > F        =    0.0000
    Residual |  6.63047046       119  .055718239   R-squared       =    0.8623
-------------+----------------------------------   Adj R-squared   =    0.8612
       Total |  48.1544731       120  .401287276   Root MSE        =    .23605

------------------------------------------------------------------------------
      sweINF |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
sweStringency |  -.0309573    .001134   -27.30   0.000    -.0332028   -.0287119
       _cons |   1.132051   .0276537    40.94   0.000     1.077294    1.186808
------------------------------------------------------------------------------
```

Spain

```
. regress espINF espStringency

      Source |       SS           df       MS      Number of obs   =       121
-------------+----------------------------------   F(1, 119)       =    703.54
       Model |    50.63416         1    50.63416   Prob > F        =    0.0000
    Residual |  8.56449622       119  .071970557   R-squared       =    0.8553
-------------+----------------------------------   Adj R-squared   =    0.8541
       Total |  59.1986563       120  .493322136   Root MSE        =    .26827

------------------------------------------------------------------------------
      espINF |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
espStringency |  -.0177976    .000671   -26.52   0.000    -.0191262   -.0164689
       _cons |   .9348498   .0348639    26.81   0.000     .8658158    1.003884
------------------------------------------------------------------------------
```

From the models, we see that both Spain and Sweden have R-squared values that are preceding 0.85. These R-squared values confirm a strong relationship between stringency and inflation since stringency primarily affects how smoothly both consumers and producers can move, and thus on a grander scale, controls the flow of money. Once again, the P-values indicate that stringency is a vital variable - 0.0000 tells us with 95% confidence that the coefficients are not 0.

This model still hasn't used enough economic indicators for a definite conclusion. To strengthen the model, we add two more variables: marginal cases and unemployment.

```
. regress sweINF sweStringency  sweCasesMargin sweUnemp

      Source |       SS           df       MS      Number of obs   =       121
-------------+----------------------------------   F(3, 117)       =    325.07
       Model |  42.9959947         3  14.3319982   Prob > F        =    0.0000
    Residual |  5.15847834       117  .044089558   R-squared       =    0.8929
-------------+----------------------------------   Adj R-squared   =    0.8901
       Total |  48.1544731       120  .401287276   Root MSE        =    .20998

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      sweINF |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
sweStringency |  -.0214039   .0028957    -7.39   0.000    -.0271387   -.0156692
sweCasesMargin |  -.0068289   .0025447    -2.68   0.008    -.0118685   -.0017894
    sweUnemp |   -.171264   .0550475    -3.11   0.002    -.2802827   -.0622453
       _cons |   2.351758    .396805     5.93   0.000     1.565906    3.137609
------------------------------------------------------------------------------
```

Sweden

```
.
. regress espINF espStringency   espCasesMargin espUnemp

      Source |       SS           df       MS      Number of obs   =       121
-------------+----------------------------------   F(3, 117)       =    371.55
       Model |   53.575055         3  17.8583517   Prob > F        =    0.0000
    Residual |  5.62360125       117  .048064968   R-squared       =    0.9050
-------------+----------------------------------   Adj R-squared   =    0.9026
       Total |  59.1986563       120  .493322136   Root MSE        =    .21924

------------------------------------------------------------------------------
      espINF |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
espStringency |  -.0141025    .001425    -9.90   0.000    -.0169247   -.0112804
espCasesMargin |   .0018475   .0006015     3.07   0.003     .0006562    .0030388
    espUnemp |   -.567863   .0909212    -6.25   0.000    -.7479276   -.3877984
       _cons |   8.750207   1.248925     7.01   0.000     6.276777    11.22364
------------------------------------------------------------------------------
```

Spain

Let's interpret the coefficients first. For the non-strict country, Sweden, we see a negative relationship between inflation and marginal cases. One might be quick to assume that this good, as cases rise, prices fall. Contrary to instinct, this means deflation; as good as this sounds on paper, from an economic standpoint, this can throw the country into a deflationary spiral and harm it in the long term (Pologeorgis). Whereas Spain, the stricter of the two, has a minimal positive coefficient, this indicates that more cases will bring a healthy rate of inflation, which is beneficial for the economy. Furthermore, Spain has a significant negative ratio of unemployment. In this long term, this depicts that as inflation increases, unemployment will significantly decrease, once again indicating, Spain is set to be stronger economically. Lastly, both countries' models undergo an increase in the adjusted R-squared and drop in root MSE.

For the last addition to the model, we once again add the variable of time. As mentioned earlier, this data spans over a significant period. With time, we can now see with every passing day and future day to come, how can our model better predict which measures will work in a country's favor economically.

Sweden

```
. regress sweINF sweStringency  sweCasesMargin sweUnemp t

      Source |       SS           df       MS      Number of obs   =       121
-------------+----------------------------------   F(4, 116)       =    467.65
       Model |   45.342698         4  11.3356745   Prob > F        =    0.0000
    Residual |  2.81177509       116   .02423944   R-squared       =    0.9416
-------------+----------------------------------   Adj R-squared   =    0.9396
       Total |  48.1544731       120  .401287276   Root MSE        =    .15569

------------------------------------------------------------------------------
      sweINF |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
sweStringency |  -.0077513   .0025564    -3.03   0.003    -.0128146    -.002688
sweCasesMargin |  -.0050641   .0018953    -2.67   0.009    -.0088179   -.0013102
    sweUnemp |  -.2390142   .0413928    -5.77   0.000    -.3209978   -.1570305
           t |  -.0090931   .0009242    -9.84   0.000    -.0109235   -.0072627
       _cons |   3.171961   .3057998    10.37   0.000     2.566286    3.777636
------------------------------------------------------------------------------
```

Spain

```
. regress espINF espStringency   espCasesMargin espUnemp t

      Source |       SS           df       MS      Number of obs   =       121
-------------+----------------------------------   F(4, 116)       =    812.60
       Model |  57.1587794         4  14.2896948   Prob > F        =    0.0000
    Residual |   2.0398769       116  .017585146   R-squared       =    0.9655
-------------+----------------------------------   Adj R-squared   =    0.9644
       Total |  59.1986563       120  .493322136   Root MSE        =    .13261

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      espINF |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
espStringency |   .0008467   .0013563     0.62   0.534    -.0018396     .003533
espCasesMargin |  -.0001915   .0003909    -0.49   0.625    -.0009657    .0005827
    espUnemp |   -.586584   .0550107   -10.66   0.000    -.6955396   -.4776284
           t |  -.0138799   .0009723   -14.28   0.000    -.0158056   -.0119542
       _cons |   9.397747   .7567917    12.42   0.000     7.898825    10.89667
------------------------------------------------------------------------------
```

We see the adjusted R-squared values with this model have both headed 0.90, indicating a reliable model. With Sweden, we witness an inverse and frail relationship between time and inflation. The ratio outlines that inflation barely falls with each day. On the contrary, Spain - the stricter counterpart - describes that inflation will decrease at a more reserved rate with each passing day. At this point, the models can persuasively demonstrate that even from an economic standpoint, Spain transcends Sweden with its more rigorous methods. However, once again, we must confirm the soundness of our models.

Beginning with the test for omitted variables. Both regression models accept the null hypothesis of no omitted variables, which confirms the soundness.

Sweden

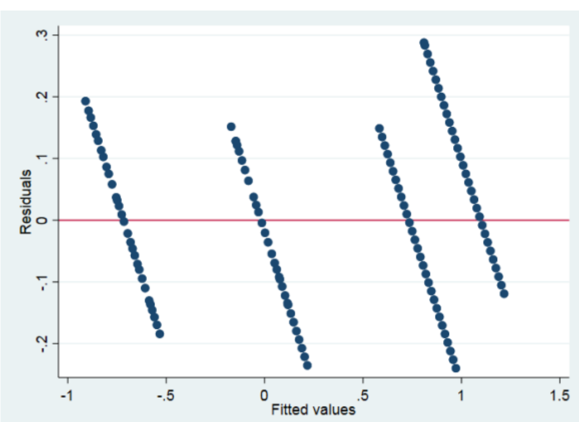
```
. ovtest

Ramsey RESET test using powers of the fitted values of sweINF
       Ho:  model has no omitted variables
                 F(3, 113) =     35.29
                  Prob > F =      0.0000
```

Spain

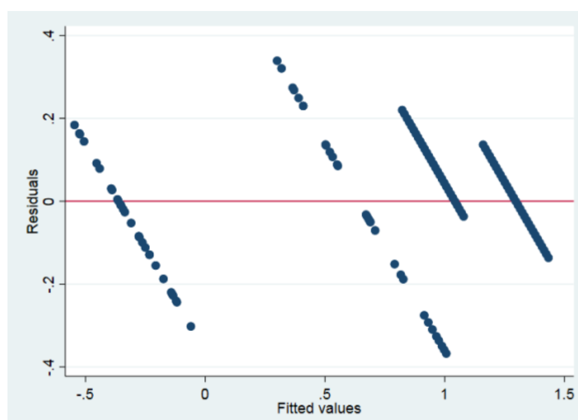
```
. ovtest

Ramsey RESET test using powers of the fitted values of espINF
       Ho:  model has no omitted variables
                 F(3, 113) =     38.87
                  Prob > F =      0.0000
```

Secondly, we can solidify that our model is sound by graphing residuals against fitted values. However, in this case, we are faced with an awkward graph, but it seems like to be evenly plotted with no specific trends or curves to show it being biased. So, to better confirm the soundness, we test for heteroskedasticity. We want constant variance between residuals, which is homoskedasticity. By the visuals below, it is clear the P-values lie outside the rejection region and so it is safe to assume homoskedasticity.

Spain



Sweden



```
. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of sweINF

         chi2(1)      =     0.89
         Prob > chi2  =   0.3452
```

Sweden

```
. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of espINF

         chi2(1)      =     1.71
         Prob > chi2  =   0.1904
```

Spain

Therefore, the data provided, alongside the rigorous use of linear regression and supporting articles based on Sweden and Spain; the evidence is ample to conclude that stricter restrictions, like Spain's, are worth the cost.

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