Evaluating the Veracity of the Laffer Curve in Flat-Income-Tax Economies

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Abstract. The Laffer Curve is a concept that postulates a concave downward curve, representing the relationship between a country's tax rates and tax revenue. This theory proposes that an increase in tax rates would initially raise the government's tax revenue to a certain threshold, and further hikes in tax rates beyond this threshold would result in a decline in total tax revenue. This paper aims to empirically evaluate the validity of the Laffer Curve theory within nations with a flat income tax system. By establishing a quadratic model accounting for the changes in income tax rates and tax revenue of eleven nations, this paper has found that only one of them verifies the Laffer Curve theory. The discrepancy is further analyzed, and the limitations of the model are identified, with further research suggestions in later sections.

Keywords: Laffer curve, Empirical evaluation, Flat income tax system.

1. Introduction

The Laffer Curve, initially published in 1978 in Wanniski's book, *The Way the World Works*, introduced the idea of a prohibitive range where increases in tax rate could lead to a reduction in tax revenue beyond a certain level [1]. Over the years, many economists, epitomized by Mirowski's 1982 critique, have called attention to potential issues with the theory. By questioning the model's empirical robustness and practical implications, the issue of the model's oversimplification of complex behavioral economic problems and the challenges associated with acquiring absolute values for key underlying factors are identified [1]. While the theory of the Laffer Curve has been broadly explored within a progressive tax system, its applicability in economies with a flat tax system seems under-investigated. Although the number of flat-tax countries in the world that had previously altered their income tax rates remains small this paper aims to empirically test if the prevailing academic sentiment that the Laffer Curve is predominantly impractical is true. Thus, this research question on evaluating the Laffer Curve's veracity in countries with a flat income tax is proposed.

2. Methodology – the Laffer Curve Model

This paper adopts a robust econometric approach derived from the foundational concept of the Laffer Curve. A quadratic econometric model has been established to reflect the hypothesized concave downward relationship between tax rates and tax revenue. The equation of the Laffer Curve model in this paper is mathematically written as

$$\text{Total Tax Revenue}_i = \beta_0 + \beta_1 \text{TaxRate}_i + \beta_2 \text{TaxRate}_i^2 + u_i \tag{1}$$

To align with the Laffer Curve theory, β_1 must be greater than zero, and β_2 must be a negative number to ensure the concave downward curve.

This model has subsequently been operationalized in a regression analysis using the STATA software for every country. The regression code is as follows

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regress tax revenue tax rate c.taxrate#c.tax rate
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Data from eleven out of nineteen nations that have adopted a flat income tax system were accessible and incorporated into this study, as only those eleven countries had modified their income tax rates historically.

3. Case Presentation

For a clearer presentation of results, five countries were selected as representative cases in this paper. By categorizing the six cases into three groups based on their statistical significance and consistency with the model, the veracity of the Laffer Curve model is assessed, and the difference among the groups is later analyzed.

3.1. Statistically Significant Cases that are Consistent with the Model

Having tested all eleven nations' data, only one country, Hungary, validates the relationship between tax rates and tax revenue proposed by the Laffer Curve.

3.1.1. The Case of Hungary

The historical data of Hungary are a highly accurate fit of the Laffer Curve model. Twenty-four pieces of data were collected, representing the income tax rate and tax revenue from 1999 to 2022 [2,3]. Equation (1) and Regression code were implemented. The results are shown in Table 1. below.

Table 1. Hungary

<table>
<tr><td>Source</td><td>SS</td><td>df</td><td>MS</td><td colspan="3">Number of obs=24</td></tr>
<tr><td rowspan="2">Model</td><td rowspan="2">1.5502e+09</td><td rowspan="2">2</td><td rowspan="2">775118986</td><td colspan="3">F (2, 24)=31.64</td></tr>
<tr><td colspan="3">Prob>F=0.0000</td></tr>
<tr><td rowspan="2">Residual</td><td rowspan="2">21123816.8</td><td rowspan="2">21</td><td rowspan="2">24494841.3</td><td colspan="3">R-squared=0.7509</td></tr>
<tr><td colspan="3">Adj R-squared=0.7271</td></tr>
<tr><td>Total</td><td>2.0646e+09</td><td>23</td><td>89766506</td><td colspan="3">Root MSE=4949.2</td></tr>
<tr><td>tax revenue</td><td>Coefficient</td><td>Std.err.</td><td>t</td><td>p>|t|</td><td colspan="2">[95% conf. interval]</td></tr>
<tr><td>tax rate</td><td>3622.632</td><td>1019.759</td><td>3.55</td><td>0.002</td><td>1501.927</td><td>5743.337</td></tr>
<tr><td>c.taxrate#c.taxrate</td><td>-76.31639</td><td>18.42449</td><td>-4.14</td><td>0.000</td><td>-114.6322</td><td>-38.00057</td></tr>
<tr><td>_cons</td><td>-815.4748</td><td>11751.25</td><td>-0.07</td><td>0.945</td><td>-25253.53</td><td>23622.58</td></tr>
</table>

Firstly, the regression above is a good fit of the model to the data, evidenced by a high 0.7509 R-squared, meaning 75.09% of the dependent variable (tax revenue) variability is explained by the independent variable (tax rate) in this model. Given that the adjusted R-squared is similar at 0.7271, the explanatory capacity of this model is reinforced as the value of 0.7271 is still considered high even after adjusting for the number of predictors. Additionally, the value of the F-statistic in this regression is 31.64, and the p-value is close to zero at 0.0000. This further indicates that the model is statistically significant and fits the data better with no predictors. In particular, the coefficient for the variable tax rate is a positive number of 3622.632, suggesting a positive relationship between tax rate and tax revenue, as the Laffer Curve model predicts initially. Furthermore, the negative coefficient at -76.31639 captures the quadratic relationship between the tax rates and tax revenue implied by the Laffer Curve. The t-statistic for tax rate and tax rate squared is 3.55 and -4.14 respectively. The p-value of these two coefficients is less than the standard 5%, further making them statistically significant. Although the value of the constant term does not align with the Laffer Curve's predictions that suggest the tax revenue is zero at zero tax rate, its t-statistic is -0.07 with a high p-value at 0.945. This means the constant term is not statistically significant at any level. Therefore, the case of Hungary proves the Laffer Curve model to be highly accurate, given both statistically significant positive coefficients for the linear term (tax rate) and a negative coefficient for the quadratic term (tax rate squared), as well as a high R-squared value.

3.2. Statistically Significant Cases that Oppose the Model

Although statistically significant, two out of the eleven nations, Estonia, and Bulgaria, appeared to have an exactly opposite relationship between their tax rates and tax revenue as the Laffer Curve predicts.

3.2.1. The Case of Estonia

Equation (1) is found to be highly accurate and relevant in the case of Estonia. However, the signs for both coefficients are the opposite of what the Laffer Curve theory predicts. Twenty-one pieces of data were accessible for Estonia, corresponding to the income tax rate and tax revenue from 2002 to 2022 [2,4]. The results are shown in Table 2. below.

Table 2. Estonia

Source	SS	df	MS	Number of obs=21		
Model	43195836.2	2	21597918.1	F (2, 24)=31.47		
				Prob>F=0.0000		
Residual	12352524.4	18	686251.357	R-squared=0.7776		
				Adj R-squared=0.7529		
Total	55548360.7	20	2777418.03	Root MSE=828.4		
tax revenue	Coefficient	Std.err.	t	p>|t|	[95% conf. interval]	
tax rate	-9562.417	2618.372	-3.65	0.002	-15063.41	-4061.421
c.taxrate#c.tax rate	194.8158	57.06842	3.41	0.003	74.91951	314.7121
_cons	118859.8	29721.58	4.00	0.001	56417.12	181302.6

The coefficient for tax rate is negative at -9562.417, suggesting that as the tax rate increases by one-unit, total tax revenue collected will decrease by 9562.417 units, which is the opposite of what the Laffer Curve suggests in the initial phase of tax increase. This coefficient is statistically significant, given a t-statistic of -3.65 and a low p-value of 0.002. The positive coefficient of the rate squared further highlights the opposition to the Laffer Curve model in this case. The t-statistic for this coefficient is 3.41, and its p-value is also low at 0.003, indicating a robust statistical significance at any standard level. Furthermore, the value of the constant term is again statistically significant at 118859.9 with a t-statistic of 4.00 and a p-value of 0.001. This reinforces the contradiction to the Laffer Curve theory in this case because even at zero income tax rate, the government can still gain a revenue of 118859.8 units.

Overall, despite a high value of R-squared of 0.7776, Estonia illustrates a reversed relationship between tax rates and tax revenue as the model claims.

3.2.2. The Case of Bulgaria

Likewise, although Bulgaria overall displays a decent fit to the equation (1), its statistical significance is much less than Estonia, and most importantly, it demonstrates an opposite relationship between tax rates and tax revenue to the argument of the Laffer Curve. Twenty-four pieces of data were collected, representing the period from 1999 to 2022 [2, 5].

Table 3. Bulgaria

Source	SS	df	MS	Number of obs=24		
Model	849889752	2	424944876	F (2, 24)=14.26		
				Prob>F=0.0001		
Residual	625631472	21	29791974.9	R-squared=0.5760		
				Adj R-squared=0.5356		
Total	1.4755e+09	23	64153096.7	Root MSE=5458.2		
Tax revenue	Coefficient	Std.err.	t	p>|t|	[95% conf. interval]	
Taxrate	-1111.574	642.7674	-1.73	0.098	-2448.282	225.1338
c.taxrate#c.taxrate	12.46339	13.91516	0.90	0.381	-16.47477	41.40156
_cons	30709.47	5682.027	5.40	0.000	18893.04	42525.89

The results overall indicate a moderate fit of the equation (1), as both its R-squared and adjusted R-squared are more than 50%. However, the same issue of an opposite relationship between tax rates and tax revenue to the Laffer Curve theory occurs.

This is evidenced by a negative coefficient for tax rate, which is statistically significant at a 10% significance level. A concave upward curve is then created, given a positive coefficient for tax rate squared. However, this coefficient is not statistically significant as its t-statistic is 0.90 with a p-value of 0.381. Additionally, the constant term is positive at 30709.47 with a high level of statistical significance due to its t-statistic of 5.40 with a close-to-zero p-value of 0.0000. This means that even at zero income tax rate, there is still 30709.47 units of tax revenue.

Therefore, the regression of Bulgaria opposes the Laffer Curve model.

3.3. Statistically insignificant cases

Eight out of the eleven countries tested are revealed to be statistically insignificant. The insignificance arose from possessing statistically insignificant predictors and a low R-squared value. Two cases, Moldova and Georgia, are chosen to exemplify each of these reasons respectively.

3.3.1. The Case of Moldova

Despite having a high R-squared of 0.7506 and an adjusted R-squared value of 0.7150, the coefficients of the model are statistically insignificant, suggesting the model might not be accurate in representing the relationship between tax rates and tax revenue. The high value of R-squared may be driven by omitted variable bias in the model that is correlated with both the tax revenue and tax rate. Seventeen years of data from 2006 to 2022 were observed [2,6].

Table 4. Moldova

Source	SS	df	MS	Number of obs=17		
Model	4453206.87	2	2226603.43	F (2, 24)=21.07		
				Prob>F=0.0001		
Residual	1479512.52	14	105679.466	R-squared=0.7506		
				Adj R-squared=0.7150		
Total	5932719.38	16	370794.961	Root MSE=325.08		
Tax revenue	Coefficient	Std.err.	t	p>|t|	[95% conf. interval]	
Tax rate	357.9207	520.2317	0.69	0.503	-757.8653	1473.707
c.taxrate#c.taxrate	-17.59214	16.86977	-1.04	0.315	-53.77419	18.58991
_cons	841.0373	3867.693	0.22	0.831	-7454.339	9136.414

This case suggests the Laffer Curve model's invalidity, given that none of the coefficients is statistically significant here. For instance, although the coefficient for the tax rate is positive and the coefficient for the rate squared is negative as the Laffer Curve predicts, the p-values of their t-statistic are both exceptionally high at 0.503 and 0.315 individually. Hence, the Laffer Curve model does not provide credibility in this case, as neither of the linear and quadratic terms is valuable in affecting the outcome of tax revenue.

3.3.2. The Case of Georgia

The Laffer Curve model is inoperative in all aspects in the case of Georgia, as the regression not only has an acutely low R-squared value of 0.1358 but also carries statistically insignificant predictors. Nineteen pieces of data were analyzed, reflecting the years between 2004 and 2022 [2,7].

Table 5. Georgia

Source	SS	df	MS	Number of obs=19		
Model	113674789	2	56837394.5	F (2, 24) =1.26		
				Prob>F=0.3112		
Residual	723510624	16	45219414	R-squared=0.1358		
				Adj R-squared=0.0278		
Total	837185413	18	46510300.7	Root MSE=6724.5		
tax revenue	Coefficient	Std.err.	T	p>|t|	[95% conf. interval]	
tax rate	5137.114	4044.887	1.27	0.222	-3437.664	13711.89
c.taxrate#c.tax rate	-135.8562	118.2394	-1.15	0.267	-386.5125	114.8002
_cons	-38764.74	33681.66	-1.15	0.267	-110166.7	32637.19

Apart from its low R-squared value, both tax rate and tax rate squared have p-values that are much greater than a 10% significance level, meaning neither of them is relevant in explaining the changes in tax revenue. Furthermore, the model's F-statistic value is 0.3112, which is larger than 5%, indicating this model is not better than a model with no predictors. Hence, the case of Georgia serves as another piece of evidence in exhibiting that the Laffer Curve theory does not hold up in practical scenarios.

4. Case Analysis

Based on the findings from the five case studies, two primary areas warrant analysis: firstly, the reason why Hungary closely adheres to the Laffer Curve model while Estonia and Bulgaria portray the exact opposite scenario; and secondly, why the model appears to be inapplicable in the majority of nations with a flat income tax structure.

To elucidate the first area, analysis from a behavioral aspect becomes imperative. Hungary, having a large informal economy as big as 23.3% of its GDP, provides enough incentives for the population to respond more to tax rate changes, compared to both Estonia and Bulgaria where the informal economies are smaller [8]. Estonia only has an informal economy the size of 15.7% of its GDP, while Bulgaria has successfully shrunk its informal economy by two-thirds [9,10]. Therefore, when the income tax rate decreases, there is much more movement from the informal economy to the formal one in Hungary, when tax evasion diminishes.

Furthermore, the elasticity of taxable income in each country plays a crucial role in determining the country's alignment with the Laffer Curve model. Empirical studies indicate that while Hungary generally exhibits a modest tax price elasticity of 0.06, the top quintile of its population displays a considerably high elasticity, reaching as high as 0.45, a figure at the upper end of even global observations [11]. In contrast, Estonia's e-governance system enables its elasticity of taxable income to be notably inelastic, due to the system minimizing chances for tax evasion as payments are traceable.

Another justification for such discrepancy stems from the Laffer Curve model itself. When Estonia and Bulgaria are in the prohibitive range on the model, their negative coefficient for the tax rate is explained. This is shown in Fig.1 below, where in the prohibitive range, tax revenue decreases with an increase in the tax rate [12].

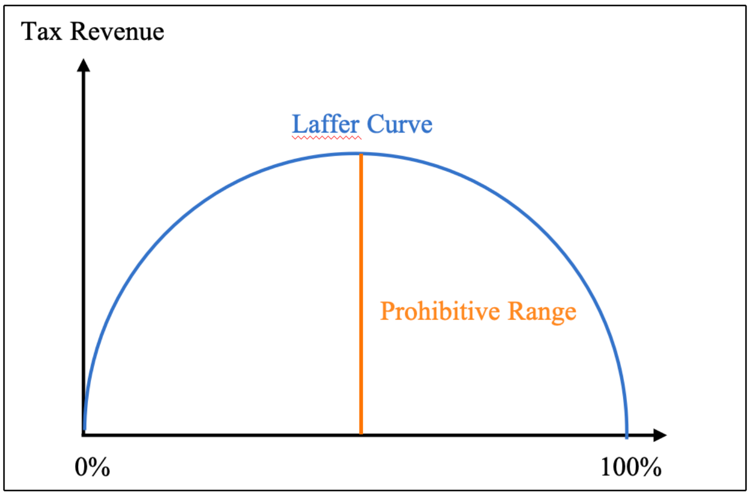

Figure 1. Prohibitive Range

Finally, several reasons underpin the Laffer Curve model's limited applicability in real-world scenarios. The over-simplification of the model essentially omits relevant variables in determining the tax revenue, such as economic growth rates, investment levels, interest rates, inflation rates and so on. Furthermore, the dynamics effects of tax rate changes are not modeled. For example, this model only captures the immediate effect of a tax rate reduction, which is a rapid decline in tax revenue.

However, it tends to overlook the potential long-term benefits. A surge in consumption stemming from such temporary expansionary fiscal policy could generate more employment, augmenting the total tax revenue over an extended period. Considering these constraints, the Laffer Curve model is indeed likely to produce inaccurate predictions, like in the cases of Moldova and Georgia.

5. Limitations

Firstly, none of the datasets of the eleven countries contain a large sample set, as the accessible data are all relatively recent, restricting the model's representativeness. This could also result in the problem of overfitting.

Secondly, the model neglects the sectoral differences in various countries. Assuming Estonia, representative of an advanced economy, could be amid an economic upswing, while Georgia, as an emerging economy, is in a recovery phase from a recession concurrently. This scenario then made comparisons imprecise as the tax revenue increase in Estonia may not be the outcome of simply a tax rate increase but rather of the population's income raising proportionally more. Thus, more factors affecting the outcome of the tax revenue such as business cycles should be included in the model, too. By adding factors such as business cycles, how changes in tax rates affect labor-leisure choices can also be assessed, contributing to a more comprehensive model.

Lastly, the scope of this paper is limited to nations with a flat income tax system, whereas the Laffer Curve theory encompasses various tax types and structures. Other research has found that by elevating a different form of tax, such as a consumption tax, tax revenue can be raised dramatically, evidenced by a notable 8% increase for Mexico [13]. Therefore, the Laffer Curve's veracity can be further assessed if the model includes other types of taxes and structures.

6. Conclusion

The findings of this paper are consistent with the prevailing academic consensus regarding the veracity of the Laffer Curve model; that is, the inherent limitations of this theory render its practical utility in real-world contexts. Specifically, within countries with a flat income tax structure, only the case of Hungary proves to align with the predictions of the Laffer Curve model. While the variations in the outcome of the studied case can be attributed to the size of the informal economy in each country and its position relative to the prohibitive range, the oversimplification of the Laffer Curve model serves as the primary reason for its lack of validity.

Nevertheless, it is essential for further research to aim to address the Laffer Curve's inherent constraints and simplifying assumptions. As much more empirical data is needed to enhance the reliability and precision of the model, future studies should aim to integrate a broader spectrum of variables, including income levels, economic growth rates, and unemployment levels. It is also ideal to introduce interaction terms into this quadratic model and integrate time-series data with lagged variables. Additionally, incorporating all kinds of taxes and tax structures into the model would further strengthen the precision of outcomes. In essence, while the quadratic model in this paper delivers a foundational framework for analyzing the accuracy of the theoretical predictions in flat-income-tax countries, a refined and more comprehensive approach should be established to fill this gap.

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