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A Short Play on the Idea of the Laffer Curve in Transition Economies

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Abstract

Very strong emotions have accompanied the idea of the Laffer Curve from the very beginning. This simple analysis does not try to solve the discussion. The author has constructed the (TBI-Tax Burden Index), a special measure of taxes. The special feature of this measure is that it tries to take into account both tax rates and tax ceilings while measuring the average taxation. The ensuing analysis gives us some evidence of the presence of some kind of the Laffer-like relationship in countries analysed. It shows that the Laffer Curve for these three countries can be bell shaped. On the other hand this relationship does not seem to play an important role in determining budget revenues in these countries. It seems that differences in revenues among countries are more the result of other factors specific to each country. Therefore, even if the main objective of a government is to maximize revenues, it should not pay to much attention to this issue, it would do much better trying to make tax system as simple as possible, minimizing both incentives and possibilities for tax evasion and tax avoidance.

1. Introduction

Very strong emotions have accompanied the idea of the Laffer Curve from the very beginning. This simple idea has both very powerful supporters such as former U.S. president Ronald Reagan, who seemed to be convinced by its transparent and easy logic and very renowned opponents such as James Tobin, who called this idea "as ancient as it is trivial" and Robert Solow. They both argumented that this idea was purely political, and that neither economic theory nor empirical research had been able prove that any relationship of this kind really existed.

This unpretentious paper does not try to solve this discussion. It is only a simple analysis based on a poor data set that tries to answer a very simple question: Does any evidence exist for the Laffer Curve, or at least some kind of a laffer-like relationship in three countries of Central Europe: the Czech Republic, Hungary and Poland.

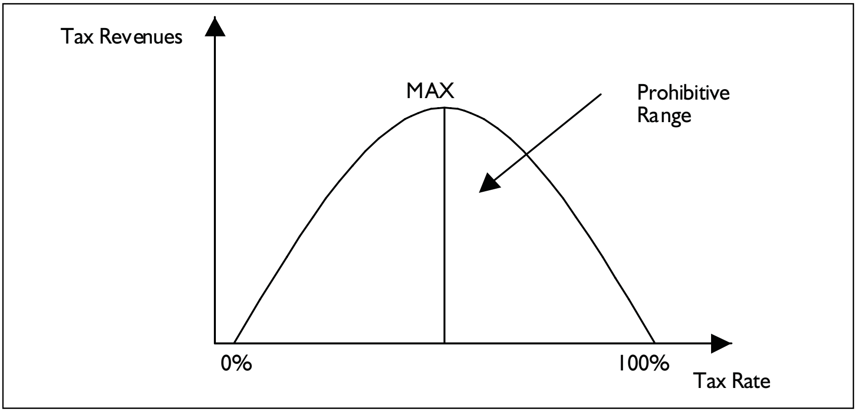
The paper is constructed in the following way. The next section presents very briefly some main theoretical argumentation and questions that have arisen around this idea during last 20 years. It also presents some results of earlier analyses. The third section explains the reader a an index of income tax rates (Tax Burden Index – TBI) that has been constructed by the author especially for this paper, the same section presents also main sources of data used in the ensuing empirical section which presents the results of statistical, graphical and econometric analysis of the data. The fifth section concludes. All tables, empirical results and empirical figures are presented in section six.

2. A Brief Remainder of the Laffer's Idea

As the popular story goes; in the end of seventies, during a meeting with Ronald Reagan Arthur Laffer drew on the napkin a curve describing the theoretical relationship between tax revenues and tax rates. The curve presented by Laffer was bell shaped (see Figure 1). It meant that after some critical point increasing taxes not only does not lead to further increase in revenues, but to make things worse revenues start to decrease. Laffer tried in this way to convince the president that lowering tax rates can lead to an increase in revenues.

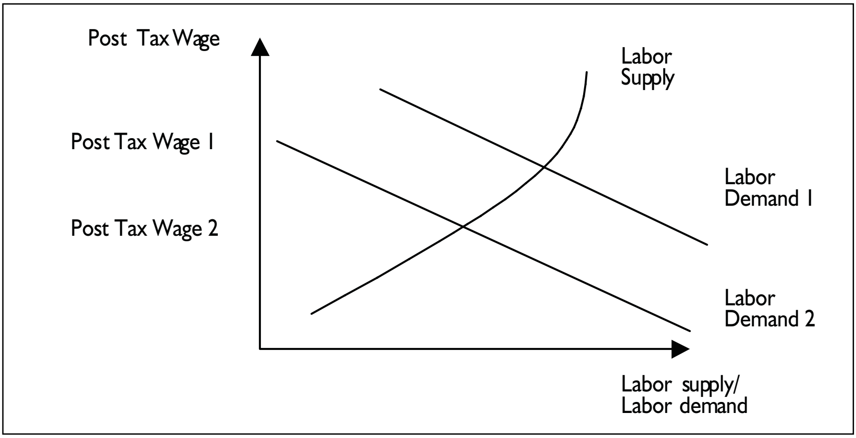
The idea underpinning this relationship seems to be quite simple. It is obvious that with taxes equal to zero there are no revenues. Therefore the left hand side end of the curve seems to be perfectly defined. Pure logic indicates that in the case of a 100% tax rate, no one would like to work and pay taxes, and therefore budget income would also be zero, or very close to zero. Therefore, under the assumption of continuity, a function describing the relationship between tax rate and budget revenues has to have some maximum. When taxes are high enough to reach the maximum of the curve (point "MAX" on the Figure 1), further increase in tax rates will lead to decrease in revenues. Laffer called the negative sloped part of the curve "the prohibitive range", (see Figure 1).

Figure 1. The Laffer Curve



The are two possible theoretical explanations for the existence of the relationship described by Laffer. The first one refers to the theory of labor supply and labor demand and can be summarized by the diagram presented in Figure 2 [1].

Figure 2. Labor supply – labor demand derivation of the Laffer Curve



[1] Mirowski (1982) is the source of this diagram.

Let us assume that the Labor Supply is a positive function of Post Tax Wage, i.e. the wage as perceived by the employee, and the Labor Demand is a function of Pre-Tax Wage, i.e. the cost of the worker perceived by the employer. In this situation the change in the tax rate leads to a shift in the Labor Demand function, when taxes increase the Labor Demand function shifts inwards (from Labor Demand 1 to Labor Demand 2 on the Figure 2). This shift leads to a decrease in the number of hours worked lowering the aggregate output, and therefore the tax-base. It leads also to a decrease in the Post Tax Wage. When this effect dominates over the positive effect of increased taxes we find ourselves on the negatively sloped part of the Laffer Curve, i.e. in its "prohibitive range".

Although the logic of the Laffer Curve presented above seems to be very attractive, there are a lot of doubts, and some of them concerning even the basic assumptions necessary to draw such a line. One of the main problems with the Laffer Curve is that it assumes the straight relationship between tax rates and hours worked, or "effort" put by the employee. However, if one wanted to investigate such a relationship with more details, one would have to take into account all changes in wages and prices being the consequence of the change in tax rates. For example, adapting quite simple general equilibrium model, it is possible to show [Malcolmson, 1986] that the Laffer Curve does not need to be continuous and may not have any interior maximum. Everything depends the on prevailing technology and the labor supply elasticity. For certain perfectly plausible shapes of production functions a more negative elasticity of labor supply implies more positive slope of the curve. The magnitude of the labor supply elasticity as such is also questionable, for example for adult males in the USA it has been shown to be close to zero [Mirowski, 1982]. Therefore Malcolmson (1986) suggests that it is impossible to determine the shape, or even existence of the Laffer Curve on a purely theoretical basis. Only empirical work can show us whether such a relationship exists or not. On the other hand, if one wanted to determine the shape of the Laffer Curve, in a really convincing manner, one would have to build a model allowing for all possible general equilibrium effects of tax increase.

With all these questions in mind, one can assume that the labor supply is not the main factor deciding about the shape of the Laffer Curve. It is perfectly plausible to assume that economic agents do not work less as taxes increase, but instead they put some of their effort into underground economy, and this is a main cause of possible budget losses. One can describe the mechanics of this process using the following formula [Sultan, 1999]:

$$B^{te}+B^{cc} <=> C^{e}+C^{h}+p^{*}i^{*}C^{r}+C^{pd}+C^{pp} \qquad (1)$$

where:

B^{te} – the amount of tax that is evaded

B^{cc} – compliance costs saved

C^e – direct costs of evading
C^h – costs of hiding evasion
p – probability/risk of being caught
i – certainty of the punishment if caught
C^r – value of the risk
C^{pd} – personal discomfort
C^{pp} – peer pressure or tax morality.

One can roughly assume that we find ourselves on the positively sloped part of the Laffer Curve as long as the left hand side of the Formula (1) is smaller then the right hand side. As soon as the total costs of tax evading become lower then the sum of tax evaded plus the costs of "paying" taxes, we can reach the prohibitive range of the curve. The higher a tax rate and the more complicated a tax system, the bigger is the probability that the left hand side of the above equation will be bigger then the right hand side. High tax rate means high B^{te}. Sophistication and lack of transparency of a tax low means both: high B^{cc} and low C^e, C^h and "p", since there are much more opportunities to evade taxes and it is much easier to hide tax evasion when a system is complicated. When the tax system is sophisticated enough it is also much easier to avoid taxes without breaking the low, therefore some cost elements simply disappear.

Adopting this way of thinking however, leads to estimating the shadow economy in order to evaluate the magnitude of the Laffer effect. Although it always seems to be very risky, there exist numerous estimations of the shadow economy both for developed and for developing countries [Kloc, 1998]. For example according to Kaufmann&Kaliberda (1995) [cited in Kuzmin, 1999], levying a 20% Value Added Tax on only the quarter of the Ukrainian shadow economy would increase budget revenues more then enough to cover the entire budget deficit. I think that these numbers let us realize of the significance of the shadow economy problem in developing countries. Hence, although there are no reasons to believe that this problem is as overwhelming in Central European Countries as it is in the former USSR, it does not mean that it is negligible.

Empirical analysis of the Laffer hypothesis has been done both in the USA and in Europe. As far as earlier papers are concerned in 1979 Canto, Joines and Webb tried to use simple ARIMA models based on the US data to estimate the effects of tax rates on Economic Activity. The results they have obtained indicated the positive effect of the Kennedy tax cut of 1964. Mariger (1995) estimated the effect of 1988 tax cut on the labor supply using the panel data of married man and women for the years 1985–1988. According to his findings this reform has increased hours worked by no more then 2 percent. Hsing (1996) using the US time series for years 1959–91 estimated that the revenue maximizing tax rate oscillates between 32.67% and 35.21%. As far as the European analyses are concerned, Van Ravenstein and Vijlbrief (1988) estimated the revenue maximizing marginal tax rate in Holland to be equal 70.1%.

3. Tax Burden Index and Sources of Data

In light of my earlier discussion neither the presence nor the shape of the Laffer Curve are as obvious as pure logic would suggest. This paper is not sophisticated enough to either prove anything or to try to estimate the functional form of the Laffer Curve. Nevertheless, it tries to examine whether there are any signs of the presence of such kind of relationship in three countries in Central Europe.

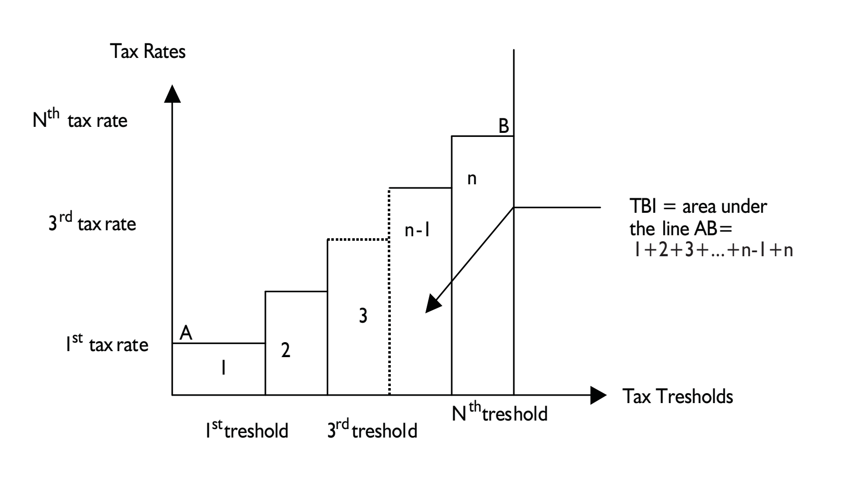
However, there is also one more problem one has to cope with when trying to analyze any relationship, variables have to be well defined and measurable. In this case it does not seem to be so easy. What one needs here, is some measure of average taxation. If one wanted to use a measure taking into account only tax rates as such, one would measure only one and not the most important factor responsible for the shape of the tax system in any country. It is easy to imagine two countries with exactly the same tax rates, but with completely different "taxes". Different structure of tax ceilings would in this case be responsible for all differences, even setting aside different tax reliefs and other differences in the details of a tax law. Therefore the measure of average taxation used in this paper has to take into account both: tax rates and tax ceilings.

A Tax Burden Index (TBI) has been constructed in the following way:

*TBI = First Tax Rate * First Ceiling + Second Tax Rate*(Second Ceiling-First Ceiling)+…+n^{th} tax rate*(n^{th} – (n^{th}–1)Tax Ceiling)* (2)

Diagram from the Figure 3 illustrates the above formula. Tax rates are represented by the vertical axis, and tax ceilings (thresholds) by the horizontal axis. TBI as defined in the Formula (2) is the area under the line AB. In fact this area is the sum of areas of the set of *n* rectangles. The area of each rectangle is defined by the tax rate, and the income bracket corresponding to this rate. For example in Poland in 1997 the first tax rate was equal 20%, and all incomes not higher then 20 870 PLN a year were taxed according to this rate. It means that the area of the first rectangles was 20%*20 870 = 4174. The second tax rate was 32% and the second tax ceiling was 41 740 PLN. It means that all incomes higher then 20 870 and lower then 41 740 were taxed according to the rate 32%. Therefore the area of the second rectangle was 32%*(41 740–20 870)=6678,4. All further rectangles are defined in the same way, and the sum of all rectangles is the TBI.

Figure 3. The definition of the TBI (Tax Burden Index)



Obviously, this definition of the TBI needs a more detailed explanations. There are two obvious problems one could notice analyzing the above definition of the TBI. The first is the way one calculates tax ceilings in order to make them comparable across countries. Clearly it would make no sense to calculate the TBI in the simple manner described by the above Polish example if one wanted to compare the TBI across the set of countries.

The second problem is the *n*th Tax Ceiling. It has to be invented for the needs of this paper. Normally, and three countries analyzed here are not an exception in this respect, only the lower limit of the last tax bracket is defined, therefore the *n*th tax ceiling does not exist at all and the area of the *n*th rectangle is infinite. It means, that the entire measure (TBI) could be exchanged be the last (highest) tax rate only. It would obviously make no sense in our case, since, as I have already mentioned, what we are trying to take into account are not only tax rates but the total tax burden i.e. the structure of tax rates and thresholds.

The first problem has been quite easy to solve in a manner that should not raise any serious doubts. Tax ceilings have been calculated in every country as a percentage of GDP-per capita in a given year. For example, in 1997 in Poland the first tax ceiling was

20 870 PLN, and GDP-per capita 11 490 PLN, hence the first "comparable" tax ceiling was 20870/11490 = 1,82 (or 182%), hence the area of the first rectangle was 1,82*20%=0,364 This method of calculating tax ceilings and the TBI seems to give us measures comparable across any group of countries.

The second problem seems to be much harder to solve, since it required decisions based on some ad-hoc assumptions and calculations and therefore it is automatically exposed to critique.

The first assumption that has been made in this paper is that the upper limit of the last tax threshold should be set equal for all countries analyzed. It seems quite clear since if one tried to set different limits for every country the measure would lose comparability. Choosing such a common limit would be quite easy if the lower limit of the last tax bracket ($n-1^{th}$ threshold) would be similar across countries, in this case the n^{th} tax ceiling could be set just "a little bit above" the $n-1^{th}$ threshold for all countries. Unfortunately this is not the case for the three countries analyzed here, the $n-1^{th}$ tax ceilings differ a lot across them.

My choice of the last (n^{th}) tax ceiling is (due to lack of other data) based on the following information. In Poland only about 1% of taxpayers have incomes above the $n-1^{th}$ tax ceiling. This ($n-1^{th}$) ceiling was for example 3,20 (320% of GDP/per capita) in 1993 and 4,33 (433% of the GDP per capita) in 1992. These are the lowest and the highest numbers for Poland. In Hungary the $n-1^{th}$ tax ceiling was about 1,5 (150% of average GDP/ per capita) in the years 1992–97 and about 10% of tax payers paid taxes according to the highest rate in years 1996–97 and almost 20% in the year 1995. On the other hand in Czech Republic the $n-1^{th}$ ceiling was about 11 (1100% of the GDP/per capita) in some years. If one wanted to chose the n^{th} tax ceiling to take into account all ceilings in this country, the TBI in Hungary and in Poland would be completely determined by the last (the highest one) tax rate, i.e. similar to the case of "infinite nth tax ceiling". Therefore, considering all three cases, I have chosen to set the n^{th} tax ceiling equal to 5 (500% of GDP/per capita) in all countries and for all years. It means that my measure does not take into account taxpayers whose incomes are more the 5 times as big as the GDP/per capita in their countries. However I hope that, bearing in mind the Polish case, where extremely low number of tax payers had incomes higher then 400% of GDP we find this number sufficiently reasonable.

This number lets to take into account all tax rates in both Poland and Hungary. In The Czech Republic during 1993–95 and in 1997 the last tax rate was excluded from calculations. However if one assumes that the percentage of taxpayers having incomes as high as 11*GDP-per capita is similar to that in Poland, this omission looks fair (I do not have data on taxpayers from the Czech Republic). *For data on tax ceilings, tax rates, taxpayers and TBI* (see Table 1).

Nevertheless, part of the analysis has been done also for the TBI calculated for the n^{th} tax ceiling equal to 4 (400% percent of GDP/per capita) and then to 6 (600% of GDP per capita). The results have not been qualitatively different than those obtained, when the TBI had been calculated with n^{th} ceiling equal to 5. Anyway I am presenting these results in the Table 8.

Most of the data for this paper comes from the paper of Magdalena Tomczyńska (1999). The data on shares of taxpayers in Hungary and in Poland comes from the national Ministries of Finance, as I have already mentioned it has not been possible to obtain similar data for the Czech Republic. The data on PIT revenues in 1997 has been taken from OECD Revenue Statistics 1965–97, and these are all estimated numbers. IFS-IMF CD-ROM XI'1998 was the source for GDP and population figures.

4. Analysis and Results

This section can be divided in two main parts. The first is a simple study based on tables and graphs. The second part presents the results of some econometric analysis.

Table 2 (see section 6) presents coefficients from the following regression run for each country separately:

$$Revenue = constant + \beta TBI .$$

These coefficients are then compared to the following variables: average budget revenues from the PIT, the average TBI in every country and average number of tax rates. We can treat the last of these as an approximation of the complexity of a tax system in a given country, and also as an additional measure of tax progressiveness, although the TBI also tries to measure it.

It should also be mentioned at this point, that in the case of the Czech Republic all tax rates have been included, not only those taken into account while calculating the TBI. In the case of Hungary the relationship between the TBI and revenues is negative. Hungary is also the country with the highest average TBI. On the other hand in Poland and in the Czech Republic the corresponding coefficients are positive. The TBIs in both countries are quite similar and much lower than in Hungary. On the other hand, the number of tax rates in Poland is much more stable (see Table 1) and smaller than in the Czech Republic. One can suspect this factor may explain the differences in the slopes of the relationship (the coefficient β) between in these two countries.

Obviously no strong conclusions can be drawn from such a simple analysis, however it can be interpreted as the prima facie evidence of the presence of some kind of Laffer Curve in these countries. Both an increase in tax rates above some critical point and extensive tax complexity result in a decrease in budget revenues.

The next step in the analysis is the inspection of graphs. Figure 4 presents the cross-plot of the TBI and revenues from the three countries analyzed. As one can see the cross-plot divides naturally in three parts, one for each country. Each part is labeled in the graph with the name of the corresponding country. In this way this cross-plot can be treated as a graphical representation of Table 2.

However if one treats the data set as a simple cross section it is possible to fit a line described by a second order polynomial function illustrating the relationship between the TBI and revenues. Since by definition the Laffer Curve has a constant point equal to zero, this restriction has been applied in this case.

The fitted line is concave, and it is the next indication of existence of the Laffer Curve in countries analyzed. Clearly, this does not prove anything, especially taking into account that in all three cases points "belonging" to one country lie on one side of this line. It would indicate that there are other important factors, specific to each country determining the PIT revenue independently of tax rates. This observation is consistent with the earlier suggestions indicating an important role for the tax system complexity, when one tries to analyze cross-country differences in PIT budget revenues.

We now come to the econometric part of the analysis. The Table 3 is an econometric extension of Figure 4. It presents the results of regressing revenues on TBI and squared TBI without the constant term. As could have been expected, the coefficients are the same as these on the graph, (slight differences observed are the result of roundings made by the econometric software). However, as one can see, although the t-statistics on the estimated coefficients are significant the overall value of this estimation seems to be very questionable. The F-statistic, (bolded) indicates that the TBI itself is not able to explain differences in PIT revenues. The Probability of F-stat equal to 0,25 means that one is not able to reject the hypothesis that the overall significance of the model is zero, for any reasonable critical value (i.e. max. 0,05).

This situation changes after including to the number of tax rates the into the model as an additional variable. Results of estimation with this variable included are presented in Table 4. The improvement in the regression results is evident. The F-statistic shows that the probability of overall insignificance of the relationship is practically zero, also all t-statistics are significant as well. The positive coefficient on the TBI and the negative coefficient on TBI^2 suggest the existence of a Laffer-like relationship between the tax burden and budget revenues.

However the results suggest also that the level of average taxes, although they are negatively correlated with budget revenues after some critical point, is not the most important factor determining revenues. In order to see this more clearly lets draw a graph with two lines corresponding to the function described by results from Table 4. For one of the lines the NUMBER OF RATES has been set to 3 (as in Poland), for the second one to 5 (similar as in the Czech Republic and Hungary). As one can see (Figure 5), two bell shaped lines have been obtained. REVENUES (on the vertical line) are almost totally determined by the distance between these to lines, and not by their nice Laffer's type shape. Additionally, this function reaches its maximum when the TBI equals 1,86 (this number means that the average single personal income tax rate should be equal to 37%, to maximize budget revenues) i.e. a number only slightly smaller then average TBI in Hungary. This means that if the NUMBER OF RATES was the same in all countries, the Hungarian government would, on average, collect the highest revenues. But it shows also that cutting taxes a little bit, would not decrease, or could even increase revenues in this country. The issue looks quite different in both Poland and the Czech Republic. In both of these countries increasing taxes would result in an increase of revenues.

Obviously interpreting the results of the above analysis in this way, one can not forget that data set used for this analysis was very poor. Both because of the short time series available, and also due to lack of other important information such as number and size of tax reliefs and the effectiveness of tax collection. On the other hand even if one tried to include information into the analysis one could find it really difficult due to a possible lack of comparability of the data and also due to extremely short time series available. Hence, one can not treat the lines presented on the graph in Figure 5 as the point estimations of real Laffer Curves. These lines only illustrate certain general tendencies.

Since analyzing a data set of this kind, treating it as pure cross section seems to be somewhat informal, pooled data analysis has been also applied. Results of two pooled regressions both of which calculated with the NUMBER OF RATES variable included are presented in Tables 5 and 6. The results of the first one, where all coefficients have been calculated as if they were common for all three countries look very similar to the previous cross section estimation. One could expect it, since this kind of analysis, like the previous (cross section) one, also calculates some average relationship for all countries. Hence, it does not take into account any differences across countries analyzed.

In the Table 6 I am presenting the results of the analysis which tries to take into account heterogeneity across our countries. Both the TBI and also the TBI^2 are estimated as cross section specific variables. It means that the coefficients of both variables: the *TBI* and the TBI^2 have been calculated separately for Hungary, Poland and the Czech Republic. The Number of Rates is treated as the common coefficient. It is not possible to treat this variable as a cross section specific, since it has not been changing in Poland during the years analyzed. The result of the analysis suggests that, when one tries to analyze our three countries separately, the Laffer effect is detectable only in Hungary. In Poland and in the Czech Republic the coefficients on the TBI^2 are not statistically significant. This result is not strange if we consider that Hungary is the only country, where the straight relationship between the TBI and revenues is negative. It means that Hungary is the only country in our group, where the Laffer Curve has really become visible. Very short time series does not let us to detect any evidence for the existence of that curve in the countries where it has not been clearly observed.

This analysis, can not be overinterpreted either. In fact it suffers from exactly the same drawbacks as the earlier two. The number of cross-section and time series observations is very small, especially when compared with relatively big number of estimated coefficients.

All estimations thus far have been performed without the intercept. Absence of a constant term biases regression statistics and especially R^2 which becomes impossible to interpret and also (in the case of pooled-regression) Durbin-Watson statistic. Therefore results of regressions with the intercept included, corresponding to those from tables 3–5 are presented in Table 7. I have not tried to estimate the regression corresponding to Table 6, since it would mean estimating 10 coefficients with 15 observations, and simply it does not make sense. Pooled-regression has been estimated by the fixed-effects method. Results change slightly, however they are not qualitatively different. Only the second cross-section equation shows that coefficients on the TBI are practically insignificant, and that the only factor that really matters for PIT revenues is tax system complexity (NUMBER OF RATES). Pooled regression do not confirm this result. Both significance and magnitude of NUMBER OF RATES coefficient decreased in pooled-estimation. One can suspect that this variable has been "replaced" by fixed effects which have not been allowed earlier. Both the shape, and limited influence of the Laffer Curve effect on tax revenues has been confirmed.

5. Conclusions

It can be claimed that this simple analysis gives us some evidence of the presence of some kind of the Laffer-like relationship in countries analyzed. It shows that the Laffer Curve for these three countries can be bell shaped. On the other hand this relationship does not seem to play an important role in determining budget revenues in this countries. It seems that differences in revenues between countries are more the result of other factors specific to each country represented by the number of tax rates. If, in spite of the poor quality of the data set and simplicity of the analysis, one treated the obtained point estimate of the revenue maximizing TBI seriously, one would conclude that both the Czech Republic and Poland are still on the positively sloped part of the Laffer Curve, while Hungary swings around the maximum. Simple correlations of the TBI and budget revenues calculated for these three countries seem to confirm this observation, although correlation coefficient between NUMBER OF RATES and REVENUES in Hungary equals –0,96. It means that it is really possible that changes in complexity of the tax system and not changes it the TBI itself decided about budget revenues in this country.

As far as policy implication resulting from this paper are concerned. It was really interesting to find some evidence of the Laffer Curve in three countries analyzed. However, taking into account all theoretical and empirical problems relating to this idea, estimating the maximum point of that curve for tax policy use seems to be extremely risky. Therefore, even if the main objective of a government is to maximize revenues, it should not pay to much attention to this issue, it would do much better trying to make tax system as simple as possible, minimizing both incentives and possibilities for tax evasion and tax avoidance.

Figure 4. Revenues and TBI in the Czech Republic, Hungary and Poland. A Cross-plot

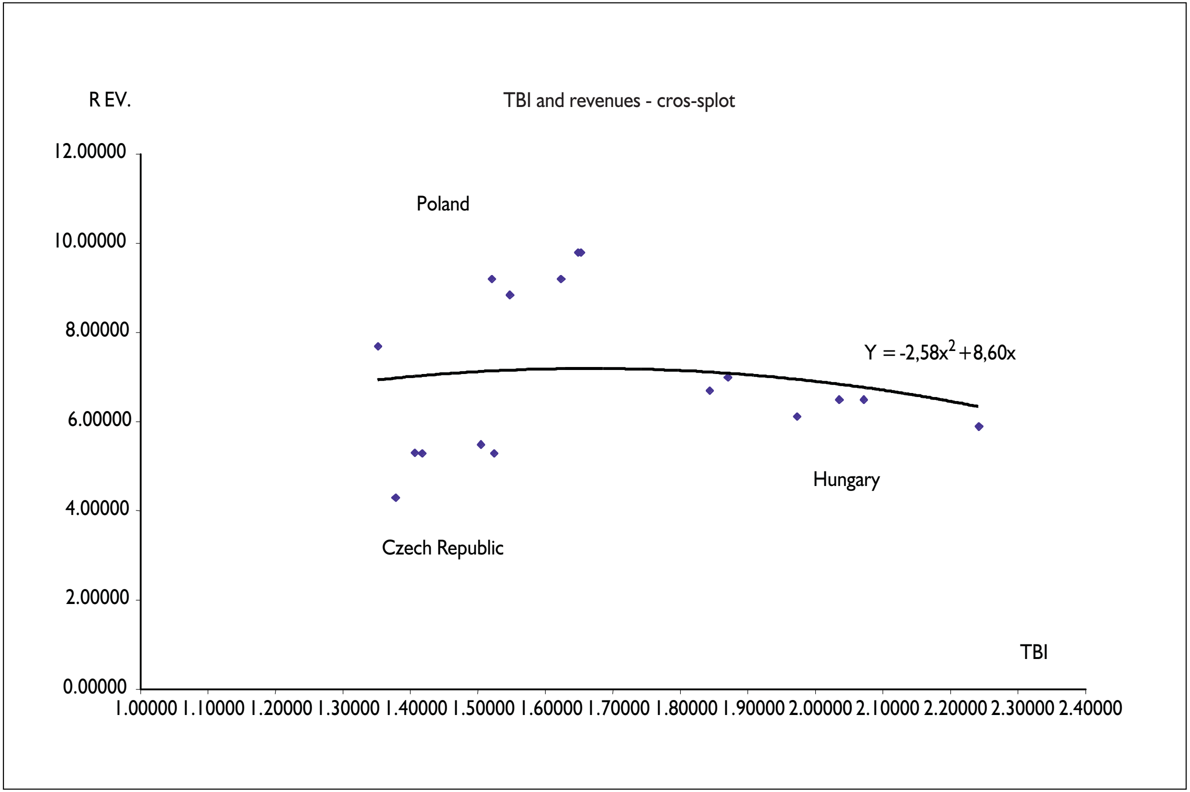


Figure 5. Estimated Laffer Curves with 3 and 5 Tax Rates

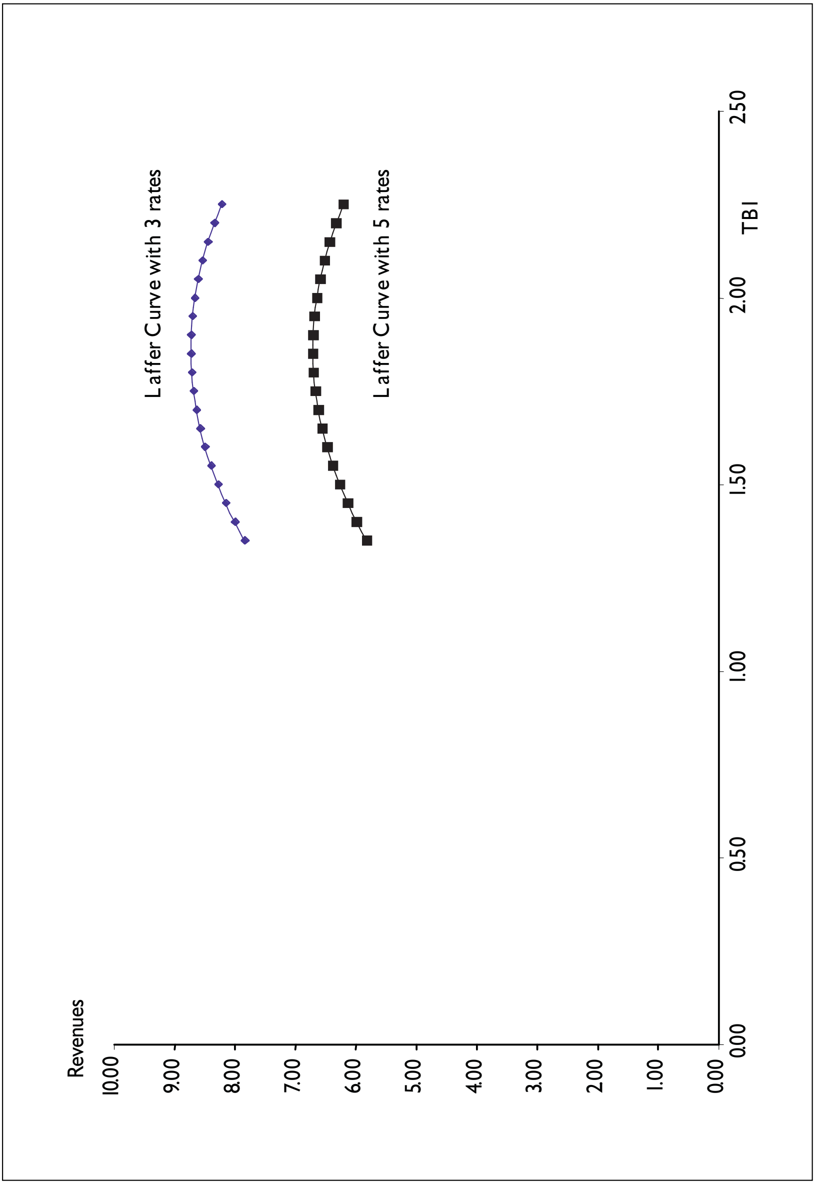


Table 2. Average revenues, TBI, and Tax Rates in the Czech Republic, Hungary and Poland, and coefficients of simple bivariate regressions of TBI on revenues in each country

	Coefficient β	REVENUE	TBI	TAX RATES
HUNGARY	-1.92	6.45	1.96	4.67
POLAND	6.49	9.09	1.56	3.00
CZECH R.	4.80	5.14	1.45	5.60

Table 3. Results of the cross section regression without intercept and Number of Rates

Dependent Variable: REVENUES
Method: Least Squares
Included observations: 17

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TBI	8.64	1.60	5.42	0.00
TBI^2	-2.59	0.89	-2.91	0.01

R-squared	0.09	Mean dependent var	7.00
Adjusted R-squared	0.03	S.D. dependent var	1.77
S.E. of regression	1.75	Akaike info criterion	4.06
Sum squared resid	45.68	Schwarz criterion	4.16
Log likelihood	-32.52	**F-statistic**	**1.42**
		Prob(F-statistic)	**0.25**

Table 4. Results of the cross section regression with Number of Rates

Dependent Variable: REVENUES
Method: Least Squares
Included observations: 17

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TBI	12.63	1.17	10.81	0.00
TBI^2	-3.39	0.53	-6.34	0.00
NUMBER OF RATES	-1.01	0.18	-5.56	0.00

R-squared	0.72	Mean dependent var	7.00
Adjusted R-squared	0.67	S.D. dependent var	1.77
S.E. of regression	1.01	Akaike info criterion	3.01
Sum squared resid	14.23	Schwarz criterion	3.16
Log likelihood	-22.61	**F-statistic**	**17.59**
		Prob(F-statistic)	**0.00**

Table 5. Results of the pooled regression with Number of Rates included

Dependent Variable: REVENUES
Method: Pooled Least Squares
Included observations: 5
Total panel observations 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TBI	13.21	1.11	11.91	0.00
TBI^2	-3.47	0.49	-7.01	0.00
NUMBER OF RATES	-1.15	0.17	-6.77	0.00

R-squared	0.81	Mean dependent var	6.97
Adjusted R-squared	0.78	S.D. dependent var	1.88
S.E. of regression	0.88	Sum squared resid	9.32
Log likelihood	-8.90	**F-statistic**	**25.82**
Durbin-Watson stat	0.92	**Prob(F-statistic)**	**0.00**

Table 6. Results of the pooled regression with the Number of Rates treated as the common coefficient and TBI and TBI^2 as the cross section (country) specific coefficients

Dependent Variable: Revenues

Method: Seemingly Unrelated Regression
Included observations: 5

Total panel observations 15

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Number of Rates	-0.28	0.02	-12.74	0.00
The Czech Republic – TBI	5.50	2.46	2.24	0.06
Poland – TBI	8.08	1.41	5.74	0.00
Hungary – TBI	8.07	0.18	43.79	0.00
The Czech Republic – TBI^2	-0.59	1.69	-0.35	0.73
Poland – TBI^2	-1.06	0.88	-1.21	0.26
Hungary – TBI^2	-2.08	0.10	-21.26	0.00
R-squared	0.98	Mean dependent var		6.97
Adjusted R-squared	0.97	S.D. dependent var		1.88
S.E. of regression	0.32	Sum squared resid		0.83
Durbin-Watson stat	2.10			

Table 8. MW Results of cross-section regression with Number of Rates for the TBI calculated with the n^{th} ceiling equal to 4 (400% of GDP/per capita) and 6 (600% of GDP/per capita)

The N^{th} ceiling = 4
Dependent Variable: Revenue
Method: Least Squares
Included observations: 17

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TBI (with the nth ceiling equal to 4)	16.68	1.46	11.42	0.00
TBI^2 (with the nth ceiling equal to 4)	-5.83	0.85	-6.89	0.00
Number of rates	-1.03	0.20	-5.20	0.00

R-squared	0.69	Mean dependent var	7.00
Adjusted R-squared	0.64	S.D. dependent var	1.77
S.E. of regression	1.06	Akaike info criterion	3.11
Sum squared resid	15.62	Schwarz criterion	3.25
Log likelihood	-23.40	F-statistic	15.40
		Prob(F-statistic)	0.00

N^{th} ceiling = 6
Dependent Variable: Revenue
Method: Least Squares
Included observations: 17

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TBI (with the nth ceiling equal to 6)	9.77	0.97	10.04	0.00
TBI^2 (with the nth ceiling equal to 6)	-1.99	0.38	-5.20	0.00
Number of Rates	-1.04	0.17	-6.00	0.00

R-squared	0.74	Mean dependent var	7.00
Adjusted R-squared	0.71	S.D. dependent var	1.77
S.E. of regression	0.96	Akaike info criterion	2.91
Sum squared resid	12.88	Schwarz criterion	3.06
Log likelihood	-21.76	F-statistic	20.17
		Prob(F-statistic)	0.00

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