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Research Article / *Araştırma Makalesi*

THE CORPORATE INCOME TAX RATE MAXIMIZING TAX REVENUES AND MARKET OUTPUT: EMPIRICAL EVIDENCE FROM THE UNITED KINGDOM, THE UNITED STATES, AND TÜRKİYE

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ABSTRACT

This study estimates the corporate income tax rate that maximizes tax revenues and market output for the United Kingdom, the United States, and Türkiye using annual data from 1986-2021. The analysis conducted through the Augmented ARDL method shows a parabolic relationship between tax revenues and the corporate income tax rate in all three countries. There is a parabolic relationship between market output and the corporate income tax rate only in the United Kingdom. The optimal corporate income tax rate that maximizes market output in the United Kingdom is 22%, while the optimal corporate income tax rate for tax revenues is 32%. The optimal corporate income tax rate that maximizes tax revenues in the United States is 43%, while the optimal corporate income tax rate for tax revenues in Türkiye is 25%. Since the current corporate income tax rate in the United Kingdom is 25%, the government can increase this rate to increase tax revenues. The current corporate income tax rate in the United States (21%) is well below the optimal rate. The government has a wide manoeuvrable area to increase tax revenues. Türkiye's current corporate income tax rate (25%) equals the optimal rate. This situation shows that Türkiye attaches more importance to tax revenues than the other two countries.

Keywords: *Optimal Tax Rate, Corporate Income Tax, Khaldun-Laffer Curve, Tax Revenue, Market Output*

JEL Classification: *H21, H25, E62, C32*

VERGİ GELİRLERİNİ VE PİYASA ÜRETİMİNİ MAKSİMİZE EDEN KURUMLAR VERGİSİ ORANI: BİRLEŞİK KRALLIK, AMERİKA BİRLEŞİK DEVLETLERİ VE TÜRKİYE'DEN AMPİRİK KANITLAR

ÖZET

Bu çalışma, 1986-2021 dönemine ait yıllık verileri kullanarak vergi gelirlerini ve piyasa üretimini maksimize eden kurumlar vergisi oranını Birleşik Krallık, Amerika Birleşik Devletleri ve Türkiye için tahmin etmektedir. Genişletilmiş ARDL yöntemi aracılığıyla yapılan analizde, üç ülkede de vergi gelirleri ile kurumlar vergisi oranı arasında parabolik bir ilişki vardır. Piyasa üretimi ile kurumlar vergisi oranı arasında ise sadece Birleşik Krallık'ta parabolik ilişki vardır. Birleşik Krallık'ta piyasa üretimini maksimize eden optimal kurumlar vergisi oranı %22, vergi gelirlerinde ise optimal kurumlar vergisi oranı %32'dir. Amerika Birleşik Devletleri'nde vergi gelirlerini maksimize eden optimal kurumlar vergisi oranı %43, Türkiye'de ise vergi gelirleri için optimal kurumlar vergisi oranı %25'tir. Birleşik Krallık'ta güncel kurumlar vergisi oranı %25 olduğu için hükümet vergi gelirlerini artırmak amacıyla bu oranı artırabilir.

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Amerika Birleşik Devletleri'nde güncel kurumlar vergisi oranı (%21) optimal oranın oldukça altındadır. Hükümetin vergi gelirlerini artırmak için geniş bir manevra alanı bulunmaktadır. Türkiye'de ise güncel kurumlar vergisi oranı (%25), optimal orana eşittir. Bu durum, Türkiye'nin diğer iki ülkeye göre vergi gelirlerine daha fazla önem verdiğini göstermektedir.

Anahtar Kelimeler: *Optimal Vergi Oranı, Kurumlar Vergisi, Haldun-Laffer Eğrisi, Vergi Gelirleri, Piyasa Üretimi*

JEL Sınıflandırması: *H21, H25, E62, C32*

1. Introduction

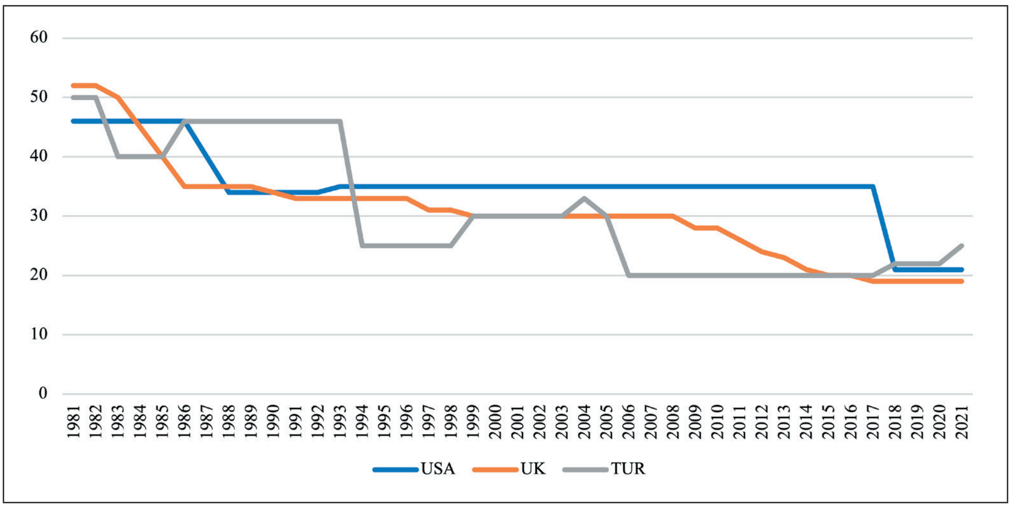
Tax revenues are critical in countries where natural resource income is limited. In these countries, taxes are the most important source of financing for public expenditures. Every government wants to collect maximum tax revenues from taxpayers. For this purpose, it changes tax rates from time to time. In particular, changes to income taxes affect the decisions of market actors in areas such as work, production, consumption, savings, and investment. Governments apply personal income tax (PIT) at a progressive rate due to concerns such as fair distribution of income and fair distribution of tax burden. However, they prefer a flat rate tariff in corporate income tax (CIT). High or progressive CIT rates negatively affect companies' investment and production decisions.

The failure of Keynesian policies in the 1970s and the increase in the size of the public economy, along with inflation and unemployment, increased interest in supply-side economic policies. Supply-side economists suggested reducing public expenditures and tax rates on income as a solution (Canto et al., 1981). The issue that policymakers think about from these suggestions is whether the reduction in tax rates will reduce tax revenues. At this point, a sentence attributed by Wanniski (1978) to Arthur B. Laffer, the chief economic advisor to then-United States (USA) President Ronald Reagan, comes to mind: "There are always two tax rates that provide the same revenue." This sentence shows a parabolic relationship between tax revenues and tax rates. He named this inverted U-shaped curve the Laffer curve. The peak of the Laffer curve is the optimal tax rate that maximizes tax revenues. According to Laffer (2004), the normal range is the area between the point where the tax rate is zero and the optimal tax rate. The prohibitive range is between the point where the tax rate is 100 and the optimal tax rate. A country in the prohibitive range increases its tax revenues if it reduces its tax rates. However, this increase in tax revenues is limited to the point where the tax rates reach the optimal rate.

Laffer (2004) stated that the historical origin of the parabolic relationship between tax revenues and tax rates is based on the work of the 14th-century philosopher Ibn Khaldun, "The Muqaddimah." According to Khaldun (1377), obtaining high tax revenues with low tax rates is possible. Because if the state reduces tax rates, individuals' desire to work increases. Similarly, the 18th-century philosopher Hume (1955) stated that high tax rates would negatively affect industrial production. In his study, Blinder (1981) stated that the relationship between tax revenues and tax rates was explained by Dupuit (1844) before the Laffer curve and that it would be more accurate to call this curve the Dupuit curve. Fullerton (1982) pointed out that Smith (1776) explained the same relationship in his famous work "The Wealth of Nations" and stated that the curve in question was the Smith-Dupuit curve. Since the origin of this curve, better known as the Laffer curve, dates back to Khaldun, we preferred to call this curve the Khaldun-Laffer curve (K-L curve), as in the studies of Adams (1981), Aktan (1989), and Şen et al. (2017).

Most studies on the K-L curve (Stuart, 1981; Krause, 2009; Vogel, 2012; Ferreira-Lopes et al., 2020) have only examined the relationship between tax revenues and tax rates. However, the K-L curve shows the effect of tax rates on tax revenues and total market output. Tax rates first maximize market output. In other words, the optimal tax rate that maximizes tax revenues is higher than the optimal tax rate in market output (Canto et al., 1981; Aktan, 1989; Laffer, 2004). Since the primary policy tool of supply-side economics is the reduction in income taxes and the number of studies analyzing the K-L curve in CIT is less than in PIT, we preferred to test the K-L curve in CIT. Among the studies analyzing the K-L curve in CIT, only Ridley & Davison (2022) investigated the effects of tax rates on tax revenues and gross domestic product (GDP) for OECD countries. With this motivation, the study aims to analyze the K-L curve in CIT for the USA, the United Kingdom (UK), and Türkiye (TUR) from 1986 to 2021. This study is the first to estimate optimal CIT rates that maximize both CIT revenues and market output for three countries, which is a unique value. Other innovations that the study brings to the literature are as follows: We also measure the success of the policies pursued by three countries in CIT, since we estimate the optimal CIT rates in the study. At the same time, we determine in which range of the K-L curve the countries are in and make inferences about the CIT policies that politicians will follow.

Figure 1: CIT Rates



The UK has been the most consistent country regarding CIT rate reductions. The CIT rate, 52% in 1981, fell to 50% in 1983, 45% in 1984, 40% in 1985, and 35% in 1986. The CIT rate gradually decreased from 1990 to 1999, at 30% in 1999-2008. The UK gradually reduced CIT rates from 2009 to 2017. The UK, which applied a CIT rate of 19% in 2017-2022, increased this rate to 25% in 2023. The USA received a CIT of 46% in the 1981-1986. This rate decreased to 40% in 1987 and 34% in 1988. The USA, which applied the CIT rate of 35%

for 25 years (1993-2017), reduced this rate to 21% in 2018. The current CIT rate in the USA is 21%. Conversely, TUR could not follow as radical and long-term policies as the USA and UK in reducing CIT rates. TUR reduced the CIT rate from 50% in 1981 to 40% in 1983 but increased it to 46% in 1986. The CIT rate, which was 46% in 1986-1993, was 25% in 1994-1998. TUR increased this rate to 30% in 1999 and 33% in 2004. The CIT rate, which was 30% in 2005, was 20% in 2006-2017. TUR gradually increased CIT rates to 25% starting in 2018 (See Figure 1). Our sample consists of the USA, UK, and TUR because the politicians most affected by supply-side economic policies in the 1980s were US President Ronald Reagan, UK Prime Minister Margaret Thatcher, and TUR Prime Minister Turgut Özal.

The following sections of the study, prepared by research and publication ethics, are as follows: The first section reviews the relevant empirical literature. The second section provides information about the dataset, model, and method. The third section reports the empirical findings obtained from the analysis and discusses the aspects of the findings that overlap and differ from the literature. The last section includes the study's results and recommendations for future studies and policymakers.

2. Related Empirical Literature

The empirical literature on the Laffer curve begins with studies such as Canto et al. (1981), Stuart (1981), and Fullerton (1982). Canto et al. (1981) analyzed quarterly data from the USA for 1951-1964 and investigated whether the K-L curve was valid in PIT and CIT. According to the study, the PIT and CIT rates applied in the USA are very close to the optimal tax rates. The tax cuts implemented by Kennedy in 1962 and 1964 did not cause a significant expansion in market production and a severe decrease in tax revenues. Stuart (1981) estimated the PIT rate that maximized Sweden's tax revenues to be 70% in 1962-1977. The PIT tax rate applied in Sweden in 1977 was 80%. Accordingly, Sweden is in the prohibitive range of the K-L curve in PIT. In addition, Sweden's current PIT rate negatively affects the economic growth rate. Fullerton (1982), who examined the relationship between PIT rates and tax revenues and labour supply elasticities in the USA, confirms that the K-L curve is in the normal range. Most of the studies that follow these studies (Bender, 1984; Browning, 1989; Hsing, 1996; Krause, 2009; Karas, 2012; Sanz-Sanz, 2016; Şen et al., 2017; Lin & Jia, 2019; Sanz-Sanz, 2022) test the K-L curve in PIT.

Although the starting point of the K-L curve is taxes on income, there are also studies analyzing the K-L curve in consumption taxes (Matthews, 2003; Trabandt & Uhlig, 2011; Mohamed Nor et al., 2013; Nourry et al., 2013; De Oliveira & Costa, 2015; Hiraga & Nutahara, 2017; Vasilev, 2018; Miravete et al., 2018). From these studies, Matthews (2003) estimated the optimal tax rate in value-added tax (VAT) to be 18.0-19.3% for 14 EU countries. The analysis results show that Denmark and Sweden are in the prohibitive range of the K-L curve, while Germany and Spain are in the normal range. De Oliveira & Costa (2015), analyzing data from 27 EU countries for 1995-2011, calculated the tax rate that maximizes VAT revenues as approximately 22%. This rate is slightly higher than the rate estimated by Matthews (2003). While many countries are in the normal range of the K-L curve for VAT, a few countries, such as Portugal, are in the prohibitive range. Trabandt & Uhlig (2011), in their analysis of the USA and EU countries, indicate that there is a rate that maximizes tax revenues for income taxes and capital taxes. However, there is no optimal tax rate for consumption taxes in the K-L curve.

Miravete et al. (2018), who analyzed the K-L curve in the excise tax on alcoholic beverages, used data from companies producing alcoholic beverages in the US state of Pennsylvania. According to the analysis results, the tax rate that maximizes excise tax revenues is lower than the applied tax rate. In other words, the K-L curve in the excise tax on alcoholic beverages in Pennsylvania is in the prohibitive range. Mohamed Nor et al. (2013) tested whether the K-L curve validates the excise tax on cigarettes in Malaysia from 1980-2009. The analysis results show Malaysia's K-L curve is in the prohibitive range. A 16.5% reduction in the excise tax on cigarettes will increase tax revenues and reduce cigarette consumption.

The number of studies analyzing the K-L curve in CIT is less than that conducted in PIT. Clausing (2007), from the studies conducted on OECD, analyzed the data of 29 OECD countries for 1969-2002 and estimated that the CIT rate that maximizes CIT revenues is 33%. This study shows a parabolic relationship between CIT and tax rate as in the K-L curve. In addition, smaller and more open economies can achieve revenue maximization with lower tax rates than other countries. Devereux (2007) investigated the relationship between CIT rates and tax revenues for 20 OECD countries from 1965 to 2004. The study's findings indicate the existence of the K-L curve in CIT, as in Clausing (2007). Like these two studies, Brill & Hassett (2007), who used data from 29 OECD countries from 1980-2005, also provide empirical evidence that the K-L curve validates CIT. According to the results of the analysis, the CIT rate that maximizes CIT revenue in the last period is 26%. On the other hand, Kawano & Slemrod (2012) analyzed data from the same group of countries from 1980 to 2008. They found the relationship between the CIT rate and CIT revenues weak. In a more recent study, Liapis et al. (2020), who examined the data from OECD countries for the period 2000-2016, obtained findings supporting the K-L curve in both PIT and CIT.

Among the studies on EU countries, Vogel (2012) tested whether there is a relationship like the K-L curve in income and consumption taxes. According to the study results, the K-L curve is parabolic in PIT and CIT, while the K-L curve is linear in consumption taxes. In addition, EU countries are in the normal range of the K-L curve in PIT and CIT. In a more recent study, Ferreira-Lopes et al. (2020) analyzed the data from 15 Eurozone countries from 1995-2011 with seemingly unrelated regression models. They estimated the optimal tax rates in VAT, CIT, and labor taxes. Especially in taxes on income, the tax rates that maximize tax revenues in Western European countries are higher than in Eastern European countries. Wald test results show that the optimal tax rates are higher in all three taxes during economic recession periods. Hájek et al. (2021), who analyzed the factors affecting CIT revenues in EU countries from 2000-2012, also found a relationship between CIT rates and CIT revenues similar to the K-L curve. Steinmüller et al. (2019) analyzed the relationship between tax revenues and tax rates using panel data from 193 countries (the most significant sample) from 1996-2016. According to the study results, countries are generally in the normal range of the K-L curve in CIT. The main reason is the tax competition between countries to attract foreign capital.

One of the first studies conducted on countries, Singhand & Jain (1999) analyzed India's data from 1950-1999. The analysis results show that reductions in the CIT rate increase CIT revenues and support the K-L curve. Gupta & Gupta (2019), who analyzed India's data for 1996-2016, estimated the tax rates that maximize tax revenues in PIT and CIT. According to the analysis results, the optimal tax rate for PIT is 53%, while it is approximately 41% for CIT. Considering the current tax rates, India is in the normal range of the K-L curve regarding both PIT and CIT.

Stinespring (2009) investigated the effect of the CIT rate applied by 50 states in the USA from 1996 to 2007 on CIT revenues. According to the study results, 22 states are in the prohibitive range of the K-L curve in CIT, while 28 states are in the normal range. Strulik & Trimborn (2012) estimated the dynamic K-L curve in the USA's PIT, CIT, and capital taxes. In the study, the K-L curve is parabolic in PIT, while the K-L curve is flatter in CIT. In a more recent study, Menichini (2020) obtained evidence of the K-L curve in CIT by analyzing firm data in the USA from 1950 to 2015. Accordingly, the CIT rate that maximizes CIT revenues is 68%.

Gomeh & Strawczynski (2020), who analyzed panel micro data of Israeli firms for 2006-2015, estimated the CIT rate to maximize CIT revenues in the range of 26-38%. This estimate is very close to the CIT rate applied by the Israeli government. Azlan Annuar et al. (2018) tested whether the K-L curve is valid in Malaysia's CIT for 1996-2014. According to the analysis results with the ARDL approach, the optimal CIT rate that maximizes CIT revenues is 25.52%. This finding supports the reductions in the CIT rate implemented in Malaysia since 1988. Şen & Bulut-Çevik (2021) estimated the rate that maximizes tax revenues in CIT for TUR by analyzing the data from 1980-2019. As a result of OLS regression and Johansen cointegration analyses, the estimated optimal CIT rate is 23.5%. This rate is very close to the CIT rate applied by the government in TUR. Mehmood et al. (2022) analyzed the K-L curve in CIT using Pakistan's data for 1991-2020. According to the threshold regression analysis results, the optimal CIT rate (26%) is lower than the current CIT rate (29%). This result supports the K-L curve and shows that Pakistan is in the prohibitive range of the K-L curve in CIT.

There are also studies investigating the effects of CIT rates on GDP and market output (Lee & Gordon, 2005; Romer & Romer, 2010; Arnold et al., 2011; Gemmell et al., 2014; Shevlin et al., 2019; Gechert & Heimberger, 2022; Ridley & Davison, 2022). However, only Ridley & Davison (2022) estimated the CIT rate to maximize GDP and CIT revenues for OECD countries. According to the results of the analysis, the optimal CIT rate that maximizes CIT revenues is 32%, while the optimal CIT rate for GDP is 26%. However, to our knowledge, no study has estimated the CIT rate that maximizes market output so far. Unlike all studies in the literature, the current study estimates the CIT rate to maximize both CIT revenues and market output. We make this estimate for three countries (the USA, UK, and TUR) that have been affected by supply-side economic policies since the 1980s.

3. Methodology

We used annual data from 1986-2021 to estimate CIT rates that maximize tax revenues and market output in the UK, USA, and TUR samples. We tested the CIT rate that maximizes tax revenues in Model 1 and the CIT rate that maximizes market output in the equations we established in Model 2. We estimated the optimal CIT rates (ctr_{opt} – Laffer peak) by taking the derivative of both tax revenues and market output concerning the CIT rate and equating it to zero (equation 3). Summary statistics of the variables we used in the models are given in Table 1. Accordingly, "ctr" indicates the CIT rate, "cit/gdp" indicates the ratio of CIT revenues to GDP, "lnindpro" indicates the logarithmic form of actual industrial production (constant 2015), and "lnrgdp" indicates the logarithmic form of real GDP. in the equations is the error term. We obtained all variables used in the models from the OECD (2024) database. In the period under review, the UK has the highest average (2.83) in the ratio of CIT revenues to GDP. This is followed by the USA (2.04) and TUR (1.50). In the industrial production to GDP ratio, the UK

(94.25) ranks first, while TUR (60) ranks last. Jargue-Bera (J-B) test statistics show that most data are normally distributed. While "ctr" and "ctr^2" are not normally distributed in the USA and TUR, "$lnrgdp_{(t-1)}$" is not normally distributed in all three countries.

$$cit/gdp_t = \beta_0 + \beta_1 ctr_t + \beta_2 ctr^2{}_t + \varepsilon_t \tag{1}$$

$$lnindpro_t = \beta_0 + \beta_1 ctr_t + \beta_2 ctr^2{}_t + \beta_3 lnrgdp_{(t-1)}\ x\ ctr_t + \varepsilon_t \tag{2}$$

$$ctr_{opt} = \frac{-\beta_1}{2\beta_2} \tag{3}$$

Table 1: Summary Statistics

Variables	Country	Mean	Med.	Max.	Min.	Std.D.	Skew.	Kurto.	J-B	Prob.
cit/gdp	UK	2.83	2.71	4.14	1.78	0.56	0.32	2.44	1.05	0.59
	USA	2.04	2.09	3.08	1.26	0.44	0.12	2.61	0.30	0.86
	TUR	1.50	1.59	2.09	0.76	0.36	-0.48	2.32	2.02	0.36
ctr	UK	0.29	0.30	0.35	0.19	0.05	-0.72	2.18	3.97	0.14
	USA	0.34	0.35	0.46	0.21	0.05	-1.52	7.60	44.25	0.00
	TUR	0.29	0.25	0.46	0.20	0.10	0.85	2.15	5.28	0.07
ctr^2	UK	0.08	0.09	0.12	0.04	0.03	-0.51	2.04	2.89	0.24
	USA	0.12	0.12	0.21	0.04	0.03	-0.45	7.90	36.20	0.00
	TUR	0.09	0.06	0.21	0.04	0.07	1.03	2.36	6.77	0.03
lnindpro	UK	94.25	96.69	108.21	73.47	10.43	-0.40	1.87	2.82	0.25
	USA	84.50	90.35	102.25	54.81	15.57	-0.63	1.86	4.22	0.12
	TUR	60.00	47.60	115.79	24.08	29.41	0.66	2.08	3.77	0.15
$lnrgdp_{(t-1)}$	UK	0.02	0.02	0.06	-0.12	0.03	-3.04	14.26	238.82	0.00
	USA	0.02	0.03	0.05	-0.03	0.02	-1.51	5.48	22.36	0.00
	TUR	0.04	0.06	0.11	-0.06	0.04	-0.92	3.04	4.90	0.09

The method of this study is cointegration analysis. To determine the stationarity levels of the variables, we applied the PP unit root test developed by Phillips & Perron (1988), which is among the traditional unit root tests, and the LS unit root test developed by Lee & Strazicich (2003), which also takes into account structural breaks. We preferred the ARDL bounds test approach that Pesaran et al. (2001) suggested in the cointegration analysis. In order to apply the ARDL bounds test, the variables must be stationary at different levels, and no series must be stationary in the second difference (Göksu, 2023: 384). The mathematical forms of the ARDL models are given in equations (4) and (5).

$$cit/gdp_t = \beta_0 + \sum_{i=1}^{l} \beta_{1i}\,\Delta cit/gdp_{t-i} + \sum_{i=0}^{l} \beta_{2i}\,\Delta ctr_{t-i} + \sum_{i=0}^{l} \beta_{3i}\,\Delta ctr^2{}_{t-i} + \beta_4 cit/gdp_{t-1} + \beta_5 ctr_{t-1} + \beta_6 ctr^2{}_{t-1} + \sigma_t \tag{4}$$

$$lnindpro_t = \gamma_0 + \sum_{i=1}^{l} \gamma_{1i}\, \Delta lnindpro_{t-i} + \sum_{i=0}^{l} \gamma_{2i}\, \Delta ctr_{t-i} + \sum_{i=0}^{l} \gamma_{3i}\, \Delta ctr^2{}_{t-i} + \sum_{i=0}^{l} \gamma_{4i}\, \Delta lnrgdp_{(t-1)}\; x\; ctr_{t-i} + \gamma_5 indpro_{t-1} + \gamma_6 ctr_{t-1} + \gamma_7 ctr^2{}_{t-1} + \gamma_8 lnrgdp_{(t-1)}\; x\; ctr_{t-1} + \sigma_t \quad (5)$$

In the equations, "Δ" represents the first difference operator, "*l*" represents the lag length, "$\beta_1, \beta_2, \beta_3$" and "$\gamma_1, \gamma_2, \gamma_3$" represent the short-term coefficients, "$\beta_4, \beta_5, \beta_6$" and "$\gamma_4, \gamma_5, \gamma_6$" represent the long-term coefficients, "β_0" and "γ_0" represent the constant term, and "σ_t" represents the residual value. Pesaran et al. (2001) proposed the overall F-bounds test (F_{OVR}) that considers the lagged values of the dependent and independent variables in the ARDL approach. In addition, the test that only considers the dependent variable's lagged value is the t-bounds test (t_{DV}). McNown et al. (2018) and Sam et al. (2019) developed the augmented ARDL (A-ARDL) approach, which takes into account only the lagged values of the independent variables in explaining the dependent variable. This approach suggests the exogenous F-bounds test (F_{IDV}) and the F_{OVR} and t_{DV}. We used the unrestricted error correction model (UECM) to estimate the short-term coefficients. The mathematical forms of the UECM equations of both models are given in equations (6) and (7), respectively.

4. Empirical Findings

Before starting the cointegration analysis, we applied PP and LS unit root tests to determine the stationarity levels of the data. According to the unit root test results, none of the variables are I(2). The variables in the models are stationary at different levels. PP unit root test results are in Table 2, and LS unit root test results are in Table 3. We considered the LS unit root test results when deciding on the stationarity levels of the data.

Since the variables are stationary at different levels and most of the dependent variables are I(0), we used the A-ARDL method in the cointegration relationship. The F_{OVR}, t_{DV}, and F_{IDV} statistics obtained from this method were compared with the critical values calculated by Narayan et al. (2005), Pesaran et al. (2001), and Sam et al. (2019), respectively. The A-ARDL bounds test results are given in Table 4.

When the statistical values of F_{OVR}, t_{DV}, and F_{IDV} tests, which take into account the lagged values of both the dependent variable and the independent variables, are compared with the critical values, there is a cointegration relationship in all models. In the UK, USA, and TUR, the ratio of CIT revenues to GDP, CIT rates, and the square of the CIT rates move together in the long run (model 1). In addition, in all three countries, total market output, CIT rates, the square of the CIT rates, and the product of the one-period lagged value of GDP, and the CIT rate move together in the long run (model 2).

The short-term and long-term coefficients estimated in the A-ARDL bounds test and the diagnostic test results are given in Table 5. In the long term, the coefficient of the CIT rate for model 1 is 19.76 in the UK, 10.16 in the USA, and 15.95 in TUR, and is significant at the 1% level. The coefficient of ctr^2 is -31.41 in the UK, -11.76 in the USA, and -31.66 in TUR, and is significant at the 5% level in the UK and USA and 1% level in TUR. Based on these coefficients, according to the formula in equation (3), the CIT rate that maximizes tax revenues is 32% in the UK, 43% in the USA, and 25% in TUR. In the short term, the ECT coefficient is negative and significant at 1% in all three countries.

In the long term, the coefficient of the CIT rate for model 2 is 11.55 in the UK and is significant at the 5% level. The coefficient of ctr^2 is -26.25 in the UK and is significant at the 1% level. Based on these coefficients, the CIT rate that maximizes market output according to the equation (3) formula is 22% in the UK. The ECT coefficient is negative and significant at 1% in the short term. Although the models are significant and the variables are cointegrated in the USA and TUR, the CIT ratio that maximizes market output is not calculated because the coefficients are not statistically significant.

Table 2: PP Unit Root Test Results

PP Test		Level			First difference			
Variables	**Country**	**C**	**C&T**	**No C&T**	**C**	**C&T**	**No C&T**	**Result**
cit/gdp	UK	-2.4541 [0.1353]	-2.5382 [0.3091]	-1.0345 [0.2650]	-3.9796^{a} [0.0043]	-3.8821^{b} [0.0243]	-4.0391^{a} [0.0002]	I(1)
	USA	-2.0921 [0.2489]	-1.8725 [0.6466]	-0.6265 [0.4385]	-3.4949^{b} [0.0145]	-3.3920^{c} [0.0698]	-3.4944^{a} [0.0010]	I(1)
	TUR	-1.1264 [0.6939]	-2.6621 [0.2575]	0.2288 [0.7466]	-6.2025^{a} [0.0000]	-6.2565^{a} [0.0001]	-6.2466^{a} [0.0000]	I(1)
ctr	UK	0.3937 [0.9797]	-1.6365 [0.7569]	-2.4863^{b} [0.0145]	-4.8354^{a} [0.0004]	-4.8773^{a} [0.0022]	-3.8287^{a} [0.0004]	I(1)
	USA	-2.1176 0.2393	-2.5152 0.3193	-1.7583^{c} 0.0748	-5.4500^{a} 0.0001	-5.5290^{a} 0.0004	-5.3359^{a} 0.0000	I(1)
	TUR	-1.7210 [0.4120]	-1.9991 [0.5810]	-1.5610 [0.1099]	-5.5295^{c} [0.0001]	-5.5832^{c} [0.0003]	-5.4586^{c} [0.0000]	I(1)
ctr^2	UK	0.0717 [0.9587]	-1.8846 [0.6404]	-2.6193^{b} [0.0104]	-5.1584^{a} [0.0002]	-5.1200^{a} [0.0012]	-4.1285^{a} [0.0002]	I(1)
	USA	-3.0641^{b} [0.0390]	-3.3567^{c} [0.0744]	-2.0911^{b} [0.0368]				I(0)
	TUR	-1.7710 [0.3879]	-1.9281 [0.6181]	-1.9257^{c} [0.0528]	-5.6145^{a} [0.0001]	-5.7004^{a} [0.0003]	-5.5318^{a} [0.0000]	I(1)
lnindpro	UK	-1.6389 [0.4523]	-1.7437 [0.7094]	1.4038 [0.9571]	-3.7347^{a} [0.0080]	-3.6843^{b} [0.0377]	-3.5106^{a} [0.0009]	I(1)
	USA	-2.0428 [0.2681]	-0.7299 [0.9624]	1.3814 [0.9552]	-3.4304^{b} [0.0169]	-3.4956^{c} [0.0564]	-3.5000^{a} [0.0010]	I(1)
	TUR	1.4982 [0.9990]	-1.2924 [0.8729]	5.7269 [1.0000]	-4.6312^{a} [0.0008]	-5.0952^{a} [0.0012]	-3.3369^{a} [0.0015]	I(1)
$lnrgdp_{(t-1)}$ x ctr	UK	-1.9824 [0.2928]	-2.9189 [0.1694]	-1.8704^{c} [0.0593]	-5.2097^{a} [0.0002]	-5.1482^{a} [0.0011]	-5.2080^{a} [0.0000]	I(1)
	USA	-2.8625^{c} [0.0604]	-3.3645^{c} [0.0732]	-1.8505^{c} [0.0619]	-10.3056^{a} [0.0000]	-10.6399^{a} [0.0000]	-8.8458^{a} [0.0000]	I(1)
	TUR	-6.1512^{a} [0.0000]	-6.4840^{a} [0.0000]	-3.9075^{a} [0.0003]				I(0)

Notes: "(c) Sig. 10%", "(b) Sig. 5%", "(a) Sig. 1%. Results are C&T. SIC was used.

Table 3: LS Unit Root Test Results

Variables	Level			First difference			Decision
	Lag	Break Years	t-stat.	Lag	Break Years	t-stat.	
UK							
cit/gdp	4	1987-1992	-4.000941**	-	-	-	I(0)
ctr	1	1989-2009	-2.916962	4	2007-2014	-6.584793***	I(1)
ctr^2	3	1988-1996	-1.085307	4	2010-2013	-8.107346***	I(1)
lnindpro	2	2005-2016	-3.583516**	-	-	-	I(0)
$lnrgdp_{(t-1)}xctr$	1	1989-2007	-3.215333	1	1998-2006	-3.647829**	I(1)
USA							
cit/gdp	1	2010-2016	-5.713866***	-	-	-	I(0)
ctr	2	1993-2015	-1.846695	0	1993-1995	-3.611233**	I(1)
ctr^2	2	1993-2015	-1.854860	0	1994-2014	-3.594521**	I(1)
lnindpro	1	1993-1996	-2.090047	0	1992-2010	-3.593653**	I(1)
$lnrgdp_{(t-1)}xctr$	0	1995-2017	-3.196583	0	1992-2016	-5.713352***	I(1)
TUR							
cit/gdp	4	2005-2012	-4.336116***	-	-	-	I(0)
ctr	0	1991-2017	-1.997634	0	1995-1997	-5.223607***	I(1)
ctr^2	0	1992-2017	-1.949824	0	1991-1997	-4.869275***	I(1)
lnindpro	4	2000-2010	-1.855616	0	1992-2006	-3.596724**	I(1)
$lnrgdp_{(t-1)}xctr$	1	1991-1997	-4.474909***	-	-	-	I(0)

Notes: “(*) Sig. 10%”, “(**) Sig. 5%”, “(***) Sig. 1%”. Results are C&T. SIC was used.

Table 4: A-ARDL Cointegration Results

UK		**Test Statistics**	**Model 1**	**Model 2**
Model 1	Model 2	F_{OVR}	3.30**	10.63***
f (cit/gdp | ctr, ctr^2)	f (lnindpro | ctr, ctr^2, $lnrgdp_{(t-1)\,x}$ ctr)	t_{DV}	-2.98**	-3.02**
ARDL (2, 1, 0)	ARDL (1, 1, 0, 1)	F_{IDV}	4.95**	11.91***
k:2 m:2 n=35	k:3 m:2 n=34	Cointegration	Yes	Yes
USA		Test Statistics	Model 1	Model 2
Model 1	Model 2	F_{OVR}	8.68***	6.33***
f (cit/gdp | ctr, ctr^2)	f (lnindpro | ctr, ctr^2, $lnrgdp_{(t-1)\,x}$ ctr)	t_{DV}	-5.08***	-5.33***
ARDL (2, 0, 0)	ARDL (1, 1, 1, 2)	F_{IDV}	12.82***	7.38***
k:2 m:2 n=35	k:3 m:2 n=34	Cointegration	Yes	Yes
TUR		Test Statistics	Model 1	Model 2
Model 1	Model 2	F_{OVR}	4.16**	7.84***
f (cit/gdp | ctr, ctr^2)	f (lnindpro | ctr, ctr^2, $lnrgdp_{(t-1)\,x}$ ctr)	t_{DV}	-2.12**	-5.89***
ARDL (1, 1, 1)	ARDL (1, 0, 0, 0)	F_{IDV}	5.72***	9.60***
k:2 m:2 n=34	k:3 m:2 n=34	Cointegration	Yes	Yes

Notes: The study estimates the model according to case #III. F_{OVR}: Narayan (2005); t_{DV}: Pesaran et al.(2001); F_{IDV}: Sam et al.(2019).

Table 5: A-ARDL Results

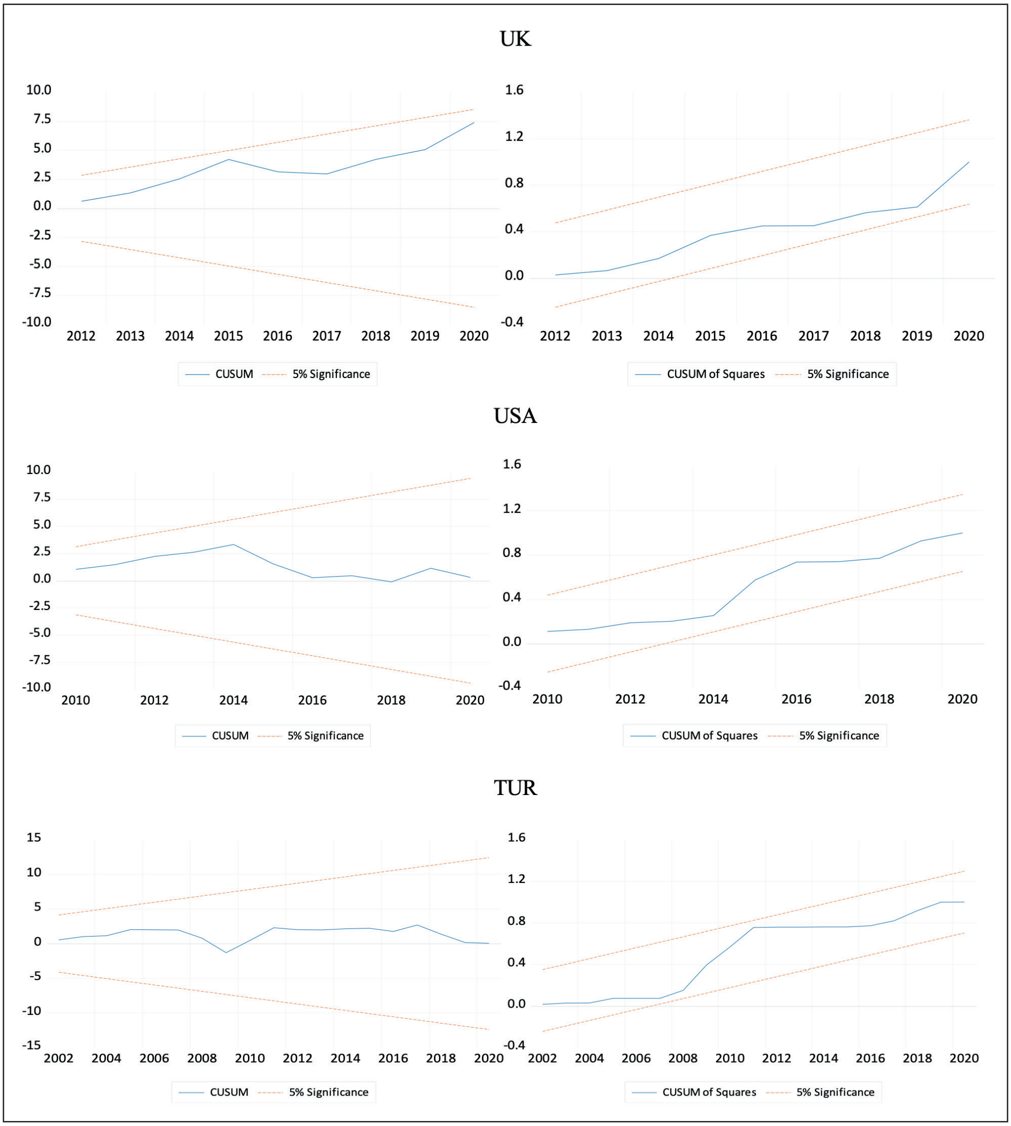
Model 1	**UK**			**USA**			**TUR**		
A) Long Run	coef.	t-stat.	p-value	coef.	t-stat.	p-value	coef.	t-stat.	p-value
ctr	19.76	4.45	0.0001	10.16	5.36	0.0000	15.95	5.89	0.0000
ctr^2	-31.41	-2.23	0.0338	-11.76	-2.19	0.0361	-31.66	-4.34	0.0002
B) Short Run									
D(cit/gdp(-1))	0.38	2.63	0.0135	0.66	5.54	0.0000	-	-	-
D(ctr)	17.70	2.72	0.0110	-	-	-	16.49	3.57	0.0013
D(ctr^2)	-	-	-	-	-	-	-24.26	-3.52	0.0015
Dummy	-0.22	-0.72	0.4776	-0.55	-2.72	0.0108	-0.34	-2.36	0.0256
CointEq(-1)*	-0.33	-3.26	0.0029	-0.53	-5.27	0.0000	-0.18	-3.66	0.0010
C) Diagnostic Tests	test value		p-value	test value		p-value	test value		p-value
X^2_{SC}	0.35		0.8383	0.75		0.6873	4.12		0.1275
X^2_{FF}	3.11		0.0890	4.18		0.0730	0.12		0.7354
$X^2_{NORM(J-B)}$	0.23		0.8919	2.01		0.3670	0.41		0.8154
$X^2_{HET(BPG)}$	7.09		0.3124	1.33		0.9316	2.42		0.8771
$X^2_{HET(ARCH)}$	1.05		0.3067	0.98		0.3218	0.01		0.9144
Cusum/$Cusum^2$	Stable			Stable			Stable		
Model 2	**UK**			**USA**			**TUR**		
A) Long Run	coef.	t-stat.	p-value	coef.	t-stat.	p-value	coef.	t-stat.	p-value
ctr	11.55	2.44	0.0219	-4.98	-0.45	0.6540	3.053	0.37	0.7135
ctr^2	-26.25	-3.01	0.0058	10.63	0.51	0.6142	-2.88	-0.31	0.7557
$lnrgdp_{(t-1)}xctr$	18.20	2.75	0.0108	21.37	0.58	0.5664	-15.03	-0.55	0.5876
B) Short Run									
C	-0.62	-7.08	0.0000	6.25	6.75	0.0000	7.50	8.49	0.0000
D(ctr)	3.69	6.62	0.0000	-2.76	-3.07	0.0053	-	-	-
D(ctr^2)	-	-	-	3.01	3.01	0.0060	-	-	-
D($lnrgdp_{(t-1)}xctr$)	1.23	3.22	0.0034	4.16	8.36	0.0000	-	-	-
D($lnrgdp_{(t-1)}xctr$) (-1)	-	-	-	7.16	1.42	0.1693	-	-	-
Dummy	-5.59	-3.33	0.0026	-5.47	-3.28	0.0032	-0.35	-0.13	0.8977
CointEq(-1)*	-0.18	-6.46	0.0000	-0.01	-5.34	0.0000	-0.01	-5.89	0.0000
C) Diagnostic Tests	Test value		p-value	Test value		p-value	Test value		p-value
X^2_{SC}	2.14		0.3426	1.35		0.5088	3.75		0.1537
X^2_{FF}	0.33		0.5678	1.21		0.2831	0.08		0.7753
$X^2_{NORM(J-B)}$	1.66		0.4372	2.18		0.3371	1.19		0.5505
$X^2_{HET(BPG)}$	2.96		0.8887	0.22		0.9782	4.35		0.5003
$X^2_{HET(ARCH)}$	0.22		0.6400	2.61		0.1059	0.66		0.4179
Cusum/$Cusum^2$	Stable			Stable			Stable		

Notes: Dummy UK: 2002; USA: 2001; TUR: 2004 in model 1. Dummy UK: 2011; USA: 2009; TUR: 2001 in model 2.

According to the diagnostic test results, no serial correlation and heteroscedasticity problem exists in all models established for the three countries. All models are suitable for normal distribution, with no functional form error. Cusum test results show that all established models are stable within the 95% confidence interval.

Figure 2: Cusum and Cusum SQ Test Results (Model 1)

Figure 3: Cusum and Cusum SQ Test Results (Model 2)



5. Conclusion and Result

This study estimates the CIT rate that maximizes tax revenues and market output and uses annual data from 1986-2021. We established two separate models while estimating the optimal CIT rate for the UK, USA, and TUR. Model 1 estimates the CIT rate that maximizes tax revenues, and model 2 estimates the CIT rate that maximizes market output. At the same time, this study questions whether the K-L curve is valid in CIT.

According to the A-ARDL bounds test results, there is a cointegration relationship for tax revenues in the long run. The coefficients of the independent variables in the model are statistically significant. These results confirm the K-L curve for CIT in all three countries. This finding is consistent with the results obtained by Devereux (2007), Clausing (2007), Kawano & Slemrod (2012), and Liapis et al. (2020), who confirmed the K-L curve in CIT. The variables are also cointegrated in the model estimating the optimal CIT rate in market output. However, the long-term coefficients of the independent variables are statistically significant only in the UK. Therefore, the K-L curve is valid in the UK regarding market output but not in the USA and TUR.

Based on the long-term coefficients of the independent variables, the optimal CIT rate that maximizes tax revenues for the UK is 32%, and the CIT rate that maximizes market output is 22%. These results are consistent with the basic assumption of the K-L curve that market output will be maximized before tax revenues (Canto et al., 1981; Aktan, 1989; Laffer, 2004). The UK increased its CIT rate from 19% to 25% in 2023. This rate is lower than the optimal CIT rate we estimated for tax revenues (32%) but higher than the optimal CIT rate we estimated for market output (22%). In other words, the UK is in the normal range of the K-L curve for tax revenues. However, it has moved into the prohibitive range for market output.

The optimal CIT rate that maximizes tax revenues in the USA is 43%. The USA reduced its CIT rate from 35% to 21% in 2018. This rate is well below the optimal CIT rate we estimated for tax revenues (43%). The K-L curve is valid for the CIT applied in the USA. However, the USA is within the normal range of the K-L curve regarding tax revenues. This finding supports the finding of Menichini (2020), who concluded that the K-L curve is valid for the USA from 1950 to 2015. However, Menichini (2020) estimated the optimal CIT rate to be much higher (68%). In addition, the finding obtained for the USA in this study differs from Strulik and Trimborn (2012), who estimated the K-L curve linearly.

The CIT rate that maximizes tax revenues in TUR is 25%. TUR increased the CIT rate from 20% in 2006-2017 to 25% in 2018. Therefore, the optimal tax rate is applied in CIT for TUR. In CIT, TUR is at the peak of the K-L curve. This finding is consistent with the study by Şen & Bulut-Çevik (2021), which found the K-L curve valid. In addition, the optimal CIT rate estimated by Şen & Bulut-Çevik (2021) (23.5%) and the rate we estimated in this study (25%) are very close to each other.

The policy implications that emerge from the findings of the study are as follows: The fact that the optimal CIT rate for tax revenues in the UK is 32%, the optimal CIT rate for market output is 22%, and the current CIT rate is 25% indicates that the UK can increase the CIT rate to increase tax revenues. However, the current rate is above the optimal CIT rate for market output, indicating that increases in the CIT rate will reduce market output. The optimal CIT rate that maximizes tax revenues in the USA (43%) is higher than the current rate (21%). The USA can increase the CIT rate to increase tax revenues. However, it should not be ignored that the CIT rate increase may negatively affect market output due to the cost element. The current CIT rate of TUR is equal to the optimal CIT rate we estimated in this study. Considering that TUR is a developing country, the CIT rate can be reduced in sectors that create high-added value. Estimating different optimal CIT rates in the three countries we examined in this study requires tax policies to be designed differently in each country. In addition, tax policies should be implemented dynamically in terms of budget balance, market output, and new investments.

This study estimates optimal CIT rates for only three countries from 1986 to 2021. In future studies, optimal CIT rates can be estimated for countries such as the EU, OECD, and developed countries. Since tax revenues do not consist solely of CIT revenues, it can be tested whether the K-L curve is valid for each tax levied on income and expenditure. If the optimal tax rate can be applied to each tax, it will be easier for countries to achieve a budget balance.

Conflict of Interest

There is no conflict of interest.

Author Contributions

Since a single author writes the study, the author contribution rate is 100%.

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