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Estimating the Total Tax Gap Based on the Size of the Shadow Economy

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The scientific problem of estimating the size of the tax gap is the interpretation of the tax gap results. Many interpretations focus on a single number, ignoring the context of the methodology and data source used or the evolution of GDP. This paper examines the variability of tax gap estimates and the high dependence of the output on the chosen methodology, keeping the assessment of the shadow economy as the first step in estimating the tax gap. The study collects and deploys all the known methods used to estimate the total tax gap and identifies the spread of estimation using the case study of the Czech Republic's gap for the period of 1993–2012 evaluation. The paper analyzes data from official sources such as the OECD, the EU, the CSO, the Ministry of Finance and Tax Administration reports. The first part of the analysis estimates the size of the shadow economy using the most common estimation methods. Due to the variability of the methods used, the results show the range of different values with a surprisingly high variability between 2.2 per cent and 19.5 per cent for the year 2012. Based on the previous results of the shadow economy, the amount of total tax gap of the Czech Republic for the period 1993–2012 is determined. The range of the values is wide, based on the method of estimating the size of the shadow economy. The results are presented in the context of other previously realized estimates and compared with the results of relevant studies. The most important finding of the study is the confirmation of the wide range of the tax gap results, which theoretically eliminates any possible simplified approach to the interpretation of the size of the tax gap.

Keywords: *Tax Gap; Shadow Economy; GDP; Revenue Collection; Tax Evasion; Tax Administration.*

Introduction

Tax evasion is one of the factors impeding tax revenue mobilization (Dare, du Plessis & Jansen, 2019). According to the Internal Revenue Service (IRS), the tax gap is the difference between what taxpayers should pay and what they really paid on time (Internal Revenue Service, 2012). According to Majerová (2016), the tax gap arises from three main areas of noncompliance with the tax law: firstly - underreporting of income, second - underpayment of taxes, and third - failure to file tax returns. Overall, the tax gap may indirectly involve the so-called offshore centers with a high level of banking secrecy (Picard & Pieretti, 2011). Even small states of the European Union try to identify their competitive advantage in different areas (Arter, 2000), some of them choose the path of fiscal competitive advantage (Gaidelys, 2016). Her Majesty's Revenue and Customs (HMRC) defines the tax gap as the difference between the tax that is really paid and the tax that should be paid if all individuals and companies declared their activities and transactions correctly, in accordance with the legislation in force (the letter of the law) and the intentions of the legislator (the spirit of the law) (HM Revenue and Customs, 2013). The tax gap is adjusted by the results of the control checks by the tax authorities (HM Revenue and Customs, 2013). The Swedish Skatteverket defines the tax gap as the *difference between* the *tax* that *would have been* determined – if *all taxpayers* had reported *all their activities* and *transactions correctly*- and the tax that is actually reported. (Swedish National Tax Agency, 2008).

The concept of tax gap is described in the article by Mazur and Plumley (2007). They explain the concept of the tax gap, discuss how it is estimated and point out some limitations of the estimates. Branham (2009) reports that within the tax gap, underreporting of individual income accounts for more than half of the uncollected revenue. Hajek & Olexova (2022) examine the relation between the tax gap and various forms of tax evasion in relation to personal income tax. Uryszek & Klonovska (2022) investigate the extent of fiscal unsustainability in Poland and estimate that the tax gap is necessary to stabilize the size of the public debt and follow a path towards fiscal sustainability.

Lederman (2010) declares that the tax gap can potentially be reduced by implementing sophisticated information evaluation tools and the appropriate application of reporting requirements. The actual issue of the importance of the information reporting obligation is aimed in particular, at the elimination of the sales tax gap already mentioned by Montano (2010). An effective policy of neutralizing and minimizing tax differences is possible only if there is evidence-based research into all channels of confidentiality of income and the determination of the volume of each (Tiutiunyk, Kobushko & Ivaniy, 2019).

In most countries, the tax gap is measured only in indirect taxes, particularly VAT. Canikalp, Unlukaplan & Celik (2016) determined the VAT gap in Turkey in the

period 1993-2014 based on the European Commission reports using the top-down method. The VAT gap importance has been increasing and becoming a political challenge together with the taxation burden shift from direct taxes to indirect taxes, particularly the VAT worldwide (Warren & McManus, 2007).

The European Union and its member states are also primarily concerned with measuring the VAT gap, because contributions to the EU budget are paid according to the amount of VAT collected, and at the same time VAT collection is the largest share of the collection tax collection - about 40 %. Andrejovska, Koneecna &Hakalova (2020) examined the relationship between the tax gap and VAT tax revenues and selected determinants of tax evasion in the EU member states.

The Czech Republic, as an EU member state, is obliged by the Commission Decision No. 98/527/EC on the treatment for national accounts purposes of VAT fraud (the discrepancies between theoretical VAT receipts and actual VAT receipts) to calculate the value of tax evasion of this tax.

The Czech Statistical Office and the Directorate General of Customs are responsible for the implementation of this Decision. Article 1 states that the Member States shall calculate the value of VAT evasion without the complicity of the purchaser using the methods set out in the Annex to this Decision (European Commission, 1998). For the purposes of the above calculation, the Member States shall determine theoretical VAT receipts and actual VAT receipts and calculate the discrepancy between these two amounts using the following formula: Evasion "without complicity" is equal to theoretical VAT receipts less actual VAT receipts less time differences less bankruptcies less missing revenue (evasion "with complicity"). Article 2 states that in order to make the adjustment described in Article 1, the Member States may apply a method which is equivalent to that described in the first subparagraph of Article 1, and which produces comparable results (European Commission, 1998).

As the estimates of the size of the shadow economy and the tax gap are used by the policy makers as a strict argument to apply important and irreversible steps, especially in the area of tax policy, the aim of this article is to verify the validity of the estimates of the tax gap using different methods, their variability and to identify the range of the estimates using the Czech Republic data as a case study.

The tax gap is one of the key motives for major fiscal policy changes at the national and especially at the supranational level, such as the EU and the OECD. Often, only a single number is mentioned and used as an argument. This can be misleading information, since it is not in context with the methods used. This fact is the motivation for the author's research.

The scientific problem consists in the fact that there is no study comparing the results of different methods, which underlines the necessity of a strict interpretation of the tax gap results within the limits of the methods and data used.

This study brings a novel approach to the estimate and understanding of the tax gap using almost all existing methods in a demonstrative way, limited only by data availability.

The main objective of the study is to verify the disproportion of the results of different methods and to identify the range of the estimated results for the shadow economy and, subsequently, for the total tax gap.

The partial objective of the study is to apply the methods to the concrete case of the tax gap estimate – the Czech Republic in this paper, demonstrating the high variability of the selected state tax gap results.

The methods of estimating the tax gap presented in this paper are based on the assessment of the shadow economy over the period of *1993–2012*. The reason for choosing this time series is the availability of data, which shows significant delays in all sources. Given the main objective of the paper (to verify the imbalance of methods), the age of the period is not relevant. All assessment methods are described in detail in the Methodology section of this paper.

According to many authors (e.g. Kundeliene, Stankevicius & Kabasinskas, 2016; Petre, Rodica & Vizoli, M., 2019), this area requires continuous extension of research and monitoring of results in order to address the phenomenon of tax avoidance and evasion.

Theoretical Background

The tax gap can be measured in two steps. The first step is to determine the theoretical tax liability, and the second step is to subtract the actual tax collected from this theoretical liability. The micro (direct) or macro (indirect) method can be used to determine the theoretical tax liability can be used.

Micro methods include tax audits and tax surveys. In some countries, such as the United States of America (Toder, 2007), the UK (HM Revenue & Customs, 2012) and Sweden (Swedish National Tax Agency, 2008), the tax audits are used to determine the shadow economy. Based on a random sample of taxpayers, the tax administration carries out a detailed audit of their income and expenditure in order to uncover untaxed or not fully taxed income. This method provides detailed information on the structure and persons involved in the tax gap. (Schneider & Enste, 2000) The disadvantage resides in the fact that there are only audits of registered taxpayers or filed tax returns with limited validity highly dependent on the previous tax control effectiveness.

Macro methods are based on a detailed analysis of national accounts. The method based on national accounts focuses on measuring the VAT tax gap. There are two procedures: 1) Calculation based on the use of spreadsheets – commodities are divided into approximately 500 items, each is assigned a corresponding VAT rate, then the theoretical VAT collection is calculated, from which the actual VAT collection is deducted. 2) Calculation based on nominal GDP adjusted for VAT-exempt items. It uses a consumer method of calculating GDP. This procedure uses more aggregated data than the preceding procedure, hence it can only be used to define the trend. Methods based on measuring the shadow economy consist in two steps: the first step is to calculate the size of the shadow economy, and the second step is to calculate the theoretical tax collection, from which the actual tax collection is then substracted. The shadow economy does not only mean illegal activities, but also unreported income from the production of legal goods and services, both from monetary and barter transactions. It can be said that the shadow economy includes all activities that would generally be taxable if they were reported to the state (tax) authorities (Schneider & Enste, 2002), see Table 1.

Table 1

Activities Included in the Informal Economy (*Source: Schneider & Enste, 2002*)

Type of activity	**Monetary transactions**		**Non-monetary transactions**	
Illegal	Trade with stolen goods; drug dealing and manufacturing; prostitution; gambling; smuggling and fraud.		Barter of drugs, stolen goods, and smuggling. Producing or growing drugs for person use. Theft for own use.	
Legal	**Tax evasion**	**Tax avoidance**	**Tax evasion**	**Tax avoidance**
	Unreported income from self-employment. Wages, salaries and other assets from unreported work related to legal market of goods and services	Employee discounts and fringe benefits	Barter of legal goods and services	All do-it-yourself work and all neighborly help

Tanzi (2002) identifies four main causes leading to the rise of shadow economy: taxes, regulations, prohibitions and corruption. Albulescu, Tamasila & Taucean (2016) investigated the effect of taxation, corruption and financial stability on the shadow economy in 23 OECD countries. Their findings support the idea that excessive tax burden, financial instability, and institutional weaknesses rank among the factors influencing the shadow economy and subsequently the tax gap value (Albulescu, Tamasila & Taucean, 2016). Dang, Nguyen & Tran (2022) analyze the effects of corruption and institutional quality on shadow economy to test the hypothesis of greasing and sanding the wheels of corruption.

Freytag, Schneider & Spiegel (2022) examine the relation between a change of the overall index of economic freedom and the change of the shadow economy in 141 countries over the period 2000-2007. They results demonstrate that first, the higher the economic freedom, the lower is the shadow economy, and second, the effects are asymmetrically, they are stronger when economic freedom increases than in the case of a decrease. Mazhar & Meon (2017) observe a relation between inflation and the size of the shadow economy, and a relation between the tax burden and the size of the shadow economy. According to Goel & Nelson (2017), the bureaucratic complexity is more significant than monetary severity in driving the shadow economy. The improvement of the tax system towards the investment-friendly environment can have a decisive influence on the size of the tax gap and especially on the economic growth (Kindsfateriene, & Lukaševicius, 2008).

The shadow economy can be measured by using direct and indirect methods. Direct methods are based on individual (micro) data and include surveys and audits. Indirect methods are based on mass (macro) data (Schneider & Enste, 2000).

The advantage of the direct method of selective survey resides in the opportunity to obtain detailed information about the structure of the shadow economy and its participants. The disadvantage and its limit are the sensitivity of formulated questions, the memory of respondents when surveying retrospective data. Moreover, respondents are not always willing to admit their participation in the shadow economy and their reluctance may affect the outcome of the whole survey. (Schneider & Enste, 2000). Schneider has data for the Czech Republic for the period 1999–2007 and 2003–2012 (Schneider, 2013). Selective surveys in the Czech Republic are conducted by Hanousek and Palda (2002; 2006) and they dispose of the shadow economy estimates for 1995, 1997, 1999, 2000, 2002 and 2004.

In 2000, 2002, and 2004 they conducted surveys of samples of 1,062, 1,041 and 1,066 people. In each of these surveys they inquired retrospectively about previous years. In 2000, they asked about the years 2000, 1999, and 1995; in 2002 they inquired about the years 2002, 2000, and 1997; and in 2004 they inquired about the years 2004, 2002, and 1999. Using statistical analysis, they found that there was no statistically significant difference between the data obtained retrospectively and those obtained for a particular year during another selective survey. We can say that the respondents remember well their past tax evasion (Hanousek & Palda, 2006).

Indirect methods include the discrepancy method, the labor market method, the physical input method (electricity consumption), the transaction method, and the currency demand method (Schneider & Enste, 2002).

The discrepancy method is based on the difference between income and expenditure of the national accounts, which should be equal. It is theoretically assumed that the income of the national accounts is correct, and the difference between it and expenditure is an indicator of the shadow economy. In fact, this established part is not the whole size of the shadow economy, because already during the formation of the national accounts there is a kind of refilling using different statistical methods, which leads to distortions (Schneider & Enste, 2000). The theoretical assumptions might not be met and the methods cannot be applied.

The labor market method compares the official data on participation in the labor market with data from comparable countries or with data from previous periods in the same country. A certain limitation and disadvantage is that, in the chosen base period, it is considered that the participation in the shadow labor market is zero. If the same data on (un) employment are used by two different people, and each chooses a different base period, each person gets a different estimate of the shadow economy for prior and future periods (Frey & Pommerehne, 1984). For this reason, the obtained values can only serve as a lower bound for estimates. The next step may be to multiply the obtained values by the labor productivity on the informal labor market, and so we get the volume of shadow economy.

The method of physical output (the electricity consumption method) is based on the fact that electricity consumption goes through the overall economy and all its activities; therefore, it is possible to use it to determine the size of the shadow economy (Schneider & Enste, 2000). Two methods based on energy consumption can be used to measure the shadow economy. The Kaufmann-Kaliberda method assumes that the development of electricity consumption and the development of GDP are elastic. (Kaufmann & Kaliberda, 1996). The difference between the development of electricity consumption and GDP denotes the growth or decline of the shadow economy. The main weakness of this method is the need to determine the size of the shadow economy for the base year, so the limit of validity is that rather than the size, this method sets the trends.

The Lackó method explores the relationship between electricity consumption and other factors such as its price, the shadow economy, the tax to GDP ratio, expenditure on public services to GDP ratio, and the number of months in which it is necessary to heat (Lacko, 2000). The author also made estimates for the Czech Republic; see Table 2.

Table 2

The Ratio of the Shadow Economy to the Official GDP in the Czech Republic (*Source: Lacko, 2000*)

Year	1989	1990	1991	1992	1993	1994	1995
The ratio of shadow economy (as % of GDP)	6.0	6.7	12.9	16.9	16.9	17.6	21.8

The transaction method is based on the assumption that both the official and shadow economies use money to carry out transactions and that there is a relationship between the number of transactions, the velocity of money circulation, and the gross domestic product. It is based on the quantity theory of money. Firstly, the period in which the shadow economy was at zero is determined. The difference between the base period and the actual nominal income is made up by the shadow economy. Important for the calculation itself is the year in which there were no transactions in the shadow economy were carried out and this value can significantly distort the calculation. It is assumed that any discrepancy must be due to the shadow economy, but the circulation of money and its amount are also influenced by other factors (payment cards, internet banking) (Feige, 1990). The predictive value of the method is limited and might vary in different states based on the popularity of local cash payments.

The currency demand method is based on the assumption that there is a constant ratio (C/D) between the quantity of money in circulation (C) and demand deposits (D). We choose the period in which the shadow economy is zero, and we find the actual ratio of C and D. By calculating the ratio of actual money supply to actual demand deposits, the value of C* can be determined, corresponding to the amount of money needed for the formal economy. If C-C* is multiplied by the velocity of money circulation (V), the size of the shadow economy will be found out for a given year. This method, as well as the transaction method, theoretically assumes that currency transactions in the shadow economy are carried out in cash. The main weakness of this method is that it is necessary to choose the year in which the shadow economy did not participate in the amount of money and the demand for it. Another weakness is the inability to determine whether the velocity of money circulation in the shadow economy is the same as in the official economy. It can be higher, assuming that in the shadow economy everything accelerates, but also lower, considering that incomes remain hidden for some time (Barthelemy, 1988).

Ekici & Besim (2016) preferred another approach. They measured the size of the shadow economy in North Cyprus using micro-econometric methods, calculating its implications on national accounts and fiscal balances.

Methodology

To measure the shadow economy in the Czech Republic, the procedures based on collective data are selected because the direct method is primarily used by tax administration (tax audits), and these procedures are too expensive and time-consuming (large surveys) and can provide distorted information.

To calculate the total shadow economy (in % of GDP), the method of physical output based on the electricity consumption (electricity method) is used:

$$S_t = S_{t-1} (1 + 1/\mu * gEt - gYt) \quad (1)$$

where S_t is the shadow economy in year t, gEt is the annual development of electricity consumption, gYt is the annual development of GDP, μ is the elasticity of electricity consumption and GDP development. This method is sensitive to the estimate of the shadow economy in the base year, so for the base year 1993 the estimate of the shadow economy by Kaufmann and Kaliberda and also by Lackó is used. The calculation of the shadow economy is also based on the estimates of Hanousek and Palda for the base year 1995.

Another method used to calculate the shadow economy in the Czech Republic in the period 1993–2012 is the labor market method. It is used to determine how many people participated in the shadow labor market. This method assumes that the development trend of the economically active persons/population over 15 years of age and employed persons/population aged over 15 is stable. The proportion of the economically active population in the total population over 15 years of age and the proportion of employed population in the population over 15 years of age are determined. The difference observed between these proportions for individual years is then determined. The smallest difference over the whole period is subtracted from the difference for a given year and then multiplied by the population over 15 years of age in that year. The result is the number of people participating in the shadow economy in a given year.

In addition, the currency demand method is used to calculate the shadow economy in the Czech Republic. It assumes that there is a permanent relationship between the amount of currency in circulation and demand deposits. When calculating the shadow economy using this method, data on the volume of currency in circulation, the velocity of money in the economy, and the volume of demand deposits

are used. The data were obtained from the ARAD and CZSO databases. The calculation of the shadow economy is based on the currency demand method:

$$SE = (C\text{-}C^*)*V \quad (2)$$

$$C^* = D_t*C/D_{(base\ year)} \quad (3)$$

$$V = GDP/M_1 \quad (4)$$

where C is the amount of currency in circulation, C^* is the amount of currency in circulation in the official sector, V is the velocity of money in the economy, D_t are demand deposits in a given year, D (base year) are demand deposits in the base year, GDP is gross domestic product at current year prices, and M_1 is the monetary aggregate.

To be able to detect tax evasion on the basis of identified estimates of the shadow economy, several conditions must be met: there must be a strong correlation between GDP and tax collection, and the amount of tax quota in the formal and informal economies should be identical. Depending on the basis of the correlation between tax collection and the size of GDP, a linear regression function is formed:

$$y = a + bx \quad (5)$$

where y is the annual tax collection and x is GDP, $R^2 = 0.983936433700733$

The following data on tax collection and gross domestic product for the period 1993-2012 were used for the calculation (Tables 3 and 4).

Table 3

Gross Domestic Product in the Czech Republic at Current Prices (in CZK mil.) (*Source: CZSO, 2016*)

Year	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
GDP	1,144,645	1,323328	1,533,676	1,761,575	1,884,924	2,061,583	2,149,023	2,269,695	2,448,557	2,567,530
Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
GDP	2,688,107	2,929,172	3,116,056	3,352,599	3,662,573	3,848,411	3,758,979	3,790,880	3,823,401	3,845,926

Table 4

Tax Collection in the Czech Republic (in CZK mil.) (*Source: Customs Administration of the Czech Rep. and CZSO, 2016*)

Year	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Total Tax collection	230,338	266,933	300,072	328,296	340,121	365,528	391,804	400,801	440,201	473,771
Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Total Tax collection	507,696	551,387	628,270	633,614	715,953	739,894	653,988	686,694	702,026	724,125

To calculate tax evasion, the Czech Republic's gross domestic product at current prices, tax collection in the Czech Republic, and the volume of the shadow economy in the Czech Republic as a percentage of gross domestic product are needed. For the calculation of hypothetical tax evasion, estimates of the shadow economy by Hanousek & Palda (2006) and by Schneider, Buehn & Montenegro (2010), and Schneider (2013) were also used. A linear regression function was created to calculate the theoretical tax collected:

$$y_t = a + bx \quad (6)$$

where y_t is the theoretical amount of tax collected and x is the total economy.

Hypothetical tax evasion for the period 1993-2012 was calculated as the difference between theoretical and actual tax collection:

Hypothetical tax evasion = theoretical amount of tax collected – actual amount of tax collected (7)

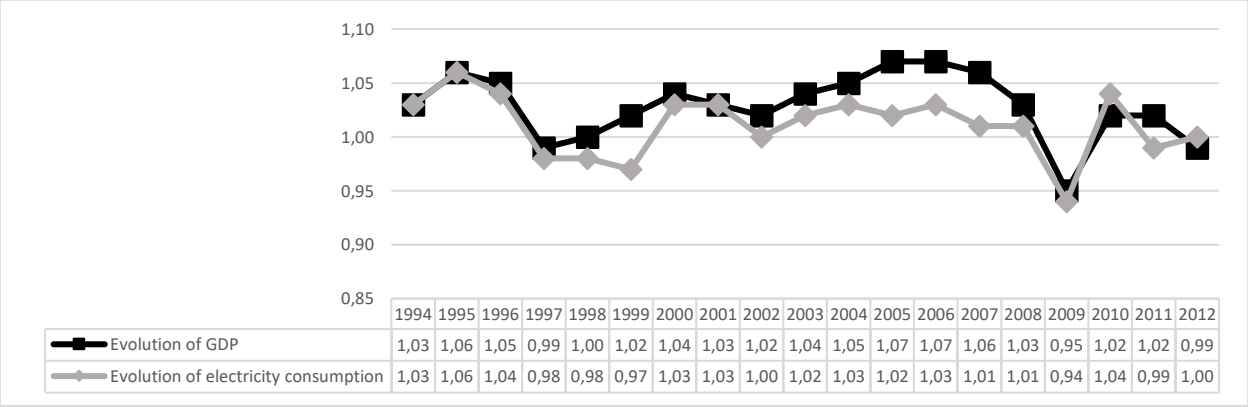
Due to the differences in the methods described above, it can be assumed that the range of the size of the shadow economy calculated by the different approaches is in the order of tens of percent.

Based on the data availability, the authors selected most of the existing methods, which are commonly published in scientific articles or methods mentioned by the General Financial Directorate of the Czech Republic in partial information or mentioned by the OECD (e.g., 2011).

Results

Measuring the Shadow Economy: The Physical Output Method (Electricity Consumption Method)

To determine the shadow economy using this method, it is necessary to determine the size of the shadow economy in the year 0. For the year 1993, the estimate of Kaufmann and Kaliberda was used: 16.9%. The unit of elasticity was chosen. The evolution of GDP and the evolution of electricity consumption are copied (Figure 1).



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Evolution of GDP	1,03	1,06	1,05	0,99	1,00	1,02	1,04	1,03	1,02	1,04	1,05	1,07	1,07	1,06	1,03	0,95	1,02	1,02	0,99
Evolution of electricity consumption	1,03	1,06	1,04	0,98	0,98	0,97	1,03	1,03	1,00	1,02	1,03	1,02	1,03	1,01	1,01	0,94	1,04	0,99	1,00

Figure 1. Evolution of GDP and Electricity Consumption (*Source: Own Elaboration, Data: CZSO*)

This method is therefore very sensitive to estimating the shadow economy in the base year. A time series of electricity consumption and GDP was constructed from 1993 to 2012. For the base year, the estimates of Kaliberda and Kaufmann (1993, 16.9 %), Lackó (1993, 27.1 %), and Hanousek and Palda (1995, 15.8 %) were used. The calculated data show a downward trend, which is more meaningful in terms of this method than the percentage size of the shadow economy, which is highly dependent on the chosen size of the base year (see Table 3).

Table 5

Volume of the Shadow Economy in % of GDP - the Physical Output Method (Electricity Consumption Method) (*Source: own elaboration*)

Estimate of the shadow economy – Electricity consumption method - Hanousek and Palda							
Year	**GDP (in CZK mil.)**	**GDP (growth)**	**Electricity (GWh)**	**Electricity consumption**	**Shadow economy (in % of GDP)**	**Shadow economy (in CZK mil.)**	**Total activity (GDP + SE)**
1995	2,328,028		52,155		15.80	367,828	2,695,856
1996	2,433,713	1.0454	54,146	1.0382	15.69	381,750	2,815,463
1997	2,412,965	0.9915	53,163	0.9818	15.53	374,850	2,787,815
1998	2,407,271	0.9976	52,196	0.9818	15.29	368,046	2,775,317
1999	2,447,696	1.0168	50,855	0.9743	14.64	358,328	2,806,024
2000	2,550,148	1.0419	52,292	1.0283	14.44	368,249	2,918,397
2001	2,629,135	1.0310	53,775	1.0284	14.40	378,663	3,007,798
2002	2,685,643	1.0215	53,581	0.9964	14.04	377,092	3,062,735
2003	2,786,789	1.0377	54,781	1.0224	13.83	385,321	3,172,110
2004	2,918,955	1.0474	56,388	1.0293	13.58	396,294	3,315,249
2005	3,116,056	1.0675	57,664	1.0226	12.97	404,060	3,520,116
2006	3,334,815	1.0702	59,421	1.0305	12.45	415,245	3,750,060
2007	3,526,071	1.0574	59,752	1.0056	11.81	416,324	3,942,395
2008	3,635,344	1.0310	60,478	1.0122	11.58	421,140	4,056,484
2009	3,471,494	0.9549	57,112	0.9443	11.46	397,902	3,869,396
2010	3,557,216	1.0247	59,255	1.0375	11.61	412,958	3,970,174
2011	3,621,908	1.0182	58,634	0.9895	11.28	408,415	4,030,323
2012	3,584,924	0.9898	58,708	1.0013	11.41	408,882	3,993,806

Measuring the Shadow Economy: The Labor Market Method

A time series of economically active/population over 15 years of age and employed population/population over 15 years of age was created from 1993 to 2012. It was found that their development does not follow the same trend. The smallest difference was found in 1996, which was used as a base year with zero participants in the shadow labor market.

Table 6

Participation in the Shadow Labor Market (*Source: Own Elaboration*)

Year	**Economically active**	**Employed**	**Population over 15 years of age**	**Average monthly salary**	**Labor force/ Population over 15 years of age**	**Employed/ Population over 15 years of age**	**Difference**	**Extent of participation in the shadow labor market**	**Number of people participating in the shadow labor market**
1993	5,094	4,873	8,293	5,904	0.6142	0.5877	0.0265	0.0027	22,326
1994	5,148	4,927	8,355	7,004	0.6162	0.5897	0.0265	0.0026	21,931
1995	5,171	4,963	8,406	8,307	0.6151	0.5903	0.0247	0.0009	7,568
1996	5,173	4,972	8,448	9,825	0.6124	0.5886	0.0238	0.0000	0
1997	5 185	4,937	8,487	10,802	0.6109	0.5817	0.0293	0.0054	45,906
1998	5,201	4,866	8,523	11,801	0.6103	0.5709	0.0394	0.0155	132,459
1999	5,218	4,764	8,555	12,797	0.6099	0.5569	0.0531	0.0292	250,076
2000	5,186	4,732	8,586	13,219	0.6040	0.5511	0.0529	0.0291	249,735
2001	5,146	4,728	8,577	14,378	0.5999	0.5512	0.0488	0.0249	213,705
2002	5,139	4,765	8,599	15,524	0.5976	0.5541	0.0435	0.0197	169,070
2003	5,132	4,733	8,637	16,430	0.5942	0.5480	0.0462	0.0224	193,167
2004	5,133	4,707	8,673	17,466	0.5918	0.5427	0.0491	0.0253	219,030
2005	5,174	4,764	8,716	18,344	0.5936	0.5466	0.0471	0.0232	202,288
2006	5,199	4,828	8,773	19,546	0.5926	0.5503	0.0423	0.0185	162,058
2007	5,198	4,922	8,845	20,957	0.5877	0.5565	0.0312	0.0074	65,390
2008	5,232	5,002	8,944	22,592	0.5850	0.5593	0.0257	0.0018	16,534
2009	5,286	4,934	9,009	23,344	0.5868	0.5477	0.0391	0.0152	137,295
2010	5,269	4,885	9,015	23,864	0.5844	0.5419	0.0426	0.0187	168,644
2011	5,223	4,872	8,965	24,455	0.5826	0.5435	0.0391	0.0153	136,766
2012	5,257	4,890	8,965	25,112	0.5864	0.5455	0.0409	0.0171	153,099

Measuring the Shadow Economy: The Currency Demand Method

The ratio of currency in circulation to demand deposits was calculated for the period from 1993 to 2012. The lowest ratio was for the year 1993, and this year was chosen as a base year with zero size of the shadow economy. It has been found that the velocity of money in the economy, which is influenced by the emergence of cashless payment systems, has a significantly larger effect than the ratio of demand deposits to currency in circulation. For this reason, the values calculated by this method cannot be considered indicative of the shadow economy.

Table 7

Participation in the Shadow Labor Market (*Source: own elaboration*)

Year	M1	C	D	C/D	C*	C-C*	V	GDP	SE	SE as % of GDP	SE+GDP
1993	282,975	46,300	236,675	0.1956	46,300	0	4.05	1,144,645	0	0.00	1,144,645
1994	349,217	73,317	275,900	0.2657	53,973	19,343	3.79	1,323,328	73,299	5.54	1,396,627
1995	388,692	91,675	297,017	0.3087	58,104	33,571	3.95	1,533,676	132,461	8.64	1,666,137
1996	421,950	110,525	311,425	0.3549	60,923	49,602	4.17	1,761,575	207,080	11.76	1,968,655
1997	400,675	117,200	283,475	0.4134	55,455	61,745	4.70	1,884,924	290,470	15.41	2,175,394
1998	380,200	119,883	260,317	0.4605	50,925	68,958	5.42	2,061,583	373,918	18.14	2,435,501
1999	416,550	140,242	276,308	0.5076	54,053	86,188	5.16	2,149,023	444,654	20.69	2,593,677
2000	479,300	166,275	313,025	0.5312	61,236	105,039	4.74	2,269,695	497,405	21.92	2,767,100
2001	540,400	173,983	366,417	0.4748	71,681	102,302	4.53	2,448,557	463,533	18.93	2,912,090
2002	716,576	188,452	528,124	0.3568	103,315	85,136	3.58	2,567,530	305,048	11.88	2,872,578
2003	827,827	213,460	614,367	0.3474	120,187	93,273	3.25	2,688,107	302,876	11.27	2,990,983
2004	933,988	231,356	702,631	0.3293	137,454	93,903	3.14	2,929,172	294,498	10.05	3,223,670
2005	1,011,707	251,378	760,329	0.3306	148,741	102,637	3.08	3,116,056	316,122	10.14	3,432,178
2006	1,163,002	278,602	884,400	0.3150	173,012	105,589	2.88	3,352,599	304,383	9.08	3,656,982
2007	1,328,392	310,602	1,017,790	0.3052	199,107	111,494	2.76	3,662,573	307,407	8.39	3,969,980
2008	1,447,104	336,195	1,110,909	0.3026	217,324	118,871	2.66	3,848,411	316,124	8.21	4,164,535
2009	1,573,768	356,276	1,217,493	0.2926	238,174	118,101	2.39	3,758,979	282,088	7.50	4,041,067
2010	1,767,498	354,716	1,412,782	0.2511	276,378	78,338	2.14	3,790,880	168,017	4.43	3,958,897
2011	1,939,929	364,717	1,575,212	0.2315	308,154	56,563	1.97	3,823,401	111,480	2.92	3,934,881
2012	2,101,651	383,031	1,718,620	0.2229	336,208	46,823	1.82	3,830,466	85,339	2.23	3,915,805

It is important to note that these figures on the shadow economy can only serve as a lower limit for estimates of the shadow economy and give an idea of the development of the shadow economy. This is because this method is based on the fact that in one year, the shadow economy was zero. The change in the velocity of money circulation in the economy caused by the introduction of cashless payment systems has a more significant impact on the development of the calculated value than the C-C*.

In order to be able to tax the shadow economy, there must be a strong correlation between the amount of GDP and tax collection, and it is necessary to assume that the tax rates in the shadow and official economies are identical. It has been proven that there is a strong correlation between the amount of GDP and tax collections since the coefficient of determination for the observed relationship is 0.9839.

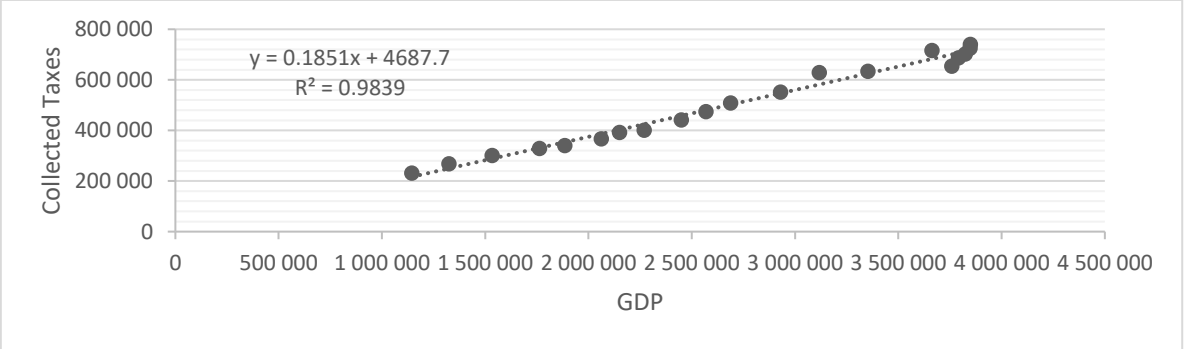


Figure 2. Relationship between the Taxes Collected and the GDP Evolution (*Source: own elaboration*)

A linear regression function was then formulated:

$y = 4687.72686185624 + 0{,}185093369949385x$

$R^2 = 0.983936433700733$

To calculate the hypothetical tax evasion, the gross domestic product at current prices, tax collection, and the volume of the shadow economy as a percentage of GDP must be known (Schneider & Buehn 1999–2007, Schneider, Buehn & Montenegro 1999-2007, Schneider 2003–2012, Hanousek & Palda 1995, 1997, 1999–2002, 2004, 2006, author's calculations 1993–2012).

The volume of the shadow economy in the Czech Republic in the period 1993–2012, according to the above-mentioned authors and our own calculations, is presented in Table 8.

The volume of the total economy was then calculated. The theoretical tax revenue was calculated by substituting it into the linear regression function. The hypothetical tax evasion amount is calculated as the difference between the theoretical and actual tax collected (Table 9).

Table 8

Participation in the Shadow Labor Market

		1993	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
1	Buehn, Schneider							19.3	19.1	18.9	18.8
2	Schneider, Buehn, Montenegro							18.9	19.1	19.3	19.4
3	Schneider										
4	Hanousek, Palda´ survey 2000			15.8				20.3	25.1		
	Hanousek, Palda´ survey 2002					23.1			25.9		23.9
	Hanousek, Palda ´ survey 2004							22.2			23.2
	Hanousek, Palda´ survey 2006									21.2	
	Hanousek, Palda´ average			15.8		23.1		21.25	25.5	21.2	23.55
Author´s calculations	Currency demand method	0.0	5.5	8.6	11,8	15.4	18,1	20.7	21.9	18.9	11.9
	Electricity consumption method – Kaufmann, Kaliberda	16.9	17.0	16.9	16,8	16.6	16,3	15.6	15.4	15.4	15.0
	Electricity consumption method - Lackó	27.1	27.2	27.1	26,9	26.6	26,2	25.1	24.7	24.7	24.1
	Electricity consumption method - Hanousek, Palda			15.8	15,7	15.5	15,3	14.6	14.4	14.4	14.0
		2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
1	Buehn, Schneider	18.7	18.4	17.8	17,3	17.0					
2	Schneider, Buehn, Montenegro	19.5	19.8	20.4	20,9	21.2					
3	Schneider	19.5	19.1	18.5	18,1	17.0	16.6	16.9	16.7	16.4	16.0
4	Hanousek, Palda´ survey 2000										
	Hanousek, Palda´ survey 2002										
	Hanousek, Palda´ survey 2004		21.4								
	Hanousek, Palda´ survey 2006		23.4		22.0						
	Hanousek, Palda´ average		22.4		22.0						
Author´s calculations	Currency demand method	11.3	10.1	10.1	9.1	8.4	8.2	7.5	4.4	2.9	2.2
	Electricity consumption method - Kaufmann, Kaliberda	14.8	14.5	13.9	13.3	12.6	12.4	12.2	12.4	12.0	12.2
	Electricity consumption method - Lackó	23.7	23.3	22.2	21.3	20.2	19.8	19.6	19.9	19.3	19.5
	Electricity consumption method - Hanousek, Palda	13.8	13.6	13.0	12.5	11.8	11.6	11.5	11.6	11.3	11.4

Table 9

Hypothetical Tax Evasion (in CZK mil.)

Year		**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
1	Buehn, Schneider							87,423	104,232	103,355	95,493
2	Schneider, Buehn, Montenegro							85,832	104,232	105,168	98,345
3	Schneider										
4	Hanousek, Palda´ average			33,341		94,047		95,180	131,119	113,779	118,067
Author´s calculations	Currency demand method	-13,784	-3,739	13,007	40,777	67,218	89,955	92,956	116,059	103,495	62,612
	Electricity consumption method - Kaufmann, Kaliberda	22,021	24,225	36,402	57,083	71,352	83,067	72,859	88,797	87,427	77,431
	Electricity consumption method - Lackó	43,632	49,291	65,320	90,058	106,296	120,682	110,403	127,910	129,512	120,454
	Electricity consumption method - Hanousek, Palda			33,341	53,592	67,653	79,085	68,885	84,657	82,972	72,877
		2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
1	Buehn, Schneider	87,585	95,230	55,843	98,972	81 899					
2	Schneider, Buehn, Montenegro	91,565	102,820	70,839	121,311	110,372					
3	Schneider	89,575	95,772	57,573	97,110	79,187	97,491	162,654	134,734	123,578	
4	Hanousek, Palda´ average		116,917		128,137						
Author´s calculations	Currency demand method	50,603	49,980	11,691	47,957	23,552	35,622	98,674	50,760	30,983	8,277
	Electricity consumption method - Kaufmann, Kaliberda	68,033	74,103	33,073	74,160	52,158	65,260	131,652	106,677	95,595	79,151
	Electricity consumption method - Lackó	112,388	121,561	81,292	123,979	103,764	118,463	183,069	159,195	147,046	131,498
	Electricity consumption method - Hanousek, Palda	63,338	69,079	27,968	68,886	46,695	59,628	126,209	101,117	90,149	73,609

In 2006, depending on the method used to calculate the size of the shadow economy, the hypothetical tax evasion ranged from CZK 47,957 million to CZK128,137 million. The authors are aware of the fact that estimating the size of the shadow economy is more or less accurate depending on the method used. Most often, the size of the shadow economy is reported to be between 10 and 25%. Therefore, the hypothetical tax evasion is calculated for this interval in all years (see Table 10). This fact also confirms the assumption defined by the authors in the Methodology chapter..

Table 10

Hypothetical Tax Evasion - a Fixed Range of SE (in CZK mil.)

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Fixed range of SE - 10%	7,403	7,188	16,876	35,053	48,342	58,904	50,431	66,003	63,020	53,673
Fixed range of SE - 15%	17,996	19,435	31,070	51,356	65,787	77,983	70,319	87,008	85,680	77,435
Fixed range of SE - 20%	28,589	31,682	45,264	67,659	83,231	97,062	90,208	108,013	108,341	101,196
Fixed range of SE - 25%	39,183	43,928	59,457	83,962	100,675	116,141	110,096	129,019	131,001	124,958
Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Fixed range of SE - 10%	44,298	49,688	10,856	53,672	34,445	48,341	116,038	89,827	81,117	63,604
Fixed range of SE - 15%	69,175	76,796	39,694	84,699	68,341	83,957	150,826	124,911	116,501	99,196
Fixed range of SE - 20%	94,053	103,905	68,532	115,726	102,237	119,572	185,614	159,994	151,885	134,789
Fixed range of SE - 25%	118,931	131,013	97,370	146,754	136,132	155,188	220,402	195,077	187,270	170,382

As can be seen from the table with calculations, the hypothetical tax evasion in 2012 was in the range of CZK 63,604 million to CZK 170,382 million, assuming that the size of the shadow economy in that year was in the range of 10–25 %.

Research Limits

It will be useful to conduct research in another time period to verify the spread of the shadow economy estimates. However, such research is only meaningful if data are available for several consecutive years. Extending the period by only a few years may not be effective. In the next time series, it would be interesting to use the methods defined in this paper and also new methods, such as, the stochastic tax frontier model approach of authors Nerudova & Dobranschi (2019).

Conclusions

The tax gap amount in the Czech Republic was calculated in two steps: first, it was necessary to determine the theoretical tax liability, and second, to subtract the actual tax collected from it. To calculate the theoretical tax liability, the authors used a method based on measuring the shadow economy. The methods used to measure have resulted in a wide range of values.

The physical output method (electricity consumption method) was employed. The authors created a time series of electricity consumption and GDP from 1993 to 2012. The estimates of Kaufmann and Kaliberda, Lacko, and Hanousek and Palda were used for the base year. The calculated data show a decreasing trend in the shadow economy. According to the estimate of Kaufmann and Kaliberda, the shadow economy declined from 16.9 % in 1993 to 12.12 % in 2012, while according to the estimate of Lacko, the shadow economy declined from 27.1 % in 1993 to 19.54 % in 2012. Based on the estimate of Hanousek and Palda, it dropped from 15.8 % in 1995 to 11.41 % in 2012.

The authors also employed the labor market method, and calculated the ratio of the economically active population to the population of over 15 years of age together with the ration of the employed to the population over 15 years of age. They found that their development did not follow the same trend. The slightest difference between these ratios was in 1996, which was therefore chosen as the base year with zero participation in the shadow labor market. The lowest non-zero participation was in 1995, i.e., 7,568 people; the highest was in 1999, i.e., 250,076 people; and in 2012 it was 153,099.

When using the currency demand method, the authors calculated the ratio between the amount of currency in circulation and demand deposits for the years 1993 to 2012. The lowest ratio was in 1993. Therefore, it was chosen as the base year with a zero-shadow economy. The lowest extent of the non-zero shadow economy was in 2012 (2.23 %), and the highest one was in 2000 (21.92 %). It has been found that the velocity of money circulation in the economy, which is influenced by the emergence of cashless payment systems, has a greater impact on the resulting calculation than the ratio between the amount of currency in circulation and demand deposits. For this reason, the values calculated by this method cannot be considered indicative of the shadow economy in the Czech Republic.

Based on the data found, the authors proceeded to tax the shadow economy. In order to be able to tax the shadow economy, there must be a strong correlation between GDP and tax collection, assuming the same tax rate in the informal and formal economies. The coefficient of determination for the relationship between tax collection and GDP is 0.9839, indicating a strong dependence. The authors used not only their estimates of the shadow economy but also estimates made by Schneider with Buehnem (from 1999 to 2007) (Schneider & Buehn, 2012), Schneider with Buehn and Montenegro (from 1999 to 2007) (Schneider, Buehn & Montenegro, 2012), Schneider (from 2003 to 2012) (Schneider, 2013), and Hanousek with Palda (years 1995, 1997, 1999–2002, 2004 and 2006) (Hanousek & Palda, 2002; Hanousek & Palda, 2006). The authors calculated the volume of the total economy (official and shadow). They entered these data into the linear regression function and estimated theoretical tax collection, from which they subtracted the actual tax collection and obtained the hypothetical tax gap.

The study confirmed that estimates of the size of the shadow economy are highly dependent on the method used.

The findings imply that policy decisions should take into account the range of values and respect the context of estimates, and, in particular, the results of the measurement must be understood in the context of the methods and data used.

In accordance with the defined main objective of the paper, it can be stated that if the shadow economy in 2012 was between 10 % and 25 % of GDP, then the hypothetical tax gap would be in the interval between CZK 63,604 million and CZK 170,382 million, which can be considered

as the total tax gap interval for the case of the Czech Republic in the analyzed period. Such a wide interval should be declared and used when interpreting the value of the tax gap in the future.

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