

The Hard Shadow of the Greek Economy: New Estimates of the Size of the Underground Economy and Its Fiscal Impact

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Abstract

This paper presents new estimates of the Greek underground economy and explores the link between the underground economy and aggregate debt. We show that the Greek underground economy has been underestimated heavily and has been on a rising trend again since Greece adopted the Euro. We also present evidence that the size of the underground economy is positively related to the debt-to-GDP ratio, implying that fighting the underground economy is also conducive to financial and macroeconomic stability. Our results suggest that for our sample of eleven EMU member countries the loss of the inflation tax as an economic policy instrument had drastic consequences. While the underground economy did not have a statistically significant impact on aggregate debt before the introduction of the Euro, it has pushed up the debt-to-GDP ratio in our sample since.

JEL Classifications: O17; E63; E41; H26; H63

Keywords: underground economy, MCDR approach, inflation tax, debt-to-GDP ratio, debt crisis

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1 Introduction

Fighting illicit and underground economic activities ranks highly on political agendas, as detrimental effects of the underground economy¹ are numerous. The misallocation of resources causes an erosion of a country's tax and social security contribution bases with due consequences for public finances and the quality of public goods provided. In particular, since the European Monetary Union (EMU) became engulfed by the recent debt crisis, the budgetary consequences of the underground economy have again moved into the spotlight of public and academic interest. Some of the countries that were most severely hit by the crisis, such as Greece and Spain, belong to those with traditionally large underground economies.²

Yet, fighting the underground economy requires accurate information about its size and development. However, determining the size of the underground economy is fraught with measurement problems because, by definition, illicit economic activities are not recorded officially. The objectives of this paper are, therefore, twofold. First, we aim to provide an accurate and comprehensive estimation of the size and evolution of the Greek underground economy since 1960. In doing so, we make use of the recent methodological advances by Pickhardt and Sardà (2011, 2013). Our study provides a far longer time series for the Greek underground economy than the vast majority of the literature³ and thus additional insights into its development. Our results show that the size of the Greek underground economy has been underestimated heavily in the previous literature. Our results also

¹ Here, and in the following, we use the term "underground economy" interchangeably with expressions like shadow economy, black economy, hidden economy, unrecorded economy, etc. (see Kazemier 2006 for further details).

² Interestingly, the four countries most severely hit by the financial crisis in the European Monetary Union are the four former cohesion states (Ireland, Greece, Portugal and Spain). In a paper published well before the recent crisis, Fitz Gerald (2006) already pointed to the structural economic problems in these countries and concluded that, whilst Ireland, Portugal and Spain saw a significant convergence towards the average living standard in the European Union in the 1990s, the progress in Greece, in overcoming its structural economic problems, was far less fast.

³ See, e.g., the studies by Dell'Anno et al. (2007), Pavlopoulos (2002), Schneider et al. (2010) and Tatsos (2001). To the best of our knowledge, only Elgin and Oztunali (2012) cover a longer period.

suggest that the trend of a decreasing relative size of the Greek underground economy, evident after it became a member of the EU in 1981, shows clear signs of discontinuation well before the recent crisis struck. All in all, the size of the Greek underground economy shows far stronger fluctuations than reported in previous studies.

The second objective of this paper is to investigate the link between aggregate debt and the underground economy. The question we ask is whether a large underground economy can contribute significantly to the emergence or deepening of budgetary imbalances and thus, eventually to an unsustainable debt position that could give rise to severe economic and financial turmoil. To do that, we analyze empirically the relation between public debt, the inflation tax – since it is the only instrument to generate revenue from illicit economic activities, which are mainly carried out in cash – and the size of the underground economy for a sample of eleven European countries that were the first to introduce the Euro (in 1999 for the EMU founding members and in 2001 for Greece as the first additional entrant).⁴ However, the inflation tax disappears as a national policy instrument when entering a monetary union and, as a result, the relation between aggregate debt and the underground economy may change. Theory suggests that public finances in countries with large underground economies could deteriorate as a compensating element is eliminated. We therefore split our sample into a pre- and post-Euro introduction subsample.

We find clear evidence that the size of the underground economy and the debt-to-GDP ratio are positively related in our sample. In line with theoretical considerations, a larger underground economy typically goes hand in hand with a higher debt burden. Our results also show that an increase in the inflation tax revenue (computed as the inflation tax rate times the size of the underground economy) lowers the debt-to-GDP ratio. This effect

⁴ Prinz and Beck (2012) have pointed to the nexus between public finances and the underground economy recently. They find evidence for a positive relationship between the size of the underground economy and public debt relative to GDP (as well as the change in public debt/GDP) for a sample of 21 OECD countries.

moderates the detrimental effect that an increase in the underground economy has on public finances, without, however, fully balancing it. Moreover, we find a drastically changing picture when we distinguish between the pre-Euro and the Euro era. We find evidence that the inflation tax was successfully used to contain the negative effect of a large underground economy on public finances, but once the inflation tax was not available any longer as a national policy instrument, the potentially disruptive link between the size of the underground economy and public debt reappeared. In other words, the loss of the inflation tax as a policy instrument should give governments an additional incentive to fight illicit economic activities.

In the next section of this paper, existing estimates of the Greek underground economy are reviewed and new results are presented. In section three, we discuss our findings in detail and investigate their relation to the aggregate debt burden in section four. In section five, we set out our conclusions.

2 The Greek Underground Economy

2.1 Existing Estimates

It is perhaps somewhat surprising that, despite the topicality of the problem, estimates of the Greek underground economy are rather scarce. In fact, there are only a few international and national studies that derive figures for the size and/or the evolution of the Greek underground economy. The available estimates are summarized in Table 1, which represents the largest collection of Greek underground economy estimates available to date.

Tatsos (2001), Pavlopoulos (2002), Dell'Anno et al. (2007) and Elgin and Oztunali (2012) seem to be the only studies that derive a longer time series of the Greek underground economy and thus shed light on its longer-term development trend. The

picture that emerges from these papers is not unambiguous though. While studies such as Tatsos (2001), Pavlopoulos (2002) and Dell'Anno et al. (2007) find an increase over time in the size of the Greek underground economy, even though the estimated values differ, Elgin and Oztunali (2012) detect a declining trend.

Tatsos (2001) uses the popular currency demand approach (Klovland version) and estimates a steady increase of the Greek underground economy between 1960 and 1997 from about 26 percent to nearly 37 percent of GDP (see Table 1, column *TAT*). Yet, the approach used by Tatsos (2001) can be criticized on methodological grounds following the work by Ahumada et al. (2007). These authors have pointed out that, unless the long run income elasticity of money demand is one, the currency demand method is often inconsistent with the assumption of equal velocities of cash circulation in both the legal and underground economy, i.e. a central assumption of practically every currency demand approach.⁵ Table 1 also shows the values, which were produced by applying the correction procedure that Ahumada et al. (2007) provide to the original Tatsos (2001) values. As can be seen, the corrected Tatsos (2001) values (column *A-TAT*) differ substantially from the original values in column *TAT* for the entire period.

The study presented by Pavlopoulos (2002) is related to that by Tatsos (2001) as Pavlopoulos presents a sensitivity analysis of the results obtained by Tatsos in addition to results from his own estimations. Due to the rather large number of alternative results presented by Pavlopoulos, we have selected two examples in order to illustrate the spread of his results (see Table 1, *PAV1* and *PAV2*).

Dell'Anno et al. (2007) use the popular MIMIC method and find that the size of the Greek underground economy increased from about 15 percent in 1968 to 26 percent in

⁵ If the condition $\beta = 1$, with β denoting the long run income elasticity of money demand, is not fulfilled, Ahumada et al. (2007) provide the following correction procedure: $(\bar{Y}_U/\bar{Y}_L)^{1/\beta} = Y_U/Y_L$ where the ratio $\bar{Y}_U/\bar{Y}_L$ denotes the faulty size of the underground economy and Y_U/Y_L the correct size of the underground economy. The condition $\beta = 1$ is generally required, except in the rather unlikely case where the size of the underground economy is exactly equal to the size of the legal economy.

2004. Interestingly, their results show that the Greek underground economy fluctuated substantially throughout the whole period. However, they point out that their empirical results for Greece are “quite erratic” and should be interpreted “with caution” (Dell’Anno et al. (2007), p. 67) as they may be affected by substantial adjustments of the Greek National Accounts starting in the end 80s.

Elgin and Oztunali (2012) apply a new approach that is based on a two-sector general equilibrium model and find that the Greek underground economy has decreased steadily from about 47 percent in 1960 to 27 percent in 2009 (see Table 1, column *EO*), a finding that sharply contrasts with all other results presented in Table 1.⁶

Other studies present estimates for the Greek underground economy for shorter time periods or individual years only. Schneider et al. (2010) employ the MIMIC method and find that, during the period 1999 to 2007, the relative size of the Greek underground economy was fairly stable in the range from 26 to 28 percent of official GDP. Also based on a MIMIC approach, Tafenau et al. (2010) estimate the size of the Greek underground economy to be 20.6 percent of official GDP in 2004. Kanellopoulos (1992) and Kanellopoulos et al. (1995) use a discrepancy approach and find that the size of the Greek underground economy was about 13 percent of official GDP in 1982 and 35 percent of official GDP in 1988.

Even though previous studies do not suggest a coherent pattern for either the size or the evolution of the Greek underground economy, there is consensus in the literature that it is the largest among the EU-15 as well as the Eurozone countries and significantly above the EU-28 or OECD average. Available estimates suggest that in the EU-28 the Greek underground economy is matched in size only by lower income EU-28 countries such as Cyprus, Malta and Slovenia (whose underground economy has been estimated between 24

⁶ Also, it is worth mentioning that Elgin and Oztunali (2012) calibrate their results with the 2007 value of Schneider et al. (2010), which explains why both studies report the same value in 2007 (see Table 1).

and 28 percent of official GDP in the last ten years), and exceeded by countries such as Bulgaria, Romania and Croatia (whose underground economy has been estimated between 29 and 36 percent of official GDP in the last ten years).⁷

2.2 The Modified-Cash-Deposits-Ratio (MCDR) Approach

No ideal method to estimate the size of the underground economy exists. All approaches used in the literature are subject to methodological problems (see, e.g., Thomas 1999). Our estimation rests on the recently developed MCDR approach, pioneered by Pickhardt and Sardà (2011, 2013), that provides a simple and transparent calculation procedure for the size of the underground economy while at the same time avoiding the methodological shortcomings recently pointed out by Ahumada et al. (2007) and Breusch (2005a, b, c, d) with respect to the popular and widely used MIMIC and currency demand approaches. Moreover, the MCDR measures all cash-using illicit economic activities, i.e. not just those caused by tax pressure or excessive regulation that can be addressed through economic policy but also illegal activities such as drug dealing, human trafficking, etc.

The MCDR approach essentially is a modified version of the Gutmann approach (1977),⁸ which is based on the assumption that households in the legal economy wish to hold cash (C) and sight deposits (D) in constant proportion, λ . However, data shows that payment preferences have changed substantially during the period under consideration, not only in Greece but in all industrialized countries (see, e.g., ECB 2007). Cashless means of payment have become more and more important. To account for the shift in payment preferences, Gutmann's original assumption is replaced by the assumption that all currency in circulation in the base year represents the entire cash agents wish to hold in any year

⁷ See Schneider (2010). For a recent overview of the underground economy in non-OECD countries see Buehn and Schneider (2012) and Elgin and Oztunali (2012).

⁸ The derivation of the MCDR model from the Gutmann (1977) approach is discussed at length in Pickhardt and Sardà (2011, 2013). Therefore, we do not repeat all details here but concentrate on the main aspects.

after the base year for legal cash transactions while all additional transactions in the legal economy are carried out through sight deposits, cheques, debit and credit cards etc.

Hence, any cash holdings in excess of those in the base year are fully attributed to the underground economy. Based on these assumptions, Irving Fisher's (1911) quantity theory of money yields,

$$\frac{C_t - C_0}{C_0 + D_t} = \frac{Y_{Ut}}{Y_{Lt}}, \quad (2)$$

where C_t denotes currency in circulation outside banks at the end of the year t , C_0 is currency in circulation outside banks at the end of the base year, here 1960, D_t represents sight deposits held by domestic non-banks (non-MFIs) at the end of the year t , C_L denotes currency used for legal transactions, and C_U denotes currency for underground economy transactions, with $C_0 = C_{Lt}$ and $C_t - C_0 = C_{Ut}$. Y_{Lt} denotes the size of the legal economy and Y_{Ut} is the size of the underground economy, where t denotes the time period, with $t = 1, \dots, Z$. Applying (2) to the Greek data set yields the underground economy profile *GR0* in Table 1.

Even though the modification embedded in (2) provides a way to render the Gutmann approach applicable to recent data, it still suffers from some fairly restrictive assumptions. Further auxiliary modifications to the model may therefore include: (1) that inflation may require an increase in C_0 over time to allow agents to carry out their preferred set of cash transactions; (2) that changes in the size of the population may require an adjustment of C_0 over time; (3) that a certain fraction of C_t may be held abroad; (4) likewise, that a certain fraction of C_t may be hoarded by national agents; (5) that the number and set of transactions, which agents wish to carry out in cash, may change over time, for example,

due to the evolution of new non-cash payment methods and facilities; (6) that some proceeds from underground activities may in fact be held as sight deposits, for example, because illegal transactions did not involve any cash payments at all; and, finally, (7) that the size of the underground economy may not have been close to zero in the base year⁹.

In this paper, we can only address the first two modifications (inflation and population) due to limited data availability.¹⁰ Moreover, the data for Greece do not show a sharp change in cash holdings or sight deposits at the time of the Euro introduction so that no additional correction of C_t is required.

Given the first additional modification, the adjustment of C_0 to inflation, (2) changes to (3),

$$\frac{C_t - IC_{0t}}{IC_{0t} + D_t} = \frac{Y_{Ut}}{Y_{Lt}}, \quad (3)$$

where IC_0 denotes the inflation adjusted value of C_0 . Applying (3) yields the underground economy profile *GRI* shown in Table 1. The second additional modification consists of adjusting IC_0 to population development over time and yields,

$$\frac{C_t - PIC_{0t}}{PIC_{0t} + D_t} = \frac{Y_{Ut}}{Y_{Lt}}, \quad (4)$$

⁹ The problem that calculating cardinal values of the underground economy with the MIMIC or currency demand approach requires a known initial value for the size of the underground economy, which often is not available, is well-known in the literature. The MCDR approach assumes that the size of the underground economy is zero in the base year. Alternatively, one could use the results of previous studies for the base year. However, due to the methodological problems pointed out above that other studies are fraught with some degree of arbitrariness would have been introduced with this, too. Moreover, Ahumada et al. (2008) have demonstrated that the need to assume a known initial condition might reappear in models based on a short-run money demand function.

¹⁰ Also, the third modification (cash held outside the country) does not seem relevant because there is no reliable evidence that substantial amounts of Drachma were held outside Greece during the period under consideration.

where PIC_0 denotes the population and inflation adjusted value of C_0 . Hence, according to (4), it is assumed that, on average, agents wish to hold a constant real currency budget to carry out their preferred set of legal transactions in cash.

Application of (4) to the Greek data set yields the size of the Greek underground economy according to the MCDR approach, which is displayed in column $GR2$ of Table 1. For information purposes only, the profile based on estimating equation (2), denoted by $GR0$, and equation (3), denoted by GRI , are included in Table 1 as well. It is worthwhile highlighting that $GR2$ represents one of the largest available consistent time series of the Greek underground economy.¹¹

Table 1: Size of the Greek Underground Economy in Percent of GDP

$GR0$	GRI	$GR2$	Year	TAT	DGA	SBM	EO	PAV1	PAV2	V	A-TAT
0.00	0.00	0.00	1960	26.1	---	---	47.37	64.16	7.32	48 ^U	41.8
11.56	10.03	9.52	1961	26.2	---	---	46.49	66.50	7.56	---	41.9
26.17	24.80	23.76	1962	26.2	---	---	44.96	72.68	8.54	---	41.9
41.45	37.19	35.60	1963	26.4	---	---	43.82	75.02	8.80	---	42.1
61.39	55.73	53.51	1964	27.2	---	---	42.59	75.31	8.73	---	42.9
77.11	67.78	64.95	1965	26.5	---	---	41.12	73.17	8.26	66.4 ^U	42.2
89.71	74.77	71.31	1966	27.7	---	---	39.58	75.60	8.55	---	43.4
132.76	112.02	107.01	1967	28.7	---	---	38.50	78.24	8.89	96.6 ^U	44.5
120.11	101.52	96.39	1968	29.9	15.00	---	37.60	82.40	9.49	---	45.6
126.13	105.01	99.30	1969	29.4	14.00	---	36.69	80.51	9.05	---	45.2
130.14	107.24	101.29	1970	28.3	13.00	---	35.50	79.97	8.89	64.4 ^U	44.0
134.02	109.86	103.82	1971	28.1	10.00	---	34.41	83.69	9.41	---	43.8
134.45	110.62	105.06	1972	27.3	8.00	---	33.28	85.84	9.66	---	43.0
169.88	130.16	123.51	1973	26.1	6.00	---	32.21	76.73	8.14	---	41.8
207.10	137.51	129.30	1974	27.4	4.00	---	30.94	86.67	9.69	---	43.1
215.87	136.70	127.71	1975	27.7	4.00	---	30.38	88.25	9.90	62.2 ^U	43.4
221.09	139.24	129.63	1976	29.2	3.80	---	29.97	94.00	10.73	---	45.0
245.60	150.64	139.07	1977	29.4	5.00	---	29.48	94.27	10.78	---	45.2
254.55	156.69	143.94	1978	29.0	6.00	---	29.19	90.44	10.09	---	44.8
251.59	147.82	134.20	1979	28.9	6.00	---	28.89	86.12	9.36	---	44.7
232.60	129.57	116.17	1980	28.3	6.00	---	28.78	86.48	9.33	45.4 ^U	44.0
253.10	133.98	119.03	1981	26.9	8.00	---	28.86	81.14	8.53	---	42.6
217.58	115.89	102.61	1982	31.2	12.50	---	28.81	91.12	10.01	13.3 ^{K1}	46.9
253.83	122.16	106.32	1983	32.2	20.00	---	28.89	91.33	10.05	---	47.9
225.40	111.24	96.87	1984	33.6	24.00	---	28.92	96.11	10.76	55.2 ^X	49.2
240.51	119.16	103.92	1985	32.6	23.00	---	28.97	93.26	10.28	---	48.3
231.45	104.41	89.11	1986	33.2	22.00	---	28.93	94.38	10.45	---	48.9

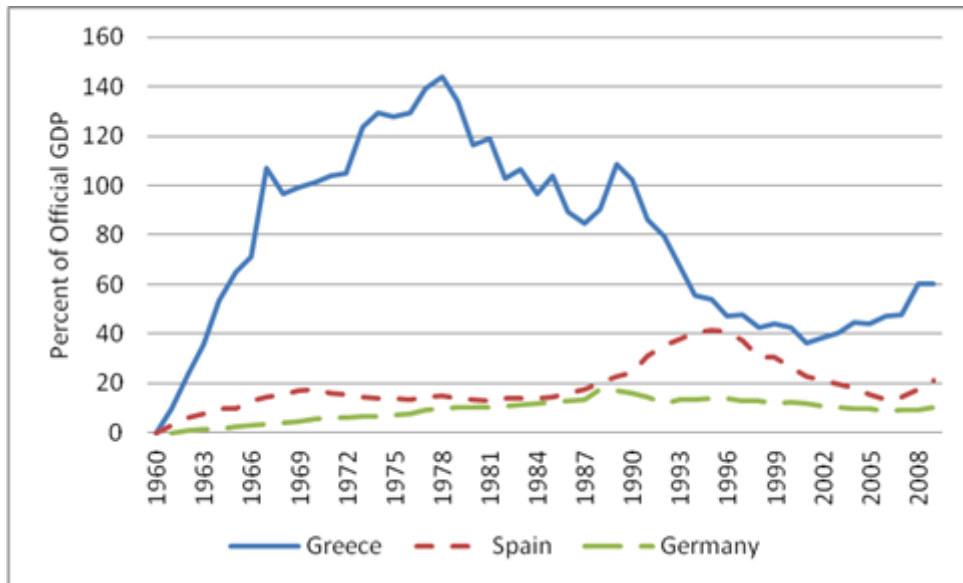
¹¹ Further quantitative adjustments to $GR2$ would be desirable, as discussed above, but are (currently) impossible due to a lack of reliable data. Moreover, even a prediction of the sign of the net effect after including all remaining modifications into our model is not possible because these additional adjustments can be expected to have different signs.

213.98	98.99	84.57	1987	33.9	<i>21.50</i>	---	28.78	95.78	10.71	---	49.5
230.15	106.03	90.52	1988	32.0	<i>21.50</i>	---	29.02	88.43	9.51	34.6 ^{K2}	47.7
258.48	125.57	108.46	1989	30.1	<i>21.50</i>	---	28.98	87.10	9.30	---	45.8
238.19	118.68	102.38	1990	32.3	20.9	---	29.00	89.70	9.69	---	48.0
207.36	101.41	86.18	1991	33.0	<i>20.00</i>	---	28.85	89.40	9.58	---	48.7
194.03	94.43	79.29	1992	33.2	<i>19.00</i>	---	28.84	90.31	9.70	140 ^{XL}	48.9
168.05	81.48	67.30	1993	34.3	<i>24.00</i>	---	28.85	93.19	10.14	---	49.9
126.57	67.00	55.73	1994	34.7	<i>26.00</i>	---	28.92	95.10	10.40	30.5 ^X	50.3
119.91	64.84	53.81	1995	35.5	26.1	---	28.94	96.95	10.63	---	51.0
104.99	57.39	47.28	1996	35.6	<i>27.00</i>	---	28.97	99.23	10.97	---	51.1
99.84	57.28	47.75	1997	36.7	<i>29.00</i>	---	28.82	102.32	11.39	---	52.1
80.53	50.03	42.60	1998	---	<i>32.00</i>	---	28.94	---	---	---	---
72.30	49.88	44.01	1999	---	<i>33.00</i>	28.5	28.79	---	---	---	---
71.82	48.61	42.49	2000	---	31.9	28.7	28.50	---	---	---	---
63.29	42.17	36.48	2001	---	<i>30.00</i>	28.2	28.13	---	---	---	---
66.90	44.63	38.62	2002	---	<i>29.00</i>	28.0	27.90	---	---	---	---
65.91	46.07	40.57	2003	---	<i>28.00</i>	27.4	27.72	---	---	---	---
67.81	49.83	44.72	2004	---	<i>26.00</i>	27.1	27.39	---	---	20.6 ^T	---
63.84	48.42	43.92	2005	---	---	26.9	26.92	---	---	---	---
67.19	51.76	47.21	2006	---	---	26.4	26.76	---	---	---	---
67.15	52.17	47.70	2007	---	---	26.5	26.50	---	---	---	---
85.46	66.12	60.43	2008	---	---	---	26.16	---	---	---	---
81.16	64.95	60.04	2009	---	---	---	27.39	---	---	---	---

Note: GR0 is the initial profile without modifications, GR1 is the inflation adjusted profile and GR2 is the inflation and population adjusted profile; all based on own calculations based on the MCDR approach. TAT denotes data by Tatsos (2001). DGA denotes data by Dell'Anno et al. (2007), where figures in italics are read from Fig. 4, p. 68 and the remaining figures are taken from Table 6, p. 69. SBM denotes data taken from Schneider et al. 2010, Table 2, p. 455. EO denotes data taken from Elgin and Oztunali (2012). PAV1 and PAV2 denotes data by Pavlopoulos (2002), Table 1.10, column $\beta 1=0.78$, p. 82 and Table 1.13, column $\beta 1=0.78$, p. 87, respectively. V denotes figures taken from various authors, where superscript K1 denotes Kanelopoulos (1992), K2 denotes Kanelopoulos et al. (1995), T denotes Tafenau et al. (2010), U denotes data based on the cash-deposits-ratio approach, Table 1.4, (column: benchmark of 29% in 1984), p. 52, of Pavlopoulos (2002). XL denotes data from Lekatsas (1995), X denotes data from an unauthored study and both XL and X are quoted from Table 1.1, p. 41, of Pavlopoulos (2002).

Figure 1 provides a graphical representation of the Greek underground economy according to the GR2 profile. As points of reference, two other EU countries, Germany as a country with a relatively small underground sector and Spain as one of the countries with the largest underground economy within the Eurozone and the OECD (see, e.g., Schneider 2009, 2011), are also included.

Figure 1: Evolution of the Underground Economy in Greece, Spain and Germany in Percent of Official GDP during 1960–2009



Note: Data for Greece is from our own calculation, GR2 profile; data for Spain is taken from Pickhardt and Sardà (2013), S2 profile and data for Germany from Pickhardt and Sardà (2011), G3 profile. All estimates are based on the MCDR approach¹².

3 Size and Development of the Greek Underground Economy

Several observations stand out from Table 1 and Figure 1. First, the size of the Greek underground economy has been underestimated seriously in previous studies. Our results only converge towards the corrected values of Tatsos in the early to mid-1960s and in the mid-1990s as well as to the values of Pavlopoulos in the mid 1980s and early 1990s (see Table 1, columns *A-TAT* and *PAVI*).¹³ It is important to keep in mind though that the currency demand approach usually estimates additional cash holdings due to tax pressure, whereas the MCDR approach also covers cash-using underground economy activities that are independent of tax pressure, such as illegal drug dealing, human trafficking, etc. Hence, the MCDR approach can be expected to yield larger estimates for the size of the cash-using

¹² There are many more estimates for both Spain and Germany. With 21.3 percent and 22.6 percent of official GDP in 2005 Schneider (2010) and Arrazola et al. (2011) for example present estimates for Spain which are close to our figures. For the German underground economy, too, other estimates report figures that are very closely in line with ours. For example, Feld and Schneider (2010) present an estimate of 15.4 percent of official GDP and Buehn et al. (2009)'s estimate is 17.4 percent of official GDP.

¹³ The fact that applying the Ahumada correction to the original Tatsos' (2001) results leads to a substantial upward shift of the whole time series can be understood as another indication that previous studies tend to report too low levels for the Greek underground economy.

underground economy than the traditional currency demand approach. Therefore, our results can also be interpreted as being supportive to the view that high profit rates in illegal activities are important driving forces for the Greek underground economy, too.

Secondly, our estimates show a markedly different development trend for the Greek underground economy compared to previous work. Results by Tatsos (2001), Dell'Anno et al. (2007) and Pavlopoulos (2002) suggest a steady increase in size. In contrast, results by Elgin and Oztunali (2012) suggest a steady decrease from 1960 to 2009, whilst our results show that the evolution of the Greek underground economy is rather hump-shaped with a peak in the mid to end 1970s. According to the MCDR approach, the size of the Greek underground economy reached exorbitantly high levels between 1973 and 1979, that is, at the end of the military dictatorship and shortly thereafter, and started to fall after the transition to a new democratically elected regime had been completed, the new constitution approved and, therefore, uncertainty regarding the future political and economic course of the country had declined. Greece's joining the EU in 1981 added to this. However, caution seems in order when interpreting the rather steep increase in the underground economy in the mid- to end-1970s. Owing to a lack of precise data it cannot be ruled out that the model overstates the size of the cash-using Greek underground economy for this period as the pervasive political and economic uncertainty may have led to substantial cash hoarding.¹⁴

Albeit still considerable in comparison to other industrialized countries (see also Figure 1), the introduction of the Euro in 2001 marks the lowest level of the underground economy since the early 1960s after a steady and rather steep decline in the 1990s. Greece enjoyed an economically stable and prosperous time in the 1990s with high growth rates and a substantial increase in per capita income. The economic reform programmes that

¹⁴ As explained above the MCDR approach is based on Gutmann (1977). Therefore, any increase in money demand above the level C_0 is interpreted as being caused by an increase in the size of the underground economy as it is assumed that all transactions in the underground economy are carried out in cash.

were initiated in order to be eligible for EMU membership can also be expected to have borne fruit with respect to a reduction in illicit economic activities.¹⁵

Thirdly, Figure 1 shows that the size of the Greek underground economy exceeds the Spanish and German during the whole time period under consideration many times over. The difference in size between the underground economies of Greece and particularly Spain as another former conversion country appears striking. On the other hand, both countries show a striking difference in the pervasiveness of corruption in public administration (as measured by, e.g., the corruption perceptions index provided by Transparency International¹⁶). Recent studies on the relation between corruption and the underground economy reach the conclusion that corruption of bureaucracy and government gives rise to a larger underground sector especially the lower the income of a country and the poorer the quality of institutions are.¹⁷ It is also well-known that tax morale and the quality of state institutions have a considerable influence on the size of the underground economy. Feld and Schneider (2010) conclude based on an OECD sample that the quality of state institutions and tax morale are inversely related to the incentive to engage in undeclared economic activities.

It is also interesting to note that, whilst the size of the Spanish underground economy shows a downward trend after EMU membership in 1999, the opposite is true for the

¹⁵ Following the signing of the Maastricht Treaty in 1991 Greece adopted a stabilisation programme and, for example, managed to bring inflation and the budget deficit down to around 2% and 3% of GDP in 1999 from 27% and 15% in 1990 (see Fitz Gerald 2006 for a comprehensive account of the conversion process of the former cohesion countries).

¹⁶ Data can be found at www.transparency.org. Measures of corruption are as intensely debated as underground economy estimates. For an example of how different measures (perceptions and non-perceptions based) can lead to different results see Dreher and Schneider (2010).

¹⁷ See, for example, Dreher and Schneider (2010), Friedman et al. (2000) and Johnson et al. (1998). Theoretically, the relation between the size of the underground economy and the corruption of bureaucracy and government is not unambiguous (see Dreher and Schneider 2010). Both could be substitutes for example if bribing government officials is motivated by the desire to secure a lucrative public sector contract which would then be fulfilled in the official economy. On the other hand, corruption and undeclared activities can be complementary when economic activities are moved to the underground sector in order to avoid high levels of corruption or when undeclared activities can only be sustained or expanded in the underground sector through bribery.

Greek underground economy after 2001. While our approach does not allow the identification of the underlying causes for the path of the underground economy, this development, especially in light of the successful economic reforms in the 1990s, can be understood as indicative of diminishing reform efforts after having reached the goal of EMU membership. Data on real unit labour costs, particularly in the manufacturing sector, point to a loss in competitiveness for Greece after entering the EMU.¹⁸ Such a development would normally result in an increase in unemployment, especially as counteracting monetary policy interventions could not be resorted to. However, official figures do not show a significant movement in employment aggregates for Greece after EMU entry. Therefore, the underground economy can be conjectured to have acted as a buffer that provided both households and firms with the means to compensate for income or profit losses.¹⁹

Fourthly, all in all our results display much less stability than other estimates. The amplitude covered is substantially higher than in other studies on the Greek underground economy.

As a modified version of the Gutmann (1977) approach, the MCDR model is not immune to some of the criticism put forward against it (see, e.g., Thomas 1999). Following Gutmann, our estimates are based on the assumption that all cash exceeding PIC_0 is used for transactions in the underground economy. In other words, it is ignored that cash may be hoarded, e.g., for precautionary reasons or because not all profits made in the underground economy can immediately be laundered into interest bearing assets.²⁰ This assumption could therefore introduce an upward bias in the estimates whose magnitude is hard to gauge as reliable data is not available. On the other hand, by the logic of the MCDR

¹⁸ This is mirrored in an increase in the Greek current account deficit in the 2000s compared to the 1990s.

¹⁹ See, e.g., Busato and Chiarini (2004) for the risk-sharing opportunities offered by the underground sector.

²⁰ See Feige (1994) and Pickhardt and Sardà (2012).

approach, the currency demand in the base year adjusted for inflation and population changes (PIC_0) is taken as the legal transactions motivated currency demand for all other years and only cash holdings in excess of this threshold are attributed to the underground economy. This leads to a rather conservative estimate of the Greek underground economy as payment preferences have shifted towards cashless means of payment.

Finally, the estimation results of all monetary models react quite sensitively to changes in the underlying benchmark.²¹ Hence, in order to minimise arbitrariness, the base year in which the Greek cash-using underground economy is assumed to be zero has to be chosen carefully. The year 1960 was chosen as the macroeconomic environment at that time was rather favorable with a GDP growth rate of more than 11%, marking the start of an economically successful decade. Moreover, cash-using underground activities such as illegal soft and hard drug dealing, illegal prostitution, human trafficking, etc. were of far less concern. The fact that in these times barter exchanges typically played a much bigger role to conduct underground economy activities also supports the assumption that the cash-using underground economy was negligibly small in 1960.²²

4 The Greek Underground Economy and Debt Sustainability

4.1 Hypotheses, Data and Model

Our results show that, despite its falling trend between the mid-seventies and the adoption of the Euro in Greece in 2001, the Greek underground economy has continuously been extremely high especially when compared to countries such as Germany and Spain (Figure 1). Naturally, the question arises whether Greece's historically large underground sector has contributed to the debt crisis that Greece has been facing since 2008.

²¹ As shown by Ahumada et al. (2008), estimates using the Tanzi method also require a benchmark value, if short-run models that include the lagged dependent variable are used.

²² Another assumption of monetary models that is subject to critique in the literature is that of equal money velocities in the underground and legal economies. However, as long as there is no reliable knowledge about the velocity of money in the underground sector, this assumption is widely accepted.

Theoretically, a large underground economy gives rise to serious misallocations of resources. Apart from distorting optimal choices on the individual level, public finances can suffer due to an erosion of a country's tax and social security contribution bases.

To shed light on the empirical relationship between the underground economy and aggregate debt, we formulate two hypotheses. Firstly, countries with a large underground economy relative to their legal economy can be expected to have comparatively high public debt.²³ The economic reason is that the underground economy's GDP cannot be taxed by ordinary levies; all other things equal, the tax base of countries with large underground economies is smaller than that of other countries. It is also important to bear in mind that the debt-to-GDP ratio is calculated on the basis of 'official' GDP. Identical levels of public debt then imply different ratios of debt-to-(official) GDP for otherwise comparable countries. Secondly, the debt-to-GDP ratio should be negatively related to the inflation tax. This tax is particularly important for countries with an underground sector that is comparatively large relative to the legal economy as it is the only tax available to policymakers to generate (indirect tax) revenue from illicit economic activities.²⁴ Since in general higher taxes are negatively related to public debt and deficits via the government's budget constraint, the inflation tax should be negatively correlated with the debt-to-GDP ratio.

Similar points have previously been made in the literature. For example, Ercolani (2007) argues that countries with a relatively large underground economy compared to official economic activity can be expected to show a relatively small fiscal-tax-to-inflation-tax ratio. He presents supportive empirical evidence with Greece as a case in point as the economy with the largest relative underground economy size and the lowest fiscal-tax-rate-

²³ See Prinz and Beck (2012) for a theoretical derivation of the link between the ratio of debt to GDP, the size of the underground economy and inflation. For example, Bovi and Claeys (2008) find a strong positive correlation between debt-to-GDP and the size of the underground economy for Italy.

²⁴ Transactions in the underground economy are usually carried out in cash. This is precisely the idea upon which our empirical approach relies.

to-inflation-tax ratio among the OECD countries in his sample. Further evidence for a negative relation between (direct) taxes and the size of the underground economy as well as a positive relation between inflation and the size of the underground economy is presented by Mazhar and Méon (2012) for a panel of 162 developed and developing countries. They conclude that large underground economies give governments a strong incentive to shift from direct taxes to the inflation tax to finance public budgets. These results are in line with theoretical work by Cavalcanti and Villamil (2004), Koreshkova (2006) and Nicolini (1998) who show in (calibrated) models that the optimal inflation rate depends positively on the size of the underground economy.

Our hypotheses are tested for a panel of eleven European countries that were the first to introduce the Euro. More precisely, ten founding members of the EMU are included plus Greece which was admitted as the first additional member in 2001, i.e. two years after the start of EMU. Luxembourg as the remaining founding member of the EMU was eliminated from the sample due to lack of data. In alphabetical order the sample thus comprises: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain. Data on the size of the underground economy was taken from Table 1 for Greece (*GR2*), from Pickhardt and Sardà (2011, 2013) for Spain and Germany (profiles *S2* and *G3*) and from Schneider (2009, 2011) for the remaining countries. All other data was retrieved from the OECD statistical warehouse (<http://stats.oecd.org>).

We follow Prinz and Beck (2012) and employ the following empirical model²⁵:

$$\frac{B_t}{Y_{Lt}} = C_1 + \beta_1 \frac{B_{t-1}}{Y_{Lt-1}} + \beta_2 \frac{Y_{Ut}}{Y_{Lt}} + \beta_3 \cdot IT_t + \beta_4 \frac{IT_t \cdot Y_{Ut}}{Y_{Lt}} + CON + \varepsilon_t \quad (5)$$

²⁵ Even though the empirical model by Prinz and Beck (2012) that we borrow may be criticized for lacking fully specified micro foundations, it is well supported by theory as it is derived from a theoretical model which is based on macroeconomic (accounting) relations.

where C_I is a constant. Debt (B_t), expressed relative to legal GDP (Y_{Lt}), is hypothesized to depend on its lagged value (B_{t-1}/Y_{Lt-1}), the contemporary size of the underground relative to the legal economy (Y_{Ut}/Y_{Lt}), the contemporary inflation tax IT_t as well as an interaction variable involving the inflation tax and the size of the underground economy. The latter can be interpreted as the inflation tax revenue with IT_t being the tax rate and Y_{Ut} the tax base. As explained above, a large underground economy relative to its legal counterpart implies a stronger reliance on the inflation tax to generate public revenue.

CON denotes the control variables employed. These are (a) the long-term interest rate, lagged by one period, to take the financing costs of public debt into account; (b) the contemporary rate of unemployment to consider expenditure-relevant effects of the business cycle; (c) the current account balance (surplus or deficit) relative to GDP to capture the impact of external trade on public finances; and (d) the growth of unit labour costs to account for producer cost inflation. β_1 to β_4 denote the estimation coefficients and ε_t is the error term. To control for autocorrelation in the debt-to-GDP level, an AR(1) process was also included in the regression.

4.2 Empirical Results I: Sample Analysis

Our results, summarized in Table 2, show a statistically significant effect (with an error probability of 2.11%) of the size of the underground economy, the variable $(IT_t \cdot Y_{Ut}/Y_{Lt})$ and the unemployment rate on the debt-to-GDP ratio.²⁶ As hypothesized, a bigger underground economy pushes up the debt-to-GDP ratio. While the inflation tax itself does not have a statistically significant effect on the debt-to-GDP ratio, the interaction variable (inflation tax revenue) is negatively correlated with debt-to-GDP (with an error probability of

²⁶ The correlation matrix is available upon request from the authors.

4.24%) in line with our theoretical considerations above. Moreover, the AR(1) process is stationary as the inverted AR roots are smaller than unity (.78).

Table 2: Estimations for the Debt-to-GDP Ratio with Respect to the Size of the Underground Economy and the Inflation Tax in a Cross-Section of Eleven EMU Countries, 1992-2010

(Panel Least Squares, Unbalanced Panel, Cross-section Fixed Effects)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.2419**	4.7224	2.3806	0.0185
Debt/GDP (-1)	0.4999***	0.0659	7.5880	0.0000
Size underground economy	0.3563**	0.1529	2.3301	0.0211
Inflation tax	-0.0703	0.3690	-0.1906	0.8491
Size underground economy $\times$ inflation tax	-0.0372**	0.0182	-2.0462	0.0424
Long-term interest rate (-1)	0.6689**	0.2992	2.2353	0.0268
Unemployment rate	1.5137***	0.2323	6.5172	0.0000
Current account /GDP	-0.3502**	0.1594	-2.1973	0.0295
Growth labor unit cost	-0.0221	0.0923	-0.2392	0.8112
AR(1)	0.7762***	0.0617	12.5780	0.0000
R-squared	0.9921			
Adjusted R-squared	0.9911			
Durbin-Watson statistic	1.8669			
Inverted AR Roots	.78			

***, **: Statistically significant (in this order) on the 1% and the 5% level, respectively.

Source: Own calculations based on data from *oecd.stat*, Schneider (2009, 2011) and from Table 1 for Greece (GR2), as well as from Pickhardt and Sardà (2011, 2013) for Spain and Germany (profiles S2 and G3).

Our results thus indicate that an increase in the size of the underground economy has an effect on the debt-to-GDP ratio through two channels. Firstly, it pushes up aggregate debt relative to GDP directly since the base for direct taxation is eroded. Secondly, an increase in the size of the underground economy broadens the base for the inflation tax and thus exerts downward pressure on the debt-to-GDP ratio. While the first effect is dominant, the second has a (weakly) moderating effect. Quantitatively, the estimation indicates that a reduction by 1% in the size of the underground economy relative to the legal economy

averaged over these eleven countries would decrease the debt-to-GDP ratio by about 0.35%. The last variable that turned out to have a significant effect on the debt-to-GDP ratio is the unemployment rate. It has a considerably large debt increasing effect, as is to be expected due to anti-cyclical stabilisation policies.

As robustness checks, we ran the same regression as before but excluded, one at a time, Greece and Spain as countries with large underground economies and Germany as a country with a moderately sized underground economy from the sample. The results for the regression without Greece (shown in the Appendix, Table A1) indicate that neither the size of the underground economy nor the interaction term of the underground economy and the inflation tax are statistically significant there; the size of the underground economy even has a negative sign. However, the inflation tax now has a statistically weakly negative effect on the debt-to-GDP ratio.²⁷ These results suggest that the Greek underground economy has a dominant impact on the relationship between the size of the underground economy and public debt in the considered EMU countries. Since the estimations with and without Greece are stable, the lack of statistical significance of the underground economy variable in the regression without Greece may indicate that data variability in the estimation sample is too small.²⁸ Whether Greece is an outlier country in the EMU concerning the impact of the size of the underground economy and the debt-to-GDP-ratio therefore cannot be decided.

To check the robustness of the estimation presented in Table 2 further, the above regression is run for the same countries, but this time excluding Spain (shown in the Appendix, Table A2). The main results of Table 2 remain qualitatively unchanged as the size of the underground economy, and the interaction of the underground economy and the inflation tax have the expected sign and an even stronger impact on the debt ratio. The

²⁷ The AR(1) process is stable (inverted AR roots .71).

²⁸ We thank an anonymous referee for this hint.

AR(1) process is stable again (inverted AR roots .97). These results confirm the conclusion reached so far. As a final robustness test, Germany is excluded from the regression; the results are shown in the Appendix, Table A3. Also in this case all qualitative results continue to hold and the AR(1) process is stable (inverted AR roots .73). Hence, the estimation in Table 2 is robust with respect to the exclusion of countries.

4.3 Empirical Results II: Sub-sample Analysis

To check the impact of the inflation tax on the debt-to-GDP ratio, the sample is split up into a sub-sample containing data for 1992 to 2001, and a second sub-sample for the period from 2002 to 2010. Since data are available from 1992 onwards, the sub-samples are of similar size (ten and nine years, respectively). Although the decision on the first wave of EMU-countries was made in 1999, Euro notes and coins were only introduced at the beginning of 2002.

Table 3 shows the regression results for the first sub-sample, 1992 to 2001. The inflation tax played a crucial role in limiting the debt-to-GDP ratio in this period since its sign is negative and the coefficient value is remarkably large. Moreover, the size of the underground economy is not statistically significant. Only the combined effect of the inflation tax and the underground economy has an increasing effect on the debt-to-GDP ratio. With inverted AR roots of .52, the dynamic process is stationary.

For the second sub-sample comprising the time from 2002 to 2010, the picture changes quite drastically (Table 4). The inflation tax is now statistically insignificant whereas the size of the underground economy has the expected positive sign, i.e. it increases the debt-to-GDP ratio. Moreover, the combination of the inflation tax and the underground economy has a statistically significant small decreasing effect on the debt-to-GDP ratio. The dynamic process is stationary with inverted AR roots of .65. The estimation result may

be interpreted as a consequence of the common monetary policy in the EMU as the possibility to reduce the debt-to-GDP ratio by printing money is eliminated. However, this result comes at a price: the size of the underground economy increases the debt-to-GDP ratio because of the loss of the inflation tax, as predicted by theory.

Table 3: Estimations for the Debt-to-GDP Ratio with Respect to the Size of the Underground Economy and the Inflation Tax in a Cross-Section of Eleven EMU Countries, 1992-2001
(Panel Least Squares, Unbalanced Panel, Cross-section Fixed Effects)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	14.54535**	5.746199	2.531300	0.0139
Debt/GDP (-1)	0.620366***	0.089926	6.898592	0.0000
Size underground economy	-0.195628	0.297394	-0.657806	0.5131
Inflation tax	-3.003208***	1.069795	-2.807275	0.0067
Size underground economy $\times$ inflation tax	0.139334**	0.058636	2.376245	0.0206
Long-term interest rate (-1)	0.103618	0.347473	0.298203	0.7665
Unemployment rate	1.425743***	0.261027	5.462057	0.0000
Current account /GDP	-0.422506*	0.246398	-1.714732	0.0914
Growth labor unit cost	-0.011437	0.146605	-0.078009	0.9381
AR(1)	0.515631***	0.151409	3.405557	0.0012
R-squared	0.9954			
Adjusted R-squared	0.9940			
Durbin-Watson statistic	2.0579			
Inverted AR Roots	.52			

***, **: Statistically significant (in this order) on the 1% and the 5% level, respectively.

Source: Own calculations based on data from *oecd.stat*, Schneider (2009, 2011) and from Table 1 for Greece (GR2), as well as from Pickhardt and Sardà (2011, 2013) for Spain and Germany (profiles S2 and G3).

Table 4: Estimations for the Debt-to-GDP Ratio with Respect to the Size of the Underground Economy and the Inflation Tax in a Cross-Section of Eleven EMU Countries, 2002-2010
(Panel Least Squares, Unbalanced Panel, Cross-section Fixed Effects)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.959489	11.27362	0.794731	0.4293
Debt/GDP (-1)	0.468006**	0.180997	2.585713	0.0117

Size underground economy	0.456326**	0.218258	2.090769	0.0399
Inflation tax	0.373033	0.488087	0.764276	0.4471
Size underground economy $\times$ inflation tax	-0.060148**	0.022872	-2.629800	0.0104
Long-term interest rate (-1)	0.563346	0.723182	0.778981	0.4384
Unemployment rate	1.956246***	0.421443	4.641779	0.0000
Current account /GDP	-0.684053***	0.243040	-2.814573	0.0062
Growth labor unit cost	0.069419	0.140957	0.492480	0.6238
AR(1)	0.652121***	0.172712	3.775758	0.0003
R-squared	0.9916			
Adjusted R-squared	0.9895			
Durbin-Watson statistic	1.9698			
Inverted AR Roots	.65			

***, **: Statistically significant (in this order) on the 1% and the 5% level, respectively.

Source: Own calculations based on data from *oecd.stat*, Schneider (2009, 2011) and from Table 1 for Greece (GR2), as well as from Pickhardt and Sardà (2011, 2013) for Spain and Germany (profiles S2 and G3).

Our results imply that the structural problems created by a large underground sector should be a particular concern for EMU member and EMU candidate countries. Without the moderating effect of the inflation tax a large underground economy can contribute to the emergence of an unfavorable public debt development, which, if left unanswered, can generate potentially severe economic disruptions as recent experience shows.

5 Conclusions

In this paper, one of the most comprehensive time series on the size of the Greek underground economy is presented and macroeconomic risks that policy inactivity with regard to the underground economy may generate are highlighted. Our results show that the size of the Greek underground economy has been highly underestimated in the literature. Moreover, after many years of decline, the Greek underground economy has embarked on an upward trend again since Greece entered the European Monetary Union.

Whether the size of the underground economy can contribute significantly to the build-up of aggregate debt was then tested for a panel of eleven EMU countries. Our empirical evidence confirms the theoretically well-founded positive relation between the debt-to-GDP ratio and the size of the underground economy. Our results also point to the drastic consequences that the loss of the inflation tax as an economic policy instrument had for our sample of eleven EMU member countries. As long as national policymakers could generate public revenue from illicit economic activities, the negative impact of the underground economy on public finances could be counterbalanced. Once this was not possible any more (after the introduction of the Euro), the underground economy emerged as a statistically significant explanatory factor for the debt-to-GDP ratio. In this light our results add to the literature that points to the economic costs of a monetary union.

The MCDR approach offers a simple, transparent and flexible method to measure the size of the underground economy. While not immune to some of the criticism against the underlying Gutmann (1977) approach it addresses some of the methodological problems of more traditional monetary models. However, the contribution of possible causes to the development of the underground economy cannot be disentangled. Refinements that address this shortcoming in future research seem particularly relevant and promising from an economic policy point of view as the MCDR model includes all cash using illicit economic activities, such as drug dealing, human trafficking, etc., and not just those caused by tax pressure or excessive regulation. However, only fighting the latter can be assigned to economic policy and lead to a substantial improvement in public finances and. Fighting the former is a task for the prosecution services instead (and, if successful, will lead to a loss of public revenue as revenue from illegal activities can only be collected through the inflation tax).

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Appendix

Table A1: Estimations for the Debt-to-GDP Ratio with Respect to the Size of the Underground Economy and the Inflation Tax in a Cross-Section of Ten EMU Countries without Greece, 1990-2010 (Panel Least Squares, Unbalanced Panel, Cross-section Fixed Effects)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	15.6227***	4.3392	3.6004	0.0004
Debt/GDP (-1)	0.5648***	0.0663	8.5134	0.0000
Size underground economy	-0.1937	0.2266	-0.8546	0.3941
Inflation tax	-1.1122*	0.6245	-1.7811	0.0769
Size underground economy × inflation tax	0.0264	0.0382	0.6914	0.4904
Long-term interest rate (-1)	0.6146**	0.2920	2.1047	0.0370
Unemployment rate	1.4946***	0.2287	6.5361	0.0000
Current account /GDP	-0.3880**	0.1621	-2.3933	0.0180
Growth labor unit cost	-0.0249	0.0995	-0.2500	0.8029
AR(1)	0.7121***	0.0784	9.0880	0.0000
R-squared	0.9917			
Adjusted R-squared	0.9907			
Durbin-Watson statistic	2.0135			
Inverted AR Roots	.71			

***, **, *: Statistically significant (in this order) on the 1%, 5%, 10% level.

Source: Own calculations based on data from *oecd.stat*, *Schneider (2009, 2011)* and from *Pickhardt and Sardà (2011, 2013)* for Spain and Germany (profiles S2 and G3).

Table A2: Estimations for the Debt-to-GDP Ratio with Respect to the Size of the Underground Economy and the Inflation Tax in a Cross-Section of Ten EMU Countries without Spain, 1990-2010 (Panel Least Squares, Unbalanced Panel, Cross-section Fixed Effects)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	22.00486	13.39821	1.642373	0.1026
Debt/GDP (-1)	0.468728***	0.061082	7.673792	0.0000
Size underground economy	0.569526***	0.165967	3.431556	0.0008
Inflation tax	0.279161	0.361674	0.771856	0.4414
Size underground economy × inflation tax	-0.050168***	0.017913	-2.800579	0.0058
Long-term interest rate (-1)	0.956986***	0.293656	3.258864	0.0014
Unemployment rate	1.828669***	0.263911	6.929120	0.0000

Current account /GDP	-0.318792*	0.150239	-2.121891	0.0355
Growth labor unit cost	-0.023825	0.086436	-0.275638	0.7832
AR(1)	0.969872***	0.017299	56.06647	0.0000
R-squared	0.9915			
Adjusted R-squared	0.9910			
Durbin-Watson statistic	2.0902			
Inverted AR Roots	.97			

***, **, *: Statistically significant (in this order) on the 1%, 5%, 10% level.

Source: Own calculations based on data from *oecd.stat*, Schneider (2009, 2011) and from Pickhardt and Sardà (2011, 2013) for Spain and Germany (profiles S2 and G3).

Table A3: Estimations for the Debt-to-GDP Ratio with Respect to the Size of the Underground Economy and the Inflation Tax in a Cross-Section of Ten EMU Countries without Germany, 1990-2010 (Panel Least Squares, Unbalanced Panel, Cross-section Fixed Effects)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.65196***	4.412812	2.640483	0.0092
Debt/GDP (-1)	0.477508***	0.062004	7.701289	0.0000
Size underground economy	0.344755**	0.144928	2.378807	0.0187
Inflation tax	0.092303	0.371640	0.248366	0.8042
Size underground economy × inflation tax	-0.040317**	0.017970	-2.243518	0.0265
Long-term interest rate (-1)	0.757485**	0.297004	2.550419	0.0119
Unemployment rate	1.732190***	0.242147	7.153459	0.0000
Current account /GDP	-0.440746***	0.160510	-2.745916	0.0068
Growth labor unit cost	-0.034466	0.097491	-0.353532	0.7242
AR(1)	0.730729***	0.062361	11.71767	0.0000
R-squared	0.9923			
Adjusted R-squared	0.9912			
Durbin-Watson statistic	1.8796			
Inverted AR Roots	.73			

***, **, *: Statistically significant (in this order) on the 1%, 5%, 10% level.

Source: Own calculations based on data from *oecd.stat*, Schneider (2009, 2011) and from Pickhardt and Sardà (2011, 2012a) for Spain and Germany (profiles S2 and G3).