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HOW STRONGLY THE HIDDEN ECONOMY OF A SMALL COUNTRY CAN BE INFLUENCED BY DRASTIC EVENTS: CASE OF MACEDONIA

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Abstract
Hidden economy presents a big concern for both developing and developed countries. Of particular interest is precise determination of the temporal pattern of hidden for small developing economies, which exhibit many peculiarities. Several methods for estimation of hidden economy are effectively used in economic research. Appropriate model based on some of these methods for small developing economies is required. Modified electric energy household consumption model is proposed in this work. Using this model, temporal variations of hidden economy in Republic of Macedonia were calculated for the period 1992–2014. For the sub-period 1999–2007 the obtained values are in excellent agreement with values reported in literature obtained by dynamic multiple indicators multiple causes method, proving that the method proposed in this work produces highly relevant results. Thus obtained temporal pattern of the hidden economy in Macedonia, using deconvolution in Gaussians, is described by five contributions: baseline at 32% and four Gaussian peaks corresponding to hyperinflation, Kosovo conflict, security crisis in Macedonia and banking crisis. After the expiration of the effects of these shocks, hidden economy approaches the baseline at about 32 %. It is proposed to use this modified method for estimating size of hidden economy in various small economies.

Keywords: developing countries, modelling, regression variables, economic transition.

Jel Classification: E26; Q43; P29

INTRODUCTION

The phenomenon of hidden economy, the part of the economy that is not immediately visible when using official reporting methods, nowadays attracts high interest of researchers (Cichocki and Tyrowicz 2010; Gonzalez-Fernandez and Gonzalez-Velasco 2015; Murashov and Ratnikova 2016; Schneider 2016a). Factors influencing extent of shadow economy (Schneider and Enste 2000) have been studied extensively; thus, it has been shown that hidden economy is connected to: tax evasion (Pickhardt and Prinz 2012; Schneider 2016b), unemployment (Adriana 2014), public debt (Prinz and Beck 2012), intelligence (Salahodjaev 2015), internet usage (Elgin 2013), tourism (Din et al. 2016), etc.

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Besides these general factors, for small countries it is expected the size of the hidden economy to be strongly modified by various shocks both from external and from internal origin, quite often of noneconomic nature. In this work the case of Republic of Macedonia was studied, as a typical example of a small country which economy was stricken by different unfavourable influences. Some data for Macedonia are already reported in broader context for limited time periods (Lacko 2011; Schneider, Buehn, and Montenegro 2010). The data from (Schneider, Buehn, and Montenegro 2010) are highly relevant and provide a reliable value of the baseline for the observed phenomenon for Macedonia, but no marked oscillations are observed as expected for Macedonia, owing to the use of general method using strongly limited number of country specific parameters. Previously, initial assessments have been made using dynamic multiple indicators multiple causes (DYMIMIC) method (Schneider, Buehn, and Montenegro 2010) and household electricity consumption method (Lacko 2011) for a period of about twenty years. Results obtained using these two methods were reported in (Novkovska 2016), where significant oscillations have been observed. Above described methods are indirect. Direct methods for estimation of the size of hidden economy, based on statistical surveys, have also been developed. They have advantages in terms of comparability and detail, but tend to under-report the extent of undeclared work. A systematic overview of the extent and nature of undeclared work of the country, and how it is being tackled, has been provided in (Williams, Baric, and Renooy 2013; Dzhekova et al. 2014). Based on thus obtained results, in (Williams et al. 2015) the policy approach towards the undeclared economy has been evaluated.

In the present work a modified Lacko (2011) model for a single country is proposed, using several country specific parameters, allowing obtaining as much as possible detailed picture of temporal variations of hidden economy for a specific country. The household electricity approach has been used since the basic quantity on which it relies, electric energy consumption, is precisely measureable and regularly reported.

1. DESCRIPTION OF THE MODIFIED MODEL

The household electricity approach, or Lacko method, (Lacko 2011) in a cross-country analysis is described by these two simultaneous equations:

$$\ln E_i = a_1 \ln C_i + a_2 \ln PR_i + a_3 G_i + a_4 Q_i + a_5 H_i + a_6 + u_i \quad (1)$$

with coefficients $a_1 > 0$, $a_2 < 0$, $a_3 > 0$, $a_4 < 0$ and $a_5 > 0$ and

$$H_i = \hat{a}_1 T_i + \hat{a}_2 S_i + \hat{a}_3 D_i \quad (2)$$

with coefficients $\hat{a}_1 > 0$, $\hat{a}_2 < 0$ and $\hat{a}_3 > 0$,

where

i the number assigned to the country,
E_i per capita household electricity consumption in country i,
C_i per capita real consumption of households without the consumption of electricity in country i in US dollars (at purchasing power parity),
PR_i real price of consumption of 1 kWh of residential electricity in US dollars (at purchasing power parity),
G_i relative frequency of months requiring heating in houses in country i,
Q_i ratio of energy sources other than electricity energy to all energy sources in household energy consumption, Hi is the per capita output of the hidden economy,
Ti ratio of the sum of paid personal income, corporate profit and taxes on goods and services to GDP,
S_i ratio of public social welfare expenditures to GDP, and
D_i sum of the number of dependants over 14 years and inactive earners, both per 100 active earners.

In order to obtained more details on the temporal pattern of the studied phenomenon, a method modified for a specific single country is used here. Following equations were used as starting ones:

$$\ln E = k_1 \ln C + k_2 \ln PR + a_3 G + k_4 Q + a_5 H + k_6 + k_7 HY + k_8 CR + u \tag{3}$$

with coefficients $k_1 > 0$, $k_2 < 0$, $a_3 > 0$, $k_4 < 0$, $a_5 > 0$, $k_7 > 0$ and $k_8 > 0$ and

$$H = \hat{a}_1 T + \hat{a}_2 S + \hat{a}_3 D \tag{4}$$

with coefficients $\hat{a}_1 > 0$, $\hat{a}_2 < 0$ and $\hat{a}_3 > 0$,

where the country index has been omitted since a single country is considered.

Two new dummy variables were introduced, particular for Macedonia: HI – having value 1 for year 1995 where hyperinflation attained pick intensity and 0 for all other years and CR – having value 1 for year 2002 where security crisis occurred and 0 for all other years.

Besides the introduced dummy variables and their parameters k_6 and k_7, the specifics of the country were reflected by using set of country specific values for the parameters k_1, k_2, k_3 and k_5. The values of the parameters $a_4 < 0$, $\hat{a}_1 > 0$, $\hat{a}_2 < 0$ and $\hat{a}_3 > 0$ were fixed to the values obtained in (Lacko 2011) cross-country analysis, in order to be comparable to the values obtained for other countries. Thus, the above modification is expected to provide simultaneously reflecting of country specifics and high comparability with other countries.

Theoretical (predicted) values of electric energy consumed in households (E_{pr}) is obtained when taking antilogarithm of ln$E$ without residuals (u) after replacing value of H with the right hand side of the equation (4):

$$E_{pr} = \exp\left(k_1 \ln C + k_2 \ln PR + a_3 G + k_4 Q + a_5 \cdot \hat{a}_1 T + a_5 \cdot \hat{a}_1 S + a_5 \cdot \hat{a}_1 d + k_6 + k_7 HY + k_8 CR\right) \tag{5}$$

Values of country specific parameters were obtained by best fit (multiple linear regression) of the theoretical curve to the series of observed values.

Finally, the size of the hidden economy (HE) is obtained as

$$HE = k \frac{H}{\ln E_{pr}} = \tag{6}$$

$$= k \frac{\hat{a}_1 T + \hat{a}_2 S + \hat{a}_3 D}{k_1 \ln C + k_2 \ln PR + a_3 G + k_4 Q + a_5 \cdot \hat{a}_1 T + a_5 \cdot \hat{a}_1 S + a_5 \cdot \hat{a}_1 d + k_6 + k_7 HY + k_8 CR}$$

where k is a calibration constant, to be obtained by using an absolute value of hidden economy for a given year obtained by different method providing an absolute value. In this work the value from the work (Schneider, Buehn, and Montenegro 2010) for year 2002 (k = 35.1 %) is used.

2. RESULTS AND DISCUSSION

Data used in this work are summarized in Table 1 (calculations using data from State Statistical Office of Macedonia, Eurostat and World Bank). The entire period since independence in year 1992 until year 2014 (the most recent available set of data) has been covered. Available data from State Statistical Office of Macedonia, Eurostat and World Bank have been used and calculations made to obtained the required values of variables used in the model. Some data for the first few years were estimated by extrapolation, and hence for the first two years (1992 and 1993) lower reliability can be expected than for the rest of the considered period. Overall, the period starting from the independence and transition from socialist to market economy until recent years has been covered.

Table 1. Input data for the model and the estimated size of hidden economy (HE)

year	*E* (kWh) per capita	*C* (US$) PPP	PR (US$) PPP	G	Q (%)	T (%)	S (%)	D (%)	HI	CR	HE
1992	931.43	763.93	0.039	0.42	35.00	24.04	12.72	59.85	0.00	0.00	35.85
1993	1075.80	857.41	0.049	0.42	35.00	23.81	12.52	59.80	0.00	0.00	36.15
1994	1725.20	1217.17	0.045	0.42	35.00	23.58	12.33	59.76	0.00	0.00	34.69
1995	1580.00	1183.51	0.051	0.42	35.00	23.35	12.13	59.71	1.00	0.00	35.02
1996	1498.00	975.89	0.046	0.42	35.58	23.64	11.93	61.07	0.00	0.00	36.38
1997	1479.40	916.26	0.044	0.42	35.58	22.00	12.20	64.98	0.00	0.00	35.95
1998	1578.30	872.86	0.041	0.42	35.31	21.60	11.12	57.05	0.00	0.00	33.70
1999	1573.02	845.52	0.041	0.42	34.00	22.62	11.03	52.06	0.00	0.00	33.09
2000	1428.00	894.50	0.037	0.42	33.31	24.00	10.61	53.44	0.00	0.00	34.69
2001	1147.31	874.02	0.075	0.42	31.60	22.70	10.85	50.17	0.00	1.00	33.23
2002	1764.98	1502.97	0.058	0.42	37.96	24.22	10.45	52.86	0.00	0.00	35.10
2003	1787.01	1554.39	0.061	0.42	36.46	21.55	10.75	62.74	0.00	0.00	35.59
2004	1732.54	1630.82	0.057	0.42	33.14	21.84	10.30	69.65	0.00	0.00	37.90
2005	1620.61	1608.40	0.059	0.42	37.27	23.59	9.69	67.08	0.00	0.00	39.47
2006	1524.32	2069.34	0.069	0.42	32.49	21.96	9.61	69.08	0.00	0.00	38.26
2007	1264.25	2214.56	0.091	0.42	39.35	22.85	9.17	66.38	0.00	0.00	39.60
2008	1256.14	2223.48	0.089	0.42	39.79	23.06	9.29	61.96	0.00	0.00	38.23
2009	1417.27	2029.31	0.071	0.42	35.55	21.23	9.46	57.40	0.00	0.00	34.28
2010	1426.52	2031.25	0.080	0.42	29.43	20.04	8.91	56.73	0.00	0.00	33.39
2011	1239.54	1984.13	0.092	0.42	28.86	19.70	8.58	55.89	0.00	0.00	33.44
2012	1583.00	1739.28	0.102	0.42	19.10	8.58	55.89	0.24	0.00	0.00	33.19
2013	1485.00	1661.29	0.106	0.42	18.40	8.58	55.89	0.01	0.00	0.00	31.63
2014	1473.00	1918.79	0.107	0.42	18.90	8.58	55.89	0.01	0.00	0.00	31.82

Table 2. Parameters of the model

Parameter	Value	Standard Error	Method
k_1	0.4943	0.27	Fitted value
k_2	-0.5834	0.34	Fitted value
a_3	1.0494	-	Fixed value
k_4	-1.0907	0.56	Fitted value
$a_5 \cdot \hat{a}_1$	0.0202	-	Fixed value
$a_5 \cdot \hat{a}_2$	-0.0164	-	Fixed value
$a_5 \cdot \hat{a}_3$	0.0071	-	Fixed value
k_6	1.2616	2.7	Fitted value
k_7	0.1899	0.26	Fitted value
k_8	0.0612	0.13	Fitted value

The parameters of the model are summarized in Table 2. It is seen that the signs of all of the parameters are in agreement with these supposed in the model.

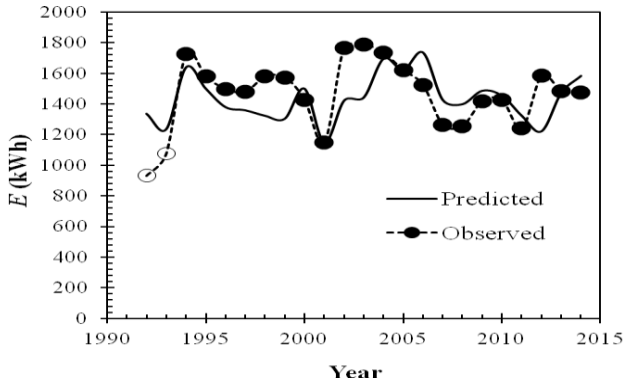

Figure 1. Predicted values of the electric energy consumed in households (full line, E_{pr}) compared to the observed values (broken line and circles, E). Empty circles are for years where significant difference between predicted and observed values is observed

In figure 1 the predicted values of electric energy consumed in households (E_{pr}) are shown as one with the observed values (circles). The curves are close to each other (full circles), except in the points for first two years, most probably because of the lower reliability of the data in the initial period of transition (empty circles).

In figure 2 the values for the size of hidden economy as percentage of official GDP obtained using the model proposed in this work (equation 6) are depicted for the entire period from year 1992 to year 2014 (thick line, full circles). For a comparison, the values for Macedonia reported in (Schneider, Buehn, and Montenegro 2010) are also shown (thin line, grey filled circles). As is seen, results obtained by these two different methods are close to each other in the sub-period from year 1999 to 2007; a correlation coefficient

of 0.900 is obtained for these two variables. Here obtained values for the size of hidden economy are also shown in the rightmost column in the Table 1.

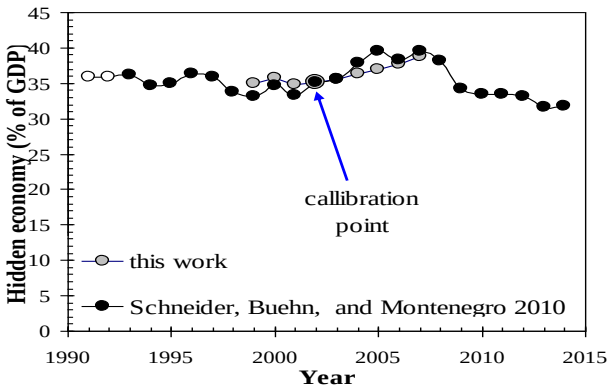

Figure 2. Hidden economy in Macedonia as precentage of official GDP obtained in this work (thick line, full circles) compared to the values reported by Schneider, Buehn, and Montenegro (2010) (thin line and grey field circles). Empty circles are for years where significant difference between predicted and observed values of electric energy consumed in households is observed

The small variations may be due to some fluctuations in the result obtained in this work or to oscillations having real nature. Therefore, in order to analyze in details the temporal pattern of the hidden economy obtained in this work, a deconvolution of the signal using multiple Gaussian pulse, described with the expression was done (7)

$$HE = HE_0 + \sum_{m=1}^{4} HE_m \exp\left(\frac{Y - CY_0}{\sigma_m^2}\right), \quad (7)$$

where Y is for the year, HE_0 is the baseline value of hidden economy, YC_i is the central year for a given Gaussian pulse, HE_m is its magnitude and σ_i is its standard deviation.

Estimates of the values of the parameters HE_0, YC_i, and HE_m are displayed in Table 3 for i =1 to 4. Baseline value is 32 %

Table 3. Parameters of the deconvolution

Pulse number	Magnitude (%)	Central Year	Standard Deviation (%)
0 (baseline)	32.0	-	-
1	4.5	1996	2.00
2	3.0	2000	0.89
3	7.5	2005	2.65
4	5.0	2008	1.00

In figure 3 the result for hidden economy obtained using equation (7) is shown as one with observed values. Excellent fitting of the observed values with the theoretical curve is obtained; corresponding correlation coefficient is 0.849. Therefore, one can conclude

that the oscillations of the size of hidden economy obtained using the model proposed here are due to some realistic factors rather than to some stochastic fluctuations.

The shapes of the pulses described by expression (7) are displayed separately in the lower part of figure 3. Their origins were identified as follows:

a) The pulse cantered at year 1996 has been attributed to the hyperinflation whose peak occurred in year 1995 (Wyzan 1993);
b) The pulse cantered at year 2000 has been attributed to Kosovo conflict that influenced the Macedonian economy;
c) The most marked pulse is that cantered around year 2005, starting in year 2011, attributed to the security crisis in Macedonia (Hislope 2003) and
d) The fourth pulse corresponds to the global banking crisis (Colombo, Onnis, and Tirelli 2016) that also influenced Macedonia.

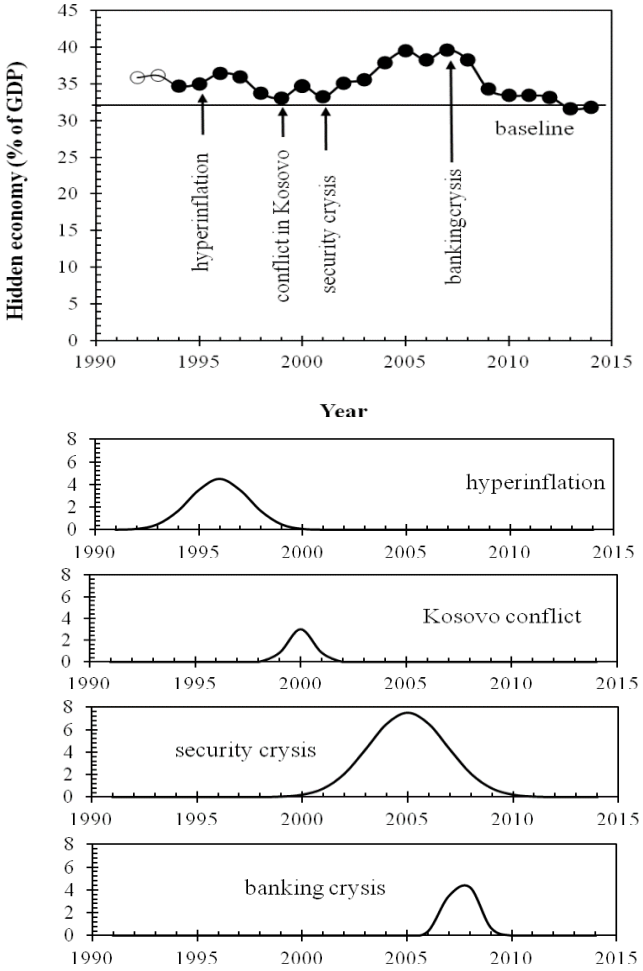

Figure 3. Deconvolution of temporary pattern of hydden economy in Maedonia in four Gaussians

It is to be noted that the obtained temporal pattern can be precisely described by superposition of these five contributions. Therefore, the observed oscillations in the estimated hidden economy can be better attributed to some shocks in the society influencing the economy rather than to stochastic fluctuations.

CONCLUSION

The proposed in this work modified Lacko model for estimating the size of shadow economy in small developing country can be successfully applied to the case of Macedonia. The results obtained by this method closely correspond to the known relevant literature results for the time periods for which these exist. Therefore, it is justified to use the results for a single country using the proposed modified method.

For the period from year 1992 (since independence) to year 2014 temporal pattern of hidden economy displays several maxima. Detailed analysis based on deconvolution in four Gaussian peaks shows that the observed peaks are closely related to the maxima (central years) of Gaussian pulses corresponding to four most important severe shocks that Macedonian economy survived in the studied period: hyperinflation in year 1995, Kosovo conflict in 1999 year, security crisis in Macedonia in year 2001 and the global banking crisis of 2008. The most important event that initiated long and strong increase of the hidden economy was the security crisis in year 2002. Effect of this shock on hidden economy lasted almost for a decade attaining a peak value of about 8%, corresponding to additional ¼ of the baseline size of the shadow economy. Another one rather important shock was that produced by negative side effects that occurred during transformation of the economy accompanied by political and monetary independence. Its effect on the hidden economy was somehow smaller – about ¾ of the first one both in length and magnitude. These two extreme events have low probability to be repeated in the near future, and hence one can expect only oscillations of smaller size, such as crises in the neighbourhood.

Based on this, one can recommend the use of here proposed compact model for estimation of the size of hidden economy of small developing countries in transition for relatively long period of time. Using deconvolution method, contributions from different shocks causing increase of hidden economy can be effectively separated.

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