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Analyzing How a Growth in Energy Prices Impact on the Size of the Shadow Economies around the World

We assume that a growth of energy prices could create additional incentives for firms to conceal their incomes that results in the higher size of the shadow economy in a country. To verify this hypothesis we apply a formal analysis of the model where a representative firm attempts to 'optimize' its concealed income in the context of a non-rigid outside control. We show that institutional improvements would allow the lower SE share in GDP. To test this hypothesis empirically, we construct regressions of the shares of the shadow economy in GDP over 2003-2008 using the estimations both available in the publications and ours calculated by Currency Demand Approach which we modified and applied, unlike the previous modifications, to cross-sectional data. A specific interaction variable used in our regression equations, being a combination of both tax burden variable and institutional quality indicator, allows considering an important fact that the high level of taxes assumes the shadow economy bigger in size in the counties with poor institutional environment and vice versa – in those with sound environment due to a high supply of public goods and services. To calibrate the model, we applied the algorithm which allows considering the fact that foreign currency (US dollars in our case) along with domestic one is included in the shadow economy's transactions. Finally, the hypothesis suggested by us concerning the impact of relative energy prices on the size of the shadow economy in a country was verified on the basis of large samples of both cross-sectional and panel data. The estimations of the regression parameters which we obtained can demonstrate a stable character of their values despite the methods we applied to in our analysis.

Keywords: shadow economies, energy prices, institutions, econometric methods.

JEL Classification: C21, C23, E26, D02, D24.

1. Introduction

This article analyzes what conditions and factors drive the shadow economy (the SE). Unlike the other authors who study this issue, we include a price factor, namely, how energy prices impact on the sizes of the shadow sectors in the world economies. We assume that any increase in firm's costs associated with higher energy prices could create additional incentives for firms to conceal their incomes in order to avoid tax and social payments. Our hypothesis is that the energy price factor can also increase the SE size measured as a share of the concealed income in GDP. To verify it, we construct regressions of the SE shares in GDP over 2003-2008 when a steady energy prices growth has been observed in most countries of the world, using the SE estimations available (Schneider, Buehn, Montenegro, 2010). The Cross Sectional Analysis of these data displays a strong positive dependence on real energy prices in the countries of the world. The same results can be obtained by applying a random effect model with both panel and dynamic panel data with instrumental variables over 2003-2008.

We operate on the fact that the SE shares in GDP which we use in our study have been obtained on a basis of the MIMIC model (multi-indicator and multi-factor model) which directly produces the indices of how the SE change per years of the specified period for the countries under study. So, to receive our estimations, we had to rely on those previously made by other researchers. However, they, having presented such estimations, refer to the publications containing the calculations made on the basis of the analysis of power consumption dynamics, at least, those made for economies of the CIS (Alexeev, Pyle, 2003). Therefore, the SE indicators run the danger of being sufficiently dependent on energy prices just because of their origin, but not of how firms actually behave. Besides, the SE estimations presented by foreign researchers covers the time period only up to 2007 (Schneider et al., 2009). That is why we, unlike other authors who studded this issue, calculated our own SE estimations through the Currency Demand Approach applied to cross-sectional data. Both sets of estimations were examined by us through identical statistical analysis. Both analyses has verified our hypothesis.

The empirically obtained conclusions concerning the dependence of energy prices and the SE sizes both for ours and MIMIC estimations have been received on the basis of the cross-sectional and panel data adjusted for possible endogeneity and first order autocorrelation (Arellano-Bond estimator, Sargan-Hansen test).

2. Literature Review

Tax burden, which includes welfare payments, is the most important cause of emergence and growth of the SE (Lippert, Walker, 1997; Johnson et al., 1998a, 1998b, Shneider, 2000, 2003; Tanzi, 1999). These works show that ineffective tax collecting rather than tax sizes causes concealment of economic activities and incomes (Johnson, Kaufmann, Zoido-Lobatón, 1998b). Revenues from taxation can facilitate higher quality of management, better provision of public goods and services, and a lower share of the SE (Friedman et al., 2000; Johnson et al., 2000). It means that if a tax share in revenues grows in the countries with sound institutional environment, then the SE won't increase and, perhaps, will start dropping. The strengthened government control and/or shortcomings of institutional systems could cause the higher SE too. The works (Schneider, 2000; Johnson et al. 1998a) show that a share of the SE and quality of government control are theoretically and empirically related.

Many authors emphasize corruption as a cause of prime concern, specifically for emerging and transitional economies (Ernste, Schneider, 1998; Johnson et al., 1998b; Fried-man et al., 2000; Dreher, Kotsogiannis, McCorriston, 2005; Dreher, Schneider, 2006; Schneider, Buehn, 2009). The fact that corruption and the SE are complementary is also noted (Cule, Fulton, 2005). The greater government control an economy experiences, the bigger SE and corruption are. However, the higher SE reduces corruption in high income countries and makes it bigger in low income economies (Dreher, Schneider, 2006; Schneider, 2006).

One more factor is a poorly developed public sector (Johnson et al., 1998a, 1998b; Friedman et al., 2000) that reduces quality of regulation of the economy. At the same time, "tax morals" reflecting the general spirit of economic agents "to withdraw into the shadows" play an important role. As for the former CIS countries, the SE is rooted in their historical reality (Schneider, Klinglmair, 2004; Torgler, Schneider, 2007a, 2007b; Alexeev, Pyle, 2003).

The SE impacts on the economic development are different for developed, emerging, and transition economies. The positively related SE and rates of the economic growth observed in developed and transition countries can be explained by the advantages of competition and absence of excess regulation, while in emerging economies such correlation is negative due to reduced tax revenues and, as a result, the deteriorated regulation and reduced provision of public goods and services (Schneider, Klinglmair, 2004). How the SE ('black’ market) influences the income distribution during a transition period is described by Polterovich (Polterovich, 1993).

There are three approaches to assess the size of SE (i.e. a SE share in GDP), such as a direct count, indirect assessment, and that based on modeling several factors and the SE indicators.

The direct count methods are based on the respondents' surveys or microeconomic analysis of tax payments and incomes. The indirect methods includes an analysis of the revealed discrepancies between separate economic indicators such as income and expenses, on- and off-the-record employment, monetary transactions (or money demand) and other macro-indicators, power consumption and incomes, and etc (Feige, 2004; Giles, Tedds, 2002; Lackó, 1996, 2000). The authors of these works show that all these methods have their advantages and disadvantages for analyzing different types of shadow activities.

The third approach based on the models where the SE acts as a non-observable and indirectly estimated variable allows for all major factors which have impact on the shadow economy (Frey, Weck-Hannemann, 1984; Shneider, Klinglmair, 2004; Giles, Tedds, 2002; Bajada, Schneider, 2003). This approach and model are called the MIMIC Model (multiple-indicators multiple-causes model). T. Breusch criticized this approach in detail (Breusch, 2005) and comes to a conclusion that it won't be considered satisfactory for such measurements since it is over-reliant on the instruments measuring the indicators and hypotheses and calibration chosen for the model. In response, R. Dell'Anno and T. Schneider published their work (Dell'Anno, Schneider, 2006) where they analyze the arguments given by T. Breusch (Breush, 2005) in detail, but came to a conclusion that the MIMIC model will be quite applicable if all assumptions and calibration techniques are carefully discussed and presented.

The works (Schneider, Enste, 2000; Schneider, 2000, 2003, 2007; Schneider, Buehn, 2009; Schneider, Buehn, Monte-negro, 2010) made the greatest contribution to researching the shadow economy. The latter (Schneider, Buehn, Montenegro, 2010) presents their MIMIC estimations of the SE size made for 162 countries of the world over 1999 – 2006/2007. The study which covers a great deal of the countries along with dynamics analysis of the indicators and significant factors can display how important the results of the study are (Schneider, 2012).

F. Schneider and others (Schneider et al., 2010) used some results obtained by Alexeev and Pyle (Alexeev, Pyle, 2003) to assess the SE sizes. These estimations, as it was said above, were made through applying the Electricity Consumption Methodology. For the first time the approach was described by Kaufmann and Kaliberda (Kaufmann, Kaliberda, 1996) where the authors made an assumption that an electricity-to-GDP ratio in the short term is usually close to one. The authors find that a difference between the growth rates of the GDP and electricity consumption could be considered as an indicator of how the SE changes in a country. M. Lasko also supported the idea of applying the Electricity Consumption Methodology and presented her estimations for the Post-Soviet countries (Lacko, 2000). In her opinion, it would be better to apply another indicator such as the household electrical consumption per capital, since informal economic activities are concentrated in households. However, this is rather debatable proposal, especially for transitional economies.

The fact that F. Schneider and others (Schneider et al., 2010) used the estimations made by Alexeev and Pyle (Alexeev, Pyle, 2003) means that energy prices have been initially included in their estimations due to the Electricity Consumption Methodology. To have the objective results concerning a relationship between relative energy prices and the SE, it would be advisable to offer an alternative technique for assessing the SE – without the Electricity Consumption Methodology.

Here we present our estimation technique which would allow us to analyze the impacts of relative energy prices. Besides, we took into account to what degree national economies are dollarized, since it is a worldwide practice to use foreign currencies (mostly the US dollar) along with national ones in shadow activities. At the same time, as the USA currency in cash participates both inside and outside the USA, there is a need in additional adjustments for assessing the SE. Schneider et al. (Schneider et al., 2010) did not discuss this idea. Anyway, the high level of dollarization could misrepresent the conclusions made.

3. Methodology

Our empirical analysis is based on the theoretical model in (Friedman et al., 2000), which describes the behavior of a firm who decides what part of its activity will be hidden from tax and regulation authorities. The model has been developed to explain why tax and regulation burdens result in the greater SE sizes in a low tax rates economy, while in the lower SE – in that with rather high tax rates.

Assume that a firm, in attempt to hide its activity from government or regulatory authorities, solves the following problem:

$$\max_{Y_2}\left[\left(1-t-r(T)\right)(Y-Y_2)R_1(T)+Y_2R_2(T)-k(T)(Y_2)^2/2\right], \qquad (1)$$

where *Y* and *Y2* are the reported and shadow incomes of a firm; *t* is the tax rate; *r* is the parameter of bureaucratic expenditures associated with the excessive regulation; *k* is the effectiveness of the legal system; *T* is the tax revenue; *R1=R1(T)* and *R2=R2(T)* are the returns from reported and shadow investments, respectively. We assume that $dr/dT \le 0, dk/dT \ge 0, dR_i/dT \ge 0, i=1,\ 2$. Doing so, we supplement the Friedman's model (Friedman et al., 2000) where the institutional parameters *r* and *k* were supposed to be independent on tax revenue. We think that the more means a government has, the better economic policy, laws, and law enforcement are – in other words – the higher institutional quality is. Moreover, instead of *R2(T)=1*, as it is in the Friedman's model (Friedman et al. 2000), we assume that efficiency of shadow incomes may have a positive dependence on both budgetary funds and those officially received.

One more modification is connected with considering the impact of the changed relative energy prices on the parameters of the model. We assume that the parameter *Ri* also depends on the average real expenses *AC*: $R_i = R_i(T, AC)$, $\frac{\partial R_i}{\partial T} > 0$, and $\frac{\partial R_i}{\partial (AC)} < 0$, *i*=1, 2, adopting that higher expenses cut the return from investments. The shadow income in its steady state is equal to:

$$Y_2 = \begin{cases} \frac{1}{k(T)} \cdot (R_2(T, AC) - (1 - t - r(T))R_1(T, AC)), \text{ если } Y_2 < Y; \\ Y \text{ в противномслучае.} \end{cases} \qquad (2)$$

It is easy to see that Y_2 >0 only if *R1/Rr2* (for convenience of further discussion $R_2 / R_1 = \alpha$) is:

$$* \qquad \alpha > 1 - t - r(T), \qquad (3)$$

It means that *R2* can't be much less than *R1*. Otherwise, no SE can arise in this model.

This brings up several questions. How adequately can this model explain an ambiguous relationship between taxes and the SE sizes? Whether growing tax rates may result in the greater SE if the initial tax level was low, while – in the lower SE if the initial tax level was high? Obviously, an increase in a total volume of taxes cannot directly influence the firms' behavior and higher tax rates always inspire them to make their hidden incomes higher; but along with this, *T* grows beyond the firm's control and, therefore, *R1* and *R2* do the same. The question to what extent the SE size changes or, in other words, what sign the SE derivative has, is quite in order.

To answer this question, consider at first another function of the returns from reported and shadow investments. Having *AC* fixed, let us introduce the following notation:

$$R_1(T(t), AC) = \bar{R}_1(t), \quad R_2(T(t), AC) = \bar{R}_2(t). \tag{4}$$

If an economy is on the ascending part of the Laffer curve, then $d\bar{R}_i(t)/dt > 0,\ \ i = 1,\ 2$, and if there is no change in combined income in an economy, then $d\bar{R}_i(t)/dt = \partial R_i(T, AC)/\partial T$.

Considering that *r* and *k* depend on *t* (though these functional dependences are beyond the firm's control), it is possible to write down:

$$r(T) = \bar{r}\left(t\right),\ \ d\bar{r}/dt < 0, k(T) = \bar{k}\left(t\right),\ \ d\bar{r}/dt > 0\,. \tag{5}$$

The higher tax rate bringing higher government revenues results in a drop of the firm's losses from overregulation of shadow activities.

The derivative of *Y2* on *t* in the equation (2) produces together with the conditions (4)–(5):

$$\frac{\partial Y_2}{\partial t} = \begin{cases} \geq 0, & \text{если } \alpha e_2 - (1 - t - \bar{r}(t))e_1 \geq -t + \left[(\alpha - (1 - t - \bar{r}(t))e_k + r\left|e_r\right|\right]; \\ < 0, & \text{если } \alpha e_2 - (1 - t - \bar{r}(t))e_1 < -t + \left[(\alpha - (1 - t - \bar{r}(t))e_k + r\left|e_r\right|\right]. \end{cases} \tag{6}$$

where e_1, e_2, e_k, e_r are the elasticity coefficients of *R1*, *R2*, parameters of effectiveness of legal system *k*, and bureaucratic expenses connected with overregulation *r* at the tax rate *t*. The expression given in square brackets shows how the institutional variables *k* and *r*, which change in response to the changed *t*, impact on the sign of the derivative. If the expression is equal to zero or not large against the change of the parameters $t, \bar{R}_1(t)$, и $\bar{R}_2(t)$, the condition $\partial Y_2/\partial t < 0$ could be met only if e_1 is considerably higher than e_2 (due to (3)). At the same time, high values of e_k and $\left|e_r\right|$ soften this condition.

Now consider the conditions when a growth of energy prices causes an increase in the SE size *Y2*. For this purpose, having returned to the former notations and taken the derivative of *Y2* on *AC* in (2), we come to the condition:

$$\alpha\varepsilon_2 - (1 - t - r(T))\varepsilon_1 > 0, \tag{7}$$

where ε_1 и ε_2 are the elasticity coefficients of the functions $R_1(T,AC)$ and $R_2(T,AC)$ against average expenses. Thus, the SE grows in response to the growth of expenses if R_2 и ε_2 are rather high, but not less than R_2 и ε_2. However, R_1 и ε_1 seem to be higher than R_2 и ε_2. It would appear reasonable to suggest that legal incomes could be used more productive in comparison with shadow ones (firstly, shadow incomes should be "washed" and this would require certain expenditure, and, secondly, most of the shadow incomes goes for consumer purposes).

So, according to the solution of the model (2), the change of the relative energy prices, having made the expenses *AC* higher, may, at least temporarily, generate a SE growth trend even if institutional environment does not change. Theoretically, the changed structure of prices has to change immediately the structure of the production factors with a reduced share of those which became relatively more expensive. Energy consumption, accordingly, reduces along with a relative growth of the power factor. If the production function is the scale function of constant returns to scale, the real costs per a unit of output comes back to their previous value.

Therefore, theoretically, the impact of the higher energy prices on the SE size couldn't be considered significant. However, there is an important circumstance which may aggravate a problem since it may hinder a return of the system to its starting position. There are serious empirical evidences displaying that the effect of the higher energy prices resulted in a drop of energy intensity of production is immediate only partly and mostly apparent during the long time. The American scientist J. Sweeney who analyzed the experience of the 1970s – early 1980s (Sweeney, 1984) writes that the response of an economy to the changed energy prices includes the processes when other production factors may replace energy resources or one type of energy resources may substitute others; or when a manufacture of one final product shifts to the production of others; or when the structure of production changes. Each of these processes or a combination of them may take up to a decade and even more years. As the energy-consuming equipment usually have severe requirements for the consumed energy per unit of output, an economy will react to increased energy prices up to the time during which the substitution of new equipment for old one will be fully accomplished, and this may take quite a long time. If so, it is reasonable to expect that the SE sizes over this period will be higher than their equilibrium values.

However, if new and less energy-intensive technologies have already replaced the old ones as a responce to the previous increase in energy prices, then the next drop would not restore the specific energy consumption to its previous level (to install the old equipment instead of the new one would not be economically and technically reasonable because the new technological links had already taken place). Therefore, the above model (as well as empirical results discussed below) is adequate to the time period when an increase in prices took place, and it may predict a ‘prices – energy consumption’ hysteresis which cannot exist in reality. This is one of the shortcomings of this approach.

The time period for assessment. To make econometric assessments for analyzing how energy prices impacted on the SE sizes, we chose the time period from 2003 to 2008 when an obvious and rapid growth of relative energy prices took place. Such an apparent tendency has not been observed over previous time. For example, the average relative energy prices rose in the OECD countries approximately by 3% in 2001 as compared to 2000 with the following drop in 2002 (Fig. 1). A steady growth can be seen only since 2003. We do not attempt to prove that a drop of energy prices results in the SE shrunking, but think this may happen. Anyway, we assume this fact with no neglecting any asymmetry in the cause-and-effect relationship under study. That is why 2009 was excluded from our analysis.

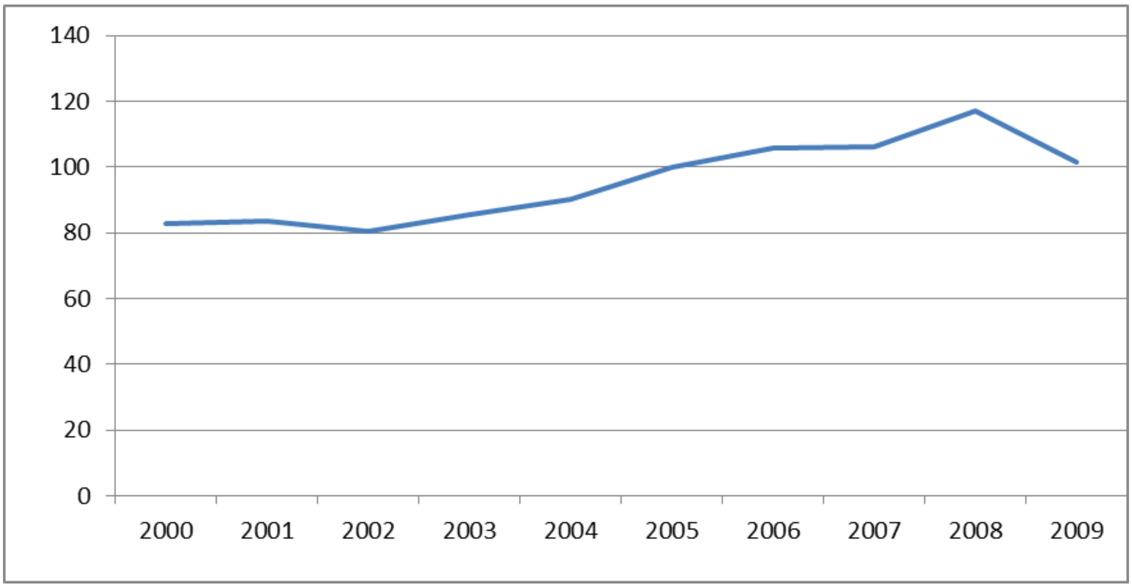

Figure 1

Dynamics of Relative Energy Prices in the OECD Countries, 2005 = 100%

Source: International Energy Agency (http://data.iea.org).

Data and variables. The next chapters of the paper discuss the results of the econometric analysis of the SE sizes in the different countries all over the world. Along with the estimations available in the work by Schneider, Buehn, and Montenegro (Schneider, Buehn, Montenegro, 2010), we made our estimations obtained by the Currency Demand Approach. The reason of doing so is the following. The above estimations have been received on a basis of the MIMIC model (MIMIC estimations) which directly produces indexes of the SE change per years of the specified period for the countries under study. To estimate the shares of the SE in GDP requires involving the estimations made by other researchers earlier. Characterizing these estimations, they refer to the publications, among others, where dynamics of the electricity consumption were considered, at least, for the economies of the CIS (Alexeev, Pyle, 2003). Therefore, there is a danger that these estimations can show a significant relationship with the energy prices just because of their origin, but not of firms' real behavioral characteristics.

To make our regressions for the SE sizes, we use the following variables and their sources: *Y* is the purchasing power parity GDP (provided in the World Bank World Development Indicators Data Publications); four indices of institutional effectiveness out of six ones in total given in (Kaufmann, Kraay, Mastruzzi, 2008) such as *GE* (government effectiveness) – quality of the administrative personnel and ability of the government to achieve goals), *RQ* (regulatory quality) – the degree of non-market intervention in the economy by the government, *RL* (rule by law) – to what degree economic agents can be sure that all applicable regulations will be followed and contracts will be performed, and *CC* (control of corruption) – economic agents' assessments of corruption in the economy; p_E is the energy prices in industrial sectors (provided by the International Energy Agency and located at the address: http://data.iea.org, and European Bank for Reconstruction and Development (Transition Report, 2006)); *P* is the output price calculated as a nominal GDP- purchasing power parity GDP ratio.

*sm*03, ..., *sm*08 are the SE shares in GDP calculated by us for 2003-2008; and *ss03*..., *ss07* are the SE shares in GDP calculated by us on the basis of the MIMIC model (Schneider, Buehn, Montenegro, 2010).

Instrumental variables. Child mortality per year is a tool to measure institutional quality (World Development Indicators 2013 CD ROM).

4. Assessing the SE Size by the Currency Demand Approach

The Currency Demand Approach for assessment of the SE sizes is based on the assumption that shadow transactions are carried out by means of currency in cash to avoid taxes and regulations (Tanzi, 1983; Schneider, Klinglmair, 2004). We modified the equation offered by them to the form:

$$\ln\left(\mathrm{M0/M2}\right) = \gamma_0 + \gamma_1 \ln(1+Tr)RL + \gamma_2 \ln\left(Sr/Y\right) + \gamma_3 \ln R + \gamma_4 y + u\,, \qquad (8)$$

and expect that $\gamma_1 < 0$, $\gamma_2 > 0$, $\gamma_3 < 0$, $\gamma_4 > 0$ where $\mathrm{M0/M2}$ is the cash share in the monetary aggregate 'money plus quasimoney (M2)' (given in the Yearbook 2013. International Financial Statistics); *R* is the deposit interest rate (given in the World Bank World Development Indicators

Data Publications); *Tr* is the share of federal tax revenues in GDP (or the tax burden) (calculated on the data given in the World Bank World Development Indicators Data Publications); *Sr* is the share of subsidies and other transfers in GDP[1] (calculated on the data given in the World Bank World Development Indicators Data Publications); and *yt* is the per capita income.

All changes of the SE sizes in the model (8) are associated with the second term in the right part of the equation, i.e. the interaction variable. Thus, along with the fact that the model is applied to cross-sectional data, but not to dynamic ones, there are two serious points distinct from the classical approach offered by Tanzi (Tanzi, 1983):

1. The variable *Sr* in the specification is the share of subsidies and transfers in GDP instead of the share of wages in GDP, since the latter used in the time when the Currency Demand Approach started being applied and then widely spread has lost its explaining force, most likely, due to new payment technologies, while the share of subsidies and transfers in GDP appeared to become more significant as it is quite possible to assume that subsidies and other transfers are highly monetized;

Table 1

Estimation of the Share of Money in Cash (M0) in Aggregate M2 all over the World

	2003 г.	2004 г.	2005 г.	2006 г.	2007 г.	
Число наблюдений Number of observations	66	65	60	48	97	
Константа Constant	–1,6838, *t-value* = –7,84	–1,8675, *t-value* = –11,46	–1,8135, *t-value* = –11,11	–1,4790, *t-value* = –5,65	–1,55, *t-value*=–10,05	–1,6 *t-va*
Интерактивный член Interaction term ln(1+*Tr*)*RL*	–1,35334, *t-value* = –2,23	–1,6031, *t-value* = –2,86	–1,7409, *t-value* = –3,98	–1,6274, *t-value* = –2,51	–1,48, *t-value*=–2,52	–1,3 *t-va*
Доля субсидий в ВВП Share of subsidies in GDP	4,3305, *t-value* = 4,43	4,5747, *t-value* = 4,95	3,677, *t-value* = 5,03	2,8528, *t-value* = 2,90	3,14, *t-value*=2,83	2,94 *t-va*
Натуральный лога-	–0,2581,	–0,2020,	–0,2064,	–0,2294,	–0,22,	–0,1

[1] The WDI database gives the following definition of the subsidies:: «Subsidies, grants and other social benefits include all unrequited, nonrepayable transfers on current account to private and public enterprises; grants to foreign governments, international organizations, and other government units; and social security, social assistance benefits, and employer social benefits in cash and in kind».

рифм ставки процента по депозитам Natural logarithm of the interest rate	*t-value* = –3,14	*t-value* = –2,93	*t-value* = –3,02	*t-value* = –2,14	*t-value*=–2,71	*t-va*
Натуральный логарифм ВВП на душу населения Natural logarithm of the GDP per capita	–0,4665, *t-value* = –4,80	–0,4034, *t-value* = –4,92	–0,3400, *t-value* = –5,11	–0,4021, *t-value* = –3,40	–0,33, *t-value*= –5,29	–0,3 *t-va*
R-squared	0,5594	0,5961	0,6581	0,6841	0,4162	0,35
F-value	28,29	29,30	40,94	26,53	35,73	21,1
Root mse	0,54562	0,50244	0,43977	0,49331	0,655	0,68

2. We use the interaction term ln(1+*Tr*)*RL* (the tax burden ln(1 + *Tr*) multiplied by *RL* (the index of rule of law which is included in the set of indices characterizing institutional quality)) instead of the variable of the tax burden ln(1 + *Tr*). Since *RL* is a variable expected to be positive for the economies with sound institutions and negative – for those with poor ones, the negative sign of the regression coefficient is quite explainable. The inclusion of *RL* reflects the statement concerning a different impact of the higher taxes on the SE sizes of the countries with the different institutional qualities (Friedman et al., 2000). The higher share of taxes in GDP means the higher tax revenues in the countries with sound institutions (and, therefore, better provision of public goods and services), better regulation quality, and the lower SE sizes, while the higher tax burden and, therefore, the higher SE sizes – in the countries with poor institutions.

The estimations (see Table 1) can display validity of the model. However, on both theoretical and common sense grounds the regressors used in the specification (8) are endogenous to the variable to be estimated. To remove this problem through applying other methods would require additional information. For example, a two-step least spreads method requires such the instrumental variables as those which *ex ante* would be correlated with regressors, but uncorrelated with a dependent variable. Unfortunately, finding such variables seems impossible in this case. For example, there are no indicators which would be both connected with an interest rate and unconnected with the characteristics of monetary supply. The same is true of other regressors.

At the same time, if we would manage to find such instrumental variables and obtain estimations by such a two-step model, we would yield very similar results which are of a little effect on the calculated estimations of the SE. The tests carried-out by us could also evidence with a certain probability that the endogeneity doesn't influence the results, and the model is quite effective as a basis for further calculations. Thus, the estimation test results (3) (see Table 1) can't be rejected for lack of information so far. In our opinion, that is why the problem of a possible endogeneity of such regressors has not been stated and discussed in the studies devoted to both the SE estimation and criticism of such assessment methods (see, for example, (Breusch, 2005)). So, we see the SE indicators received by us as acceptable.

Calibrating procedure for the Currency Demand Model applied to finding the SE estimations. Normally, choosing a set of basic indicators and using the parameters of the model to be estimated as indexes proceeds applying the model constructed. Such a procedure is called calibration of the model. In our case, as we applied the model for cross-sectional data but not dynamic ones, the results show only the difference of the SE estimations for in various countries. If we want to have the dynamics, it is necessary to set certain parameters, for example, the average SE sizes for the countries under study or parameters for a single country having the most reliable estimates (for example, the USA). Relying on the SE sizes already known, it would be possible to reproduce the dynamics of the estimated indicators too.

The Currency Demand Approach applied to cross-sectional data yields rather reliable results, but it has an essential fault to overcome which requires additional assumptions and transforming procedures. The point is that foreign currency (mostly, the US dollar) along with national one are used in shadow operations practically all over the world. Not every dollar emitted by the US Federal Reserve remains in the country. A great portion of the US dollars is imported by both banking and private economic agents to other states and used by other countries as foreign currency reserves, store of value, and for other purposes, including shadow transactions. So, the direct estimations of the SE sizes (Current Demand estimations) on cross-sectional data make the SE size overestimated if no appropriate adjustments made. Moreover, in view of the large size of the American economy, which GDP is about 20% of the world one, it is also very probable that such estimations be underestimated for other countries. We adjusted our estimations of the SE taking into account the dollarization levels (results of the calibration of the model (8) see in Table 1)

The calibration procedure includes two stages[2].

At the first stage we define the ratios of the country's SE served with national currency to the

[2] The calibration procedure of the model (3) is described in details in в (Суслов, 2011).

world's SE served with the US dollars measured as (η_i):

$$\eta_i = \frac{x_1 + x_2}{Y_{USA}} / \frac{x_i}{Y_i}, \quad i = 1,...,n, \tag{9}$$

where *x1* is the absolute size of the SE in the USA; *x2* is the absolute size of the SE in the world served with US dollars without the SE in the USA; *xi* – the absolute size of the SE in the *i* country, but without that its part which is served with the US dollars; Y_{USA} and Y_i are GDP of the USA and the *i* country, respectively; *n* is the number of the countries in the sample without the USA (thus, the total number of the countries in the sample is equal to *n + 1*).

To assess η_i, we applied the benchmarking procedures to the estimations given in Table 1. Here, the economy of the USA was chosen as such a sample for comparisons.

The assessment procedure consists in the following. The ratios of the money in cash *M0* to the aggregate *M2* are calculated proceeding from the parameters of the econometric model which would be available if it reflects the economic conditions peculiar to the USA. However, we consider the conditions for *i* country together with the variables which are responsible for the shadow economy. It means that for each country the variables not connected with its SE are adopted at the level equal to those existed in the economy-benchmark, and the variables reflecting its SE – at the actual levels. The comparison of such estimations with the level of the USA gives the ratios of the SE sizes in a certain country to thoseat in the economy-benchmark, i.e. gives the coefficients η_i.

At the second stage we calculate the SE estimations by taking into account the fact that the SE served with the US dollars covers not only the USA, but also the other countries of the world. Our basic assumption at that, is that the SE, which covers all the countries of the worlds except the USA and served with the Us dollars, is distributed between the countries proportionally to their shares in the total SE without the USA's SE. We find such an assumption quite adequate in the context of lack of information concerning the extent the economies of the world are dollarized. So:

$$\sum_{i=1}^{n} \left(x_i + \frac{x_i x_2}{p_i \sum_{i=1}^{n} x_i} / Y_i \right) + \frac{x_1}{Y_{USA}} = (n+1)\overline{sm}, \tag{10}$$

where $\overline{sm}$ is the average relative SE size for the countries all over the world (the same as that provided in (Schneider, 2010)).

We receive the following system of *n* equations (9) and one equation (10) with *n + 1* unknowns *xi*, *i = 1,…, N, x2*. At that, *x1* (the absolute SE size in the USA) is borrowed from (Schneider et al., 2010).

Having determined all the unknowns, we can calculate our estimations of the ES sizes:

$$sm_i = x_i + \frac{x_i \; x_2}{p_i \sum_{i=1}^{n} x_i} / Y_i. \tag{11}$$

The assumptions we used for solving the system of the equations (9)–(10) are described in detail in (Suslov (Суслов), 2011).

As for the estimations of the SE given by Schneider and others (Schneider et al., 2010), at the first stage the parameters of the equation where various indicators act as regressors were estimated (such as fiscal freedom (Schneider et al., 2010), tax burden, GDP per capital, and etc.). The ratio of the aggregates *M0/M1* is considered as a value to be estimated. As a result, the authors received the SE estimations for 162 countries of the world over 1994 to 2006. At first, they estimated the regression equations for each country which look like as follows:

$$\eta_t = 0{,}14 x_{1t} - 0{,}06 x_{2t} - 0{,}05 x_{3t} - 0{,}127 x_{4t}, \tag{12}$$

where x_{1t} is the government size (Schneider et al., 2010), x_{2t} is the tax freedom (Schneider et al., 2010), x_{3t} is the business freedom (Schneider et al., 2010), and x_{4t} is the GDP per capital. Then the received estimates are reduced to those of 2000:

$$\eta_t = \frac{\eta_t}{\eta_{2000}} \eta^*_{2000}, \tag{13}$$

where η_t is the estimation of the SE for the country according to (12), η_{2000} is the assessment of the equation (12) with x_{1t}, ..., x_{4t} for *t = 2000*, and η^*_{2000} is the estimation of the SE size for the country in 2000 (Schneider, 2007).

Comparison of the SE estimations. Summary statistics of our year-by-year SE estimations and those of other authors is presented in the Table 2, and the year-by-year estimations for each country– in the Appendix, Table A1. As can see from Table 2, our estimations are rather close to those made by others through MIMIC model, whereas the correlation coefficients of these indicators are from 0.72 to 0.76 for separate years. The coefficients mostly differ by a little smaller average dispersion of the SE estimations. In our opinion, the explanation of this is rather obvious – this occurs due to our assumption of a proportional distribution of the total SE without the USA' share served in the US dollar between the countries. Most likely, this means that we over-estimated the ES sizes in the countries with the high income, sound institutions, and lower dollarized currency circulation, while we underestimated them for the countries with the low and average income, poor quality of institutions, and intensive dollar circulation, that results in leveling-off the countries' indicators.

Table 2

The ES Estimations in GDP: Summary Statistics

Переменная Variable	Число наблюдений Number of observations	Среднее значение Average value	Отклонение Deviation	Минимум Minimum	Максимум Maximum
*sm*03	85	0.3420	0.1181	0.087	0.5658
*ss*03	116	0.3354	0.1439	0.084	0.687
*sm*04	85	0.3419	0.1247	0.088	0.6004
*ss*04	116	0.3388	0.1451	0.086	0.692
*sm*05	85	0.3468	0.1303	0.089	0.5798
*ss*05	116	0.3442	0.1484	0.087	0.699
*sm*06	85	0.349	0.139	0.089	0.6275
*ss*06	116	0.350	0.151	0.089	0.713
*sm*07	119	0.354	0.129	0.0847	0.6889
*ss*07	100	0.355	0.1126	0.09	0.725
*sm*08	120	0.3518	0.118	0.09	0.649
*ss*08	No data	No data	No data	No data	No data

Note: The authors' estimations of the SE shares in GDP for various countries (*sm*03–*sm*06) are given in the Appendix, Table A1

5. Statistical Analysis of the SE Estimations

We developed the models which explain how real energy prices impact on the SE sizes (the SE shares in GDP are given in Table 3) and how they react to changes in the sizes of the SE (Table

4). We included two regressors in the specification for cross-sectional data – real energy prices and quality of regulation (one of the indices of institutional quality) – to measure how adequate and efficient the country's economic policy is. Since the latter could not be considered completely exogenous in the SE regression equation, we apply a two-step assessment algorithm using the geographical distance of the countries from the equator as an instrumental variable. This approach has been offered and realized by R. Hall and Tsch. Jones (Hall, Jones, 1999) for analyzing how institutional conditions impact on income. They assume that there is a cause-effect relation between institutional conditions and quality of the institutions in the European countries, namely, the more the impact has been observed in a historical retrospective, the better the institutions protect property rights and contracts. The geographical distance from the equator could be considered as an adequate measure of such influence, since more favorable life conditions for Europeans are averagely connected with the higher latitudes.

To ease the heteroskedasticity of the problem, we also used robust covariance matrix estimation (White's estimator). The Table 3 allows concluding that the countries where real energy prices are higher, with other factors being equal, have the higher SE. This can be explained by firms' wishes to compensate their higher expenses through avoiding tax and social payment that explains a higher share of the concealed income.

Table 3

***IVLS* Estimations (Real Energy Prices as a Variable)**

Variable	2003	2004	2005	2006	2007	2008
Data 1. Dependent variable ln(*ss*): MIMIC estimations						
Number of observations	78	75	76	75	72	–
Constant	–0,9854, *t-value*= –12,50	–0,9434, *t-value*= –9,67	–0,9154, *t-value*= –10,09	–0,9396, *t-value*= –10,47	–0,9444, *t-value*= –9,48	–
Real energy prices (P/p_E)	–0,1064, *t-value*= –2,06	–0,1200, *t-value*= –2,00	–0,1467, *t-value*= –2,29	–0,0728, *t-value*= –1,74	–0,137, *t-value*= –2,73	–
Regulation quality index(*RQ*)	–0,4399, *t-value*= –3,91	–0,4303, *t-value*= –3,45	–0,4357, *t-value*= –3,98	–0,4524, *t-value*= –4,00	–0,437, *t-value*= –4,31	–
R-squared	0,5447	0,5440	0,5600	0,5483	0,501	–
F-value	8,00	6,40	8,30	8,10	7,21	–

Root MSE	0,36557	0,36417	0,35715	0,35892	0,345	–
Data 2. Dependent variable ln(*sm*): the authors' estimations on the basis of the Currency Demand Approach						
Number of observations	61	60	62	55	55	54
Constant	–0,8945, *t-value*= –15,77	–0,8201, *t-value*= –12,68	–0,7911, *t-value*= –11,35	,42011, *t-value*=17,46	,435, *t-value*=23,36	,42, *t-value*=20,27
Real energy prices (P/p_E)	–0,0616, *t-value*= –2,77	–0,0869, *t-value*= –2,57	–0,1070, *t-value*= –2,65	–0,0875, *t-value*= –2,32	–0,0585, *t-value*= –2,17	–0,051, *t-value*= –2,57
Regulation quality index (*RQ*)	–0,4362, *t-value*= –6,43	–0,5149, *t-value*= –7,19	–0,5512, *t-value*= –7,05	–0,147132, *t-value*= –12,83	–0,1525, *t-value*= –17,91	–0,1415, *t-value*= –15,61
R-squared	0,7918	0,8108	0,7773	0,8933	0,8917	0,8583
F-value	20,65	26,11	24,88	26,45	25,45	26,7
Root MSE	0,19446	0,19892	0,21844	0,09472	0,09624	0,0891

Note: The dependent variables ln(*ss*) and ln(*sm*) are the natural logarithm of the SE share in GDP (White's estimator), p_E is the energy prices, *P* is the average price in the economy (so, P/p_E is the quantity inverse to the energy prices). The regulation quality *RQ* is instrumented by geographical latitude.

We developed the panel models for the period 2003-2008 (when a stable increase of prices have been observed) to test an actual correlation of the changes in energy prices and the SE. Panel data analysis allows both estimating availability of correlations taking into account the individual effects of the considered subjects and analyzing those developing in time. Panel data have not only properties of time-series data, but also cross-sectional ones. If 'short' panel data are under consideration (the small number of time periods and large number of subjects), the issue of stationarity loses its sense and, therefore, there is no need to use incremental indicators (to Baltagi, 2005, p. 234; Анатольев, 2003).

At first we estimated the parameters of the random- and fixed-effects models (Baltagi, 2005) and then defined that the random-effects model is the most suitable through statistical tests (the Hausman test also confirmed this fact). The results of the estimation are presented in the Appendix, Table A2. They show that relative energy prices as a factor can be considered significant both for our estimates obtained and those of other authors (Schneider et al., 2010). Thus, regardless the method we use to calculate the SE sizes, the growth of relative energy prices serves to the higher SE share in GDP, which counts in favor of our hypothesis. In other words, our hypothesis is completely confirmed for the indicators developed by the Currency Demand Approach and given in the section 4 of our paper (Sample 1) as well as for the data set developed by the MIMIC model (Sample 2)/ Though, as it is necessary to recognize, the relationship found is less apparent.

The variables to be estimated and those under study may be autocorrelated for various years that leads to the correlation of variables and recursive residuals and make the estimated coefficients inconsistent. Moreover, the presented estimations are obtained on the assumption of an exogenous character of the dependent variables, while in fact this assumption is often violated. There is a problem of spatial dependence in the regression equation as any country may equally come under the influence of energy prices.

Due to the above facts, we assessed the regression equation parameters for the dynamic panel data with lagged regressors, their differences, and annual dummy variables considered as instrumental variables for the authors' SE estimations. The analysis was carried out with the help of the Panel Data Analysis Using Stata12 Program and Xtabond2 Command (Roodman, 2006). This Command applies the GMM estimation and allows defining whether the application of the set and quantity of the instrumental variables is expedient. It also allows testing whether these instrumental variables are exogenous. We used as instrumental variables to calculate our estimations the one- and two-years lagged relative energy prices and the interaction variable ln(1+Tr) RL, which are dummy for each year under study. So, 20 instrumental variables participated in our assessment. Since we used a two-year lag in the calculation, the dummy variables for 2003 and 2004 were not included in the regression equation. The results obtained are presented in the Table 4.

Table 4

The SE Shares in GDP in the Countries of the World Estimated with the Use of Energy Prices (dynamic panel data, xtabond2$, the number of groups=20, and number of observations =314)

(the estimations of the significant factors are printed in bold type)

Variable	Authors' estimations (Coefficient, significance value)
One-year lagged size of the SE	–0,1479, *z–value* =–0,46

Two-year lagged size of the SE	0,0359, *z–value* =0,15
Interaction variable ln(1+*Tr)RL*	**–0,571,** ***z–value* = –5,40**
One-year lagged interaction term ln*(1+Tr) RL*	0,1116, *z–value* =0,599
Two-year lagged interaction term ln*(1+Tr) RL*	0,0054, *z–value* = 0,02
Logarithm of the quantity inverse to real energy prices, ln(p/p_e)	**–0,082,** ***z–value* = –2,4**
One-year lagged logarithm of the quantity inverse to real energy prices, ln(p/p_e)	–0,09, *z–value* = –1,97
Two-year lagged logarithm of the quantity inverse to real energy prices, ln(p/p_e)	0,022, *z–value* = 0,71,
Dummy variable (2005)	–0,044, *z–value* = –1,18
Dummy variable (2006)	–0,0854, *z–value* = –1,49
Dummy variable (2007)	0,00801, *z–value* = 0,24
Arellano-Bond Estimator for AR(1)	*z*=–1,05, *Pz*>*z*=0,296
Arellano-Bond Estimator for AR(2)	*z*=0,78, *Pz*>*z*=0,437
Sargan test (the instruments are unreliable and the model is valid despite the great number of instrumental variables)	*chi*(2)=13,24, *Pz*>*chi*(2)=0,152
Hansen test (the instruments are reliable and the model is weaker due to the great number of instrumental variables)	*chi*(2)=5,09, *Pz*>*chi*(2)=0,826
Sargan-Hansen test (difference) whether a set of the instrumental variables is exogenous	*chi*(2)=4,99, *Pz*>*chi*(2)=0,835

The Arellano-Bond estimator (Arellano, Bond, 1991) allows receiving estimations of dynamic panel data including those where heteroskedasticity of the estimations is taken into account. The problem of heteroskedasticity arises in our study because of the fact that cross-sectional subjects under study are of the different sizes whereby the errors have various dispersion indices (Baltagi, 2001). As Arellano and Bond confirmed, the Sargan test is inapplicable due to presence of heteroskedasticity in the test (Arellano, Bond, 1991). They prove that if there is heteroskedasticity, the result of the Sargan test showing an inadequate character of the model and therefore, incorrectness of the specification, is erroneous. They offered and applied an alternative approach, namely, the Arellano-Bond estimator for the specification of the model and quality of instrumental variables. The results of the test are presented in Table 5.

Table 5

The Results of the Arellano-Bond Estimator Showing a Lack of Autocorrelation in the First Order Autoregression

Порядок Order	Выборка 1 Sample 1	Выборка 2 Sample 2
z	–1,201	–1,8524
Prob>z	0,2298	0,064

Sources: Sample 1 includes the Currency Demand estimations (233 observations and 67 groups) and Sample 2 includes MIMIC estimations (Shneider et al., 2010) (239 observations and 68 groups)

According to data provided in the Table 5, our hypothesis is that there is a lack of the first order autocorrelation for both authors' estimations (Currency Demand estimations) and MIMIC estimations (Shneider et al., 2010).

So, the use of dynamic panel data is reasonable for both the authors' and MIMIC estimations (Shneider et al., 2010). In both cases, we observe the dependence of relative energy prices and the SE sizes in the countries of the world. As for the equation parameters of the MIMIC estimations, the lagged logarithm of the quantity inverse to real energy prices also impacts on the SE sizes. In our opinion, this could be explained by the fact that estimations made by Shneider and others (Shneider et al., 2010) include the results calculated with taking into account energy consumption dynamics, at least, for the economies of the CIS countries (the authors refer, among others, to (Alexeev, Pyle, 2003)). Therefore, there is a danger of the SE indicators showing a significant dependence on energy prices just because of their origin, but not due to firms' real behavior.

The indicator of institutional quality appeared to be insignificant for the dynamic panel data used for the authors' estimations, whereas it is significant in the MIMIC model. Moreover, the lag of the values under study is significant for the authors' estimations that confirm a need to consider autocorrelations. The MIMIC estimations show that the SE size over a certain period of time doesn't depend on the estimations of the previous period. Such a dependence of our estimations could be explained by the fact that we considered the level of dollarization in economies, namely, the number of dollars circulating in the economy at a certain time period was correlated with that circulated in the previous interval of time. In our opinion, this fact could quite certainly determine the presence of autocorrelation.

6. Conclusions

In this study we make an attempt to show that the SE may grow because of the increased energy prices, at least, in the time their rather rapid growth, since firms receive additional incentives to conceive their incomes. It is connected with the fact that the growing expenditures due to higher actual energy prices can make legal investments less efficient and this fact could make the SE higher, at least, for some time and economic agents attempt to avoid tax and social payments by concealing their incomes in order to compensate their increased expenditures.

We managed to verify this hypothesis on the cross-sectional data, panel random effect data, and dynamic panel data concerning the SE sizes in the countries of the world over 2003 to 2008. We made our analysis on the basis of the SE estimations available in (Schneider, Buehn, Montenegro, 2010) and those calculated by us through Currency Demand Approach applied, unlike the similar methods, to cross-sectional data.
Having applied cross-sectional data analysis, simple panel fixed and random effects data models, dynamic panel data models to calculation of our and MIMIC estimations, we empirically show that relative energy prices impact on the sizes of the SE in the countries all over the world Thus, we can state that relationship of the SE size and relative energy prices is rather stable, showing the importance of the latter regardless of the specification and calculation methods. The analysis of the panel data demonstrates that a negative impact of a long running increase in energy prices on the SE sizes becomes stronger. However, our analysis concerns only those time periods when

a rather long increase in real energy prices has been observed. We cannot state that a drop in energy prices is a factor of the SE shrinking, though it could be and is predicted by the theoretical model, but most likely this could not take place in reality.

Appendix

Table A1

The Estimation of the SE Share in GDP All over the World

(modified Currency Demand Approach (variables *sm*03-*sm*08))

	2003	2004	2005	2006	2007	2008
Afganistan				0.57	0.55	0.59
Albania	0.46	0.43				
Algeria				0.58	0.63	0.59
Angola	0.73	0.70	0.66	0.56	0.52	0.51
Armenia	0.49	0.50	0.45	0.39	0.39	0.37
Australia	0.12	0.11	0.12	0.11	0.13	0.14
Austria	0.13	0.12	0.13	0.12	0.13	0.15
Bangladesh	0.48	0.51	0.53	0.50	0.58	0.57
Belarus	0.69	0.69	0.69	0.56	0.58	0.52
Belgium	0.14	0.13	0.14	0.13	0.15	0.16
Benin	0.42	0.44	0.45	0.40	0.44	0.43
Bolivia	0.53	0.60	0.63	0.54	0.59	0.46
Bosnia and Herzegovina	0.40	0.39	0.41	0.37	0.39	0.38
Bulgaria	0.42	0.40	0.41	0.36	0.38	0.39
Cameroon	0.36	0.36	0.37			
Canada	0.16	0.16	0.16	0.14	0.17	0.18
Chile	0.25	0.22	0.21	0.19	0.22	0.23
China	0.40	0.42	0.44	0.39	0.42	0.40
Columbia	0.46			0.43		
Congo, Rep.	0.53	0.48	0.44	0.35	0.40	0.35
Costa Rica		0.32	0.33	0.34	0.34	0.31
Croatia	0.28	0.27	0.27	0.26	0.28	0.28
Cyprus	0.15	0.14	0.14	0.11	0.12	0.13
Czech Republic	0.26	0.25	0.25	0.22	0.24	0.24

Denmark	0.10	0.08	0.08	0.08	0.08	0.10
Dominican Republic		0.46	0.40	0.35	0.40	0.41
Egypt	0.64	0.74	0.70	0.64	0.69	0.64
El Salvador	0.34	0.36	0.38	0.35	0.41	0.42
Estonia	0.24	0.23	0.23	0.20	0.21	0.23
Finland	0.12	0.11	0.11	0.10	0.13	0.14
France	0.14	0.13	0.14	0.12	0.15	0.16
Georgia	0.50	0.48	0.47	0.39	0.41	0.39
Germany	0.16	0.16	0.17	0.15	0.17	0.19
Ghana	0.36	0.36	0.35	0.35	0.38	0.40
Greece	0.19	0.18	0.19	0.17	0.19	0.21
Guatemala	0.46	0.48	0.48	0.43	0.49	0.47
Honduras	0.40	0.43	0.45	0.42	0.47	0.48
Hungary	0.23	0.21	0.22	0.20	0.22	0.23
Iceland	0.11	0.10	0.09	0.08	0.10	0.13
India	0.50	0.51	0.49	0.45	0.48	0.54
Indonesia	0.57	0.57	0.57	0.53	0.57	0.56
Iran, Islamic Rep.	0.67	0.66	0.64	0.52	0.55	0.50
Ireland	0.13	0.12	0.12	0.10	0.12	0.14
Israel	0.18	0.18	0.18	0.16	0.19	0.20
Italy	0.18	0.18	0.20	0.18	0.20	0.22
Cote d"ivore	0.46	0.50	0.53	0.52		
Jamaica				0.34	0.38	0.38
Jordania	0.40	0.41	0.40	0.36	0.41	0.40
Kazahstan	0.47	0.47		0.47		
Kenya	0.44	0.44	0.46	0.48	0.52	0.53
Korea, Rep	0.22	0.22	0.21	0.19	0.21	0.26
Kuweit	0.39	0.39	0.36	0.31	0.36	0.33
Kyrgyz Republic				0.61		
Latvia	0.30	0.29	0.29	0.23	0.24	0.24
Lebanon	0.31	0.33	0.36	0.35	0.41	0.42
Lithuana		0.28	0.27	0.23	0.26	0.26
Luxembourg	0.12	0.11	0.11	0.11	0.13	0.13
Malaysia	0.36	0.37	0.36	0.32	0.36	0.37

Malta	0.10	0.09	0.09			
Moldova	0.58	0.53	0.53	0.48	0.49	0.43
Marroco	0.36	0.36	0.38			
Namibia	0.29	0.31	0.32	0.27	0.31	0.32
Nepal	0.65	0.63		0.56	0.63	0.61
Netherlands	0.13	0.12	0.12	0.11	0.13	0.15
New Zealand	0.11	0.10	0.10	0.09	0.11	0.13
Nicaragua	0.42	0.47	0.47	0.44	0.50	0.49
Norway	0.10	0.09	0.09	0.13		
Pakistan	0.68	0.70	0.70	0.56	0.65	0.65
Paraguay				0.47	0.48	0.44
Peru	0.40	0.41	0.44	0.39	0.44	0.44
Philippines	0.49	0.54	0.51	0.44	0.48	0.48
Poland	0.28	0.29	0.27	0.25	0.27	0.26
Portugal	0.17	0.16	0.17	0.17	0.19	0.20
Romania	0.39	0.38	0.34	0.30	0.31	0.32
Russian Federation	0.47	0.43	0.44	0.39	0.41	0.40
Singapore	0.23	0.22	0.22	0.21	0.23	0.24
Slovak Republic	0.24	0.23	0.24	0.22	0.25	0.26
Slovenia	0.19	0.19	0.20	0.18	0.21	0.21
South Africa	0.32	0.30	0.30	0.26	0.32	0.37
Spain	0.18	0.18	0.19	0.17	0.20	0.21
Sri Lanka	0.51	0.54	0.51	0.45	0.52	0.51
Sweden	0.12	0.11	0.12	0.10	0.13	0.14
Switzerland	0.15	0.15	0.15	0.14	0.17	0.18
Thailand		0.47	0.47	0.41	0.46	0.47
Togo				0.47	0.51	0.45
Trinidad and Tobago	0.30	0.33	0.32	0.32	0.34	0.33
Tunisia	0.35	0.34	0.35	0.32	0.37	0.37
Turkey				0.36		
Ukraine	0.67	0.64	0.58	0.49	0.48	0.45
United Kingdom	0.13	0.13	0.13	0.10	0.12	0.14
United States	0.09	0.09	0.18	0.09	0.09	0.09
Uruguay	0.32	0.33	0.31	0.26	0.29	0.28

Venezuela, RB	0.44	0.50	0.50			
Zambia	0.55	0.56	0.50	0.39	0.45	0.41

Table A2

The SE Shares in GDP in the World's Countries Estimated with the Use of the Currency Demand Approach (dynamic panel data, xtabond2$, the number of groups=20, and number of observations =314)

(the coefficients for significant variables and their values are printed in bold type)

Variable	Coefficient, significance value
One-year lagged size of the SE	–0,1479, *z–value* =–0,46
Two-year lagged size of the SE	0,0359, *z–value* =0,15
Interaction variable ln(1+*Tr)RL*	**–0,571, *z–value* = –5,40**
One-year lagged interaction term ln*(1+Tr) RL*	0,1116, *z–value* =0,599
Two-year lagged interaction term ln*(1+Tr) RL*	0,0054, *z–value* = 0,02
Logarithm of the quantity inverse to real energy prices, ln(p/p_e)	**–0,082, *z–value* = –2,4**
One-year lagged logarithm of the quantity inverse to real energy prices, ln(p/p_e)	–0,09, *z–value* = –1,97
Two-year lagged logarithm of the quantity inverse to real energy prices, ln(p/p_e)	0,022, *z–value* = 0,71,
Dummy variable (2005)	–0,044, *z–value* = –1,18
Dummy variable (2006)	–0,0854, *z–value* = –1,49
Dummy variable (2007)	0,00801, *z–value* = 0,24

Arellano-Bond Estimator for AR(1)	*z*=–1,05 *Pz*>*z*=0,296 (?так?да)
Arellano-Bond Estimator for AR(2)	*z*=0,78 *Pz*>*z*=0,437
Sargan test (the instruments are unreliable and the model is valid despite the great number of instrumental variables)	*chi*(2)=13,24 *Pz*>*chi*(2)=0,152
Hansen test (the instruments are reliable and the model is weaker due to the great number of instrumental variables)	*chi*(2)=5,09 *Pz*>*chi*(2)=0,826
Sargan-Hansen test (difference) whether a set of the instrumental variables is exogenous	*chi*(2)=4,99 *Pz*>*chi*(2)=0,835

Table A3

The SE Shares in GDP in the World's Countries (MIMIC Estimations, Schneider et al.,2010) Estimated with the Help of Energy Prices (dynamic panel data, xtabond2, the SE estimations for 2003–2007, the number of groups=49, and number of observations = 62)

(the coefficients for significant variables and their values are printed in bold type)

Variable	Coefficient, significance value
One-year lagged size of the SE	–6,606, *z-value* =–0,55
Two-year lagged size of the SE	9,466, *z-value* =0,56
Interaction variable ln(1+*Tr)RL*	**–0,3807, *z-value* = –2,63**
One-year lagged interaction term ln*(1+Tr) RL*	0,0615, *z-value* = 0,06
Two-year lagged interaction term ln*(1+Tr) RL*	–0,3279, *z-value* = –0,53
Logarithm of the quantity inverse to real energy prices, ln(p/p_e)	**–0,0504, *z-value* = –2,07**
One-year lagged logarithm of the quantity inverse to real energy prices, ln(p/p_e)	**–0,2534, *z-value* = –2,74**

Two-year lagged logarithm of the quantity inverse to real energy prices, $\ln(p/p_e)$	0,108491, *z-value* = 1,05
Dummy variable (2005)	0,0546, *z-value* = 1,32
Dummy variable (2006)	0,0307, *z-value* = 0,43
Dummy variable (2007)	0,00801, *z-value* = 0,24
	z=0,65 *Pz*>*z*=0,518
Arellano-Bond Estimator for AR(1)	*z*= – *Pz*>*z*=– 0,623
Arellano-Bond Estimator for AR(2)	*chi*(2)=25,*14Pz*>*chi*(2)=0,000
Sargan test (the instruments are unreliable and the model is valid despite the great number of instrumental variables)	*chi*(2)=7,90*Pz*>*chi*(2)=0,246
Hansen test (the instruments are reliable and the model is weaker due to the great number of instrumental variables)	*chi*(2)=1,23 *Pz*>*chi*(2)=0,942
Sargan-Hansen test (difference) whether a set of the instrumental variables is exogenous	

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