UNRECORDED ECONOMY IN UKRAINE: ITS MEASUREMENT, WITH EMPIRICAL APPLICATIONS

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Abstract

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Abstract

I view taxes as an attenuation of absolute property rights on income proceedings of economic agents. Unrecorded economic activities act as an effective check on the state captures of real resources in the form of taxes. It is argued that significant unrecorded sector activity would show up in extensive ratios of currency to money supply and electricity intensity. I link real captures of the state in the form of taxation (and tax burden), unrecorded economy and currency in circulation, and electricity demand (deemed to be good indicators of unrecorded economy). I indirectly test the existence of a positive effect of taxes on the unrecorded economy, and calculate the size of the unrecorded economy relative to the official GDP in Ukraine on the basis of electricity demand function and the assumption of similar technologies in recorded and unrecorded sectors. I apply pair-wise Granger causality tests to track the possible causation between the size of the unrecorded economy relative to the official GDP, share of non-state industrial output, inflation and budget deficit. Private economy expansion reduces, albeit insignificantly, the size of the unrecorded economy relative to the official GDP; inflation increases the size of the unrecorded economy relative to the official GDP; and the budget deficit is increased if the size of the unrecorded economy increases.

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GLOSSARY

Word. [Click and type definition here.]

1. INTRODUCTION

Conventionally, a nation's wealth comprises domestic product and claims on foreign resources in the form of foreign liabilities. Domestic official product as reflected in national statistical registers covers the value of final output less intermediate consumption. It is now a standard view that statistical presentation of domestic wealth should be augmented by the value of unrecorded output. Inclusion of unrecorded output into domestic statistics is topical for transition countries. First, it is believed that unrecorded output is of a large magnitude. And second, its evolution can explain, at least partially, the dramatic fall in economic performance exhibited by most of post-socialistic countries in their transition to market-based economies. The Ukrainian economy, for instance, suffered an 87.2 percent cumulative decline in official real GDP since 1990 (UEPLAC, 2000, p.6).

Researchers, policymakers and officials in charge of compiling national income accounts are now concerned about accurate presentation of domestic product in statistical reports. The quality of statistics is viewed as a valued input both by its external and internal users, since it enhances the quality of their decisions. Thus, government policy is, ceteris paribus, more predictable and effective if it is based on a more accurate information set. One of the purposes of the study is to provide quarterly estimates of unrecorded economy. First, these estimates would raise estimates of total GDP in Ukraine and shed some light on the evolution of the total output, and second the quarterly nature of estimates would give a basis for building up models of other economic processes, where GDP is an important component.

Statistical agencies normally adjust national product for the value of unrecorded activities using household budget surveys, enterprises' data and tax agency data (OECD, 1997; Ukrainian Statistics Committee, 1999).

Since domestic product is reflected on the uses, income and sources sides, corrections for unrecorded income should be made on these three sides. Presentation of domestic income on the sources' side calls for corrections of income by types of economic activity, scale of economic activity and ownership structure of economic activity. Trade, construction, services and household sector are believed to be major types of economic activities that create informal income. It is also suggested that small-scaled economic operations are associated with creation of unrecorded income.

Recent research on the unrecorded economy in Ukraine (Eilat and Zinnes, 2000) points out that hidden income outstrips official income for some years after the break-up of the Soviet Union. These results suggest that unrecorded economy comprises not only homemade production but also unveiled production of registered, officially operating entities in virtually all sectors of the economy (and hence, it is contented that mis-reporting is more relevant for Ukraine rather than under-coverage or non-response)[1].

The most frequently cited unrecorded output estimates for Ukraine are from Kaufmann and Kaliberda (1996), where they use an assumption of a unitary elasticity of total electricity consumption with respect to total (unrecorded and recorded) income (GDP) for an imputation of unofficial economy. One of their findings is that the size of unofficial economy relative to the total economy in Ukraine (official plus unofficial economy) is uniformly rising from 1989 until 1994. Their estimates of unofficial economy imply that the size of unofficial economy is quite large in relation to official economy (e.g. for 1994 it constitutes 94 per cent). Major criticisms of the method are that it does not count for the price effect and structural effects in electricity consumption, and that the restriction of a unitary total income elasticity of electricity consumption is

[1] Under-coverage and non-response as defined by OECD (1997) include statistical biases in computation of recorded economy and informal (small-scaled) economy, while mis-reporting covers deliberate output concealment.

stringent. I appreciate the intuition of Kaufmann and Kaliberda concerning the use of electricity as an indicator of unrecorded economy and try to overcome the flaws of their method in an econometric set-up. I build my estimates of unrecorded economy on the basis of an estimable electricity consumption function.

Econometric imputation of unrecorded activities might be done if unrecorded activities are not "white noise" and are subjected to some identifiable laws of development. My suggestion is that unrecorded activities follow deterministic pattern and are dependent on real value of taxes (or tax burden). Taxes present a component of domestic wealth but they also present attenuation of absolute property rights of economic agents on income proceedings.[2] I conjecture that since taxes violate absolute property rights, an increase in the real value of resources the state captures in the form of taxes prompts economic agents go underground. This establishes the link "unrecorded economy - cause variable[3]". There is a mixture of empirical results concerning the effect of taxes upon unrecorded economy. Some researchers establish an unambiguously positive link between taxation and unrecorded economy (e.g. Crane and Nouzrad, 1986, Loayza, 1997) and some provide a directly opposite effect of taxation upon unrecorded economy[4] (Friedman et al., 1999, Johnson et al., 1998). I indirectly test the effect of real value of taxes (tax burden) on unrecorded economy.

Underestimation of domestic wealth should also be reflected in consumption of inputs. Money is an indispensable means for intermediation of transactions, and significant underestimation of domestic wealth may be reflected in an increase of currency in relation to M1 or M2. Electricity is also an input commonly used in diverse production processes. In the presence of substantial unrecorded activities

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2 Here I define property rights broadly, not confining them to rights on tangible assets.

3 As an alternative measure of causal variable of unrecorded economy I use the enterprise tax burden.

4 Tax rates and tax burden were tried to establish this link (see e.g.. Johnson et al. (1998), Friedman et al (1999)).

the ratio of electricity to official GDP should be overestimated. This establishes the link "indicator variable – unrecorded economy".

Finally, electricity consumption relative to real official GDP and currency in circulation in relation to M2 as indicators of unrecorded activities should be associated with perceived causes of unrecorded activities. This gives the basis for the model "causes-unrecorded economy-indicator (use of inputs)".

I use tax burden as a causal variable, and currency in circulation and electricity consumption as indicator variables[5]. My contention is that a larger level of the cause variable translates into a larger level of an indicator variable.

I am interested in whether both real and monetary indicators are associated with the real value of taxes (tax burden), and whether real value of taxes (tax burden) is influential in reflecting unrecorded output.

I also study the links between inflation, budget deficit and unrecorded economy and whether an expansion of private economy influences unrecorded activities.

This thesis is organized in the following way. Section 2 presents the framework "causes-unrecorded economy – indicator" which will be of use in the formulation of estimable electricity and money demand models with an additional scale variable – unrecorded transactions. Section 3 starts with the literature overview of potential causes of unrecorded economy. It also presents literature on conventional money and electricity demand modeling, and provides discussion of money demand modeling in the presence of unrecorded transactions and imputation of series of unrecorded income on the basis of money demand and gross electricity consumption data. Section 4 presents a formal model of electricity and money demand with an additional scale variable - unrecorded transactions. Section 5 introduces hypothesis and ends up with empirically testable electricity and money demand functions. They give the basis for testing

[5] Although conventionally currency relative to M2 (Tanzi, 1982, 1983) is used for the purpose of prediction of unrecorded transactions I use the level of real money balances as an indicator of unrecorded transactions. The reason is that if the level of real money balances is dependent upon both recorded and unrecorded transactions then it can indirectly reveal the levels of unrecorded and recorded transactions.

the relationship between the level of unrecorded transaction and the measure of taxes. Section 6 relates graphically electricity intensity, money in relation to M2 and tax burden. In Section 7 I estimate electricity and money demand, and calculate unrecorded economy series on the basis of electricity demand. Section 8 investigates causation between estimates of unrecorded economy, inflation, budget deficit and the level of non-state industrial production. The thesis ends with concluding remarks.

2. Framework "causes-unrecorded economy-indicator"

In this section I present the problem encountered while assessing the link "unrecorded economy – causes" and "unrecorded economy - indicators" and its possible solution in the models which link an indicator of unrecorded economy and its causes.

A normally established relationship between a studied variable and its observable determinants suffices for policy implications and positive inferences. Consider unrecorded economy, the variable of interest to this study, and its causes. A priori causes are tax rates and/or tax burden, wage arrears, probability of detection of non-compliant behavior, inflation and excessive regulation. Suppose that unrecorded economy is perceived to be bad and the policy maker faces the problem of its reduction. Assume also that ex ante it is thought that the most important determinant of unrecorded activities is wage arrears and, hence, it is a relevant instrument for the reduction of a target variable, unrecorded economy.

Generally, the task of researcher is to confirm or reject this a priori contention in an econometric set-up. The relative effects of possible determinants upon unrecorded economy can be derived from an empirical model, and a policy instrument can be replaced if it proved to be less powerful on the empirical grounds than other instruments. Hence, on the basis of an econometric set-up, the effectiveness of the policy, targeting the change of unrecorded economy, can be assessed.

The problem is that link "unrecorded economy – causes" can be established on the theoretical grounds but cannot be tested directly in empirical model. The reason is that, although perceived determinants are generally presented in the form of well arranged statistical series, our variable of ultimate interest - unrecorded economy - is not counted by statistical agencies. This necessitates an

indirect look at levels and evolution of unrecorded economy and the link of interest: "causes – unrecorded economy".

Of course, the presence of unrecorded economy implies a larger volume of transactions in comparison to their officially stated levels. A larger level of transactions should, in turn, show up in statistics of inputs' use (Tanzi, 1999). Of special interest to researches were statistics of labor use, the use of currency relative to money supply, and households' electricity consumption (see Schneider and Enste, 2000). Later on I call the use of currency in circulation and electricity demand indicators of unrecorded economy. A larger volume of transactions also reflects the larger real wealth of the country. Several variables may indicate the presence of unrecorded economy and wealth greater than stated officially in the economy. These are expenditures of households relative to registered income, number of automobiles purchased, or amount of gasoline consumed.

Again, we cannot estimate directly the link "unrecorded economy – indicator". Basically, an indicator of unrecorded economic activity is also an indicator of registered economic activity, and models of an indicator function (electricity consumption, real money balances) should include two scales of economic activity. Although the data on indicator variables and registered scale of economic activity (official real GDP) are present, another relevant variable is often missing in the structural relationship – the scale of unrecorded economy.

There are several models, which indirectly study the links "unrecorded economy-indicator", "unrecorded economy-causes", or both, and (or) impute the scale of unrecorded economy.

One of the ways to look at the link "unrecorded economy - indicator" is to determine whether the tight relationship between an indicator variable and scale of registered activity is maintained without an explicit introduction of unrecorded transactions into the structural model. This is done in the study of Treml and Alexeev (1993), where they find for the Soviet Union that the relationship between consumption of different non-durable goods and savings as dependent

variables and official money income as an independent variable became weaker over time. These statistical facts corroborate their contention that evolution of underground economy and income earned from illegal sources was not a trivial phenomenon for the Soviet Union.

I distinguish two kinds of models dealing with an estimation of unrecorded economy. The first type assumes some relationship between indicator and scale of economic activity (total GDP, official GDP or unrecorded GDP) and obviates ex ante linking of unrecorded economy with its perceived causes. Models of Kaufmann and Kaliberda (1996) and Gutmann (in Scheider, 2000 and Lacko, 1982) could be classified as models of this type. Kaufmann and Kaliberda provide estimates of unofficial economy for Ukraine solely on the basis of an indicator variable and its supposed constant relationship with the total economy. They use aggregate electricity consumption as an indicator of the total economy and time-invariant unitary total income elasticity of electricity consumption for the imputation of unofficial economy. Gutmann (in Schneider, 2000) assumes a constant ratio of currency in circulation to deposits in the absence of unrecorded activity. All upward deviations from the ratio are attributed by him to unrecorded transactions. The stringency of assumptions in these methods necessitates elaboration of more comprehensive links between unrecorded transactions and their indicators. These links are established in models of the second type. The second type includes the models, which link unrecorded economy with its causes and indicators. Models multiple indicators–multiple causes (MIMC), single indicator–single cause (SISC), and single indicator–multiple causes (SIMC), could be classified as models of the second type.

The MIMC approach enables the construction of indexes of unrecorded economy in cross sections of countries (Frey in Schneider and Enste, 2000). Another model, which gives estimates of unrecorded economy in an econometric set-up, is a single indicator – single cause model (Tanzi, 1982, 1983). Tanzi chooses currency demand relative to money supply (M2) as an indicator of

unrecorded economy, and marginal (average) tax rates as its cause. Lacko (2000) uses household electricity consumption as a single indicator variable and inflation, government expenditures, tax rates, the output fall in transition countries since the start of reforms as multiple causes of unrecorded economy (SIMC). The SIMC and SISC provide a qualitative test of relevance of the unrecorded scale variable in determination of an indicator variable and an indirect test of the relevance of perceived causes in reflecting unrecorded economy.

Since single indicator-single cause (SISC) and single indicator-multiple causes models (MIMC) provide estimates of unrecorded economy and give the test of importance of cause variable(s) in reflecting unrecorded economy–two tasks I intend to complete–I use them.

3. Literature review

This section gives possible determinants of unrecorded economy to be accounted for in an econometric set-up; it looks closely at conventional (ignoring unrecorded economy) modeling of indicator variables (currency demand and electricity consumption); and reviews how previous studies dealt with imputation of unrecorded economy.

3.1. *The link "cause-unrecorded economy"*

This subsection reviews literature on the causes of unrecorded economy.

Major theoretical foundations were laid for the decision of an individual taxpayer (or self-employed individual) as to full tax compliance (Allingham and Sandmo as in Cullis, 1998). Classical determinants of a tax evasion decision are probability of detection, fine rate, and opportunity costs of full compliance. There is no consensus regarding the direction of a change of tax compliance with respect to the change in tax rate. As usual, comparative statics includes substitution and income effects. An increase in the tax rate causes a fall in tax

compliance since the opportunity costs of a compliant behavior increase (substitution effect), while at the same time it might cause an increase in compliance if taxpayer's absolute risk aversion is a non-increasing function of income (income effect). Hence, an increase in the tax rate will provoke an indisputable increase in the tax evasion if substitution effect is larger than income effect (Cullis, 1998).

An aggregate measure of non-compliant behavior comprises both tax evasion and unrecorded output. Although unrecorded output (underestimation of value added by registered economic agent or the total amount of value added by non-registered economic entity) necessarily implies tax evasion, tax evaded income does not necessarily distort national accounts data (for details see Yakovlev, 1999). One could transfer money holdings to a sham firm via bank accounts, and convert them into unaccounted cash holdings to pay for high-taxed parts of gross revenue (e.g. labor). This presupposes an increase in the total volume of transactions, fully accounted production (or revenues) and reduction in reported labor costs. This in turn implies an underestimation of domestic wealth only if compilation of domestic product heavily relies upon the data of state tax administration (used for the computation of GDP by income method).

On the aggregate level tax evasion and unrecorded economy are considered to be influenced by inflation (Crane and Nouzrad, 1986, Lacko, 2000), level of government expenditures (Lacko, 2000), tax rates and institutional framework (law enforcement mechanisms, regulation measures, etc.). Most studies find that unrecorded economy grows with an increase in tax rate (Lacko, 2000, Crane and Nouzrad, 1986, Bhattacharyya, 1990). Giles (1999) terms a positive relationship between tax rates (tax burden) and unrecorded economy as a stylized fact of empirical literature on unrecorded economy. Nevertheless, the opposite effect of taxes is established in Friedman et al. (1999) and Johnson et al. (1998). The former study relates higher tax rates and the latter higher ratio of taxes to official GDP (tax burden) to lower size of unrecorded economy relative to recorded

economy for samples of countries.[6] Nevertheless, it is worth noting that Friedman et al. (1998) established the result using the series of unofficial economy from Schneider (1998). Schneider estimated the size of unofficial economy for some countries on the basis of money demand method, which supposes the positive correlation between tax rates and unofficial economy as a starting assumption, with the causation running from tax rates to unofficial economy.

Schneider and Enste (2000) find that a higher regulation burden increases the size of shadow economy relative to official economy for a sample of countries. Johnson et al. (1998) find for a broad set of countries that the more severe is corruption and the larger the tax burden in a particular country the larger is unofficial economy. Taking into account negative relationship between the size of unofficial economy relative to official GDP and tax burden obtained in one-variable regression, they interpret this result as if an increase in tax burden does not matter per se for an increase of unofficial economy relative to official GDP. They argue that only in combination with larger corruption and weaker rule of law, an increase in the tax rates increases the size of unofficial economy relative to official GDP.

There is no well-established theory concerning the effect of other aforementioned variables on tax evasion (government expenditures, rule of law) although some insight can be done from the perspective of public choice theory.

One of the major concerns about tax organization is that it should be efficient and equitable (Musgrave, 1987). These issues are encompassed by the benefit principle of taxation when an individual pays for public goods provision (e.g. legal order) in accordance with his marginal valuation (Lindahl-pricing). The benefit principle enhances equitability in contributing to the costs of public goods

[6] The sample used by Friedman et al. (1999) covers data of 69 countries (8 Asian countries, 4 African countries, 4 Middle Eastern countries, 15 Latin American countries, 20 countries from Europe, US and Australia, and 18 post-communist countries in Eastern Europe and the Former Soviet Union). The sample used by Johnson et al. (1998) includes the data of OECD, Latin America and transition countries.

provision (since a wealthier individual values an additional unit of public good more than less affluent individual). Wicksell (in Buchanan, 1952), Buchanan (1952, 1987) indicates that it is costly to reveal benefits of particular individuals from public goods and hence maintain that particular budget and public finance packages should be voted for and approved by majority in a constitutional set-up. Contractarian economics states that there should exist an implicit contract between the state and individual taxpayers as to expenditure-revenue packages, if government programs are to be effectively implemented. Taxpayers are more likely to agree to the value of take-offs[7] by the state if it provides expenditures agreed upon by the majority of taxpayers. If the state breaches the contract regarding provision of public goods, tax evasion is justified. Summing up, in the contractarian view the state is committed to provide valued public goods for the tax resources it takes from public.

An additional note should be made about public goods. Presently, it is not relevant to limit the state functions to provision of conventional public goods (public health facilities, infrastructure, and judiciary). Government is also responsible for a sound economic policy, or fundamentals (inflation, budget deficit, current account, etc.) which could also be conceived as public goods. And if the state fails to ensure low inflation, low budget deficit, then, apart from free riding incentives for not contributing to public goods provision in the form of tax obligations, there is also an additional incentive for the economic agent to hide his income. Hence, state failure in provision of valued public expenditures as well as overall policy failure may serve as a cause of existence of large unrecorded sectors in transition countries.

Another condition for a widespread tax evasion and large unrecorded sector is a so-called rule-following behavior. Tax evasion schemes often involve multiple players, with cooperation by all players to be successful. Thus, determinants of

[7] One could think of real value of taxes in terms of resources captured by the state, or in terms of attenuated absolute property rights on income proceedings of economic entities.

unrecorded sector proposed in the literature are tax morale of the public, real value of resources captured by the state in the form of taxes, probability of detection, fine rate, excessive regulations, the quality of public goods as perceived by taxpayers and the quality of fundamentals.

3.2. *Modeling indicator functions and imputation of unrecorded output thereof*

Since I attempt to uncover the magnitude of unrecorded economy in Ukraine using indicator functions, it is important to look at conventional modeling of money demand and electricity consumption. I separate this section into two subsections: one is an overview of money demand and the other of electricity demand literature. Each subsection, in turn, includes the description of modeling proposed indicator in the presence of unrecorded economy.

3.2.1. *Conventional modeling of money demand*

Different theories of money demand advance different determinants of holding money by economic agents. The knowledge of determinants provides the basis for econometric modeling of money demand.

Classical economics contends that money is needed to establish the comparability of the values of other commodities (money as a numeraire) and to facilitate transactions (money as a medium of exchange). The quantity theory of money demand explains what amount of money is needed to support the given volume of transactions in a particular period of time. Fisher's "equation of exchange" (the Fisher identity) and the Cambridge version of money demand represent the essence of the quantity theory of money demand. The similarity between these formulations is that both relate aggregate money holdings to the scale of economic activity (the Fisher identity uses the total volume of

transactions and the Cambridge version of money demand uses nominal income for the scale of economic activity). Several scale variables are proposed to represent transactions in an econometric formulation of money demand. Among them are consumption (part of income spent on consumption goods), gross domestic product, and wages relative to gross domestic product (or relative to other income components of domestic product).

In the portfolio demand approach money is viewed as an asset alternative to interest bearing assets. This approach suggests that forgone interest on non-monetary assets is the opportunity cost of holding currency. Money in turn gives non-pecuniary gains such as safety and liquidity services in intermediation of transactions.

The consumer demand approach considers money as a consumer good providing the flow of services. The level of money balances is chosen in utility maximization problem, where the opportunity cost of holding money is not only the forgone gain on interest bearing assets but also the gain on purchases of real assets in the current period. Friedman (1956 in Sriram, 1990) suggests expected rate of inflation as the forgone yield on holding money instead of real assets.

The combination of the transactions' demand, portfolio demand and consumer demand approaches gives the foundation for the conventional econometric modeling of money demand.

3.2.2. *Modeling money demand in the presence of unrecorded economy*

If unrecorded transactions create sub-demand for money balances then the conventional money demand function should be augmented by additional scale variable. Tanzi (1982, 1983) and Bhattacharyya (1990) implicitly hold this view. Tanzi uses tax burden as a proxy for unrecorded activities, while Bhattacharyya uses two scale variables (unrecorded and recorded output) and two money aggregates (one for supporting the recorded activities and another one for

supporting the unrecorded activities). Bhattacharyya (1990) assumes that unrecorded economy may be approximated by a polynomial of official GDP, and calculates hidden output for Great Britain for the years 1960-1984, quarterly. Tanzi (1982, 1983) uses a static long-run equation for money demand with two variables standing for official scale variables: recorded transactions per capita measured as real official GDP per capita, and a ratio of wage bill to official GDP. It should be noted that it is common to use only one scale variable for official transactions and therefore the use of a second scale variable may be unwarranted.

An imputation of unrecorded economy from money demand is done through de-composition of estimated currency holdings into components supporting recorded and unrecorded sectors. An assumption of similar velocities in both sectors enables estimation of hidden output and tax evasion.

Major criticism of the use of monetary approach for the imputation of unrecorded economy in transition countries is that there is no stable money demand function in transition economies.

3.2.3. *Conventional modeling of electricity consumption and modeling of electricity consumption in the presence of unrecorded economy*

Most studies of electricity demand focus on "the residential, commercial, industrial, and occasionally national aggregate demand for electricity" (Berndt, 1991, p. 331). All of the studies I have encountered incorporate price and scale (output) effects into electricity demand (e.g. Baxter and Rees, 1968, Bell, 1973).

Persons and Matthews (1928) indicate that production of electricity is a good proxy for the "index of physical volume of business". The physical input approach puts this contention in the following form: electricity consumption is a good proxy for the development of an overall business activity in the country.

Electricity input method for the calculation of unrecorded economy, elaborated by Kaufmann and Kaliberda (1996) is based on an assumption that

the elasticity of electricity consumption with respect to total income (GDP) is equal to unity. Looking at trends of electricity consumption through the years allows them to determine the trends of the overall economy; then subtracting the elaborated index of official GDP from the index of the total GDP, they obtain the measure of unofficial GDP in Ukraine. Kaufmann and Kaliberda are criticized for not accounting price effects and effects of structural changes in Ukrainian economy while calculating unofficial economy.

4. Theoretical model and empirically testable implications

This section develops modeling of indicator variables of unrecorded economy– money demand and electricity consumption–with an indirect introduction of unrecorded economy into the models. Conventionally, money demand and electricity consumption have only one scale variable, namely–official GDP. If unrecorded output is believed to be large, one should augment the indicator function by the value of unrecorded output. Since one does not have series of unrecorded output, the introduction of unrecorded output should be done indirectly, by modeling a functional form of unrecorded economy. Finally, observable causes of unrecorded economy would show two effects in the indicator model. The first one is the response of unrecorded economy to the cause variable and the second one is the response of an indicator variable to unrecorded economy.

First, I introduce a formal presentation of money demand with inclusion of an unrecorded scale variable. The same is done for electricity demand. Finally, I arrive at empirically testable functions of money demand and electricity demand.

4.1. *Model of currency demand with unobserved scale variable*

Currency demand in the recorded sector is conventionally modeled as

$$M_{rt} = f(R_t, P_t, \mathbf{Z_t}, RY_t) \quad (1)$$

Where

M_{rt} are nominal currency held for transactions in recorded sector;

R_t is nominal interest rate on assets alternative to money (opportunity cost of holding money);

P_t is price level;

RY_t is registered scale variable (real official GDP, real official consumption);

$\mathbf{Z}_t$ is the vector of other variables influencing nominal money holdings;

t denotes time.

The partial derivative of nominal money holdings with respect to changes in prices is expected to be positive. If an individual is to maintain the purchasing power at desired level an increase in prices prompts him, ceteris paribus, to increase nominal money holdings. The partial derivative of nominal cash holdings with respect to changes in nominal interest rate is expected to be negative since the nominal interest rate reflects opportunity costs an economic agent forgoes holding money instead of investing them into interest bearing assets. The partial derivative of money holdings with respect to changes in the scale variable is expected to be positive: larger amount of transactions, which means larger scale of a registered economic activity, requires a larger amount of money.

The modification of currency demand in the unrecorded sector presented in Bhattacharyya (1990) is:

$$M_{urt} = g(Y_{ht}) \quad (2)$$

Where

M_{urt}, stands for nominal currency held for transactions in unrecorded sector;
Y_{ht} is hidden transactions;
t denotes time.

Since we do not observe money holdings in unrecorded and recorded sectors, but normally have series of total currency holdings, the function explaining money holdings in the economy is the following (modification of Bhattacharyya, 1990):

$$M_t = f(R_t, P_t, RY_t, \mathbf{Z_t}) + g(Y_{ht}) \quad (3)$$

Where
M_t stands for total currency holdings equal to the sum of unrecorded and recorded sector currency demand.

Here money demand is additive in sub-demand for money caused by unrecorded transactions. An increase in unrecorded transactions should cause an increase in demand for money (normal relationship between money demand and scale variable). Therefore, the partial derivative of money holdings with respect to changes in unrecorded transactions is expected to be non-negative. The function encompasses the traditional currency demand specification obtained by an imposition of the restriction: $g(Y_{ht})=0$ for each t.

I present an alternative functional form of money demand with hidden transactions, introduced explicitly:

$$(\frac{M}{P})_t = h_1(R_t, RY_t, \mathbf{Z'_t}) h_2(Y_{ht}) \quad (4)$$

Where

$(\frac{M}{P})_t$ stands for real money balances;

$\mathbf{Z}'_t$ is the vector of other variables influencing real money holdings;
Y_{ht} is the measure of unrecorded transactions;
t denotes time.

In (4) real money balances are homogenous of degree zero in prices and Z'_t may include inflation as a variable controlling for this restriction. I purposefully do not term my Y_{ht} variable as unrecorded GDP (or hidden output). Unrecorded transactions are not necessarily real transactions (equivalent to real official GDP): they may represent fictitious transactions where money is needed and sales or revenues are fully reported.[8]

Also note that in (4), in contrast to (3), money holdings for recorded transactions are dependent on money holdings for unrecorded transactions and vice versa, which seems quite plausible. An argument runs the following way. In the absence of unrecorded transactions an economic agent holds money for the ease of transacting, but immediately forgoes the interest paid on the alternative use of money – depositing in a bank or buying bonds and/or securities. Hence, an economic agent faces a trade-off between holding money for the ease of transacting or investing it into interest bearing assets. In (3) it is assumed that the partial effect of interest rate change upon money holdings, given unrecorded transactions change and recorded transactions are held constant, is equal to zero. It means that there is no trade-off between holding money for unrecorded transactions and its investing into interest-bearing assets. In (4) I relax this

[8] Yakovlev (1999) provided the results of survey of Russian entrepreneurs in different branches of economic activity concerning cash evasion schemes. Cash evasion schemes are elaborate plans intended to circumvent taxes. The most popular scheme of illegal reduction of tax obligations, not confined to a particular kind of activity, is called "obnalichivaniye". It involves legal transaction – transfer by customer of cashless payments to a sham firm in accordance to contract, and illegal transaction – transfer of cash from a sham firm back to the customer. Thus obtained cash is used for payments of high-taxed parts of gross revenue (salary payments, profit payments). This scheme does not imply underestimation of sales, or revenue, and therefore underestimation of real GDP would not result if statistical agencies rely upon firms' production data in compiling of national income accounts. In the absence of comparable survey for Ukraine I suppose that Ukraine's experience is similar to Russia's in this respect.

restriction. There a change in the interest rate, given recorded transactions are held constant and unrecorded transactions change, will provoke a change in money balances of an economic agent. One could also think of a scale variable from the perspective of income side of GDP calculation. Functional form (4) implies that an increase in income from sources different from the official sources induces larger demand for money, dependent upon the income accrued from the official sources. In (3) this is not true, since recorded and unrecorded income have independent effects upon real money holdings.

The conventional money demand (1) is obtained by imposition of the following restriction: $h_2(Y_{ht})=1$ for each t, which is equivalent to a condition that desired money balances are not altered by unrecorded income or unrecorded transactions.

I can't incorporate explicitly unrecorded income series into (3) and (4) since it is not computed by statistical agencies. Hence, it should be counted for indirectly by the use of an appropriate functional form for the unrecorded economy.
I present the following form of unrecorded output series:

$$Y_{ht} = h_3(\mathbf{X_t}) \tag{5}$$

Where $\mathbf{X_t}$ – is the vector of observable causes of unrecorded economy (tax burden, excessive regulation, ease of non-compliance, probability of detection, and severity of punishment for non-compliant behavior).

Combining (4) and (5) I obtain the following relationship between money balances and their observable determinants:

$$(\frac{M}{P})_t = h_1(R_t, RY_t, \mathbf{Z'_t})h_2(h_3(\mathbf{X_t})) \tag{6}$$

This is the version of the "single indicator-multiple causes" model discussed above. Indicator of unrecorded transactions is presented by the sub-demand for real balances (reflected in $h_2\ (h_3\ (\mathbf{X}_t))$) and cause variables of unrecorded transactions are presented by the vector **X**.

Equation (6) has the following implications. First, money balances respond to conventional observable variables – interest rate and recorded transactions – through the functional form $h_1(.)$. Second, the response of money balances to the changes in variable of vector X has two components. The first one is response of unrecorded transactions to changes in variable of vector X through the functional form $h_3(.)$, and the second one is response of money balances to changes in unrecorded transactions through the functional form $h_2(.)$.

If vector **X** does not explain variations in unrecorded output, then the meaningful restriction is $h_2(h_3(\mathbf{X}_t))=1$.

4.2. Model of electricity demand with unrecorded scale variable

In this section I present the version of the "single indicator-multiple causes" model, with electricity consumption as an indicator of unrecorded transactions.

Let aggregate electricity demand be a function of registered GDP, real price, unrecorded transactions and other variables.

$$EL_t = f(RY_t, P_t, Y'_{ht}, \mathbf{O_t}) \qquad (7)$$

Where

EL_t is aggregate electricity demand;

RY_t is registered scale variable (real official GDP);

P_t is real price for electricity;

Y'_{ht} is the measure of unrecorded transactions;

$\mathbf{O_t}$ is the vector of other variables influencing aggregate electricity demand.

Real official GDP is normally used for official real transactions (here rationalized as production-side estimate of real official GDP): more registered

production reflected in larger level of real official GDP requires more electricity for production purposes. The partial derivative of electricity demand with respect to changes in recorded transactions is expected to be positive. The partial derivative of electricity demand with respect to changes in real price for electricity is expected to be negative, since larger real price means a larger cost for an economic agent using electricity in a production process. If unrecorded transactions require electricity in production process then the partial derivative of electricity demand with respect to changes in unrecorded transactions is expected to be non-negative.

Assuming that electricity demand is separable in unrecorded transactions, I end up with the following functional form of electricity demand:

$$EL_t = f_2(RY_t, P_t, \mathbf{O_t})\, f_3(Y'_{ht}) \tag{8}$$

In (7) and (8) unrecorded transactions' variable is changed: I use Y'_{ht} rather than Y_{ht} used in the model of real money balances. The difference is in following. Electricity demand is driven mostly by electricity intensive production processes, and hence real transactions determine electricity demand. In (8) it is assumed that unrecorded transactions matter for the level of electricity consumed. Therefore, my unrecorded scale variable in (8) denotes production-side dimension of unrecorded activities, or the real side of unrecorded activities. Opposite to unrecorded transactions' variable in electricity demand, unrecorded scale variable in money demand equation may stand for either fictitious transactions or real transactions.

As in the case of money demand, electricity demand in (8) reduces to conventional electricity demand if $f_3(Y'_{ht})=1$ for each t.

Given the vector of causes of unrecorded transactions is $\mathbf{X}'$, I obtain the following presentation of electricity demand:

$$EL_t = f_2(RY_t, P_t, \mathbf{O_t})\, f_3(h_3(\mathbf{X'_t})) \quad (9)$$

The simple reason of using $\mathbf{X}'$ for the causes of unrecorded transactions rather than $\mathbf{X}$ used in money demand is that indicators differ and transactions variables differ. Money holdings is the variable in the choice set of the majority of economic agents, therefore a more catholic version of causes is needed. Electricity, in turn, is more heavily used by industrial producers rather than, for example, trade or construction firms. Therefore, variables causing unrecorded transactions, relevant in determination of electricity consumed, are more specific to production side of domestic economic activities.

Here, again, electricity demand has an indirect link with unrecorded scale variable. Response of electricity demand to changes in the variable out of vector X has two components. First, the direct response of unrecorded output to a variable out vector of $\mathbf{X}'$ is produced through the functional form $h_3(.)$, and second, response of electricity demand to changes in unrecorded transactions acts through functional form $f_3(.)$ If unrecorded transactions do not alter electricity demand, or equivalently, if electricity consumption is not an appropriate indicator of unrecorded transactions, then relevant restriction is $f_3(h_3(\mathbf{X}'_t))=1$ for each t. It will be the case if production in unrecorded sector is not electricity intensive production.

5. Hypothesis and Empirically testable model

Taking into account what have been said in the above section, I develop empirically testable functions of relationship "causes – unrecorded economy – indicator". I arrive at single indicator-single cause models of money demand and electricity demand. My empirical specification of money and electricity demand

provides a possibility of testing the relationship between real value of taxes (tax burden in case of electricity demand) and unrecorded economy.

5.1. *Hypothesis*

This section states a hypothesis to be tested indirectly on the basis of empirical money and electricity demand functions.

As was mentioned in the *Literature Section,* theoretically and empirically it is ambiguous whether an increase in tax rate (tax burden) induces a larger volume of unrecorded transactions. I want to study the direction of changes of unrecorded economy with respect to changes in taxation pattern.

As indicated, taxes present a component of domestic wealth but they also present attenuation of absolute property rights of economic agents on income proceedings. Absolute property rights are defined as follow: 1) the right to make physical use of physical objects (in a broad sense, income proceedings or the value of sold product); 2) the right to income from it; 3) the power of management, including that of alienation (Furubotn, 1998, p. 77). I conjecture that since taxes violate the second characteristic of absolute property rights, an increase in the tax burden, or real value of taxes prompts economic agents go underground. This is my null hypothesis. Alternative hypotheses are that real value of taxes (tax burden) does not cause unrecorded transactions or that an increase in real value of taxes (tax burden) causes a reduction of unrecorded economy.

Vihanto (2000) contends that an increase in resources captured by the state in the form of taxes induces a further increase in tax evasion if the public goods provided by the state are of a poor quality. This also conforms to an intuition behind the existence of tax evasion and unrecorded transactions presented in contractarian economics literature. An economic agent is less likely to abide by the rules of tax compliance and transparent accounting procedures if government

does not fulfill its function of provision of valued public goods and sound macro policies. Hence, the effect of state's capture of resources in the form of taxation should be controlled for by the quality of public goods provided by the state.

5.2. Empirically testable models

I suggest the following structural presentation of money demand:

$$(\frac{M}{P})_t = a_0(R_t)^{a_1}(RY_t)^{a_2}(Y_{ht})^{a_3}(\prod_i^n Z_{it}^{'g_i})e^{x_t} \quad (10)$$

Where

a_1, a_2, a_3 are exponents for nominal interest rate, registered scale variable, and unrecorded scale variable respectively;

g_i is the vector of exponents for variables $Z_{it}^{'}$ (i= 1,…,n);

ξ_τ is white noise series.

The model is of an estimable form but for inclusion of unrecorded output. Relevance of Y_{ht} could be tested via imposing the restriction α_3=0. This corresponds to the restriction $h_2(Y_{ht})$=1.

As I said previously, the inability to incorporate unrecorded transactions series prompts me to develop the functional form of unrecorded output.

I hypothesize the following form of unrecorded output:

$$Y_{ht} = T_t^{b_1}e^{w_t} \quad (11)$$

Where

T_t is the measure of taxes (real value of taxes or tax burden);

b_1 is an exponent for the measure of taxes;

w_t is white noise series;

t denotes time.

It is assumed in (11) that there is a long-run relationship between the real value of taxes and the level of unrecorded economy (including economic activity with and without underestimation of domestic product). I use the real value of taxes rather than tax rates since they are directly linked to the value of resources the state takes out of the public regardless of activity any individual agent may pursue. I explicitly rule out all the other variables (inflation, quality of government expenditures, probability of detection and severity of punishments, tax morale of the public) assuming that they cause short-run deviations expressed in the error term from the long-run relationship between real cash balances and unrecorded economy.

My intention to use only taxes in determination of unrecorded output is based on the following arguments. First, taxes are in the decision set of economic agents and therefore it is reasonable to assume that they form some quantifiable rules as to under-reporting of income (sales), while encountering the changes in taxation pattern.

As to other possible determinants of unrecorded transactions, they are either specific to a particular economic activity (probability of detection, ease of non-compliant behavior) or presumably are not directly in the decision problem of an economic agent (inflation, or quality of government expenditures). I contend that the public weighs inflation and economic fundamentals on the qualitative grounds rather than have well defined decision rules of non-compliance with respect to the changes in these variables. In (11) I assume that the changes in the quality of public goods and other presumable determinants of unrecorded economy cause the shocks to the structural relationship between unrecorded transactions and real value of taxes. The enterprises' survey in Ukraine (Gray and Whiston, 1999) revealed that the legislative conditions (which may be deemed as

a proxy for the quality of public goods), administrative controls by public agencies and inflation are not the most important problems of enterprises. The tax burden represented by severity and complexity of the existing tax system, in turn, is the main constraint for enterprises to operate officially. This may serve as a partial justification for the presentation of unrecorded transactions series in (11). Nevertheless, as indicated earlier, the quality of public goods may be the relevant determinant in choosing the level of unrecorded transactions. Yet there are the problems in assessing the quality of public goods in a particular economy for the short successive periods of time. In several works the quality of public goods is represented as the index for cross section of countries (Johnson et al., 1997, Loayza, 1997), so that its comparison can be made only between the countries within one year. The difficulty in assessing the quality of the public goods by scholars and international agencies within the economy for the short successive periods of time may serve as an additional though weak argument for the particular presentation of unrecorded transactions series in (11).

Combining (10) and (11) gives me the following function:

$$(\frac{M}{P})_t = \alpha_0 (R_t)^{a_1} (RY_t)^{a_2} (T_t^{b_1})^{a_3} (\prod_i^n Z_{it}^{'g_i}) e^{m_t} \qquad (12)$$

Note that if taxation is irrelevant in determination of unrecorded output, so that $\beta_1 = 0$, then the restriction $h_2(h_3(X_t)) = 1$ is satisfied if deterministic part of unrecorded transactions function is taken into account.

In natural logarithms my money demand function will be:

$$m_t^* = \alpha' + \alpha_1 r_t + \alpha_2 ry_t + \alpha_3 \beta_1 t_t + \sum_i^n z_{it} g_i + m_t \qquad (13)$$

Under (11), or equivalently

$$m^*_t = \alpha' + \alpha_1 r_t + \alpha_2 ry_t + \phi t_t + \sum_i^n z_{it}\gamma_i + \mu_t \qquad (14)$$

Where $\phi = \alpha_3 \beta_1$

m_t^* is desired (long-run) real money balances;

μ_t is white noise series;

t denotes time.

Here lower-case letters determine variables in logs. Equation (14) is a single indicator – single cause model, which provides the possibility of testing the response of unrecorded economy to changes in taxation pattern. Certainly, neither α_3 nor β_1 can be separately estimated, though one could infer one elasticity having knowledge of the other. Thus, once the model (14) is estimated, having the knowledge of elasticity of money holdings with respect to changes in unrecorded income (output), one can infer the elasticity of unrecorded output with respect to changes in tax burden and calculate unrecorded income series.

Several testable implications can be derived from (14).

1. $\phi = 0$.

Given that money is a normal good (response of money holdings to changes in both scale variables are positive and hence $\alpha_3 > 0$), the hypothesis that $\phi = 0$ could be interpreted as a test of zero elasticity of unrecorded economic activities with respect to changes in taxation pattern.

If ϕ proves to be statistically significant and non-zero, it establishes the link between taxes and unrecorded income.

2. $\phi > 0$.

If $\phi > 0$ then, given a response of demand for real money balances to an increase in transactions is unambiguously positive ($\alpha_3 > 0$), the changes in real value of

taxes (or tax burden) cause the changes in unrecorded transactions in the same direction ($\beta_1 > 0$), which is the corroboration of my hypothesis.

3. $f < 0$.

If $f < 0$ then, given $\alpha_3 > 0$, the change in real value of taxes (or tax burden) causes the change in unrecorded economy in the opposite direction $\beta_1 < 0$[9].

Empirically testable model of electricity demand with u nrecorded scale variable

Now I turn to an empirically testable model of electricity demand with unrecorded transactions' variable introduced indirectly.

Let electricity demand be of Cobb-Douglas form.

$$EL_t = m_0 (RY_t)^{m_1} (P_t)^{m_2} (Y'_{ht})^{m_3} \left(\prod_{j=1}^{k} O_{jt}^{\sigma_j}\right) e^{j_t} \qquad (15)$$

Where

m_1 is an exponent for the registered scale variable;

m_2 is an exponent for the real price variable;

m_3 is an exponent for the variable which stands for unrecorded transactions;

σ_j is the vector of exponents for variables O_{jt} (j=1,…, k);

j_t is white noise series.

The form of unrecorded output series corresponding to my hypothesis is:

$$Y'_{ht} = (T'_t)^{b_2} e^{v_t} \qquad (16)$$

---

9 This result will disable estimation of unrecorded economy in Tanzi's fashion. The reason is that the level of "excess" currency demand caused by taxation will be negative, and by the Fisher identity unrecorded transactions will also be negative. This result, if model is correct, will cast doubts on the Tanzi's (1982, 1983) currency demand method of imputation of unrecorded economy.

Where ν_t is white noise series.

Note the two differences in the form of unrecorded transactions variable compared to (11). The use of Y ' is explained previously. A different measure of transactions in turn requires different measure of taxation variable. As I have said previously, the vector of causes of unrecorded transactions entering electricity demand should be specific to production activities. The best representative for unrecorded transactions' variable is output, or value added of industrial enterprises. For the tax variable in (19) I propose to use enterprise tax burden. The intention to use enterprise tax burden is based on the fact that it presents a good measure of enterprises' obstacles from running their businesses officially. In (16) I assume that enterprises facing changes in tax burden form quantitative rules as to unrecorded transactions. Again, inflation, quality of government expenditures, probability of detection are presumably assessed by enterprises on qualitative grounds rather than are incorporated into a well defined problem of choosing the level of unrecorded transactions. I assume that the changes in these variables cause shocks to the structural relationship between unrecorded transactions and enterprise tax burden.

Then taking into account (16) I obtain the following structural form of electricity demand:

$$EL_t = m_0 (RY_t)^{m_1} (P_t)^{m_2} (T_t^{b_2})^{m_3} (\mathbf{O_t})^{m_4} e^{h_t} \qquad (17)$$

Where

h_t - white noise series.

Taking natural logarithms from the both sides of (17), I get

$$el_t = m' + m_1 ry_t + m_2 p_t + m_3 b_2 t_t + \sum_j^k s_j o_{jt} + h_t \qquad (18)$$

Or equivalently

$$el_t = \mu + \mu_1 ry_t + \mu_2 p_t + \lambda t_t + \sum_j^k \sigma_j o_{jt} + \eta_t \qquad (19)$$

Where $\lambda = \mu_3 \beta_1$.

In (18), (19) lower-case letters denote variables in logs.

Following testable implications arise from (19):

1. $\lambda = 0$. This condition is equivalent to the statement that either unrecorded transactions are not electricity intensive, and therefore electricity is not a good indicator of unrecorded transactions, or that unrecorded transactions are not responsive to enterprise tax burden.

2. $\lambda > 0$. This equivalent to the following statement. Given that changes in unrecorded transactions non-negatively affect electricity demand, increase of enterprise tax burden causes an increase in unrecorded real transactions.

3. $\lambda < 0$. Given that changes in unrecorded transactions non-negatively affect electricity demand, this condition means that changes in enterprise tax burden cause the changes in unrecorded transactions in the opposite direction.

6. Ukrainian context

In this section I link graphically the indicators of unrecorded economy – currency in circulation relative to money supply (M2) and electricity intensity – to its supposed cause variable, tax burden.

In the above set-up electricity is dependent, among other factors, on recorded and unrecorded transactions. Hence, electricity consumed may let us determine indirectly the total level of economic activity, though it is not too suggestive in revealing the level of unrecorded transactions in particular. If one divides electricity by the level of registered transactions, then the resulting indicator will be a function of unrecorded transactions and other factors. The larger unrecorded transactions relative to recorded transactions will cause an upward

movement in electricity intensity, given unrecorded sector has the same technology as recorded sector and other factors are held constant. The similarity of technologies in recorded and unrecorded sectors could be the case if registered enterprises in the broad range of industries are engaged into unrecorded transactions, which fits contention of Kaufmann and Kaliberda (1996).

The table below presents levels of electricity intensity for different transition countries and average level of electricity intensity for European Union countries (nominal value of official GDP of each country is translated into purchasing power equivalent for the purpose of cross-country comparison).

Table 1. Electricity intensity in CEE Countries (1995)[10]

Country	Electricity intensity (kWh/USD_{ppp})
Albania	17.8
Belarus	28.3
Bosnia & Herzegovina	42.3
Bulgaria	26.0
Croatia	18.6
Czech Republic	18.1
Estonia	35.0
Hungary	16.3
Latvia	16.2
Lithuania	30.0
Macedonia	35.4
Moldova	29.4
Poland	18.6
Romania	28.2
Slovakia	21.6
Slovenia	12.7
Ukraine	**48.7**
EU-15	9.0

Source: http://www.geo.ut.ee/bankwatch/energy/enrep-2.htm

As one can see, Ukraine has the most electricity intensive economy compared to the sample of countries presented in table 1. Although different reasons may lie behind the large use of electricity per unit of real output, soft budget constraints and prices below marginal valuation to mention a few, one should also think about the possibility of such a relatively abnormal ratio due to the presence of unaccounted output.

I cannot check directly whether unrecorded transactions explain electricity intensity. Yet if unrecorded transactions increase with an increase in tax burden, then on the a priori grounds I may suspect that higher tax burden will result in an

[10] Comparable figure for Russia is not available.

increase of electricity intensity. Therefore it is important to look at whether the time pattern in electricity intensity has some similarities with the time pattern of tax burden.

Figures 1, 2, 3, 4 track the following variables over the period 1992:1-1999:4: electricity consumption relative to real official GDP, ratio of industrial production relative to official GDP[11], share of overall taxes in official GDP, and share of enterprise taxes in official GDP (all series are seasonally adjusted). The vertical axis of the Figure 1 measures million kWh of electricity used per unit of 1990 constant roubles. The vertical axis of the Figure 2 measures the share of nominal industrial output in nominal official output pre-multiplied by a constant (see Footnote 11). The vertical axis of the Figure 3 expresses the percentage share of overall taxes in official GDP. The vertical axis of the Figure 4 measures the percentage share of enterprise taxes in official GDP.

[11] It measures the share of nominal industrial output in nominal official GDP in a particular quarter multiplied by the ratio of nominal official GDP in the same quarter of the base year 1990 to nominal industrial output in the same quarter of the base year 1990. I use real industrial output index (base year 1990) and real official GDP index (base year 1990) for construction of this ratio. The ratio is obtained by division of real industrial index by real official GDP index. Thus, real industrial index in quarter j, year t/real official GDP index in quarter j, year t = (nominal industrial output in quarter j year t/nominal industrial output in quarter j, year 1990)/(nominal official GDP in quarter j, year t/nominal official GDP in quarter j, year 1990). Or equivalently, (nominal industrial output in quarter j, year t/nominal official GDP in quarter j, year t)*(nominal official GDP in quarter j, year 1990/nominal industrial output in quarter j, year 1990).

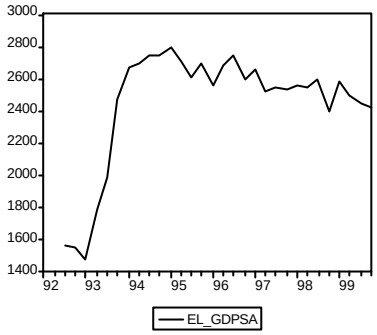

Figure 1. Electricity consumption relative to real official GDP (1992:1 - 1999:4)
Source: my estimates based on UEPLAC (2000) data.

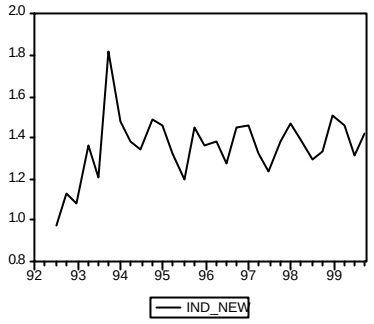

Figure 2. Industrial production relative to official GDP (1992:1-1999:4)
Source: my estimates based on UEPLAC (2000) data.

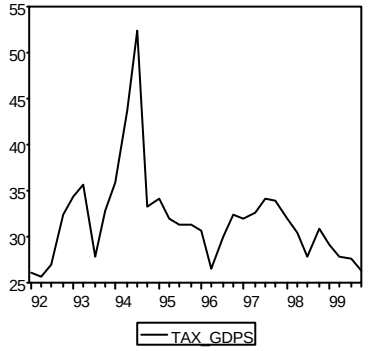

Figure 3. Share of overall taxes in official GDP (1992:1-1999:4)
Source: my estimates based on UEPLAC (2000) data.

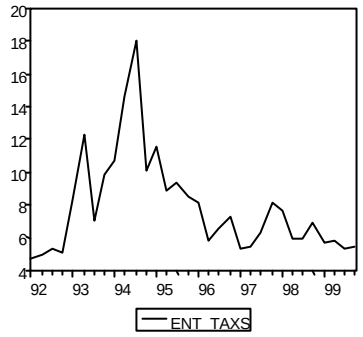

Figure 4. Share of enterprise taxes in official GDP (1992:1-1999:4)
Source: my estimates based on UEPLAC (2000) data.

From the Figure 1 it can be seen that there was persistent growth of electricity intensity from 1993:1 until 1995:1, stable until 1993:3, with an increased quarterly growth afterwards, and declining from 1994:1 until 1995:1[12]; from 1995:1 electricity intensity fluctuated nearly around a constant level. Data on enterprise

[12] Note that growth is positive; and, hence, levels of electricity intensity were uniformly rising until 1995:1.

taxes relative to official GDP and overall taxes in relation to official GDP signify that there was persistent growth in those indicators since 1993:3 until 1994:3, then a significant fall within a quarter and since 1996:2 series of enterprise taxes relative to official GDP were nearly a seasonally stochastic process. Time paths of electricity intensity and tax burdens are positively related: of special interest is the period 1993:3-1994:3, when an abnormal growth in tax burdens corresponds to a high growth in electricity intensity. Nevertheless, Figure 2 reveals that in 1993:3-1993:4 there was an 'abnormal' increase of the ratio of industrial production to official GDP, which afterwards reduced to stochastic seasonality. This increase may partially explain growth in the electricity intensity in the period 1993:3-1993:4.

Another a priori contention is that the underground economy induces the growth of currency in circulation (for the purposes of circumvention of taxes and transacting in unrecorded sector). Currency in circulation in my set-up is also dependent, among other factors, on the level of recorded and unrecorded transactions. Again, the level of currency may let us determine indirectly the level of recorded and unrecorded transactions, although it is not too helpful in the separate revealing of unrecorded transactions. One of the possible indicators of the presence of unrecorded transactions is the ratio of currency in circulation to monetary aggregate M2 (Cagan, 1958). The weight of currency in the holdings of domestic assets (currency itself and bank deposits) may be explained by opportunity cost motives and transactions motives in the recorded sector. In my set-up it may also be determined by unrecorded transactions. The latter are supposedly influenced by the real value of resources captured by the state in the form of taxes.

The issue of interest on this stage is whether both monetary and real indicators of unrecorded economy are associated with tax measure. To explore this issue similar measure of tax variable should be used in order to track supposed positive link between these indicators and tax measure. Two measures of tax variable were

used to establish graphically the relationship between taxes and electricity intensity: overall tax burden and enterprise tax burden. Overall tax burden (share of overall taxes in official GDP) may serve as an alternative to the real value of taxes proposed in the above section for the cause variable of unrecorded transactions in case of money demand. It measures the weight of taxes in the registered GDP, or how much of resources the state takes off from the public in terms of registered yearly GDP. If an increase in the share of overall taxes in official GDP leads to an increase in unrecorded transactions then the weight of currency in the holdings of domestic assets will be positively affected by the share of taxes in official GDP.

Figure 5 presents currency in relation to M2 (series are seasonally adjusted). The series of the share of overall taxes in official GDP are presented in the Figure 3. The vertical axis of the Figure 5 measures the percentage share of currency in circulation in the monetary aggregate M2.

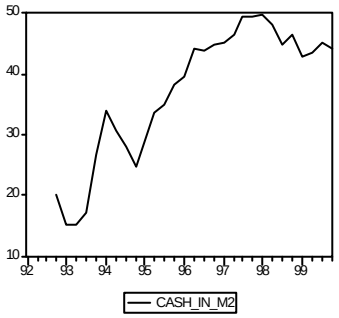

Figure 5. Currency in circulation in relation to M2 (1992:1-1999:4).
Source: my estimates based on UEPLAC (2000) data.

One can see the pattern of 'abnormal' growth of ratio of currency to M2 for the period 1993:3-1994:1 (when there is almost one-to-one correspondence with the growth in tax burden). The introduction of a new currency in 1996 and

curtailment of inflation can tentatively explain somewhat stabilized levels of the ratio of currency holdings with respect to M2 after 1997.

The tentative conclusion from the graphs is that cash evasion (reflected by the growing ratio of currency in circulation with respect to money supply) corresponds to an increase in production evasion (reflected by the growing ratio of electricity to real official GDP).

Of course, the similarity of time paths of electricity intensity, currency relative to M2 and tax burden for some periods does not presuppose a tight economic relationship between them. The relationship between an indicator (currency in circulation, electricity consumption) and unrecorded economy caused by tax burden should be tested empirically. Moreover, not merely tax burden matters for the evolution of unrecorded activities relative to the official economy, but also whether economic agents perceive the tax burden as excessive or fair. Surveys covering these issues may be instructive in this respect.

The major constraints to running the business in Ukraine (irrespective of the size of business), as revealed by survey of enterprises, are: *existing tax system*, lack of working capital, low market demand for the products, legislative conditions, inflation, and administrative controls by public agencies (Gray and Whiston, 1999).[13]

An additional evidence on how public weighs the tax burden extant is provided by a survey of households and entrepreneurs in Ukraine. Table 2 presents views of entrepreneurs on the matter of optimal tax rates.

[13] Impediments to running business officially are grouped in the order of decreasing importance.

Table 2. Entrepreneurs' view of optimal tax rates.

Kind of taxes	Percentage of respondents	Tax rate conceived to be optimal	Existing tax rates
Profit taxes	50% 42%	5-10% 11-20%	30%
Value added tax (VAT)	47% 15% 23%	6-10% 11-20% no response	20%
Payroll taxes	67% 20% 13%	<20% 21-30% no response	37.5%

Source: Intellectual Fund "Vidrodzhennya" (1999).

As seen from Table 2, existing tax rates are far in excess of those perceived to be optimal by respondents-entrepreneurs. The survey also covered questions about compliance and considerations of the particular respondent regarding existing tax rates (whether they are large or not). On average, eleven percent of respondents pay taxes in full amount (11.5 percent of city dwellers and 9 percent of rural respondents). Seventy-five percent of respondents consider existing tax rates excessively large. In turn, ninety-three percent of those who know existing tax rates view them as excessively large.

Given that graphical presentation and survey evidence is not sufficient to draw definitive conclusions about the chain "tax burden-unrecorded economy-indicator," I present the test on these links in empirical part.

7. Empirical Section

7.1. *Data description*

In this section I describe variables used in money demand and electricity demand specifications.

As discussed earlier, modeling money demand requires data on scale and opportunity cost variables. I use real GDP and real consumption for transactions variable. Quarterly real consumption, for the period 1992:1-2000:4, is in 1990 constant roubles (UEPLAC, 2000). Real GDP comprises two data sets: nominal GDP and GDP deflator. The former is available for the period 1992:1-2000:4, the latter - for the period 1992:3-2000:4 (UEPLAC, 2000). The base period for calculation of GDP deflator is 1990. Currency in circulation is quarterly, for the period 1992:1-2000:4 (UEPLAC, 2000).

Several money-denominated assets are proposed to represent alternatives to money balances (Goldfeld and Sichel, 1990, Judd and Scadding, 1982). Among them are government bills, short-term and long-term bearing assets, and equities. Therefore, yield on government bills, rates on the short-term and long term bearing assets, return on equities are normally used for opportunity cost variables. The only opportunity cost variable, available in long series for Ukraine from published sources, is weighted average of interest rates on deposits of commercial banks of Ukraine. Hence, an interested user is constrained in the choice of returns on assets alternative to money. An absence of these data may cause the problems of mis-specification of money demand if economic agents consider these assets the relevant alternatives to currency holdings.

Inflation, a variable of vector z' in money demand (refer to specification 14), is computed from the consumer price index (CPI) in Ukraine for the period 1992:1-2000:4 (UEPLAC, 2000). The base year for calculation of CPI is 1990.

The share of enterprise, excise and household income taxes, social security and pension payments in official GDP are used for calculation of real value of taxes

and enterprise tax burden, and are available for the period 1992:3-2000:3 (UEPLAC, 2000).

The following data are used in modeling electricity demand. Quarterly electricity consumption, for the period 1992:1-1999:4, is taken from Energorynok. It is measured in million kilowatts per hour. The price variable is the weighted average of tariffs for electricity consumption by industrial consumers and population (both rural and urban) obtained from Minenergo. The weights used are shares of electricity consumption by industrial consumers and population in overall consumption of electricity. Real price is obtained by deflating the constructed price by the producer price index (PPI), which is taken from UEPLAC (2000). I use the variable reflecting structural changes in the economy for the variable of vector **o** in electricity demand (refer to equation 19). It is the ratio of real industrial output index to real official GDP index[14]. Indexes are available for the period 1992:3-1999:4 (UEPLAC, 2000). For 1990 both indexes are equal to 100.

7.2. *Methodological Issues*

In this section I discuss the problems of estimation of money demand and electricity demand outlined in economic literature. The problems could be divided into conceptual and technical.

Among conceptual questions is an inclusion of appropriate opportunity cost variables and inflation into money demand specification. I also discuss how previous studies dealt with a functional form of money demand.

Discussion of technical problems covers the issues of endogeneity in money demand and electricity demand and their identification.

[14] I will give the extensive explanation of using this variable later.

7.2.1. *Conceptual Issues*

The issue of opportunity costs in money demand equation has special relevance for transition and developing countries. Normally, an inclusion of interest rate on deposits and yield on bonds issued by the government suffices for presentation of opportunity costs of holding real cash balances. Reformulation of opportunity costs variable in transition and developing countries is needed because of wide scale foreign currency holdings by public.

The phenomenon of currency substitution in developing and transition countries calls for introduction of returns on foreign currency into money demand. Currency substitution is termed as the use of foreign currency as a unit of account, a store of value and medium of exchange (Calvo as in Van der Ploeg, 1994). Foreign currency provides more liquidity services the more widely it is used for transactions in a given country. Some researchers argue that instability of money demand with traditional scale and opportunity cost variables can be explained by the diversification of portfolio in favor of foreign money rather than domestic assets (Calvo as in Van der Ploeg, 1994).

Another issue is the inclusion of inflation into the money demand specification. While inflation is accounted for by the nominal interest rate, it is argued that inflation should enter money demand function as a separate determinant. The reasons for inclusion of inflation are following. Roughly speaking, households hold their wealth in cash, which provides liquidity and non-pecuniary services, interest-bearing assets, which provide accruals over nominal value of currency, and real assets. While opportunity costs of holding money instead of depositing it are reflected by the nominal interest rate in the money demand equation, the opportunity costs of holding cash balances instead of real assets can be represented by inflation. Inflation is the cost one incurs by forgoing the opportunity of purchasing real assets. Suppose that the actual inflation rate is zero. Then, taking aside other factors, the only thing an individual loses is the difference between utility from the current consumption of commodity services

and utility derived from consumption of similar commodity services in future period, deflated by a discount factor. In turn, if actual inflation is non-zero, then in the next period purchasing power of money balances is reduced, and an individual can't acquire the same amount of goods as in the previous period. The utility reflected by the differential between purchasing power of money balances in current period and next period is lost. It constitutes an additional cost of holding money rather than using it for purchases of real assets.

In the above section I presented demand for real cash balances, which is homogenous in prices of degree zero. Hendry and Ericsson (1991) argue that one should test empirically this kind of homogeneity of real cash balances rather than impose the restriction ex ante. This is another reason for an inclusion of inflation into money demand specification.

The last argument is that the inflation may capture effect of substitution of foreign currency for domestic money holdings. Generally, effect of currency substitution is incorporated by an inclusion of changes in nominal foreign exchange rate and difference between domestic and foreign inflation (Giovanni as in van der Ploeg, 1994). If inflation of foreign currency is assumed to be negligible, domestic inflation along with the changes in nominal foreign exchange rate may serve as proxies for currency substitution phenomenon. If foreign assets are the relevant alternative to domestic money holdings then the yield on foreign assets should be also included into the vector of opportunity costs of domestic real money balances. The phenomenon of the importance of foreign assets in determination of domestic money holdings is called asset (indirect) substitution.

The issue worth discussing is presentation of an estimable function of money demand. To my knowledge there are three ways of modeling money demand function. The first way is via a static long-run equation (Tanzi, 1982, 1983; Bhattacharyya, 1990). The second, more widespread, method introduces short-run dynamics into money demand (Goldfeld and Sichel, 1990). It is argued that households and economic entities may undershoot or overshoot their targeted

long-run levels of money holdings, and hence they adjust their currency holdings by elimination of a portion of this differential within one period. In accordance with the adjustment rule, nominal and real partial adjustment models are distinguished (Goldfeld and Sichel, 1990). Within the group of adjustment models there is also an adaptive expectations model (Feige in Goldfeld and Sichel, 1990), where money holders respond to expectations of real income and interest rate. The third way is general-to-specific modeling, where one encompasses both partial adjustment models and long-run static models.

7.2.2. *Technical issues*

In this subsection I discuss the issue of endogeneity of independent and dependent variables in money demand and electricity demand functions and the separation of demand from supply functions.

The issue of endogeneity arises when dependent and some (or all) independent variables are determined simultaneously. Endogeneity renders estimators inconsistent, and hence should be corrected whenever one expects it to be present in the model.

There are several variables which are suspect to be co-determined within the money demand model. These are real cash balances, nominal interest rate, real official GDP, and inflation. In most studies endogeneity is not discussed, and money demand is estimated with the help of ordinary least squares procedure (OLS). For the sake of results some authors argue that OLS performs as well as two stage least squares procedure (TSLS), which allows corrections for endogeneity (Laidler in Goldfeld and Scihel, 1990). TSLS requires appropriate instruments highly correlated with endogenous variables and uncorrelated with residuals. Proposed instruments (Goldfeld in Cooley and LeRoy, 1981) are government expenditures, population, discount rate and lagged money stock.

Mehra (1978) studies functions of interest rate, real tranactions and real (nominal) money stock separately, allowing for simultaneous determination of these variables within the system of equations. He finds for the U. S. data that the only meaningful relationship runs for money demand determined by nominal interest rate, real money balances as left-hand side variables since this way of looking at money demand gives a solution of the problem of endogeneity. Models with interest rate and real transactions on the left-hand side produce endogeneity problems and render estimators biased and inconsistent for Mehra's sample of U. S. data. Performing a similar study requires a large data set, since it is based on analysis of regressions, each with several lead values of dependent variable and several lead and lagged values of all independent variables. At present I do not possess a large enough sample to make a similar analysis of endogeneity.

The issue of separation of demand from supply is usually solved by an introduction of an additional variable into one of the functions, which is distinct from the other variables simultaneously shared by demand and supply functions.

It is argued that it is money demand that is estimated in an econometric set-up, since money supply function has an additional variable (the only variable that distinguishes demand from supply)–discretion by the central bank over reserves requirements of commercial banks. In this case the only function which is exactly identified is money demand function. The presence of a demand specific variable in the system of supply-demand equations would provide an exact identification of both money demand and money supply.

Within the electricity consumption function variables, suspect of simultaneous determination, are a left-hand side variable – electricity consumption and right-hand side variables – price of electricity and official real GDP. Electricity may determine the level of economic activity if it is widely used in production processes.[15] In turn, the level of economic activity expressed by the real official

[15] One could think of electricity as the input entering aggregate production function. Therefore electricity, combined with other inputs, affects an aggregate measure of economic activity (real GDP).

GDP may determine electricity consumption. The potential problem of co-determination of real official GDP and electricity demand is evident. In Ukrainian context prices faced by electricity consumers may be deemed as exogenous since they are set administratively. Hence, at least one instrument is needed for the correction of possible endogeneity between electricity consumed and real official GDP. Lagged electricity, government expenditures, lagged prices and money aggregate M2 are proposed instruments.

The issue of identification of electricity supply and demand functions can be resolved if one assumes that electricity supply is set in accordance with the government plan, since all major electricity supplies prior to 1999 were state owned. The fact that electricity consumption data differ from electricity production data may serve as an additional argument for exact identification of electricity demand.

7.3. *Empirical model of money demand*

In this section I provide two ways of estimation of money demand: by means of general-to-specific modeling and long-run static modeling. I give the reasons for using general-to-specific modeling and provide discussion of results obtained for the both types of models. They are single indicator-single cause models (SISC).

First I provide a general model since it encompasses a long-run static model and a real partial adjustment model.

Model 1.

$$m=\mu_0+\mu_1 m(-1)+\mu_2 m(-4)+\mu_3 m(-5)+\phi_1 ry+\phi_2 ry(-1)+\phi_3 ry(-4)+\phi_4 ry(-5)+\pi_1 r+\pi_2 r(-1)+\pi_3 r(-4)+\pi_4 r(-5)+\lambda_1 inf+\lambda_2 inf(-1)+\theta_1 t+\theta_2 t(-1)+\theta_3 t(-4)+\theta_4 t(-5)+\varepsilon$$

m - natural logarithm of real cash balances (currency in circulation divided by CPI);

ry - natural logarithm of real official GDP;

r - natural logarithm of nominal interest rate;

inf - log(cpi / cpi(-1))-inflation;

t - natural logarithm of real value of taxes (exclusive of value added tax);

ε - white noise series.

I have both conceptual and technical reasons for the dynamic specification. The conceptual reasons are based on the assumption that economic agents form their current decisions on the present and retrospective values of choice and constraining variables. The static specification presented in (14), in urn, may be deemed as a model of long run response of real money holdings to their determinants. Estimated model 1 can be reduced to the long-run form by equating all lags of dependent and independent variables separately and estimating the long-run equation of real money balances. The merit of model 1 is that it encompasses real partial adjustment models and static long-run models used in most studies of money demand. Of course it would be better to include up to five lags of both money holdings and independent variables but since I am constrained by the length of the data series I use this restricted version of the general-to-specific modeling.

The choice of alag structure of the model is based on the following arguments. The fourth lag is introduced to account for a possible seasonal structure in the formation of real money balances. The first lag can be explained from the

prospective of partial stock adjustme nt theory. If an economic agent "misses" his desired level of real money holdings in the previous period, he partially eliminates the differential between desired and actual real money balances within one period (in my case it is a quarter). The presence of the fourth and fifth lags in money balances can be explained by the long adjustment period of money balances to their desired levels. This means that the history of money balances formation matters. Continuous disruptions in the real and asset markets may necessitate the long adjustment period of real money balances to their desired levels. As a common feature of general-to-specific modeling, the lag structure of independent variables entering money demand specification is similar to the lag structure of dependent variable.

The technical reason for using an auto-regressive distributed model is that it overcomes the problem of spurious regression which is possible in case of time series data (Verbeek, 2000).

As discussed earlier, the coefficient of the scale variable is expected to be positive; coefficient of nominal interest rate is expected to be negative. Inflation represents additional costs of holding money. It reduces the domestic purchasing power of money. Therefore, an increase in inflation increases costs of holding money. In accordance with this reasoning the sign of the inflation coefficient is expected to be negative. Inflation can also partially capture the effect of currency substitution. An increase in inflation causes the reduction of the value of the domestic currency relative to foreign currency, given that foreign inflation does not change, and may cause a reduction in real money holdings. This is another explanation of why the coefficient before inflation variable is expected to be negative. I do not include nominal exchange rate into money demand model, normally used along with inflation variable to control for currency substitution phenomenon (in Ukrainian case it is dollarization). My arguments are based on the following observations. There are two periods corresponding to the time period of my sample when nominal hryvnia/dollar exchange rate was not

changing significantly. The first period comprises the years 1997 and 1998 when there was allowed a band of hryvnia/dollar exchange rate and second period is the period of 2000:1-2000:4 where exchange rate was artificially sustained on the nearly constant level by means of appropriate monetary policies. Therefore I end up with a large portion of observations of nominal exchange rate, which do not have sufficient variability to detect possible correlation with demand for domestic real money balances. Nevertheless, nominal exchange rate may be a relevant variable, and its exclusion may cause the problems of mis-specification of money demand. Sriram (1990), for example, argues that coefficient before inflation variable in some studies of money demand in developing countries is overstated since it partially includes the response of real money balances to the changes in the nominal exchange rate. In case of asset substitution, foreign interest bearing assets should be the relevant alternatives for holdings of domestic money for the exchange rate to have an additional importance in determination of money demand. Although the free access to foreign capital markets is closed in Ukraine by means of capital controls, domestic agents have an opportunity to replace foreign currency deposits in domestic banks for domestic money and domestic interest bearing assets. I can not test the possibility of the asset substitution with my data set since prior to 1998 Ukrainian commercial banks did not provide National Bank of Ukraine - the first-hand collector of monetary statistics in Ukraine - with information on yield on foreign currency deposits.

The coefficient of my prime interest is the long-run coefficient of real value of taxes. To obtain this coefficient from model 1, one should divide the sum of coefficients of the level and all lags of the tax variable by one minus the sum of coefficients of the level and all lags of real money balances. My null hypothesis is that long-run coefficient before real value of taxes is positive, which means that an increase in the real value of taxes leads to an increase in unrecorded transactions. Alternative hypotheses are that taxation is not important in

determination of unrecorded transactions or that unrecorded transactions negatively correlate with taxation pattern.

I exclude the value added tax (VAT) from the tax variable since it can act as an effective check of the true value of transactions in bilateral transactions (de Soto, 1989): the buyer does not have an incentive to undervalue transactions since he will not be reimbursed by the true value of VAT (if he adds the further value to the product bought), the seller in turn does not have an incentive to overvalue transactions since he will have to pay a larger amount of VAT than he is obliged to in case if transactions are in-voiced in the full amount. The clash of interests of buyer and seller with regard to circumvention of VAT is evident. This is why some argue that taxation of consumption is less conducive to evasion than taxation of individual and corporate profits (see e.g. Ministry of Economic Affairs in Ukraine, 2000).

Since some researchers argue that consumption should enter money demand instead of real official GDP (Mankiw and Summers, 1986), I also develop *Model 2*, which has the same structure as *Model 1* but for official transactions variable: it has the real official consumption instead of real official GDP.

Finally, the estimation results of models 1, 2 are presented in table 3.

Table 3. Results of money demand estimation by general-to-specific method.

Dependent variable: **m** (real money balances) Method: OLS Sample (adjusted): 1993:2 – 2000:3		
Independent variables	Coefficients	
	Model 1 (real official GDP as a scale variable)	**Model 2** (real consumption as a scale variable)
Intercept	-0.93** (0.18)	-0.97** (0.29)
m(-1)	-	0.34** (0.10)
m(-4)	0.71** (0.04)	0.38** (0.07)
t	0.38** (0.08)	0.51** (0.098)
t(-1)	0.51** (0.1)	-
t(-4)	-0.41** (0.08)	-0.41** (0.11)
t(-5)	-0.41** (0.07)	-
inf	-0.52** (0.07)	-0.33** (0.07)
inf (-4)	-	-0.11* (0.05)
$R^2_{adjusted}$	0.93	0.91
Prob (F-statistic) S. E. of regression	0.000000 0.0599	0.000000 0.067
DW statistic	2.009	2.66
Prob (Jarque-Bera)	0.70	0.86
Breusch-Godfrey serial correlation LM test	No correlation of 1,2,3,4 order is detected	Hypothesis of no 1 order serial correlation in residuals can be rejected at 10% level of significance
White heteroscedasticity Prob (F-statistic)	0.53	0.82
Chow breakpoint test: 1996:3. Prob(F-statistic)	0.31	0.77
Chow forecast test: 1996:3-2000:3. Prob (F-statistic)	0.66	0.78
Ramsey RESET test Prob (F-statistic)	0.25	0.31

Standard errors are in parentheses; * denotes statistical significance at the 5% level of significance; **denotes statistical significance at the 1% level of significance

Solved long-run equation for Model 1:

m* =constant + **0.37t*-1.6 inf***

Solved long-run equation for Model 2:

m* =constant + **0.24t*-1.79 inf***

The first thing I should mention is that in models 1, 2 I assumed that current inflation, real official GDP, real value of taxes and nominal interest rate are predetermined, the condition needed for consistency of estimates. The reason is that I was unable to find appropriate instruments for correction of possible endogeneity. I also assumed an exact identification of money demand, which follows the logic presented in *Methodological Section*[16].

Models 1 and 2 are obtained by the use of successive tests of over-identifying restrictions and Wald tests, in particular the tests of the statistical relevance of lags, the level of each variable and of statistical relevance of the lag structure[17]. A possible problem with models 1 and 2 is that of a small sample size. Basically, general-to-specific modeling is performed when one possesses a large sample of observations.

Generally, model 1 and model 2 fit the data quite well. Model 1 performs slightly better than model 2 in terms of adjusted R^2; it also has a lower standard error of regression. The variables retained in the process of successive reduction are highly significant. Both models perform equally well in terms of White test of heteroscedasticity in residuals, normality of residuals, and stability tests. P-values of respective tests show that there is no heteroscedasticity, non-normality of residuals at any plausible significance level. There is no structural break in money demand after 1996:3[18] in both models. Ramsey RESET test fails to reject the null hypothesis of stability of models 1 and 2 at any plausible significance level. The qualitative difference between two models is in the LM test of serial correlation in

[16] In a conventional set-up it is argued that money demand is exactly identified and money supply is not identified since monetary authorities have an additional variable in money supply function: discretion over the reserve requirements of commercial banks. My set-up provides an exact identification of both functions since the real value of taxes enters money demand function and presumably is not included into money supply function. This is a by-product observation not fully elaborated here since modeling of money supply is out of scope of this particular work.

[17] Successive reduction of model from the general to specific form is performed in fashion proposed by Charemza and Deadman (1997).

[18] Period 1996:3 was chosen to test for the structural break in money demand since hryvnia, the new currency, was introduced in this quarter. A priori it may be expected that money demand behaved differently before and after the introduction of hryvnia. The period after 1996:3 is deemed to be different from the previous period in terms of reforms in Ukrainian economy (see Volkov A., 2000).

residuals. The null hypothesis of no first order correlation in residuals can be rejected at a 10% level of significance for model 2, while the higher order correlation of residuals can be rejected at any plausible level of significance. Model 1, in turn, does not produce serial correlation of residuals of the 1, 2, 3 and 4 orders.

Summing up, on statistical grounds model 1 with real official GDP as a scale variable performs better than model 2 with real official consumption as a scale variable.

I also estimate a static long-run model for money demand, since the previous studies, accounting for an unrecorded scale variable indirectly in the money demand specification, mostly use a static presentation of money demand. I call it model 3. It corresponds to (14) but includes seasonal dummies for the elimination of seasonality in dependent and independent variables (Greene, 2000). The model suffered from serial correlation in residuals, therefore a correction for the detected first, second and third order auto-correlation in residuals was performed. For the estimation of model 3 I assumed that current inflation, nominal interest rate, real official GDP, and real value of taxes are predetermined within a period. I also assumed that inflation is fully accounted in the nominal interest rate in the long run and does not have a separate influence upon real money holdings. It may be explained as if economic agents had already made the desired purchases of real assets and foreign currency in the short run, and allocate the rest of their income between domestic interest bearing assets and domestic consumption in the longer run. The final estimation results of model 3 are presented in table 4.

Table 4. Results of money demand estimation for the static long-run model with correction for auto-correlation in residuals.

Dependent variable: **m** Method: OLS Sample adjusted: 1993:4 2000:3	
Independent variables	**Model 3** (long-run static model with correction of auto-correlation in residuals)
Intercept	-7.57** (0.78)
ry	1.55** (0.32)
r	-0.21** (0.07)
t	0.34** (0.09)
D2	-0.07 (0.05)
D3	-0.27** (0.06)
D4	-0.26** (0.07)
AR (1)	0.76** (0.17)
AR (2)	0.56 ** (0.21)
AR (3)	-0.42** (0.15)
$R^2_{adjusted}$	0.898
S. E. of regression	0.085
DW statistic	2.09
F-statistic	17.6
Prob (F-statistic)	0.000000
Inverted AR roots	.75+.03i .75-.03i -.75
Prob (Jarque-Bera)	0.22
Breusch-Godfrey serial correlation LM test	No correlation of 1,2,3,4 order is detected
White heteroscedasticity Prob (F-statistic)	0.43
Chow breakpoint test: 1996:3. Prob(F-statistic)	0.04
Chow forecast test: 1996:3-2000:3. Prob (F-statistic)	0.08
Ramsey RESET test Prob (F-statistic)	0.14
standard errors are in parentheses ** denotes statistical significance at the 1% level	

The fit of model 3 in terms of adjusted R^2 cannot be compared to the fit of models 1 and 2 since the number of observations left for the calculation of model 3 differs from the number of observations on which models 1 and 2 are based. Model 3 has a larger standard error of regression compared to models 1 and 2. The weakness of model 3 is that it poorly performs in terms of Chow test of the structural stability of the model. It turns out that the null hypothesis of no structural break in money demand after 1996:3 can be rejected at a 5% level of significance for the Chow breakpoint test and at a 10% level of significance for the Chow forecast test. Actually stability tests are the most important tests in money demand models since the knowledge of the stable structural relationship of real money balances and relevant independent variables is a valuable tool for the conduct of monetary policy.

7.3.1.*Discussion of Results*

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First note that models 1and 2 give comparable coefficients of inflation. Models 1,2 and 3 give comparable coefficients for the variable which stands for real value of taxes. Coefficient of the tax variable implies that an increase in real value of taxes by 10% leads in the long-run to an increase in real cash balances by approximately 3.7% (in model 1), 2.4% (in model 2), and 3.4% (in model 3). In my set-up it means that, given that elasticity of cash balances with respect to unrecorded transactions is positive, the response of unrecorded economy to changes in real value of taxes is also positive. If the state increases the take-offs of resources in the form of taxes, economic agents respond by increasing unrecorded transactions, simultaneously choosing money balances for their intermediation. My hypothesis that an increase in the state take-offs of resources in the form of taxes leads to an increase in unrecorded transactions cannot be rejected.

The sign of the coefficient of inflation variable in models 1 and 2 conforms to expectations, and so do the signs of coefficients of conventional variables in model 3. Model 3, compared to model 1 and 2, gives somewhat dissimilar results in terms of variables other than the variable standing for real value of taxes. While model 3 contains conventional variables, models 1 and 2 have lost both scale and opportunity cost variables in the process of successive reduction of the general model. There may be two sets of explanations of this result. The first is purely statistical: the procedure of transforming models 1 and 2 from their general form to more economic presentation seeks for the best fit of the dependent series to the set of independent variables regardless of theory. Moreover, inflation variable and nominal interest rate may be highly collinear, and this may explain the absence of interest rate in the estimation of models 1 and 2. Second, the interpretation of models 1,2 and model 3 may differ with regard to their structural form. The first two models are of a dynamic nature and show how real money balances respond to changes in the set of independent variables over a reasonable time span. Model 3 is of a long run nature. Hence, the difference in results can be interpreted in the following way. In the short run the most influential variables for the decision of economic agents to hold money balances are inflation and real value of taxes while in the long run desire to hold money is determined by the opportunity cost variable and transactions motives in recorded and unrecorded sectors. In the short run, real money balances of economic agents are reduced if inflation increases, which means that the relevant alternatives to money balances in the short run are purchases of real assets and foreign currency. In the long run nominal interest rate may incorporate the changes in inflation and therefore economic agents consider domestic interest bearing assets as a relevant alternative to holdings of money. Yet I did not find a sensible explanation as to why money holdings respond to changes in recorded transactions in the long run, while in the short run they are not affected by recorded transactions.

The logic behind the estimation of unrecorded economy from fitted money demand is the following. First, calculate a so-called excess money demand, i.e. money demand which is solely explained by real value of taxes. Second, calculate that portion of money demand which is attributed to conventional factors, a so-called legal money demand. Third, having had real official GDP and legal money demand, calculate the income velocity of currency in recorded sector, and finally, assuming that income velocity in recorded and unrecorded sectors are the same, calculate unrecorded economy on the basis of the Fisher identity (see e.g. Tanzi, 1982).

But if estimation of the unrecorded economy in Tanzi's fashion were tried on the basis of well performing model 1or 2, then results would be negative which is quite absurd. Another reasons for not performing the estimation of unrecorded economy on the basis of money demand function is that the results of models 1, 2 and 3 differ and that technical problems (endogeneity issues) were not resolved while estimating the money demand.

7.4. *Empirical model of electricity demand*

In this section I present estimation of electricity demand. It indirectly accounts for unrecorded transactions and has the form of a "single indicator – single cause" model.

The large magnitude of unrecorded economy obtained in some studies is implicitly based on an assumption that mis-reporting permeates the whole economy. Monetary data do not necessarily presume the creation of an additional real income (output) out of the real money balances. Of course, the Fisher identity holds for each period since it is of an accounting character, but it does not necessarily mean that it holds for an excessive currency in circulation.

The physical input approach suggests that electricity consumption is a good predictor of total economic activity. Kaufmann and Kaliberda (1996) base their estimates of the total GDP in Ukraine on the basis of assumption of unitary elasticity of electricity consumption with respect to total GDP. This enables them to construct estimates of unrecorded economy. The approach is valid if a particular economy is electricity intensive and if no structural changes occur within the period of the estimation. That Ukraine has a highly electricity intensive economy is established in *Ukrainian Context* section. The possibility of structural changes within economy and hence changes in the pattern of electricity consumption still need to be accounted for (this point is borrowed from Lacko in Feige, 1999).

In empirical specification of electricity demand one should not overlook the unobserved scale variable, which is presumably large in Ukraine (a priori assertions are based on Kaufmann and Kaliberda, 1996). I fulfill this requirement in my empirical specification of electricity demand based on single indicator-single cause model (SISC).

To be sure, electricity consumption responds not only to changes in observed and unobserved scale variables but also to the cost variable (real price) and structural changes. A real price variable is constructed as a weighted average of tariffs for industrial producers and households deflated by the producer price index (PPI). An increase in the real price should, ceteris paribus, induce a fall in electricity used. "The structural changes" variable used is the ratio of real industrial production index to real official GDP index. A shift of the economy towards industrial production should increase, ceteris paribus, the level of electricity consumed. I also explicitly introduce a tax burden imposed on enterprises as a cause of unrecorded output. Since electricity is mostly used by industry[19] and the main economic unit of an industry is an enterprise I am

[19] On average, the share of industrial consumption of electricity amounts to slightly more than 55% of the aggregate electricity consumption for 1992-1999 (own estimates based on the data of Energorynok).

introducing an enterprise related cause variable rather than an overall tax burden (measured as the ratio of total tax collections to total GDP) or real value of taxes. I also assume that an increase in an enterprise tax burden induces firms to update their decisions as to registering of transactions in favor of an increase in unregistered transactions. An increase in unregistered transactions in turn implies an increase in unrecorded value added. This is the point that needs to be tested.

Summing up, my model is

$$el_t = constant + \mu_1 ry_t + \mu_2 p_t + \mu_3 ent_t + \mu_4 ind_t + seasonal\ dummies + \nu_t$$

Where

el-natural logarithm of electricity consumption;

ry-natural logarithm of real official GDP ;

p- natural logarithm of weighted real price for electricity – real value of weighted tariffs for industrial consumers and households (both urban and rural);

ent-natural logarithm of enterprise taxes relative to GDP;

ind- natural logarithm of index of real industrial production relative to index of real official GDP;

Seasonal dummies are $d_i = 1$ in quarter i, 0 otherwise (i=1,..,4).

v- white noise series.

Expectations for the structural coefficients of variables entering the electricity demand function are following. An estimate of μ_1 is expected to be positive since a larger production reflected in a larger level of real official GDP requires more electricity for production processes. An estimate of μ_2 is expected to be negative since an increase in the real cost of electricity should reduce, ceteris paribus, electricity consumed. The coefficient μ_3 on the a priori grounds is expected to be

positive: an increase of the weight of industrial production in the overall GDP should, ceteris paribus, increase electricity consumed, since industrial consumers have the largest share in the total of electricity consumed (see Footnote 19). The μ_3 coefficient of the enterprise tax burden is of my major interest. If it is not statistically and economically significant this may be interpreted as either unrecorded sector is not an intensive electricity user (and hence industrial enterprises are not engaged in the unrecorded transactions) or that tax burden is not important in determination of unrecorded economy.

The estimation results of the electricity demand model are presented in table 5.

Table 5. Electricity demand

Dependent variable: **el** Sample(adjusted): 1992:3 1999:4	Method of estimation		
Independent variables	OLS	TSLS	GMM
		Instruments used: ind, el(-1), ent, p, log (M2)	
Intercept	8.09** (0.35)	7.75** (0.40)	7.77** (0.26)
ry	0.57** (0.046)	0.63** (0.06)	0.64** (0.03)
p	-0.04* (0.02)	-0.06** (0.02)	-0.06** (0.01)
ent	0.18** (0.03)	0.19** (0.03)	0.16** (0.02)
ind	0.16 (0.12)	0.23* (0.12)	0.26** (0.06)
D2	-0.197** (0.02)	-0.199** (0.02)	-0.198** (0.02)
D3	-0.26** (0.03)	-0.26** (0.03)	-0.26** (0.02)
D4	-0.19** (0.03)	-0.2** (0.03)	-0.2** (0.02)
$R^2_{adjusted}$	0.946	0.946	0.927
S. E. of regression	0.04	0.04	0.04
DW statistic	1.6	1.82	1.54
F statistic	73.15	61.84	-
Prob (F-statistic) J statistic	0.000000 -	0.000000 -	- 0.128
Prob (Jarque-Bera)	0.72	0.88	0.94
Breusch-Godfrey serial correlation LM test	No correlation of 1,2,3,4 order is detected	No correlation of 1,2,3,4 order is detected	-
White heteroscedasticity Prob (F-statistic)	0.56	0.08	-
Ramsey RESET test Prob (F-statistic)	0.12	-	-

standard errors are in parentheses
* denotes statistical significance at the 10% level
**denotes statistical significance at the 1% level of significance

First I estimate electricity demand by ordinary least squares (OLS). The model performs quite well in terms of adjusted R^2. Structural variable is the only variable, which is statistically insignificant at a 10% level of significance. Since time series data may produce spurious regression, I check for co-integrating relationship between variables (see appendix 1). I do not do separate testing of stationarity of the variables entering the model since available time series are not long enough to produce definitive conclusions. The null hypothesis of the absence of co-integrating relationship between electricity consumption and its suggested determinants cannot be accepted at the 10% level of significance.

I use a two stage least squares procedure (TSLS) for correction of possible endogeneity between real official GDP and electricity consumption. In the presence of endogeneity, real official GDP should be instrumented in order to obtain consistent estimates of structural coefficients[20]. TSLS also solves the problem of possible non-stationarity in the data (Johnston, 1997). I also use generalized method of moments (GMM) although it usually performs efficiently in large samples (Johnston, 1997). The reason for using GMM is that it enables me to check quickly the validity of the used instruments (EViews routinely reports the J statistics needed for the test). OLS did not show serial auto-correlation in residuals (including the first-order auto-correlation), and this enabled me to employ a one period lagged value of the dependent variable as an instrument for GDP. Another instrument used is the natural logarithm of M2. J-statistic indicates that instruments proved to be statistically valid at 1, 5 and 10% levels of significance.

An improvement brought by TSLS and GMM over OLS is that they produce a significant and nearly the same coefficient of the variable, which stands for structural changes in economy (ind). All the other coefficients have expected

[20] It can be hardly believed that electricity consumed determines enterprise tax burden and ratio of index of real industrial production relative to the index of real official GDP. Therefore, I do not have to instrument these variables. General discussion of endogeneity in electricity demand is presented in section *Methodological Issues.*

signs and are highly significant in all three modifications of estimation of electricity demand.

The coefficient of interest is that of enterprise tax relative to official GDP. Results of the model suggest that an increase in enterprises tax burden by 10% increases, ceteris paribus, electricity consumption by approximately 2%, the rest is attributed to variation in seasonal characteristics of electricity consumption and structural changes in economy (variable ind). A positive coefficient of the enterprise tax burden in my set-up means that electricity is a relevant indicator of unrecorded economy and that an increase in the enterprises tax burden prompts them to increase unrecorded transactions, which is the statistical corroboration of my hypothesis.

7.4.1. *Estimation of unrecorded economy*

In this section I provide an estimation of unrecorded economy. The procedure is based on the decomposition of electricity demand in two portions: the portion used for the creation of real output in recorded sector and the portion used for the creation of unrecorded output. The logic behind the estimation conforms to Tanzi's (1982) method of estimation of underground economy on the basis of money demand.

The procedure is as follows: first, I calculate "excess" electricity consumption, or the portion of electricity induced by the tax burden. The difference between the total electricity consumption and this portion gives me electricity, which is explained by the conventional factors: price, structural and income variables. I call it "legal" electricity. Then I obtain the ratio of official GDP to "legal" electricity. This gives me a guide of what amount of real official GDP is produced by a unit of "legal" electricity. Under the assumption that unrecorded sector has the same technology as registered sector, I obtain unrecorded GDP pre-multiplying this ratio by excess electricity consumption. Assumption of the same technology in

both sectors is needed since it enables me to state that real GDP produced per unit of electricity is the same in both sectors.

Several notes of caution should be given with regard to this estimation technique. First, it is rather crude to name excess electricity demand as electricity consumed for the production of unrecorded output, and the rest as electricity used for the production of the recorded output. Second, for the accuracy of estimation, electricity demand should explain the level of real output produced, since I infer unrecorded output from the excess electricity and the ratio of real official GDP to electricity explained by conventional factors. A statistical check of whether electricity consumption explained by conventional factors causes real official GDP is performed by means of a vector error correction approach (VEC). VEC shows the long run co-integrating relationship between variables of interest and the short run adjustment of the dependent variable to its long-run equilibrium. The estimation of VEC for the real official GDP and electricity consumption explained by conventional factors is presented in appendix 2. Results suggest that there is a meaningful statistical relationship between real official GDP and electricity consumption explained by conventional factors, which substantiates my estimation procedure.

Third, one should be sure that the use of an excess electricity demand necessarily implies that an output produced with its use is the valued output and is comparable to the output accounted in the official statistics.

In table 6 I present the size of estimated unrecorded GDP relative to official GDP in Ukraine calculated on the basis of electricity demand function and the same ratio calculated by Harvard/CASE Project (J. Szyrmer and D. Snelbecker, 2000) on the basis of household surveys.

Table 6. The size of unrecorded economy relative to official GDP in Ukraine, quarterly (in per cent).

Period	The size of unrecorded economy relative to official GDP, quarterly (in per cent)	
	My estimates	Harvard/CASE[a] Ukraine Project
1992 Q3	31	-
1992 Q4	32	-
1993 Q1	37	-
1993 Q2	51	-
1993 Q3	37	-
1993 Q4	47	-
1994 Q1	43	-
1994 Q2	55	-
1994 Q3	59	-
1994 Q4	48	-
1995 Q1	45	-
1995 Q2	43	53.3
1995 Q3	43	62.9
1995 Q4	44	27.0
1996 Q1	37	34.1
1996 Q2	33	27.8
1996 Q3	35	64.0
1996 Q4	40	29.1
1997 Q1	28	38.5
1997 Q2	32	34.0
1997 Q3	35	58.2
1997 Q4	43	30.2
1998 Q1	35	40.3
1998 Q2	34	36.9
1998 Q3	33	-
1998 Q4	39	-
1999 Q1	29	-
1999 Q2	33	-
1999 Q3	31	-
1999 Q4	34	-

[a] Source: Szyrmer J. and D. Snelbecker 2000. *Reforms for Ukraine: ideas and actions.* Kyiv: Alterpres. Estimates are based on discrepancy between income and expenditures of surveyed households.

Although the results are divergent (only the second quarter estimates in both methods coincide), the main finding from the comparison is that the yearly estimates produced by both methods for 1996 and 1997[21] are comparable in the magnitude. Thus, for 1996 my estimate of the size of unrecorded economy relative to official GDP is equal to 36.5 per cent, while that of Harvard/CASE is 38.8 per cent. For 1997 my estimate of the size of unrecorded economy relative to official GDP is equal to 36.5 per cent while that of Harvard/CASE is 34.6 per cent.

Of course, my estimates of unrecorded series are not the ultimate truth, but I hope that they present at least approximate figures, which can contribute to understanding of the true evolution of the total output in Ukraine.

There are other studies, which provide yearly estimates of unrecorded economy in Ukraine. In the table below I present my estimates of unrecorded economy and the estimates from those studies known to me. Since estimates of unrecorded economy in other studies are of a yearly nature, I convert my estimates of the size of unrecorded economy relative to registered GDP into yearly figures.

[21] These are the only years where it is possible to construct the yearly estimates of unrecorded economy on the basis of discrepancy method.

Table 7. The size of unrecorded economy relative to official GDP in Ukraine, yearly (in per cent).

Year	The size of unrecorded economy relative to official GDP in Ukraine, yearly (in per cent)		
	My estimates	**KK[a]**	**Lacko[b]**
1989	-	13.6	-
1990	-	18.3	19.5
1991	-	26.8	28.1
1992	-	31.9	37.4
1993	42.5	41.8	47
1994	51.6	62.5	54.6
1995	43.6	74.9	52.8
1996	36.5	84.3	-
1997	34.6	86.5	-
1998	35.5	84.3	-
1999	32.0	81.4	-

[a] Source: my estimates. Estimates are based on the electricity consumption approach of Kaufmann and Kaliberda (1996).
[b] Source: Lacko (2000). Estimates are based on the household electricity approach developed by Lacko (2000).

The results are quite divergent , though my estimates are slightly comparable in magnitudes to those presented in Lacko (2000) for 1993-1995. My estimates and estimates of Lacko (2000) indicate that growth rate of the size of unrecorded

economy relative to registered GDP started falling after 1994, the beginning year of serious reforms in Ukraine (Havrylyshyn O., 1997). In accordance to the Kaufmann and Kaliberda's method unrecorded economy started falling only after 1997. Except from a significant divergence in the estimates, there could be little gained from comparison between my estimates and estimates based on the Kaufmann and Kaliberda's method, which comprise the longest coinciding period and use the aggregate electricity data. The possible explanation of divergence is that estimates based on the Kaufmann and Kaliberda's method are overstated since all variations of electricity consumption in their method are explained solely by two scale factors, while cost and structural factors of the change in electricity consumption are neglected. My estimates, in turn, use this information. One point is worth mentioning. My estimate of the unrecorded economy derived from the electricity consumption function is rather close to that presented by Derzhkomstat (1999) for 1999.[22]

8. Pair-wise Granger causality tests

This section explores the statistical meaningfulness of several links between the size of unrecorded output relative to official GDP and some indicators of economic development[23] by means of pair-wise Granger causality tests. After establishing the direction of the causation between variables of interest by means of Granger causality tests, I look at whether there is a long run co-integrating relationship between these variables. Between two variables x and y there may be two co-integrating relationships: one is normalized in terms of x, and the other is normalized in terms of y. If Granger causality test indicates that variable x does not Granger cause variable y I do not perform the estimation of the long-run co-

[22] Derzhkomstat estimate of unrecorded GDP for 1999 is 20% of official GDP, while my estimate is approximately 32%.

[23] The source and characteristics of the data on these indicators are presented in appendix 3.

integrating relationship between these variables normalized in terms of y. I use VEC command in EViews to estimate the long-run co-integrating relationship.

VEC command automatically gives an output of co-integrating equation and vector error correction mechanism (VEC). VEC restricts variables in equation to converge to their long-run co-integrating relationship allowing short-run dynamics (EViews, 1996). For current purposes I am not interested in the short-run adjustment of the size of unrecorded economy relative to official GDP and chosen variables to their co-integrating relationship. Hence, I present only the long-run relationship between the size of the unrecorded economy relative to the official GDP and several indicators of economic development.

I emphasized earlier that unrecorded economy might respond to the quality of fundamentals. First, I test the relationship between inflation and unrecorded economy.

First proposition is that a positive relationship between inflation and the size of unrecorded economy relative to real official GDP may be expected. Crane and Nouzrad (1986) state that if risk aversion of an individual is an increasing function of real disposable income, then inflation may increase the level of tax evasion (and unrecorded economy). The reason is that inflation erodes the value of income any individual agent obtains, and if an individual economic agent is willing to maintain the desired level of real disposable income, he may pursue unrecorded transactions under some assumptions of risk aversion.

The second contention is that an increase of unrecorded economy relative to official economy causes the fall of aggregate prices. Since unrecorded sector does not pay taxes, it may charge lower prices than recorded sector for similar products. Therefore, it may be possible that price competition between recorded and unrecorded sector leads to the fall of aggregate price level in economy.

The results of Granger causality between inflation and the size of unrecorded economy relative to real official GDP, and the long-run co-integrating relationship of these variables are presented in appendix 3. They suggest that an

increase in inflation causes an increase in the size of unrecorded economy relative to the official economy, while the reverse causation is not true. Therefore, the first proposition is (statistically) valid for Ukraine.

Next, I study the relationship between the size of the unrecorded economy relative to the official real GDP and budget deficit. Some previous work (e.g. Schneider and Enste, 2000) emphasized that there might exist a spiral, "an increase in shadow economy-budget deficit–(an increase in tax burden)-further increase in shadow economy". The mechanism of a spiral is following. First, an increase in the size of unrecorded economy relative to official economy results in tax evasion and ultimately causes an increase in the budget deficit. Second, in order to cover the budget deficit government needs more in tax revenues and implements aggressive policies of tax collections. Third, these measures increase the effective tax burden imposed on economic agents operating officially. And lastly, facing even harder constraints in official economy, more economic agents engage in unrecorded transactions, which means that the size of unrecorded economy relative to official economy increases.

Results of Granger causality test between the size of unrecorded economy relative to official economy and budget deficit and the long-run co-integrating relationship between these variables are presented in appendix 3 They suggest that budget deficit does not Granger-cause the size of unrecorded output relative to real official GDP, while there may be expected the positive effect of the size of shadow economy relative to real official GDP on the budget deficit. A spiral "budget deficit-increase in the tax burden-shadow economy-larger budget deficit" is not maintained for Ukraine.

Finally, I test the causation between private economy and the size of unrecorded economy relative to official economy. I use the share of non-state industrial output in the overall industrial output as a proxy for the expansion of the private economy. Results (see appendix 3) suggest that the development of non-state industrial output Granger-causes the size of the shadow economy

relative to real official GDP, while the causation "shadow economy $\Rightarrow$ non-state industrial output" is not (statistically) valid. The results of co-integrating relationship between the share of non-state industrial output and the size of unrecorded output relative to official output are quite encouraging since they imply that an expansion of the private economy induces the fall in the relative weight of shadow economy in registered economy.

Concluding Remarks

This study is of a positive nature and explored three issues. The first issue of interest was the direction of response of unrecorded transactions to changes in taxation pattern using real and monetary indicators and appropriate tax variables. I argued that the scale of unrecorded transactions should augment conventional electricity demand and money demand functions. I fulfilled this task indirectly by introducing appropriate tax variables into electricity demand and money demand, which gave me the possibility of testing the relationship between taxes and unrecorded economy. The second issue of interest was an estimation of unrecorded economy. And finally, I studied the relationship between the size of unrecorded economy relative to official GDP and several indicators of economic development.

Summary of the results is following. Both money and electricity demand indirectly confirmed that the increase in the real value of taxes and tax burden imposed on the enterprises positively affects unrecorded economy. Estimates of unrecorded economy were obtained from an electricity demand function. Expansion of the private economy seems to reduce the size of unrecorded economy relative to official economy. An increase of unrecorded economy relative to registered GDP increases the budget deficit. Inflation increases the size of unrecorded economy relative to official economy.

I did not make any statements of the normative character since the issue of whether unrecorded economy is bad or good for economic development of the country was not pursued here and needs a separate study. But if we agree with the official Ukrainian government position that measures directed to the reduction of the size of unrecorded economy relative to official GDP should be taken if this ratio is more than 30% (Ministry of Economic Affairs in Ukraine, 2000) then the following can be proposed on the basis of analysis. The measures to be considered by the government in order to reduce the size of unrecorded economy relative to the official GDP and reduce the budget deficit, are to control inflation, promote further expansion of the private economy and reduce the tax burden.

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Appendix 1 Test of a unit root performed on OLS residuals in electricity demand.

ADF Test Statistic	-4.397867	1% Critical Value*	-2.6453
		5% Critical Value	-1.9530
		10% Critical Value	-1.6218

Critical value for Augmented Dickey-Fuller co-integration test with quarterly seasonals for number of regressors m=4, 30 observations and 10% level of significance –4.37. Hence, the null hypothesis of no co-integration cannot be accepted at the 10% significance level.

Appendix 2. Vector Error Correction for the model where real official GDP is explained by "legal" electricity.

ry is real official GDP;

EL_DEC electricity explained by conventional factors ("legal" electricity);

D difference operator.

Included observations: 27 after adjusting endpoints
Standard errors and t-statistics are in parentheses

Cointegrating Eq:	Coint. Eq.
ry(-1)	1.000000
EL_DEC(-1)	-1.476799
	(0.17631)
	(-8.37614)
C	12.33447
Error Correction:	**D(y)**
CointEq	-0.730649
	(0.12548)
	(-5.82281)
D(ry(-1))	0.562804
	(0.14930)
	(3.76971)
D(ry(-2))	0.551973
	(0.19275)
	(2.86364)

D(EL_DEC(-1))	-1.230495
	(0.28887)
	(-4.25972)
D(EL_DEC(-2))	-0.756850
	(0.25550)
	(-2.96218)
C	-0.154477
	(0.05368)
	(-2.87790)
D1	0.051570
	(0.06054)
	(0.85189)
D2	0.283946
	(0.09797)
	(2.89836)
D3	0.172548
	(0.08159)
	(2.11482)
R-squared	0.868481
Adj. R-squared	0.810028
Sum sq. resids	0.050504
S.E. equation	0.052969
Log likelihood	46.48950
Akaike AIC	47.15616
Schwarz SC	47.58811
Mean dependent	-0.029234
S.D. dependent	0.121529

Appendix 3. Pair-wise Granger causality tests

sh_GDP is the size of unrecorded economy in relation to official GDP;

b_def budget deficit, in per cent to official GDP, positive value means deficit, negative-surplus (UEPLAC, 2000);

inf- inflation;

s_nonst - share of non-state industrial production in overall registered production (UEPLAC, 2000).

Pair-wise Granger Causality Tests

Sample: 1992:1 1999:4
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
INF does not Granger Cause SH_GDP	28	4.40203	0.02406
SH_GDP does not Granger Cause INF		0.52303	0.59960

Can reject only the null hypothesis that inflation does not Granger-cause the size of unrecorded economy relative to official GDP at the 10% significance level.

Co-integrating relationship between inflation and the size of unrecorded economy relative to official GDP lagged once is summarized below in EViews output. An increase in inflation by 10% causes a long-run increase in the size of unrecorded economy relative to official GDP by almost 2%.

Included observations: 28 after adjusting endpoints
Standard errors and t-statistics are in parentheses

sh_gdp(-1)	1.000000
inf(-1)	-0.180244
	(0.05160)
	(-3.49324)
C	-0.336803

The corresponding long run equation is:
sh_gdp=0.18*inf+0.33
(0.05)

Pair-wise Granger Causality Tests

Sample: 1992:1 1999:4
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
sh_gdp does not Granger Cause b_def	28	5.03070	0.01541
b_def does not Granger Cause sh_gdp		1.80233	0.18744

Cannot reject only the null hypothesis that the size of unrecorded economy relative to official GDP does not Granger cause budget deficit at the 10% level of significance.

Co-integrating relationship between budget deficit and the size of unrecorded economy relative to official GDP lagged once is presented below. An increase in the size of unrecorded economy relative to official GDP by 10% causes an increase in budget deficit by almost 5%.

Included observations: 28 after adjusting endpoints
Standard errors and t-statistics are in parentheses

b_def(-1)	1.000000
sh_gdp(-1)	-0.493041
	(0.08350)
	(-5.90458)
C	0.130637

The corresponding long run equation is:
b_def=0.49*sh_gdp+0.13
(0.08)

Pair-wise Granger Causality Tests

Sample: 1992:1 1999:4
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
Sh_gdp does not Granger Cause s_nonst	27	1.69889	0.20601
s_nonst does not Granger Cause sh_gdp		5.37711	0.01255

Can reject only the null hypothesis that the share of non-state industrial output does not Granger cause the size of unrecorded economy relative to official GDP at the 10% significance level.

EViews output of co-integrating relationship between the size of unrecorded economy relative to official GDP and share of non-state industrial output lagged once is presented below. Effect of an increase of the share of non-state industrial output on the size of unrecorded economy relative to official GDP is negative but almost negligible.

Included observations: 27 after adjusting endpoints
Standard errors and t-statistics are in parentheses

sh_gdp(-1)	1.000000
s_nonst(-1)	0.003092
	(0.00107)
	(2.88295)
C	-0.414245
	(0.09325)
	(-4.44244)

The corresponding long run equation is:

sh_gdp=-0.003*s_nonst+0.41
(0.0001) (0.09)