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The Shadow Economy Analysis  
in the Czech Republic

*Bachelor thesis*

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## **Anotace (abstrakt)**

Tato bakalářská práce se skládá ze dvou hlavních částí. První se zabývá prezentací teoretických poznatků týkajících se jevu zvaný šedá ekonomika. Tato část popisuje definice, příčiny, důsledky a metody odhadování stínové ekonomiky. V druhé části prezentujeme výsledky odhadů velikosti šedé ekonomiky v České republice v letech 1990-2009 použitím Kaufmann - Kaliberda modelu a metody měření poptávky po oběživu. Také zde analyzujeme získaný vývoj velikosti šedé i celkové ekonomické činnosti.

Podle výsledků získaných metodou měření poptávky po oběživu velikost neoficiální ekonomiky poklesla z 18.4% na 14.2 - 15.7% HDP v letech 1994-2009, ale ve stálých cenách její velikost stagnovala. Tedy vývoj celkové a oficiální ekonomické činnosti se výrazně neliší. Výsledky Kaufmann - Kaliberda metody se ukázaly jako nepravděpodobné, což je způsobeno sestavením tohoto modelu.

## **Klíčová slova**

Šedá ekonomika, metoda měření poptávky po oběživu, Kaufmann - Kaliberda model, Česká republika

## **Abstract**

The paper contains of two main parts. First one is focused on presenting a theoretical background considering the shadow economy. It provides definitions, causes, consequences and methods to estimate the informal economy. In second part we present estimates of the size of the shadow economy in the Czech Republic from 1990 to 2009 using Kaufmann - Kaliberda and currency demand approach. We also analyze the obtained development of the shadow and overall economic activity.

According to currency demand method results the size of the informal economy decreased from 18.4% to 14.2 - 15.7% of official GDP over the period 1994 to 2009, but it stagnates in constant prices. Hence, the development of overall and official economic activity does not differ significantly. Kaufmann - Kaliberda method results turned out to be implausible because of the construction of this model.

## **Keywords**

Shadow economy, currency demand model, Kaufmann - Kaliberda model, the Czech Republic

## **Declaration of Authorship**

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# Teze Bakalářské práce

**Termín odevzdání:** květen 2011  
**Student:** Petr Filipec  
**Konzultant:** Petr Janský M.Sc.

**Název práce:** Analýza rozsahu šedé ekonomiky v ČR

## Charakteristika tématu:

Šedá ekonomika je nedílnou součástí ekonomiky jakéhokoliv státu, která v žádném případě není zanedbatelná. Obecně se dá říci, že státy, které více ovlivňují vlastní hospodářství, především v podobě regulací a vysokého zdanění, mají největší rozsah šedé ekonomiky. Podle odhadů se Česká republika nachází zhruba na 20-25% HDP, čímž se řadí přibližně do evropského průměru. Názory na dopad stínové ekonomiky se různí. Nelze ji označit pouze za negativní součást hospodářství státu, ale je potřeba proti jejímu vzrůstu podnikat kroky, které by ji udržely v optimální velikosti. Tato práce si klade za cíl podrobně analyzovat rozsah šedé ekonomiky v rámci České republiky a zachytit jeho vývoj v letech 1993-2011.

## Současný stav poznání:

Zásadní, avšak ne jednoznačně zodpověditelná, je otázka: Co ve skutečnosti je šedá ekonomika resp. co všechno lze do tohoto sektoru zařadit. Odpovědi můžeme v odborné literatuře najít hned několik, jedna z nich například tvrdí, že se jedná o aktivity splňující tato kritéria: vyhýbání se daňovým poplatkům, ignorování



měnových požadavků (např. ignorace lokálního platidla jako jediné legální měny), obcházení regulací, neprůkaznost ve statistikách, ilegalita [2]. Jiná tvrdí, že to jsou neregistrované ekonomické aktivity, kterou jsou započítány do oficiální velikosti hrubého národního produktu [3]. Každé z těchto definic nechává nezodpovězené otázky, ale intuitivně si i laik dokáže pod tímto termínem představit dostatečně vymezenou část ekonomiky státu. Existují 3 základní důvody, proč bychom měli držet sektor šedé ekonomiky na co nejnižší úrovni. Pokud je jeho vysoká míra způsobena vysokým zdaněním, pak další zvýšení daňového zatížení vede k násobnému odlivu ekonomiky do šedé zóny, což se projeví především v rozpočtovém deficitu. Dále rozhodování státu je závislé na indikátorech oficiální ekonomiky, pokud je rozsah stínového sektoru příliš velký, rozhodování se stane značně neefektivním. A konečně šedá ekonomika odvádí pracovní sílu z oficiálního sektoru a vytváří tak další konkurenci registrovaným firmám [1].

### **Metody zpracování tématu:**

Zaměřím se na analýzu pomocí makroekonomických modelů nejčastěji používaných pro měření úhrnu šedé ekonomiky, tedy metoda využívající poptávku po oběživu a metoda sledující spotřebu elektřiny. Dále aplikuji komplexnější model "multiple-indicator multiple-causes", který by měl poskytnout přesnější výsledek a umožní nám určité srovnání s výsledky výše zmíněných, jednodušších modelů. V další části provedu srovnání odhadů z dřívějších analýz s mnou získaným výstupem. V závěrečné části testování se zaměřím na makroekonomická data (inflace, růst, nezaměstnanost, ...) a porovnáám jejich vývoj se získaným rozsahem šedé ekonomiky. Všechny postupy budou aplikovány na data poskytnuté českým statistickým úřadem.

**Osnova:**

1. Úvod
2. Charakterizace šedé ekonomiky
3. Metody měření
4. Analýza velikosti šedé ekonomiky v ČR
5. Závěr

**Reference:**

- [1] Schneider F, Enste DH. (2000): *Shadow economies: Size, causes, and consequences.*, Journal of economic literature. 77-114.
- [2] Eilat Y, Zinnes C. (2002): The evolution of the shadow economy in transition countries: consequences for economic growth and donor assistance. World Development.
- [3] Schneider F. (2004): The Size of the Shadow Economies of 145 Countries all over the World: First Results over the Period 1999 to 2003. IZA DP. 1431
- [4] Schneider F. (2000): The increase of the size of the shadow economy of 18 OECD countries: some preliminary explanations. CESifo.
- [5] Dell'Anno R, Gómez-Antonio M, Pardo A. (2007): The shadow economy in three Mediterranean countries: France, Spain and Greece. A MIMIC approach. Empirical Economics. 33(1):51-84.

V Praze dne .....

Podpis konzultanta

Podpis studenta

# Contents

<b>List of tables and figures</b>	<b>3</b>
<b>Introduction</b>	<b>4</b>
<b>1 Definition of the shadow economy</b>	<b>6</b>
1.1 The structure of the national economy . . . . .	6
1.2 Verbal definition . . . . .	7
<b>2 The main causes of the shadow economy</b>	<b>9</b>
2.1 Tax and social security contribution burdens . . . . .	9
2.2 Intensity of regulations . . . . .	10
2.3 Public sector services . . . . .	11
2.4 Official economy . . . . .	11
2.5 Social transfers . . . . .	12
<b>3 Consequences of the shadow economy</b>	<b>12</b>
3.1 Negative influence of the shadow economy . . . . .	12
3.2 Positive influence of the shadow economy . . . . .	13
3.3 Indicators of the shadow economy . . . . .	14
3.3.1 Monetary indicators . . . . .	14
3.3.2 Labour market . . . . .	14
3.3.3 State of the official economy . . . . .	15
<b>4 The size of the shadow economy</b>	<b>15</b>
4.1 Developing countries . . . . .	15
4.2 Transition countries . . . . .	16
4.3 Highly developed OECD countries . . . . .	17
4.4 The Czech Republic . . . . .	17

<b>5</b>	<b>Methods to estimate the shadow economy</b>	<b>19</b>
5.1	The physical input (electricity consumption) method . . . . .	19
5.1.1	The Kaufmann - Kaliberda method . . . . .	19
5.1.2	The Lackó method . . . . .	22
5.2	The currency demand approach . . . . .	25
5.3	The MIMIC approach . . . . .	28
<b>6</b>	<b>New estimates for the Czech Republic</b>	<b>32</b>
6.1	Kaufmann - Kaliberda method results . . . . .	32
6.2	Currency demand method results . . . . .	34
6.3	Analysis of the estimated development of the shadow and overall economy in the Czech Republic . . . . .	39
<b>7</b>	<b>Comparison of previous and new estimates</b>	<b>43</b>
	<b>Conclusion</b>	<b>45</b>
	<b>References</b>	<b>47</b>

## List of Tables

1	A taxonomy of shadow economy activities . . . . .	8
2	The size of the shadow economy around the world . . . . .	17
3	A survey of previous estimates for the Czech Republic (%GDP) . . .	18
4	Estimates obtained using Kaufmann - Kaliberda approach . . . . .	33
5	Econometric results for currency demand approach (OLS) . . . . .	35
6	Variance inflation factors of Model 1 and Model 2 . . . . .	35
7	Shadow economy estimates obtained using currency demand method .	38
8	A survey of previous and new estimates for the Czech Republic (%GDP)	43

## List of Figures

1	The structure of the national economy . . . . .	6
2	Time series plot of previous estimates for the Czech Republic . . . . .	18
3	General structure of the MIMIC model . . . . .	30
4	Development of the shadow, official and overall economy (KK approach)	32
5	Development of the shadow economy (CD approach) . . . . .	38
6	Time series plots of variables used in currency demand method . . . .	40
7	Development of the official, shadow and overall economy (CD approach)	42
8	Growth of the official, shadow and overall economy (CD approach) . .	42

# Introduction

The topic of the shadow economy is a fascinating area of research, because it is simply “surrounded by mystery”. Unofficial economy activities are a fact of everyday life, probably every one of us sometimes contribute to the shadow economy. But when it comes to measuring and examining this phenomenon, it is a very challenging (almost impossible) task. The reason for the intangibility of the informal economy can be found in its character. Basically all individuals that participate in shadow activities naturally do not want to be exposed by authorities. And since institutions do not have information about these activities, neither do economists.

The elusiveness of the unofficial sector is reflected in the field of methods, which try to capture the size and development of the shadow economy. Over time scientists invented several models for this purpose, but all of them have serious disadvantages, which basically make impossible to estimate the informal economy precisely. In spite of the problematic character of the shadow economy, many scientists had been attracted to this area of research and consequently quite a large literature on this topic was written. On the contrary, I think that the inscrutability of this phenomenon actually might be the reason of scientific concern. It is also one of the main reasons, why this topic attracted me.

Despite the considerable size of the shadow economy, it seems that motivation of governments to deal with this phenomenon is quite low. Solving this problem would probably bring significant additional resources and make policy decisions much more effective. But when countries try to reduce the share of shadow activities, it is usually through shortsighted measures such as punishment or prosecution instead of complex reforms of the tax and regulation systems.

The target of this paper is to shed more light on questions concerning the shadow economy and to analyze its situation in the Czech Republic. I will try to estimate the size and development of the informal sector over the period 1990 to 2009. The first section is focused on the definition of shadow economy activities, which regrettably is not unified. The goal of next two sections is to describe main causes, consequences and indicators of the unofficial sector, that can be used for under-

standing and estimating the size of this phenomenon. Section 4 provides a survey of estimated shadow economies around the world classified according to types of countries (developing, transition and developed) with the subsection concerning only the Czech Republic. Next section describes in detail the most utilized approaches to estimate the size of the unofficial economy, its procedures and disadvantages. Finally the last two sections calculate and interpret own estimates of the size of the unofficial economy and shows its development in the Czech Republic. Data used for the estimation are presented in section 6 with its sources. Hence, this paper should answer at least the following questions:

- (i) What kind of economic activities are related to the unofficial sector?
- (ii) What are the main causes and consequences of participating in the shadow economy?
- (iii) How can be this part of national economy measured?
- (iv) What is the approximate development and size of the informal economy in the Czech Republic?

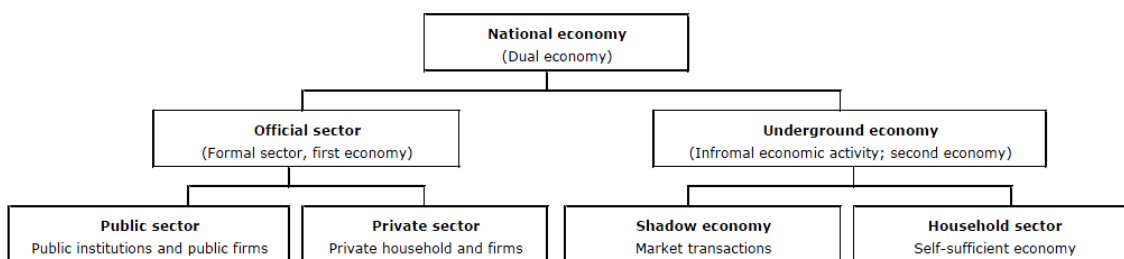
The short version of answers to these key questions and all important results of the analysis are also described in conclusion.

# 1 Definition of the shadow economy

## 1.1 The structure of the national economy

At first, we must show the division of the national economy and locate the informal sector. Schneider and Enste (2002) provide Figure 1, which gives us the basic idea.

**Figure 1:** The structure of the national economy



Source: Schneider and Enste (2002)

The official (formal) sector is the part of the economy, which is influenced by government (i.e. it is regulated, taxed, registered in statistics etc). This sector is further divided to public and private and most of these activities are counted towards the official GDP. On the other hand, the underground economy consists of informal economic activities (i.e. activities that are not registered in government institutions), thus this sector is not included in the official GDP. The reasons are formulated by Schneider and Enste (2002):

- (i) “According to international customs, one refrains from registering the activities in the context of the GNP (self-sufficiency economy),
- (ii) the transactions cannot be recorded in the national account statistics at all, or only partly, due to practical problems and insufficient methods, or
- (iii) the added value is not revealed, hence it cannot be recorded (shadow economy).”

Self-sufficient activities relate to non-market transactions, usually voluntary work, neighborhood assistance etc. In contrast, the shadow economy is based on



value added activities, hence it avoid official statistics on purpose. These market transactions are hidden to avoid regulations, paying taxes, social security contributions etc.

## 1.2 Verbal definition

Unfortunately the definition of the shadow economy is ambiguous, which also relates to various names of this sector such as informal, unofficial, irregular, hidden, invisible or black economy (in this paper we call it shadow, informal, unofficial economy or sector). Different papers explain this phenomenon in various ways. I picked a few examples that I found the most suitable:

- (i) According to Frey et al. (1982) the shadow economy constitutes “the part of economic activity which contributes to value added and which should be included in national income according to national accounting conventions, but which is presently not registered by the societal measurement agencies”.
- (ii) Frey and Schneider (2000) formulated a simple definition that the informal economy “comprises all presently not recorded productive (i.e. value-adding) activities which should be in the national product (GNP)”.
- (iii) Smith (1994) defines it as “market-based production of goods and services, whether legal or illegal, that escapes detection in the official estimates of GDP”.

These definitions still leave open several questions and do not precisely distribute all economic activities among official and informal ones. But, in addition to the structure of the national economy mentioned above, they should provide quite specific picture of the informal sector. The heterogeneity in defining the shadow economy is also caused by different character of this sector in developing (often centrally planned economies), developed and transition countries.

To make this picture even sharper, we should name all activities that contributes to the underground economy. Eilat and Zinnes (2002) mention the following activities:

- (i) Tax evasion (also social security contribution and other specific charges),
- (ii) Ignoring currency requirements (e.g., local currency as the only legal tender),
- (iii) Regulation avoidance (e.g., “licensing”),
- (iv) Avoiding statistics reports,
- (v) Illegal transactions (e.g. drug dealing).

Another view on a classification of shadow economy activities is denoted in Table 1. It provides some concrete actions, so it should be helpful for creating a more distinctive idea about the unofficial sector.

**Table 1:** A taxonomy of shadow economy activities

<b>Type of Activity</b>	<b>Monetary Transactions</b>		<b>Non-Monetary Transactions</b>	
Illegal Activities	Trade in stolen goods; drug dealing and manufacturing; prostitution; gambling; smuggling and fraud		Barter: drugs, stolen goods, smuggling etc. Produce or growing drugs for own use. Theft for own use.	
	<b>Tax Evasion</b>	<b>Tax Avoidance</b>	<b>Tax Evasion</b>	<b>Tax Avoidance</b>
Legal Activities	Unreported income from self-employment; Wages, salaries and assets from unreported work related to legal services and goods	Employee discounts, fringe benefits	Barter of legal services and goods	All do-it-yourself work and neighbor help

Source: Schneider and Enste (2000)

Table 1 clears up that the shadow economy includes illegal and legal activities, in form of monetary (usually cash trade) and non-monetary (barter, no cash involved) transactions. Legal activities are further divided to tax avoidance, which is completely legal, and tax evasion, when legal activities become illegal.

## 2 The main causes of the shadow economy

In general, any government intervention into market structure (taxes, fees, regulations etc.) can be considered as the primary cause of the informal economy. These interventions affect decisions of certain group of people (e.g. not to commit some of their taxable income, increase in “cash on hand” transactions etc). The concrete factors that directly or indirectly contribute to increase in the size of the shadow economy are various, but according to Schneider and Enste (2000) the most important ones are following:

- (i) “The rise of the burden of taxes and social security contributions combined with the increase in the density and intensity of regulations in the official economy, especially on labor markets,
- (ii) The (forced) reduction of weekly working time, the earlier retirement and the increasing unemployment rate,
- (iii) The long-term decline of civic virtue and loyalty towards public institutions combined with a declining tax morale.”

These are still very general items, which relate to many activities. More specific information about the shadow economy determinants is given by following classification, which is based on Schneider et al. (2010b) and Schneider and Enste (2000).

### 2.1 Tax and social security contribution burdens

In almost all papers the tax and social security contribution burdens are considered as the main causes of the increase of the shadow economy. This burden affect the distribution of time between labor and leisure and it also enhance labor supply in the informal economy. Growing deductions from wages in form of taxes and social security contributions increase the difference between labor costs and net salaries in the official economy. They also enhances incentives to work in the shadow economy, where this difference equals zero.

It is not easy to define the measurement of the taxation, because of the different systems among countries. Therefore, we must utilize some proxy variables in order to express the size of the tax burden in a given country. In a previous research, empirical analyses show that the following variables (related to taxes) have a strong influence on the size of the shadow economy:<sup>1</sup>

- (i) Total direct tax burden (including social security contributions),
- (ii) Total indirect tax burden,
- (i) Tax system complexity.

The estimated coefficients attribute the most significant influence to the burden of direct taxation, followed by the complexity of the tax system. As concrete causal variables, we can use these proxies: direct and indirect taxes as a share of total tax revenues; or government expenditures as percentage of GDP.

## 2.2 Intensity of regulations

Government regulations are included in the group of factors, which generate incentives for people to enter the underground sector. These measurements usually increase the social utility, but in exchange for violating the market structure. When we think of e.g. trade barriers, minimum wages, quotas or labor restrictions for foreigners, we realize that all these regulations violate the market structure (through the increase of the labor cost). Consequently they produce a gap for expansion of the unofficial economy.

Again empirical evidence confirms this hypothesis, e.g. Johnson, Kaufmann and Shleifer (1997) find out, that countries with more general regulation usually confront a bigger size of the shadow economy (as a share of GDP).

Measuring the intensity of government regulations (number of people working in the unofficial economy, due to restrictions affecting business and labor market) is

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<sup>1</sup>See e.g. Allingham and Sandmo (1972); Schneider (1986); Neck et al. (1989); Schneider and Neck (1992); Loayza (1997)

a challenging task. We can use few indexes such as Heritage Foundation's business or economic freedom and World Bank's regulatory quality index.

### **2.3 Public sector services**

The bigger share of the shadow economy on the overall economy, the lower are state revenues, which in consequence reduce the quality of public goods (e.g. infrastructure) and services. It can alternatively lead to an increase in tax burden or to combination of both, i.e. high tax rates and low quality or insufficient quantity of public goods and services. And again it leads to stronger incentives to participate in the informal economy.

Capturing the quality of public sector services is a difficult task, but we can use the World Bank's Government effectiveness indicator. It measures the quality of public and civil services and the degree of the independence from politics. It also captures the quality of policy formulation and reliability of government in this matter.

### **2.4 Official economy**

The condition of the official economy is crucial for deciding whether to work in the underground sector or not. In a healthy, prospering economy, where people have opportunities to get a high quality job with decent salary, the motivation to participate in the shadow economy is quite low. In contrast, in an economy going through recession, facing a rise of unemployment, high inflation etc., is much more likely that people want to compensate losses through additional unofficial activities. In order to express the situation of the official economy we can use variables such as unemployment rate; inflation rate (GDP deflator); or openness (international trade as percentage of GDP).

## 2.5 Social transfers

The social welfare system in form of high progressivity in taxation and consequential redistribution leads to strong disincentives to work in the official economy. Especially individuals with high payments are significantly motivated to participate in the informal economy, because of much higher income. They also can receive social transfers, while working in the shadow economy. We can measure this cause through few variables such as the size of marginal tax rates.

## 3 Consequences of the shadow economy

We cannot easily mark the whole unofficial sector as a negative phenomenon (from economical sight). It is assumed that some of shadow economy activities have a positive influence on social welfare. But usually the economy is better off if an individual participate in the official economy rather than in the informal sector. However, it is much less obvious whether is better to completely skip a given activity or do it in the shadow economy. Since there are various types of these activities, it is hard to generalize the influence, but it is probable, that only illegal activities have a bad impact in total.

### 3.1 Negative influence of the shadow economy

Eilat and Zinnes (2002) introduce several negative impacts of existence of the shadow economy. They can be classified whether they are related to macroeconomic, microeconomic or social problems.

One of the main macroeconomic problems is a reduction in tax revenues. If we assume that higher tax rates reduce the official economy and enhance the shadow sector, the overall tax revenues will eventually start to fall. This losses in revenues force governments to additional increase of tax rates and so this “vicious spiral” can lead to a collapse of whole system. Anyhow, the lack of revenues is a serious cause of problems in financing all government activities such as wages, public services and goods, pensions etc.

Another negative impact is a distortion of official statistics, which provide an inaccurate information about the current situation and lead to bad macro-policy decisions. For example an increase in unemployment rate can be caused either by a decrease in overall employment or by movement of employees from official to unofficial sector.

The previous problem is connected with an inability of government to establish the macroeconomic stability (due to ineffectiveness of macro policy). For example monetary and fiscal policies are weakened because shadow economy companies avoid taxes and are less connected to banking system and financial markets.

A significant microeconomic bad impact of the shadow economy is inefficiency in resource allocation. As an example, one can think of any shadow company that has an unfair advantage in labour market, because of zero taxes and regulations and it can clearly offer higher wages. Similarly, an advantage in goods (or services) market is due to lower costs (no taxes for purchaser). On the other side, this company would not be registered and so it would seem very unreliable. Hence, the investments would be most likely distracted from such firm. This means that shadow economy companies are either small firms (without the need of high investments) or large firms (which are registered, but misreport output).

Another microeconomic problem related to shadow economy is that the costs of running a given company are increased by dealing with avoiding official regulations, taxes, licensing etc.

Finally, the social consequence of the informal economy is a disintegration of social norms. Disrespect of official institutions, norms and law supported by corruption can lead to a significant deficit of legitimacy of the current social order. However, it is questionable whether this “bad moral” is a consequence or cause of the shadow economy.

### **3.2 Positive influence of the shadow economy**

Eilat and Zinnes (2002) recognize some positive effects of the shadow economy. There are a significant influence on employment especially during recession or in the

early stages of transformation. It is assumed that during these periods a majority of people working in the unofficial sector could not get a job in the official economy.

Also, a major part of the money earned in the shadow economy is actually spent in the official sector. Thus, a significant part (approximately 66 percent according to Schneider (2002a)) of lost tax revenues is returned through consumption.

Finally, neoclassics look at the shadow economy as a respond to the economic environment's demand for small services and manufacturing. If we accept this hypothesis, it would mean that informal economy provides an entrepreneurial spirit and more competition, which lead to higher efficiency of the official sector. Also, the possibility of selection between formal and informal economy can contribute to a higher potential for economic growth.

### **3.3 Indicators of the shadow economy**

In order to capture changes in the size of the shadow economy, we should think of indicators, that can provide this information. Schneider et al. (2010b) come up with the following proxies, some of them correspond to consequences mentioned above:

#### **3.3.1 Monetary indicators**

It is assumed that a major part of transactions in the shadow economy is made in cash. The reason for this is that cash is the only financial instrument, which is untraceable (it is not registered in financial institutions). To capture this effect, we can take monetary aggregates and use few proxies e.g.  $M0/M1$ , where  $M0$  corresponds to the currency outside the banks and  $M1$  to  $M0$  plus deposits; or  $M0/M2$ , where  $M2$  corresponds to  $M1$  plus term and other deposits.

#### **3.3.2 Labour market**

Since the shadow economy is strongly related to labour market, it is obvious that the indicators of its situation should be included in the list of important determinants. A subgroup of people that are strongly involved in underground economy activities



do not try to find a job in official sector and therefore they are excluded from labor force. Corresponding variables can be: labour force participation rate, which is the share of population that is economically active and supplying labour during for a concrete period on population in the working age (usually 15-65 years); or growth rate of total labour force, which is the economically active population supplying labour.

### **3.3.3 State of the official economy**

Shadow economy activities strongly influence the state of the official economy. Some of these effects are quite obvious, e.g. the higher the size of the shadow economy, the lower are tax revenues, thus this leads to lower government expenditures, i.e. to lower GDP. Proxy variables for these effect are the following: GDP per capita base on purchasing power parity; or annual growth rate of GDP per capita.

## **4 The size of the shadow economy**

Talking about the informal economy brings up an obvious question: Actually, how large is the shadow economy? Of course, the answer to this question vary across countries. Schneider (2007) state estimates (obtained using the MIMIC and the currency demand approach) for 145 countries since 1999 to 2005 and classify them according to different categories.

### **4.1 Developing countries**

The results for developing countries are quite various in dependence on the continent (Africa, Asia, Latin America) at which is a particular country located, but there are still significant discrepancies between countries situated at the same continent.

The size of the shadow economy in Africa vary between 28 and 65 percent of official GDP. The average size increased during these years from approximately 41.3% to 42.8%. The median position is held by Mozambique with 43.5%. The highest result gets Zimbabwe with 64.6%, the lowest gets South Africa with 28.2%. The

large amount of shadow economy activities in Africa is given by high backwardness of this region and by low number of opportunities in the official sector.

In Asia, some of the countries are highly developed (Singapore, Israel, Hong Kong), while other are quite underdeveloped (Thailand, Cambodia etc). Thus, the discrepancies in the size of the shadow economy are even higher than in the case of Africa. The lowest share of the informal economy has Singapore with 12.1% and on the contrary, the highest share has Thailand with 53.6%. The median country is Republic of South Korea with 27.6% GDP. The average size of the shadow economy increased from 28.5% to 29.8%. It is obvious that the average size of the informal sector is significantly lower in Asia than the average size in Africa and Latin America. It is caused by the higher number of developed countries in this region, which means that the potential for future growth of shadow economies in Asia is also higher.

The sizes of shadow economies in Latin American countries are similar to sizes in African countries. The average shadow economy was 41.1% in 1999 and over year increased to 42.2% of GDP in 2005. The smallest share of the informal activities has Chile with the size of 19.4% and the largest share hold Bolivia with the size of 67.2% of official GDP. At the median position occurs Brazil with 41.8%. The causes of the high amount of unofficial activities are similar as in African countries. For many citizens the cost of living can be covered only if they work in the shadow economy. Countries in this region struggle with serious problems such as high illiteracy, public debt or inflation, which lead to a lack of opportunities in the official sector.

## **4.2 Transition countries**

The average size of the shadow economy of East and Central European and former Soviet Union countries increased from 38.1% of GDP in 1999 to 38.8% in 2005. The biggest informal sector has Georgia with 66.4% and on the other hand, the lowest shadow economy is the Slovak Republic or in the Czech Republic with 18.2-18.3%. The median country is Bulgaria with 37.3%. As we can see, these results are comparable to figures related to developing countries. The large of the unofficial sector in this region is determined by historical circumstances of the communist era.

### 4.3 Highly developed OECD countries

The shadow economies in developed countries are significantly lower as indicate the following text. The average size of the unofficial economy decreased (unlike the shadow economies of transition and developing countries) from 16.8% in 1999 to 14.8% in 2005. The position of the country with the largest informal economy is held by Greece with 26.3% and the lowest share of the shadow economy has the United States with the size of 7.9% of official GDP. The median country is Ireland with 14.1%.

Table 2 summarize the sizes of the unofficial economy around the world mentioned above.

**Table 2:** The size of the shadow economy around the world

Region	Shadow economy (% GDP)	Average size (% GDP)
Africa	28 - 65	42
Latin America	19 - 67	42
Asia	12 - 53	29
Transition Countries	18 - 66	38
Developed Countries	8 - 26	16

Source: Values were taken from Schneider (2007).

### 4.4 The Czech Republic

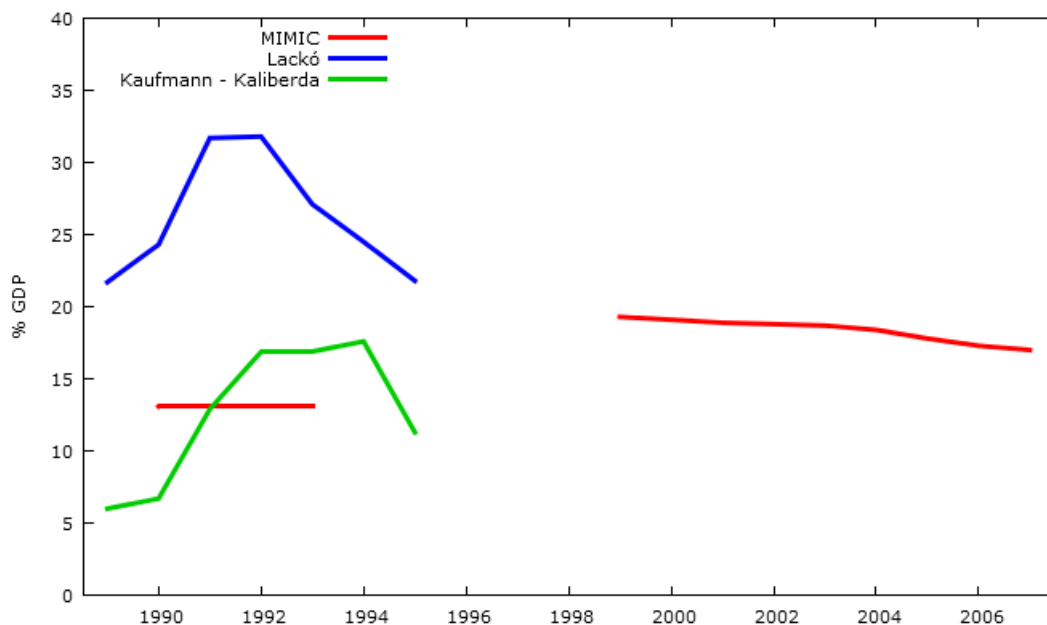
Since this paper's primary target is to estimate the size of the shadow economy for the Czech Republic, it is necessary to make a survey of previous results. I collected estimates over the period 1989 to 2007, with missing values in 1996-1998. I also could not find any result obtained using currency demand approach. The most frequently used method is the MIMIC model, the physical input approach was applied only during late 90s. Table 3 and Figure 2 shows collected results and the development of the size of the informal economy.

**Table 3:** A survey of previous estimates for the Czech Republic (%GDP)

Year	MIMIC	Lackó	Kaufmann - Kaliberda
1989		21.7	6.0
1990	13.1*	24.3	6.7
1991	13.1*	31.7	12.9
1992	13.1*	31.8	16.9
1993	13.1*	27.1	16.9
1994		24.5	17.6
1995		21.8	11.3
1996			
1997			
1998			
1999	19.3		
2000	19.1		
2001	18.9		
2002	18.8		
2003	18.7		
2004	18.4		
2005	17.8		
2006	17.3		
2007	17.0		

Source: Data were collected from Schneider et al. (2010b), Lackó (2000), Johnson et al. (1997) and Schneider (2002b); \*Average 1990-1993 = 13.1% GDP.

**Figure 2:** Time series plot of previous estimates for the Czech Republic



Source: Data were collected from Schneider et al. (2010b), Lackó (2000), Johnson et al. (1997) and Schneider (2002b).

As we can see the results vary among different estimation methods. The average of the Kaufmann - Kaliberda approach is 12.6% of official GDP over the given period, the average of the Lackó method is 26.1%, so even between methods, which are based on the same idea, are quite significant differences. Changes in development of the shadow economy are similar, but the absolute size differs very strongly. The average result of the MIMIC model is 17.1%. The chart denotes that there was a serious increase in shadow economy activities after transformation. Approximately four years after the fall of communist government the size of the informal economy started to decrease. In the period from 1999 to 2007 the unofficial economy share were, according to MIMIC results, quite stable, slightly decreasing. With approximately 17% of official GDP the Czech Republic rank with the average of highly developed OECD countries.

## **5 Methods to estimate the shadow economy**

To measure the size and development of the unofficial economy we can basically choose between direct and indirect approaches. The direct ones are micro models, which use data from either voluntary replies or tax auditing. These methods are accompanied with several complications starting with the difficult data collection or its inaccuracy (people usually do not want to report shadow activities) etc. Thus we will focus on indirect approaches, which are based on the macroeconomic data analysis. The following text provides a detailed description about the physical input (Kaufmann - Kaliberda and Lackó model), currency demand and MIMIC method, which are the most frequently applied ones.

### **5.1 The physical input (electricity consumption) method**

#### **5.1.1 The Kaufmann - Kaliberda method**

A simple macroeconomic approach that was used by Del Boca and Forte (1982), Pozo (1996), Kaufmann and Kaliberda (1996) and Johnson et al. (1997). Kaufmann and Kaliberda (1996) assume that the electricity consumption is the single best

indicator of overall economic activity and they also assume that an electricity/overall GDP elasticity is very close to one. In other words consumption of electric power provides a proxy measurement of the overall economic activity and GDP provides a measurement of the official economic activity, thus the difference between those two variables gives us an estimate of the size of unofficial economic activity.

However we must consider possible biases in utilizing consumption of electric power as a proxy for overall economic activity. According to Kaufmann and Kaliberda (1996) there are basically three main factors that could cause an upward bias:

- (i) higher electric power consumption per unit of output due to capacity under-utilization during recession;
- (ii) technological issues caused by insufficient maintenance; and
- (iii) substitution with other energy sources (e.g. gas, coal);

and four other factors that could cause a downward bias:

- (i) more effective electricity utilization (very low efficiency after transformation and consequently implementing energy-saving measures);
- (ii) price rise of electric power consumption;
- (iii) a change of industry structure at a given country (from high to low electricity utilizing); and
- (iv) underreporting of electric power usage.

Using approximation we can assume that the upward-biasing factors are roughly canceled by the downward-biasing factors, so we will maintain the unitary elasticity assumption. Nevertheless, the price efficiency in energy industry differs among countries, hence we should distribute them into different categories. Again Kaufmann and Kaliberda (1996) created a classification of output elasticity of electricity consumption:

- (i) “the energy-efficient economies, which comprise the Central and Eastern European countries where energy price adjustments have been more significant and started earlier - assumed output elasticity of electricity consumption of 0.9 (in the upswing);
- (ii) the energy neutral economies, comprising the Baltics, where price adjustment has taken place but started later - assumed unitary elasticity of electricity consumption; and
- (iii) the energy inefficient economies, comprising the rest of the former Soviet Union states, with relatively little (or delayed) price adjustment - assumed output elasticity of electricity consumption of 1.15.”

Since we consider GDP as an estimate of the size of official economic activities, we should also think about its measurement biases. There is a possibility that the official GDP does not reflect all new products produced in the official economy, but it also probably captures some unofficial activities, thus we can assume that these measurement biases are not significant.

The size of the unofficial economy is derived as a difference between estimates for overall and official economic activities. We must collect data for electricity consumption and GDP for required years and express them as a percentage of base year (usually the first one). Thus in addition, we need to establish a baseline of the size of the unofficial economy, thus we use a previous empirical estimate for the base year (assumed from another research). Formulas for calculating the share of shadow economy activities are following:

$$UEI_t = OvEI_t - OfEI_t = OvEI_{t-1} + \frac{EC_t - EC_{t-1}}{EC_t \cdot e_{OvE}^{EC}} \cdot OvEI_{t-1} - OfEI_t \quad (1)$$

$$UES_t = \frac{UEI_t}{OfEI_t} \quad (2)$$

where

- $UEI_t$  is an unofficial economy index in year  $t$ ;

- $OverEI_t$  is an overall economy index in year  $t$ , i.e. electric power consumption in year  $t$  as a percentage of electricity consumption in the base year;
- $EC_t$  is electricity consumption in year  $t$ ;
- $e_{OverE}^{EC}$  is an electricity consumption/overall economic activity elasticity;
- $OfEI_t$  is an official economy index in year  $t$ , i.e. GDP in year  $t$  as a percentage of GDP in the base year; and
- $UES_t$  is the size of the unofficial economy as a percentage of GDP.

The critique of this method was formulated by Schneider and Enste (2000):

- (i) Only a part of the informal economy is captured by this method, because not all unofficial economy activities require a certain amount of electric power and also alternative energy sources can be utilized.
- (ii) The model does not consider a technological progress over time, thus it could lead to a significant downward bias.
- (iii) More efficient production and utilization of electricity and decreasing differences among countries probably cause changes in the electricity consumption/GDP elasticity.
- (iv) One more disadvantage is that we need a previous estimate of the size of the shadow economy and our new results are significantly dependent on its value.

### 5.1.2 The Lackó method

Another approach using electricity consumption data for estimating the size of the shadow economy invented Lackó (1996, 1998 and 2000). She assumes that the hidden economy is present in all sectors of the economy, including the households, in addition, a large proportion of non-registered economic agents work in households or earn revenues directly for them. Lackó supposes that if this section of underground economy is high, the rest of the shadow economy will also be high.



The method is described by the following equations (Lackó (2000)):

$$\ln ER_{ij} = \alpha_1 \ln C_{ij} + \alpha_2 AG_{ij} + \alpha_3 G_{ij} + \alpha_4 Q_{ij} + \alpha_5 PR_{ij} + \alpha_6 H_{ij} + u_{ij} \quad (3)$$

$$\alpha_1 \geq 0, \alpha_2 \leq 0, \alpha_3 \leq 0, \alpha_4 \leq 0, \alpha_5 \leq 0, \alpha_6 \geq 0$$

$$H_{ij} = \beta_1 TL_{ij} + \beta_2 TC_{ij} + \beta_3 D_{ij} + \beta_4 I_{ij} + \beta_5 EX_{ij} \quad (4)$$

$$\beta_1 \geq 0, \beta_2 \geq 0, \beta_3 \geq 0, \beta_4 \geq 0, \beta_5 \geq 0$$

where

- $i$  is the number assigned to the country,
- $j$  is the number assigned to the year,
- $ER_{ij}$  is per capita household electricity consumption,
- $C_{ij}$  is per capita real consumption of households (at purchasing power parity),
- $AG_{ij}$  is the share of GDP produced in agriculture in total official GDP,
- $G_{ij}$  is index for weather-differences - the relative frequency of months with the need for heating in houses (under 10°C) multiplied by the average temperature in January,
- $Q_{ij}$  is the ratio of energy sources other than electric energy to all energy sources in household energy consumption;
- $PR_{ij}$  is real price of consumption of 1 kWh residential electricity in US dollars (at exchange rate),
- $H_{ij}$  is per capita output of the hidden economy,
- $TL_{ij}$  is tax rate on labour income,
- $TC_{ij}$  is tax rate on capital income,

- $D_{ij}$  is output decline (or growth) since 1989:  $D_{ij} = 1 - \frac{GDP_{ij}}{GDP_{1989}}$ ,
- $I_{ij}$  is annual inflation rate of consumer prices,
- $EX_{ij}$  is general government expenditure as a percentage of GDP.

Equation (4) describes factors that determine the hidden economy. The first two independent variables represent the tax burden. According to Lackó (2000) taxes levied on labour income influence employers and employees decisions about how much labour to demand or supply in the official economy. Similarly taxes on corporations have an impact on decisions whether to start up business in the official economy or in the informal sector. The third explanatory variable in equation (4) is growth or decline in aggregate output, the coefficient is related to the reaction of household to the change in output. Lackó (2000) assumes that households respond not only to the annual decline or growth in output, but also to the cumulated changes since 1989. The level of inflation changes the impact of taxes on economic activities. With rising inflation the effective tax burden increases and on the other hand tax burden falls as inflation declines. The fifth explanatory factor is the level of government expenditures. It can increase the size of the hidden economy if a growing role of the government forces out start-ups in the private sector. It can also decrease its size through enforcing the controlling function, i.e. spending more resources to fight against crime and corruption (unlikely in transition and developing countries).

Using an econometric estimation we can evaluate the size of the hidden economy. At first, we substitute (4) into (3):

$$\begin{aligned} \ln ER_{ij} = & \gamma_1 \ln C_{ij} + \gamma_2 AG_{ij} + \gamma_3 G_{ij} + \gamma_4 Q_{ij} + \gamma_5 PR_{ij} + \gamma_6 TL_{ij} + \gamma_7 TC_{ij} + \\ & + \gamma_8 D_{ij} + \gamma_9 I_{ij} + \gamma_{10} EX_{ij} + u_{ij} \end{aligned} \quad (5)$$

And then we can calculate an index that shows how much household electricity is related to the hidden economy in country  $i$  in year  $j$ :

$$h_{ij} = \frac{\gamma_6 TL_{ij} + \gamma_7 TC_{ij} + \gamma_8 D_{ij} + \gamma_9 I_{ij} + \gamma_{10} EX_{ij}}{\ln ER_{ij}} \quad (6)$$

For the calculation of the share of the hidden economy on GDP we must estimate how much GDP is produced by one unit of electricity in the shadow economy. We can take a specific result from some previous estimation produced by another method and then use this proportion for other countries. Lackó (2000) utilized an estimate that in the early 1990s the hidden economy was 10-11% of official GDP in USA. Thus, she worked with 10.5 percent ratio of the shadow economy to the official GDP.

The critique formulated by Schneider and Enste (2000) is following:

- (i) Only a part of the informal economy is captured by this method, because not all unofficial economy activities require a certain amount of electric power and also alternative energy sources can be utilized.
- (ii) Shadow economy activities can also be situated outside household sector.
- (iii) Again a significant disadvantage is the need of the base value.

## 5.2 The currency demand approach

Schneider and Enste (2000) found that this method “was first used by Phillip Cagan (1958), who calculated a correlation of the currency demand and the tax pressure for the United States over the period 1919 to 1955.” Cagan’s approach was improved by Tanzi (1980 and 1983), who added econometric regression and estimated a function of demand for currency over the period 1929 to 1980.

The model is based on assumption that cash is usually used for underground economy transactions, thus an increase in the size of the shadow economy leads to an increase in currency demand. The approach also assumes that cash is the only financial instrument which is untraceable (it is not registered in financial institutions).

The demand for currency is econometrically estimated as a dependent variable on all possible factors (interest rates, income development etc). The basic form of

this function (Tanzi (1983)) is the following:

$$\ln \left( \frac{C}{M_2} \right)_t = \beta_0 + \beta_1 \ln (1 + TW)_t + \beta_2 \ln \left( \frac{WS}{Y} \right)_t + \beta_3 \ln R_t + \beta_4 \ln \left( \frac{Y}{N} \right)_t + u_t \quad (7)$$

$$\beta_1 \geq 0, \beta_2 \geq 0, \beta_3 \leq 0, \beta_4 \geq 0$$

where

- $\ln$  denotes natural logarithms,
- $t$  is the number assigned to the year,
- $\frac{C}{M_2}$  is the ratio of cash holdings to current and deposit accounts,
- $TW$  is a weighted average tax rate (to proxy changes in the size of the shadow economy),
- $\frac{WS}{Y}$  is a proportion of wages and salaries in national income,
- $R$  is the interest paid on savings deposits (to capture the opportunity cost of holding cash),
- $\frac{Y}{N}$  is the per capita income.

According to Schneider (2000) the model should capture all possible conventional factors and other variables such as tax burden and government regulations, which are assumed to be main causes, that encourage people to work in the shadow economy. The increase in demand for currency, which cannot be explained by the conventional methods, is attributed to rising of tax burden or regulations. The difference between the real development of currency and the "natural" development of currency, when we hold the level of taxation and government regulations at the historically lowest values, gives us the size of the shadow economy, i.e. the presumptions of this approach are:

- (i) The velocity for currency used in the official and unofficial economy is the same.

- (ii) There was no shadow economy, when the tax burden and regulations were at the lowest level.

The size of the shadow economy can be calculated using the following formula:

$$SE_t = \frac{RCU_t - LCU_t}{RCU_t} \quad (8)$$

where

- $t$  is a number assigned to the year,
- $SE_t$  is the estimated size of the shadow economy as a percentage of GDP,
- $RCU_t$  is a value of the real currency holdings,
- $LCU_t$  is a value of estimated currency holdings, when we keep the tax burden and regulations at the lowest level in our regression.

The currency demand is one of the most commonly used methods, nevertheless it has been criticized on several grounds (Schneider and Enste (2000)):

- (i) The approach measures only the part of the shadow economy, because not every transaction in the shadow economy is paid cash (e.g. barter). Thus, the estimation is probably downward biased.
- (ii) Studies usually consider only the tax burden as a single cause of the unofficial economy. Since data for other variables such as intensity of regulations or “tax morality” is not available, they cannot be considered in the analysis.
- (iii) Other weakness is the inapplicability for eurozone countries nowadays.
- (iv) Currencies like US dollar, which are used in more countries as an international currency, provide a biased result while estimating using this approach. Its currency demand is not entirely dependent on the demand in home country.

### 5.3 The MIMIC approach

Schneider et al. (2010a) points out that methods mentioned above consider just one indicator (electric power consumption, currency demand), that exclusively reflects changes in the size of the shadow economy. It is obvious, that this assumption is not realistic. The shadow economy influences production, labor and money markets. In addition, the causal variables, that influence the size of the informal economy, are considered only in several papers (applying the currency demand approach) and also usually take into account just the tax burden. The MIMIC approach uses multiple causes, which determine the size of the hidden economy, as well as the multiple indicators, which record changes in the size of the shadow economy.

This approach was firstly used by Weck (1983), Frey and Weck (1983), Frey and Weck-Hanneman (1984). Schneider and Enste (2000) describes this approach as a model that consists of two parts, the measurement model assigns dependencies between the unobserved variables and observed indicators and the structural equation model (SEM) examines the relationship between unobserved variables and observed causal variables by using covariance matrix. In this case the unobserved variable is the shadow economy. According to Schneider et al. (2010a) SEM compares “the covariance matrix of the observed variables, with the parametric structure imposed on it by a hypothesized model. The relationships among the observed variables are expressed by its covariances and it is assumed that they are generated by several unobserved variables.” In the measurement model the unobserved variable ( $\eta$ ) is first linked to the observed indicators ( $Y_p$ ) and then dependencies between unobserved variable ( $\eta$ ) and the observed causes ( $X_q$ ) is recognized using a structural equation model.

Dell’Anno et al. (2007) show that the shadow economy ( $\eta$ ) is linearly determined by observable (considering disturbance  $\zeta$ ) exogenous causes  $x_1, x_2, \dots, x_q$ :

$$\eta = \gamma_1 x_1 + \gamma_2 x_2 + \dots + \gamma_q x_q + \zeta. \quad (9)$$

And the unobserved variable ( $\eta$ ) linearly determines a set of observable en-

ogenous indicators  $y_1, y_2, \dots, y_p$  (considering disturbances  $\varepsilon_1, \varepsilon_2, \dots, \varepsilon_p$ ):

$$y_1 = \lambda_1 \eta + \varepsilon_1, y_2 = \lambda_2 \eta + \varepsilon_2, \dots, y_p = \lambda_p \eta + \varepsilon_p. \quad (10)$$

Marking the vectors:

$$x' = (x_1, x_2, \dots, x_q)$$

$$y' = (y_1, y_2, \dots, y_p)$$

$$\gamma' = (\gamma_1, \gamma_2, \dots, \gamma_q)$$

$$\lambda' = (\lambda_1, \lambda_2, \dots, \lambda_p)$$

$$\varepsilon' = (\varepsilon_1, \varepsilon_2, \dots, \varepsilon_p)$$

We get a shorter formulas for (9) and (10):

$$\eta = \gamma'x + \zeta \quad (11)$$

$$y = \lambda\eta + \varepsilon \quad (12)$$

by assuming  $E(\zeta\varepsilon') = 0'$  and defining  $E(\zeta^2) = \sigma^2$ ,  $E(\varepsilon\varepsilon') = \Theta^2$ ,  $E(\zeta^2) = \psi^2$  and  $E(\zeta\zeta') = \Phi^2$ , where  $\Theta^2$  and  $\Phi^2$  is a diagonal matrix with standard deviations of the  $\varepsilon$  and  $\zeta$  on its diagonal. Equation (11) represents the structural equation model and equation (12) represents the measurement model.

Inserting equation (11) into equation (12) gives us the following model:

$$y = \lambda(\gamma'x + \zeta) + \varepsilon = \Pi'x + \nu, \quad (13)$$

where coefficient matrix and disturbances are:

$$\Pi = \lambda\gamma',$$

$$\nu = \lambda\zeta + \varepsilon.$$

Thus the covariance matrix for  $\nu$  is defined as:

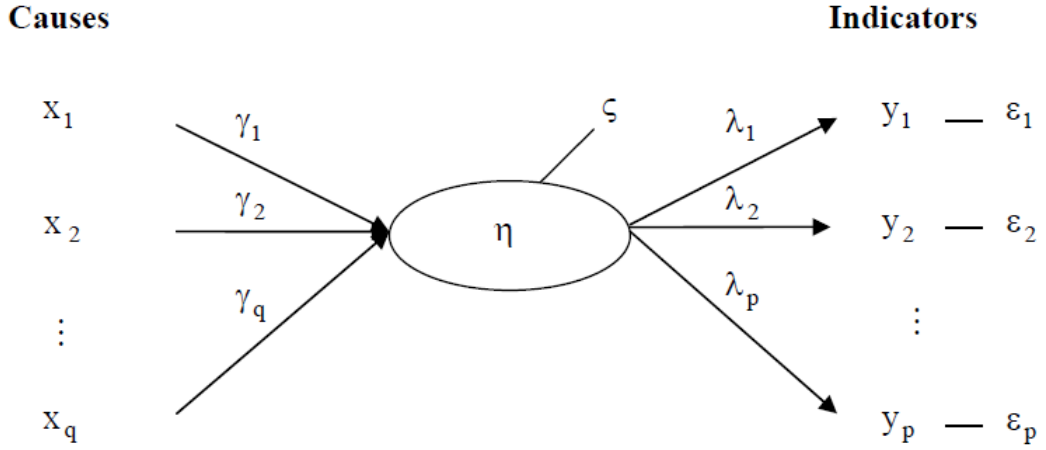
$$\Omega = Cov(\nu) = E(\nu\nu') = \lambda\lambda'\sigma^2 + \Theta^2 \quad (14)$$

From equations (11) and (12) we can derive the covariance matrix  $\Sigma$  of the multiple indicators multiple causes model. It shows dependencies between the observed variables of the model. This covariance matrix is defined as:

$$\Sigma(\hat{\theta}) = \begin{pmatrix} \lambda(\gamma'\Phi^2\gamma + \psi^2) + \Theta^2 & \lambda\gamma'\Phi^2 \\ \Phi^2\gamma\lambda' & \Phi^2 \end{pmatrix}, \quad (15)$$

where  $\Sigma(\hat{\theta})$  is a function of the parameters  $\lambda$ ,  $\gamma$ ,  $\Phi^2$ ,  $\Theta^2$  and  $\psi^2$ . The target of the procedure is to estimate these parameters and covariance matrices in order to get an estimate of the covariance matrix  $\Sigma$  (i.e.  $\hat{\Sigma} = \Sigma(\hat{\theta})$ ). The MIMIC model is denoted in Figure 3 using path diagram.

**Figure 3:** General structure of the MIMIC model



Source: Schneider et al. (2010a)

As soon as we have coefficients from MIMIC model, we can derive the MIMIC index using the provided structural equation (9), which is in this case the relationship between shadow economy (latent variable) and its significant causal variables:

$$\tilde{\eta}_t = \gamma_1 x_{1t} + \gamma_2 x_{2t} + \dots + \gamma_q x_{qt} \quad (16)$$

Second step is converting the above index to an estimate of the size of the shadow economy in year  $t$ . Therefore, we need a base value (a previous trustworthy estimate) in given units (percentage of official GDP in this case). Then, the estimate



of the unofficial economy would be defined as:

$$\hat{\eta}_t = \frac{\tilde{\eta}_t}{\tilde{\eta}_u} \eta_u^* \quad (17)$$

where

- $\tilde{\eta}_t$  and  $\tilde{\eta}_u$  are given by (16),
- $\eta_u^*$  is a taken previous estimate in year  $u$ ,
- $t$  is a year for which we want to calculate the estimate,
- $u$  is a year of the exogenous estimate (base value).

To sum up, there are three steps in estimating the size of the shadow economy using the MIMIC approach. At first, we must confirm the hypothesized relationships between the latent variable (shadow economy) and certain causes and indicators. Through this relationship we can calculate the MIMIC index using model results. This calculations gives us only relative numbers, thus for obtaining the absolute size of the shadow economy, it is necessary to convert the MIMIC index to requested units using a previous estimate.

Even this complex approach is criticized on several grounds (Breusch (2005)):

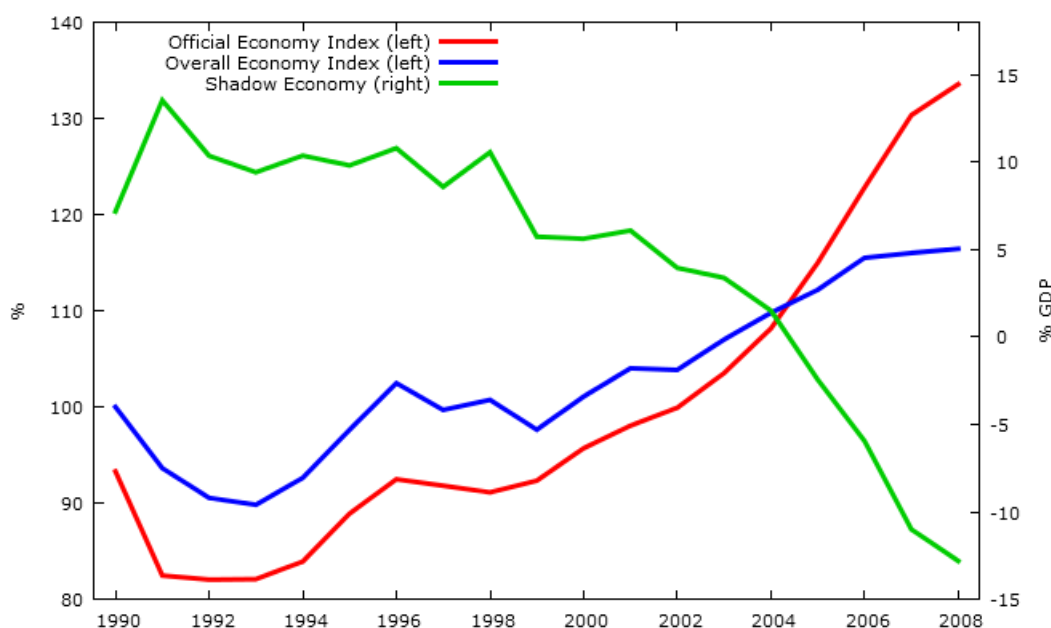
- (i) The results are very unstable depending on the data period or the list of countries included in the analysis.
- (ii) Also the list of causes and indicators are unconvincing for the estimating the size of the shadow economy.
- (iii) The biggest disadvantage of the MIMIC approach is the relative result of the model and the need of further benchmarking and calibration. One can say that the final output is fully dependent on some previous estimate, that may not be accurate at all.

## 6 New estimates for the Czech Republic

### 6.1 Kaufmann - Kaliberda method results

I chose the physical input approach as an initial estimation procedure to measure the size of the shadow economy in the Czech Republic. I worked with World Bank's data, specifically GDP (constant 2000 US\$) and electric power consumption (kWh) over the total period 1990 up to 2008. As we mentioned, when describing this method, we must take a previous estimate of the size of the unofficial economy in order to calculate new estimates. Thus, I assumed that in 1990 the size of the informal sector was 6.7% of the overall economy (this estimate is taken from Johnson et al. (1997), who used the same method). To calculate results I used equations (1) and (2), which were mentioned while describing the procedure of this approach. Table 4 and Figure 4 shows the development of calculated estimates in the given period applying unitary elasticity scenario.

**Figure 4:** Development of the shadow, official and overall economy (KK approach)



The chart denotes that shadow economy activities strongly decreased over the period, in contrast with the overall and official economy, which both increased. As we can see in Table 4, since 2005 we get negative values of the size of the shadow

**Table 4:** Estimates obtained using Kaufmann - Kaliberda approach

<b>Year</b>	<b>Official Economy Index (%)</b>	<b>Overall Economy Index (%)</b>	<b>Unofficial Economy Index (%)</b>	<b>Shadow Economy (%GDP)</b>
1990	93.30	100.00	6.70	7.18
1991	82.47	93.63	11.16	13.54
1992	82.04	90.54	8.50	10.36
1993	82.09	89.83	7.73	9.42
1994	83.91	92.62	8.71	10.37
1995	88.90	97.63	8.72	9.81
1996	92.48	102.47	9.99	10.80
1997	91.81	99.69	7.88	8.59
1998	91.11	100.74	9.63	10.57
1999	92.33	97.63	5.30	5.74
2000	95.70	101.07	5.37	5.62
2001	98.05	104.02	5.97	6.09
2002	99.91	103.86	3.95	3.95
2003	103.51	107.01	3.50	3.38
2004	108.15	109.78	1.63	1.51
2005	114.98	112.18	-2.81	-2.44
2006	122.81	115.51	-7.30	-5.95
2007	130.34	116.00	-14.34	-11.00
2008	133.55	116.44	-17.11	-12.81
Avg	99.34	102.67	3.33	4.46

economy. These results indicate that Kaufmann - Kaliberda approach is absolutely inapplicable these days. Assuming the definition of the informal economy, we know that negative and even very low results are unrealistic, therefore this analysis is completely biased, even if we apply Kaufmann - Kaliberda method using different elasticity scenarios (negative records would not disappear). We could test a sensitivity of this model by inserting various initial values, but still it is evident that because of technological progress, we cannot use this model anymore. The average size of the informal economy is 4.46% of official GDP, the lowest value is -12.81% and the highest value is 13.54%. To understand, why we got very inaccurate values, we must realize when this method was developed. As we mentioned, it was in middle 90s and it was applied especially on transition countries after fall of communist era. In this period the physical input approach could have been quite accurate, because in early years of the expansion of free market and capitalism the electric

power consumption increased rapidly. But approximately since new millennium we do not observe sufficient increase in electricity consumption in comparison to GDP. Thus, the assumption of the single best indicator of overall economic activity seems to be unrealistic.

## 6.2 Currency demand method results

The next approach I chose for measuring the size of the unofficial economy is the monetary method, which estimates the development of the demand for currency. I utilized the data from OECD, World Bank and Heritage Foundation statistics. As a dependent variable I chose monetary aggregate M1 (current LCU) from OECD divided by World Bank's population. As a proxy for the tax burden I used taxes on income, profits, capital gains, payroll, workforce, property, goods and services and social security contributions in current LCU from OECD database divided by GNI in current LCU from World Bank database (positive sign expected). As other independent variables I used immediate interest rates (annual %, OECD, negative sign expected), GDP per capita (current LCU, World Bank, positive sign expected), GDP deflator (annual %, World Bank, positive sign expected), average annual wages (current LCU, OECD, positive sign expected), lagged observation of dependent variable (positive sign expected) and as a proxy of regulation index I utilized Heritage Foundation's economic, business and fiscal freedom (0-100, higher is better, negative sign expected). The data were collected for a period since 1994 to 2009. The econometric method is Ordinary Least Squares estimation of linear regression model and the results are shown in Table 5.

It denotes two possible scenarios of the estimated demand for currency and shows only coefficients for significant variables. Regulation indexes turn out to be insignificant as well as GDP per capita or level of wages. It does not mean that regulations do not influence the size of the shadow economy, but either these indexes are not very well constructed or regulations do not affect the part of the unofficial economy, which is reflected in level of currency holdings. The results concerning tax burden are also quite interesting, maybe little unexpected. As we can see, direct

**Table 5:** Econometric results for currency demand approach (OLS)

<b>Independent variables</b>	<b>Model 1 (1994-2009)</b>		<b>Model 2 (1994-2009)</b>	
Intercept	0.666	(0.48)	1.073	(0.29)
Lagged M1 per capita	0.662	(0.00)***	0.743	(0.00)***
Deposit interest rates	-0.190	(0.01)***	-0.147	(0.01)**
Average annual wages				
GDP deflator	1.156	(0.09)*		
GDP per capita				
Total taxation			6.522	(0.00)***
Direct taxation				
Indirect taxation				
Social security contributions	22.410	(0.00)***		
Economic freedom				
Business freedom				
Fiscal freedom				
$R^2$	0.9886		0.9845	
F test ( $F$ )	239.1	(0.00)	254.2	(0.00)
Breusch-Godfrey test ( $F$ )	0.083	(0.78)	0.208	(0.66)
White's test ( $\chi^2$ )	15.56	(0.34)	9.293	(0.41)
Breusch-Pagan test ( $\chi^2$ )	0.575	(0.97)	2.105	(0.55)
Jarque-Bera test ( $\chi^2$ )	0.925	(0.63)	0.086	(0.96)
Doornik-Hansen test ( $\chi^2$ )	1.156	(0.56)	1.538	(0.46)

Dependent variable is M1 per capita. P-value of given statistics is in brackets. \*\*\*, \*\*, \* denote significance at 1, 5 and 10% significance level.

and indirect taxation turns out not to be significant separately and only if we sum all tax variables or we use just social security contributions as a single proxy of tax burden, the given variable will turn out to be significant. In other words given these results, it seems that the part of the shadow economy, which is indicated through level of cash holdings, is influenced mainly by social security contributions in the Czech Republic. The sign is positive as expected in both cases. Other significant variables are interest rates of deposits, lagged observation of currency holdings and,

**Table 6:** Variance inflation factors of Model 1 and Model 2

<b>Independent variables</b>	<b>VIF (Model 1)</b>	<b>VIF (Model 2)</b>
Lagged M1 per capita	4.329	3.773
Deposit interest rates	5.750	3.761
GDP deflator	2.894	
Total taxation		1.127
Social security contributions	2.152	

in first scenario, GDP deflator. Signs are positive for all variables except interest rates, exactly as expected.

We also should take a look at assumptions of Ordinary Least Squares estimation method. The results of tests, that should check these assumptions, are written in Table 6. Breusch-Godfrey test does not deny the null hypothesis of absence of autocorrelation in the model up to 78% (66%) significance level. Similarly White's and Breusch-Pagan tests do not deny homoscedasticity in the model at reasonable significance level, as well as Jarque-Bera and Doornik-Hansen tests do not deny normality of residuals. Table 6 denotes Variance inflation factors of both estimated models. All VIF values are below 10, which means that this test do not indicate a multicollinearity problem. Null hypothesis ( $\beta_1 = \beta_2 = \dots = \beta_p = 0$ ) of F test is denied and finally  $R^2$  is very high, therefore we can conclude that the estimated models are quite accurate.

Thus, final equations for currency demand were estimated as following:

$$\ln \left( \widehat{\frac{M_1}{POP}} \right)_t = 0.666 + 0.662 \ln \left( \frac{M_1}{POP} \right)_{t-1} - 0.19 \ln R_t + 1.156 \ln (1 + D)_t + 22.41 \ln (1 + SOC)_t \quad (18)$$

$$\ln \left( \widehat{\frac{M_1}{POP}} \right)_t = 1.073 + 0.743 \ln \left( \frac{M_1}{POP} \right)_{t-1} - 0.147 \ln R_t + 6.522 \ln (1 + TOT)_t \quad (19)$$

where

- $t$  is a number assigned to year,
- $\frac{M_1}{POP}$  is monetary aggregate M1 divided by total current population (M1 per capita),
- $R$  is an immediate interest rate,
- $D$  is GDP deflator,

- *SOC* is an average rate of social security contributions (as percentage of GDP), and
- *TOT* is an average total tax rate (as percentage of GDP).

The next step in measuring the size of the shadow economy using currency demand approach is applying equation (8). However, since we cannot assume that in case of the Czech Republic the size of the informal sector equaled zero, when the tax burden was at the lowest level during the given period (1994-2009), we must derive the level of taxation, which would not cause any incentives to participate in the unofficial economy, from previous estimates.

Given Table 3 we can derive the previous estimate of the size of informal economy as an average of values for all three estimation methods (MIMIC, Lackó, Kaufmann - Kaliberda). We do not have a particular number for the MIMIC approach in 1994, but we can suppose the average value did not change significantly since 1993, thus we can use value 13.1% of official GDP for the MIMIC method in 1994. Hence, the average result of the size of shadow economy is 18.4% of official GDP in 1994. We can now calculate the base level of taxation using the following formula (Model 2, similarly for Model 1):

$$\ln(LTAX) = \frac{(1 - SE_{1994}) \ln\left(\frac{M_1}{POP}\right)_t - 1.073 - 0.743 \ln\left(\frac{M_1}{POP}\right)_{t-1} + 0.147 \ln R_t}{6.522} \quad (20)$$

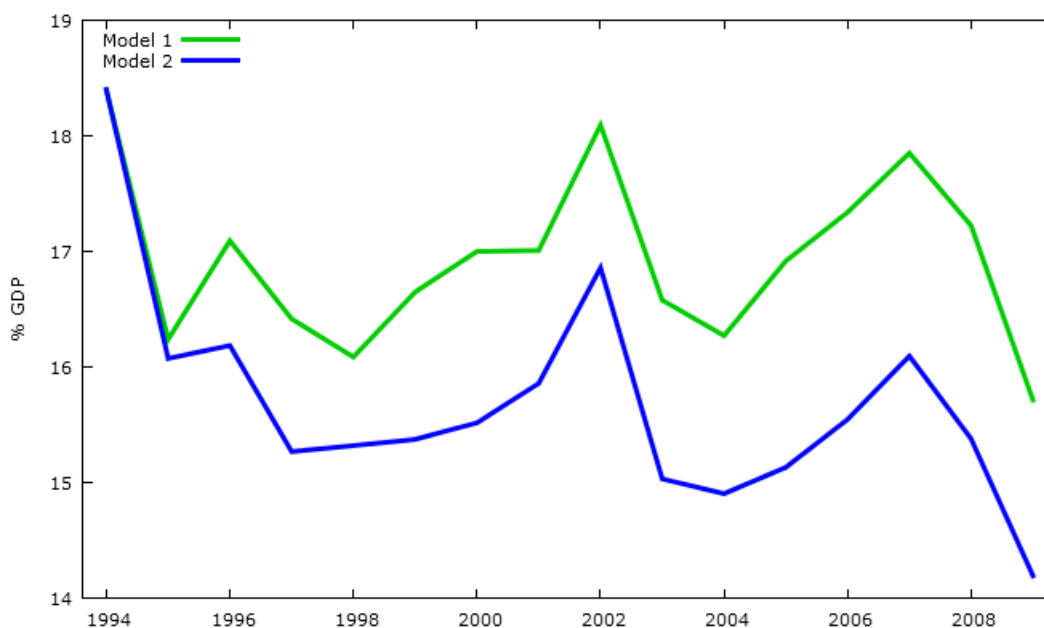
where  $SE_{1994}$  is a base level of shadow economy in 1994 taken from other analysis. The value of  $LTAX$  is 1.07 for Model 1 and 1.055 for Model 2, which does not make much sense since  $LTAX$  is an average rate of social security contributions for Model 1 and it is an average rate of total taxation for Model 2, which should be certainly higher.

As soon as we get the value of  $LTAX$  we can use equation (8) and calculate the estimated size of the shadow economy. Results for the Czech Republic from 1994 to 2009 are shown in the Table 7 and Figure 5.

**Table 7:** Shadow economy estimates obtained using currency demand method

Year	Model 1 (%GDP)	Model 2 (%GDP)
1994	18.40	18.40
1995	16.24	16.07
1996	17.09	16.19
1997	16.42	15.27
1998	16.09	15.32
1999	16.65	15.37
2000	17.00	15.52
2001	17.01	15.86
2002	18.09	16.86
2003	16.58	15.03
2004	16.27	14.90
2005	16.92	15.13
2006	17.34	15.55
2007	17.85	16.09
2008	17.22	15.38
2009	15.71	14.19
Avg	16.93	15.70

**Figure 5:** Development of the shadow economy (CD approach)



Results show that a long-term development of the size of the unofficial economy seems to be slightly decreasing in the Czech Republic. The highest value is 18.4% of official GDP in 1994 (that is our base value taken from previous estimates). The lowest result is 15.71% (14.19% for Model 2) in 2009. The average estimated size



is 16.93% for Model 1 and 15.70% for Model 2. The chart shows that there were at least two significant upward fluctuations in 2002 and during 2006-2007. Also as we can see the development of the shadow economy activities are very similar in both cases, only the absolute size is different. This fact can be explained with the construction of the model, the size of the shadow economy is primarily derived from M1 per capita variable and those two models differs only in how the dependent variable is explained. But since both models use similar explanatory variables, the results are also quite similar. When we think of the absolute size of the shadow economy we must realize that all presented estimates are approximate because of the complicated character of the informal sector and its complex measurement.

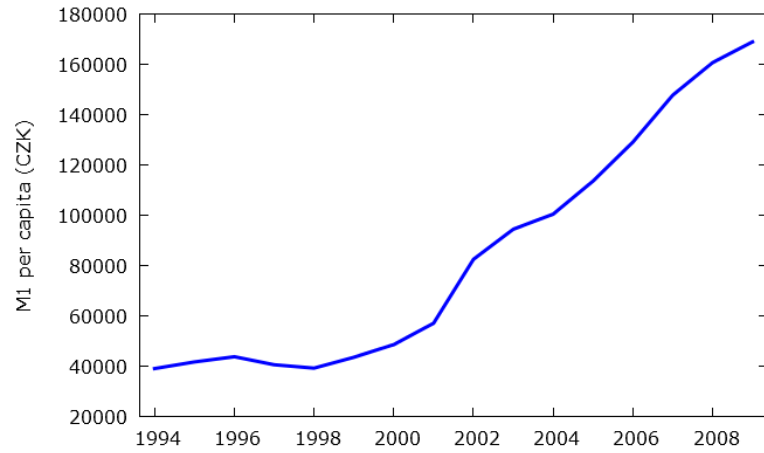
### **6.3 Analysis of the estimated development of the shadow and overall economy in the Czech Republic**

In this section we will try to analyze the estimated development of the size of the informal economy in years 1993-2009. As we mentioned the Kaufmann - Kaliberda method did not provide any applicable output, thus we will describe only data obtained using currency demand method.

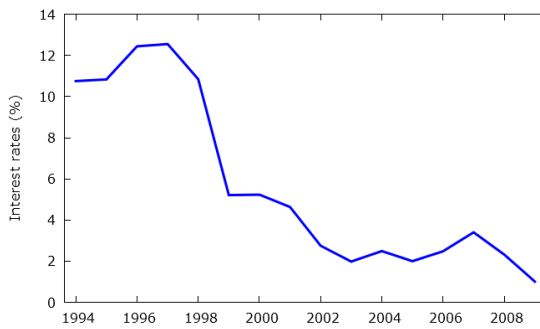
As was written in section 5.2, the currency demand approach assumes that a change in amount of currency in economy can be explained with changes in variables, that do not incite people to participate in the shadow economy. Or it can be explained with changes in variables, that can cause an increase of the informal sector (tax burden, regulations etc.) In our estimations only several variables turned out to be significant. Variables that explain “natural” changes in the currency demand are deposit interest rates, GDP deflator and lagged M1 per capita in Model 1 and the same without deflator in Model 2. Variables that cause an increase in amount of currency, that is utilized in the shadow economy, are in our estimate proxies for the tax burden. It is a social security contributions rate in Model 1 and total taxation rate in Model 2. To verify whether the estimated values correspond with the changes in independent variables, we should take a look at plots of its development in time, which are shown in Figure 6.

**Figure 6:** Time series plots of variables used in currency demand method

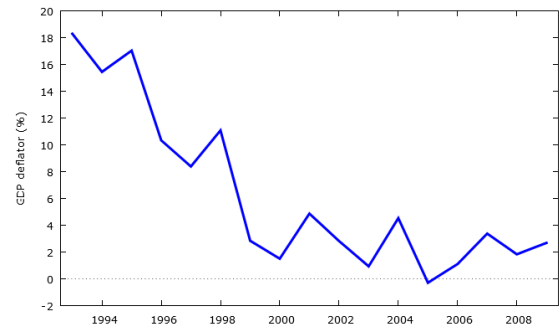
**(a)** M1 per capita



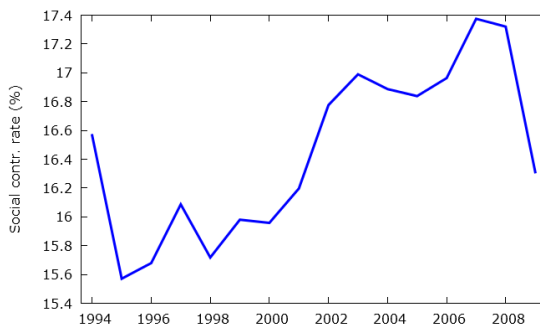
**(b)** Interest rates



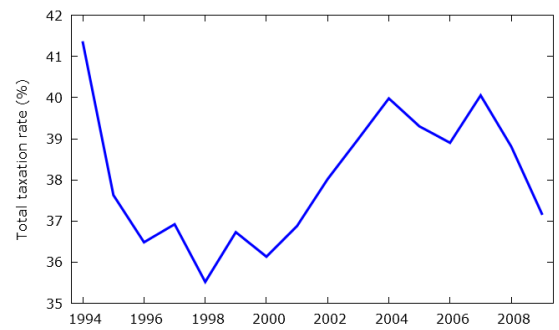
**(c)** GDP deflator



**(d)** Social security con. rate



**(e)** Total taxation rate



The first chart shows the development of M1 per capita variable, which has an increasing trend. Next two charts are developments of variables, that should explain “official” changes in currency demand. Deposit interest rates, which have negative influence on the amount of currency (higher interest rates mean lower motivation to keep cash), is mostly decreasing as well as GDP deflator, which has, on the contrary, positive influence on currency demand (higher inflation means higher prices, which lead to higher need of cash). Last two charts picture the development of a single cause of the shadow economy in our models. Figure (d) shows the development of social security contributions rate, which is used in Model 1 and Figure (e) denotes changes in total taxation rate, which is used in Model 2.

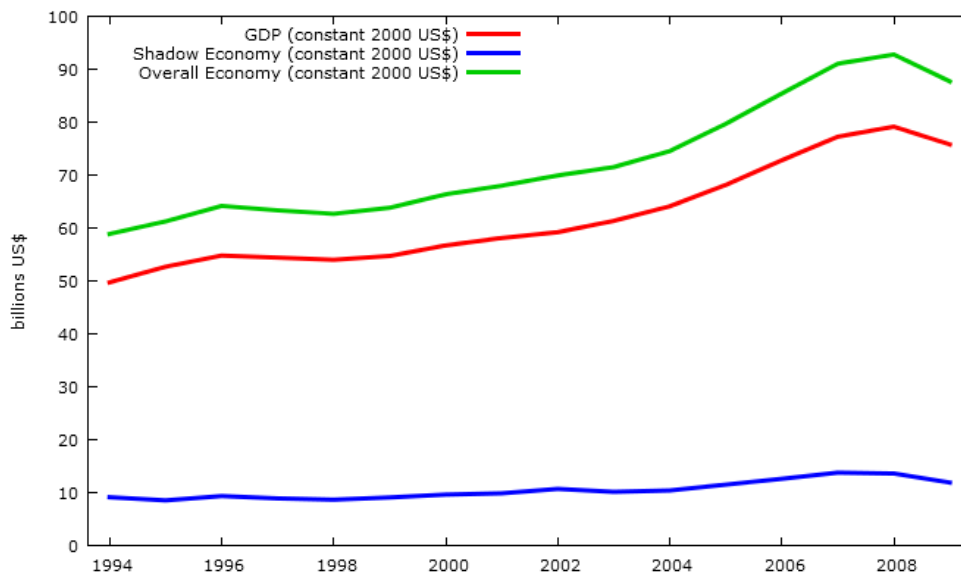
Changes in the tax burden should be approximately reflected in the development of the informal economy and as we can see, the chart of social security contributions rate is much closer to this assumption than the chart of total taxation rate. As an example, chart (d) correspond with Figure 5 in significant decrease in 1995 or in notable increase in 2002 and 2007 etc. Chart (e) is less reflected in Figure 5, it can be due to a missing explanatory variable. This behavior confirms the previous statement, that the shadow economy is probably dependent mainly on social security contributions (among tax variables) in the Czech Republic. After this analysis Model 1 seems to be of better quality than Model 2.

Regrettably, we are unable to say anything about other causes of the shadow economy because of the construction of this model. As was already mentioned, the independent variable is fully explained with variables denoted in Table 5. Estimates of the size of the informal economy are obtained by expressing the difference between current amount of currency and some hypothetical level of currency with minimum tax burden, that would not motivate people to participate in the unofficial sector. Hence, explaining the estimated development of the shadow economy with other possible causes like business cycle, regulation or state of the official economy would be completely meaningless. Hypothetically, we can think about development of the level of taxation, but since it is a political tool and thus its changes do not reflect the state of economy precisely, it would not lead to a meaningful conclusion.

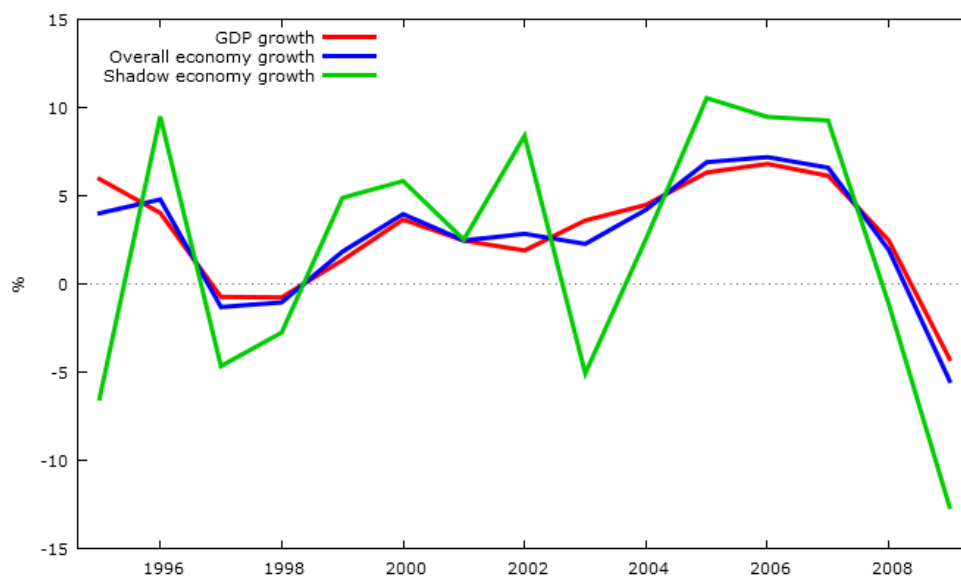
In section 1.1 we divided national economy among official and informal sector.

Official economy is represented by GDP and since we calculated the size of the unofficial sector, we can express the estimated size and development of overall economic activity. Our results point out that the shadow economy probably has a decreasing trend in percentage of official GDP, thus we should find out how it influences the overall economy activity. Figure 7 shows the development of the overall, official and shadow economy in billions US\$ over the period 1994 up to 2009 and Figure 8 shows growth of these variables from 1995 to 2009.

**Figure 7:** Development of the official, shadow and overall economy (CD approach)



**Figure 8:** Growth of the official, shadow and overall economy (CD approach)



Charts reveal that despite the fact that estimated size of the shadow economy is decreasing in percentage of official GDP, it is constant or very slightly increasing in constant prices in years 1994-2009. Hence, growth of the overall economy is very similar to growth of the official economy as denoted in Figure 8.

## 7 Comparison of previous and new estimates

**Table 8:** A survey of previous and new estimates for the Czech Republic (%GDP)

	PREVIOUS ESTIMATES			NEW ESTIMATES		
Year	MIMIC	Lackó	Kaufmann - Kaliberda	Model 1	Model 2	Kaufmann - Kaliberda
1989		21.7	6.0			
1990	13.1*	24.3	6.7			7.2
1991	13.1*	31.7	12.9			13.5
1992	13.1*	31.8	16.9			10.4
1993	13.1*	27.1	16.9			9.4
1994		24.5	17.6	18.4	18.4	10.4
1995		21.8	11.3	16.2	16.1	9.8
1996				17.1	16.2	10.8
1997				16.4	15.3	8.6
1998				16.1	15.3	10.6
1999	19.3			16.7	15.4	5.7
2000	19.1			17	15.5	5.6
2001	18.9			17	15.9	6.1
2002	18.8			18.1	16.9	4.0
2003	18.7			16.6	15.0	3.4
2004	18.4			16.3	14.6	1.5
2005	17.8			16.9	15.1	-2.4
2006	17.3			17.3	15.6	-6.0
2007	17.0			17.9	16.1	-11.0
2008				17.2	15.4	-12.8
2009				15.7	14.2	

Source: Own calculations and Schneider et al. (2010b), Lackó (2000), Johnson et al. (1997) and Schneider (2002b); \*Average 1990-1993 = 13.1% GDP.

Comparative Table 8 summarizes all results of the size of the shadow economy obtained for the Czech Republic. The discrepancy between Kaufmann - Kaliberda estimates is probably caused by ex-post revision of data. Also Johnson et al. (1997)

calculated the share of the unofficial economy on overall economy instead of the shadow economy share on official economy (i.e. in percentage of GDP). It is difficult to compare our currency demand estimates, because we do not have any previous ones. As we mentioned in section 5, every method has its own disadvantages, therefore we can expect different results obtained using different methods. Table 8 shows that the absolute values of estimates of Model 1 and MIMIC method are quite similar, but our results are more volatile. We can assume that MIMIC approach provides more accurate values, because it considers more causes and indicators than currency demand approach. That is most likely the reason of discrepancy in the development of results.

## Conclusion

This paper provides a detailed description about the phenomenon called the shadow economy and an attempt to estimate its size in the Czech Republic over the period 1993 up to 2009. The definition of the informal economy is not unified, but basically any unregistered value-adding activity is considered as shadow, i.e. it comprises all economic activities that evade taxes, ignore currency requirements or regulations, avoid statistics reports or are illegal.

Among main causes of the unofficial economy are level of tax and social security contribution burdens, intensity of regulations, state of public sector services, state of official economy and system of social transfers. Proxy variables of these causes are utilized in models for estimating the size of the shadow economy, as well as proxy variables for indicators of the size of the unofficial sector, which primarily are an amount of monetary aggregates, state of labour market and state of official economy as well.

This paper also summarizes consequences of the shadow economy. We found that the main negative impacts of the informal sector are reductions in tax revenues, distortion of statistics, inefficiency in resource allocation and disintegration of social norms. There are several opinions, that the shadow economy has also some positive influence. They argue that it cannot be proven whether is better to do an activity in the unofficial economy or not to do it at all. Positive impacts of the informal sector are e.g. provision of additional employment during recession or the fact that a major part of money obtained through unofficial economy activity is spent in the official sector.

For measuring the size of the shadow economy was developed several models. The most commonly used are indirect approaches such as physical input (Lackó and Kaufmann - Kaliberda), currency demand and MIMIC methods. They utilize macroeconomic variables for estimating the size of the unofficial economy. The Lackó method assumes that a major share of shadow economy is performed in households, thus it attempts to estimate the electricity consumption of households. Kaufmann - Kaliberda model considers electricity consumption as a single best indicator of

overall economy activity, therefore the difference between overall and official (GDP) economy is a share of informal sector. The currency demand approach is built on assumption, that most shadow economy transactions are made in cash. It econometrically estimates the demand for currency and capture the increase of cash holdings due to increase in the size of the shadow economy. Finally, the MIMIC approach is a complex structural equation model, which considers all possible causes and indicators of the unofficial economy (for which we can collect data). It estimates dependencies among these variables, which are consequently used for determining the size of the informal sector.

I estimated the size of the unofficial sector in the Czech Republic using Kaufmann - Kaliberda and currency demand methods. As far as I know, there are not any previous estimate obtained using currency demand for the Czech Republic. The first mentioned approach regrettably did not provide any plausible results, but currency demand model gave us some usable estimates. The conclusion of this analysis is that the size of the shadow economy falls from approximately 18.4% of official GDP in 1994 to 14.2 - 15.7% in 2009, the development of the informal economy seems to be decreasing in percentage of official GDP, but it has a constant or slightly increasing trend in constant prices, thus the developments of overall and official economy are very similar in constant prices.

Regrettably, the character of the shadow economy causes research in this area to be accompanied with overcoming many obstacles. Since we still have only weak models for measuring the size of the informal economy, it is important to realize, that they suit well for the development analysis and for comparative analysis among countries rather than for determining the absolute size of the unofficial sector. This fact is confirmed by discrepancies between results of different approaches and by the common need of a previous estimate (base value), which sets the direction of new results. And because we usually do not have any reliable base value, our estimates will be most likely biased. Hence, a further research is welcomed in this area.



## References

- M. G. Allingham and A. Sandmo. Income tax evasion: A theoretical analysis. *Journal of public economics*, 1(3-4):323–338, 1972.
- T. Breusch. The canadian underground economy: an examination of giles and tedds. *Canadian Tax Journal*, 53(2):367, 2005. ISSN 0008-5111.
- D. Del Boca and F. Forte. Recent empirical surveys and theoretical interpretations of the parallel economy in italy. *The underground economy in the United States and abroad, Lexington (Mass.), Lexington*, pages 160–178, 1982.
- R. Dell’Anno, M. Gómez-Antonio, and A. Alañon-Pardo. The shadow economy in three mediterranean countries: France, spain and greece. a mimic approach. *Empirical Economics*, 33(1):51–84, 2007.
- Y. Eilat and C. Zinnes. The evolution of the shadow economy in transition countries: consequences for economic growth and donor assistance. *World Development*, 2002.
- B. Frey and H. Weck-Hanneman. The hidden economy as an unobserved variable. *European Economic Review*, 26(1-2):33–53, 1984.
- B. S. Frey and F. Schneider. Informal and underground economy. *International Encyclopedia of Social and Behavioral Science*, 12, 2000.
- B. S. Frey and H. Weck. Estimating the shadow economy: A Naive Approach. *Oxford Economic Papers*, 35(1):23–44, 1983.
- B. S. Frey, H. Weck, and W. W. Pommerehne. Has the shadow economy grown in germany? an exploratory study. *Review of World Economics*, 118(3):499–524, 1982.
- S. Johnson, D. Kaufmann, A. Shleifer, M. I. Goldman, and M. L. Weitzman. The unofficial economy in transition. *Brookings papers on economic activity*, 1997(2): 159–239, 1997.

- D. Kaufmann and A. Kaliberda. Integrating the unofficial economy into the dynamics of post-socialist economies: A framework of analysis and evidence. *World*, 1996.
- M. Lackó. Hidden economy—an unknown quantity? comparative analysis of hidden economies in transition countries, 1989–95. *Economics of Transition*, 8(1):117–149, 2000.
- M. Lackó. Hidden economy in East-European countries in international comparison. *International Institute for Applied Systems Analysis (IIASA), Laxenburg*, 1996.
- M. Lackó. The hidden economies of visegrad countries in international comparison: a household electricity approach. *Hungary—towards a market economy*, page 128, 1998.
- N. Loayza. *The economics of the informal sector: a simple model and some empirical evidence from Latin America*. World Bank, Policy Research Dept., Macroeconomics and Growth Division, 1997.
- R. Neck, M. Hofreither, and F. Schneider. The consequences of progressive income taxation for the shadow economy: Some theoretical considerations. *The political economy of progressive taxation, Heidelberg: Springer publishing company*, page 149–176, 1989.
- S. Pozo. Exploring the underground economy. *Books from Upjohn Press*, 1996.
- F. Schneider. Estimating the size of the danish shadow economy using the currency demand approach: An attempt. *The Scandinavian Journal of Economics*, 88(4): 643–668, 1986.
- F. Schneider. The increase of the size of the shadow economy of 18 oecd countries: some preliminary explanations. *CESifo*, 2000.
- F. Schneider. Shadow economy. *Readings in Public Choice and Constitutional Political Economy*, page 511–532, 2002a.

- F. Schneider. The size and development of the shadow economies of 22 transition and 21 OECD countries. *Institute for the Study of Labor (IZA) discussion paper*, 514, 2002b.
- F. Schneider. Shadow economies and corruption all over the world: new estimates for 145 countries. *Economics: The open-access, open-assessment e-journal*, 1 (2007-9):2007–9, 2007.
- F. Schneider and D. Enste. Shadow economies around the world: size, causes, and consequences. *International Monetary Fund*, 2000.
- F. Schneider and D. Enste. *The shadow economy: an international survey*. Cambridge University Press, 2002.
- F. Schneider and R. Neck. The development of the shadow economy under changing tax systems and structures: some theoretical and empirical results for austria. 1992.
- F. Schneider, A. Buehn, and C. E. Montenegro. *Shadow Economies all over the World: New Estimates for 162 Countries from 1999 to 2007*. World Bank, 2010a.
- F. Schneider, A. Buehn, and C. Montenegro. New estimates for the shadow economies all over the world. *International Economic Journal*, 24(4):443–461, 2010b.
- P. Smith. *Assessing the size of the underground economy: the Statistics Canada perspectives*, volume 7. Canadian Economic Observer, 1994.
- V. Tanzi. The underground economy in the united states: Estimates and implications. *Banca Nazionale del Lavoro*, 135(4):427–453, 1980.
- V. Tanzi. The underground economy in the united states: Annual estimates, 1930-1980. *IMF-Staff Papers*, 30(2):283–305, 1983.
- H. Weck. *Schattenwirtschaft: eine Möglichkeit zur Einschränkung der öffentlichen Verwaltung: eine ökonomische Analyse*. P. Lang, Frankfurt am Main; New York, 1983.