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SHADOW ECONOMIES AROUND THE WORLD: WHAT DO WE REALLY KNOW?*)

Friedrich Schneider**)

Abstract:

Using the DYMIMIC approach, estimates of the shadow economy in 110 developing, transition and developed OECD countries are presented. The average size of the shadow economy (in percent of official GDP) over 1999-2000 in developing countries is 41%, in transition countries 38% and in OECD countries 17%. An increasing burden of taxation and social security contributions are the driving forces of the shadow economy. If the shadow economy increases by one percent the growth rate of the "official" GDP of a developing (of a developed and/or transition) country decreases by 0.6% (increases by 0.8 and 1.0% respectively).

JEL-class.: O17, O5, D78, H2, H11, H26.

Key-words: shadow economy, interaction of the shadow economy with the official one, tax burden, government regulation, DYMIMIC method

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Contents

1 Introduction

As shadow economic activities are a fact of life around the world, most societies attempt to control these activities through various measures like punishment, prosecution, economic growth or education. Gathering statistics about who is engaged in shadow economy activities, the frequencies with which these activities are occurring and the magnitude of them, is crucial for making effective and efficient decisions regarding the allocations of a country's resources in this area. Unfortunately, it is very difficult to get accurate information about these shadow economy activities on the goods and labor market, because all individuals engaged in these activities wish not to be identified. Hence, the estimation of the shadow economy activities can be considered as a scientific passion for knowing the unknown.

Although quite a large literature[1)] on single aspects of the hidden or shadow economy exists and a comprehensive survey has been written by Schneider (the author of this paper) and Enste (2000), the subject is still quite controversial[2)] as there are disagreements about the definition of shadow economy activities, the estimation procedures and the use of their estimates in economic analysis and policy aspects.[3)] Nevertheless around the world, there are some indications for an increase of the shadow economy but little is known about the development and the size of the shadow economies in transition, development and developed countries over the period 1990 to 2000.

Hence, the goal of this paper is threefold: to undertake the challenging task to estimate the shadow economy for 110 countries, to provide some insights about the main causes of the shadow economy and to study the dynamic effects of the shadow economy on the official one. In section 2 an attempt is made to define the shadow economy and some theoretical considerations about the reasons why the shadow is increasing are undertaken. Section 3 presents the empirical results of the size of the shadow economy over 110 countries all over the world. Section 4 presents the dynamic effects of the shadow economy on the official one. In section 5 a summary is given and some policy conclusions are drawn. Finally in the two

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1) The literature about the „shadow", „underground", „informal", „second", "cash-" or „parallel", economy is increasing. Various topics, on how to measure it, its causes, its effect on the official economy are analyzed. See for example, survey type publications by Frey and Pommerehne (1984); Thomas (1992); Loayza (1996); Pozo (1996); Lippert and Walker (1997); Schneider (1994a, 1994b, 1997, 1998a); Johnson, Kaufmann, and Shleifer (1997), Johnson, Kaufmann and Zoido-Lobatón (1998a); Belev (2003); Gerxhani (2003) and Pedersen (2003). For an overall survey of the global evidence of the size of the shadow economy see Schneider and Enste (2000, 2002), Schneider (2003) and Alm, Martinez and Schneider (2004).

2) Compare e.g. in the Economic Journal, vol. 109, no. 456, June 1999 the feature "controversy: on the hidden economy".

3) Compare the different opinions of Tanzi (1999), Thomas (1999), Giles (1999a,b) and Pedersen (2003).

appendices (1 and 2) the various methods to estimate the shadow economy are presented and the data set as well as some further econometric results are shown.

2 Some Theoretical Considerations about the Shadow Economy

2.1 Defining the Shadow Economy

Most authors trying to measure the shadow economy face the difficulty of how to define it. One commonly used working definition is all currently unregistered economic activities that contribute to the officially calculated (or observed) Gross National Product.[4)] Smith (1994, p. 18) defines it as „market-based production of goods and services, whether legal or illegal that escapes detection in the official estimates of GDP." Or to put it in another way, one of the broadest definitions of it, includes…"those economic activities and the income derived from them that circumvent or other wise government regulation, taxation or observation".[5)] As these definitions still leave open a lot of questions, table 2.1 is helpful for developing a better feeling for what could be a reasonable consensus definition of the underground (or shadow) economy.

From table 2.1, it becomes clear that a broad definition of the shadow economy includes unreported income from the production of legal goods and services, either from monetary or barter transactions – and so includes all economic activities that would generally be taxable were they reported to the state (tax) authorities. In this paper the following more narrow definition of the shadow economy is used:[6)] The shadow economy includes all market-based legal production of goods and services that are deliberately concealed from public authorities for the following reasons:

(1) to avoid payment of income, value added or other taxes,

(2) to avoid payment of social security contributions,

(3) to avoid having to meet certain legal labor market standards, such as minimum wages, maximum working hours, safety standards, etc., and

(4) to avoid complying with certain administrative procedures, such as completing statistical questionnaires or other administrative forms.

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4) This definition is used for example, by Feige (1989, 1994), Schneider (1994a, 2003) and Frey and Pommerehne (1984). Do-it-yourself activities are not included. For estimates of the shadow economy and the do-it-yourself activities for Germany see Karmann (1990).

5) This definition is taken from Del'Anno (2003), Del'Anno and Schneider (2004) and Feige (1989); see also Thomas (1999), Fleming, Roman and Farrell (2000).

6) Compare also the excellent discussion of the definition of the shadow economy in Pedersen (2003, pp.13-19), who uses a similar one.

Hence, in this paper, I will not deal with typical underground, economic (classical crime) activities, which are all illegal actions that fits the characteristics of classical crimes like burglary, robbery, drug dealing, etc. I also include not the informal household economy which consists of all household services and production. Also this paper does not focus on tax evasion or tax compliance, because it would get to long, and moreover tax evasion is a different subject, where already a lot of research has been underway.[7)]

Table 2.1: A Taxonomy of Types of Underground Economic Activities[1)]

Type of Activity	Monetary Transactions		Non Monetary Transactions	
Illegal Activities	Trade with stolen goods; drug dealing and manufacturing; prostitution; gambling; smuggling; fraud; etc.		Barter of drugs, stolen goods, smuggling etc. Produce or growing drugs for own use. Theft for own use.	
	Tax Evasion	**Tax Avoidance**	**Tax Evasion**	**Tax Avoidance**
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

[1)] Structure of the table is taken from Lippert and Walker (1997, p. 5) with additional remarks.

2.2 The Main Causes of Determining the Shadow Economy

2.2.1 Tax and Social Security Contribution Burdens

In almost all studies[8)] it has been found out, that the tax and social security contribution burdens are one of the main causes for the existence of the shadow economy. Since taxes affect labor-leisure choices, and also stimulate labor supply in the shadow economy, the distortion of the overall tax burden is a major concern of economists. The bigger the difference between the total cost of labor in the official economy and the after-tax earnings (from work), the greater is the incentive to avoid this difference and to work in the shadow economy. Since this difference depends broadly on the social security burden/payments and the overall tax burden, they are key features of the existence and the increase of the shadow economy.

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7) Compare, e.g. the survey of Andreoni, Erard and Feinstein (1998) and the paper by Kirchler, Maciejovsky and Schneider (2002).

8) See Thomas (1992); Lippert and Walker (1997); Schneider (1994a,b, 1997, 1998a,b, 2000, 2003b); Johnson, Kaufmann, and Zoido-Lobatón (1998a,1998b); Tanzi (1999); Giles (1999a); Mummert and Schneider (2001); Giles and Tedds (2002) and Dell'Anno (2003), just to quote a few recent ones.

But even major tax reforms with major tax rate deductions will not lead to a substantial decrease of the shadow economy.[9)] Such reforms will only be able to stabilize the size of the shadow economy and avoid a further increase. Social networks and personal relationships, the high profit from irregular activities and associated investments in real and human capital are strong ties which prevent people from transferring to the official economy. For Canada, Spiro (1993) found similar reactions of people facing an increase in indirect taxes (VAT, GST). This fact makes it even more difficult for politicians to carry out major reforms because they may not gain a lot from them.

Empirical results of the influence of the tax burden on the shadow economy is provided in the studies of Schneider (1994b, 2000) and Johnson, Kaufmann and Zoido-Lobatón (1998a, 1998b); they all found statistically significant evidence for the influence of taxation on the shadow economy. This strong influence of indirect and direct taxation on the shadow economy is further demonstrated by discussing empirical results in the case of Austria and the Scandinavian countries. For Austria the driving force for the shadow economy activities is the direct tax burden (including social security payments), it has the biggest influence, followed by the intensity of regulation and complexity of the tax system. A similar result has been achieved by Schneider (1986) for the Scandinavian countries (Denmark, Norway and Sweden). In all three countries various tax variables (average direct tax rate, average total tax rate (indirect and direct tax rate)) and marginal tax rates have the expected positive sign (on currency demand) and are highly statistically significant. These findings are supported by studies of Kirchgaessner (1983, 1984) for Germany and by Klovland (1984) for Norway and Sweden, too.

In this study an attempt will be made to investigate the influence of the direct and indirect tax burden as well as the social security payments on the shadow economy for developing, transition and highly developed countries. Hence, for the first time this influence is investigated for developing, transition and highly developed countries for the same time period and using the same estimation technique.

9) See Schneider (1994b, 1998b) for a similar result of the effects of a major tax reform in Austria on the shadow economy. Schneider shows that a major reduction in the direct tax burden did not lead to a major reduction in the shadow economy. Because legal tax avoidance was abolished and other factors, like regulations, were not changed; hence for a considerable part of the tax payers the actual tax and regulation burden remained unchanged.

2.2.2 Intensity of Regulations

The increase of the intensity of regulations (often measured in the numbers of laws and regulations, like licenses requirements) is another important factor, which reduces the freedom (of choice) for individuals engaged in the official economy.[10)] One can think of labor market regulations, trade barriers, and labor restrictions for foreigners. Johnson, Kaufmann, and Zoido-Lobatón (1998b) find an overall significant empirical evidence of the influence of (labor) regulations on the shadow economy, the impact is clearly described and theoretically derived in other studies, e.g. for Germany (Deregulation Commission 1990/91). Regulations lead to a substantial increase in labor costs in the official economy. But since most of these costs can be shifted on the employees, these costs provide another incentive to work in the shadow economy, where they can be avoided. Empirical evidence supporting the model of Johnson, Kaufmann, and Shleifer (1997), which predicts, inter alia, that countries with more general regulation of their economies tend to have a higher share of the unofficial economy in total GDP, is found in their empirical analysis. A one-point increase of the regulation index (ranging from 1 to 5, with 5 = the most regulation in a country), ceteris paribus, is associated with an 8.1 percentage point increase in the share of the shadow economy, when controlled for GDP per capita (Johnson et. al. (1998b), p. 18). They conclude that it is the enforcement of regulation, which is the key factor for the burden levied on firms and individuals, and not the overall extent of regulation - mostly not enforced - which drive firms into the shadow economy. Friedman, Johnson, Kaufmann and Zoido-Lobaton (1999) reach a similar result. In their study every available measure of regulation is significantly correlated with the share of the unofficial economy and the sign of the relationship is unambiguous: more regulation is correlated with a larger shadow economy. A one point increase in an index of regulation (ranging from 1-5) is associated with a 10 % increase in the shadow economy for 76 developing, transition and developed countries.

These findings demonstrate that governments should put more emphasis on improving enforcement of laws and regulations, rather than increasing their number. Some governments, however, prefer this policy option (more regulations and laws), when trying to reduce the shadow economy, mostly because it leads to an increase in power of the bureaucrats and to a higher rate of employment in the public sector. In this study the effect of government

[10)] See for a (social) psychological, theoretical foundation of this feature, Brehm (1966, 1972), and for a (first) application to the shadow economy, Pelzmann (1988).

regulation on the development of the shadow economy will be investigated for developing, transition and highly developed countries.

2.2.3 Public Sector Services

An increase of the shadow economy can lead to reduced state revenues which in turn reduce the quality and quantity of publicly provided goods and services. Ultimately, this can lead to an increase in the tax rates for firms and individuals in the official sector, quite often combined with a deterioration in the quality of the public goods (such as the public infrastructure) and of the administration, with the consequence of even stronger incentives to participate in the shadow economy. Johnson, Kaufmann, and Zoido-Lobatón (1998a,b) present a simple model of this relationship. Their findings show that smaller shadow economies appear in countries with higher tax revenues, if achieved by lower tax rates, fewer laws and regulations and less bribery facing enterprises. Countries with a better rule of the law, which is financed by tax revenues, also have smaller shadow economies. Transition countries have higher levels of regulation leading to a significantly higher incidence of bribery, higher effective taxes on official activities and a large discretionary framework of regulations and consequently to a higher shadow economy. Their overall conclusion is that "wealthier countries of the OECD, as well as some in Eastern Europe find themselves in the 'good equilibrium' of relatively low tax and regulatory burden, sizeable revenue mobilization, good rule of law and corruption control, and [relatively] small unofficial economy. By contrast, a number of countries in Latin American and the Former Soviet Union exhibit characteristics consistent with a 'bad equilibrium': tax and regulatory discretion and burden on the firm is high, the rule of law is weak, and there is a high incidence of bribery and a relatively high share of activities in the unofficial economy." (Johnson, Kaufmann and Zoido-Lobatón 1998a p. I). Unfortunately, due to lacking data, for example the effect of corruption on the size of the shadow economy could not be investigated.

3 The Size of the Shadow Economies all over the World – Econometric Estimates and Findings for 110 Countries

3.1 Econometric Results

In tables 3.1 to 3.3 the econometric estimations using the DYMIMIC approach (latent estimation approach) are presented for the 66 developing countries, 23 transition countries

and 21 industrialized and highly developed OECD-countries.[11)] This grouping was necessary because the available data situation is different for these countries. For the 66 developing countries and the 23 transition countries the estimation was done for three different points of time 1990/91, 1994/95 and 1999/2000 and for the 21 OECD countries I have four points of time 1990/91, 1994/95, 1997/98 and 1999/2000. For the developing and transition countries I have as cause variables the following ones: share of direct and indirect taxation (in % of GDP) as the two tax burden variables; burden of state regulation or state interference (share of public administrative employment in % of total employment), unemployment quota and GDP per capita as two cause variables for the status of the "official" economy. As indicator variables I have employment quota (in % of the population between 18 and 64), annual rate of GDP, and annual rate of local currency per capita.[12)]

The estimation results for the 66 developing countries are shown in table 3.1. All cause variables are statistically significant and have the theoretically expected signs. The two tax burden variables together have the quantitative most important influence followed by the burden of state regulation and the "official" employment situation (unemployment quota) on the size of the shadow economy – a result which is in line with the theoretical argumentation of section 2. The estimated coefficient of the burden of state regulation has the quantitative largest impact on the size of the shadow economy as single independent variable, showing that state regulation is the most important factor for the shadow economy in the developing countries. Also the indicator variables are statistically significant and have the expected signs.[13)]

11) The classification which country is a developing country follows the one done by the World Bank (2002) using a benchmark a per capita income of 9,265 USD or less. The others with a higher income are either transition or industrialized countries (here 21 OECD countries). The grouping of the transition countries is done following the grouping in of the OECD country studies (Paris, various years).

12) Here we have the problem, that in some developing and transition countries the USD is also a widely used currency, which is not considered here, because we got no reliable figures of the amount of USD in these developing and transition countries.

13) The estimation results are in general robust, if other indicator variables are normalized; e.g. if the variable currency per capita is normalized the share of direct taxation becomes insignificant as well as the variable GPD per capita.

Table 3.1: DYMIMIC Estimations of the size of the shadow economy of 66 developing countries in Middle and South America, Africa and Asia over 1990/91, 1994/95 and 1999/2000

Cause Variables	**Estimated Coefficients**
Share of direct taxation (in % of GDP)	λ_1 = 0.19(*) (1.79)
Share of indirect taxation and custom duties (in % of GDP)	λ_2 = 0.235* (3.31)
Burden of state regulation (share of public administrative employment in % of total employment)	λ_3 = 0.292* (2.69)
Unemployment quota	λ_4 = 0.284* (3.21)
GDP per capita	λ_5 = -0.143* (-2.23)
Indicator Variables	**Estimated Coefficients**
Employment quota (in % of population 18-64)	λ_6 = -0.643* (-3.45)
Annual rate of GDP	λ_7 = -1
Change of currency per capita	λ_8 = 0.361* (4.99)
Test-statistics	RMSEA[1)] = 0.000* (p-value) = 0.563 Chi-square[2)] = 402.34 (p-value = 0.000) N = 198 DF[3)] = 28

Notes:
t-statistics are given in parentheses ( ); * (*) means | t-statistics | > 1.96 (| t-statistics | > 1.72).
1) p-value for test of close fit; RMSEA < 0.05; the p-value varies between 0.0 and 1.0.
2) If the structural equation model is asymptotically correct then the matrix S (sample covariance matrix) will be equal to $\Sigma(\theta)$ (model implied covariance matrix). This test has a statistical validity if there are large sample ($N \geq 100$) and multi normal distributions both is given for a all three equations in table 3.1 to 3.3 using for a test of multi normal distributions.
3) The degrees of freedom are determined by $0.5 (p + q) (p + q + 1) - t$; with p = number of indicators; q = number of causes; t = the number for free parameters.

In table 3.2 the results are presented for the 23 transition countries. Again all cause variables are statistically significant and similar as the case of the developing countries the two tax burden variables have together the quantitative largest impact on the size of the shadow economy. Then follows annual rate of GDP per capita followed by the unemployment quota and burden of state regulation. The three indicator variables are also statistically significant and the estimated coefficients have the theoretically expected sings.

Finally, in table 3.3 the results for 21 highly developed OECD countries are shown. For these countries the data situation is somewhat better: Not only have I more data points but also I have two additional cause variables, tax morale (an index) and now as separate variable, the burden of social security payments (in % of GDP). The additional indicator variable in the average working time (per week).[14)] Again all seven cause variables are statistically significant and have the theoretically expected sign. The tax and social security burden variables are quantitatively the most important ones followed by the tax moral variable which has the single biggest influence; hence the tax payers attitude against the state institutions/government is quite important to determine whether one is engaged in shadow economy activities or not. Also the shape of the official economy measured in unemployment and GDP per capita have a quantitative important influence on the shadow economy. Turning to the four indicator variables they all have a statistically significant influence and the estimated coefficients have the theoretically expected signs. The quantitatively most important are the employment quota and change of currency per capita.[15)]

[14)] Using this indicator variable one has the problem that, of course, this variable is influenced by state regulation, so that this variable is not really exogenous; hence the estimation may be biased.

[15)] The variable currency per capita or annual change of currency per capita is heavily influenced by banking innovations; hence this variable is pretty unstable in the estimations with respect to the length of the estimation period. Similar problems are already mentioned by Giles (1999a) and Giles and Tedds (2002).

Table 3.2: DYMIMIC Estimation of the Shadow Economy of 23 Central and East European and Former Soviet Union Countries, Years 1990/91, 1994/95 and 1999/2000

Cause Variables	**Estimated Coefficients**
Share of direct taxation + share of social security payments (in % of GDP)	λ_1 = 0.484* (3.94)
Share of indirect taxation + custom duties (in % of GDP)	λ_2 = 0.374* (2.91)
Burden of state regulation (share of public administrative employment in % of total employment)	λ_3 = 0.124* (2.09)
Unemployment quota	λ_4 = 0.343* (3.47)
GDP per capita	λ_5 = -0.204* (-3.49)
Indicator Variables	**Estimated Coefficients**
Employment quota (in % of population 18-64)	λ_6 = -0.713* (-5.49)
Annual rate of GDP	λ_7 = -1.00 (Residuum)
Change of currency per capita	λ_8 = 0.412* (3.69)
Test-statistics	RMSEA[1)] = 0.000* (p-value = 0.619)
	Chi-square[2)] = 403.41 (p-value = 0.00) N = 69 D.F.[3)] = 28

Notes:
t-statistics are given in parentheses ( ); * (*) means | t-statistics | > 1.96 (| t-statistics | > 1.72).
[1)] p-value for test of close fit; RMSEA < 0.05; the p-value varies between 0.0 and 1.0.
[2)] If the structural equation model is asymptotically correct then the matrix S (sample covariance matrix) will be equal to $\Sigma(\theta)$ (model implied covariance matrix). This test has a statistical validity if there are large sample ($N \geq 100$) and multi normal distributions both is given for a all three equations in table 3.1 to 3.3 using for a test of multi normal distributions.
[3)] The degrees of freedom are determined by 0.5 (p + q) (p + q + 1) – t; with p = number of indicators; q = number of causes; t = the number for free parameters.

Table 3.3: DYMIMIC Estimation of the Shadow Economy of 21 highly developed OECD Countries, years 1990/91, 1994/95, 1997/98, 1999/2000 and 2001/02

Cause Variables	**Estimated Coefficients**
Share of direct taxation (in % of GDP)	λ_1 = 0.410** (3.41)
Share of indirect taxation (in % of GDP)	λ_2 = 0.213(*) (1.92)
Share of social security contribution (in % of GDP)	λ_3 = 0.523* (4.59)
Burden of state regulation (share of public administrative employment in % of total employment)	λ_4 = 0.203(*) (1.84)
Tax morale	λ_5 = 0.614* (4.06)
Unemployment quota	λ_6 = 0.399* (3.41)
GDP per capita	λ_7 = -0.134* (-3.64)
Indicator Variables	**Estimated Coefficients**
Employment quota (in % of population 18-64)	λ_8 = -0.713* (-3.49)
Average working time (per week)	λ_9 = -1.00 (Residuum)
Annual rate of GDP (adjusted for the mean of all 22 OECD countries)	λ_{10} = -0.345* (-3.513)
Change of currency per capita	λ_{11} = 0.384* (4.71)
Test-statistics	RMSEA[1)] = 0.000* (p-value = 0,74) Chi-square[2)] = 421.36 (p-value = 0.000) N = 105 D.F.[3)] = 61

Notes:
t-statistics are given in parentheses ( ); * (*) means | t-statistics | > 1.96 (| t-statistics | > 1.72).
[1)] p-value for test of close fit; RMSEA < 0.05; the p-value varies between 0.0 and 1.0.
[2)] If the structural equation model is asymptotically correct then the matrix S (sample covariance matrix) will be equal to $\Sigma(\theta)$ (model implied covariance matrix). This test has a statistical validity if there are large sample ($N \geq 100$) and multi normal distributions both is given for a all three equations in table 3.1 to 3.3 using for a test of multi normal distributions.
[3)] The degrees of freedom are determined by $0.5 (p + q) (p + q + 1) - t$; with p = number of indicators; q = number of causes; t = the number for free parameters.

Summarizing, the econometric results demonstrate that for all three groups of countries the theoretical considerations in section 2 can be confirmed: The tax and social security payment burden are the driving forces of the shadow economy closely followed by the status of the official economy for the developed and transition countries and by the tax moral variable for the highly developed OECD countries. For the developing countries the burden of state regulation is the single most important factor and it would be interesting whether corruption has a positive influence on the shadow economy, but due to lack of data this could not be investigated.[16)]

In order to calculate absolute values of the size of the shadow economies from these DYMIMIC estimation results the author used the already available estimations from the currency demand approach in combination with the DYMIMIC approach for Australia, Austria, Germany, Hungary, Italy, India, Peru, Russia and the United States (from studies of Chatterjee, Chaudhury and Schneider (2003), Del'Anno and Schneider (2004), Bajada and Schneider (2003), Alexeev and Pyle (2003), Schneider and Enste (2002) and Lacko (2000)). With the help of the absolute values of the shadow economy (in % of GDP) for these countries the absolute values of the shadow economy for all other countries could be calculated. The results are shown in the next section.

3.2 The Size of the Shadow Economies for 110 Countries for 1990/91, 1994/95 and 1999/2000

When showing the size of the shadow economies over three periods of time in the 90s for 110 countries which are quite different in location and developing stage, one should be aware that such country comparisons give only a very rough picture of the ranking of the size of the shadow economy over the countries and over time, because the DYMIMIC and the currency demand methods have shortcomings, which are discussed in appendix 1 (part 6.2); see also Thomas (1992, 1999), Tanzi (1999), Pedersen (2003) and Ahumada, Alvaredo, Canavese A. and P. Canavese (2004). Due to these shortcomings and space reasons a detailed discussion of the (relative) ranking of the size of the shadow economy is not been done.

16) In a sub-sample of 52 developing countries corruption has the expected statistically significant positive influence on the size of the shadow economy; however the quantitative importance is far below all other independent variables (tax burden, state regulation, and statues of the official economy).

3.2.1 Developing Countries [17)]

The results of the shadow economies of the developing countries are grouped for Africa, Asia and Central and South America,[18)] and are shown in tables 3.4.-3.6. The results for 24 African countries are shown in table 3.4. If I first consider the development of the shadow economy of these 24 African countries over the three periods of time, we realize that shadow economy in these African nations has been remarkably increased. On average, the size of these 24 African shadow economies was 33.9% of official GDP in 1990/91, increased to 37.4% in 1994/95 and increased further to 41.2% in 1999/2000. This is an increase of 7.3% of official GDP over 11 years. If I now turn to the latest results for 1999/2000 Zimbabwe, Tanzania and Nigeria (with 59.4, 58.3 and 57.9% respectively) have by far the largest shadow economies; in the middle are Mozambique, Cote d'Ivoire and Madagascar with 40.3, 39.9 and 39.6%; at the lower end are Botswana with 33.4, Cameroon with 32.8 and South Africa with 28.4%.

Table 3.4: The Size of the Shadow Economy in 24 African Countries

No.	Shadow Economy [in % of GDP] using the DYMIMIC and Currency Demand Method			
	Country	Average 1990/91	Average 1994/95	Average 1999/2000
1	Algeria	28.7	31.9	34.1
2	Benin	39.6	42.3	45.2
3	Botswana	27.6	30.9	33.4
4	Burkina Faso	31.9	35.4	38.4
5	Cameroon	25.9	28.7	32.8
6	Cote d'Ivoire	33.4	36.2	39.9
7	Egypt, Arab Rep.	30.5	32.4	35.1
8	Ethiopia	33.7	37.4	40.3
9	Ghana	32.9	35.4	38.4
10	Kenya	28.4	31.2	34.3
11	Madagascar	32.4	35.8	39.6
12	Malawi	33.5	37.0	40.3
13	Mali	32.7	36.9	41.0
14	Morocco	29.8	32.7	36.4
15	Mozambique	35.9	38.1	40.3
16	Niger	32.2	37.4	41.9
17	Nigeria	46.7	51.5	57.9
18	Senegal	35.1	39.1	43.2
19	South Africa	22.1	24.2	28.4
20	Tanzania	45.6	51.3	58.3
21	Tunisia	30.9	33.6	38.4

[17)] For an extensive and excellent literature survey of the research about the shadow economy in developing countries see Gerxhani (2003),who stresses thorough out her paper that the destination between developed and developing countries with respect to the shadow economy is of great importance. Due to space reasons this point is not further elaborated here also the former results and literature are not discussed here.

[18)] The disadvantage of these grouping is that in Asia we have also highly developed countries like Japan, Singapore, etc. and also in Africa the state of South-Africa.

No.	Country	Average 1990/91	Average 1994/95	Average 1999/2000
22	Uganda	37.2	40.1	43.1
23	Zambia	40.7	44.3	48.9
24	Zimbabwe	47.3	53.4	59.4
	Unweighted Average	*33.9*	*37.4*	*41.2*

Source: Own calculations.

In table 3.5 the results for Asia are shown, recognizing that it is somewhat difficult to treat all Asian countries equally because Israel, Singapore and Hongkong are highly developed countries and the others are more or less developing countries. If I again discuss first the development of the shadow economy over these three periods of time the average shadow economy of these 25 Asian countries was 20.9% of official GDP in the year 1990/91, increased to 23.4% in 1994/95 and to 26.3% in 1999/2000. An increase of 5.4% over these 11 years.

Table 3.5: The Size of the Shadow Economy in 25 Asian Countries

No.	Country	Shadow Economy [in % of GDP] using the DYMIMIC and Currency Demand Method		
		Average 1990/91	Average 1994/95	Average 1999/2000
1	Bangladesh	28.4	32.4	35.6
2	China	10.5	12.0	13.1
3	Hong Kong, China	11.9	13.4	16.6
4	India	20.6	21.8	23.1
5	Indonesia	15.4	17.6	19.4
6	Iran, Islamic Rep.	13.7	16.8	18.9
7	Israel	16.3	18.9	21.9
8	Japan	8.2	9.6	11.3
9	Jordan	15.4	17.1	19.4
10	Korea, Rep.	22.3	24.9	27.5
11	Lebanon	27.4	30.4	34.1
12	Malaysia	25.1	27.4	31.1
13	Mongolia	16.2	17.1	18.4
14	Nepal	31.7	35.2	38.4
15	Pakistan	28.2	31.4	36.8
16	Philippines	37.2	40.1	43.4
17	Saudi Arabia	14.2	16.0	18.4
18	Singapore	9.8	11.2	13.1
19	Sri Lanka	36.2	40.1	44.6
20	Syrian Arab Republic	12.8	16.2	19.3
21	Thailand	43.2	47.3	52.6
22	Turkey	26.3	29.4	32.1
23	United Arab Emirates	19.8	22.7	26.4
24	Vietnam	10.9	12.3	15.6
25	Yemen, Rep.	20.7	23.4	27.4
	Unweighted Average	*20.9*	*23.4*	*26.3*

Source: Own calculations.

If I consider the results of these 25 Asian countries[19] for the latest time period, Thailand has by far the largest shadow economy in the year 2000 with the size of 52.6% of official GDP; followed by Sri Lanka (44.6%) and the Philippines (43.4%). In the middle range are India with an estimated shadow economy of 23.1% of official GDP, Israel with 21.9% and Taiwan and China[20] with 19.6%. At the lower end are Singapore (13.1%) and Japan (11.3%). One realizes that the average size of the Asian shadow economies is considerably lower compared with the ones of African and South and Latin American States – partly due to the fact that in Asia there is a much greater number of highly developed industrialized countries with lower shadow economies.

In table 3.6 the results of the sizes of the shadow economies for the three periods of time 1990/91, 1994/95 and 1999/2000 for 17 South and Latin American countries are shown. Discussing again first the development of the shadow economy over time in all 17 Central and South American Countries has increased. On average the size of the shadow economy for these 17 Central and South American Countries was 34.2% in 1990/91, increased to 37.7% in 1994/95 and further to 41.5% in 1999/2000. This means an increase of 7.3% over 11 years, a similar size like in the African countries. If I now turn to the size of the shadow economy for the latest period 1999/2000 the largest shadow economy has Bolivia with 67.1%, followed by Panama (64.1%) and Peru (59.9%). The smallest shadow economies are in Chile (19.8%) and Argentina (25.4%). Overall the average sizes of the shadow economies of South and Latin America and of Africa are generally similar.

Table 3.6: The Size of the Shadow Economy in 17 Central and South American Countries

No.	Country	Shadow Economy [in % of GDP] using the DYMIMIC and Currency Demand Method		
		Average 1990/91	Average 1994/95	Average 1999/2000
1	Argentina	22.1	24.8	25.4
2	Bolivia	55.4	60.4	67.1
3	Brazil	32.5	36.4	39.8
4	Chile	13.6	16.4	19.8
5	Colombia	33.4	36.2	39.1
6	Costa Rica	22.0	24.2	26.2
7	Dominican Republic	28.4	30.4	32.1
8	Ecuador	28.9	31.4	34.4
9	Guatemala	41.4	45.9	51.5
10	Honduras	40.7	44.3	49.6

[19] The case of India has been extensively investigated by Chatterjee, Chaudhury and Schneider (2003).

[20] Here only parts of China are considered, which are converted into market economy.

No.	Country	Average 1990/91	Average 1994/95	Average 1999/2000
11	Jamaica	31.4	33.2	36.4
12	Mexico	24.1	27.1	30.1
13	Nicaragua	40.1	43.2	45.2
14	Panama	51.4	58.2	64.1
15	Peru	47.1	52.3	59.9
16	Uruguay	41.3	45.3	51.1
17	Venezuela, RB	27.4	30.4	33.6
	Unweighted Average	*34.2*	*37.7*	*41.5*

Source: Own calculations.

3.2.2 Transition Countries

The measurement of the size and development of the shadow economy in the transition countries has been undertaken since the late 80s starting with the work of Kaufmann and Kaliberda (1996), Johnson et.al. (1997) and Lacko (2000). They all are using the physical input (electricity) method (see Appendix 7.1.2.5) and come up with quite large figures. In the work of Alexeev and Pyle (2003) and Belev (2003) the above mentioned studies are critically evaluated arguing that the estimated sizes of the unofficial economies are to a large content a historical phenomenon and partly determined by institutional factors.

In this paper the sizes of the shadow economies of the transition countries which have been estimated over the three time periods 1990/91, 1994/95 and 1999/2000 using the DYMIMIC and currency demand approach, are presented in table 3.7. Turning again first to the development of the size of the shadow economy over time, all 23 transition countries showed an increase of the shadow economy over the 90s. The average size of the shadow economy of these 23 Transition countries was 31.5% in 1990/91, increased to 34.6% in 1994/95 and finally to 37.9% of official GDP in 1999/2000; an increase of 6.4 percentage points of official GDP over 11 years. If we now consider the size of the shadow economy for single countries for the latest period, Georgia has the by far largest shadow economy at 67.3% of GDP, followed by Azerbaijan with 60.6% and Ukraine with 52.2%. In the middle field are Bulgaria and Romania (36.9 and 34.4%, respectively) and at the lower end are Hungary (25.1%), the Czech Republic (19.1%) and the Slowac. Republic (18.9%).

Table 3.7: The Size of the Shadow Economy in 23 East and Central European and Former Soviet Union Countries

No.	Country	Shadow Economy [in % of GDP] using the DYMIMIC and Currency Demand Method		
		Average 1990/91	Average 1994/95	Average 1999/2000
1	Albania	32.6	30.6	33.4
2	Armenia	43.8	44.3	46.3
3	Azerbaijan	50.3	57.4	60.6
4	Belarus	44.2	46.0	48.1
5	Bosnia and Herzegovina	28.3	31.9	34.1
6	Bulgaria	29.4	33.2	36.9
7	Croatia	28.4	30.4	33.4
8	Czech Republic	15.9	17.2	19.1
9	Georgia	57.8	62.4	67.3
10	Hungary	21.4	23.9	25.1
11	Kazakhstan	33.7	38.4	43.2
12	Kyrgyz Republic	32.4	36.1	39.8
13	Latvia	32.5	36.3	39.9
14	Lithuania	24.7	27.1	30.3
15	Moldova	36.4	41.7	45.1
16	Poland	21.3	24.3	27.6
17	Romania	26.2	30.6	34.4
18	Russian Federation	37.5	41.3	46.1
19	Slovak Republic	14.3	16.2	18.9
20	Slovenia	21.5	24.3	27.1
21	Ukraine	43.3	47.3	52.2
22	Uzbekistan	27.3	30.1	34.1
23	Yugoslavia, Fed. Rep.	21.9	25.8	29.1
	Unweighted Average	*31.5*	*34.6*	*37.9*

Source: Own calculations.

3.2.3 Highly developed OECD-Countries

OECD countries typically have a smaller shadow economy than the other country groupings. For 21 OECD countries the results are not only shown for the year 2000, but also over an extended time period, i.e. from 1989 to 2002/2003; the results are presented in table 3.8.

Table 3.8: The Size of the Shadow Economy in OECD Countries

OECD-Countries	Size of the Shadow Economy (in % of GDP) using the Currency Demand and DYMIMIC Method					
	Average 1989/90	Average 1994/95	Average 1997/98	Average 1999/2000	Average 2001/2002[1)]	Average 2002/2003[1)]
1. Australia	10.1	13.5	14.0	14.3	14.1	13.8
2. Belgium	19.3	21.5	22.5	22.2	22.0	21.5
3. Canada	12.8	14.8	16.2	16.0	15.8	15.4
4. Denmark	10.8	17.8	18.3	18.0	17.9	17.5
5. Germany	11.8	13.5	14.9	16.0	16.3	16.8
6. Finland	13.4	18.2	18.9	18.1	18.0	17.6
7. France	9.0	14.5	14.9	15.2	15.0	14.8
8. Greece	22.6	28.6	29.0	28.7	28.5	28.3
9. Great Britain	9.6	12.5	13.0	12.7	12.5	12.3
10. Ireland	11.0	15.4	16.2	15.9	15.7	15.5
11. Italy	22.8	26.0	27.3	27.1	27.0	26.2
12. Japan	8.8	10.6	11.1	11.2	11.1	11.0
13. Netherlands	11.9	13.7	13.5	13.1	13.0	12.8
14. New Zealand[2)]	9.2	11.3	11.9	12.8	12.6	12.4
15. Norway	14.8	18.2	19.6	19.1	19.0	18.7
16. Austria	6.9	8.6	9.0	9.8	10.6	10.8
17. Portugal	15.9	22.1	23.1	22.7	22.5	22.3
18. Sweden	15.8	19.5	19.9	19.2	19.1	18.7
19. Switzerland	6.7	7.8	8.1	8.6	9.4	9.5
20. Spain [3)]	16.1	22.4	23.1	22.7	22.5	22.3
21. USA	6.7	8.8	8.9	8.7	8.7	8.6
Unweighted Average over 21 OECD countries	13.2	15.7	16.7	16.8	16.7	16.4

Sources: Own calculations
1) Preliminary values.
2) The figures are calculated using the DYMIMIC-method and currency demand approach. Source: Giles (1999b); values for 1999/2000, 2001/2002 and 2002/2003 own calculations.
3) The figures have been calculated for 1989/90, 1994/95 and 1997/98 from Mauleon (1998) and for the later periods own calculations.

For the calculation of the size of the shadow economy, again, for the 21 OECD countries a combination of the DYMIMIC method with the currency demand method is used.[21)] Considering again the latest period 2002/2003, Greece has with 28.3% of official GDP the

[21)] The case of Australia has been extensively investigated by Bajada (2002) and Bajada and Schneider (2003).

largest shadow economy, followed by Italy with 26.2%[22)] and Portugal with 22.3%. In the middle-field is Germany with a shadow economy of 16.8% of official GDP, followed by Ireland with 15.5% and France with 14.8% of official GDP. At the lower end are Austria with 10.8% of GDP and the United States with 8.6% of official GDP. For these OECD countries one realizes over time a remarkable increase of the shadow economies during the 90s. On average the shadow economy was 13.2% in these 21 OECD states in the year 1989/90 and it rose to 16.4% in the year 2002/2003. If we consider the second half of the 90s, we realize that for the majority of OECD countries the shadow economy is not further increasing, even (slightly) decreasing, like for Belgium from 22.5% (1997/98) to 21.5% (2002/2003), for Denmark from 18.3% (1997/98) to 17.5% (2002/2003) or for Finland from 18.9% (1997/98) to 17.6% (2002/2003) or for Italy from 27.3% (1997/98) to 26.2% (2002/2003). For others, like Austria, it is still increasing from 9.0% (1997/98) to 10.8% (2002/2003), or Germany from 14.9% (1997/98) to 16.8% (2002/2003). Hence, one can't draw a general conclusion whether the shadow economy is further increasing or decreasing at the end of the 90s. It differs from country to country but in some countries some efforts have been made to stabilize the size of the shadow economy and in other countries (like Austria or Germany) these efforts were not successful up to the year 2003.

4 The Dynamic Effects of the Shadow Economy on Official Economy

4.1 Theoretical Background

Generally, the view prevails that the informal sector/the shadow economy influences the tax system and its structure, the efficiency of resource allocation between sectors, and the official economy as a whole in a dynamic sense. In order to study the effects of the shadow economy on the official one, several studies integrate underground economies into theoretical or empirical macroeconomic models.[23)] For example, Houston (1987) develops a theoretical business cycle model, in which there are tax and monetary policy linkages with the shadow economy, and concludes that the existence of a shadow economy could lead to an overstatement of the inflationary effects of fiscal or monetary stimulus. In an empirical study

[22)] An extensive study of the size of the shadow economy of Italy was done by Del'Anno (2003) and Del'Anno and Schneider (2003), who achieve a similar but somewhat lower magnitude of the Italian shadow economy.

[23)] For Austria this was done by Schneider, Hofreither, and Neck (1989) and Neck, Hofreither, and Schneider (1989). For further discussion of this aspect see Quirk (1996) and Giles (1999a).

for Belgium Adam and Ginsburgh (1985) focus on the implications of the shadow economy on "official" growth and find a positive relationship between the growth of the shadow economy and the "official" one and under certain assumptions (i.e. very low entry costs into the shadow economy due to a low probability of enforcement). They conclude that an expansionary fiscal policy is a positive stimulus for both the formal and informal economies.
Another hypothesis is, that a substantial reduction of the shadow economy leads to a significant increase in tax revenues and therefore to a greater quantity and quality of public goods and services, which ultimately can stimulate economic growth. Some authors found empirical evidence for this hypothesis. Loayza (1996) presents a simple macroeconomic endogenous growth model in which production technology depends on congestable public services and in which “excessive” taxes and regulations are imposed by governments unable to enforce fully compliance. He concludes that an increase in the relative size of the informal economy reduces economic growth in economies where (1) the statutory tax burden is larger than the optimal tax burden and where (2) the enforcement of compliance is weak. The reason for this negative correlation is the strongly negative correlation between the informal sector and public infrastructure indices, while public-infrastructure is the key element for economic growth. Loayza (1996) also finds empirical evidence for Latin America countries that if the shadow economy increases by one percentage point (of GDP) - ceteris paribus - the growth rate of official real GDP per capita decreases by 1.22 percentage points. However, this negative impact of informal sector activities on economic growth is not broadly accepted, e.g. by Asea (1996). For example, the Loayza (1996) model is based on the assumption that the production technology depends on tax-financed public services, that are subject to congestion and that the informal sector is not paying any taxes but must pay penalties that are not used to finance public services. The negative correlation between the size of the informal sector and economic growth is therefore not very surprising.

Further, in the neoclassical view the underground economy is optimal in the sense that it responds to the economic environment's demand for urban services and small-scale manufacturing. From this point of view the informal sector provides the economy with a dynamic and entrepreneurial spirit and can lead to more competition, higher efficiency, and stronger boundaries and limits for government activities. Put it differently, the informal sector may help to create markets, increase financial resources, enhance entrepreneurship, and transform the legal, social, and economic institutions necessary for accumulation“ (Asea, 1996 p. 166). The voluntary self-selection between the formal and informal sectors may provide a higher potential for economic growth and hence a positive correlation between an

increase of the informal sector and economic growth. Finally, considering both lines of theoretical argumentation, the effects of an increase of the shadow economy on "official" economic growth therefore remain considerably ambiguous. It may be that on the one side in highly developed countries people/entrepreneurs are overburdened by tax and regulation so that a rising shadow economy stimulates/increases the official one as additional value added is created and additional income earned in the shadow economy is spent in the official one. On the other side in developing countries a rising shadow economy leads to a considerable erosion of the tax base with the consequence of a lower provision of public infrastructure and basic public service (e.g. an efficient juridical system) and with the final consequence of lower official growth.

One of the first researchers, who econometrically investigate the relationship between the shadow economy and the official one for New Zealand and Canada are Giles and his co-workers (Giles (1997a, 1997b, 1999a) and Giles, Tedds and Werksneh (2002)). They find, that there is clear evidence of Granger causality from the official GDP to the shadow economy, but only very mild evidence of Granger causality in the reverse direction. This result is supported by similar evidence for New Zealand reported by Giles. In this paper, I test empirically the impact of the size of the shadow economy upon "official" economic growth for developing, transition and highly developed countries. Hence, I construct a panel data set for 110 countries for the time period from 1990 to 2000 in order to estimate the possible effects of the shadow economy on the official one.

The panel data set consists of variables[24)] that the growth theory suggests to be relevant for economic growth [Barro et al. 1995 and Breton 2001]. The data set includes such explanatory variables as the size of the shadow economy (as percent of "official" GDP), capital accumulation, labour force and population growth rates, inflation rates, an indicator for openness, figures on foreign direct investment, the corruption index, government expenditures and GDP per capita [to control for the convergence hypothesis[25)]] in order to estimate the relationship between economic growth, the shadow economy, and other possible factors.

[24)] A description of the countries, variables and sources can be found more detailed in the part 7.2, Appendix at the end of this paper.

[25)] The convergence theory argues that countries with a lower GDP per capita should have higher annual GDP growth rates since they are following a catching up process.

4.2 The Main Results

I intend to estimate a basic equation for the entire sample of 110 developing and developed countries and further estimations for two separate sub-samples of 21 OECD countries and 89 developing and transition countries. Such a splitting up of the total sample is an additional test of robustness of the findings from the total sample. In all three regressions, the dependent variable is the average applied growth rate in per capita GDP over the 1990 to 2000 period. Appendix 2 (6.2) contains a description of the countries and our variables.

4.2.1 The Sample of 110 Developing and Developed Countries

The empirical estimation equation is the following:

"official" economic growth = a1 (shadow economy industrialized[26)] countries) +
a2 (shadow economy developing countries) +
a3 (openness) +
a4 (inflation rate all other countries) +
a5 (inflation rate transition countries) +
a6 (government consumption) +
a7 (lagged GDP per capita growth rate) +
a8 (total population) +
a9 (capital accumulation rate) +
a10 (constant) + ε_{it}

with the expected signs = $a1 > 0, a2 < 0, a3 > 0, a4 < 0, a5 < 0, a6 < 0, a7 > 0, a8 > 0, a9 > 0$

Not all of the theoretically relevant variables for economic growth just like expenditures on research and development [R&D] as an indicator for technological progress or indicators for human capital like school enrollment and number of persons with secondary and tertiary education were available[27)] for all 110 countries for the regression analysis but a reduced dataset of 104 countries is quite adequate for testing the dynamic influence of the shadow economy on the official one.[28)]

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26) These are here the 23 transition countries and the 21 highly developed OECD countries of western type.

27) Some variables were not available at all but most variables were available only for a small number of countries and many observations would have been lost if using the particular variable in the regression analysis [for example using patents per year as a proxy variable for expenditures on R&D results in a sample consisting only of 30 countries]. The 110 countries are listed in the appendix 2 (part 6.2).

28) Unfortunately, 6 developing countries were lost due to missing or unreliable data.

Putting all possible (for all countries available) variables into an equation explaining economic growth did not deliver satisfying results, since many conventionally important variables were insignificant. For example labour force growth has no influence on the GDP growth rate in the model despite the fact that theory suggests a positive relationship between labour force growth and economic growth [Breton 2001]; similarly, the foreign direct investment had not a statistically significant impact on annual GDP growth.

Accordingly, I followed a 'testing down procedure'[29)] to address possible misspecification. After testing different model specifications the following model, reported in table 4.1, resulted, which is "my best" model.

Table 4.1: Results of the Panel Regression; Time period 1990 -2000, 104 developing, transition and industrialized countries

Dependent Variable	**Annual GDP per capita Growth Rate**
Independent Variables:	**Estimated Coefficients:**
Shadow Economy Industrialized (Transition	0.077**
and Developed OECD) Countries	(2.63)
Shadow Economy Developing Countries	-0.052**
	(2.37)
Openness	0.012**
	(2.14)
Inflation Rate Other Countries	0.023
	(1.32)
Inflation Rate Transition Countries	-0.021**
	(4.10)
Government Consumption	-0.181**
	(3.23)
Lagged Annual GDP per capita Growth Rate	0.154**
	(3.06)
Total Population	0.000036**
	(2.07)
Capital Accumulation Rate	0.019*
	(1.88)
Constant	0.062**
	(4.13)
Number of countries	104

[29)] The 'testing down procedure' means that step by step insignificant variables are dropped from the equation after carrying out F-tests on joint significance [see Wooldridge 2000, page 139 - 150]. For example the coefficient on GDP per capita was insignificant and the convergence theory cannot be supported with the available data.

Overall R-Squared	0.347
Within R-Squared	0.266
Between R-Squared	0.417
Wald-CHI²	94.63
	(0.000)
Absolute value of z-statistics in parentheses ** significant at 10%; ** significant at 5%.* *Random effects GLS-regressions; 104 countries, period 1990-2000; yearly data*	

Source: Own Calculation by the author

This regression clearly shows a highly interesting and statistically significant *negative* relationship between the shadow economy of developing countries and official rate of economic growth and a statistically significant *positive* relationship between the shadow economy in industrialized countries and economic growth. If the shadow economy in industrialized countries raises by 1 percentage point of GDP (e.g. shadow economy increases from 10 of 11 percent of official GDP) official growth increases by 7.7 percent; in contrast, for developing countries an increase of the shadow economy by 1 percentage point of official GDP is associated with a decrease in the official growth rate by 4.9 percent. Also all other variables (except the inflation rate in other countries) have a statistically significant influence on growth. For example, the more open a country the higher is official growth and if the inflation rate in transition countries increases by 1 percent official growth decreases by 2.1 percent. Similarly, an increase in the state sector by 1 percent is a associated with a decreases in growth by 1.8 percent. On the other hand, an increase in the total population by 10 million leads to an increase in official GDP by 0.36 percent.

In general these results clearly show a statistically significant *negative* impact of the shadow economy of developing countries on the growth rate of the official economy and a *positive* influence of the shadow economy on the growth rate of industrialized countries. All other variables have plausible signs and are generally statistically significant on a 5 percent confidence level.

4.2.2 21 OECD countries

When one focuses more narrowly on highly developed OECD countries, I find similar results. The 21 OECD countries are Australia, Austria, Belgium, Canada, Denmark, Germany, Finland, France, Greece, Great Britain, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland, Spain, and the USA. As before I estimate a panel regression with the official growth rate of GDP per capita of the 1990 up to 2000 period as

dependent variable. For these 21 OECD countries I specify the following growth equation:

"official" growth (annual GDP per capita) = a1 (trendvariable) +
a2 (shadow economy) +
a3 (openness) +
a4 (capital accumulation rate) +
a5 (annual FDY growth rate) +
a6 (annual labour force growth rate) +
a7 (constant) + ε_{it}

For the signs we expect a1 > 0, a2 > 0, a3 > 0, a4 > 0, a5 > 0.

Table 4.2: Growth equation for 21 OECD Countries 1990 – 2000; results of a Panel regression

Dependent Variables	**Annual GDP per capita Growth Rate**
Explanatory Variables:	**Estimated coefficients**
Trend Variable	-0.003** (3.36)
Shadow Economy	0.078** (2.05)
Openness	0.016** (2.47)
Capital Accumulation Rate	0.127** (3.47)
Annual FDI Growth Rate	0.004** (2.49)
Annual Labour Force Growth Rate	0.951** (2.44)
Constant	6.206** (3.36)
Number of countries	21
Overall R-Squared Within R-Squared Between R-Squared Wald-Chi²	0.370 0.213 0.716 51.10 (0.000)

Absolute value of z-statistics in parentheses
** significant at 10%;*
*** significant at 5%;*
Random effects GLS-regressions; 21 countries, period 1990-2000; yearly data

Source: Own Calculation by the author

The empirical estimation results are shown in table 4.2. The trend variable clearly has a negative and a statistically significant influence on the official growth rate in the OECD countries – a result which is not unusual for the period of the 90s for most OECD countries, as it reflects the overall poor economic performance of most OECD countries during the 90s. Again, the shadow economy has a positive and a statistically significant influence on the official growth rate of GDP per capita. An increase in the shadow economy by 1 percentage point (of official GDP) is associated with an increase in the annual growth rate of 7.8 percent. In addition, increases in the capital accumulation rate by 1 percentage point, lead to an official growth by 12.7 percent. If foreign direct investment increases by 1 percentage point, annual growth rate increases by 0.4 percent. If the annual labor force rate increases by 1 percent, growth rate increases by 9.5 percent.

4.2.3 83 Transition and Developing Countries[30)]

Official economy growth of highly industrialized, developing and transition countries may be quite different then that of developed and transition countries and the explanatory factors that influence the growth rate may also be quite different (due to institutional reasons), I finally present an estimation with only developing and transition countries. For these 83 countries I specify the following growth equation:

"Official" growth (annual GDP per capita) = a1 (shadow economy transition countries) +
a2 (shadow economy developing countries) +
a3 (foreign direct investment lagged) +
a4 (inflation rate other countries) +
a5 (inflation rate transition countries) +
a6 (government consumption) +
a7 (lagged annual GDP growth per capita) +
a8 (population rate) +
a9 (capital accumulation rate) +
a10 (constant) + ε_{it}

For the signs we expect: a1 > 0, a2 < 0, a3 > 0, a4 < 0, a5 < 0, a6 < 0, a7 > 0, a8 > 0, a9 > 0. The empirical results are shown in table 4.3.

[30)] As argued already in section 4.2.1 due to data reasons 6 developing countries were lost.

Table 4.3: Results of the Panel Regression; Time period 1990-2000, 83 transition and developing countries

Dependent Variable	**Annual GDP per capita Growth Rate**
Independent Variables:	**Estimated Coefficients:**
Shadow Economy Transition Countries	0.099** (3.80)
Shadow Economy Developing Countries	-0.045** (-2.36)
FDI lagged	0.00049 (0.05)
Inflation Rate Other Countries	0.0263 (1.28)
Inflation Rate Transition Countries	-0.021** (-3.69)
Government Consumption	-0.184** (3.25)
Lagged Annual GDP per capita Growth Rate	0.154** (3.06)
Total Population	0.000036* (1.80)
Capital Accumulation Rate	0.015 (1.42)
Constant	0.067** (5.00)
Number of countries	83
Overall R-Squared	0.3211
Within R-Squared	0.263
Between R-Squared	0.443
Wald-CHI²	73.89 (0.000)

Absolute value of z-statistics in parentheses
** significant at 10%; ** significant at 5%.*
Random effects GLS-regressions; 83 countries, period 1990-2000; yearly data

Source: Own Calculation by authors

Table 4.3 reveals a statistically significant *positive* influence of the shadow economy of transition countries and again a statistically significant *negative* influence of the shadow economy on developing countries (the usual result). In particular, an increase of 1 percent in the relative size of the shadow economy in transition countries increases official growth in the transition countries by 9.9 percent, and decreases growth in developing countries by 4.5 percent. As for other variables, the foreign direct investment lagged has no statistically insignificant influence. The inflation rate in transition countries has a negative statistically significant influence; an increase by 1 percent, leads to a decrease by 2.1 percent in official

growth. Government consumption or the size of the state sector has again a negative statistically significant influence. If the state sector increases by 1 percentage point (in official GDP) official growth goes down by 18.4 percent. The lagged annual GPD per capita growth rate has a large positive statistically significant influence, and total population also has a positive (through small) impact on growth. The capital accumulation is not statistically significant.

In summary, all three sets of regression clearly indicate that the shadow economy has a statistically significant influence on official economic growth. For transition countries and highly industrialized (OECD) countries this influence is *positive*, while for developing countries the shadow economy has a negative influence on official growth. These results (at least partly) confirm the discussion of the theoretical considerations in part 5.1.

5 Summary and Conclusions

There have been many obstacles to overcome to measure the size of the shadow economy and to analyze its consequences on the official economy, but as this paper shows that some progress has been made. I provided estimates of the size of the shadow economies for 110 countries for three periods of time (1990/91, 1994/95 and 1999/2000) using the DYMIMIC and the currency demand approach. Hence, some insights can be provided into the size and development of the shadow economy of developing, transition and highly developed OECD countries.[31)] The first conclusion from these results is that for all countries investigated the shadow economy has reached a remarkably large size; the summarized results are shown in table 5.1.

[31)] In the appendix some critical discussion of these two methods is given, they have well known weaknesses, compare also Pedersen (2003).

Table 5.1: Average Size of the Shadow Economy for Developing, Transition and OECD-Countries in Terms of Value-Added for 2000

Countries / Year	Average Size of the Shadow Economy – Value added in % of official GDP using DYMIMIC and Currency Demand method		
	(Number of Countries)		
Mostly developing countries:	**1990/91**	**1994/95**	**1999/2000**
Africa	**33.9** *(24)*	**37.4** *(24)*	**41.2** *(24)*
Central and South America	**34.2** *(17)*	**37.7** *(17)*	**41.5** *(17)*
Asia	**20.9** *(25)*	**23.4** *(25)*	**26.3** *(25)*
Transition countries	**31.5** *(23)*	**34.6** *(23)*	**37.9** *(23)*
Highly developed OECD Countries	**13.2** *(21)*	**15.7** *(21)*	**16.8** *(21)*

Source: Own calculations.

Moreover, I have also demonstrated that there is an empirically strong interaction of the shadow economy with government policies and with the official economy. From these empirical results I draw three further conclusions:

(1) The empirical results convincingly demonstrate that an increasing burden of taxation and social security payments, combined with rising state regulatory activities, are the major driving forces for the size and growth of the shadow economy.

(2) A further important result is that the shadow economy has a statistically significant and quantitatively important influence on the growth of the official economy. If the shadow economy increases by one percentage point (shadow economy in percent of official GDP) the official growth in a developing country declines between 4.5 and 5.7 percent. For developed (industrialized and /or transition) countries we find the opposite result. If the shadow economy increases by one percentage point (in % of GDP) the growth rate in industrialized countries increases by 7.7 percent and by 9.9 percent in transition countries, respectively.

(3) Finally, to conclude: Shadow economies are a complex phenomenon, present to an important extent in all type of economies (developing, transition and developed).

People engage in shadow economic activity for a variety of reasons, among most important, of which we can count are government actions, most notable taxation and regulation. With these two insights, goes a third, no less important one: a government aiming to decrease shadow economic activity has to first and foremost analyze the complex relationships between the official and shadow economy – and even more important – among consequences of its own policy decisions.

6 Appendices

6.1 Appendix 1: Methods to Estimate the Size of the Shadow Economy

As has already been mentioned in chapters 2 and 3 estimating the size of a shadow economy is a difficult and challenging task. In this appendix I give a short but comprehensive overview on the various procedures to estimate the size of a shadow economy. Three different types of methods are most widely used, and each is briefly discussed.

6.1.1 Direct Approaches

These are micro approaches that employ either well designed surveys and samples based on voluntary replies or tax auditing and other compliance methods. Sample surveys designed to estimate the shadow economy are widely used in a number of countries[32)]. The main disadvantage of this method is that it presents the flaws of all surveys. For example, the average precision and results depend greatly on the respondent's willingness to cooperate, it is difficult to asses the amount of undeclared work from a direct questionnaire, most interviewers hesitate to confess a fraudulent behavior, and responses are of uncertain reliability, which makes it difficult to calculate a real estimate (in monetary terms) of the extend of undeclared work. The main advantage of this method lies in the detailed information about the structure of the shadow economy, but the results from these kinds of surveys are very sensitive to the way the questionnaire is formulated[33)].

[32)] The direct method of voluntary sample surveys has been extensively used for Norway by Isachsen, Klovland and Strom (1982), and Isachsen and Strom (1985). For Denmark this method is used by Mogensen et. al. (1995) in which they report „estimates" of the shadow economy of 2.7 percent of GDP for 1989, of 4.2 percent of GDP for 1991, of 3.0 percent of GDP for 1993 and of 3.1 percent of GDP for 1994. In Pedersen (2003) estimates of the Danish shadow economy contain the years 1995 with 3.1% up to 2001 with 3.8%.

[33)] The advantages and disadvantages of this method are extensively dealt by Pedersen (2003) and Mogensen et. al (1995) in their excellent and very carefully done investigations.

Estimates of the shadow economy can also be based on the discrepancy between income declared for tax purposes and that measured by selective checks. Fiscal auditing programs have been particularly effective in this regard. Since these programs are designed to measure the amount of undeclared taxable income, they may also be used to calculate the shadow economy.[34)] However, a number of difficulties beset this approach. First, using tax compliance data are equivalent to using a (possibly biased) sample of the population. In general, the selection of tax payers for tax audit is not random but based on properties of submitted (tax) returns that indicate a certain likelihood of (tax) fraud. Consequently, such a sample is not a random one of the whole population, and estimates of the shadow based upon a biased sample may not be accurate. Second estimates based on tax audits reflect only that portion of shadow economy income that the authorities succeed in discovering, and this is likely to be only a fraction of hidden income.

A further disadvantage of these two direct methods (surveys and tax auditing) is that they lead only to point estimates. Moreover, it is unlikely that they capture all „shadow" activities, so they can be seen as providing lower bound estimates. They are unable to provide estimates of the development and growth of the shadow economy over a longer period of time. As already argued, they have, however at least one considerable advantage - they can provide detailed information about shadow economy activities and the structure and composition of those who work in the shadow economy.

6.1.2 Indirect Approaches

These approaches, which are also called „indicator" approaches, are mostly macroeconomic ones and use various economic and other indicators that contain information about the development of the shadow economy (over time). Currently there are five indicators that leave some „traces" of the shadow economy.

6.1.2.1 The Discrepancy between National Expenditure and Income Statistics

This approach is based on discrepancies between income and expenditure statistics. In national accounting the income measure of GNP should be equal to the expenditure measure of GNP. Thus, if an independent estimate of the expenditure site of the national accounts is available, the gap between the expenditure measure and the income measure can be used as an

34) In the United States, IRS (1979, 1983), Simon and Witte (1982), Witte (1987), Clotefelter (1983), and Feige (1986). For a more detailed discussion, see Dallago (1990) and Thomas (1992).

indicator of the extent of the black economy.[35] Since national accounts statisticians are anxious to minimize this discrepancy, the initial discrepancy or first estimate, rather than the published discrepancy should be employed as an estimate of the shadow economy. If all the components of the expenditure site are measured without error, then this approach would indeed yield a good estimate of the scale of the shadow economy. Unfortunately, however, this is not the case. Instead, the discrepancy reflects all omissions and errors everywhere in the national accounts statistics as well as the shadow economy activity. These estimates may therefore be very crude and of questionable reliability.[36]

6.1.2.2 The Discrepancy between the Official and Actual Labor Force

A decline in participation of the labor force in the official economy can be seen as an indication of increased activity in the shadow economy. If total labor force participation is assumed to be constant, than a decreasing official rate of participation can be seen as an indicator of an increase in the activities in the shadow economy, ceteris paribus.[37] One weakness of this method is that differences in the rate of participation may also have other causes. Also, people can work in the shadow economy and have a job in the „official' economy. Therefore such estimates may be viewed as weak indicators of the size and development of the shadow economy.

6.1.2.3 The Transactions Approach

This approach has been most fully developed by Feige.[38] It is based upon the assumption, that there is a constant relation over time between the volume of transaction and official GNP, as summarized by the well-known Fisherian quantity equation, or M*V = p*T (with M = money, V = velocity, p = prices, and T = total transactions). Assumptions also have to be made about the velocity of money and about the relationships between the value of total transactions (p*T) and total (=official + unofficial) nominal GNP. Relating total nominal GNP to total transactions, the GNP of the shadow economy can be calculated by subtracting the official GNP from total nominal GNP. However, to derive figures for the shadow

35) See, e.g., Franz (1983) for Austria; MacAfee (1980) O'Higgins (1989) and Smith (1985), for Great Britain; Petersen (1982) and Del Boca (1981) for Germany; Park (1979) for the United States. For a critical survey, see Thomas (1992).

36) A related approach is pursued by Pissarides and Weber (1988), who use micro data from household budget surveys to estimate the extend of income understatement by self-employed.

37) Such studies have been made for Italy, see e.g., Contini (1981) and Del Boca (1981); for the United States, see O'Neill (1983), for a critical survey, see again Thomas (1992).

38) For an extended description of this approach, see Feige (1996); for a further application for the Netherlands, Boeschoten and Fase (1984), and for Germany, Langfeldt (1984).

economy, one must also assume a base year in which there is no shadow economy and therefore the ratio of p*T to total nominal (official = total) GNP was „normal“ and would have been constant over time, if there had been no shadow economy.

This method, too, has several weaknesses, such as the required assumptions of a base year with no shadow economy, and of a „normal“ ratio of transactions to nominal GNP. Moreover, to obtain reliable shadow economy estimates, precise figures of the total volume of transactions should be available, and this availability might be especially difficult to achieve for cash transactions, because they depend, among other factors, on the durability of bank notes in terms of the quality of the papers on which they are printed.[39)] Also, the assumption is made that all variations in the ratio between the total value of transaction and the officially measured GNP are due to the shadow economy. This means that a considerable amount of data is required in order to eliminate financial transactions from “pure” cross payments, which are legal and have nothing to do with the shadow economy. In general, although this approach is theoretically attractive, the empirical requirements necessary to obtain reliable estimates are so difficult to fulfill, that its application may lead to doubtful results.

6.1.2.4 The Currency Demand Approach

The currency demand approach was first used by Cagan (1958), who calculated a correlation of the currency demand and the tax pressure (as one cause of the shadow economy) for the United States over the period 1919 to 1955. 20 years later, Gutmann (1977) used the same approach but without any statistical procedures. Cagan’s approach was further developed by Tanzi (1980, 1983), who econometrically estimated a currency demand function for the United States for the period 1929 to 1980 in order to calculate the shadow economy. His approach assumes that shadow (or hidden) transactions are undertaken in the form of cash payments, so as to leave no observable traces for the authorities. An increase in the size of the shadow economy will therefore increase the demand for currency. To isolate the resulting „excess“ demand for currency, an equation for currency demand is econometrically estimated over time. All conventional possible factors, such as the development of income, payment habits, interest rates, and so on, are controlled for. Additionally, such variables as the direct and indirect tax burden, government regulation and the complexity of the tax system, which are assumed to be the major factors causing people to work in the shadow economy, are

[39)] For a detailed criticism of the transaction approach see Boeschoten and Fase (1984), Frey and Pommerehne (1984), Kirchgaessner (1984), Tanzi (1982a,b, 1986), Dallago (1990), Thomas (1986, 1992, 1999) and Giles (1999a).

included in the estimation equation. The basic regression equation for the currency demand, proposed by Tanzi (1983), is the following:

$$\ln (C / M_2)_t = \beta_O + \beta_1 \ln (1 + TW)_t + \beta_2 \ln (WS / Y)_t + \beta_3 \ln R_t + \beta_4 \ln (Y / N)_t + u_t$$

with $\beta_1 > 0, \beta_2 > 0, \beta_3 < 0, \beta_4 > 0$

where

ln denotes natural logarithms,
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),
WS / Y is a proportion of wages and salaries in national income (to capture changing payment and money holding patterns),
R is the interest paid on savings deposits (to capture the opportunity cost of holding cash) and
Y / N is the per capita income.[40)]

Any „excess" increase in currency, or the amount unexplained by the conventional or normal factors (mentioned above) is then attributed to the rising tax burden and the other reasons leading people to work in the shadow economy. Figures for the size and development of the shadow economy can be calculated in a first step by comparing the difference between the development of currency when the direct and indirect tax burden (and government regulations) are held at its lowest value, and the development of currency with the current (much higher) burden of taxation and government regulations. Assuming in a second step the same income velocity for currency used in the shadow economy as for legal M1 in the official economy, the size of the shadow can be computed and compared to the official GDP.

The currency demand approach is one of the most commonly used approaches. It has been applied to many OECD countries,[41)] but has nevertheless been criticized on various grounds.[42)] The most commonly raised objections to this method are several:

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40) The estimation of such a currency demand equation has been criticized by Thomas (1999) but part of this criticism has been considered by the work of Giles (1999a,b) and Bhattacharyya (1999), who both use the latest econometric technics.

41) See Karmann (1986 and 1990), Schneider (1997, 1998a), Johnson, Kaufmann and Zoido-Lobatón (1998a), and Williams and Windebank (1995).

42) See Thomas (1992, 1999), Feige (1986), Pozo (1996), Pedersen (2003) and Ahumada, Alvareda, Canavese A. and P. Canavese (2004).

(i) Not all transactions in the shadow economy are paid in cash. Isachsen and Strom (1985) used the survey method to find out that in Norway, in 1980, roughly 80 percent of all transactions in the hidden sector were paid in cash. The size of the total shadow economy (including barter) may thus be even larger than previously estimated.

(ii) Most studies consider only one particular factor, the tax burden, as a cause of the shadow economy. But others (such as the impact of regulation, taxpayers' attitudes toward the state, „tax morality" and so on) are not considered, because reliable data for most countries is not available. If, as seems likely, these other factors also have an impact on the extent of the hidden economy, it might again be higher than reported in most studies.[43)]

(iii) As discussed by Garcia (1978), Park (1979), and Feige (1996), increases in currency demand deposits are due largely to a slowdown in demand deposits rather than to an increase in currency caused by activities in the shadow economy, at least in the case of the United States.

(iv) Blades (1982) and Feige (1986, 1996), criticize Tanzi's studies on the grounds that the US dollar is used as an international currency. Instead, Tanzi should have considered (and controlled for) the presence of US dollars, which are used as an international currency and held in cash abroad.[44)] Moreover, Frey and Pommerehne (1984) and Thomas (1986, 1992, 1999) claim that Tanzi's parameter estimates are not very stable.[45)]

(v) Most studies assume the same velocity of money in both types of economies. As argued by Hill and Kabir (1996) for Canada and by Klovland (1984) for the Scandinavian countries, there is already considerable uncertainty about the velocity of

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43) One (weak) justification for the only use of the tax variable is that this variable has by far the strongest impact on the size of the shadow economy in the studies known to the authors. The only exception is the study by Frey and Weck-Hannemann (1984) where the variable „tax immorality" has a quantitatively larger and statistically stronger influence than the direct tax share in the model approach. In the study of Pommerehne and Schneider (1985), for the U.S., besides various tax measures, data for regulation, tax immorality, minimum wage rates are available, the tax variable has a dominating influence and contributes roughly 60-70 percent to the size of the shadow economy. See also Zilberfarb (1986).

44) In another study by Tanzi (1982, esp. pp. 110-113) he explicitly deals with this criticism. A very careful investigation of the amount of US-$ used abroad and the US currency used in the shadow economy and to "classical" crime activities has been undertaken by Rogoff (1998), who concludes that large denomination bills are major driving force for the growth of the shadow economy and classical crime activities due largely to reduced transactions costs.

45) However in studies for European countries Kirchgaessner (1983, 1984) and Schneider (1986) reach the conclusion that the estimation results for Germany, Denmark, Norway and Sweden are quite robust when using the currency demand method. Hill and Kabir (1996) find for Canada that the rise of the shadow economy varies with respect to the tax variable used; they conclude „when the theoretically best tax rates are selected and a range of plausible velocity values is used, this method estimates underground economic growth between 1964 and 1995 at between 3 and 11 percent of GDP." (Hill and Kabir [1996, p. 1553]).

money in the official economy, and the velocity of money in the hidden sector is even more difficult to estimate. Without knowledge about the velocity of currency in the shadow economy, one has to accept the assumption of an „equal“ money velocity in both sectors.

(vi) Ahumada, Alvaredo, Canavese A. and P. Canavese (2004) show, that the currency approach together with the assumption of equal income velocity of money in both, the reported and the hidden transaction is only correct, if the income elasticity is 1. As this is for most countries not the case, the calculation has to be corrected.

(vii) Finally, the assumption of no shadow economy in a base year is open to criticism. Relaxing this assumption would again imply an upward adjustment of the size of the shadow economy.

6.1.2.5 The Physical Input (Electricity Consumption) Method

(1) The Kaufmann - Kaliberda Method[46)]

To measure overall (official and unofficial) economic activity in an economy, Kaufmann and Kaliberda (1996) assume that electric-power consumption is regarded as the single best physical indicator of overall (or official plus unofficial) economic activity. Now, overall economic activity and electricity consumption have been empirically observed throughout the world to move in lockstep with an electricity to GDP elasticity usually close to one. This means, that the growth of total electricity consumption is an indicator for growth of overall (official and unofficial) GDP. By having this proxy measurement for the overall economy and then subtracting from this overall measure the estimates of official GDP, Kaufmann and Kaliberda (1996) derive an estimate of unofficial GDP. This method is very simple and appealing. However, it can also be criticized on various grounds:

(i) Not all shadow economy activities require a considerable amount of electricity (e.g. personal services), and other energy sources can be used (gas, oil, coal, etc.). Only a part of the shadow economy will be captured.

(ii) Over time, there has been considerable technical progress, so that both the production and use of electricity are more efficient than in the past, and this will apply in both official and unofficial uses.

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46) This method was used earlier by Lizzeri (1979), Del Boca and Forte (1982), and then was used much later by Portes (1996), Kaufmann and Kaliberda (1996), Johnson, Kaufmann and Shleifer (1997). For a critique see Lackó (1998).

(iii) There may be considerable differences or changes in the elasticity of electricity/GDP across countries and over time.[47)]

(2) The Lackó Method

Lackó (1996, 1998, 1999, 2000) assumes that a certain part of the shadow economy is associated with the household consumption of electricity. This part comprises the so-called household production, do-it-yourself activities, and other non registered production and services. Lackó further assumes that in countries where the portion of the shadow economy associated with the household electricity consumption is high, the rest of the hidden economy (or the part Lackó cannot measure) will also be high. Lackó (1996, pp.19 ff.) assumes that in each country a part of the household consumption of electricity is used in the shadow economy.

Lackó's approach (1998, p.133) can be described by the following two equations:

$$\ln E_i = \alpha_1 \ln C_i + \alpha_2 \ln PR_i + \alpha_3 G_i + \alpha_4 Q_i + \alpha_5 H_i + u_i \quad (1)$$

with $\alpha_1 > 0, \alpha_2 < 0, \alpha_3 > 0, \alpha_4 < 0, \alpha_5 > 0$

$$H_i = \beta_1 T_i + \beta_2 (S_i - T_i) + \beta_3 D_i \quad (2)$$

with $\beta_1 > 0, \beta_2 < 0, \beta_3 > 0$

where

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

47) Johnson, Kaufmann and Shleifer (1997) make an attempt to adjust for changes in the elasticity of electricity/GDP.

In a cross country study, she econometrically estimates equation (1) substituting H_i by equation (2). The econometric estimation results can then be used to establish an ordering of the countries with respect to electricity use in their respective shadow economies. For the calculation of the actual size (value added) of the shadow economy, Lackó further must know how much GDP is produced by one unit of electricity in the shadow economy of each country. Since these data are not known, she takes the result of one of the known shadow economy estimations, that were carried out for a market economy with another approach for the early 1990s, and she applies this proportion to the other countries. Lackó used the shadow economy of the United States as such a base (the shadow economy value of 10.5% of GDP taken from Morris(1993)), and then she calculates the size of the shadow economy for other countries. Lackó's method is also open to criticism:

(i) Not all shadow economy activities require a considerable amount of electricity and other energy sources can be used.

(ii) Shadow economy activities do not take place only in the household sector.

(iii) It is doubtful whether the ratio of social welfare expenditures can be used as the explanatory factor for the shadow economy, especially in transition and developing countries.

It is questionable which is the most reliable base value of the shadow economy in order to calculate the size of the shadow economy for all other countries, especially, for the transition and developing countries.

6.1.3 The model approach[48]

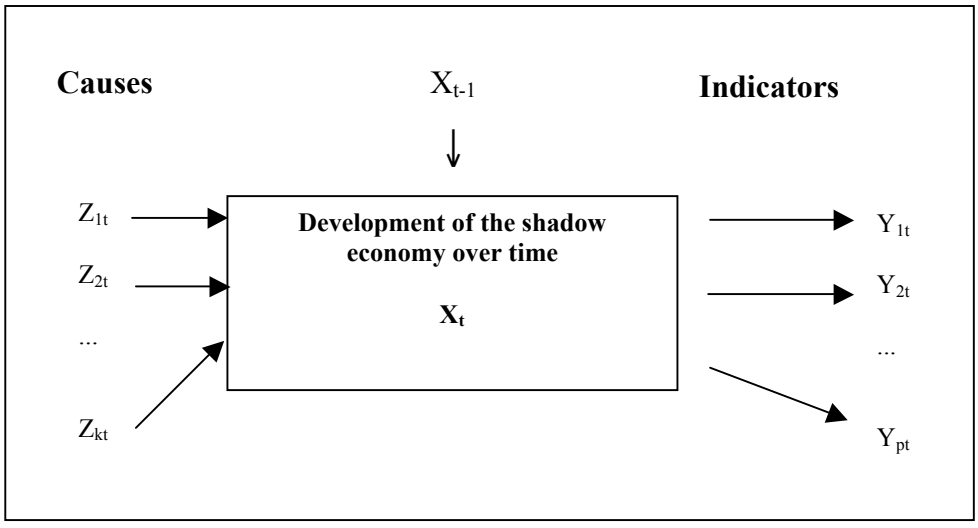
All methods described so far that are designed to estimate the size and development of the shadow economy consider just one indicator that "must" capture all effects of the shadow economy. However, it is obvious that shadow economy effects show up simultaneously in the production, labor, and money markets. An even more important critique is that the causes that determine the size of the shadow economy are taken into account only in some of the monetary approach studies that usually consider one cause, the burden of taxation. The model

48) This summary is derived from a longer study by Aigner, Schneider, and Ghosh (1988, p. 303), applying this approach for the United States over time; for Germany this approach has been applied by Karmann (1986 and 1990). The pioneers of this approach are Weck (1983), Frey and Weck-Hannemann (1984), who applied this approach to cross-section data from the 24 OECD countries for various years. Before turning to this approach they developed the concept of „soft modeling" (Frey, Weck, and Pommerehne (1982), Frey and Weck (1983a and 1983b)), an approach which has been used to provide a ranking of the relative size of the shadow economy in different countries.

approach explicitly considers multiple causes leading to the existence and growth of the shadow economy, as well as the multiple effects of the shadow economy over time.

The empirical method used is quite different from those used so far. It is based on the statistical theory of unobserved variables, which considers multiple causes and multiple indicators of the phenomenon to be measured. For the estimation, a factor-analytic approach is used to measure the hidden economy as an unobserved variable over time. The unknown coefficients are estimated in a set of structural equations within which the "unobserved" variable cannot be measured directly. The DYMIMIC (dynamic multiple-indicators multiple-causes) model consists in general of two parts, with the measurement model linking the unobserved variables to observed indicators.[49)] The structural equations model specifies causal relationships among the unobserved variables. In this case, there is one unobserved variable, or the size of the shadow economy; this is assumed to be influenced by a set of indicators for the shadow economy's size, thus capturing the structural dependence of the shadow economy on variables that may be useful in predicting its movement and size in the future. The interaction over time between the causes Z_{it} (i = 1, 2, ..., k) the size of the shadow economy X_t, in time t and the indicators Y_{jt} (j = 1, 2, ..., p) is shown in Figure 6.1.

Figure 6.1: Development of the shadow economy over time.



There is a large body of literature[50)] on the possible causes and indicators of the shadow economy, in which the following three types of causes are distinguished:

[49)] One of the latest paper dealing extensively with the DYMIMIC approach, its development and its weaknesses is from Del'Anno (2003) as well as the excellent study by Giles and Tedds (2002).

[50)] Thomas (1992); Schneider (1994a, 1997, 2003); Pozo (1996); Johnson, Kaufmann and Zoido-Lobatón

Causes

(i) The burden of direct and indirect taxation, both actual and perceived. A rising burden of taxation provides a strong incentive to work in the shadow economy.

(ii) The burden of regulation as proxy for all other state activities. It is assumed that increases in the burden of regulation give a strong incentive to enter the shadow economy.

(iii) The „tax morality" (citizens' attitudes toward the state), which describes the readiness of individuals (at least partly) to leave their official occupations and enter the shadow economy: it is assumed that a declining tax morality tends to increase the size of the shadow economy.[51)]

Indicators

A change in the size of the shadow economy may be reflected in the following indicators:

(i) Development of monetary indicators. If activities in the shadow economy rise, additional monetary transactions are required.

(ii) Development of the labor market. Increasing participation of workers in the hidden sector results in a decrease in participation in the official economy. Similarly, increased activities in the hidden sector may be expected to be reflected in shorter working hours in the official economy.

(iii) Development of the production market. An increase in the shadow economy means that inputs (especially labor) move out of the official economy (at least partly), and this displacement might have a depressing effect on the official growth rate of the economy.

The latest use of the model approach has been undertaken by Giles (1999a, 1999b, 1999c) and by Giles, Tedds and Werkneh (2002), Giles and Tedds (2002), Chatterjee, Chaudhury and Schneider (2002) and Bajada and Schneider (2003). They basically estimates a comprehensive (dynamic) MIMIC model to get a time serious index of the hidden/measured output of New Zealand, Canada, India or Australia, and then estimate a separate "cash-demand model" to obtain a benchmark for converting this index into percentage units. Unlike

(1998a, 1998b); Giles (1997a, 1997b, 1999a, 1999b, 1999c); Giles and Tedds (2002), Giles, Tedds and Werkneh (2002), Del'Anno (2003) and Del'Anno and Schneider (2004).

51) When applying this approach for European countries, Frey and Weck-Hannemann (1984) had the difficulty in obtaining reliable data for the cause series, besides the ones of direct and indirect tax burden. Hence, their study was criticized by Helberger and Knepel (1988), who argue that the results were unstable with respect to changing variables in the model and over the years.

earlier empirical studies of the hidden economy, they paid proper attention to the non-stationary, and possible co-integration of time serious data in both models. Again this DYMIMIC model treats hidden output as a latent variable, and uses several (measurable) causal variables and indicator variables. The former include measures of the average and marginal tax rates, inflation, real income and the degree of regulation in the economy. The latter include changes in the (male) labor force participation rate and in the cash/money supply ratio. In their cash-demand equation they allow for different velocities of currency circulation in the hidden and recorded economies. Their cash-demand equation is not used as an input to determine the variation in the hidden economy over time – it is used only to obtain the long-run average value of hidden/measured output, so that the index for this ratio predicted by the DYMIMIC model can be used to calculate a level and the percentage units of the shadow economy. Overall, this latest combination of the currency demand and DYMIMIC approach clearly shows that some progress in the estimation technique of the shadow economy has been achieved and a number of critical points have been overcome.
However, also against this method objections can be raised, which are

(1) instability in the estimated coefficients with respect to sample size changes,
(2) instability in the estimated coefficients with respect to alternative specifications,
(3) difficulty to obtain reliable data on cause variables other than tax variables, and
(4) the reliability of the variables grouping into "causes" and "indicators" in explaining the variability of the shadow economy.

6.2 Appendix 2: Data Set and Detailed Estimation result

6.2.1 Countries

The following Table 6.1 presents the 110 countries in the sample and the two data of most interest: the size of the shadow economy in percent of GDP for the year 2000 and the annual GDP Growth Rate in percent again for the year 2000.

Table 6.1: List of countries investigated

Country	Shadow Economy 2000	GDP Growth Rate 2000
Albania	33.4	9.15
Algeria	34.1	5.05
Argentina	25.4	1.77
Armenia	46.3	8.16
Australia	15.3	4.21
Austria	10.2	5.34
Azerbaijan	60.6	20.37
Bangladesh	35.6	8.58
Belarus	48.1	8.30
Belgium	23.2	6.13
Benin	45.2	8.42
Bolivia	67.1	5.04
Bosnia and Herzegovina	34.1	0.00
Botswana	33.4	-2.06
Brazil	39.8	7.68
Bulgaria	36.9	9.30
Burkina Faso	38.4	4.66
Cameroon	32.8	8.45
Canada	16.4	6.17
Chile	19.8	8.51
China	13.1	9.92
Colombia	39.1	1.04
Costa Rica	26.2	-0.37
Cote d'Ivoire	39.9	0.77
Croatia	33.4	5.96
Czech Republic	19.1	5.47
Denmark	18.2	6.34
Dominican Republic	32.1	9.86
Ecuador	34.4	3.98
Egypt, Arab Rep.	35.1	7.73
Ethiopia	40.3	8.01
Finland	18.3	7.91
France	15.3	5.32
Georgia	67.3	8.20
Germany	16.3	5.24
Ghana	38.4	7.03
Greece	28.6	7.18
Guatemala	51.5	6.03
Honduras	49.6	6.52
Hong Kong, China	16.6	14.26
Hungary	25.1	7.63
India	23.1	6.35
Indonesia	19.4	6.96
Iran, Islamic Rep.	18.9	7.14
Ireland	15.8	15.67

Table 6.1: List of countries investigated

Country	Shadow Economy 2000	GDP Growth Rate 2000
Italy	27.0	5.25
Jamaica	36.4	4.10
Japan	11.3	4.78
Jordan	19.4	4.57
Kazakhstan	43.2	16.14
Kenya	34.3	1.82
Korea, Rep.	27.5	10.43
Kyrgyz Republic	39.8	7.70
Latvia	39.9	7.87
Lebanon	34.1	2.03
Lithuania	30.3	5.52
Madagascar	39.6	8.06
Malawi	40.3	4.25
Malaysia	31.1	14.61
Mali	41.0	6.86
Mexico	30.1	9.09
Moldova	45.1	1.56
Mongolia	18.4	3.88
Morocco	36.4	2.60
Mozambique	40.3	4.89
Nepal	38.4	8.62
Netherlands	13.0	5.94
New Zealand	12.7	4.86
Nicaragua	45.2	7.25
Niger	41.9	2.45
Nigeria	57.9	6.89
Norway	19.1	4.45
Pakistan	36.8	7.05
Panama	64.1	2.27
Peru	59.9	5.31
Philippines	43.4	6.28
Poland	27.6	6.32
Portugal	22.6	6.00
Romania	34.4	3.74
Russian Federation	46.1	8.81
Saudi Arabia	18.4	8.86
Senegal	43.2	8.08
Singapore	13.1	13.76
Slovak Republic	18.9	4.90
Slovenia	27.1	7.24
South Africa	28.4	5.58
Spain	22.6	6.30
Sri Lanka	44.6	8.73
Sweden	19.1	6.17
Switzerland	8.8	5.37
Syrian Arab Republic	19.3	7.52

Table 6.1: List of countries investigated – cont.

Country	Shadow Economy 2000	GDP Growth Rate 2000
Tanzania	58.3	7.00
Thailand	52.6	5.18
Tunisia	38.4	7.42
Turkey	32.1	10.05
Uganda	43.1	5.90
Ukraine	52.2	8.48
United Arab Emirates	26.4	0.00
United Kingdom	12.6	5.97
United States	8.7	7.44
Uruguay	51.1	1.24
Uzbekistan	34.1	7.86
Venezuela, RB	33.6	5.06
Vietnam	15.6	7.93
Yemen, Rep.	27.4	12.64
Yugoslavia, Fed. Rep.	29.1	0.00
Zambia	48.9	4.86
Zimbabwe	59.4	-5.58

6.2.2 Definition of the Variables

6.2.2.1 General Information

(1) All calculations and estimations are based on the software package 'Intercooled Stata 8.0'.

(2) All growth rates or shares as described in the following section. For example a growth rate of 2 percent is defined as 0.02 instead of 2.0.

(3) If for some reasons observations for important countries for one year are missing we used the following formula to calculate the average growth rate for these variables:

$$\left(\frac{variable_{t+n}}{variable_t} \right)^{\frac{1}{n}} = \varnothing \ growth \ \ rate \qquad \textbf{[A.1]}$$

Multiplying the value of the variable from year t with the average growth rate gives the value for t+1. Formally:

$$\varnothing \ growth \ rate \times variable_t = variable_{t+1} \qquad \textbf{[A.2]}$$

(4) In parenthesis the Stata-Labels for the several variables are presented. This is necessary for understanding the regression outputs in detail below in this appendix.

6.2.2.2 Definition of the Variables

(1) GDP per capita on PPP basis [gdpc]

GDP per capita is based on purchasing power parity [PPP]. PPP GDP is gross domestic product converted to international dollars using purchasing power parity rates. An international dollar has the same purchasing power over GDP as the U.S. dollar has in the United States. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current dollars.

Source: World Bank, International Comparison Programme database.

(2) Annual GDP per capita Growth Rate [growgdpc]

Out of this GDP per capita values for the observed 109 countries over the years 1990 to 2000 the dependent variable Annual GDP per capita Growth Rate has been calculated using the formula

$$Per\ Capita\ Growth = \frac{(GDPpc_t - GDPpc_{t-1})}{GDPpc_{t-1}} \qquad \textbf{[A.3]}$$

Source: World Bank, International Comparison Programme database; own calculation by authors.

(3) Shadow Economy [shad]

The variable Shadow Economy is defined as the informal sector [shadow economy] in percent of official GDP. The estimations for the size of the shadow economy are undertaken using the DYMIMIC and the currency demand approaches; using the values calculated in section 3. But one has to keep in mind that this variable is only available for three points in time namely the years 1990/91, 1994/95 and 1999/2000.

Source: Own calculation by authors.

(4) Shadow Economy Industrialized Countries [shadind]

The variable Shadow Economy Industrialized Countries is defined as the informal sector [shadow economy] in percent of official GDP. It has the value 0 if a country is a developing

country [indicated by the value 0 in the Dummy Industrialized Countries] and the value of the shadow economy in percent of GDP if a country is an industrialized country [indicated by the value 1 in the Dummy Industrialized Countries] or a transition country [indicated by the value 1 in the Dummy Transition Countries].
Source: Own calculation by authors.

(5) Shadow Economy Developing Countries [shaddev]

The variable Shadow Economy Developing Countries is defined as the informal sector [shadow economy] in percent of official GDP. It has the value 0 if a country is an industrialized country [indicated by the value 1 in the Dummy Industrialized Countries] or a transition country [indicated by the value 1 in the Dummy Transition Countries] and the value of the shadow economy in percent of GDP if a country is a developing country [indicated by the value 0 in the Dummy Industrialized Countries].
Source: Own calculation by authors.

(6) Openness [open]

Openness is the sum of exports and imports of goods and services measured as a share of gross domestic product.
Source: World Bank national accounts data, and OECD National Accounts data files.

(7) Inflation Rate [infl]

Inflation as measured by the annual growth rate of the GDP implicit deflator which shows the rate of price change in the economy as a whole.
Source: World Bank national accounts data, and OECD National Accounts data files.

(8) Inflation Rate Other Countries [inflrest]

Inflation Rate Other Countries is equally defined to Inflation Rate but has the value 0 if a country is a transition country [indicated by the value 1 in the Dummy Transition Countries] and the value of the inflation rate if a country is a non-transition country [indicated by the value 0 in the Dummy Transition Countries].
Source: World Bank national accounts data, and OECD National Accounts data files; own calculation by authors.

(9) Inflation Rate Transition Countries [infltran]

Inflation Rate Transition Countries is equally defined to Inflation Rate but has the value 0 if a country is a non-transition country [indicated by the value 0 in the Dummy Transition Countries] and the value of the inflation rate if a country is a transition country [indicated by the value 1 in the Dummy Transition Countries].

Source: World Bank national accounts data, and OECD National Accounts data files; own calculation by authors.

(10) Government Consumption [gov]

Government Consumption is defined as general government final consumption expenditure and includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defense and security, but excludes government military expenditures that are part of government capital formation.

Source: World Bank national accounts data, and OECD National Accounts data files.

(11) Lagged GDP per capita Growth Rate [lastgrowth]

This variable is the Annual GDP per capita Growth Rate lagged for one period, thus in our case lagged for one year.

Source: Equal to [growgdpc]; own calculation by authors.

(12) Total Population in millions [pop]

Total population in millions is based on the population, including all residents who have a legal status or citizenship--except for refugees not permanently settled in the country of asylum.

Source: World Bank staff estimates from various sources including the United Nations Statistics Division's Population.

(13) Capital Accumulation Rate [caac]

The Capital Accumulation Rate is the annual growth rate of gross capital formation based on local currency. Aggregates are based on 1995 U.S. dollars. Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction

of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress." According to the 1993 SNA, net acquisitions of valuables are also considered capital formation.
Source: World Bank national accounts data, and OECD National Accounts data files.

(14) Dummy Industrialized Countries [ind]

The variable Dummy Industrialized Countries is a binary variable and takes the value 0 if a country is a developing country and 1 if the country is an industrialized country. “Developing Country” corresponds to high income classification of World Bank Indicators 2002 with per capita income of USD 9,265 or less. The same applies to “Industrialized Countries” which are defined as countries with per capita GDP of USD 9,266 or more.
Source: Own calculation by authors.

(15) Dummy Transition countries [tran]

The variable Dummy Transition Countries is a binary variable and takes the value 1 if a country is a transition country from a centrally planned economy to a market economy and 0 if the country is not.
Source: Own Calculation by authors.

(16) Dummy OECD countries [oecd]

The variable Dummy OECD countries is a binary variable and takes the value 1 if a country is member of the OECD and 0 if the country is not.
Source: Own Calculation by authors.

(17) Foreign Direct Investment [fdi]

Foreign direct investment is the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows net inflows in the reporting economy.

Source: International Monetary Fund, International Financial Statistics and Balance of Payments databases, World Bank, Global Development Finance, and World Bank and OECD GDP estimates.

(18) Annual FDI Growth Rate [fdigrowth]

Out of this FDI values for the observed 109 countries over the years 1990 to 2000 the explanatory variable Annual FDI Growth Rate has been calculated using the formula

$$FDI\ Growth\ Rate = \frac{(FDI_t - FDI_{t-1})}{FDI_{t-1}} \qquad \textbf{[A.4]}$$

Source: International Monetary Fund, International Financial Statistics and Balance of Payments databases, World Bank, Global Development Finance, and World Bank and OECD GDP estimates, own calculation by authors.

(19) Labour Force [lab]

Total labor force comprises people who meet the International Labour Organization definition of the economically active population: all people who supply labor for the production of goods and services during a specified period. It includes both the employed and the unemployed.

Source: International Labour Organization, using World Bank population estimates.

(20) Annual Labour Force Growth Rate [labgrowth]

Out of this Labour Force values for the observed 109 countries over the years 1990 to 2000 the explanatory variable Annual Labour Force Growth Rate has been calculated using the formula

$$Labour\ Force\ Growth\ Rate = \frac{(LAB_t - LAB_{t-1})}{LAB_{t-1}} \qquad \textbf{[A.5]}$$

Source: International Labour Organization, using World Bank population estimates, own calculation by authors.

(21) Share of Direct Taxation (in % of GDP)

Source: OECD, Paris 2003, Taxing Wages and World Bank (Washington D.C.), 2003, Governance Indicators.

(22) Share of Indirect Taxation and Custom Duties in % of GDP

Source: See Share of Direct Taxation.

(23) Burden of State Regulation, Share of Public Administrative Employment in % of total employment

Source: OECD, various years, Employment Outlook, Paris and International Labour Organization, using World Bank population estimates (Washington, D.C.).

(24) Employment Quota (in % of population between 18 and 64)

Source: See unemployment quota.

(25) Change of Currency per Capita, Annual Rate of Currency per Capita

Source: World Bank National Accounts Data and OECD National Accounts Data Files, Washington and Paris, various years.

(26) Tax Morale (Index)

Source: European Values Study, EUROPEAN VALUES STUDY, 1999/2000 [Computer file] 2003/Release 1, The Netherlands, Germany: Tilburg University, Zentralarchiv für Empirische Sozialforschung, Cologne (ZA), Netherlands Institute for Scientific Information Services (NIWI), Amsterdam [producer], 2003. Germany: Zentralarchiv für Empirische Sozialforschung, Cologne [distributor], 2003. Inglehart, Ronald et.al. World Values Surveys and European Values Surveys, 1981-1984, 1990-1993 and 1995-1997 [Computer file]. ICPSR version. Ann Arbor, MI: Institute for Social Research [producer], 2000. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2000.

6.2.3 Regression Outputs in more Detail

In this section of the Appendix the regression outputs are presented in a more detailed way, where several results such a t- or z-statistics, F-tests, R-Squared within, between and overall can be found. Additionally the regression results for Cluster-Regressions are listed in detail.

As already mentioned above all regressions are estimated with ‘Intercooled Stata 8.0’ using panel regression commands. For general information and econometric details concerning panel regressions see Long (1996), Greene (1997) or Wooldridge (2000).

Panel Regression Total 1990-2000 using the Fixed-Effect Approach [fe]
Total Fixed Effects [fe]

```
Fixed-effects (within) regression               Number of obs      =       193
Group variable (i): id                          Number of groups   =       104

R-sq:  within  = 0.3400                         Obs per group: min =         1
       between = 0.0375                                        avg =       1.9
       overall = 0.0291                                        max =         2

                                                F(9,80)            =      4.58
corr(u_i, Xb)  = -0.9616                        Prob > F           =    0.0001

------------------------------------------------------------------------------
    growgdpc |      Coef.   Std. Err.   t    P>|t|     [90% Conf. Interval]
-------------+----------------------------------------------------------------
     shadind |   .2317538   .3515235     0.66   0.512   -.3532252  .8167327
     shaddev |  -.3288186   .1867277    -1.76   0.082   -.6395566 -.0180805
        open |   .0343245   .0332882     1.03   0.306   -.0210711  .0897202
    inflrest |  -.0064754   .0310026    -0.21   0.835   -.0580676  .0451167
    infltran |  -.0313483   .0092144    -3.40   0.001   -.0466822 -.0160143
         gov |   .1020515   .1876892     0.54   0.588   -.2102867  .4143897
  lastgrowth |   .0442639   .0795051     0.56   0.579   -.0880426  .1765703
         pop |  -.0004899   .0004327    -1.13   0.261     -.00121  .0002301
        caac |   .0192958   .0137675     1.40   0.165    -.003615  .0422066
       _cons |   .0810733    .061764     1.31   0.193   -.0217096  .1838563
-------------+----------------------------------------------------------------
     sigma_u |  .12701133
     sigma_e |  .03371631
         rho |  .93417041   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(103, 80) =     1.14                 Prob > F = 0.2703
```

Regression Output Detail 1 - Source: Own calculation by authors

It shows that the Dummy [ind] and the Dummy [tran] are dropped from the regression with the Fixed-Effect Approach since there is no variation in these variables over time. The next step is to estimate the same equation once more with the Random-Effects Approach and afterwards test with a Hausman-McFadden-Specification Test which of the two model specifications has to be preferred[52].

H0 states that the Random-Effects model has to be preferred. H1 then suggests the Fixed-Effects Model to be the right specification. Therefore if H0 cannot be rejected at a conventional confidence level, the Random-Effects Model is the correct specification.

[52] For more details concerning 'panel regressions' and 'specification tests' see Wooldridge (2000) and Long (1996).

Panel Regression Total 1990 – 2000 using the Random-Effect Approach [re]
Total Random Effects [re]

```
Random-effects GLS regression                   Number of obs      =       193
Group variable (i): id                          Number of groups   =       104

R-sq:  within  = 0.2662                         Obs per group: min =         1
       between = 0.4174                                        avg =       1.9
       overall = 0.3436                                        max =         2

Random effects u_i ~ Gaussian                   Wald chi2(9)       =     94.63
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
    growgdpc |      Coef.   Std. Err.   z    P>|z|     [90% Conf. Interval]
-------------+----------------------------------------------------------------
     shadind |   .0769996   .0292499     2.63   0.008    .0288878  .1251115
     shaddev |  -.0516262    .021763    -2.37   0.018   -.0874231 -.0158293
        open |   .0123984   .0058027     2.14   0.033    .0028538   .021943
    inflrest |   .0230645   .0174138     1.32   0.185   -.0055786  .0517076
    infltran |  -.0210372   .0051337    -4.10   0.000   -.0294814  -.012593
         gov |  -.1806035    .055867    -3.23   0.001   -.2724966 -.0887104
  lastgrowth |    .153827   .0502364     3.06   0.002    .0711955  .2364584
         pop |    .000036   .0000174     2.07   0.039    7.39e-06  .0000647
        caac |   .0185635   .0098691     1.88   0.060    .0023303  .0347967
       _cons |   .0618808   .0149818     4.13   0.000    .0372379  .0865237
-------------+----------------------------------------------------------------
     sigma_u |   .0087508
     sigma_e |  .03371631
         rho |  .06311078   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Regression Output Detail 2 - Source: Own calculation by authors

The now following Hausman Test shows that H0 cannot be rejected at a conventional level and thus we have to give the Random-Effects model preference over the Fixed-Effects model.

Hausman–McFadden-Specification Test

```
               ---- Coefficients ----
             |      Fixed       Random
    growgdpc |    Effects      Effects       Difference
-------------+----------------------------------------
     shadind |   .2317538     .0769996         .1547542
     shaddev |  -.3288186    -.0516262        -.2771924
        open |   .0343245     .0123984         .0219262
    inflrest |  -.0064754     .0230645        -.0295399
    infltran |  -.0313483    -.0210372        -.0103111
         gov |   .1020515    -.1806035          .282655
  lastgrowth |   .0442639      .153827        -.1095631
         pop |  -.0004899      .000036         -.000526
        caac |   .0192958     .0185635         .0007323

    Test:  Ho:  difference in coefficients not systematic

               chi2(  9) = (b-B)'[S^(-1)](b-B), S = (S_fe - S_re)
                         =    10.89
               Prob>chi2 =     0.2834
```

Panel Regression for OECD Countries 1990 – 2000 [oecd==1 and re]
OECD Random Effects [re]

```
Random-effects GLS regression                   Number of obs      =        94
Group variable (i): id                          Number of groups   =        21

R-sq:  within  = 0.2128                         Obs per group: min =         3
       between = 0.7168                                        avg =       4.5
       overall = 0.3700                                        max =         5

Random effects u_i ~ Gaussian                   Wald chi2(6)       =     51.10
corr(u_i, X)       = 0 (assumed)                Prob > chi2        =    0.0000

------------------------------------------------------------------------------
    growgdpc |      Coef.   Std. Err.   z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        year |  -.0031079   .0009262    -3.36   0.001   -.0049231 -.0012926
        shad |   .0782766   .0380983     2.05   0.040    .0036054  .1529478
        open |   .0155147   .0062813     2.47   0.014    .0032036  .0278258
        caac |   .1267053   .0365311     3.47   0.001    .0551056   .198305
   fdigrowth |   .0042132   .0016938     2.49   0.013    .0008935  .0075329
   labgrowth |   .9505111   .3891057     2.44   0.015    .1878778  1.713144
       _cons |   6.205567   1.847538     3.36   0.001    2.584459  9.826674
-------------+----------------------------------------------------------------
     sigma_u |          0
     sigma_e |  .01887023
         rho |          0   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Regression Output Detail 6 - Source: Own calculation by authors

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