An Estimate of Shadow Economy in Brazil

IBRE-FGV / ETCO Institute

1. Introduction

The growth of shadow, informal, illegal economy - or any other name it might be called - is a world phenomenon. Recent studies indicate that the size of this sector of the economy that does not pay taxes, or is not measured, regulated or working within legal regulations, is much bigger than economists thought and shows increased growth.

Shadow economy did not draw the attention of economists until the sixties when it became subject of study. In 1972, a work from the International Labor Organization (ILO) gave the theme great importance and encouraged its study.

In fact, Dixon (1999) states that shadow economy drew little attention until recently. This attitude changed after the first estimates of shadow economy showed how big it could be. From then on, the population in general and the government started to worry about the phenomenon, mainly because of its effect over tax evasion. In addition to reducing tax collection, shadow economy reduces credibility in official statistics, makes the choice of public policies more difficult (for example, the optimal fiscal policy changes greatly due to the presence of this sector) and produces unfair competition with companies in the formal sector.

Theoretical studies have advanced indicating many reasons that lead people to operate in shadow economy. The most frequently mentioned factors are high tax burden, high labor costs and strong regulation of economy. On the other hand, empirical studies face a great problem that lies in the fact that they try to measure something that is not observable (as a result of its very nature), which by itself is a difficult task.

This report attempts to organize the development of literature, including its theoretical, empirical, and controversial aspects aimed at developing an index to measure the evolution of shadow economy in Brazil. Throughout this report the expressions informal economy and shadow economy are used as synonyms.

2. Definition

In spite of the great number of studies, there is still much controversy related to the definition, the estimation procedures and the use of such estimates in the creation of policies. Keith Hart (1970, 1973) is the first researcher to use the term Informal Economy to describe the part of the economy that develops outside the formal work market. Hart considers informal work almost a synonym for self-employment. The term shadow economy was also used in the literature to refer to activities that are not characterized by the attempt to avoid governmental regulations and paying taxes.

For the ILO, the informal market was seen as a way for families to obtain their subsistence. In its study, ILO analyses the relationship between the growth of shadow economy and the number of jobs in the work market and income distribution. The study

concludes that the best way to avoid the growth of shadow economy would be to improve job opportunities and reduce inequality.

De Soto's (1989) definition of shadow economy focuses on the role of regulation. In this case, shadow economy is characterized by escape from excess of regulation. according to Feige (1989), the term shadow economy comprises a wide range of economic activities that include the production and distribution of illegal goods and services, of legal goods and services sold and/or produced illegally, which practice tax evasion or benefit from fraud. Thus, shadow economy activities comprise illegal activities, not declared or controlled by public authority or not accounted for.

Examples of illegal activities are: drug and arms traffic, prostitution, among others. Non-declared activities are those that commercialize legal goods and services in an illegal way for tax evasion purposes. Non-controlled activities or activities not accounted for are those that for some reason are not controlled; do not follow current institutional regulations or whose contribution to GDP is not registered. Finally, informal activities are those in which individuals escape from costs and benefits of the legal system and from its administration rules. Obviously this set of activities does not represent strictly separate categories. In fact, there is strong overlapping among the several shadow economy activities and between shadow economy activities and formal activities, which makes their estimates even more difficult.

Harding and Jenkins (1989) classify shadow economy activities under three criteria: political, economical, and social. These three criteria are divided into the different subgroups described below.

In fact, it is hard to understand why certain subgroups form political and social criteria instead of economic criterion. This difficulty comes from the great overlapping among the criteria adopted. However, the subgroups are separated by each criterion depending on the determinants of each subgroup. For example, the regulation and the determination of legal aspects is a political decision with economic effects. As for the informal activities generated by the decision to migrate to the informal sector in order to have more free time, or to have more impact of friendship to obtain work in shadow economy, they were considered drivers of a social nature.

The criteria used to classify the political aspect were: 1) governmental regulation, 2) illegal activities and 3) national statistics. Despite the advance in the introduction of political aspects that affect shadow economy, the economic criteria is still the most used to characterize and define shadow economy. The main criteria among those used are: 1) labor situation: benefits, minimum wages, etc.; 2) tax evasion; 3) size of the activity; 4) professional situation; 5) regulation of the activity; 6) national accounts (Feige (1981) defines shadow economy as all activities that escape measurement of national accounts).

The third institutional criterion used is the social aspect. The social criteria are the following: 1) social relationships (in general shadow economy is the easiest entrance); 2) autonomy and flexibility (due to these aspects, many people prefer to enter shadow economy instead of the formal economy; 3) survival of the activity (criterion not used for developed countries).

Empirically, studies about developing countries use less political criteria for the definition of shadow economy than developed countries. In terms of the economic criteria,

there are some differences. For example, the size or scale of the operation and the size of firms are more used in less developed countries. Product measurement problems were not greatly considered in developing countries. The activity survival criterion is not used in developed countries. Just the opposite is said for underdeveloped countries, given the higher level of poverty that leads citizens to accept worse jobs or informal work to assure their survival.

3. Theories about Shadow Economy

Initially, shadow economy was seen as something outside economy. Later, studies showed the importance of shadow economy and it became part of economy. As a result, studies about the relationship between the two sectors began.

Shadow economy has distinct characteristics depending on the country's level of development. On average, less developed countries have a higher level of informality. Countries of the iron curtain had an intermediate level of development.

An important issue is the relationship between the formal and the informal sector. There is a point of view that assumes shadow economy as residual and marginal by nature and, consequently, less important. Others consider it a dynamic sector that may have significant impact on the economy. However, given negative effects in the long term, governmental policies should be directed to incorporating it to the formal sector.

A very important aspect is understanding the relationship between formal and informal economy. The effect of formal economy with informal economy can be pro-cyclical or anti-cyclical. Lubell (1991) suggests that both effects are possible: when the economy shrinks, individuals migrate to shadow economy and when formal economy expands, direct and indirect demand for goods and services increases, including in informal economy. Thus, Greenfield (1993) points out that the development of these sectors occurs in a parallel form. Similarly, Schneider (1998) documents that there is a strong relationship between the formal and informal sectors in an economy. He reports that, for Germany and Austria, at least two thirds of the income generated by shadow economy is spent in the economy's formal sector, generating great economic stimulus. The same occurs with Adam and GinsBurgh (1985) for Belgium.

However, most of the analysts agree that economic recession is one of the main causes for the development of shadow economy. As a consequence of stagnation, unemployment, and capital depreciation, informal activity is stimulated. Also, there must be a negative relationship when shadow economy increases, a result of the increase in tax burden. The decrease of formal economy occurs simultaneously with the increase of informal activity.

The reasons for participation in shadow economy may be economic or non-economic. Economic reasons are related to unemployment and strictness of the labor market, reduction of the cost of capital, increased tax burden and high cost of formal production. Reasons that are not directly economic are related to more flexibility and work satisfaction, use of professional qualifications and more free time.

The main determinants for tax evasion are: the degree of justice perceived in the tax system; the attitude of the population towards the government; religious and cultural characteristics, and ease of evasion. Another reason to migrate to shadow economy is the

excess of regulation in the market not only through taxes, but also through legislation on labor conditions, quality and limits in production such as, the great number of unnecessary sanitary restrictions, as well as a restraining bureaucracy in the collection and inspection of taxes, which burden companies with high costs.

The institutional approach (Feige) emphasizes that in less developed countries incompatibility between formal and informal institutions is more evident, and consequently, shadow economy activity is higher. For underdeveloped countries the low degree of industrialization and the existence of a surplus of subsistence labor are indicated as reasons for the expansion of shadow economy.

Tanzi (1999) highlights the role that the design and implementation of a tax system has in the determination of incentives to hide a certain economic activity. Frey and Schneider (1984) state that incentives granted in shadow economy are too high to make any method of inspection against tax evasion efficient. Thus, attempts to reduce the size of shadow economy must be directed to tax reduction, deregulation, privatization, and other pro-market measures.

Despite the *possible* short-term beneficial effects, there is a consensus that in the long term, shadow economy must be reduced in size and that, therefore, there must be an effort to make it formal.

A note about the evolution of shadow economy in Brazil.[1] It is important to highlight the multi-layered nature of this phenomenon. The point addressed in this section is particularly relevant when it comes to Brazilian economy. The phenomenon gains at least three dimensions. Obviously, there is great overlapping between the three natures of informality or shadow economy.

The *first* one refers to the set of activities that are not displayed in national accounts due to many reasons. It is called product informality. This informality has probably significantly been reduced due to the new methodology for checking national accounts. The *second* one refers to the set of activities that are not perceived by the tax authority, in other words, it refers to informality whose main purpose is tax evasion. Finally, the *third* informality form is the set of activities aimed at dodging work market regulations.

Informality exists for individuals and corporate entities. Many are the operating or intervening factors in informality. There are three types of informality for individuals. The *first* one comprises university level professionals, autonomous professionals in general whose level of fulfillment of tax obligations occupies the entire possible range, from 100% to zero. It is reasonable to consider that, on average, they fulfill about half of their tax obligations. The *second* one comprises technicians in general (electrician, plumbers, mechanics, etc.), whose level of fulfillment is certainly inferior to one fifth of that of autonomous professionals. The *third* one includes non-qualified workers (street vendors and construction workers, for example). In these last two cases, the main reason for informality is economic unavailability which leads those professionals to both fiscal evasion and reduction of labor costs, especially with the increase of such costs after the Constitution of 1988. The explosion of street vendors occurred mainly after the removal of the strong currency exchange control which fueled the black market for the dollar. The end

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[1] This subsection benefited from conversations with Dr. Everardo Maciel and Dr. José Antônio Schontag.

of the premium enabled the marketing of smuggled goods, especially those from Paraguay, encouraging the explosion of illegal commerce of these products in the streets.

In corporate entities, there is strong informality in low-value retail commerce, the so-called "*comércio formiguinha*" (mom and pop shops): bakeries, small supermarkets, bars and taverns, gas stations, etc. In these cases, tax substitution largely reduces informality. This informality is strongly linked to the labor market. In the industrial sector there is informality in the production of low-income consumer goods, which are often the same products distributed in the mom and pop shops, also informal, as explained above. Finally, there are some low-income consumer products whose governmental price control, in periods of high levels of inflation, prevented a profitable production by informal economy. Above all, the reduction of inflation and the end of official price control, which caused increase in the relative prices of formal products, added some of the incentives that made production of those products, such as cigarettes and beer, become part of informal economy.

4. Estimation and Empirical Evidence

4.1. Estimation Methodologies

Schneider and Bajada (2005) point out that estimating shadow economy activity is an extremely difficult task due to the great variety of activities included under that classification. Part of this problem is due to the definition of shadow economy. A commonly used definition describes shadow economy as all economic activity that, although contributing to the GDP, it is not recorded. Obviously, this is a partial definition since many activities that evade taxes are accounted for in the GDP.

There are several methodologies (or methods) of measuring shadow economy. They are classified into two great groups. The *direct* methodologies attempt to measure it based on a careful 'in loco' study. Questionnaires and fiscal auditing methods are used for a sample of economy. *Indirect* methodologies estimate shadow economy's size based on the measurement of some effect it has over economy. Among those, specific literature mentions the national accounts method, monetary methods, transaction methods MIMIC method, and the physical input method.

4.1.1 – Questionnaires and Surveys

The use of questionnaires and surveys normally designed to reach a representative sample of the population present direct and indirect questions to detect informality. However, there is always a bias in the answers as people tend to say that they do not participate in an "illegal" activity. This type of survey is often used by governments to know the size of illicit activities. Although this approach is useful to obtain detailed information about the labor market, such as job quality and their characteristics, it is uncertain that it can cover most of the activities that occur in shadow economy.

4.1.2 – Fiscal Auditing Methods

Tax auditing, unlike surveys and questionnaires, are involuntary. This method is very efficient in identifying tax evasion and avoidance. However, it does not seem to be very adequate to identify non-declared income because deductions need to be declared. Thus, probably only a small part of the informal activity is observed through this method.

In addition to that problem, this method only covers the small portion of those who are still working and pay their taxes. All those that do not work or offer their services in shadow activities are not observed (at least not easily) through this method.

Despite this fact, the method detects a larger part of informal activity than what is based on voluntary interviews because the agents are afraid of being punished and, as a consequence, offer less imprecise and/or biased information.

4.1.3 – National Accounts

This method is based on the principle that the public institute responsible for national accounting has quality information for the expense. The size of shadow economy is given by the difference between the product measured through added value and that measured from an expense standpoint. Obviously, the activities that are measured in terms of added value and evade taxes are excluded from this calculation. Additionally, most countries, especially developing countries, do not present an expense accounting better than a value-added accounting.

4.1.4 – Monetary Method

This methodology is very popular to estimate shadow economy. It is based on the principle that informal activity tries to remain unobserved by authorities and, consequently, presents greater demand for cash in the hands of the population than formal activities, which require more bank instruments for their transactions.

This method is based on the approach developed by Cagan (1958) to measure the demand for currency. Gutmann (1977) uses a similar approach to estimate shadow economy in the USA. Tanzi (1980, 1983) expands Cagan's equation of demand for currency and uses it as a basis to calculate informal activity in the USA between 1929 and 1980. As shadow economy's transactions are made on a cash basis, the increase of informal activities will expand the demand for currency. Many factors that cause the increase of shadow economy, such as the direct and indirect tax burden, are included in the equation that estimates the demand for currency. In the event that the additional increase in the demand for currency caused by higher taxation and the other causing factors was a result of the increase of informal economy, it is possible to determine how much of the increase in informal economy relates to the increase in the demand for currency. In other words, it is understood that more taxes increase shadow economy which, in turn, increases the demand for currency. The measurement of those effects would make it possible to estimate the size of shadow economy.

Although it is widely used, this method is subject to several objections: 1) not all shadow economy transactions are paid in cash. Thus, the size of shadow economy may be even bigger. 2) Due to the strong process of banking innovations and their impact on the demand for currency, it is almost impossible to estimate the demand for currency with the required accuracy (for a later study of informality). 3) All studies assume the same speed of currency in the formal and informal sectors. 4) Finally, it is necessary to suppose the non-existence of a shadow economy in the base year, which once again represents underestimation.

Thomas (1999) criticizes the form used to try to estimate shadow economy. The author claims that the estimate of demand for expanded currency for the existence of a

shadow economy presents weak theoretical support and could very well be measuring any other phenomenon other than shadow economy. Consequently, according to this author, the results are not very significant and should not be strong guides for the conduction of public policies.

4.1.5 – Transactions Method

The transactions method is very similar to the previous method; it uses the currency quantitative equation, assuming the existence of a continuous relationship between the volume of transactions and the official GDP. The main difference between the two methods is the use of the number of transactions made in the economy. This method also needs premises about the speed of currency and relationships between total transactions and the nominal product. In addition to that, the method also lies in the idea of an initial period with no shadow economy. Finally, in order to reach an accurate estimate of shadow economy, accurate data on the volume of transactions is necessary. It is assumed that all the variation in the ratio between the total value of transactions and the officially measured product is a consequence of shadow economy. Although it is theoretically attractive, this methodology faces a serious data problem as it is necessary to know the number of transactions that were made in the period, and the speed of currency in formal economy and in shadow economy in order to apply it.

4.1.6 – MIMIC Method

The MIMIC method (*multiple indicators multiple causes*), considers several causes for the existence and growth of shadow economy throughout time. The empirical method used is very different from the method used in other studies. It is based on statistical theory for non-observed variables, which considers multiple causes and multiple indicators for the phenomenon to be measured, and which is not observed. In the estimation, an approach of the analysis of factors is used to measure shadow economy as a non-observable variable throughout time. The method is based on the idea that shadow economy – non-observed variable, called by statistics latent variable – is caused by a set of factors (observed) and, in turn, induces or causes another set of variables, called indicative variables(which are also observed). Based on the idea that there is a linear relationship between causing variables and shadow economy, and, among shadow economy and the caused (or indicative) variables, it is possible to evaluate the evolution of the variable of interest based on the estimation of this relationship.

As explained in the previous paragraph, given that statistically it is only possible to estimate the final result of a chain with two causes – from the variables that cause shadow economy and from that to the indicative variables– the method only allows the estimation of one index. Here, it is necessary to be careful and the texts about the theme are not very accurate in respect to this point. We ask readers to be patience. Back to the topic, the result of the estimation measures the product of two effects. In order to express the evolution of informal economy in the form of index, it is necessary to normalize the result. We are free to do that and it would be necessary to examine the details of the methodology to explain it. Thus, we can choose the value of one of the parameters that are not identified (due to a causing chain) so that the index measured has base 100 in a given year. We call that procedure normalization. However, the procedure has two degrees of arbitrariness. *First*, what will be the non-identified parameter that the researcher will choose to normalize?

Second, what will be the sign of the parameter that will be normalized? As for the first degree of freedom, the result should not depend on the choice of parameter to be normalized. Common sense indicates that it should be the regressor associated with the indicative variable more closely connected to shadow economy. Concerning the second doubt, the problem is that if we normalize one parameter with the same absolute value, but with opposite signs, all signs of the remaining regressors will be inverted, but the shadow economy index will not change. Therefore, the choice of sign for the regressor to be normalized is irrelevant for the result. Once again, common sense shows that the sign that produces the expected impact of the cause variables over informality should be chosen. For example, since we know that higher tax burden increases informality, we can use this knowledge to choose the sign of the regressor to be normalized.

However, in order for an index of the informal economy to express the size, proportionally to the GDP for example, an independent observation of this statistic is necessary for a given point in time. Having these statistic data, the normalization discussed in the previous paragraph is implemented so that this index has a certain value for the year in question, thus, no longer being a simple index. That process is called calibration. Thus, in order to calibrate the method and, consequently, obtain an estimate of the latent variable, an independent observation of this variable in a certain point in time is necessary.[2]

For the implementation of the method it is necessary to choose the causes of shadow economy and its indicative variables. Thus, there is a lot of art in the implementation of this methodology. A bad choice of both sets of variables invalidates the entire exercise. The commonly used causes are tax burden and regulations and the citizens' willingness to migrate to shadow economy. The indicative variables are the increase of monetary aggregates, increase in the share of workers in informal economy (such as the number of non-registered workers, or workers that do not contribute to INSS, for example) and the evolution of the product. Similarly to the other methodologies, this one also faces a lot of criticism:

1) Giles and Tedds (2002) state that there is no guarantee that the model is capable of precisely reflecting the share of shadow economy because the causes and the indicators may reflect other economic phenomena;

2) MIMIC does not reproduce an estimation that may represent shadow economy as a percentage of GDP, but only an index;

3) The flexibility provided by the MIMIC approach does not avoid the use of variables that are difficult to measure. The application of the method needs the use of variables that are hard to measure, which may contain errors.

4.1.7 – Physical Input Method

The physical input method is divided into two: the Kaufmann-Kaliberda method and the Lackó. The Kaufmann-Kaliberda method supposes that the best physical input to measure economic activity is electricity, since the elasticity between electricity and GDP is

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[2] Note that this problem already occurred, to a certain extent, with the monetary method and the transactions method. In the first one, after estimating demand for currency including among regressors the determinant factors of the shadow economy, it was necessary to suppose that in a given year its burden was very small, which, in fact, was the equivalent of requiring knowledge of its burden to the GDP in one year.

close to one. Thus, the increase in consumption of electricity is compared to the increase in GDP. The growth of electricity consumption must increase in the same proportion as the GDP. All growth of electricity at a rate higher than the growth of the official GDP would be an indication of growth of shadow economy. Thus, it is possible to reconstruct the GDP's series under the theory of this proportionality. The method is not only simple, but also very appealing. However, it has some problems. Not all informal activities require a lot of electric power, which allows the measurement of only part of shadow economy. Throughout time there is great technical progress and the consumption of power, by unit of product, is reduced. Finally, the speed of growth of power consumption should be very different between the sectors.

Another physical input method is proposed by Lackó. This method assumes that a significant part of shadow economy is associated with activities that occur in households. In other words, part of the electric power consumed in households is, in fact, directed to the informal activity. This method is also subject to much criticism. Not all informal activities require electric power. Informal activities do not occur only in households, and it is uncertain to assume that social expenses might be used as a factor to explain informal activity (as used by the author) and it is questionable to know what is the best database to calculate the size of shadow economy, especially in developing countries.

4.2. Results

Johnson *et al.* (1997, 1998b) found evidence that more regulations lead to larger shadow economy. Other reasons are: increase in unemployment, reduction of work hours, early retirement and support to the social protection system. All these factors encourage individuals to migrate to shadow economy.

Johnson, Kaufmann and Zoido-Labaton (1998a) found evidence that high regulatory and tax burden, weak law enforcement and high levels of corruption explain the high level of informality in Latin America. In a sample of 67 countries, Schneider and Enste (2000) show that shadow economy has grown steadily in the last two or three decades.

Hill (2002) states that part of the shadow economy's growth may be a result of dissatisfaction of part of the population with the public services received and with the tax rates. On the other hand, tax evasion reduces government's capability to provide a better service.

Giles, Tedds and Werkneh (2002) examine the relationship between the reported and the non-reported product in Canadian economy. The authors used temporal data from Canadian economy and conduct Granger's causality tests (using the methodology from Toda and Yamamoto (1995)) between formal and informal income. They found causality of formal economy to informal economy. Reverse causality of shadow economy to formal economy was not found in Canadian economy.

Bajada and Schneider (2005) show that not only the size of shadow economy increased between 2000 and 2003 for most countries, but countries with low tax burden and initiatives to monitor informal activity registered higher expansion of shadow economy, a paradoxical result that will require a deeper analysis from researchers.

OCDE countries showed a decrease in shadow economy between 2000 and 2003 while the other countries studied observed an expansion of the formal sector. In addition to

that, although the comparison is difficult due to the different stages of development, it is possible to state that countries with more solid inspection institutions have more stable informal sectors (despite their smaller size) than those where inspection and the degree of institution development are worse.

5. MIMIC

Since the method that we use in our study is the MIMIC (*multiple indicators multiple causes*) method, this section is dedicated to a more detailed description of its results and the main criticism it has received.

5.1. Results with the use of MIMIC

Frey and Weck-Hannemann (1984) was the first study to adopt the non-observable variables methodology to asses the shadow economy. Tedds (1998) is the first author to use MIMIC to study Canadian economy. The indicative variables chosen were the growth rate of the actual product, the share of men in the workforce, and the amount of currency with the public. He determined that the value of each of these variables has a positive impact in shadow economy. The most important cause variables identified by the study were the tax rates and the tax burden. Tedds uses the total federal tax collection. The author filters the variables to make them stationary before making the estimation. To obtain the series in the size of shadow economy (in level), given that the MIMIC method produces only one index, the study used a measure of shadow economy for a specific year, based on a model of demand for currency.

Giles (1999) uses the MIMIC method to create a temporal series of shadow economy in New Zealand, calibrating the index with the estimation of an equation of demand for currency, similarly to the previous study. The author finds that shadow economy increased its size between 1968 from 6.8% of the product to 11.3% in 1994.

Giles and Tedds (2000) compare the results obtained in studies about shadow economy in New Zealand and Canada. The authors estimate the size of shadow economy using the MIMIC method to learn about shadow economy's behavior throughout time and, calibrate their results using the technique of estimating the demand for currency. The results show that in both countries there is an increase in shadow economy. This growth is faster and less erratic in Canada. In both economies, formal economy causes, in Granger's sense, shadow economy, while the opposite is not true. In both cases, an increase in tax burden causes a growth in shadow economy.

Giles and Tedds (2002) extend Tedds (1998). In this article, the authors estimate models with several specifications of indicative and cause variables, to obtain a certain degree of strength. The authors choose as indicative variable the growth rate of the actual product and the value of the paper-money in the hands of the population. The utilized variables that cause shadow economy were the number of people with one or more jobs, the income of self-employed workers, the nominal currency exchange rate, the ratio of income from the corporations' taxation of the product, the total indirect taxes as a percentage of the product, the actual income available per member of the workforce and the unemployment rate. The results obtained are very similar to those of Tedds (1998). They show that Canadian shadow economy is big and is growing.

Some comments about the choice of variables are pertinent here. The growth of actual product is an important indicative variable, although its relationship with formal economy is not clear. The literature has not shown a consensus about the impact of formal economy in shadow or informal economy. This occurs because shadow economy may grow driven by a strong growth of formal economy that starts to demand goods and services from shadow economy or shadow economy might grow more in periods in which formal economy is in recession due to the migration of workers between the two. Obviously, as previously mentioned, the large number of financial innovations makes it harder to use the amount of currency with the population. One possibility, instead of some monetary instrument, is to use the ratio of the total consumed by total income available, since it is assumed that people with income from informal activities consume more than they save. Thus, an increase in this ration indicates an increase in illegal activity. Finally, the rate of official participation in the workforce is used as an indicative variable. It is believed that people do not leave the work market to go to shadow economy. The cause variables used were: 1) number of self-employed workers and people with more than one job. Those people have incentives and opportunity to participate in the informal market. When economy does not grow, the number of self-employed people increases. 2) Several variables that measure different aspects of economy's tax structure.

Dell'Anno and Schneider (2003) use the MIMIC method to study shadow economy in Italy and in 21 other OCDE countries. Estimations show that shadow economy in OCDE countries varies from a maximum of 28.3% for Greece, to a minimum of 10.8% for Austria and 8.6% for the USA. A growth of shadow economy during the first half of the nineties is also observed for the OCDE countries. In the second half, shadow economy in most countries is stationary and in some cases it is decreasing.

Next, the authors comment in detail the analysis of the Italian case. The authors selected as causal variable, the tax burden, the government actual consumption, the unemployment rate, the total of self-employed workers as a percentage of the workforce, the efficiency index of the justice system, and the level of illegal activity. The indicative variables used were the actual GDP and the amount of paper-money with the population.

The main econometric difficulties pointed by the authors for the use of the MIMIC method were: 1) the calculation of confidence intervals associated with the latent variable, 2) testing if structural and measurement errors are independent, 3) identifying the property of residues, and 4) application of the model of structural equations in small samples and temporal analyses. Despite these problems, the authors state that among the methods of analysis available for the study of shadow economy, MIMIC is the most solid methodology.

The authors conclude showing that: 1) the reduction of shadow economy between 1966-1974 is a result of the reduction of self-employed workers, 2) the stability seen in the mid-nineties is due to the stability of taxes and social security; 3) differently from the Canadian case, there is a negative relationship between GDP growth and increase in shadow economy; 4) the analysis confirms the impact of tax burden and of the presence of the public sector in the dynamics of shadow economy.

Dell'Anno, Gómez and Pardo (2004) study shadow economy in France, Spain, and Greece. The authors use the MIMIC approach. They use tax burden, regulation,

unemployment rate, and number of self-employed workers as cause variables of shadow economy and the participation ratio and the ratio between paper-money in circulation and the amount of currency (M1) as indicative variables of shadow economy.

The results confirm that unemployment, tax burden, and self-employment are the main causes of shadow economy in those 3 countries. The indirect taxes are the greatest determinant of tax burden over shadow economy in Spain. In France, the direct tax is the largest fiscal determinant. In Greece, no such evidence was found. Finally, a country's level of development, described by the per capita income, and political stability seem to be possible explanations for shadow economy.

5.2. Debate about MIMIC

Helberger and Knepel (1988), in criticizing the pioneer work of Frey and Weck-Hannemann (1984), state that the MIMIC method is not very strong for changes in the periods of study and number of countries. Additionally, they claim that there is a high degree of arbitrariness in the choice of cause variables and indicative variables which, sometimes, take inverse roles in different studies, given the little theoretical support of their choices.

This first set of criticism emphasizes that, in addition to the care in the choice of indicative and causal variables, it is necessary to use a series of samples with different periods to show the robustness of the model. Quality of the data is also an essential factor for the success of the task. The meaning of the latent variable (in other words, the interpretation it will be given) depends completely on the choice of variables. The variables about taxation, for example, should contain marginal and average rates whenever possible, as well as differentiate taxation over income, taxation over production, and taxation over consumption.[3]

The use of the MIMIC model is becoming more common in the literature. Several authors have been adopting the methodology used in Giles and Tedds (2002) to perform case studies in their countries. This popularity has stimulated an intense debate over the benefits and problems associated with the use of this methodology to measure shadow economy.

Smith (2002) and Hill (2002) criticize Giles and Tedds's book for the lack of an economic theory to direct specification, for the complexity of the estimation strategy and mainly the arbitrariness that exists in the process of choosing cause and indicative variables. Another point of criticism is the estimation strategy in two stages. Hill (2002) states that there is no explanation for the exclusive use of men with more than one job in the role of cause variable which ends up being the most important variable. Another raised issue is the use of the variable in level instead of using it as a proportion of workforce. Since the objective is to build an index of the share of shadow economy in the GDP, it would be more recommended that the variables that participate in the study were expressed in the form of ratios whenever possible (in this case, as a percentage of the workforce for example). Finally, a direct measurement of self-employed workers would be better than men with more than one job. The use of the amount of nominal currency as an indicative

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[3] Most studies adopt the actual tax, since it is easier to obtain that information. However, the best fiscal measure would be marginal taxation, which is the one that really affects the agents' decision.

variable is also questionable given that the variations might indicate several other factors other than shadow economy, besides the fact that it is influenced by inflation. Hill states that the study did not explain the reasons why the direct methodology of data collection by the Canadian government, which estimates shadow economy in 5%, is so underestimated. Finally, it is agreed with the authors that it is impossible to say for sure that the latent variable is shadow economy. Hill concludes that the use of the MIMIC method makes sense, although he states that it is still difficult to know whether it is possible to apply it in a convincing way given the several difficulties.

Smith (2002) initiates his article by praising the wide extensive work made by Giles and Tedds. In it, the authors make a careful examination of literature about shadow economy in Canada; they analyze its evolution between 1976 and 1995; document the evolution of shadow economy in several countries, and list a number of causes and show the different approaches adopted for the stimulation of shadow economy. Smith criticizes the study of Giles and Tedds in terms of the use of a model of demand for currency to measure the index obtained with the MIMIC method. Another source of criticism is the use of average taxation, very distant from marginal rates, which matters in the decision of individuals.

Smith also criticizes Giles and Tedds' assurance of their results, as opposed to a literature that presents very different estimates for the statistic in question. The author states that Pissarides and Weber (1989) show that more than 35% of the income of self-employed people is not reported. Apel (1994) points out that in Sweden this number is 26% while Mirus and Smith (1997) document that between 11% and 16% of the income of self-employed people in Canada is not reported. Recently, a study made by Schuetze also for Canada shows that this number varies from 12% to 24%. There is no obvious explanation for so much variation of this number between 3 developed countries. Even so, Giles and Tedds noticed that the elevated growth in the number of self-employed workers increased the opportunity to underreport income in Canada.

Giles and Tedds (2002) started their response to Hill and Smith's criticism by saying that it is very difficult to measure the immeasurable, and that in order to execute this task it is necessary to create a series of theories that will always be subject to controversy and debate. However, since no one knows the correct value, none of the estimates can be considered wrong. The authors state that the methodology used (MIMIC) in the estimation is very interesting, but not free from criticism. The main doubt is about the real meaning of the latent variable. That question cannot be answered with certainty; however, its answer depends on how careful the choice of cause and indicative variables were made.

Another controversy in its methodology is the way to transform an index into a measurement of shadow economy (as fraction of the product). In other words, how to calibrate the index. The authors use an estimation of a model of demand for currency that incorporates a formal and an informal sector to obtain the level of shadow economy.

Finally, the authors agree that using effective taxation is not the best way to analyze the impact of fiscal policies on shadow economy, since its increase may be caused by a higher rate or by an expansion of the base, completely different policies. However, its use allows a comparison between OCDE countries and, it is also made easier by the availability of data.

Breusch (2005a) presents a very strong criticism of Giles and Tedds's (2000) measurement. The author documents that there is no difference between the measurement of shadow economy obtained by the authors and one of the cause variables used. In other words, he shows that the measurement of shadow economy is in fact a simple transformation of one of the cause variables. Additionally, this variable (SELF, which measures the income of self-employed workers in nominal values) measures the absolute value of the level of activity of the product in the sector, not the activity as a proportion of the product. Furthermore, the variable is measured in Canadian dollars and is not adjusted by inflation. These points undermine the credibility of the interpretation given by the authors, a fact they acknowledge.

Next, there is a careful analysis of the normalization process of the index obtained by the MIMIC method. Initially, Breusch (2005a) states that both the work of Giles and Tedds (2000) and several other studies use the estimations of shadow economy obtained by the method of demand for currency as if they were in fact an observation that is independent from shadow economy. Well, if it were possible to obtain a reasonable measurement of informality through the method of demand for currency for a given point in time, why not use this methodology for all points in time? Why would it be necessary to build the index with the MIMIC method? In addition to this conceptual point, Breusch shows that the econometric model used to estimate the demand for currency is not identified locally or globally. In other words, it presents different possible estimations of solution to the same econometric problem. Thus, researchers may have 'chosen' numbers that are not necessarily the right ones, but are the closest to those existing in literature.[4]

Giles and Tedds (2005) respond to the criticism made by Breusch. They state that criticism made by Breusch did not in any way invalidate their methodology. They claim that one of the advantages of MIMIC is that the model produces a temporal series of shadow economy. However, it generates only one index. As previously shown, in order to transform this index in a specific size of shadow economy, estimations of the actual size of the shadow economy in one or more points in time are necessary. The authors agree that the model of demand for currency is not identified and that in the index estimation, on the first phase of the exercise, only one variable determines the behavior of the index throughout time. Nevertheless, the authors claim that the result does not imply that the methodology used should be abandoned but, obviously, it invalidates the result of the respective study. The identification problems only mean that the specific form of demand for currency must be reconsidered and that one of the cause variables used in the estimate is subject to questioning. In respect to the model's prediction, the authors state that the estimation with stationary data and the prediction with the data before removing the differences is the correct form.

Breusch (2005b) presents the most comprehensive criticism found in literature regarding the use of the MIMIC method in the estimation of shadow economy. The author critically examines the MIMIC method and three of its most recent applications found in literature: Giles and Tedds (2002), Bajada and Schneider (2005), and Dell'Anno and Schneider (2003). Initially, the author shows that there is nothing very original in the MIMIC methodology. He shows that it is very much possible to rewrite the equations to be

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[4] Different statistic packages use different methods to solve the same problem. When the estimated equation (or model) is globally identified, the solutions must be equal. In a non-identified model, this does not occur.

estimated and reinterpret the MIMIC model as a particular form of linear regression model and simultaneous equations. The author also carefully examines the auxiliary procedures used in the calibration of the index obtained through MIMIC. He states that it would be more appropriate to call this procedure as anchorage instead of calibration. Breusch concludes that the three applications use subjective procedures.

In addition to the lack of a common methodology in the three studies analyzed, the three cases differ in terms of the interpretation of the latent variable, in the calibration approach and other adjustments used in the data. In all three articles analyzed, the transformation of the data is not documented. Thus, it is not clear for the reader the extent to which the results of MIMIC are modified to be compatible with evidence from other studies. In some cases, the inference is sensitive to units of measure used to measure the variables. Such sensitivity is not desired in any estimation, since it is affected by factors that are irrelevant to the theory. As a consequence, the method lacks objectiveness, since it is subject to manipulation. The differentiation of data with the purpose of solving problems of single roots and co-integration, not always solves them and can cause serious estimation problems. Finally, the author reports several errors and anomalies in the three studies.

According to Breusch (2005b), Giles and Tedds (2002) differentiate the data in an arbitrary way and estimate the coefficient with the data in level. The calibration is also made in an arbitrary way and it originates from an estimate of a non-identified model of demand for currency. Bajada and Schneider (2005) quote Giles and Tedds as a basis for their estimations, but use a very different procedure. All the variables are differentiated only once (Giles and Tedds mix variables that are differentiated once with variables differentiated twice) to avoid problems of single roots and all variables are calculated as deviations from the averages in the estimation of the model, although this is not reported in the work. In addition to that, the variable is not normalized to present unit standard deviation as in Giles and Tedds. The authors adjust the level of the latent variable and not its scale. Since MIMIC estimates an index, this form of adjustment changes the index. The authors support the measure in a certain level instead of calibrating the benchmarking index. In other words, the authors change the variable without keeping the index relationship.[5] The conclusion is that the formulation in Bajada and Schneider (2005) solves a series of problems that come up in the contributions of Giles and Tedds, but, evidently, is not able to solve the basic conceptual problem associated with the transformation of the index into a measurement of informality.

Dell'Anno and Schneider (2003) also quote Giles and Tedds, but they use a very different method. The variables are differentiated once for the estimation without any non-stationarity test, but with that objective. The causal variables are in first difference while the indicators are the first difference of the logs. The interpretation of the latent variable is of semi-annual growth. Once again, the index is anchored instead of calibrated. The transformations made cause bias in the predictions, which seems to be a common problem in the MIMIC estimation. Breusch concludes that MIMIC does not seem to be an adequate

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[5] The new "adjusted" variable loses the original property of the index to compare the growth of informal economy. For example, previously the ratio of the index between t and $t+1$ was 1.02, but in the new variable this ratio is 1.05. In other words, something was measured in the index, and that is not captured in the new variable.

model to measure the size of shadow economy, since the ways to calibrate the index do not seem to be correct.

In addition to that criticism, Breusch, quoting one of the basic statistic works that created the method, Joreskög and Goldberger (1975), remembers that the MIMIC method must satisfy the following properties:

1) the indicative variables should be measurements of shadow economy with noise;

2) given the causes, the indicators should be mutually non-correlated.

In other words, the model requires: indicators conditionally independent from the cause variables; indicators mutually independent, premises that are not tested in the works under review.

Given the extension of the criticism from Breusch (2005b), Dell'Anno and Schneider (2006) respond to it by defending the MIMIC approach as one of the best methods to study shadow economy. The authors state that the estimation of shadow economy is a "minefield" because any method used requires the adoption of a series of theories to solve the problems relative to the data used. They note that the interpretation of the MIMIC method as a linear model of simultaneous equations made by Breusch is not new. Moreover, the fact that a model is a special case of simultaneous equations models does not scientifically invalidate it. The authors state that Breusch does not replicate the procedure adopted in Dell'Anno and Schneider with accuracy.

As for the criticism made by Breusch in terms of the normalization of parameters during the estimation, the authors state that the choice of the parameter's sign in the normalization affects all coefficients the same way.[6] Thus, they choose the parameter's sign so that the economic relationships established by theory are maintained in the estimation. For example, the theory suggests that an increase of taxation increases the size of shadow economy, indicating a positive sign of that coefficient. Thus, the choice of sign in the normalization is made so that this positive coefficient is obtained. Therefore, this procedure is not arbitrary, but based on economic theory. The authors agree with the criticism that the transformation of the index obtained through the MIMIC in terms of size of shadow economy is difficult, caused by controversy and that there is not a consensus about the best way to execute this task in the literature.

In respect to the criticism about the use of deviation from the average in all variables, the authors claim that their use comes from the literature, since variations of the variables are determined by variations in their causes and not by some effect of levels. Finally, the authors support the use of the MIMIC approach in the estimation of shadow economy, since its flaws are due to the initial level of research and not of the lack of adequacy of the model.

After a careful reading of the debate, we reached the conclusion that the calibration process is in fact fairly arbitrary. The other criticisms from Breusch seem avoidable and have been satisfactorily responded by Dell'Anno and Schneider (2006).

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[6] During the estimation procedure one of the parameters is normalized in order to simplify estimation. This normalization affects all coefficients estimated. A change of sign in that normalization changes the sign of all parameters. See the presentation of the MIMIC method in subsection 4.1.6.

6. Estimation of Shadow Economy in Brazil

Among the methods used for estimating shadow economy, MIMIC (*multiple indicators multiple cases*) is the one that seems more promising in relation to the behavior of the shadow, "informal" and/or illegal activity. The advantage of this method resides in the use of several variables as causes for shadow economy. Furthermore, the method provides an index related to the non-official economy over time.

Once the indicator and causal variables are selected properly, in a manner that the unobserved variable measured by the method is the informal economy, MIMIC is the most suitable method for this study. The index obtained by MIMIC provides a good and reliable basis for analyzing shadow economy over time. Thus, the use of the MIMIC method was selected for the estimation of shadow economy in Brazil.

6.1- DATA

Various data were used for estimating the informal economy index, based on the MIMIC methodology. Various sources were used: Monthly Employment Survey (PME), Central Bank of Brazil (BACEN), Department of the Treasury (MF), Brazilian Institute of Geography and Statistics (IBGE), State System of Data Analysis Foundation (Seade), Inter-Union Department of Statistics and Socio-Economic Studies (Dieese), Foreign Trade Secretariat (SECEX), among others.

6.1.1 – PERIOD OF ANALYSIS

Due to data availability, the period of analysis selected for the calculation of the index is from March 2002 to August 2007. This choice was made based on the various changes in methodology through which the Brazilian series have recently undergone, especially Monthly Employment Survey (PME) and the new methodology for Gross Domestic Product (GDP), calculated by IBGE. The use of data collected prior to these changes represents a type of rupture in the sample, and as such, was avoided.

For model estimation, monthly data was used for building a database with quarterly observations. The following data was used in the estimation of the economy: Paper Money in Circulation (PMPP), percentage of informal workers, minimum wage, average nominal salary, average actual salary, federal taxes, total collection of Federal Revenue, Automotive Vehicles Tax (IPVA), State VAT (ICMS), GDP, open unemployment, exports and commercial dollar exchange rate.

6.1.2 – SERIES USED

The estimation used the following series:

A – PMPP: this series is calculated as follows: PMPP/DEP. It is obtained by means of dividing the total amount of paper money in circulation (PMPP) by cash deposits. Both series are obtained from BACEN's site.

B – NCART: this series represents the percentage of informal workers. It is obtained based on PME data and it is defined as the ratio between the number of informal workers and the employed population, less the informal workers.

C – EXP: ratio between the total amount of the manufactured goods exported and GDP, in reais. The data related to exports (FOB) is obtained from SECEX, multiplied by the ptax commercial dollar exchange rate (average monthly exchange rate, obtained from BACEN's site) and the resulting value is divided by the GDP.

D - ARRE: defined as the total collection less municipal collection; it results from the sum of various taxes (such as ICMS and IPVA) and of the total federal collection;

E – DES: unemployment was calculated by means of the ratio between the employed population (PO) and the economically active population (PEA); both variables were obtained from the monthly employment survey (PME);

F – SIMP: total collected by SIMPLES (system of collection with less bureaucracy, created by the federal government aiming at attracting companies to formality) as a fraction of the GDP;

G – CPMF: total CPMF collected, as a fraction of the total federal collection;

H – RIG: a variable built to measure the level of rigidity of the labor market. It is the result obtained from the ratio between minimum wage and average wage of the economy.

I – DIFREAL: it is the formal/informal salary premium in the labor market, which also aims at measuring the rigidity level of the labor market;

J – CORR: measure of the corruption level in the country. This variable was purchased from The PRS Group. It is obtained by means of interviews with several executives, who provide their opinion on the corruption level in the country.

6.2 - EXPECTED COEFFICIENTS

The PMPP and NCART variables are selected as indicative variables. Theory suggests that such variables are positive, which indicates that a higher circulation of currency held by the public and a higher proportion of informal workers demonstrate the development of shadow economy.

The CPMF variable was used as indicator/causal variable. As indicative variable, it is expected that a higher percentage of CPMF collection in relation to the federal collection will indicate a growth in shadow economy. That is, it is expected that its coefficient be positive, given that CPMF is collected whenever an agent (of the formal or shadow economy) uses the banking system, while the collection of the remaining taxes tends to decrease when shadow economy grows. As causal variable, it is expected that CPMF is able to decrease shadow economy, since it can be used as a variable for fighting tax evasion.

The remaining variables were used as "causal" variables of shadow economy. Since the export sector is extremely formal, it is expected that the total exported as GDP percentage brings a negative impact on shadow economy, since it fosters the growth of formal economy.

A higher rate of collection/GDP and a higher corruption level should have a positive effect on the growth of shadow economy (that is, it should present a positive coefficient).

A higher rigidity level in the labor market (measured by means of the RIG and DIFREAL variables) must be associated with a larger shadow economy (positive coefficient).

SIMPLES was an instrument created by the government to attract more companies to formality by simplifying tax and regulatory procedures in general, by means of lowering the taxes payable. Thus, an increase in the collection of SIMPLES in relation to GDP must decrease shadow economy.

Finally, theory suggests that the coefficient of the causal variables used for measuring unemployment can be either positive or negative. That is, shadow economy can develop in parallel with the development of formal economy, or it can develop when formal economy faces a crisis.

6.3 - RESULTS

The results reported in the tables below originate from the MIMIC model estimation. The indicative variables used are: the ratio between the currency held by the public and cash deposits (PMPP), the percentage of informal workers within the employed population (NCART) and the ratio between the total CPMF collection and the total collection. The causal variables used are: the ratio between the exportation of manufactured goods and GDP (EXP), total collection as GDP percentage (ARRE), unemployment (DES), the ratio between the total collected by SIMPLES and GDP (SIMP), the ratio between the total collected by CPMF and the total collection (CPMF), a rigidity measure represented by the ratio between the minimum wage and the average salary of the economy (RIG) and a variable that measures corruption (CORR).

The various specifications used demonstrate that several variables are very robust and significant. Several specifications of the MIMIC model were estimated, comprising the aforementioned variables. The results reported below only show the models which presented better adherence to the data, according to relevant statistics. First, the results of the MIMIC model estimation obtained by means of standardized data are reported. Subsequently, the MIMIC results which were estimated based on non-standardized data are reported.

Model estimation with standardized data provides estimations that report the actual impact of the causal variable on the latent variable, which, in this case, is the shadow economy. Thus, a higher coefficient indicates a higher impact of the variable on shadow economy, indicating the variables that will affect it the most. Since all variables are in the same scale, its coefficient represents the direct effect of each of them.

The selection of models is conducted so that the development of shadow economy is estimated. In order to estimate it, it is necessary to select the model that best describes it to present its evolution over time. In order to do so, several data adjustment measures were used, being χ^2 the main one. (chi-square).

6.3.1 – Selection of Models

Several adjustment measures can be used for selecting the model with the best data adjustment. In this case, the following measures for assessing model adjustment quality are used: statistic χ^2 (chi-square), root mean squared error - RMSEA, root mean squared residual – RMR and the adjusted goodness of fit index - AGFI.

The chi-square statistic is *N-1* times the minimum value of the adjustment function. Thus, as the sample grows, the statistic χ^2 tends to grow as well, since a higher number of observations will cause the model to be rejected. This fact occurs because the χ^2 assumes that the model is perfectly adjusted to the population, which is a very strong theory. A consequence of this theory is that, since the model is the not the process that generates the data, models with a good population approximation[7] are rejected as the sample grows.

Due to this fact, various other adjustment measures have appeared in literature. Several adjustment measures were proposed to reduce sample-size dependence[8]. The Adjusted Goodness of Fit Index (AGFI), which was developed by Jöreskog and Sörbom (1989), measures how much better the model is when compared with the use of no models for data adjustment. This criterion is directly dependent on χ^2 and on the degrees of freedom of the model. The best models are those which present higher values for such statistics.

Another statistic used for solving the issue related to statistic rejection χ^2 in large samples was developed by Browne and Cudeck (1993), based on the approximate population error and on the precision of the measure itself. The authors developed the RMSEA, which is a discrepancy measure. They suggest that models that present errors above 0.08 incur in high population approximation errors and must be rejected.

The six models presented are a subgroup of the models with the best statistics obtained, especially in relation to statistic χ^2. This statistic was generally rejected by the majority of the models estimated. However, since several other models presented a low statistic χ^2, it can be concluded that the remaining models were not rejected due to excess of observations, but rather, because they were actually not capable of describing the data precisely.

In addition to comparing χ^2, it was also observed whether the relevant variables were significant and whether they obtained the expected signs. As reported above, the variables generally obtained the expected signs and were significant. For instance, a positive relationship between the tax burden (ARRE) and corruption (CORR) in relation to shadow economy development was observed. It was also observed that shadow economy has a pro-cyclical behavior, growing whenever the economy picks up steadily as a whole. Finally, exports, as a proportion of the GDP, stimulate shadow economy.

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[7] Models with a small error present a low χ^2. However, as the sample grows, the statistic χ^2 tends to grow as well, since the process that generates the data differs from the process replicated by the model. Thus, for large samples, the model will be rejected by means of a high χ^2. For more information, please refer to Jöreskog and Goldberger (1993), page 123.

[8] These measures do not directly depend on sample size; however, they may indirectly do so, by means of the sampling distribution that depends on N.

6.3.2 – Standardized Estimations

It is important to notice that, in the table provided below, the model was estimated based on the standardization of all data. Thus, the estimated coefficient can be interpreted as the impact related to each variable on shadow economy. Higher absolute values of a variable indicate that it has a higher impact in relation to another.

The estimations obtained in table 1 demonstrate that the collection (ARRE), unemployment (DES) and corruption (CORR) variables are the ones that impact shadow economy the most. The unemployment variable presents a negative and significant coefficient, which indicates that a pro-cyclical relationship exists between formal and shadow economies. Thus, an increase in the unemployment rates lowers the shadow economy level.

The coefficients related to the variables corruption (CORR) and collection as GDP percentage (ARRE) are always positive and significant, indicating that shadow economy expands whenever these two variables are higher.

Another significant variable is the one that deals with the ratio between the total of manufactured goods exported and the GDP, which is negative, indicating that an increase in exports will cause a decrease in shadow economy, according to theory but contrary to other previously reported studies.[9]

Table 1 Shadow economy estimations with standardized variables.						
	6	9	10	13	15	18
Indicative variables						
PMPP/DEP.	1.000	1.000	1.000	1.000	1.000	1.000
NCART	0.548**	0.261	0.260	0.084	0.258	0.267
	(0.332)	(0.245)	(0.245)	(0.275)	(0.262)	(0.262)
Causal Variables						
EXP	0.016	-0.290**	-0.289**	-0.311**		
	(0.219)	(0.159)	(0.157)	(0.161)		
ARRE	0.3178	0.632*	0.634*	0.676*	0.422**	0.415*
	(0.324)	(0.239)	(0.238)	(0.252)	(0.220)	(0.212)
DES	-0.429	-0.194*	-0.488*	-0.392*	-0.551*	-0.568*
	(0.327)	(0.234)	(0.205)	(0.242)	(0.258)	(0.216)
SIMP	-0.260	0.249*	0.249*			
	(0.174)	(0.125)	(0.124)			
RIG	-0.056	-0.007		0.004	0.021	

[9] Arvate et alli (2006) and Ribeiro and Bugarin (2003) obtain positive estimates for exports.

	(0.218)	(0.155)			(0.159)	(0.173)	
CORR		0.681*	0.681*	0.621*	0.603*	0.602*
		(0.148)	(0.148)	(0.158)	(0.163)	(0.163)
Precision Measures of the Model							
G. L.	4	5	4	4	3	2
χ^2	7.044	7.177	8.579	5.370	0.686	0.084
P-Value	0.134	0.208	0.073	0.251	0.876	0.959
RMSEA	0.190	0.144	0.190	0.094	0.000	0.000
RMR	0.098	0.098	0.108	0.090	0.034	0.010
AGFI	0.388	0.433	0.388	0.576	0.926	0.988

Results showed that the variable corruption (CORR) has a major impact on shadow economy, with a coefficient that varies between 0.602 and 0.681. This result demonstrates that the fight against corruption is essential for reducing shadow economy, since corruption, in addition to being positively related to shadow economy, has a very high impact on it. That is, a high degree of corruption in society will stimulate the growth of shadow economy.

The rigidity measure (RIG) used was not significant. It was expected that the rigidity would contribute to the increase of shadow economy.

In relation to the variables that impact shadow economy the most, it can be concluded that corruption (CORR) and tax burden (ARRE) are those with the highest impact, followed by unemployment (DES) and then by exports (EXP).

The results reported in the table above can be summarized as follows. The variable ARRE, which measures the tax burden as GDP percentage, was always positive and significant, with coefficients that varied between 0.415 and 0.676, which infers that the tax burden stimulates the development of informal economy, as expected by theory.

The variable DES, which measures unemployment, is always negative and significant. Informal workers are not considered as being unemployed. Hence, whenever unemployment rates rise, less people work, either formally or informally. Whenever the unemployment rates increases, shadow economy decreases, which indicates its pro-cyclical development[10].

The variable CORR, which measures the corruption level observed in the economy by agents, is always positive and significant. Higher corruption levels increase shadow economy.

The variable that measures exports as GDP percentage (EXP) always had a negative coefficient, which implies that an increase in the volume of exports reduces the size of shadow economy. Theory suggests the sign of such variable, assuming that the export activity is always extremely formalized.

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[10] This result differs from other studies that were conducted in Brazil and that provided an opposite result.

The variable that measures the rigidity of the labor market (RIG) is always non-significant. No model presenting the aforementioned variables was statistically selected among the several models estimated.

SIMPLES has a positive impact on shadow economy, which differed from the expected. Thus, SIMPLES does not aid in decreasing the size of shadow economy, as suggested in theory. Therefore, our model does not demonstrate that SIMPLES is a way to make companies become part of the formal sector of the economy.

6.3.3 – Non-standardized estimations

The models presented in the previous section (6, 9, 10, 13, 15 and 18) were re-estimated without data standardization to estimate the behavior of shadow economy over time. Therefore, these models were re-estimated without data standardization to estimate shadow economy, as reported above.

Table 2 presents non-standardized estimations. Table 2 demonstrates that the coefficients differ immensely from those presented in the previous tables. This result is caused by the non-standardized data. Now, the variables are in different scales, therefore, their coefficients must be adjusted. The coefficient related to corruption, which has an important impact, is highly reduced due to the fact that, when compared to others, its scale is very high.

Table 2: Estimations of shadow economy with standardized variables.						
	6	9	10	13	15	18
Indicative variables						
PMPP/DEP.	1.000	1.000	1.000	1.000	1.000	1.000
NCART	0.187**	0.089	0.089	0.029	0.054	0.091
	(0.113)	(0.084)	(0.084)	(0.094)	(0.055)	(0.089)
Causal Variables						
EXP	0.043	-0.778**	-0.776**	-0.834**		
	(0.586)	(0.426)	(0.421)	(0.432)		
ARRE	0.360	1.281*	1.224*	1.368*	0.855**	0.841**
	(0.656)	(0.485)	(0.482)	(0.510)	(0.445)	(0.430)
DES	-1.074	-1.238*	-1.224*	-0.983*	-1.381*	-1.425*
	(0.819)	(0.587)	(0.515)	(0.606)	(0.646)	(0.541)
SIMP	-9.113	8.719*	8.709*			
	(6.096)	(4.365)	(4.362)			
RIG	-0.059	-0.008		0.005	0.022	

	(0.231)	(0.164)		(0.168)	(0.183)	
CORR		-0.041*	0.041*	0.037*	0.036*	0.036*
		(0.009)	(0.009)	(0.009)	(0.010)	(0.010)
Model Precision Measurements						
G. L.	4	5	4	4	3	2
χ^2	7.044	7.177	8.579	5.370	0.686	0.084
P-Value	0.134	0.208	0.073	0.251	0.876	0.959
RMSEA	0.190	0.144	0.190	0.094	0.000	0.000
RMR	0.098	0.098	0.108	0.090	0.034	0.010
AGFI	0.388	0.433	0.388	0.576	0.926	0.988

It can be observed that in the non-standardized estimation the variables that were significant during the standardized estimation are still significant and present the same signs. The other model statistics related to data adjustment remain the same as well. Thus, the coefficients reported above were used for estimating shadow economy.

6.4 – ESTIMATION OF SHADOW ECONOMY

The estimation of shadow economy $(\hat{\bar{\eta}})$ is very volatile and varies greatly according to its seasonality. Shadow economy peaks occur in months with low unemployment rates.

Due to this high volatility and seasonality and in order to build an index, a technique must be used for removing the seasonality. A shadow economy index must behave steadily, to indicate economy trends. In order to do so, deseasonalization techniques are used.

The technique used was the 12-month rolling average over the index. This choice is based on how important yearly seasonality is in relation to informal economy. Once the rolling average is used, the estimation is obtained. This transformation decreases the volatility related to the series and allows the analysis of the behavior of the estimated shadow economy $(\hat{\bar{\eta}})$.

Using the coefficients that were estimated without standardization for models 9, 10, 13, 15 and 18, the behavior of shadow economy is estimated according to each of these models, as observed in figure 1.

The figure demonstrates that the behavior of the series estimated is very similar, with a difference between the levels of estimations 9, 10 and 13 and estimations 15 and 18. The main change between these estimations is the presence of the variable exports, which is significant for the first three and does not exist in the specifications of estimations 15 and 18.

The absence of the variable exports justifies the difference in level between curves, s it has a negative impact on the shadow economy and it is positive.

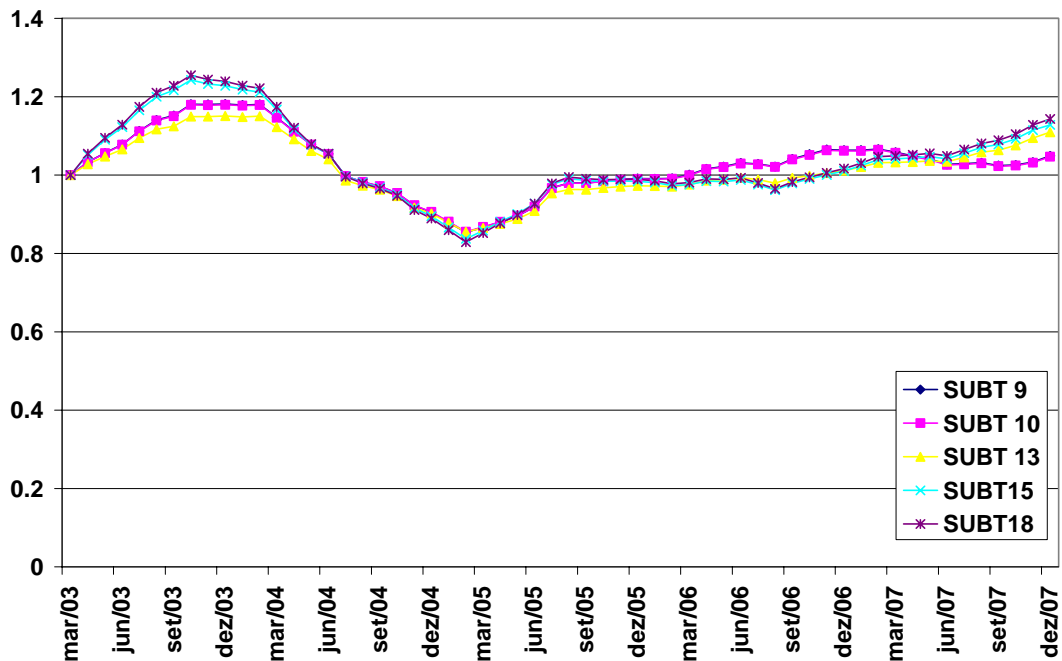**Figura 1: Estimativas da Economia Subterrânea**

Figure 1: Estimations of Shadow Economy

Mar/03, Jun/03, Sep/03, Dec/03, Mar/04, Jun/04, Sep/04, Dec/04, Mar/05, Jun/05, Sep/05, Dec/05, Mar/06, Jun/06, Sep/06, Dec/06, Mar/07, Jun/07, Sep/07, Dec/07.

Among the models presented above, those with the best fit are models 13, 15 and 18. Initially, the models selected are those which present the variables collection, corruption and exports, since they are always very significant. Among the models that presented these characteristics, model 13 presents the lowest statistic χ^2 related to its degrees of freedom and a higher P-value. Furthermore, model 13 has low RMSEA and RMR. That is, despite the fact that model 13 does not present the best RMSEA or RMR statistic χ^2, it is selected based on specifications 15 and 18, because the authors understand that the model that contains exports is the most correct from a theoretical standpoint, despite not presenting the best adherence to the data.

Graph 2 shows the estimation shadow economy $(\hat{\eta})$ obtained by the estimation of model 13.

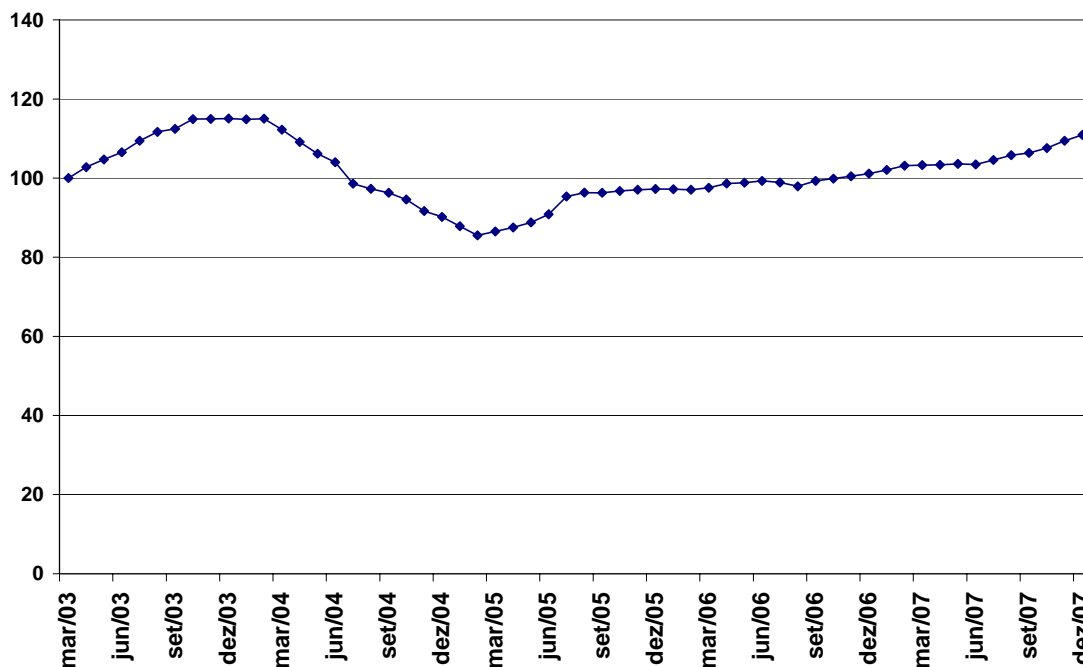**Figura 2: Índice da Economia Subterrânea**

Figure 2: Shadow Economy Index

Mar/03, Jun/03, Sep/03, Dec/03, Mar/04, Jun/04, Sep/04, Dec/04, Mar/05, Jun/05, Sep/05, Dec/05, Mar/06, Jun/06, Sep/06, Dec/06, Mar/07, Jun/07, Sep/07, Dec/07.

It can be observed that shadow economy grows between February and October 2003. From then on, the volume of the shadow economy decreases until March 2005 (June), when it continues to grow until September 2005. After a stabilization period, the shadow economy starts growing in March 2006.

Similarly to other studies, it can be observed that the Brazilian economy presented a growth in shadow economy over the last year, after a period of small decrease since mid-2005.

6.4.2 – Shadow Economy as a Fraction of the GDP

The shadow economy index presented in the graph above demonstrates the behavior of shadow economy over the last five years. However, in order to learn about the behavior of shadow economy as fraction of the GDP, it is necessary that the index be adjusted to the formal economy growth. The use of the MIMIC method to estimate shadow economy $(\hat{\eta})$ only its behavior. In order to analyze the behavior of shadow economy as fraction of the GDP, it is necessary to consider the growth of the product. Thus, the shadow economy index is divided by an actual GDP index (y_r).

$$\Delta \frac{SUBT_t}{PIB_t} = \frac{\widehat{\eta}}{y_r}$$

Therefore, with an index related to shadow economy and another related to the Brazilian economy, the index related to the shadow economy as a fraction of the GDP is obtained. The graph below presents the three aforementioned indexes: shadow economy, actual GDP and shadow economy as a fraction of the GDP.

Figura 3: PIB, Economia Subterrânea e a Razão Subterrânea/Formal
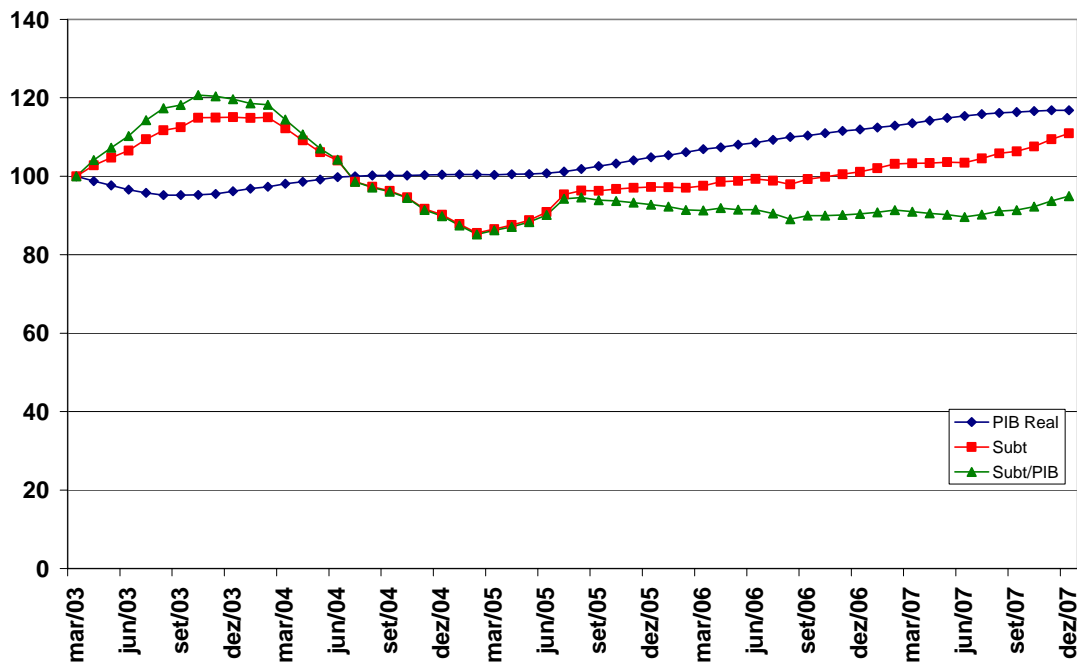

Figure 3: GDP, Shadow Economy and Shadow/Formal Ratio

Mar/03, Jun/03, Sep/03, Dec/03, Mar/04, Jun/04, Sep/04, Dec/04, Mar/05, Jun/05, Sep/05, Dec/05, Mar/06, Jun/06, Sep/06, Dec/06, Mar/07, Jun/07, Sep/07, Dec/07.

The graph above demonstrates that, despite presenting a growth of almost 11% between March 2003 and December 2007, shadow economy as a fraction of the GDP lost ground in the period due to a growth of almost 17% in the actual GDP in the same period. Thus, the shadow economy decreased 5% in the period analyzed. However, the graph above demonstrates that, at the moment, shadow economy is growing more rapidly than the actual GDP, allowing shadow economy as a fraction of the GDP to recover part of the ground lost.

7. Conclusion

This work carried out a careful study of the literature that studies and estimates the behavior of shadow economy. The various methods used to measure shadow economy were analyzed and the debates involving each of these methods were studied.

It was concluded that the best available method for estimating shadow economy is MIMIC, which was used for estimating the behavior of the Brazilian shadow economy over the last years.

The estimation of the Brazilian economy demonstrated that the variables that present a higher impact on shadow economy are activity level (measured by the unemployment rate), tax burden (measured by the ratio of the total taxation over GDP) and the perception related to corruption in the Brazilian economy. It was demonstrated that the higher the activity level, the higher the shadow economy, also demonstrating that it develops itself complementarily to the formal economy. Tax burden and corruption are positively related to shadow economy, that is, the higher the tax burden and the perception of corruption, the larger the shadow economy. Exports as GDP percentage negatively impact shadow economy, despite the fact that this variable was not significant in all estimations.

Finally, the evolution of shadow economy over the last years was estimated. This estimation proved to be extremely volatile. Since the objective was the estimation of a shadow economy index, a 12-month rolling average was used to flatten it and, consequently, to generate the index. It demonstrated that shadow economy develops in periods of economy expansion and retracts in periods of recession. Furthermore, these movements occur more intensely, demonstrating the high dynamism and the low rigidity of shadow economy, which adjusts itself faster than formal economy. The index demonstrated that shadow economy grew by almost 10% between 2003 and 2006.

References

Adam, Markus, C. and Victor Ginsburgh 1985. "The effects of irregular markets on macroeconomic policy: Some estimates for Belgium," *European Economic Review*, **29**(1), pp.15—33.

Apel, Mikael 1994. "An Expenditure-Based Estimate of Tax Evasion in Sweeden," Working Paper.

Alfrod, R. R. and E. L. Feige 1989. "Information distortions in social systems: The shadow economy and other observer-subject-policymaker feedbacks." *In* Feige (Ed.), *The Shadow Economy: Tax Evasion and Information Distortion*, pp.57—81. Cambridge, Cambridge University Press.

Bajada, Christopher and Friedrich Schneider 2005. "The shadow economies of the Asia-Pacific," *Pacific Economic Review*, **10**(3), pp.379—401.

Breusch, Trevor 2005a. "The Canadian shadow economy: An examination of Giles and Tedds," *Canadian Tax Journal*, **53**(2), pp.367—391.

Breusch, Trevor 2005b. "Estimating the Shadow Economy using MIMIC Models," Working Paper, Canberra, Australia.

Cagan, Phillip 1958. "The demand for currency relative to the total money supply," *Journal of Political Economy*, **66**(3), pp.302—328.

De Soto, Hernando 1989. *The Other Path: The Invisible Revolution in the Third World*. New York, Harper and Row.

Dell'Anno, Roberto e Friedrich Schneider 2006. "Estimating the Shadow Economy by Using MIMIC Models: A Response to T. Breusch´s Critique". *Discussion Paper. Linz, Austria: Department of Economics, University of Linz.*

Dell'Anno, Roberto , Miguel Gómez and Angel Pardo 2004. "Shadow economy in three Different Mediterranean Countries: France, Spain and Greece. A MIMIC Approach". *Mimeo.*

Dell'Anno, Roberto and Friedrich Schneider 2003. "The shadow economy of Italy and other OECD countries: What do we know?" *Journal of Public Finance and Public Choice*, **XXI**(2—3), pp.97—120.

Dixon, Huw 1999. "Controversy: On the use of the hidden economy estimates," *The Economic Journal*, **109**, pp.335—337.

Feige, Edgar L. 1989. " The UK´s Unobserved Economy: A Preliminary Assessment. *Journal of Economic Affairs* 1, pp. 205-212.

Feige, Edgar L. 1981. *The Shadow Economies. Tax Evasion and Information Distortion*. Cambridge, New York, Melbourne, Cambridge University Press.

Frey, Bruno and Hannelore Weck-Hannemann 1984. "The Hidden Economy as an "Unobserved" Variable," *European Economic Review*, 26/1, pp. 33-53.

Giles, David E. A. 1999. "Modeling the hidden economy and the tax-gap in New Zealand," *Empirical Economics*, **24**, pp.621—640.

Giles, David E. A. and Lindsay, M. Tedds 2005. "Response to Breusch's critique," *Canadian Tax Journal*, **53**(2), pp.392—395.

Giles, David E. A. and Lindsay, M. Tedds 2002. *Taxes and the Canadian Shadow Economy*. Canadian Tax Foundation, Toronto.

Giles, David E. A., Tedds, Lindsy, M. and Werkneh, Gugsa 2002. "The Canadian shadow and measured economies," *Applied Economics*, **34**(4), pp.2347—2352.

Greenfield, H. I. 1993. *Invisible, Outlawed, and Untaxed: America's Shadow Economy*. Westport, CT, Praeger.

Gutmann, Pierre M. 1977. "The subterranean economy," *Financial Analysts Journal*, **34**(1), pp.24—27.

Hart, Heith. 1973. "Informal Income Opportunities and Urban Employment in Ghana". *Journal of Modern African Studies* 11, pp. 61-89.

Hart, Heith. 1970. "Small Scale Entrepreneurs in Ghana and Development Planning". *Journal of Development Studies* 6, pp. 104-120.

Harding P. and Jenkins, R. 1989. *The Myth of the Hidden Economy: Towards a New Understanding of Informal Economic Activity*. Philadelphia, Open University Press, Milton Keynes.

Helberger, Christof and Helmut Knepel 1988. "How big is the shadow economy? A re-analysis of the unobserved-variable approach of B. S. Frey and H. Weck-Hannemann," *European Economic Review*, **32**, pp.965—976.

Hill, Roderick 2002. "The Shadow Economy in Canada: Boom or Bust?", *Canadian Tax Journal* 50(5), 1641-1654.

International Labor Office 1972. "Employment, Income and Inequality: A Strategy for Increasing Productivity in Kenya". Geneva: OIT.

Johnson, Simon, Kaufmann, Daniel and Andrei Shleifer 1997. "The unofficial economy in transition". Brookings Papers on Economic Activity," Fall, Washington D.C.

Johnson, Simon, Kaufmann, Daniel and Pablo Zoido-Lobatón 1998a. "Regulatory discretion and the unofficial economy," *The American Economic Review*, **88**(2), pp.387—392.

Johnson, Simon, Kaufmann, Daniel and Pablo Zoido-Lobatón 1998a. "Corruption, Public Finances and the Unofficial Economy". Discussion Paper. Washington DC: World Bank.

Jöreskog, Karl G. and Arthur S. Goldberger 1975. "Estimation of a model with multiple causes of a single latent variable," *Journal of the American Statistical Association*, **70**, pp.631—639.

Lubell, H. 1991. *The Informal Sector in the 1980s and 1990s*. Paris, OECD.

Mirus, Rolf and Roger Smith. 1997. " Self-Employment, Tax Evasion and the Shadow Economy: Micro-Based Estimates of Canada", Working Paper no. 1002, Harvard Law School, International Tax Program.

Pissarides, Christopher and Gugliemo Weber 1989 "An Expenditure-Based Esstimate of Britain's Black Economy". *Journal of Public Economics, vol. 39, pp.17-32.*

Schneider, F. and D. H. Enste 2000. "Shadow economies: Size, causes, and consequences," *Journal of Economic Literature*, **38**(1), pp.77—114.

Schneider, F. 1998. "Further Empirical Results of the Size of the Shadow Economy of 17 OECD Countries over time," *Discussion Paper. Linz, Austria: Department of Economics, University of Linz.*

Smith, Roger S. 2002. "The shadow economy: Guidance for policy markers?" *Canadian Tax Journal*, **50**(5), pp.1655—1661.

Tanzi Vito 1999. "Uses and abuses of estimates of the shadow economy," *The Economic Journal*, **109**(456), pp. 338—340.

Tanzi, Vito 1983. "The shadow economy in the United States: Annual estimates, 1930-1980," *IMF-Staff Papers*, 30(2), pp.283—305.

Tanzi, Vito 1980. "The shadow economy in the United States: Estimates and implications," *Banca Nazionale del Lavoro*, **135**(4), pp.427—453.

Tedds, Lindsey 1998. "Measuring the size of the hidden Economy in Canada". *MA extended essay*, University of Victoria, Department of Economics.

Thomas, Jim J. 1999. "Quantifying the Black Economy: 'Measurement without Theory' yet again?," *The Economic Journal*, 109 (June), pp.381-389.