

Modeling Iran`s Underground Economy: A Fuzzy Logic Approach

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Abstract

The underground economy has long been of interest to economists and has devoted extensive studies to itself in economic literature. Through fuzzy logic approach in present research, we estimated the size of underground economy of Iran over the period of 1978-2010. For this purpose and according to theoretical bases and previous studies, variables such as GDP per capita, ratio of direct taxes to GDP and an index of business environment for considering the effect of institutional structures have been used as the most important explanatory variables for estimating country's underground economy. For considering the quality of institutions in this research we have used a local index for the first time compared with other internal studies. Our results indicate an oscillatory trend as the average of relative and absolute size of underground economy has decreased during the years of first development plan compared with period of war and revolution but increased during the second plan compared with the first one. Also it has decreased over the years of third plan in comparison with the second one but again it has increased during the fourth development plan. According to the results, the average of relative size of underground economy to official output during the years of war and revolution, first, second, third and the fourth development plan was approximately estimated 21, 12, 29, 19 and 20 percent respectively. During the entire period it was approximately 20 percent.

Keywords: Business Environment, Fuzzy Logic, Underground Economy.

JEL: O1, C39, P48

1. Introduction

Underground economy is a phenomenon that has provided politicians and economic planners concern in almost every country, particularly developing countries. According to the volume of this part, it leads to the authorities' diversion from correct understanding of the general state of the economy and

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hence adopting inappropriate strategies and improper economic policies, and depriving the country from reaching the planning and policies' goals and causes people to distrust the government and authorities. Besides, underground activity causes or worsens the government's budget deficit by not paying government wages and revenue and limits government facilities in providing public goods and services. Underground economy is a response to regulations and the quality of formal institutions of a country. Although the development of the underground is affected by different factors such as tax burden and tax culture, a qualified official agency boosts the incentive for economic activity in the formal sector by providing a steady and trustworthy environment for firms (Enste, 2010: 557). Though the economic literature on the underground economy is faced with a range of definitions, the definition given by Thomas in 1991 is more accepted by researchers in this field among all. According to this definition, the underground economy is divided into four parts: households (households' consumer goods), unofficial (retail producers not required to keep accounting books), irregular (illegal production of legal goods) and illegal (illegal goods production), as parts which their statistics on the activity volume does not enter national accounts. Among these, the part that is most studied as underground economy is the irregular, where economic actors produce legal goods and services, but in order to avoid tax and other statutory payments or complying relevant regulations and guidelines, all or part of their activities is hidden from the authorities' eyes. The definition adopted in the present study is Thomas's definition of irregular part which will be examined as underground economy. Despite extensive studies in the field of underground economy there has been little attention to the official agencies and the country's state of business space role, which may be due to a lack of or limited access to the data relevant to this factor. This study estimates the size of the underground economy in Iran with respect to the most important variables including an index for the business space, the share of direct taxes in production and per capita production. It is presumed that improvement in the business space and decline in the last two variables is accompanied by reduction in the size of underground economy. Contents of this paper are organized in six sections. The second section will review previous studies and in the third section, methods for estimating the underground economy and the causes of its rise and spread are presented as theoretical basis. Research methodology and underground economy volume estimation are discussed in the fourth and fifth part, respectively. Finally, conclusions are considered in sixth section.

2. A review of some previous studies

Giles (1991) estimated the relative size of the underground economy in New Zealand over the period 1968-1994, using MIMIC method. In his study, the explanatory variables include: taxes, goods and services consumer price

index, dummy variable related to taxation on goods and services, the amount of New Zealand's economy monitoring index, real disposable earnings to total labor force and unemployment rate. The results indicate an increase in the relative size of the underground economy from 6.8 percent in 1968 to 11.3 percent in 1994 and its average is estimated approximately 9 percent of the official production.

Hui- Kuang Yu et al. (2005) practiced fuzzy method to model the underground economy of Taiwan during 1960- 2003 and used the effective tax rate and an index for the severity of government regulations as explanatory variables for this purpose. According to the results, the highest underground economy ordinal index during the period was relevant to 1990 and estimated equal to 0.762.

Kemal (2007) estimated the underground economy and tax evasion in Pakistan during 1974- 2005 using monetary regression method. According to his results, the underground economy varies between 54.6 to 62.8 percent of the official production in 2005 and tax evasion diverges between 5.7 to 6.5 percent of the official production in that year.

Ene and Hurduc (2010) used fuzzy method to estimate the size of underground economy in Romania during 1990- 2007. Explanatory variables used in this study include: the share of direct taxes in GDP, the share of indirect taxes in GDP, per capita production, unemployment rate and corruption index. Based on the results, the average relative size of the underground economy is estimated equal to 33.76 percent for the studied period.

Schneider and Buehn (2010) estimated the size of the underground economy for 162 countries over the years 1997- 2007 through MIMIC method. Tax burden and social security contributions, an indicator of the severity of regulations, an index of public services, output per capita and unemployment rate are used as the underground economy explanatory variables. In this study, three groups of countries have been classified as developing countries, Eastern Europe and central Asia countries, and OECD countries. According to the results obtained from developing countries, China had the least and Bolivia had the most relative underground economy volume during the period with an average of 12.8 percent and around 67 percent, respectively. The calculated figure for Iran is equal to 18.3 percent.

Bagheri Garmaroudi (1998) used monetary regression method to estimate the size of underground economy during the years 1971-95 and estimated the relative size of underground economy approximately 23.3 percent of the official production for that period.

Shakibayi (2001) used fuzzy method to estimate the size of the underground economy during 1964-99. In this study, total tax burden (as the ratio of tax revenue to GDP) and an indicator of the regulations severity (Fraser institute's economic freedom index) are used as explanatory variables. According to the results, the average relative size of the

underground economy has been estimated equal to 11 percent for the mentioned period.

Arabmazar Yazdi (2001) estimated the relative size of the underground economy during years 1968-98 through MIMIC method, using the direct tax burden, the burden of taxes on imports, growth in consumer prices, unemployment, an index for economic openness and per capita income as explanatory variables, equal to 11 percent. However, according to his results, per capita income is most effective explanatory variable in the underground economy.

Sahrayi (2006) estimated the size of the underground economy for the years 1978-2003 using monetary regression method. Based on the results, the average relative size of the underground economy during the mentioned period is estimated equal to 14 percent of the official production.

Khandan (2009) studied the effect of direct government intervention in different markets (capital, labor, goods) on the motivation of entering the underground sector and estimated the size of the underground economy through the years 1971- 2007 through EMIMIC¹ method. The explanatory variables in this study include: tax burden, an index for government intervention in capital, labor and goods markets, government expenditures, per capita income, unemployment and inflation. According to the results, per capita income was the most important explanatory variable in underground economy. Furthermore, the relative size of the underground economy has an upward trend during the mentioned period, as it has reached from 16.16 percent in 1971, to more than 22.19 percent in 2007.

Akbarpour Roshan (2010) estimated the average relative size of the underground economy during years 1991-2007, using monetary regression method, equal to 13.16 percent.

3. Theoretical basis

3.1. Methods to Estimate the Underground Economy

In order to estimate the size of the underground economy, macro (indirect) approaches are applied more frequently among researchers due to more ease and accuracy and also the possibility of providing time series data compared to micro (direct) approaches. The main macro methods to estimate the size of underground economy are monetary regression method, multiple indicators-multiple causes (MIMIC) method and fuzzy method. In the following we discuss the first two methods and leave the description of the fuzzy logic to the fourth section.

3.1.1. Monetary regression method

The basic assumption in this approach is that the trades in the underground sector are only done by cash money, in order to hide from the authorities'

1. Actually it is the same as MIMIC method that is developed by co-integration vector and error correction models to increase its ability in processing the time series data.

eyes. So initially we specify and estimate a regression model which its dependent variable is the ratio of currency in circulation to the deposits, considering tax along with other factors influencing this ratio, as the indicator variable for changes in the size of the underground economy. Then by equating the tax variable to zero, the cash in the formal sector of the economy and therefore the cash in the underground section are obtained. In the second step, using the quantity relation of money and the assumptions of the same velocity of money in two sectors, an estimation of the size of the underground economy is attained. Criticisms are made against this approach such as for assuming underground transactions taken place only by cash and the equality of cash flow velocities in the official and underground economy, while the only factor affecting the size of the underground economy is supposed to be tax.

3.1.2. Multiple Indicators- Multiple Causes method (MIMIC)

In this method, the variables affected by the size of the underground economy are also considered beside the influencing variables in order to estimate the size of the underground economy. So we are faced with a system of equations as follows:

$$Y = \lambda \eta + \varepsilon \quad \eta = \gamma'X + \xi$$

where η is the unobserved variable of the relative size of the underground economy and is a scalar, Y is the $(p \times 1)$ vector of indices or indicators representing the underground economy impacts on various zones, X is the $(q \times 1)$ vector of causes of the underground economy rise, and λ and γ are the $(p \times 1)$ and $(q \times 1)$ vectors of factors, respectively, and ε and ξ are random errors, which are $(p \times 1)$ and scalar, respectively and are assumed to be normal and not having two-sided correlation. By substituting the first equation into the second equation, the model is formed as a regression equation system as follows:

$$Y = \Pi X + Z$$

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

$$Z = \lambda \xi + \varepsilon$$

This system of equations is faced with identification problem, but if we constrain one of λ 's elements to a pre-determined value, the relative amounts of factors can be estimated. Then by estimating the γ vector and the second equation above, we obtain a time series but in ordinal form for the size of the underground economy (η), which can be converted to cardinal figures through calibrating method (Arabmazar Yazdi, 2001: 13-14). Criticisms against this approach mention lack of consideration for the variables except the underground economy which affect the indicators (Y) reflecting the underground economy changes, not included in model.

3.2. Causes of the underground economy rise and expansion

Gerxhani (1999) suggested that the factors affecting the underground economy can be classified into three zones: economic, social and political. His study shows that in developing and transition countries, taxes in economic zone, government regulations in political zone and national statistics such as GNP in social zone are the important and influential factors. Based on theoretical literature and empirical studies, the variables affecting the underground economy are generally classified into three groups:

1. Taxes: Taxes levied in various ways lead to hiding economic activities in pursuit of tax evasion, depending on the consistency and efficiency of the tax system, tax culture and also tax rates (Arabmazar Yazdi, 2001: 16). According to Schneider and Buehn (2010) in almost all the studies, taxes are among the main factors of the underground economy presence. In this study, the ratio of direct taxes to GDP is used for the consideration of this factor and it is assumed that this ratio increases with increase in the size of the underground economy.
2. Macro variables of official economy (per capita production or income and unemployment rate): There are two different approaches regarding the direction of relationship between official and underground economy, which in their explanation Schneider and Buehn (2008) propose that in the short-term official and underground production are substitutes and thereby increase in the official production decreases the underground production, but in the long run, these two complement each other's acts, which means the increase in the official production is simultaneously accompanied by increase in the underground production (Khandan, 2009: 81-82). In the present study similar to many others, per capita production is used as another input to the fuzzy system. However, given the long period of time, and according to the results of domestic studies¹, it is assumed that increase in per capita production is associated with increase in underground production.
3. Institutional structure and the status of the business environment: Based on the theoretical literature, the increase in the intensity of the provisions is one of the main causes of loss of freedom of choice in the official economy and the red tape in business environment increases the cost of acting in the official economy. Loayza (2006) suggested that in countries with unfavorable institutional conditions, people and firms find turning to the underground economy optimal, and according to Friedman (2000) more regulation is associated with larger underground economy (Enste, 2010: 557-558). In some studies, in order to consider this factor, the indices computed by some international institutions such as Heritage Foundation and the Fraser Institute² or more general indices such as

1. Such as Arabmazar (2001), Haghpanahan (2005), Khandan (2009)

2. Such as Schneider and Buehn (2010), Shakibayi (2001)

government size¹ are used. According to the criticisms against the world indices and their failure in showing institutional condition and the status of business environment², this study uses a local index computed by Arabmazar and Ahmadian (2010) and it is also assumed that increase in this index (improvement in the business environment) is associated with decrease in the size of the underground economy.

4. Research methodology

Fuzzy logic is a theory for acting in uncertainty and is able to give the mathematical expression to many of the concepts, variables and systems that are vague and imprecise, as this is often the case in reality, and provide a context for reasoning, inference, control and decision making under uncertainty. In many empirical analyses in economic and financial fields, the theory of fuzzy sets and fuzzy logic are used. Fuzzy logic translates natural language descriptions of the decision making policies into an algorithm that uses a mathematical model (Akhbari et al., 2010: 126). Fuzzy logic methodology includes three stages of fuzzification, fuzzy inference and defuzzification, which will be discussed in the following.

4.1. Fuzzification

In fuzzy set we are dealing with input variables having identified values and one output variable (underground economy) with unidentified value. First we have got to fuzzificate the input variables using fuzzy membership functions and data breakpoints. Accordingly, it is specified that each input variable belongs to which fuzzy set (VH, H, N, L, VL) or (very high, high, normal, low, very low) in each year and how intense is the dependence (membership degree). Triangular membership functions are shown in Figure 1, membership degree being on the vertical axis and the quantity of input variables on the horizontal axis, we have:

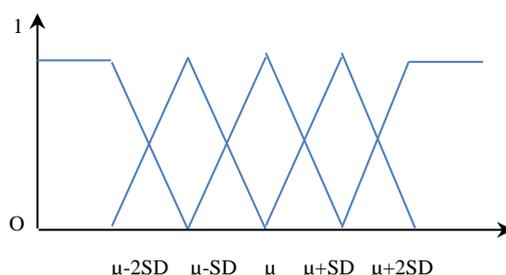


Figure 1. Triangular Membership Functions Diagram

1. Such as Schneider and Buehn (2010), Hui- Kuang Yu et al. (2005)
2. Among criticisms against these indices: 1- regarding the same scale for ranking countries with different economic, social and political characteristics 2- using indicators provided by international trade institutions aiming investment advice to foreign investors . (Arabmazar and Ahmadian (2010))

Data breakpoints are considered in Figure 1 regarding the input variable's moving average (μ) and standard deviation (SD) as ($\mu-2SD$, $\mu-SD$, μ , $\mu + SD$, $\mu +2 SD$). Note that for year t, the input variable's average is obtained from all previous years and the mentioned year and at least 6 years are considered. Therefore if the study begins from 1978, the input variable in the first year includes 1973-78 values. Deciding which set and with what degree of membership the input variable belongs to, depends on Table 1. As it is shown, each value of the input variable belongs to utmost two fuzzy sets and hence two degrees of membership is calculated for each.

Table 1. Fuzzy membership functions

Membership Function	Intervals
$M_{VL}(x)=1.0$	$-2SD \leq \mu x$
$M_{VL}(x) = (\mu - SD - x) / SD$	$\mu - 2SD \leq x \leq \mu - SD$
$M_L(x) = (x - \mu + 2SD) / SD$	$\mu - 2SD \leq x \leq \mu - SD$
$M_L(x) = (\mu - x) / SD$	$\mu - SD \leq x \leq \mu$
$M_N(x) = (x - \mu + SD) / SD$	$\mu - SD \leq x \leq \mu$
$M_N(x) = (\mu + SD - x) / SD$	$\mu \leq x \leq \mu + SD$
$M_H(x) = (x - \mu) / SD$	$\mu \leq x \leq \mu + SD$
$M_H(x) = (\mu + 2SD - x) / SD$	$\mu + SD \leq x \leq \mu + 2SD$
$M_{VH}(x) = (x - \mu - SD) / SD$	$\mu + SD \leq x \leq \mu + 2SD$
$M_{VH}(x) = 1.0$	$x \geq \mu + 2SD$

Source: Yu et al. (2005)

4.2. Fuzzy inference

In this stage, first the construction of the fuzzy rule base takes place regarding the number of input variables (NI) and fuzzy sets (NS) and the direction of relationship between input variables and output variable. The number of rules (NR) in fuzzy rule base is obtained from the following equation:

$$NR = (NS)^{NI}$$

Thus according to three input variables and five fuzzy sets (VH, H, N, L, VL), fuzzy rule base consists of 125 rules. Based on the direction of relationship between the input variables and the output variable, it is determined that the output variable (underground economy) belongs to which output fuzzy set (VB, B, A, S, VS) or (very big, big, average, small, very small) and the fuzzy rules will be deduced through if- then logic. For example, regarding the positive effect of per capita production and ratio of direct taxes variables and the negative effect of business environment index on underground economy, the following rule could be extracted:

If per capita production is very high (VH), the ratio of direct taxes is very high (VH) and business environment index is very low (VL), **then** underground economy will be very big (VB). As it can be seen, the extracted rule is based on of the expert's logical perception of these variables impact on the size of underground economy. So based on all possible states of input variables the fuzzy rule base is built using the same logic.

It should be noted that an adjustment or certainty coefficient (d_i) is

attributed to each of the rules, indicating with what probability the underground economy output variable belongs to that particular set (VB, B, A, S, VS). For instance, in the cited extraction rule the adjustment coefficient is equal to one, while if in this rule the per capita production belongs to H instead of VH, the underground economy will belong to VB set with adjustment coefficient equal to 0.8. Noting that for each year, each of the input variables belong to utmost two fuzzy sets, therefore 8 rules are activated per year at most. After constructing the fuzzy rule base¹, the fuzzification of output variable (underground economy) takes place. For this purpose the intensity dependence of output variable to the relevant fuzzy sets must be specified and in doing so the subscription (or minimum operator) of input variables membership degree multiplied by the adjustment coefficients of the relevant rule is used as follows:

$$M_i(UE) = \text{Min} (M_i(\text{GDP}), M_i(\text{BE}), M_i(\text{DT})) \times d_i$$

where i is the index of the active rule, M membership degree, UE underground economy variable, GDP per capita production, BE business environment index, DT direct tax ratio and d shows the relevant rule's adjustment coefficient. If in the year being studied, the output variable belongs to a specific set based on multiple rules, which may result in multiple degrees of membership computed for that set, here we operate through aggregation (or the maximum operator) of the calculated membership degrees to attribute one single membership degree to it. For example, suppose in year t in accordance with i, j, k rules, underground economy belongs to the set B and based on each of these rules, a degree of membership is calculated for set B . In this case we use the following equation to obtain a certain degree of membership:

$$M_i^B(UE) = \text{Max} (M_i^B(UE), M_j^B(UE), M_k^B(UE))$$

So at this stage the fuzzification of output variable is operated through the described method and it is specified that the output variable belongs to which fuzzy set each year and how intense is its dependency.

4.3. Defuzzificatin

As we need a certain amount as an inference output, so it is necessary to convert the output variable fuzzy set to a certain number. The function of converting a fuzzy set to a certain value is called defuzzification. For this purposes, in the present study centroid method is used as the following:

$$\text{Output} = \frac{\sum (M_i(UE) \times w_i)}{\sum M_i(UE)}$$

Subscript i is intended to show different sets and w represents their

1. It should be noted that here the fuzzy rule base of Akhbari et al. (2010) has been used, so that we matched it regarding the input variables of the present study.

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weights, so that it gives set VB weight 1, set B 0.75, set S 0.25 and set VS zero. The outcome of this stage (output) obtains an index of underground economy as a percentage of the official production which is an ordinal indicator, while in order to obtain the cardinal indicator of the relative size of underground economy that makes comparing the results of this study with other studies possible, we can use calibration method introduced by Giles and Tedds (2002) as follows:

$$(\eta / \text{gdp})_t^{\text{final}} = (\eta / \text{gdp})_t^{\text{ordinal}} * \mu$$

Where $\mu = (\eta / \text{gdp})_T^* / (\eta / \text{gdp})_T^{\text{ordinal}}$

η is underground production volume, gdp is the official production volume, $(\eta/\text{gdp})_t^{\text{final}}$ is the cardinal indicator of the relative size of the Underground economy in year t , $(\eta/\text{gdp})_t^{\text{ordinal}}$ is the ordinal index of the relative size of the underground economy in year t , $(\eta/\text{gdp})_T^*$ is the cardinal indicator of the relative size of the underground economy which its figure is available for year T using data out of the survey (for instance from other studies) and $(\eta/\text{gdp})_T^{\text{ordinal}}$ is the ordinal index of the relative size of the underground economy in year T (Khandan, 2009: 112). In this survey, we use the study by Haghpanahan (2005) which computed the relative size of the underground economy to the official production in 1986 equal to 24.7 percent, thus we have:

$$(\eta / \text{gdp})_T^* = (\eta / \text{gdp})_{1986}^* = 24.7$$

Finally, time series of underground economy index is obtained as a percentage of the official production for the period being studied which by multiplying it by the official GDP, gives the absolute values of the underground production.

5. Estimation of underground economy volume

As discussed above, in the present study, using three input variables, direct taxes to gross domestic product ratio, per capita production and an indicator of business environment in Iran, the volume of the underground economy for years 1978-2010 has been estimated. Estimation results are given in Table 2, in which figures relevant to official production (GDP_f) and estimated underground production (GDP_u) are in real terms (based on 1997 constant prices) and in billion rials. As it can be seen, in order that the results provide a more suitable image of the underground economy trend during this 33-year period, we divided this time period into shorter pieces: So that 1978-88 corresponds years of war and revolution, years 1989-1994 correspond the first economic development plan, years 1995-99 correspond the second plan, years 2000-2004 correspond the third plan and years 2005-2010 correspond the fourth economic development plan.

Table 2. Estimation of Underground Economy Volume

Year	GDPu	GDPf	Relative volume	Year	GDPu	GDPf	Relative volume
1978	63868.34	226182.74	28.237	1995	70977.36	264326.49	26.852
1979	54466.17	210069.07	25.928	1996	80612.06	283095.63	28.475
1980	23689.99	182277.68	12.997	1997	84667.36	292677.86	28.929
1981	35575.81	172801.74	20.588	1998	90463.35	300698.96	30.084
1982	35781.75	195191.31	18.332	1999	91328.51	306513.92	29.796
1983	44512.59	219801.42	20.251	Average	83609.73	289462.57	28.827
1984	50513.1	216342.36	23.349	2000	102012.3	322278.43	31.653
1985	47902.67	220810.12	21.694	2001	77133.72	334104.16	23.087
1986	49538.37	200560.07	24.7	2002	59817.18	361366.15	16.553
1987	34835.53	197744.82	17.616	2003	47647.12	390487.83	12.202
1988	27850.77	185288.43	15.031	2004	59535.04	414178.8	14.374
Average	42594.1	202460.89	20.793	Average	69229.08	364483.07	19.574
1989	18529.9	196735.47	9.4187	2005	96978.68	433462.86	22.373
1990	23938.75	223664.17	10.703	2006	77338.17	460387.03	16.799
1991	30251.57	251833.23	12.013	2007	95994.17	489699	19.603
1992	38500.38	262538.84	14.665	2008	99349.86	492520	20.172
1993	25336.41	258401.77	9.805	2009	107469.3	511975	20.991
1994	43411.53	257495.94	16.859	2010	113468.4	542174	20.928
Average	29994.76	241778.23	12.244	Average	98433.09	488369.65	20.144

Source: Survey calculations

Official production figures: Central Bank of the Islamic Republic of Iran

6. Conclusion and suggestions

According to estimates of the absolute size of the underground sector, we can now analyze the underground economy trend in the cited years:

1. Years corresponding to the revolution and war (1978-88): In this period, the relative size of the underground economy is approximately 21 percent. In the early years and the end of this period we witness a downward trend in the volume of underground activity due to decline in direct taxes ratio and per capita production, while from 1981 the underground production started an increasing trend and it continued until 1984 which could be as a result of mutation in the direct tax in 1981 and the increasing trend of per capita production in years 1982 and 1983 and the decline in business environment index in 1984. Again, with the negative oil shock in 1986 and reduction in per capita production, the underground economy downward trend continues until 1989.
2. Years corresponding to the first economic development plan (1989-94): The average relative size of the underground economy in these

years is approximately 12 percent. According to the results, the relative and absolute size of the underground economy is plummeting in years of the first development plan, compared to the war and revolution years. Besides, despite the relative improvement in the business environment and in fact due to increasing direct tax ratio and per capita production in these years, underground production has started an upward trend.

3. Years corresponding to the second development plan (1995-1999): In this period, the average relative size of the underground economy is about 29 percent and we observe a rising trend in the underground economy. During the second development plan the relative and absolute figures showing the size of the underground economy have increased compared to the years of the first plan. It should be mentioned that these years experienced the most unfavorable business environment due to policy implications of floating exchange rate in 1993 and rising inflation and currency fluctuations, and reaching the highest rate of inflation equal to 50 percent in 1995. Therefore, the upward trend of underground production is due to declining business environment index and increasing direct taxes and per capita production as well.
4. Years corresponding to the third development plan (2000-2004): The average relative size of the underground economy in these years is approximately 19 percent. Based on the results, we observe a decrease in relative and absolute size of the underground economy in the third plan years compared to the second development plan years, and the underground production is mainly declining as a result of improving business environment index as well as decrease in the direct tax ratio.
5. Years corresponding to the fourth development plan (2005-2010): During the fourth economic development plan years, the relative and absolute size of the underground economy has grown, compared to the third plan years. In this period the average relative volume of the underground economy is about 20 percent and generally an upward trend is observed in underground production due to declining business environment index and increasing direct tax ratio and per capita production.

Based on the results from the present study, it can be stated that the absolute volume (rather than relative volume) of the underground economy has had an upward trend during years 1978-2010, so that with fixed prices of 1997 it has increased from 63868.33 billion Rials in 1978 (28.2 percent of the official production) to 113468.35 billion Rials in 2010 (21 percent of the official production). Also, the average relative size of the underground economy in the whole period studied is approximately 20 percent.

According to the importance of institutional structure of the country and the status of business environment in the formal sector of economy in explaining the trend of underground economy movement in the passage of

time, promoting the efficiency of rules and providing a secure and appropriate environment for business must receive more consideration from authorities. Reduction and removal of complicated and baffling regulations and trying to omit bureaucracies will provide the incentives for conducting activities in the formal sector of economy.

Avoiding tax mutations could be proposed as one of the important policy notes in order to reduce hiding of economic activities which are performed aiming at preventing various tax payments.

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Appendix

Fuzzy Rules					
Rules	GDP PER CAPITA	BUSINESS ENVIRONMENT INDEX	DIRECT TAX RATIO	UE	di
1	VH	VL	VH	VB	1
2	H	VL	VH	VB	0.8
3	N	VL	VH	VB	0.6
4	L	VL	VH	B	1
5	VL	VL	VH	B	0.8
6	VH	L	VH	VB	0.6
7	H	L	VH	B	1
8	N	L	VH	B	1
9	L	L	VH	A	0.8
10	VL	L	VH	A	1
11	VH	N	VH	B	1
12	H	N	VH	B	0.8
13	N	N	VH	A	1
14	L	N	VH	A	1
15	VL	N	VH	A	0.8
16	VH	H	VH	A	0.8
17	H	H	VH	A	1
18	N	H	VH	A	1
19	L	H	VH	S	0.8
20	VL	H	VH	S	1
21	VH	VH	VH	A	1
22	H	VH	VH	A	0.8
23	N	VH	VH	S	1
24	L	VH	VH	S	1
25	VL	VH	VH	VS	0.6
26	VH	VL	H	VB	1
27	H	VL	H	VB	0.8
28	N	VL	H	B	1
29	L	VL	H	B	1
30	VL	VL	H	B	0.8
31	VH	L	H	VB	0.6
32	H	L	H	B	1
33	N	L	H	B	0.8
34	L	L	H	A	0.8
35	VL	L	H	A	1
36	VH	N	H	B	1
37	H	N	H	A	0.8
38	N	N	H	A	1
39	L	N	H	A	1
40	VL	N	H	S	0.8
41	VH	H	H	A	1
42	H	H	H	A	1
43	N	H	H	A	0.8
44	L	H	H	S	1
45	VL	H	H	S	1
46	VH	VH	H	A	1
47	H	VH	H	S	0.8
48	N	VH	H	S	1
49	L	VH	H	S	1
50	VL	VH	H	VS	0.8
51	VH	VL	N	VB	1
52	H	VL	N	VB	0.6
53	N	VL	N	B	1
54	L	VL	N	B	1

Rules	GDP PER CAPITA	BUSINESS ENVIRONMENT INDEX	DIRECT TAX RATIO	UE	di
55	VL	VL	N	A	0.8
56	VH	L	N	B	1
57	H	L	N	B	1
58	N	L	N	B	0.8
59	L	L	N	A	1
60	VL	L	N	A	1
61	VH	N	NH	B	0.8
62	H	N	N	A	0.8
63	N	N	N	A	1
64	L	N	N	A	0.8
65	VL	N	N	S	0.8
66	VH	H	N	A	1
67	H	H	N	A	1
68	N	H	N	S	0.8
69	L	H	N	S	1
70	VL	H	N	S	1
71	VH	VH	N	A	0.8
72	H	VH	N	S	1
73	N	VH	N	S	1
74	L	VH	N	VS	0.6
75	VL	VH	N	VS	1
76	VH	VL	L	VB	0.8
77	H	VL	L	B	1
78	N	VL	L	B	1
79	L	VL	L	B	0.8
80	VL	VL	L	A	1
81	VH	L	L	B	1
82	H	L	L	B	1
83	N	L	L	A	0.8
84	L	L	L	A	1
85	VL	L	L	A	1
86	VH	N	L	B	0.8
87	H	N	L	A	1
88	N	N	L	A	1
89	L	N	L	A	0.8
90	VL	N	L	S	1
91	VH	H	L	A	1
92	H	H	L	A	0.8
93	N	H	L	S	0.8
94	L	H	L	S	1
95	VL	H	L	VS	0.6
96	VH	VH	L	S	0.8
97	H	VH	L	S	1
98	N	VH	L	S	1
99	L	VH	L	VS	0.8
100	VL	VH	L	VS	1
101	VH	VL	VL	VB	0.6
102	H	VL	VL	B	1
103	N	VL	VL	B	1
104	L	VL	VL	A	0.8
105	VL	VL	VL	A	1
106	VH	L	VL	B	1
107	H	L	VL	B	0.8
108	N	L	VL	A	1
109	L	L	VL	A	1
110	VL	L	VL	A	0.8
111	VH	N	VL	A	0.8
112	H	N	VL	A	1
113	N	N	VL	A	1
114	L	N	VL	S	0.8
115	VL	N	VL	S	1
116	VH	H	VL	A	1
117	H	H	VL	A	0.8
118	N	H	VL	S	1
119	L	H	VL	S	1
120	VL	H	VL	VS	0.6
121	VH	VH	VL	S	0.8
122	H	VH	VL	S	1
123	N	VH	VL	VS	0.6
124	L	VH	VL	VS	0.8
125	VL	VH	VL	VS	1

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Output of Fuzzy Method							
Year	Active Rules	VS	S	A	B	VB	Index
1978	8,33,3,28,9,34,4,29			0.4172	0.3828	0.1295	0.6726
1979	59,84,54,79,60,85,55,80			0.5296	0.4704		0.6176
1980	89,114,84,109,90,115,85,110		0.5025	0.1572			0.3096
1981	39,64,34,59,40,65,35,60		0.0247	0.6175			0.4904
1982	69,94,64,89,70,95,65,90	0.0209	0.1529	0.5948			0.4367
1983	68,93,63,88,69,94,64,89		0.0442	0.5831			0.4824
1984	58,83,53,78,59,84,54,79			0.6166	0.1786		0.5562
1985	33,58,28,53,34,59,29,54			0.9184	0.0659		0.5167
1986	34,59,29,54,35,60,30,55			0.6466	0.3534		0.5883
1987	64,89,59,84,65,90,60,85		0.2658	0.5609			0.4196
1988	69,94,64,89,70,95,65,90	0.0447	0.4159	0.4292			0.358
1989	69,94,64,89,70,95,65,90	0.1461	0.7565	0.0485			0.2243
1990	68,93,63,88,69,94,64,89		0.8535	0.0172			0.2549
1991	68,93,63,88,69,94,64,89		0.4882	0.0825			0.2861
1992	68,93,63,88,69,94,64,89		0.4752	0.3132			0.3493
1993	73,98,68,93,74,99,69,94	0.0338	0.4798				0.2336
1994	68,93,63,88,69,94,64,89		0.3002	0.4624			0.4016
1995	58,83,53,78,59,84,54,79			0.4138	0.5234		0.6396
1996	33,58,28,53,34,59,29,54			0.2359	0.5863		0.6783
1997	33,58,28,53,34,59,29,54			0.1565	0.4857		0.6891
1998	33,58,28,53,34,59,29,54			0.0844	0.5475		0.7166
1999	33,58,28,53,34,59,29,54			0.0921	0.4794		0.7097
2000	32,57,27,52,33,58,28,53				0.7389	0.0119	0.754
2001	37,62,32,57,38,63,33,58			0.7623	0.1902		0.5499
2002	72,97,67,92,73,98,68,93		0.3824	0.522			0.3943
2003	72,97,67,92,73,98,68,93		0.695	0.1349			0.2906
2004	71,96,66,91,72,97,67,92		0.6007	0.3521			0.3424
2005	16,41,11,36,17,42,12,37			0.7051	0.1069		0.5329
2006	21,46,16,41,22,47,17,42		0.339	0.5096			0.4001
2007	21,46,16,41,22,47,17,42		0.0974	0.6391			0.4669
2008	21,46,16,41,22,47,17,43		0.0386	0.4558			0.4805
2009	21,16,22,17			0.5212			0.5
2010	21,46,16,41,22,47,17,43		0.0041	0.6835			0.4985