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Estimating the Effects of Shadow Economy on Per Capita Income: Considering and Non-Considering the Problem of Endogeneity

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Abstract

Based on the theoretical literature, there are different and sometimes conflicting approaches about the effects of the shadow economy on per capita income. Considering the importance of this issue for economic policy, this study examines the effects of the shadow economy on per capita income for the period of 2005- 2017 using a panel generalized two stage estimator (PG2SLS) in two groups of developing and developed countries. Based on the results obtained in both groups, the size of the shadow economy has a negative effect on the per capita income. Also, the effects of the shadow economy on per capita income in developed countries are much higher than in developing countries, which is somewhat countrary to the theoretical framework. Stimating the model with the assumption of endogeneity of the shadow economy, for developing countries these effects have become negative and significant, but for developed countries these effects do not have the necessary significance.

Keywords: Shadow Economy, Per Capita Income, Developed Countries, Developing Countries, Panel Generalized Two-stage Least Squares.

JEL Classification: O17, E26, E64, O57.

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1. Introduction

The economic activities are generally categorized into two parts: formal and informal activities. Most of the informal activities are organized as a shadow economy. The main motivation for these activities is creating a series of non-transparent or unusual activities to escape from the legal frameworks and especially taxes payment. However, some of the reasons for these activities are due to the government intervention, other are induced from the macroeconomic structure, and some of them also arise from the particular nature of economic activities [6].

The expansion of informal sector causes a decrement in the level of politicization of economic activities from the government's plans and policies. Consequently, the non-fulfillment of the economic policies of government or their deviation from the desired results is not far from expected. For instance, in Iran's economy, several analysts consider the large size of the informal sector to be one of the main reasons for the failure of reform programs [21], [25]. Despite the importance of the informal sector of economic activities in influencing economic policies in different countries, recently many developing countries (including Iran) with financial crisis, high inflation, repaying external debts and the growth of labor force population, especially in urban areas (due to continuous rural–urban migration). Therefore, under these conditions, it is expected that the informal sector experience more growth [21].

Based on the evidence a significant share of the economic activities of developing countries is done in the informal sector (International Monetary Fund, 2018). During the last three decades, the informal sector has expanded to a global scale. According to the Organization for Economic Co-operation and Development (OECD), three-quarters of the workers in sub-Saharan Africa, two-thirds of the workers in South and Southeast Asia, half of the workers in Latin America and the Middle East, and finally, one-fourth of the workers in countries with transition economies are working in the informal sector [5]. According to the estimation of International Monetary Fund (IMF) of the ratio of the shadow economy during the years 2000 to 2018, the size of the shadow economy in developing countries is, on average, 31.6% of GDP, while in developed economies, it is 14.2% of GDP [15]. Therefore, in comparison with the developing countries, it seems that developed

countries have been able to decrease the size of the shadow economy to a large extent and its effects on their economies. However, this ratio in developing countries is higher and even up to 2.2 times higher than the developed countries.

According to the theoretical foundations, there are different and even conflicting approaches regarding the effects of shadow activities in different countries on the official economy. So, the relationship between the shadow economy and economic growth is a controversial and important issue [5], [16], [17], [24]. Paying attention to the level of development of the countries may be able to create a more accurate view of its effects and mitigate the theoretical contradictions in this regard.

At first, it seems that because of the different institutional and legal framework between countries, the size of the shadow economy and as a result, its effects and outcomes on the economic growth of countries are also different [5]; Therefore, the large difference in the size of the shadow sector and its consequences on the economy emphasizes the difference in the behavior of economic variables at different levels of economic growth. Therefore, in developed (developing) countries, it seems that because of the improvement (weakness) of governance quality and more (less) government efficiency, the size and consequently the effects of the shadow economy on economic growth can be (not) controlled.

Reviewing experimental studies, particularly in Iran, indicates that these studies either present the informal economy in a general format and the importance and causes of its creation and classifications, or are aimed to evaluate shadow economy and estimate the process of changes in the form of particular approaches. Besides, regarding the effect of the shadow economy, most studies have focused on its effects on taxation and employment sectors.

Practically, only a few limited studies have investigated the effects of the shadow economy on economic growth. On the other hand, none of the studies, especially studies in Iran, have discussed the effects of the shadow economy on per capita income. Even in the studies that have examined the effects of the shadow economy on economic growth [16], [24], the effects of the shadow economy on economic growth have been considered only in one direction. It's while, based on the theoretical literature these two variables have undeniable effects on each other, and endogeneity in the relationship between the shadow economy and economic growth

can be seen. Since these studies did not consider the issue of endogeneity, their findings cannot be much reliable. Therefore, it is very important to pay attention to this issue in evaluation of the impact of the shadow economy, per capita income and economic growth.

Considering the available studies, there is a research gap regarding the impact of shadow economy and changes in per capita income by consideration the level of economic growth of countries and the issue of endogeneity (relationship between per capita income and shadow economy). Based on what mentioned and considering the importance of the level of economic growth and the issue of endogeneity, this research tries to evaluate the effects of the shadow economy on the per capita income in developing and developed countries. In the following, the structure of the article is as follows. Section 2 describes the theoretical foundations and experimental studies, Section 3 discusses the theoretical foundations of the research, Section 4 discusses method, Section 5 discusses the findings and Concluding remarks are at Section 6.

2. Shadow Economy

The shadow economy includes all activities that are legal from both productive and non-productive economic aspects. However, it is usually kept hidden from public officials due to the following factors: Avoid to pay income tax, value-added or other taxes, do not paying social security and Medicare costs, do not adopting certain legal standards such as minimum wage, maximum working hours, safety or health standards, and avoiding to follow specific administrative procedures such as completing administrative questionnaires or other forms. In this research the shadow economy is defined just as the definition presented in the World Bank Estimation for 162 countries by Schneider et al. [23]. Based on this definition, the shadow economy includes all market-based manufacturing activities (goods and services) that are deliberately hidden from public (government) administration.

The International Monetary Fund (IMF) (2018) published a report in which the status of the "shadow economy" of 158 countries is evaluated during the years 1991 to 2015 and has introduced the following variables as causal variables or indicators of the shadow economy:

- Effective tax rate and participation in providing national security: any change in the tax system disturbs the balance of opportunities in the labor market and may lead to the labor supply in the shadow economy.

- Quality of institutions or corruption, quality of public sector services: the quality of government institutions plays a decisive role in the development of the informal economy sector. Efficiency and neutrality in the taxes policies and other laws play an important role in the decision making for activists to enter the shadow economy sector. The effect of applying discriminatory laws and political corruption is much higher compared to the pressure on laws and taxes.

- Laws and regulations: for instance, labor laws or trade barriers limit the possibilities and opportunities of individuals in the formal economy sector and will significantly improves the motivation to leave formal activities. These laws greatly increase the cost of labor in the formal economy sector.

- The quality of services in public sector: governments have a prominent role in society which includes setting laws and regulations, providing security, providing public services, creating infrastructure, and so on. Therefore, it is possible that public welfare increase or decrease as a result of discretionary power of government. However, the better provision of public goods by the government obviously leads to an increase in the formal economy size [15].

2. 1. Economic growth and the shadow economy

Reviewing related economic theories and texts indicate that there are many mutual interactions between the official economy and the shadow economy, so that even sometimes it is impossible to make a precise demarcation between them. In general, from a theoretical point of view, two types of substitute and complementary relations are suggested between the shadow economy and the official economy. Therefore, the interaction between them is discussed based on which type of these relations overcomes the other [28].

Based on the neoclassical economics approach, complementary effects overcome the substitution effects. as a result, the interrelationship and interaction between the formal and shadow economy is positive. In the neoclassical economics approach, the shadow economy creates a dynamic and entrepreneurial spirit in

response to the demand of the economic environment for urban services and small-scale production, which leads to more competition, higher efficiency and limitation of government activities [14]. Based on this approach, the shadow economy is effective in creating markets, increasing resources, encourage entrepreneurship and strengthening legal, social and economic institutions for capital accumulation.

In the opposite theoretical spectrum, it is believed that the substitution effects overcome the complementary effects and therefore the interaction between the formal and shadow economy will be negative. Most economic studies and literature emphasize this relationship. Generally, in the theoretical literature the negative effects of the shadow economy on economic growth and the development process can be divided into three groups including macroeconomic consequences, microeconomic consequences, and social issues [28].

The most common side effects of the shadow economy in the macroeconomics branch include budgetary effects and the reduction of macro policies' effectiveness. Budgeting in the public sector: when economic activities leave the formal economy sector due to high tax rates, tax bases will be limited and there will be a decrease in tax revenues. Losing tax revenues may cause governments to increase tax rates aimed to make up for the lost revenue. When the shadow economy sector is relatively large, the amount of losing tax revenues is much more intense. Therefore, when economic enterprises enter the informal economic sector, the amount of government tax, as well as the quality and quantity of public goods and services decrease. Since the enterprises active in the official economic sector are affected by the decrement of the quality of public goods and services, this decrement acts as a driving force with negative effect on the production of economic enterprises. This cycle can be active even in the absence of tax increment. When tax revenues are insufficient to fund the public sector (and if debt and bond markets are not available), governments generally turn to financing inflationary through money creation. It causes a decrease in economic stability and the entrepreneurial motivation in the society, and finally affects economic growth and production [13].

The shadow economy may decrease the effectiveness of macroeconomic policies. This can endanger the achievement of macroeconomic stability and its preservation. For instance, the shadow economy can weaken monetary policies. As

the shadow economy weakens the relation of economic enterprises with the banking system and capital markets. In addition, in the experimental literature, it is thought that financial transaction in the shadow economy are mostly done through cash payments. However, these activities, especially in countries with high inflation, may be done in the form of set-off or using foreign exchanges. So, all these can decrease the effects of monetary policy. Similarly, since companies that are active in the shadow economy do not pay taxes, there will be a decrease in the effectiveness of fiscal policies which are based on the decrement or increment of tax rates and are implemented for encouraging or limiting economic activities. So, the shadow economy can have a negative effect on economic growth through the decrement of government's monetary efficiency and financial policies [13].

Economic literature also refers to a set of microeconomic issues that are resulted from the shadow economy. The negative outcomes of the shadow economy are generally related to its effects on the optimal use of resources and can disrupt economic growth. The availability of the shadow economy makes it possible for happening imbalance in the allocation of resources. With the stability of other conditions, the companies active in the shadow economy benefit from an unfair advantage in the labor market compared to the companies active in the formal sector. As these companies do not pay taxes, they can offer lower prices for their goods and services than the companies active in the official sector. Besides, people who buy goods and services from the informal sector do not pay consumption tax. Because of that, companies active in the informal sector can change market demand from the formal sector to the informal sector. All aforementioned affect the optimal allocation of resources [28].

Finally, the economic literature refers to some social outcomes of the shadow economy. Undermining the institutions and social norms is one of the consequences of the shadow economy, which ultimately has a negative effect on economic growth. The free riding problem (using public goods and services freely by those who have not paid for provision these goods and services) causes the few who have paid for the production and provision of public goods and services, are discouraged from continuing to pay taxes. Consequently, the provision of public goods and

services will face more and more problems and ultimately have a limiting effect on economic growth [5].

In the third approach, the interaction between the shadow economy and the formal economy is not considered inherent. It is believed that the positive or negative nature of this interaction and the way that it acts depends on the development level of the countries and its related factors. In other words, the proponents of this view believe that the sign of correlation between the official and shadow economy can be better defined and identified based on the development level of the countries. Therefore, the third approach can be assumed as including the previous approaches as it claims that the type of interaction between the formal and shadow economy may be positive or negative depending on the development conditions [22].

In other words, since the government and economic and political institutions has a significant role in affecting individuals' incentive system (for selecting the informal sector), practically, the volume of the informal sector, as well as its effects on economic growth, largely depends on the effectiveness of the government and Institutions in the society. Therefore, as there is a direct relation between different the levels of economic growth and the effectiveness of the government and social institutions in developed countries [4], [5], [6], as well as there is less tax evasion, the effectiveness of budget deficit channels on economic growth is limited due to tax evasion.

On the other hand, since the size of this sector is smaller compared to the developing countries (due to more supervisions and effective institutions), simultaneously the negative effects of the shadow economy on the effectiveness of monetary and financial policies can be decreased. Moreover, in the less developed countries which are at their initial stages of growth and development, because of the multitude of government problems in the early stages of development, the institutions and their productivity are less in this stage of development. Consequently, assuming the stability of other factors, assuming the stability of other factors, tax evasion and therefore financial crisis of the governments will increase, which will finally causes and increment in the debt of these countries or inflation that limits their economic growth. On the other hand, from the perspective of

limiting the effect of the economic policies of government, we can expect a more negative impact of the shadow economy on economic growth in this set of countries.

Due to the greater capability of governments in the developed countries in identifying and limiting the informal sector, in the micro sector a more optimal allocation of resources will be formed. Consequently, at this stage of economic growth, the effects of the informal sector on economic growth is more limited than the developing countries where governments have less ability in identifying the informal sector. So, because of a more effective institutions in developed countries in comparison to the developing countries, it seems that the shadow sector is less effective on the economic growth. Besides, the efficiency of governments and institutions affects their power to control the negative effects of the shadow economy on economic growth. Assuming the negative effect of the shadow economy on short-run economic growth, developed countries finally have the capability of controlling these negative effects. However, due to their weakness in economic management in developing countries in terms of negative effects of the shadow economy, they are not able to control these effects on economic growth well. Therefore, the long-run effects of the shadow economy can be different from these effects in the developed countries.

2. 2. Research background

In this section, the studies that are somehow related to the subject of this research are presented in two parts inside and outside of Iran, from new to old.

2. 2. 1. Studies inside Iran

Farahti [7] investigated the effect of replacing different tax items (or changing tax compositions) on the size of the shadow economy in Iran. In their research, they estimated the proposed model using autoregressive distributed lag (ARDL) bounds test during the years 1976 to 2015. The findings indicated that replacing corporate tax with income tax or goods and services tax and replacing wealth tax with income tax, goods and services tax, corporate tax or duty decreases the size of the shadow economy. In addition, replacing duty with income tax, corporate tax or goods and

services tax decreases the size of the shadow economy. While the replacement of goods and services tax with income tax does not affect the activities of this sector significantly.

Falahati et al. [6] investigated the effect of natural resource rent and institutional quality on the shadow economy in 87 countries with low and high inflation during the years 2000 to 2018. The generalized method of moments (GMM) was used to analyses the data in the study. Smart PLS software has been used for estimation of the shadow economy. The findings of this study indicate that in both groups of countries with low and high inflation, the increment of institutional quality has reduced the size of the shadow economy. Besides, natural resource rent had a positive association with the size of the shadow economy. Institutions determine significant economic factors, including the distribution of resources and equitable distribution in society. Therefore, the level of institutional quality leads to resources utilization and their optimal allocation and affects the size of the shadow economy through economic stability and reduction of uncertainty.

Shahbazi et al. [25] in their research using nonlinear autoregressive distributed lag (NARDL) model investigated the effect of positive and negative shocks to the shadow economy on financial sector development during the years 1974 to 2015 in the short and long-term studies in Iran. In this regard, multiple indicators, multiple causes models (MIMIC) calculated by Piraee and Rajaee [19] was used to measure the shadow economy. The research achievements indicate that the effect of positive and negative shocks to the shadow economy on financial sector development in the short and long-term studies was asymmetric. This asymmetry is such that in the short and long-term studies, the negative shocks to the shadow economy have a greater impact than the positive shock.

Motallebi et al. [14] have estimated the shadow economy and tax evasion in Iran using the governments financial discipline variables during the years 1967 to 2015. In this study the MIMIC method was used to estimate the shadow economy. The findings indicate that the burden of import duties and unemployment rate are the main causes of the emergence of the shadow economy in Iran. Considering three variables of inflation rate, budget deficit and government size as government's

financial discipline variables, the findings indicate that inflation and budget deficit have a positive effect on the shadow economy and its caused tax evasion.

Fotros and Dalaei Milan [8] in their study investigated the shadow economy and tax evasion in Iran. In this study stochastic dynamic general equilibrium (SDGE) model was used. The findings of their study indicate that a positive shocks on the corporate tax rate and income tax leads to a decrease in official production, an increase in underground production, an increase in tax evasion and a decrease in government revenue. Oil revenue positive shocks also increase the official production and reduce the shadow economy, and as a result, decrease tax evasion and increase the government's income.

Shahab and Pajuyan [24] have investigated the association of the shadow economy and economic growth in a set of 50 countries including two Block of 25 countries including the countries with high level of development and developing countries like Iran, during the years 1999-2007. Panel data methods is used in their research. Based on the findings at all significance levels, the existence of a Kuznets relation between the shadow economy and economic growth is undeniable. Besides, the type of relation (substitution or complementarity) between the size of the shadow economy and economic growth depends on the countries' position in the development path. This study has other significant findings, especially for Iran (of course, other developing countries of the second world). These findings, including calculations based on estimated coefficients that represents Iran's position during the study period in the upward phase of the inverted U-shaped curve and confirm the neoclassical theory of a complementary relation between economic growth and the size of the shadow economy in Iran during the aforementioned period.

Piraee and Rajaee [19] estimated the dimensions of the shadow economy in Iran during the years of 1974 to 2013. For this purpose, a time series approach in shadow economic in Iran was prepared using the MIMIC model, and its most significant causes and effects have also been investigated. The findings of the estimation of the time series approach in shadow economic indicated that the shadow economy had an increasing trend during the investigated time period. Although there are ups and downs in the first half of the time series that indicates less intensity, it represented a completely upward trend in the last two decades. On the other hand, the findings

indicate that the largest impact of the shadow economy is on the money market, and among the reasons for the emergence of the shadow economy; the price indices of consumer goods and services (inflation) has the highest positive effect on the shadow economy. Moreover, direct tax, trade openness, government size and unemployment rate respectively have the greatest effect on the shadow economy.

Renani [21] evaluated the informal sector of employment in Iran in 2003. The findings of his research indicated that the informal sector of the country in 2003 accounted for an average of 28% of the total employment. The agricultural sector provided the base for informal activities more than other economic sectors. Moreover, women, rural people and service providers with less than diploma education have more desirable conditions to participate in the informal sector compared to men, urbanites and holders of diploma and higher degrees. Based on the estimations of his research in 2033, 48% of working women, 45% of working villagers and 35% of working people with undergraduate education were active in the informal sector.

Mehrabi Boshrabadi et al. [16] in their study through reviewing various concepts and dimensions of the shadow economy, investigated the effect of the size of the shadow economy on Iran's economic growth during the years of 1972 to 2007 using vector error correction model (VECM). In their study, the shadow economy was estimated using Fuzzy logic approach. Their findings demonstrated that, with 1% increment of the size of the shadow economy in Iran, economic growth decreases by 0.38 percent. Besides, the expansion of economic activities in the informal sector is one of the factors that threaten economic growth.

Arab Mazar Yazdi [1] investigated the shadow economy, its causes and effects in Iran using the data from the years of 1967 to 1998. He used MIMIC method to investigate the shadow economy in Iran. The findings of their study indicate that the ratio of the shadow economy to the GDP was increased from about 8% during the first years of the mentioned period. Then at the end of the period, it was reached to more than 22%. The average of this index for the entire period was about 11%.

2. 2. 2. Studies Outside Iran

Wu and Schneider [28] indicated a long-term U-shaped relationship between the shadow economy size and GDP per capita using the dataset of 158 countries. Based on the authors' opinion U-shaped pattern relation between the shadow economy size and GDP per capita is worth further investigation. The question is that whether the non-uniform relation before and after the threshold is symmetrical or not. Although a long-run non-linear relationship in the shadow economy was identified in Frank Wu and Schneider's [28] research using a quadratic regression equation, the relation between GDP per capita and the size of the shadow economy may be asymmetric. One the possible scenario is that the shadow economy may accelerate productivity when the development level of country exceeds a certain stage, which is induced from industrial progress in the formal sector and technological innovations.

Nguyen and Duong [17] examined the effect of the shadow economy and corruption along with general expenses, market openness, foreign direct investment (FDI), inflation and tax revenue on the economic growth of BRICS countries. The data of this article was collected from the World Bank, Transparency International and the Heritage Foundation during the years 1991 to 2017. The authors used the Bayesian linear regression statistics to evaluate the effect of the shadow economy, corruption and other indicators on the economic growth of the investigated countries. The findings indicate that general expenses and trade openness can increase the economic growth of BRICS countries with the possibility of a positive effect of 75.69% and 67.11%, respectively. Also, FDI, inflation and tax income have a positive effect on this growth. Moreover, the main achievement of the authors is that the shadow economy and control of corruption have a positive effect on the economic growth of BRICS countries. However, the posterior probabilities of these two factors are 62.23% and 65.25%, respectively. This finding indicates that the probability of their positive effect is not high.

Devine [5] evaluated the effect of institutions and how institutions affect the formation of the shadow economy. He linked changes in the size of the informal economy to changes in the institutional environment and political cycle to indicate the reason for the size and stability of the informal economy in emerging markets and developing economies. He also used the political cycle to help explaining

variation of institutional environment. The analysis of this research indicates that the effect of the quality indicators for financial institutions, the regulatory business environment, and the political and legal environment on the size of the informal economy are significant. This research reveals that the rotating politics of the institutions has an effect on the size of the informal sector which should be controlled in the experimental analysis. Changes in institutional variables also affect informality. These findings indicate that structural reforms to improve the quality of financial institutions, the regulatory business environment, and the political-legal environment can all be useful in the decrement of the informal economy over time.

Goel et al. [10] evaluated that effect of the shadow economy on economic growth in the United States during the years 1870 to 2014. As authors mentioned shadow economic activities may stimulate or slow down economic growth depending on their interaction with the official economic sector and its effect on the provision of public goods. The authors used the analyzing standard neoclassical growth theory as a relatively new time series technique for estimating the short-term dynamics and the long-term relation between economic growth and its determinants. The findings of this study show that before World War II, the shadow economy had a negative effect on economic growth. However, after World War II, the shadow economy was advantageous for economic growth. This ambiguity about the effect of overall growth of the shadow economy is consistent with the underlying theoretical arguments.

Hajilee et al. [11] investigated the effect of the shadow economy on the development of the financial market using annual data from 1980 to 2013 in 18 emerging countries. Their study simultaneously evaluated the short- and long-term effects of the shadow economy. To this purpose, they used the nonlinear autoregressive distributed lag (NARDL) approach, which searches for the characteristics of the model in a non-linear system to evaluate the asymmetric effects of the shadow economy on the development of the financial market. The findings indicate that the shadow economy had short-term asymmetric effects on the development of the financial market in most of the emerging economies in the investigated sample.

Zaman and Goschin [29] investigated the association of the shadow economy and economic growth of Romania during the years 1999 to 2012. In their study, a new composite index was presented for the shadow economy which three indicators including the shadow economy measured per capita, the shadow economy as a percentage of GDP, and the shadow economy of each member state of the European Union that is presented as a percentage of the total shadow economy of the European Union. The three mentioned indices were calculated separately as well as a combined index for Romania during the mentioned period. Besides, the combined index of the shadow economy was used in an econometric model to measure its effect on the economic growth of Romania. Based on the findings, there is a cointegration relation between these two variables. Moreover, the findings indicate that the shadow economy is continuously related to the formal economy and indicate similar trends in the long term.

Asiedu and Stengos [2] evaluated the size of the shadow economy in Ghana during the years 1983 to 2003. In their study, the shadow economy was measured using the cash ratio method. The findings of the study indicate that the average size of the shadow economy in a long term during the research period is 40% of Ghana's GDP. This is while the trend of the shadow economy in Ghana is decreasing, so that the size of the shadow economy there decreased from 54% in 1985 to 25% in 1999.

Birinci [4] evaluated the mutual effects of the degree of economic openness, economic growth and the informal sector during the years 1964 to 2010 for 12 advanced economies. According to the findings, the informal economy affects the economic growth, but the opposite has not been confirmed. Also, the informal economy has affected the degree of openness and volume of trade. Moreover, the effects of the informal economy on economic growth have been greater than its effects on the degree of openness.

Giles et al. [9] evaluated the mutual effects of the formal and informal economy in Canada. Based on their findings, the bigger the formal economy becomes, the smaller the effects of the informal economy will be. However, the effects of the informal economy on the formal sector have not been significant enough.

In general, reviewing of experimental studies, especially in Iran, indicates that these studies either represent the informal economy and the importance and causes of its creation and classifications in a general format, or measure the shadow economy and evaluate its evolution process through special approaches. This is while regarding the effects of the shadow economy, most studies have focused on its effects on employment and the tax sector, and practically only two articles have examined the impact of the shadow economy on economic growth. Moreover, there is no agreement in foreign studies in terms of the effects of the shadow economy on economic growth like that of theoretical literature. Therefore, considering the available studies, there is an obvious gap of studies in terms of the effect of shadow economy and economic growth based on the level of development and the issue of endogeneity.

3. Model Specification and Introducing Variables

3. 1. Model without Endogeneity

The experimental model used in this research is taken from the study by Goel et al. [10] which is examined in the form of a regression model with the effect of the shadow economy on economic growth in developed and developing countries. In the following, the model and variables used are introduced.

$$GDP_{it} = \beta_0 + \beta_1 \mathrm{SHA}_{it} + \beta_2 GDI_{it} + \beta_3 UEM_{it} + \beta_4 SE_{it} + \epsilon_{it} \qquad (1)$$

Where in:

GDP_{it} , is the per capita income at constant prices of 2010 for the target country in specified year. SHA_{it} is the ratio of the shadow economy size to GDP for the target country in the specified year. GDI_{it} is the ratio of gross fixed capital formation ($GFCF$) to GDP for the target country in the specified year. UEM_{it} is the unemployment rate (the ratio of unemployed to the labor force) for the target country in the specified year. SE_{it} is the ratio of government expenditure on education to GDP for the target country in the specified year.

Table 1. Introducing the variables

Variable	Symbol	Definition	Reference
Per capita gross domestic product	GDP	Income per capita at constant prices 2010	World Bank – WDI
The shadow economy	SHA	The ratio of the size of the shadow economy to GDP	Medina and Schneider, [15]
Gross Domestic Income	GDI	The ratio of Gross fixed capital formation (GFCF) to GDP	World Bank – WDI
Unemployment	UEM	Unemployment rate (ratio of unemployed to labor force)	World Bank – WDI
Educational expenses	SE	The ratio of government expenditure on education to GDP	World Bank – WDI
Source: Research findings			

The data belonging to these variables has been collected for 109 countries during the years 2005 to 2017. Of these countries, 30 are the members of the Organization for Economic Cooperation and Development (OECD) which are considered among the selected developed countries. The remaining 79 countries are in the group of selected developing countries. Therefore, the structure of the data in this research is based on panel data model, which is followed by the introduction of these models and their appropriate estimation method according to the objective of the research.

3. 2. Experimental Model Analysis

The first step in econometrics of panel data is to recognize the cross-sectional independence of the data. For this purpose, several tests have been presented, such as: Breusch and Pagan's test and Pesaran CD test, in this article, Pesaran's CD test [18] has been used. This test is applicable for balanced and unbalanced panel data and has favorable characteristics in small samples. Also, unlike Breusch and Pagan's [2015] method, it provides reliable results for large cross-sectional dimensions and small-time dimensions and is resistant to the occurrence of one or more structural failures in individual regression slope coefficients. If the independence of the sections is confirmed, to check the existence of a unit root, one can use the first-generation unit root tests such as Levin, Lin and Chu [13] and Im, Pesaran and Shin (2003) tests, and if there is a cross-sectional If the sections are not

confirmed, the second type of tests should be used, such as Dickey-Fuller's generalization.

Table 2. Pesaran's test of cross-sectional independence

Developed countries			Developing countries		
Test statistics	P-value	Results	Test statistics	P-value	Results
0.766	0.4175	cross sectional independence	0.854	0.518	cross sectional independence
Source: Research findings					

On this basis we must use the first-generation unit root tests such as Levin, Lin and Chu [13] and Im, Pesaran and Shin [12] tests. So, we use LLC unit root test for both groups of developed and developing countries. The results of unit root tests are reported in Table 3. According to Baltagi [3], Levin-Lin-Chu (LLC) tests have a relative superiority over other methods to check the stationarity and reliability of panel data with limited time periods.

Table 3. Results of Levin, Lin and Chu [13] stationarity test

Variable	Developed countries			Developing countries		
Variable	Test statistics	P-value	Results	Test statistics	P-value	Results
GDP	-16.245	0.0000	Stationary	-12.398	0.0000	Stationary
SHA	-14.451	0.0000	Stationary	-10.571	0.0000	Stationary
GDI	-16.229	0.0000	Stationary	-12.119	0.0000	Stationary
UEM	-10.685	0.0000	Stationary	-31.984	0.0000	Stationary
SE	-12.532	0.0000	Stationary	-15.525	0.0000	Stationary
Source: Research findings						

It is clear from the table that the probability value (P-value) of all variables is lower than the common significance level of 0.05. Therefore, the null hypothesis of the existence of a unit root is rejected in all cases. Thus, it can be concluded that all the variables are stationary. Now that the stationarity of the research variables has been ensured, it is time to estimate the models.

After checking the stationarity of the variables and ensuring it, the model is better to be estimated using the ordinary least squares method. The estimation results with this method are presented below. Tables 4 and 5 show the estimated

coefficients for this model using three pooled, fixed, and random effects approaches.

Table 4. Estimation results of panel data model for developed countries

Variable	Coefficient	S.D.	P-value	Coefficient	S.D.	P-value	Coefficient	S.D.	P-value
SHA	-2273	141	0.000 0	-1002	114	0.00 0	-1074	112	0.00 0
GDI	-360	234	0.125	153	52	0.00 3	150	53	0.00 4
UEM	-740	232	0.001	-137	57	0.01 7	-133	57	0.02 1
SE	2142	648	0.001	-276	148	0.06 4	-259	149	
C	76381	739 1	0.000 0	-	-	-	56292	377 0	0.00 0
F-Statistic	102			49			210		
Source: Research findings									

Table 5. Estimation results of panel data model for developing countries

Variable	Coefficient	S.D.	P-value	Coefficient	S.D.	P-value	Coefficient	S.D.	P-value
SHA	-427	23	0.00 0	-142	16	0.00 0	-153	16	0.00 0
GDI	-160	36	0.00 0	-31	9	0.00 1	-31	9	0.00 0
UEM	-90	46	0.05 3	-184	26	0.00 0	-179	25	0.00 1
SE	225	186	0.22 6	73	47	0.12	77	47	0.10 0
C	24520	162 9	0.00 0	-	-	-	14158	113 2	0.00 0
F-Statistic	91			36			158		
Source: Research findings									

The results of all three approaches of pooled, fixed, and random effects show that the shadow economy variable has an inverse and significant relationship with per capita income in both groups of countries. In all models, the probability value

obtained for shadow economy variable is lower than the conventional significance level ($\alpha = 0.05$) Thus, the null hypothesis that the coefficient of shadow economy variable is zero is not acceptable; therefore, the coefficients of the shadow economy variable are statistically significant in the estimated models. According to the results, it can be articulated that in both groups of countries, on average, assuming the stationarity of other conditions and controlling the effect of the variables of fixed capital formation, unemployment and educational expenses, an increase in the size of shadow economy causes a decrease in per capita income. This indicates the destructive effect of the informal economy sector in reducing per capita income and economic development.

- F-Limer test

Table 5 reports the results of F-Limer's test. According to the results, heterogeneous cross-sectional effects are significant in both groups of countries.

Table 6. F-Limer test

Developed countries			Developing countries		
F statistics	P-value	Result	F statistics	P-value	Result
917.58	0.000	Using panel method	559	0.000	Using panel method
Source: Research findings					

Based on the results, therefore, the use of panel method is more preferable than the use of pooled method.

- Hausman Test

The results of the Hausman test for the two country groups are reported in Table 7. According to the results, using the fixed effects method is more appropriate than the use of the random effects method. In other words, unobserved cross-sectional effects have some kind of correlation with covariates, and these unobserved effects are not randomly distributed among countries.

Table 7. Hausman test's results for developed countries

Developed countries			Developing countries		
Chi square	P-value	Result	Chi square	P-value	Result
12.825	0.012	Using fixed effects method	14.19	0.006	Using fixed effects method
Source: Research findings					

A review of Table 3 and focusing on the results of the fixed effects model shows that assuming the stationarity of other conditions and controlling the effect of the variables of fixed capital formation, unemployment and educational expenses, a one percent increase in the size of the shadow economy in developed countries causes an average decrease of $1002 in per capita income. According to Table 4, this decrease is $142 for developing countries, that is, assuming the stationarity of other conditions and controlling the effect of the variables of fixed capital formation, unemployment and educational expenses, a one percent increase in the size of the shadow economy in developing countries causes an average decrease of $142 in per capita income. As previously stated, the shadow economy has negative effects on per capita income in developed countries, which was predictable. However, it was unexpected that the impacts in developed countries were more than those in developing countries. Despite the fact that the coefficients are largely correct, this finding is generally not consistent with the theoretical foundations stating that the effects of the shadow economy on per capita income in these countries are generally controlled due to the existence of institutional infrastructures and the government's power to collect taxes. It should be noted that the results of random effects also indicated that the effects of the shadow economy on per capita income in developed countries ($1074) is much higher than in developing countries ($153). Hence, the type of coefficient estimation method does not affect the intensity of shadow economy effects on per capita income in developed countries and, in general, the results of the model estimation using panel data method confirm the negative effects of the shadow economy on per capita income in both groups of countries and also show that the effects of shadow economy on per capita income are much higher in developed countries than in developing countries.

3. 3. Panel Estimation with the Assumption of Endogeneity

So far, model coefficients were estimated without the assumption of endogeneity of the covariates. However, the size of the shadow economy, in addition to affect the development process, can also be affected by the level of development of countries. Many empirical studies, including Soares and Afonso [26], Giles et al. [9] have argued that model estimation by panel data method can be highly biased in the presence of endogeneity and is not reliable. Given the theoretical foundations, on the one hand, and the unexpected results of shadow economy effects on per capita income, on the other hand, more attention is required regarding the relationship between the shadow economy and per capita income. Therefore, the panel model is also estimated using the instrumental variable method as follows.

Instrumental variable method provides a general solution for solving the endogeneity problem of covariate(s) [27]. Endogeneity occurs when covariates are correlated with the disturbance term, which may occur due to the omission of relevant variables, measurement errors, self-selected sample selection, etc. However, endogeneity causes inconsistency in ordinary least squares estimates. In this case, instrumental variable methods such as two-stage least squares (2SLS) are required to obtain consistent parameters [3].

An equation with the following form is considered:

$$y_{it} = Y_{it}\gamma + X_{1it}\beta + \mu_i + \upsilon_{it} = Z_{it}\delta + \mu_i + \upsilon_{it} \qquad (2)$$

where y_{it} is the dependent variable, Y_{it} is an $1 \times g_2$ vector of observations on g_2 endogenous variables included as covariates, and these variables can be correlated with the υ_{it}. X_{1it} is a $1 \times k_1$ vector of observations on the exogenous variable(s) included as covariates in the model. The vectors Z and X are as $Z_{it} = [Y_{it}\ X_{it}]$ and $X_{it} = [X_{1it}\ X_{2it}]$. γ is a $g_2 \times 1$ vector of coefficients; β is a $k_1 \times 1$ vector of coefficients; and δ is a vector of coefficients with $k = g_2 + k_1$ dimension. In this case, unlike the ordinary least squares estimator for the panel, the random effects estimator (G2SLS) treats μ_i as a random variable that is independent and normally distributed. Moreover, υ_{it} has a normal distribution with zero mean and has no correlation with X_{it} variables (just like when there are no endogenous variables in the model). [20]

Although GLS random-effects estimator is more efficient than the within-group estimator, the estimator will be inconsistent if μ_i is correlated with the X_{it} variables. Thus, it is better to use instrumental variables when estimating the model. The panel data method with instrumental variables (Xtivreg) has estimators for two-stage least squares one-way error components (2SLS) models. One-way error component models use two variance components for estimation: μ_i variance and υ_{it} variance.

Since the variance components are unknown, applied GLS should be used so that the OLS method is not inconsistent. Accordingly, the G2SLS method is a consistent and efficient method for panel data, and there is no need for the Hausman test to examine the consistency of the random pattern's method.

Based on the econometrics principles and research literature, including the studies of Soares and Afonso [26] and Goel et al. [9], the shadow economy is an endogenous variable. Therefore, the model related to the shadow economy will be estimated at the first stage and then the main model, that is, the model determining the shadow economy effects on per capita income. In this regard, the variables of labor market regulations (LAB), tax burden (TAX), government efficiency (GE) and legislative quality (RQ) were used as instrumental variables. Finally, model coefficients are estimated based on the following two-step equation:

$$GDP_{it} = \beta_0 + \beta_1 \mathrm{SHAD}_{it} + \beta_2 GDI_{it} + \beta_3 UEM_{it} + \beta_4 SE_{it} + \epsilon_{it} \quad (3)$$

and

$$SHAD_{it} = \alpha_0 + \alpha_1 GDI_{it} + \alpha_2 UEM_{it} + \alpha_3 SE_{it} + \alpha_4 LAB_{it} + \alpha_5 TAX_{it} + \alpha_6 GE_{it} + \alpha_7 RQ_{it} + u_{it} \quad (4)$$

It should be noted that in this research, this equation used to estimate the shadow economy was extracted from the study of Medina and Schneider [15].

Table 8: Results of Levin, Lin and Chu [13] stationarity test

Variable	Developed countries			Developing countries		
Variable	Test statistics	P-value	Results	Test statistics	P-value	Results
LABOR	-6.762	0.0000	Stationary	-19.371	0.0000	Stationary
TAX	-13.317	0.0000	Stationary	-42.902	0.0000	Stationary

GE	-6.022	0.0000	Stationary	-8.039	0.0000	Stationary
RQ	-6.668	0.0000	Stationary	-13.649	0.0000	Stationary
Source: Research findings						

Before estimating the model with the assumption of endogeneity, it is necessary to check the stationarity in the second equation. Table 8 shows the results of stationarity by LLC method. It is clear from the table that the probability value (P-value) of all variables is lower than the common significance level of 0.05. Thus, it can be concluded that all the variables are stationary at level. Now that the stationarity of the research variables has been ensured, it is time to start model estimations. The results of F-Limer and Hausman tests are presented in the previous section. Based on the results of the F-Limer test, panel effects are superior to pooled ones. Fixed effects model is superior to random effects model in both sets of countries, however, applied GLS should be used to avoid the inconsistency of the OLS method. Accordingly, the G2SLS method is a consistent and efficient method for panel data, and there is no need to use the Hausman test to examine the consistency of the random pattern's method, and the model should be estimated by the G2SLS method. Hence, the results for both sets of countries are presented with this method as follows.

Table 9. Estimation results with G2SLS method

Variable	Variable	Coefficient	SD	P-value
SHA	Shadow economy	470	601	0.434
GDI	Fixed capital formation	312	48	0.000
UEM	Unemployment	-307	107	0.004
SE	Educational expenses	-478	140	0.000
Chi square	196			
Source: Research findings				

According to Table 9, the probability level of the shadow economy variable for developed countries is 0.434, which is higher than the usual significance level (0.05). Thus, the null hypothesis of a zero variable coefficient cannot be rejected. According to this model, therefore, assuming the stationarity of other conditions and controlling the effect of the variables of capital formation, unemployment and educational expenses, no significant relationship was found between the size of the shadow economy and per capita income in developed countries. This can be

attributed to the efficiency of the governments of developed countries in formulating and implementing economic and social policies, as well as their ability to discover and deal with the informal sector of the economy, which limits the scope of shadow economic activities and their effect on per capita income.

Table 10. Estimation results with G2SLS method

Variable	Variable	Coefficient	SD	P-value
SHA	Shadow economy	-418	104	0.000
GDI	Fixed capital formation	-32	10	0.002
UEM	Unemployment	-127	32	0.000
SE	Educational expenses	114	56	0.044
Chi square	60			
Source: Research findings				

It can be seen from Table 10 for developing countries that the shadow economy has a significant and negative correlation with per capita income. The significance level of the per capita income variable is 0.000, which is less than the common significance level (0.05). Therefore, the null hypothesis of a zero variable coefficient is rejected. This means that the variable coefficient is statistically significant. On the other hand, the coefficient of the shadow economy is -418, that is, assuming the stationarity of other conditions and controlling the effect of the variables of capital formation, unemployment and educational expenses, a one percent increase in the size of the shadow economy causes an average decrease of $418 in per capita income in developed countries. The inverse and significant relationship between shadow economy and per capita income in developing countries can indicate the inability of these countries in limiting the scope of informal economic activities and moderating the negative effects of such activities on the development process.

4. Discussion and Conclusion

Due to the significant effects of the shadow economy on per capita income, this research seeks to provide a more accurate and comprehensive picture of the effects of this factor on per capita income in both developing and developed countries with the assumption that shadow economy is an endogenous variable. Based on the results of regression model estimation with panel data, shadow economy has a

significant negative effect on economic growth in both sets of countries. The results of all three methods of pooled, fixed and random effects also confirm the negative impact of the shadow economy on per capita income in both sets of countries. Meanwhile, in all three methods, the shadow economy coefficient estimated for developed countries is significantly higher than the coefficient estimated for developing countries. The results of F-Limer F test also confirm the superiority of panel data over pooled effects. Moreover, the results of the Hausman test emphasize the superiority of fixed effects over random effects. Based on the results of fixed effects estimation, a one percent increase in the size of the shadow economy in developed countries caused an average decrease of $1002 in per capita income, and for developing countries, a one percent increase in the size of the shadow economy caused a decrease of $142 in per capita income in this group of countries. Therefore, the negative effects of the shadow economy are clearly greater in developed countries than in developing countries, which is largely in contradiction with the theoretical foundations. One reason for this contradiction can be attributed to the bias in estimation results by the panel data method. Because based on the research literature and empirical studies, including Soares and Afonso [26] and Giles et al. [9], there is an endogenous relationship between the shadow economy and per capita income, so that ignoring this will cause bias in the results. Therefore, it is necessary to examine the model with the endogenous assumption. Estimation of model coefficients with G2SLS method led to very different results. Based on the results, the shadow economy has a significant and negative effect on per capita income in developing countries, so that a one percent increase in the size of the shadow economy caused a decrease of $418 in per capita income in these countries. However, for developed countries, the effects of the shadow economy on per capita income are not significant. Therefore, considering endogeneity assumption leads to more congruent and reliable results with theoretical foundations compared to estimation with simple panel data method. Therefore, internal and external studies investigating the effects of the shadow economy must consider the problem of endogeneity to avoid results with a lower degree of reliability. Taking into account the level of development of countries and the problem of endogeneity, therefore, the shadow economy has a negative effect on per capita income in developing

countries. This finding is the same as the results obtained by the panel data method in terms of sign, but is different in terms of the coefficient and its negative effects have increased. The results of the present study are consistent with Goel et al. [10] for the United States before the Second World War (in this period, the United States was still in the early stages of growth, and for this reason, the effect of the shadow economy on economic growth was negative), Soares and Afonso's [26] study on the developing economy of Portugal and the study of Mehrabi Boshrabadi et al [16] for Iran. However, it is in contradiction with the study of Shahab and Pajuyan [24] for Iran's economy, which estimated a u-shaped relationship for the effects of the shadow economy on economic growth. It should be noted that the u-shaped effects of the shadow economy on economic growth have been also estimated in other studies such as Goel et al. [10] and Wu and Schneider [28] for developed countries. According to these studies, the behavior of the mentioned variables depends on growth level of the countries, so that in the initial stages of growth, the shadow economy has a negative effect on economic growth, but in the more advanced stages, this effect is controlled and finally becomes positive. However, it seems that the results of Shahab and Pajuyan's [24] study for Iran's economy suffer from bias and are not very reliable due to neglecting the problem of endogeneity. On the other hand, it is not practical to compare the level of economic development of developed countries with Iran, and the result obtained in the study of Shahab and Pajuyan [24] cannot be generalized to developing countries including Iran.

The results of the two methods of panel data and G2SLS for developed countries indicated that the results obtained by these models are not comparable. The results considering the assumption of endogeneity are more consistent with theoretical foundations and have greater ability to estimate the effects of the shadow economy on per capita income in developed countries. It worth to mention that the result of this study is consistent with Goel et al. [10] for the United States after the Second World War and other studies such as Wu and Schneider [28], Giles et al. [9] and Shahab and Pajuyan [24] for developed countries. Therefore, the difference in the economic literature regarding the impact of the shadow economy variable on the economic growth can be explained to a large extent by the difference in development level of the countries and the problem of endogeneity.

As expected, due to the greater ability and effectiveness of the government as well as better institutional efficiency, the effects of the shadow economy on per capita income are more limited in developed countries, while in developing countries where the institutional efficiency and effectiveness of the government is less, the effects of this variable on per capita income become significant and positive. Accordingly, given the significant role of the governments in identification and controlling the shadow sector, it is suggested that the governments of developing countries diminish the motivation of entrepreneurs and businesses to operate in the informal sector by amending laws and improving institutional efficiency. On the other hand, governments can facilitate the reduction of the informal sector by simplifying and reducing the process of licensing, confronting monopolies, and more precisely, improving ease of doing business and providing more incentives to formal activities. Moreover, recent efforts of various countries, including Iran, to raise the tax rate and attract more taxes seem to have a positive influence on the growth of the informal sector and thereby negatively affect the per capita income in the long term. Therefore, governments should exercise ultimate accuracy in the tax sector terminology, and rather than seeking maximum taxation, they should try to find and receive an optimal level of taxation (taking into account the level of the shadow economy) to narrow its negative effects on economic growth and per capita income. Finally, given the long-term negative effects of the shadow economy on per capita income in developing countries, policy makers, while paying attention to the employment in this sector, should try to limit the informal sector because the per capita income is a consequent of almost all economic variables and the welfare of the whole society is of most important for policy makers. On the other hand, it should be noted that limiting the shadow economy does not mean the elimination of employment and businesses, but operating these services with more incentive policies in the official sector. Therefore, limiting activities in the informal sector does not necessarily mean eliminating employment and businesses in the economy.

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تجزیه و تحلیل اثرات اقتصاد سایه بر درآمد سرانه: با و بدون درنظر گرفتن مسأله درونزایی

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چکیده

براساس ادبیات نظری، رویکردهای گوناگون و گاه متبینی دربارهٔ نحوهٔ اثرگذاری اقتصاد سایه‌ای بر درآمد سرانه وجود دارد؛ بنابراین با توجه به اهمیت این موضوع برای سیاست‌گذاری‌های اقتصادی، این مطالعه تأثیرات اقتصاد سایه‌ای را بر درآمد سرانه را برای بازهٔ زمانی ۲۰۰۵ تا ۲۰۱۷ م. با استفاده از روش داده‌های تابلویی و روش حداق مربعات دو مرحله‌ای پانلی (G2SLS) در دو گروه از کشورهای درحال توسعه و توسعه‌یافته مورد سنجش قرار داده است. براساس نتایج با رویکرد داده‌های تابلویی در هردو مجموعهٔ کشورها حجم اقتصاد سایهٔ تأثیر منفی بر درآمد سرانه داشت؛ همچنین، تأثیرات اقتصاد سایه بر درآمد سرانه در کشورهای توسعه‌یافته به‌مراتب از کشورهای درحال توسعه بیشتر بود که در تناقض با مبانی نظری به‌نظر آمد. براساس نتایج حاصل از تخمین مدل با فرض درونزایی اقتصاد سایه، برای کشورهای درحال توسعه این تأثیرات منفی و معنی‌دار شد؛ اما برای کشورهای توسعه‌یافته تأثیرات از معنی‌داری لازم برخوردار نبود.

کلیدواژگان: درآمد سرانه، داده‌های تابلویی، اقتصاد سایه، روش حداقل مربعات دومرحله‌ای پانلی (G2SLS).
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