دانشگاه بوعلی سینا

مطالعات اقتصادی کاربردی ایران

۴۴

شاپای چاپی: ۲۵۳۰-۲۳۲۲؛ شاپای الکترونیکی: ۲۳۲۲-۴۷۲X

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|| سال ۱۱ || شمارهٔ ۴۴ || زمستان ۱۴۰۱ ||

راهنمای نگارش و ارسال مقاله

۱- محتوای شکلی مقاله

– مقاله‌های ارسالی نباید بیش از ۲۰ صفحهٔ A۴ باشد.

– مقاله تایپ شده با قلم B Mitra ۱۳ برنامه Word ۲۰۱۰ و مطابق با معیارهای مندرج در این راهنما ارسال شود.

۲- ساختار علمی مقاله

ساختار مقاله به‌صورت زیر تنظیم شود:

- مقدمه: شامل تعریف موضوع طرح مسأله و بیان اهداف.
- بررسی پیشینه: موضوع و چارچوب نظری و طرح پرسش‌ها/ یا فرضیات تحقیق.
- روش‌شناسی تحقیق: روش تحقیق متغیرهای مورد بررسی و فنون گردآوری و تحلیل داده‌ها.
- ارائه یافته‌ها، تجزیه و تحلیل و تفسیر آن‌ها.
- جمع‌بندی و نتیجه‌گیری.
- یادداشت‌ها و پیوست‌ها (در صورت لزوم).
- فهرست منابع فارسی و انگلیسی به روشAPA.
- خلاصه‌ای از سوابق و علایق آموزشی و پژوهشی نویسنده/ نام دانشگاه یا مؤسسه وابسته/ نشانی الکترونیکی.
- چکیدهٔ انگلیسی همراه با کلیدواژه‌ها در پایان مقاله.

۲- شیوهٔ ارجاع و استناد

– ارجاع در متن مقاله

پس از مطلب اقتباس شده، مستقیم یا غیرمستقیم: (نام خانوادگی صاحب اثر، سال انتشار: شمارهٔ صفحه یا صفحات).

در صورتی‌که اثر مورد استفاده به زبان فارسی ترجمه شده باشد، تاریخ انتشار اثر ترجمه شده و در غیر این‌صورت تاریخ انتشار متن به زبان اصلی ذکر شود.

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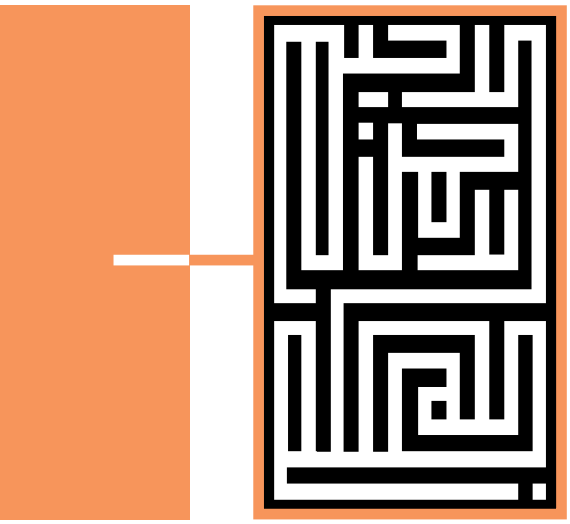

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نشریه

مطالعات اقتصادی کاربردی ایران

با صاحب امتیازی دانشگاه بوعلی سینا بر اساس آیین‌نامه نشریات علمی مصوب ۱۳۹۸/۰۲/۰۹ در ارزیابی سال ۱۳۹۹، موفق به کسب رتبه الف شده است.

بی تردید تلاش دست‌اندرکاران آن نشریه سهم بسزایی در گسترش مرزهای دانش و ارتقای کیفی و کمی جایگاه علمی کشور خواهد داشت.

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Effect of Credit Easing Policy on Recovery of Iran's Economy: Stochastic Dynamic General Equilibrium Model Approach

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Abstract

By utilizing the new Keynesian stochastic dynamic general equilibrium model, this paper examines the effects of credit easing policy on macroeconomic variables with or emphasizing on production. For this purpose, a model has been design including 5 sectors of household, enterprises, banks, government and central bank. Considering the dominance of fiscal policy over monetary policy in the Iranian economy, the integrated constraint of the government and the central bank has been used. The model has been estimated using Bayesian method and quarterly time series data during 1991 to 2017. The results of Impulse Response Function show that implementation of this policy has increased consumption, investment, government spending and ultimately production, which indicates the effectiveness of this unconventional monetary policy to get the economy out of recession. Also, in response to the positive impulse of the central bank's credit line to banks and the negative impulse of legal reserves, bank facilities increase, which is in line with theoretical expectations. The impact of the negative impulse of interbank market rate has also led to an increase in production credits.

Keywords: Recession, Credit Easing, DSGE Model, Credit Line, Bayesian Method.
JEL Classification: E12, E42, E58.

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1. Introduction

From the mid-2001s to 2019, the Iranian economy has faced several recession during the years 2007-2008, 2010-2011, 2014-2015 and 2018-2019. Comparison of GDP components in different economic activities shows that the negative growth of the agricultural sector and the decline in oil production and exports caused a significant reduction in GDP growth in 2007-2008. The significant and unprecedented decrease in GDP growth in the years 2010-2011 was due to exchange rate fluctuations and increased international sanctions. The economic growth in Iran in 2011, including oil production, has been reported at -8.6%. In 2014, a positive economic growth was experienced and a rate of 2.3% was recorded for GDP growth, including oil production. Economic growth in 2015 decreased again to -0.1% and marked the third economic recession during the years 2006 to 2015. In 2019, after two periods of positive GDP growth, the GDP growth was reported as -6.9% (Fig 1).

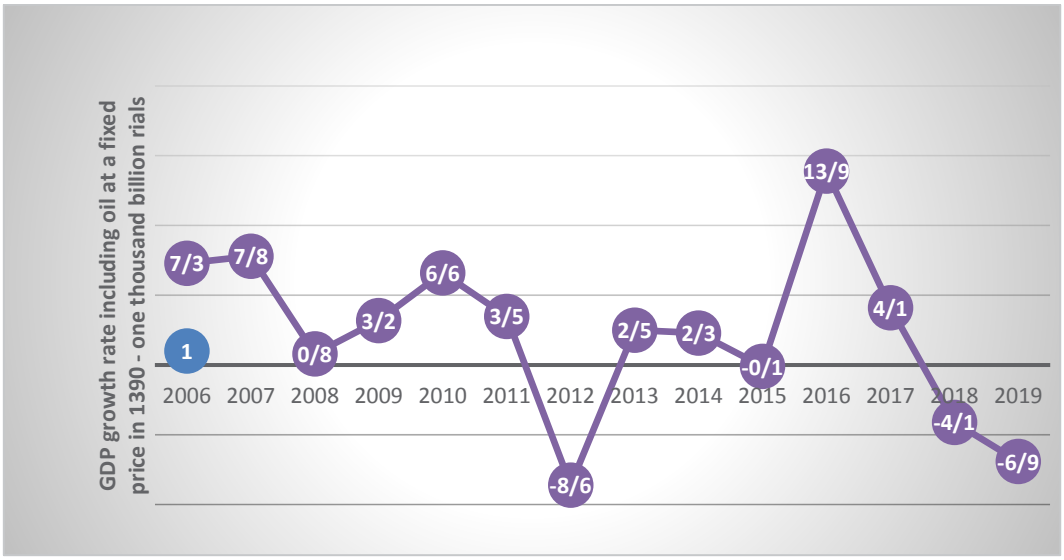

Fig. 1: Business cycles in the Iranian economy during the period 2006-2019 (Source: Central Bank of Iran, data site).

In the financial crisis of 2007-2009, central banks adopted unconventional monetary policies such as credit easing to exit the recession. One of the features of the new monetary policy tools is the use of the central bank balance sheet (by providing the necessary liquidity for lending to financial institutions), which requires the expansion of the "assets" column of the central bank balance sheet, while the Quantitative Easing Policy is focused on the central bank's liabilities column in the balance sheet. The purpose of credit easing is to support the

performance of financial markets, especially during a crisis, and to provide additional financial resources to the economy during a recession. According to the Fed, credit easing complements central banks' monetary policy by providing financial assets and stimulating turbulent markets during financial crises. In the global financial crisis, the Fed made the lending process easier to prevent banks from going bankrupt. Their solution during the crisis was to provide more credit (auction mechanism) by a combination of more available collaterals, which was known as a credit easing. Credit easing is actually providing liquidity through the following: lending to financial institutions, providing liquidity to major credit markets, and buying long-term bonds.

Given the recessionary conditions faced by the Iranian economy in recent years, measures taken by the Iranian Central Bank to ease credit provision in order to exit the recession and recovery included reduced statutory reserve requirement rate, reduced interbank market rate and the central bank credit line for the banks. In this study, we examined the effect of central bank credit easing on macroeconomic variables (investment and national product, bank lending, liquidity, inflation and exchange rate).

In this study, in order to analyze the effect of credit easing, we employed the DSGE model and quarterly data in the period 1991 to 2017. Section 2 provides literature review and the necessity of conducting the research. In Section 3, the theoretical background, model specification and test results are reported. In Section 4, the effects of credit easing on the Iranian economy and overcoming recession are examined. Section 5 is devoted to conclusions and suggestions.

2. Instruments of credit easing policy in Iran

The most important tools of credit easing policy in Iran to finance investment and productive activities in a recession are as follows:

2-1. The credit line of the Central Bank to the banks:

The credit line of the Central Bank to the banks is in fact the claims of the Central Bank from the banks, which, in the periodic financial reports, are recorded in the balance sheet of the Central Bank as assets and in the balance sheets of the banks as liabilities.

Using central bank resources in the form of overdrafts requires an additional penalty clause of the banks from the central bank at the rate of 34%, which was turned into a credit line with a lower rate by the central bank in the credit easing policy. The Central Bank has reduced the overdraft penalty rate by implementing the credit easing policy in order to increase the banks' resources to provide more

facilities and increase production. Accordingly, banks will be fined for overdraft at a rate of 16% with the collateral and at a rate of 18% without[1].

Table 1: The credit line of the Central Bank to the banks

	balance			Balance growth at the end of the year	
	August 2019	February 2019	August 2020	August 2020 to the August 2019	August 2020 to the February 2019
Central bank receivables from banks	1218.8	1106.9	1291.9	6.0	16.7

Source: Balance Sheet of the Central Bank of the Islamic Republic of Iran, 2020, pages 4 and 5.

2-2. Reducing the statutory reserve requirement rate

Reducing the statutory reserve requirement rate is one of the credit easing measures employed by the Central Bank. Banks are required to deposit a proportion of their debts (amounts received from the public as deposits) with the central bank. Since the fourth quarter of 2015, the statutory deposit rate of banks and credit institutions was determined to be between 10% and 13% based on performance, and the Central Bank has set different ratios for them depending on the combination and type of activities of the banks.

Reduction of the statutory reserve requirement rate has provided the banks with 177.610.0 billion Rial during the years 2008-2017 for lending and credit.

Table 2: Reducing the statutory reserve requirement rate

Title	2008	2009	2010	2011	2012	2013	2014
	rate						
current account	20/۰٪	17/۰٪	17/۰٪	13/5%	13/۰٪	13/۰٪	13/۰٪
deposit account	12/۰٪	10/۰٪	10/۰٪	10/۰٪	10/۰٪	10/۰٪	10/۰٪
saving account	17/۰٪	16/۰٪	15/5%	13/5%	13/۰٪	13/۰٪	13/۰٪

[1]. Report of the Monetary and Credit Council on the policy-regulatory criteria of the country's banking operations.

Cash Deposit Guarantees (Public and Private Sector)	20/۰٪	17/۰٪	17/۰٪	13/5%	13/۰٪	13/۰٪	13/۰٪
Letter of credits (public and private sector)	20/۰٪	17/۰٪	17/۰٪	13/5%	13/۰٪	13/۰٪	13/۰٪
Deposit (billion Tomans)	194328	242444	318767	819276	1061901	1272836	1646405
Deposits after deducting statutory deposit (billion Tomans)	167577	213162	282318	725703	957393	1137409	1474188
The ratio of total deposits to deposits after deduction of statutory deposit (percentage)	86	88	89	89	90	89/5	89/5
Changes in resources released as a result of the reduction in statutory reserve requirement	-	4848	9563	24578	42476	44549	51596

Source: Central Bank of Iran data site.

2-3. Reduction in the interbank market rate

The interbank market is one of the components of the money market and bank financing methods that allows transactions between banks and tries to meet their short-term needs by using surplus resources of one another, eliminating the need to refer to the central bank. In these markets, borrowing is performed through interbank interest rates. The interbank market offers two important functions in financial systems. First, it causes the central bank to play an active and effective role in the implementation of monetary policy by managing interest rates, and second, it causes the transfer of liquidity in a favorable manner from financial institutions with surplus funds to financial institutions with deficit funds. Changes in interbank market interest rates can be effectively increase and decrease bank interest rates. In recent years, the central bank has implemented a credit easing policy by reducing interbank interest rates, thereby making it easier for banks to provide funds and facilities.

Table 3. Summary of interbank market performance

Year	Transaction volume (billion Rials)	Interest rate (percentage)	Number of transactions (Item)
2009	120020	15.5	210
2010	435299	14.4	1258
2011	1400041	18.2	3544
2012	1213200	21.4	2110
2013	3110219	23.02	5886
2014	11389544	27	17370
2015	21969148	24.47	22975
2016	30957154	18.62	31403
2017	64055680	18.69	38101
2018	107149635	19.72	40663
2019	18688200	18.95	40341

Source: Central Bank of Iran, data site.

3. Theoretical background and literature review

Since the global financial crisis, which pushed the world economy into a deep recession, central banks have cut short-term interest rates to near zero to exit the recession, while also using unconventional monetary policies, including credit easing. The main goal of policymakers was first to help interbank and credit markets and then help the economy as a whole to prevent the cease of lending activities and production reduction (Marco Bruno, 2015). The need for an unconventional monetary policy also becomes apparent when, for some reason, the central bank is unable to further reduce the nominal interest rate and therefore uses other tools to determine its monetary policy stance.

Highlights and distinctions of the current research are as follows:

1- Using credit easing as an unconventional monetary policy in the country

2- Using a DSGE model and examining the instantaneous response of shocks to the recessionary gap in the Iranian economy

3- Using the combined constraint of the government and the central bank due to the lack of independence of the central bank and the dominance of fiscal policy over monetary policy in the Iranian economy.

Mirjalili (2016) examined "A Comparative Study of Conventional vs. Unconventional Monetary Policies", and introduced credit easing as an unconventional monetary policy, which has been used as a tool to get out of the recession after the global financial crisis. Major central banks used

unconventional monetary policy tools during the global financial crisis to exit the recession, and pursued monetary policy through quantitative easing, credit easing, and bank reserve changes.

Woodford (2003) states that until 2003, few central banks directly regulated the flow of capital through markets and financial institutions, but used credit controls or other methods. Until then, such controls were believed to divert relative budget expenditures to different sectors of the economy, affecting the overall interests of central banks. Recent events have led to important unconventional monetary policies.

Woodford and Cordia (2010) state that, given the recession caused by the global financial crisis, conventional monetary policies are insufficient to stabilize economic growth and enhance the GDP. Credit easing has been effective in developing economies during the global financial crisis of 2008-2009.

Jacome (2012) describes the use of credit easing as one of the most unconventional monetary policies in Latin America, as many central banks employed credit easing during the global financial crisis. The purpose of implementing this policy is to stabilize the financial system in order to prevent the collapse of financial markets and thus prevent a sharp decline in production.

A study by Ishi et al. (2009) also showed that in emerging and developing economies, credit easing has been used to reduce financial risk in the banking system at times of crisis. The experience of countries in the field of credit easing shows that it has been effective in strengthening economic activity.

Khalid EI-Fayoumi (2019) examined the effect of credit easing on employment and production in the United States and calculate the interaction between financial friction and the labor market using the SVAR model, which includes heterogeneous companies and a financial sector. He shows that the effect of credit fluctuations on employment growth is more severe for industries that face higher borrowing costs. In industries that are included in credit easing policies prefer to create assets, thereby reducing the recession. The results indicate that credit easing should not target companies that have a high potential for hiring or paying higher wages, so as not to put pressure on the workforce.

Jacome et al. (2018) examined whether credit easing is a monetary policy tool to deal with banking crises in emerging economies. They find that emerging and developing economies should be cautious when using credit easing, as they may lead to increased liquidity and inflation and higher exchange rates in the economy.

William (2015) explores the effect of lower bank interest rates, as a credit easing policy tool, on the composition and size of the Federal Reserve balance

sheet assets. The results show that in the financial crisis of 2007-2009, the implementation of credit easing policy has prevented financial collapse.

Bruno (2015), examined the effect of unconventional monetary policy and evaluates credit and quantitative easing tools as components of unconventional policy as well as the portfolio rebalancing channel. Since the oil crisis of the 1970s and the Great Depression, economists have focused on ways to account for the effects of these shocks and crises on the transmission of monetary policy and the real sector of the economy. The model includes households, Firms, and the integration of government and the central bank. The results of the new Keynesian DSGE model, indicate that unconventional monetary policies has affected the real sector of the economy.

Berkmen (2012), explored the impact of Credit and Quantitative Easing by the Bank of JapanUsing the structural VAR model. The results indicated that the credit easing measures of the Bank of Japan (Central Bank) during 1998-2010 affected economic activities. This study leads to better results than the studies conducted before 2006 in Japan and considers the credit easing as a policy with good results in the banking sector and in big corporations.

Gertler and Karadi (2009),investigated Unconventional Monetary Policy using DSGE model to evaluate the effects of central bank measures to deal with the financial crisis. The central bank, as a financial intermediary, raises more capital than the private sector by issuing government risk-free debt, and also raises balance sheet restrictions for the private sector, thereby it increases benefits from intermediation. They conclude that even if the central bank's intermediation profit was reduced to zero, they could make a profit by implementing an unconventional monetary policy.

Mohseni et al. (2019) investigated the effect of credit easing policy on economic variables using the VAR model. They estimated the variables of immediate action and reaction in the period 2005-2006. The results show a positive and significant effect of credit easing on GDP growth, private sector investment and non-oil exports as well. This will reduce the unemployment rate and the exchange rate too. They also indicated that if the credit easing policy is strengthens, it will be accompanied by improvements in the banking system and increased investment in the economy.

Akhbari and Gholizadeh (2017), explored quantitative easing policy as a kind of unconventional monetary policy during the recession. They find that the implementation of unconventional monetary policy is common due to the effectiveness of policy instruments. The necessity of this policy and its effectiveness depends on macroeconomic conditions, the tools available to the central bank and the economic structure of the implementing countries. The

results indicate that the establishment of appropriate institutional mechanisms and the identification of eligible firms can transfer financial resources to productive economic activities.

Mehrabian and Shafaei (2010) examined the effect of bank loans on economic growth. In this regard, they employed the VAR model and data from 1980 to 2008. The results indicated that granting loans to the non-governmental sector have a positive effect on the economic growth.

4. Methodology

As aforementioned earlier, whenever the monetary policy transmission channel is disrupted, conventional monetary policy instruments will not be effective enough to achieve macroeconomic goals. In such circumstances, central banks will be able to achieve macroeconomic goals through unconventional monetary policies. On the other hand, considering the structure and mechanism of the Central Bank in Iran, the most important credit easing tools available to policymakers in Iran include Central Bank credit line to banks, reduction of the interbank market rate and reduction of the statutory deposit rate. The outcome of this policy has been tested empirically using the new Keynesian DSGE model for the Iranian economy.

The DSGE model consists of five sections: household, enterprise, banks, government and central bank. Due to the fiscal dominance over monetary policy, we employed a consolidated constraint of government and central bank. To clarify the household sector, the study of Hollander and Liu (2016) has been used and the household utility function and its constraints have been adjusted according to the needs of the present study. For the definition of the banking sector,we benefited from Atta-Mensah and Dib (2008), Gerali et al. (2010), Hollander and Liu (2016) and Falagiarda and Saia (2017). For the government and its integration constraint with the Central Bank, the approaches of Falagiarda and Saia (2017) and Khiabani and Amiri (2014) have been followed. Taghipour (2014) used to model the National Development Fund. in designing the DSGE model, the Bruno (2015) has been followed and considering the fact that the monetary and financial structure of the country have distinct features, we made adjustments in Bruno (2015) model structure. First, with the dependence of the country's economy on oil revenues, these revenues, like tax revenues, bonds and government expenditures, have been consolidated between the government and the central bank. Second, since part of the oil revenues are deposited in the National Development Fund, in times of recession it can be used for the implementation of credit easing policy. Third, by adding the banking sector alongside the government-central bank consolidation clause, it is possible to examine changes in banks' statutory reserves as another

tool of credit easing policy, which is not a feature of the Bruno (2015) study. Fourth, in the household utility function, in addition to consumption, money retention and leisure, the issue of household utilization from bank deposits is also included, which is not included in the utility function of the Bruno (2015). Fifth, Bruno's (2015) study used the Rotemberg (1982) approach to model price stickiness, but in this study, we used calvo (1983) for the pricing mechanism.

- Households

Given that the household seeks to maximize utility, first the discounted inter-period utility function is defined for the household:

$$E_t \sum_{t=0}^{\infty} \beta^t \varepsilon_t^{\beta} \left\{ \frac{1}{1-\sigma_c}(C_t)^{1-\sigma_c} - \frac{1}{1+\sigma_N}(N_t)^{1+\sigma_N} + \frac{\kappa_M}{1+\sigma_M}(M_t)^{1+\sigma_M} + \hbar_t^D \ln(\frac{D_t}{P_t}) \right\}$$

In this utility function, the household gains utility from consumption(C_t), holding real money balance(M_t) and bank deposit as a financial asset(D_t) and loses utility by working(N_t) . Also, $\hbar_t^D$ the level of bank deposits in the household investment portfolio, the factor of mental discount with the parameter β shown and σ_c the inter-period consumption elasticity; σ_N the inverse of labor force elasticity; σ_M inverse of cash balance elasticity; κ_M liquidity preference coefficient and ε_t^{β} the momentum of household preferences. On the other hand, the household budget constraint to which the utility function is optimized is also specified as follows:

$$C_t + \frac{p_t^I}{p_t} I_t + \frac{M_t}{P_t} + \frac{B_t}{P_t} + \frac{D_t}{P_t} + \frac{i_{t-1}^l L_{t-1}}{p_t} + T_t = \frac{W_t}{P_t} N_t + R_{t-1}^b \frac{B_{t-1}}{P_t} + \frac{M_{t-1}}{P_t} + \frac{i_{t-1}^d D_{t-1}}{P_t} + \frac{L_t}{P_t} + r_t^k K_t + \Pi_t \quad (2)$$

The household budget constraint indicates that the total household income and expenditure must be equal. The left-hand side of Eq(2) represents expenditures (C_t), investment ($\frac{p_t^I}{p_t} I_t$), liquidity balance ($\frac{M_t}{P_t}$), purchase of bonds ($\frac{B_t}{P_t}$), deposits ($\frac{D_t}{P_t}$) , repayment of loan received in the previous period($\frac{i_{t-1}^l L_{t-1}}{p_t}$) and tax payments($T$), which are financed by household income through on the right-hand side of Eq. (2), including the supply of labor($\frac{W_t}{P_t} N_t$), interest of bonds of

the previous period($R^b_{t-1}\frac{B_{t-1}}{P_t}$), liquidity of the previous period($\frac{M_{t-1}}{P_t}$), income from deposits in the previous period($\frac{i^d_{t-1}D_{t-1}}{P_t}$), loan receipt in the current period ($\frac{L_t}{P_t}$) , capital income($r^k_t K_t$) and other household incomes from the economic activity of system enterprises in the economy(Π_t). Also, households in each time period are faced with the equation of physical capital formation. According to the literature, the subject of general equilibrium models is specified as follows:

$$K_t = (1-\delta)K_{t-1} + [1 - S(\frac{I_t}{I_{t-1}})]I_t \qquad (3)$$

In Equation (3), while δ representing the depreciation of fixed capital, it $S(\frac{I_t}{I_{t-1}})$ also represents the investment cost adjustment function that depends on the current investment and its interruption. The cost mediating function is convex and incremental, which indicates that it is costly to change the level of investment (Christiano et a, 2004). After examining the problem of household optimization and specifying the structure of the utility function and the constraints of household progress, the Lagrange function is specified as Eq. (4) for extracting the first-order conditions resulting from the optimization process, in which, the first-order conditions are extracted through investment, capital stock, labor, consumption, bonds, money demand and bank deposit supply and linearized using the Taylor expansion process of logarithmic equations.

$$\begin{aligned} \dot{\iota}_t = {} & E_t \sum_{t=0}^{\infty} \beta^t \varepsilon_t^{\beta} \left\{ \frac{1}{1-\sigma_c}(C_t)^{1-\sigma_c} - \frac{1}{1+\sigma_N}(N_t)^{1+\sigma_N} + \frac{\kappa_M}{1+\sigma_M}(M_t)^{1+\sigma_M} + \hbar_t^D \ln(\frac{D_t}{P_t}) \right\} \\ & + \lambda_t \left[\begin{array}{l} \frac{W_t}{P_t}N_t + R^b_{t-1}\frac{B_{t-1}}{P_t} + \frac{M_{t-1}}{P_t} + \frac{i^d_{t-1}D_{t-1}}{P_t} + \frac{L_t}{P_t} + r^k_t K_t + \Pi_t \\ -C_t - \frac{p^I_t}{p_t}I_t - \frac{M_t}{P_t} - \frac{B_t}{P_t} - \frac{D_t}{P_t} - \frac{i^l_{t-1}L_{t-1}}{p_t} - T \end{array} \right] \\ & + Q_t \left[(1-\delta)K_{t-1} + [1 - S(\frac{I_t}{I_{t-1}})]I_t - K_t \right] \end{aligned} \qquad (4)$$

- Firms

In order to clarify the mechanism of firms from the New Keynesian point of view, a chain of firms producing intermediate goods in an environment of monopoly competition is considered whose goods are demanded by the

companies producing the final goods and are offered to the consumers as the final goods. Therefore, the intermediate goods are combined under a Dixit-Stiglitz collector and offered as the final product. This issue can be specified as follows:

$$Y_t = [\int_0^1 (Y_t^i)^{\frac{1}{1+\varepsilon_t^p}} di]^{1+\varepsilon_t^p} \tag{5}$$

Where Y_t^i is the amount of production of the i^{th} firm and ε_t^p indicates the elasticity of substitution between different goods in the current period and in the context of monopolistic competition. These firms minimize costs according to the use of intermediate inputs. Therefore, the optimization process will be performed by minimizing the cost function in Eq. (6) relative to the constraint specified in Eq. (5).

$$\min_{Y_t^i} \int_0^1 P_t^i Y_t^i di \tag{6}$$

According to the New Keynesian perspective, it is also assumed that the intermediary producer uses a combination of capital and labor inputs in the production process, which is specified in the Cobb-Douglas production function:

$$Y_t = A_t (K_{t-1})^{\alpha} (\mathrm{N}_t)^{1-\alpha} - \Phi \tag{7}$$

While (Φ) represents the firm's fixed cost, A_t also represents the productivity momentum that follows a first-order autoregressive process. The problem of optimizing the intermediate goods firm is minimization of the cost of the firm, taking into account the constraint of the production function in which the firm pays the rent(r_t^k) and wages (W_t) for using capital(K_t) and labor (N_t), respectively:

$$\min_{N_t, \mathrm{K}_{t-1}} \frac{W_t N_t}{P_t^d} + r_t^k K_{t-1} \tag{8}$$

In the following, by forming the Lagrange function and performing the optimization process, the first-order conditions are extracted in relation to capital and labor, and the Lagrange function is specified as follows:

$$l_t = \frac{W_t N_t}{P_t^d} + r_t^k K_{t-1} + \zeta_t A_t (K_{t-1})^{\alpha} (\mathrm{N}_t)^{1-\alpha} - \Phi \tag{9}$$

By extracting the first-order conditions and simplification, the final cost function of the firm can be extracted as follows:

$$MC_t = \frac{1}{A_t}\left(\frac{1}{1-\alpha}\right)^{1-\alpha}\left(\frac{1}{\alpha}\right)^{\alpha}\left(\frac{W_t}{P_t^d}\right)^{1-\alpha}(r_t^k)^{\alpha}$$

(10)

After examining the optimization problems of firms producing intermediate and final goods, it is necessary to consider the pricing mechanism and price stickiness in the model based on Calvo's (1983) approach. Since not all firms in each period have the ability to re-optimize prices due to the theory of price stickiness, according to this theory, it is assumed that in each period they have a pricing power of $1-\omega d$ and firms who do not have the pricing power use an indexing process as follows:

$$P_t^d = (\pi_{t-1})^{\tau_d} p_{t-1}^d \qquad (11)$$

In the above equation, τ_d is the price rating order. Given the fact that in each time period some firms can adjust their prices optimally and other firms use the indexing process based on past inflation rate, the dynamic price relationship can be specified:

$$(P_t^d)^{1-\varepsilon_t^p} = \omega d\,(P_{t-1}^d)^{1-\varepsilon_t^p} + (1-\omega d)(P_{i,t}^*)^{1-\varepsilon_t^p} \qquad (12)$$

In the above relation, $P_{i,t}^*$ indicates the price level of firms that are able to optimize their prices. Next, the issue of optimization of firms with pricing capabilities should be considered. To this end, the expected discounted profit of the firm is optimized by the producers of the final goods in relation to the demand function of intermediate goods. After the optimization process and simplification, the Hybrid New Keynesian Phillips Curve is specified as follows:

$$\hat{\pi}_t^d = \frac{\beta}{1+\beta\tau_d}E_t\hat{\pi}_{t+1}^d + \frac{\tau_d}{1+\beta\tau_d}\hat{\pi}_{t-1}^d + \frac{1}{1+\beta\tau_d}\frac{(1-\omega d\,\beta)(1-\omega d)}{\omega d}\hat{MC}_t + \xi_t^p \qquad (13)$$

- Bank

Since the credit easing policies of the central bank are implemented by the banking system, it is necessary to model the banking sector in order to determine the transmission mechanism of these unconventional monetary policies. Credit received by banks from the central bank can be considered the main channel for implementing the credit easing policy. For this purpose, the banking sector is considered as a chain of banks in the framework of monopoly competition and their balance sheets are specified as follows:

$$B_t^p + L_t = L_t^{CB} + D_t + Z_t \qquad (14)$$

In the balance sheet of the banking sector specified in Eq. (14), it is shown that granting loan provided to households (L_t) and the purchase of government bonds (B_t^p) is possible though credits received from the Central Bank (L_t^{CB}), public deposits (D_t) and the net value of the bank's capital (Z_t). In the following, the expected discounted profit function of the banking sector is specified:

$$max\ E_t \sum_{t=0}^{\infty} i_t^l L_t + r_t^b B_t^G - i_t^d D_t - i_t^{ib} L_t^{CB} - \frac{\gamma^b}{2}\left(\frac{Z_t}{L_t} - \upsilon^b\right)^2 Z_t \quad (15)$$

Where, $i_t^l L_t$ is the income from loan granted by the banking system, $r_t^b B_t^G$ is the income from holding public sector Musharaka Sukuk, $i_t^d D_t$ is the profit paid on household sector deposits, $i_t^{ib} L_t^{CB}$ is the profit paid on credits received from the central bank at the interbank market rate and υ^b is the minimum capital-to-debt ratio of the banking sector determined by the regulations of the Central Bank. Therefore, by optimizing the profit function of the banking sector (Eq. 15) in relation to the balance sheet constraint (Eq. 14), the first-order conditions of the banking sector in relation to bank deposits, facilities granted by the banking sector and credits received from the central bank are provided in Eqs. (16), (17), and (18) respectively.

$$\beta_t^B \{-i_t^d + \lambda_t^B\} = 0 \quad (16)$$

$$\beta_t^B \{i_t^l - \gamma^b Z_t \left(\frac{Z_t}{L_t} - \upsilon^b\right)\left(-\frac{Z_t}{L_t^2}\right) - \lambda_t^B\} = 0 \quad (17)$$

$$\beta_t^B \left\{-i_t^{ib} + \lambda_t^B\right\} = 0 \quad (18)$$

Therefore, the banking sector has been set out in a way that the role of banks' debt to the central bank is specified and it is possible to evaluate the credit easing policy through this channel. It should also be noted that the banks' debt to the central bank is also considered in the form of a combined constraint between the government and the central bank in order to examine its comprehensiveness and dominance on the overall economy of the country.

- Government

Considering the role of the government and its fiscal policies in the Iranian economy, it seems necessary to include this sector in the theoretical framework of the designed model. On the other hand, government fiscal policies are formed

within the framework of government revenues and expenditures, which justifies the use of budget constraints in the governments to review fiscal policies.

$$\frac{B_{t+1}^{p}}{(1+r_t^b)}+B_{t+1}^{CB}+T_t+GD_t^{CB}+Oil_t=G_t+GD_{t-1}^{CB}+B_t^{p}+sub_t \quad (19)$$

In this equation, G_t is the total current and development expenditures of the government, B_t^{p} is the retained securities, sub_t is the government transfer payments, T_t is the tax revenues, GD_t^{CB} is borrowing from the banking system and Oil_t is oil revenues.

Government expenditure is specified in Eq. (20) as a function of oil revenues, tax revenues, and other revenues.

$$\log(G_t)=\mu_T \log(T_t)+\mu_{OI} \log(OI_t)+\mu_{OIL} \log(Oil_t)+\varepsilon_t^{G} \quad (20)$$

Tax revenues are considered as a function of national income in Eq. (21), other government revenues as a first-order autoregressive process in Eq. (22) and the rial value of oil revenues are also considered as a function of oil prices, oil exports and exchange rates in Eq. (23). It is noteworthy that in order to facilitate the process, the oil prices, oil production and exchange rates have been included as a self-regression process in the model.

$$\log(T_t)=\rho_T \log(Y_t)+\varepsilon_t^{Tax} \quad (21)$$

$$\log(OI_t)=\rho_{OI} \log(OI_{t-1})+\varepsilon_t^{OI} \quad (22)$$

$$\log(oil_t)=\log(er)+\log(poil)+\log(yoil) \quad (23)$$

It is noteworthy that following the study of Taghipour (2014) in Eq. (24), the National Development Fundfunction of the balance of has specified that a DF_t transfer resources of the fund from the previous period, payment of principal and interest on granted facilities LB_t and foreign exchange earnings from oil exports.

$$DF_t=DF_{t-1}+LB_t+(1-\omega)oil_t \quad (24)$$

- Central bank

To include the role of monetary authorities, the sources of the monetary base are used, according to which the monetary base includes gold reserves (Gol_t), foreign reserves of the central bank (FR_t), government debt to the central bank

(GD_t^{CB}), central bank credit line to banks (L_t^{CB}) and securities held by the central bank (B_t^p).

$$M_t = Gol_t + FR_t + GD_t^{CB} + L_t^{CB} + B_t^p \quad (25)$$

Given that banks' profit rates in Iran are set by the Monetary and Credit Council and the policies of the central bank are affected by the government budget deficit, it is assumed that increasing the rate of the monetary base is a policy-making tool for the central bank. The monetary authorities use monetary policy tools to reduce production deviation from potential one and inflation deviation from inflation target rate. The monetary policy tools are defined as follows:

$$MH_t = \rho_t^{mh} MH_{t-1} + \rho_\pi^{mh}(\pi_t - \pi_t^T) + \rho_y^{mh} y_t + \Omega_t \quad (26)$$

$$\pi_t^T = \rho_{\pi t} \pi_{t-1}^T + \varepsilon_t^{\pi T} \quad (27)$$

$$\Omega_t = \rho_\Omega \Omega_{t-1} + \varepsilon_\Omega ; \varepsilon_\Omega \sim N(0, \sigma_\Omega) \quad (28)$$

- **Consolidation of the government and the central bank**

Due to the dependence of monetary policy on government fiscal policy, the use of the consolidated constraint of the government and the central bank can reveal some of the realities of the Iranian economy based on the dominance of fiscal policy. For this purpose, the consolidated constraint of the government and the central bank is specified as follows:

$$\frac{B_{t+1}^P}{(1+r_t^b)} + M_{t+1} - Gol_{t+1} - GD_{t+1}^{CB} - L_{t+1}^{CB} - e_{t+1} FR_{t+1} + T_t + Oil_t$$
$$= G_t + B_t^P + M_{t+1} - Gol_{t+1} - GD_{t+1}^{CB} - L_{t+1}^{CB} - e_{t+1} FR_{t+1} - sub_t \quad (29)$$

Public sector debts to the central bank and banks' debts to the central bank are defined in Eq. (30) and (31) as part of a first-order autoregressive process. Also, the retained securities variable, which is a function of past values and exchange rate variables, inflation and production, and the variable of foreign reserves of the Central Bank, which is specified as a function of exchange rate, inflation and oil revenues, are specified in Eq. (32) and (33), respectively.

$$\log GD_t^{CB} = \rho_{GD} \log GD_{t-1}^{CB} + \varepsilon_t^{GD^{CB}} \quad (30)$$

$$\log(B_t^P) = \gamma_{PE} \log(e_t) + \gamma_{P\pi} \log(\pi_t) + \gamma_{PY} \log(Y_{t-1}) + \gamma_{PP} \log(B_{t-1}^P) + \varepsilon_t^{B^P} \quad (31)$$

$$\log(FR_t) = \lambda_E \log(e_t) + \lambda_\pi \log(\pi_t) + \lambda_{oil} \log(oil_t) + \lambda_{FR} \log(FR_{t-1}) + \varepsilon_t^{FR} \quad (32)$$

In the first place, the model parameters are quantified and simulated, after which, the results of the Impulse Response Function resulting from the banks' debt impulse to the central bank will be examined. Then, the model is estimated based on the real data of Iran's economy during the period of the first quarter of 1991 to the fourth quarter of 2017 using the Bayesian method and Monte Carlo Metropolis-Hasting algorithm, in which, the subsequent distribution of parameters and impulse response functions of the variables including production (y), consumption(c), capital(k), bank lending(i), bank deposits(d), liquidity(m), inflation(pai), exchange rate(ner) and government expenditures(go) in response to the central bank's credit facilitation policy impulse are examined and evaluated.

Basic model linearization

$$\hat{I}_t = \frac{\hat{q}_t}{1+\beta} + \frac{1}{1+\beta}\hat{I}_{t-1} + \frac{\beta}{1+\beta}\hat{I}_{t+1}$$ Investment dynamics (1)

$$\hat{q}_t = \frac{\beta \bar{R}^K}{\bar{q}}(\hat{R}^K_{t+1}) + \beta(1-\delta)\hat{q}_{t+1} - (\hat{R}^b_t - \hat{\pi}_{t+1})$$ Capital price dynamics (2)

$$\hat{N}_t = \frac{\hat{W}_t}{\sigma_N} - \frac{\sigma_C}{\sigma_N}\hat{c}_t$$ Labor supply (3)

$$\hat{r}^b = \sigma_c \hat{c}_{t+1} - \sigma_c \hat{c}_t$$ Demand for bonds (4)

$$\hat{m}_t = \frac{\sigma_c}{\sigma_m}\hat{c}_t - (\frac{\sigma_c}{\sigma_m})(\frac{\hat{r}^b}{\bar{r}^b})$$ Demand for money (5)

$$\hat{c}_t = \hat{c}_{t+1} - \frac{1}{\sigma_c}(\hat{R}^b_t - \pi_{t+1})$$ Euler equation of consumption (6)

$$\hat{k}_t = (1-\delta)\hat{k}_{t-1} + \delta \hat{i}_t$$ Capital accumulation equation (7)

$$\hat{Y} = \frac{1}{\bar{Y}/\bar{Y}+\bar{\Phi}}\left[\hat{A}_t + \alpha \hat{K}_{t-1} + (1-\alpha)\hat{N}_t\right]$$ Production function (8)

$$\hat{A}_t = \rho_a \hat{A}_{t-1} + \varepsilon_t^A$$ Technology auto regression process (9)

$$\hat{R}^k_t = \hat{w}_t + \hat{n}_t - \hat{k}_{t-1}$$ Capital return rate (10)

$$\hat{\pi}^d_t = \frac{\beta}{1+\beta\tau_d}E_t\hat{\pi}^d_{t+1} + \frac{\tau_d}{1+\beta\tau_d}\hat{\pi}^d_{t-1} + \frac{1}{1+\beta\tau_d}\frac{(1-\omega d\,\beta)(1-\omega d)}{\omega d}\hat{MC}_t + \xi^p_t$$ New Keynesian hybrid Philips curve (11)

$$m\hat{c}_t = -\hat{A}_t + (1-\alpha)\hat{w}_t + \alpha \hat{R}^k$$ Marginal cost of production (12)

$$\hat{d}_t = \sigma_c \hat{c}_t + \frac{\bar{i}^d}{\bar{r}^b - \bar{i}^d}\hat{i}^d$$ Bank deposit (13)

$$\frac{\bar{i}^{l}\hat{i}_t^{l}}{\bar{i}^{d}-\bar{i}^{l}}-\frac{\bar{i}^{d}\hat{i}_t^{d}}{\bar{i}^{d}-\bar{i}^{l}}=(۲+\frac{۱}{۱-\upsilon^{b}})Z_t-(۲+\frac{۱}{۱-\upsilon^{b}})\hat{L}_t$$ The relationship between loan interest and profit (14)

$$\bar{Z}\hat{Z}_t+\bar{D}\hat{D}_t+\bar{L}^{CB}L_t^{CB}=\bar{L}\hat{L}_t+\bar{B}^{p}\hat{B}_t$$ Banking balance sheet (15)

$$L_t^{CB}=\rho_{lcb}\hat{L}_{t-1}^{CB}+\varepsilon_t^{lcb}$$ Debt of the banking sector to the central bank (16)

$$G\hat{D}_t^{CB}=\rho_{GD}G\hat{D}_{t-۱}^{CB}+\varepsilon_t^{GD^{CB}}$$ Government debt to the central bank (17)

$$\hat{B}_t^{p}=\gamma_{PE}\hat{e}_t+\gamma_{P\pi}\hat{\pi}_t+\gamma_{PY}\hat{Y}_{t-۱}+\gamma_P\hat{B}_{t-۱}^{p}+\varepsilon_t^{B^{p}}$$ Equation of Sukuk (18)

$$F\hat{R}_t=\lambda_E\log\hat{e}_t+\lambda_\pi\hat{\pi}_t+\lambda_{oil}oi\hat{l}_t+\lambda_{FR}F\hat{R}_{t-۱}+\varepsilon_t^{FR}$$ Foreign reserves of the Central Bank (19)

$$MH_t=\rho_t^{mh}MH_{t-1}+\rho_\pi^{mh}(\pi_t-\pi_t^{T})+\rho_y^{mh}y_t+\varepsilon_t^{mh}$$ Rule of monetary policy (20)

$$\pi_t^{T}=\rho_{\pi t}\pi_{t-1}^{T}+\varepsilon_t^{\pi T}$$ Target inflation (21)

$$\hat{G}_t=\mu_T\hat{T}_t+\mu_{OI}O\hat{I}_t+\mu_{OIL}Oi\hat{l}_t+\varepsilon_t^{G}$$ Government Expenditure (22)

$$\hat{T}_t=\rho_T\hat{Y}_t+\varepsilon_t^{Tax}$$ Tax revenues (23)

$$poil=\rho_{po}\hat{p}_{t-1}^{oil}+\varepsilon_t^{poil}$$ Oil prices (24)

$$DF_t=DF_{t-1}+LB_t+(1-\varpi).oil+\varepsilon_t^{oil}$$ National Development Fund (25)

$$yoil=\rho_{yo}\hat{y}_{t-1}^{oil}+\varepsilon_t^{yoil}$$ Oil exports (26)

$$O\hat{I}_t=\rho_{OI}O\hat{I}_{t-1}+\varepsilon_t^{OI}$$ Other government revenues (27)

$$GD\hat{P}_t=\frac{\bar{C}}{GD\bar{P}}\hat{C}_t+\frac{\bar{I}}{GD\bar{P}}\hat{I}_t+\frac{\bar{G}}{GD\bar{P}}\hat{G}_t$$ Market clearing condition (28)

5. Estimation of model parameters

Table (4) introduces the parameters included in the model with their previous values and distribution. By calibrating the model in terms of debt impulse of banking sector to the central bank, reduced interbank market rate and reduced statutory deposit rate, the model solved and simulated using the Dinar software, based on MATLAB.

Table 4: Quantification and estimation of model parameters

parameters	Description	Distribution	Previous average	Retrieved from	Late average

μ_T	Coefficient of tax revenues in government expenditures	Beta	۰/540	Research calculations	۰/5362
μ_{OI}	Coefficient of other revenues in government expenditures	Beta	۰/20	Research calculations	۰/2172
ρ_T	Income coefficient in the tax equation	normal	۰/45	Research calculations	۰/4630
ρ_{OI}	The first-order auto-regression coefficient of other government revenues	normal	۰/80	Research calculations	۰/6853
ρ_{yo}	Autoregressive coefficient of oil exports	normal	۰/75	Research calculations	۰/8055
ρ_{po}	Autoregressive coefficient of oil price	normal	۰/92	Research calculations	۰/8897
λ_E	Exchange rate coefficient of foreign assets of the Central Bank	normal	۰/12	Research calculations	۰/0553
λ_π	Inflation Coefficient of foreign assets of the Central Bank	normal	۰/03	Research calculations	۰/029
λ_{oil}	Coefficient of oil revenues in foreign assets of the Central Bank	normal	۰/08	Research calculations	۰/0786
λ_{FR}	Central Bank Foreign Assets Interrupt Coefficient	normal	۰/88	Research calculations	۰/6437
β	Consumer time preference rates	Beta	۰/96	Komijani and Tavakolian (2012)	۰/9616
δ	Depreciation rate	normal	۰/042	Motevasel et al. (2010)	۰/0075
σ_C	Reverse of elasticity of Substitution for Intertemporal consumption	Gamma	1/52	Komijani and Tavakolian (2012)	1/519
σ_N	Reverse of labor supply elasticity	Gamma	2/21	Komijani and Tavakolian(2012)	2/1527
σ_M	Reverse demand of money	Gamma	2/24	Komijani and Tavakolian(2012)	2/2298

	elasticity				
α	Capital share of production	Beta	۰/42	Komijani and Tavakolian(2012)	۰/4467
ρ_a	Technology autoregression coefficient	Beta	۰/92	Moshiri et al(2011)	۰/9167
τ_d	Degree of indexing	normal	۰/5	Saidpour et al(2018)	۰/4317
ωd	Degree of adhesion	Beta	۰/6	Saidpour et al(2018)	۰/5698
γ_{PE}	Exchange rate coefficient of Musharaka Sukuk	normal	۰/06	Khiabani and Amiri(2012)	۰/0542
$\gamma_{P\pi}$	Inflation coefficient of Musharaka Sukuk	normal	۰/53	Khiabani and Amiri(2012)	۰/5219
γ_{PY}	Income coefficient of Musharaka Sukuk	normal	۰/18	Khiabani and Amiri(2012)	۰/1829
γ_P	Interruption of Musharaka Sukuk	normal	۰/97	Khiabani and Amiri(2012)	۰/9983
ρ_π^{mh}	Inflation significance coefficient in the monetary policy rule	normal	-۰/98	Komijani and Tavakolian(2012)	-1/0593
ρ_y^{mh}	The coefficient of importance of production in the rule of monetary policy	normal	-2/96	Komijani and Tavakolian(2012)	-2/9351
υ^b	Debt to bank capital ratio	Gamma	۰/10	Falagiarda, and Saia(2017)	۰/1238
β_B^t	Discount in Banking sector	Beta	۰/97	Falagiarda, and Saia (2017)	۰/9798

The model is estimated by Bayesian method using Monte Carlo Metropolis-Hasting algorithm and the results of impulse response functions are reported. The positive impulse of the central bank credit line to the banks as a standard deviation is considered as one of the channels of influence of the credit easing policy in the model. The response of the variables in the model of impulse response functions is reported in Fig. (2). As can be seen, in response to the positive impulse, the variables of consumption, capital and GDP have deviated from their stable

position. It is noteworthy that, in the economy, the increase in capital is more than consumption, which indicates that the flow of financial resources is created in the direction of investment. On the other hand, the size of liquidity in the economy has positively deviated from its long-term stable state and the impact of this variable on the implementation of the mentioned policy is more than other variables. The size of bank deposits and the amount of loan granted have also deviated positively from their long-term status, which is considered to be the result of the implementation of this credit easing policy. In general, it can be said that the results are in line with the theoretical expectations and realities of the Iranian economy. Therefore, adopting a credit easing policy can be fruitful to get out of the recession and affect both demand and supply.

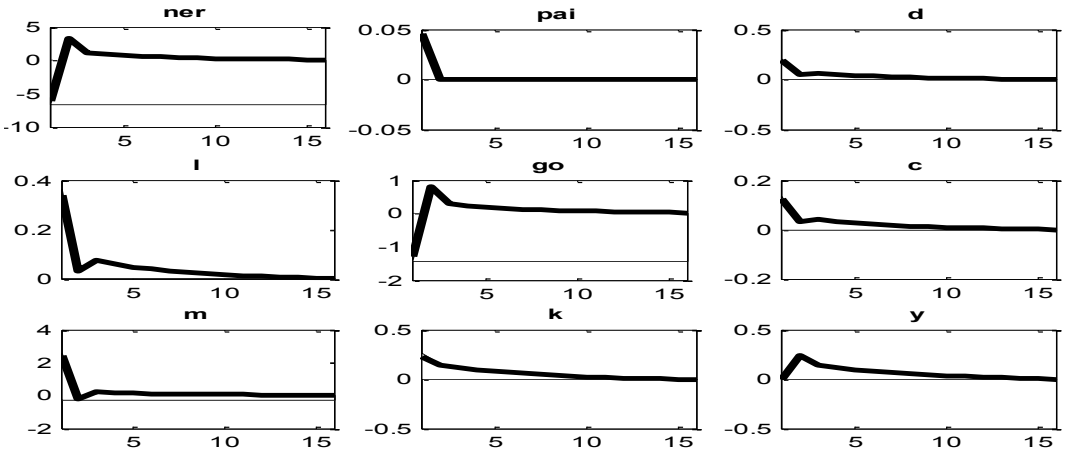

Fig. 2: Results of the reaction functions of the Central Bank credit line to banks

The estimated results of the impulse response functions show the negative momentum of the interbank market rate as a standard deviation in Fig. (3). Production, consumption and investment have positively deviated from the long-term state and after three to four periods, the effects of this impulse have been evacuated and the variables mentioned have converged to their long-term state. Another point is that capital is more strongly affected by the implementation of this policy compared to consumption, which indicates that the reduced interbank interest rates is in the direction of increasing investment and economic prosperity in the country. In response to the implementation of this policy, the amount of bank deposits and loan granted by banks has decreased. Given the fact that the reduction of the interbank market rate will also reduce the interest rate on bank deposits, the reduction in the amount of bank deposits is a reaction to the implementation of this policy. Increasing the size of liquidity is another effect of lowering the interbank market rate, which is affected by banks' access to cheap

financial resources. Due to the reduction of bank deposits, the entry of these resources into the economic environment on the one hand, and the increase in liquidity on the other, caused the formation of inflation in the economy. After a short period of time the effects of this impulse are discharged and it will be stable again. While the results show that the implementation of this policy is effective for economic prosperity, its effectiveness is higher compared to the reduction of banks' statutory reserves requirement and lesser, compared to the central bank credit line.

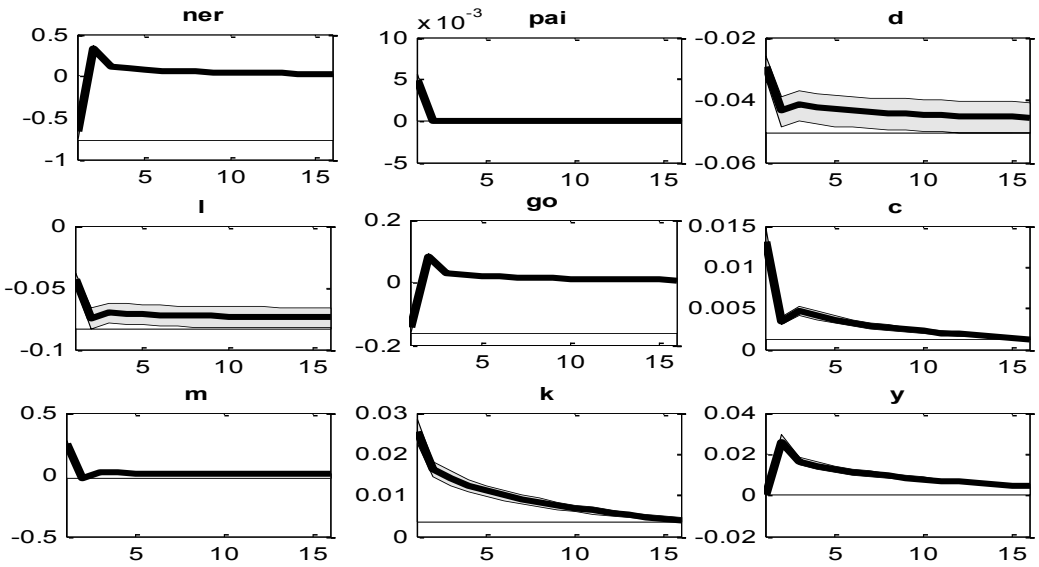

Fig. 3: Estimated results of interbank market interest rate shock

Reducing the statutory reserve requirement rate is one of the most important tools available to the central bank, which can provide a good platform to increase the banking sector's access to financial resources for lending and injecting into the manufacturing sector. The impulse response functions resulting from the estimation of the negative momentum of the statutory reserve requirement are reported as a standard deviation in Fig. (4). As a result of this policy, the variables of production, consumption and capital have been positively deviated from the long-term stable state. The greater influences and longer process of mediating the effects of this shock on capital than consumption implies that the investment is central and the economy has gotten out of recession. Although the most influential among the studied variables is liquidity, but the process of mediation and return to long-term stability in this variable takes two to three time periods. The size of bank deposits also reacted positively to the shock and returned to the long-term equilibrium after 4 to 5 time periods. The amount of loan granted by the banking sector has also increased, which is an expected result of the implementation of this

policy. Although the inflation variable also increased, all the effects of this shock were quickly eliminated after one to two periods of time. Government spending and the exchange rate also reacted negatively to this impulse in the first period, but after one time period, they reacted positively to the implementation of this policy and all the effects of this impulse were quickly evacuated. The results are in line with theoretical expectations and it can be said that the adoption of credit easing policy through reducing the statutory reserve requirement of banks, provides the possibility of economic growth or getting out of the recession. Increasing the size of loan granted by banks as well as the liquidity are the obvious consequences of implementing this unconventional monetary policy.

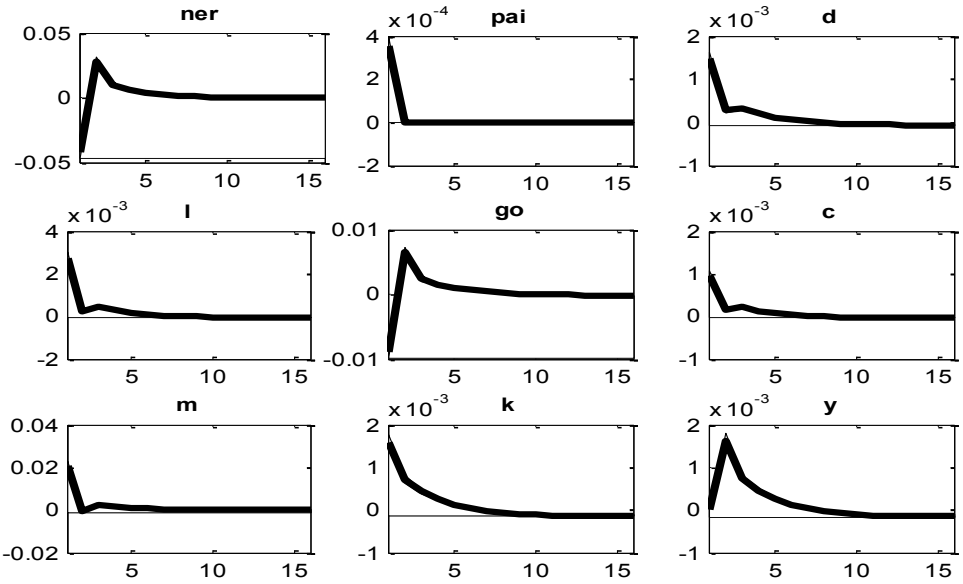

Fig. 4: Estimated results of statutory reserve requirement impulse

In general, it can be said that the results of estimating the model are in line with theoretical expectations, according to which the credit easing policy paves the way to take the economy out of the recession through increasing the credit line of the central bank to banks, reducing the statutory reserve requirement rate and reducing the interbank market rate.

Since in Bayesian method different Markov chains are used to simulate the pattern, therefore, for each chain, we can observe variance within as well as between chains. In the standard case, it is expected that by increasing the sample size, the variance within the chain tends to a constant value and the variance between the chains tends to zero (Keyumarsi et al., 2018). Therefore, if variable Q indicates the weight combination of variance between and within the chains, then the model estimation is reliable if the time path of the variable C is a stable and

without fluctuation and converges path Q to the path C. This test is known as the Gelman-Brooks test in the context of the Monte Carlo-Markov (MCMC) chain statistic. The results are reported for the first three moments including mean (Interval), variance (m2) and skewness (m3) and its diagram for the present model is as diagram (5). As can be seen, the results obtained from this diagnostic test indicate the accuracy and reliability of the results.

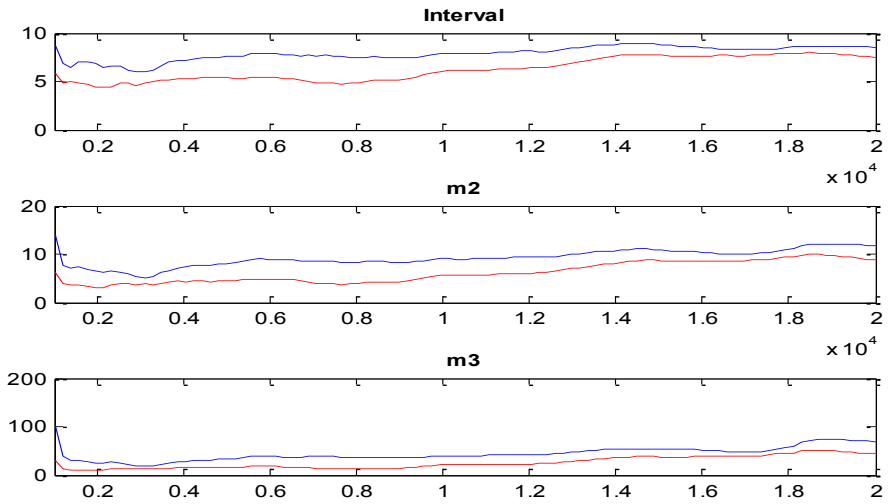

Fig. 5: MCMC Statistic for estimated model

6. Conclusions and policy recommendations

The financial crisis of 2007-2008 plunged the world into a deep recession. Many central banks in developed and developing countries have used unconventional credit easing policies to enhance economic prosperity. The main goal of policymakers is to help interbank and credit markets to increase financial stability and growth in production. The banking system communicates with the households, corporations, government and the central bank and can play a role in transferring the various economic shocks to the different economic agents and to macroeconomic variables. Given the recessionary conditions of Iran's economy, the central bank adopted a credit easing policy as an unconventional monetary policy to provide credit for the prosperity of the real sectors of the economy. One of the tools used in the Central Bank of Iran is the policy of the Central Bank credit line to banks, reducing the interbank market rate as well as reducing the statutory reserve requirement. In this study, the effect of central bank credit line shocks, statutory reserve requirement and interbank market rate has been investigated. The positive momentum of the central bank credit line and the negative momentum of the statutory reserve requirement give rise to increase the

production, consumption, investment, banking loan and liquidity in the economy, and the negative momentum of the interbank market rate increases the consumption, production, capital and banking loan. Overall, it seems that in the framework of the three channels examined based on economic data and economic realities of the country, the credit easing policy has been effective in stimulating production in the country's economy.

If the policy-maker's preference is to be more effective in supplying and increasing the country's production potential, using the tools of the National Development Fund and statutory reserve requirement will perform better than the central bank credit line and interbank interest rates. Because the use of these tools increases investment more than consumption, which while increasing demand in the short term, increases production capacity in the long run.

Therefore, in order to have a quick and short-term effect on getting out of the recession, it is preferable for banks to use the tools of the interbank market rate and the central bank credit line. Because these tools have a greater impact on consumption as a stimulus to demand to get out of the recession and create propensity.

Acknowledgement

This article is taken from the dissertation of Dr. Hadiseh Mohseni under the guidance of Dr. Mohammad Nabi Shahiaki Tash and Dr. Mosayeb Pahlavani and the advice of Dr. Seyed Hossein Mirjalili, for which I am grateful for the guidance and efforts of respected professors.

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اثر سیاست تسهیل اعتباری بر خروج از رکود در اقتصاد ایران: کاربرد مدل تعادل عمومی پویای تصادفی

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چکیده

این مقاله با استفاده از مدل تعادل عمومی پویای تصادفی کینزی جدید به بررسی تأثیر سیاست تسهیل اعتباری بر متغیرهای کلان اقتصادی با تأکید بر تولید پرداخته است؛ بدین‌منظور الگویی شامل پنج بخش: خانوار، بنگاه، بانک، دولت و بانک مرکزی طراحی شده است. با توجه به سلطهٔ سیاست مالی بر سیاست پولی در اقتصاد ایران از قید تلفیقی دولت و بانک مرکزی استفاده شده است. تخمین الگوی طراحی شده با استفاده از روش بیزین و داده‌های سری زمانی فصلی طی دورهٔ ۱۳۷۰ تا ۱۳۹۶ انجام شده است. نتایج حاصل از توابع عکس‌العمل آنی نشان می‌دهد که اجرای این سیاست باعث افزایش مصرف، سرمایه‌گذاری، مخارج دولت و درنهایت تولید شده است که بیانگر اثربخشی این سیاست پولی نامتعارف برای خروج اقتصاد از شرایط رکودی است؛ همچنین در واکنش به تکانهٔ مثبت خط اعتباری بانک مرکزی به بانک‌ها و تکانهٔ منفی ذخیرهٔ قانونی، تسهیلات بانکی افزایش یافته است که همسو با انتظارات نظری می‌باشد. اثر تکانهٔ منفی نرخ بازار بین بانکی نیز منجر به افزایش اعتبارات تولیدی شده است.

کلیدواژگان: تسهیل اعتباری، رکود، مدل تعادل عمومی پویای تصادفی، روش بیزی، خط اعتباری.
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How Macroeconomic Variables in Iran Did Respond to Oil Sanctions: An Application of Bayesian TVP-SVAR Approach

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Abstract

This paper investigates the responses of Iran's macroeconomic variables to the oil embargo against Iran. The article applies a Bayesian time-varying parameter SVAR model along the quarterly data of oil export, real exchange rate, inflation, real GDP and money supply of Iran over the period of 1991:Q2-2020:Q2. Applying time varying parameters in this study helps us to consider the economic structural changes and transition mechanism in analyzing the response of macroeconomic variables to oil embargo. The oil embargo against Iran has been intensified since 2012. To consider the effect of the oil embargo on Iranian macro variables, the model has been estimated in two different periods of time, before and after 2012. The results indicate that the escalation of the oil embargo from 2012 has caused a stagflation period and ends in a decline in real GDP and national currency depreciation. In addition, it has intensified money supply and triggers existing inflation. These results have some policy implications to overcome difficulties raises when the economy faces sanction.

Keywords: Oil Embargo, Stagflation, Bayesian TVP-SVAR, Iran.
JEL Classification: F51, E03, C11

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1. Introduction

Sanctions are a kind of foreign government arranges that impose barriers on developing process of affected countries. Restrictions arising from embargos isolate the home country and create difficulties for economic performance (Cortright, Lopez, 2000). After the Second World War, the economic embargos are substantial instruments for war in order to impose tensions and constraints to object country. Although natural resources are a strong point of a country, however, as their economies mostly depend on oil revenue; then it seems that oil is a major threaten to economic development, social equality and peace in oil-exporting countries. Consequently, oil shocks induced from oil embargos may adversely affect a country's macroeconomic performance. Iran is one of those countries which experiences variety of embargos over the last four decades and in the year 2012 an oil embargo has imposed on the Iranian oil sector by 27 members of the European Union and the United States. According to this sanction, the countries are prohibited from importing Iranian oil. These sanctions against Iran operates as a destructive factor in macro-economic performance, which leads to numerous economic fluctuations. Surely speaking, Iran has an oil-based economy and oil exports constitutes a major part of Iranian export revenues, therefore oil shocks will influence economic performance and the effects of the oil embargo are unavoidable. Oil shocks may cause oil prices to be unstable, budgets to be stretched thinner and thinner, the value of domestic savings are quickly disappearing and industrial structures would be weakened. The domestic currency depreciates and foreign exchange reserves depleted, then that is why the Iran's Central Bank limits the supply of dollar to individuals, and a growing black market for foreign exchange emerges rapidly and it simultaneously means even further depreciation of the Rials. This in turn contributes to more inflation because retailers set prices based on the free market price of the dollar. Obviously, any oil shock, such as oil embargo, will have direct and indirect long-term and short-term effects on macroeconomic variables, and it is important to study the response of macroeconomic variables as GDP, exchange rate and inflation to oil shocks.

Recently some related studies investigated the impact of oil sanctions on Iranian economy. Some of them consider its effect in a descriptive way or from theoretical and political point views. Some other investigates its effect on the performance of knowledge-based firms or on stock market, GDP and foreign direct investment, as the study of Fakhari et al. (2013), Yahya Abadi et al. (2013) and Kazerooni et al. (2014). This paper contributes to the literature in two main dimensions as follows. On one hand, there is no comprehensive study which considers the effect of oil embargo on the key macroeconomic variables in a system of interrelated equations. On the other hand, Ning (2013) and Primiciri (2005) confirms that there exist structural breaks in oil effects on macroeconomic variables and the effect of oil shocks on macroeconomic variables are changed over time because of changing in economic structures (Blanchard and Simon, (2001), Stock and Watson (2003) and Blanchard (2007)). It means that adoptive rational behavior of agents and their forward looking and some additional modifications in the transmission mechanism cause instabilities in the oil-macro relationship over time. Then economic agents do a slow-moving but continuous adjustment to oil shocks and they tend to react in pattern with smooth changes. This line of reasoning suggests that the appropriate modeling approach is a TVP-VAR model which shows a smooth evolving coefficients and heteroscedasticity in the innovations. But there is no research that considers the transition mechanism in the response process of Iranian macro variables to oil shocks. In order to close up these gaps in the literature, the main objective of this study is to analyze the effect of oil shocks which results from oil embargo on Iranian economy by using a time varying parameter (TVP) model. Applying a TVP structural VAR (SVAR) model has the advantages of drawing structural impulse responses for different years and analyzing the time varying effect of each selected event and applying priors and leads to a better model estimation. According to Wu et al. (2011) and Fernandez Villaverde et al. (2007), as oil shocks are endogenous indicator for economy, using time varying parameter would overcome the endogeneity and predictability problems of oil shocks.

The rest of the paper is organized as follows: the theoretical framework is presented in section 2. Section 3 discuses methodology of Bayesian TVP-SVAR

model. The results are reported in section 4, and finally section 5 concludes the paper.

2. Theoretical framework

Many theorists approve that countries which endowed with natural resources grow slower than other countries (Collier and Goderis, 2007). For oil exporting countries, the oil export revenues are key to the overall economy and any action limiting oil revenues (as oil sanctions) can adversely influence economic performance through different channels (Kitus et al., 2013). As oil exports forms a big share of government revenues and are positively and directly accounted in GDP, then in the first step, the reduction of oil exports caused by oil sanctions, arises the expectations of GDP reduction. In addition, the deficiency of petrodollars in exchange market, causes financial problems and limits the ability of most of companies in importing their intermediate inputs, where this situation will worsen with the exchange rate depreciation (Farzanegan et al., 2015). However, the oil petrodollars constitutes big buck of public budget and the oil revenue fluctuations can transmit to the fiscal policy and unstable real exchange rate (MehraraandOskui, 2007). Oil shocks causes inflation in the first place and this is a direct and short-run effect of oil shocks which comes up rapidly and it's magnitude depends on share of energy goods in consumer price index (CPI) and the long-run increase in CPI is the indirect effect of oil shocks that comes next (Peersman and Robays, 2009). The CPI increment effects could be decomposes into cost effect, second-round and demand effects. In fact, rising CPI leads to decline employees' purchasing power and they would demand for higher wages and the production costs of firms even further increases and the firms will rectify this condition by additional increase in prices. So this mechanism is a cyclical one and causes higher inflation levels (Zytsev ,2010).

There are bulk of studies that examined the effects of oil shocks on different macroeconomic variables in oil exporting countries. for example: Dawson (2007), Coudert et al. (2008), Ozturk et al. (2008), Rickne (2009), Mehrara and Oskui (2007), Farzanegan and Markwardt (2009), De Gregorio, Landerretche, and

Neilson (2007), Chen (2009), and Blanchard and Gali (2007) examined the effects of sanctions from different perspectives. In addition, Keshavarz Hadad et al. (2020) by applying a VARMAX GARCH-in-Mean Asymmetric BEKK model in terms of structural failure of the conditional variance, have investigated the effect of sanctions and oil price (revenue) fluctuations on the country's economy. They used real non-oil GDP, Iranian heavy oil exports, exchange rates, total stock market index and sanctions index data over 1991:Q2 to 2018:Q1. The results illustrated that a shock of oil revenue or sanctions index affected activities in all of three sectors. The increasing sanctions pressure lead to a spillover effect of uncertainty to all sectors under study and a decline in production activities and national currency depreciations. Besides, Tayebi and Sadeghi (2017) have explored the effect of mutual sanctions imposed mostly in 2012 on Iran's exchange market through its cross effects on oil exports and government budget deficit and then, impacts of the sanctions before 2012 is also evaluated. To this end, the paper has employed the ARDL method to this exploration using relevant time series data from 1980 to 2014. The obtained results indicated that the sanctions imposed before 2012 have exerted directly a weak effect on the exchange rate while they have affected volatilities of exchange rate more strongly after 2012. Moreover, Garshasbi and Yusefi (2016) by offering a new index for representing the sanction in economic modeling and applying three-stage least squares (3SLS) method for a small macroeconomic model, they have examined the contribution of the sanctions on major economic variables such as economic growth, trade, investment and employment. According to their findings, the direct effects of sanctions are only significant in growth and term of trade equations. It is also worth noting that some studies focus on the issue of that respond of macroeconomic variables to oil shocks and the change of transition mechanism over time. for example Ferraro et.al (2012), Jo (2012), Baumeister and Peersman(2012) applied TVP-VAR models in examining the effect of oil shocks of macroeconomic performance and they showed that the reaction of the macroeconomic variables to oil shocks has been changed over time. Also Ning (2013) and Primiciri (2005) showed that there exist structural breaks in oil effects on economy and oil shocks perform as an endogenous factor in domestic

economy. Then this study considers the possible transition mechanism in the response process of macroeconomic variables to oil shocks and applies a time varying VAR model which has been explained in the next section.

3. Methodology of Bayesian TVP-VAR models

Empirically, after 1980s great moderation of business cycles and volatility of many macroeconomic variables and recession of May 2008 led to change in the VAR parameters. These events end in presentation of new econometric methods which considers parameter changes as Markov Switching VARs, Regime-switching VARs and TVP-VAR. This study uses the most popular one, TVP-VAR models. This approach firstly has been presented by Litterman (1986), Doan, Litterman and Sims (1984), Sims (1989) and Canova (1993). This model focuses on error covariance matrix multivariate stochastic volatility and time varying parameter models which let coefficients be time variation.

According to Koop, Korobilis (2010) estimating VAR models without using some prior information might lead to unreliable estimates. Bayesian VAR models suggest priors in order to shrink relevant parameters and avoid over-parameterization problem. Choosing the types of priors depends on the objective of researchers; whether they want to verify validity of a theory or to make the Bayesian inferences. Using a natural conjugate prior leads to analytical estimations and reduction of computational burden and non-conjugate priors help to carry out recursive forecasting exercise using a Markov Chain Monte Carlo (MCMC) method (Sarantis, 2013). In practice natural conjugate priors don't allow for some extensions in VAR models such as: containing different explanatory variables in different equations, varying coefficients over time and heteroscedasticity of error terms. In order to overcome the weakness of natural conjugate priors, researchers of Minnesota University developed a new set of Minnesota priors. They used $\sum\hat{}$ instead of $\sum$ and they assumed a diagonal matrix for it, ignoring uncertainty in $\sum$ is disadvantage of Minnesota prior. Independent normal Wishart prior is a set of priors which allow for equations in a VAR system to contain different explanatory variables (restricted VAR). In this way, the prior

covariance matrix can be chosen by the researcher. In above mentioned priors, researchers are required to add substantial prior input in order to obtain restricted or unrestricted VAR. Yet there is another prior that automatically mange the number of shrinkages and only asks for a minimum prior input from researcher. This prior called stochastic search variable selection (SSVS). SSVS clearly describes hierarchical priors[1] which are widely used in state space models[2]. Since TVP-VAR model known as a state space equation, then the basic TVP-VAR model is written as follow:

$$y_t = Z_t\beta_t + \varepsilon_t$$
$$\beta_{t+1} = \beta_t + u_t \qquad (1)$$

This model treats the entire variable endogenous and considers the nonlinearities and time variability of parameters. The above regressions are flexible and can be written for a variety of non-linear functions. TVP-VAR models contain two structures of error variance. The first model includes homoscedasticity (if $\varepsilon_t \sim N(0,\sum)$) and the second one includes heteroscedasticity(if $\varepsilon_t \sim N(0,\sum_t)$).As mentioned before, there is a proliferation problem in VAR models, this problem is more severe with time varying parameter VAR models. In order to solve this problem, the hierarchical prior or a combination of hierarchical prior with other priors can be used. According to Ning (2013), a time varying coefficient of VAR (P) model can be specified as:

$$y_t = c_t + B_{1,t}y_{t-1} + B_{2,t}y_{t-2} + \cdots + B_{p,t}y_{t-p} + u_t \qquad t = 1,2,\dots,T \qquad (2)$$
$$u_t \sim N(0,\Omega)$$

Where $y_t$is a n*1 vector of endogenous variables at time of t, c_t is a n*1 vector of constant terms, p is the number of lags in vector y_t, $B_{p,t}$ is a n*n matrix of coefficients for p=1, …, p. u is a n*1 vector of unobserved shocks. In this model the coefficients, covariance and volatilities are allowed to vary along time. Then the Cholesky decomposition of $\Omega_t$is written as follows:

$$\Omega_t = D_t^{-1}\sum_t \sum_t' D_t^{-1} \qquad (3)$$

[1]. In order to obtain more information about hierarchical prior refer to Koop, Korobilis (2012).
[2]. For more information about Bayesian TVP-VAR models refer to Heidari (2008).

Where D_t is a lower triangular matrix with diagonal 1:

$$D_t = \begin{pmatrix} 1 & 0 & \dots & 0 & 0 \\ d_{21,t} & 1 & \dots & 0 & 0 \\ . & . & \dots & . & . \\ d_{n1,t} & d_{n2,t} & \dots & d_{nn-1,t} & 1 \end{pmatrix} \quad (4)$$

And $\sum_t$ is a diagonal matrix of standard error corresponds to each $y_{i,t}$

$$\Sigma_t = \begin{pmatrix} \sigma_{1,t} & 0 & \dots & 0 \\ 0 & \sigma_{2,t} & \dots & 0 \\ \dots & \dots & \dots & \dots \\ 0 & 0 & \dots & \sigma_{n,t} \end{pmatrix} \quad (5)$$

Now based on above phrases, equation 1 can be written as:

$$y_t = X_t' B_t + D_t^{-1} \sum_t \varepsilon_t, \quad X_t' = I_n \otimes \left[1, y_{t-1}', \dots, y_{t-p}'\right] \quad (6)$$

Where B_t is coefficient state, D_t is covariance state and $\sum_t$ is the volatility state which all of them are random walks such that:

$$B_t = B_{t-1} + \nu_t$$
$$d_t = d_{t-1} + \xi_t$$
$$log\sigma_t = log\sigma_{t-1} + \eta_t \quad (7)$$

The random walk residuals and innovation variances are independent with each other,

$$\text{V} \equiv \text{var}\begin{pmatrix} \varepsilon_t \\ \nu_t \\ \xi_t \\ \eta_t \end{pmatrix} = \begin{pmatrix} I_n & 0 & 0 & 0 \\ 0 & Q & 0 & 0 \\ 0 & 0 & S & 0 \\ 0 & 0 & 0 & W \end{pmatrix} \quad (8)$$

The priors are as the same of Primiceri (2005). Each state has a multivariate normal distribution where innovation variances have Inverse Wishart distribution.

Now each parameter has a linear state space representation and the posteriors of parameters obtain as follows:

$$p(B^t|y^t, D^t, \sum^t, V) = p(B_t|y^t, D^t, \sum^t, V) \prod_{t=1}^{T} p(B_t|B_{t+1}, y^t, D^t, \sum^t, V) \quad (9)$$

The posteriors of D^T and $\sum^T$ are derived in the same way. After obtaining priors and posteriors, each parameter would draw using Gibbs sampling method. The order of Gibbs sampling is as follows: first initializing $D^T, S^T, \sum^T$ and V then sampling B^T from $p(B^t|y^t, D^t, \sum^t, V)$ and sampling D^T from $p(D^t|y^t, B^t, \sum^t, V)$, sampling S^T from $p(S^t|y^t, D^t, \sum^t, V)$, sampling $\sum^t$ from $p\left(\sum^t|y^t, B^t, D^t, S^t, \quad V\right)$ and sampling V from $(Q, W, S|y^t, B^t, D^t, \sum^t)$. Actually the Gibbs sampling would

iterate for about 1000 times and the first 2000 iterations would be treated as burn-in data.

The period under consideration in this study is from 1991:Q2-2020:Q2. The quarterly data consists of 140 observations. In order to ascertain the effect of oil embargos, the estimates are reported for two different sample period: before and after year 2012. The date of escalating oil sanction against Iran is chosen as breaking point for our data.

4. Results

4. 1. Structural Break Point Test in the Iranian Oil Exports

Existing of structural breaks in economic regime causes unstable and insignificant coefficients in regressions. Then in the case of structural breaks, VAR models can't estimate the robustness of coefficients, therefore the TVP-VAR technique should be applied. Considering major political, economic and international events that occurred over the past 50 years like 1970s oil price shocks, the Islamic revolution of 1979, destructive 8-year war with Iraq, economic sanctions, and other international outbreaks have isolated Iran, it is expected to have several structural breaks in Iranian oil exports. This study applied the Bai and Perron structural break tests (1998, 2003) to test for structural breaks in the data. The results of the tests shown in table 1. According to the results, there is at least one breakpoint in the oil export of Iran in the period of 1991-2020. The results of multiple breakpoint tests sequentially determinate breakpoints show that there are 5 breakpoints in the parameters. Then this study considers the feature of the time-varying parameter in the estimation process.

Table 1: Multiple breakpoint tests

Breaks	# of Coefs.	Sum of Sq. Resids.	Log-L	Schwarz* Criterion	LWZ* Criterion
0	1	6.90E+12	-1603.512	24.84987	24.88562
1	3	1.29E+12	-1506.182	23.25371	23.36118

2	5	1.11E+12	-1497.280	23.18218	23.36170
3	7	1.10E+12	-1497.278	23.26412	23.51600
4	9	1.10E+12	-1497.277	23.34606	23.67065
5	11	1.10E+12	-1497.278	23.42804	23.82567

* Minimum information criterion values displayed with shading

Estimated break dates:
1: 1995Q3
2: 1995Q3, 2012Q3
3: 1995Q3, 2008Q2, 2012Q3
4: 1996Q2, 2003Q2, 2008Q2, 2012Q3
5: 1995Q3, 1999Q3, 2003Q3, 2008Q2, 2012Q3

*. Significant at the 0.05 level

4. 2. Posterior Mean of the Standard Deviation in the Oil Export

Figure 1 shows the posterior means of the standard deviation of residuals for oil exports in Iran. The fluctuations in this figure indicate the most important oil shocks over the last three decades. The figure shows that oil supply shocks have high volatility during the last 40 years; the oil embargo, the Iranian revolution, eight years of the Iran-Iraq War has led to high volatility in oil export. After the war and in the period of reconstruction the volatility gradually declined (1991-2020). The plot in figure 1 exhibits a coincidence with oil embargos imposed by the US, Europe and United Nations organizations in 1996 and oil supply volatility which gradually increases. Coincidence oil price boom in 2000, oil exports reached their peak. As the pressure of oil embargos against Iran declined in 2001-2012, the oil export volatilities decreased. Extension and renewing of oil sanctions in 2012 also caused increasing volatility in oil shocks after 2012.

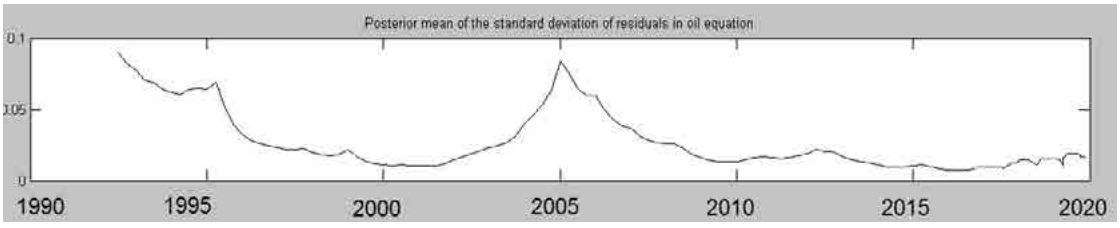

Fig. 1: Posterior Mean of the Standard Deviation in Oil Export

4. 3. Convergence Diagnostics for Hyper Parameters and Volatilities

Geweke (1992) proposed a convergence diagnostic in the Markov Chain process is based on a test for equality of the means of the first and last part of a Markov Chain. If the samples are drawn from a stationary distribution of the chain, then the two means are equal and Geweke's statistic has an asymptotically standard normal distribution. Then if $|Z| > 1.96$, iterates from the "early" segment were not yet drawn from the target distribution and should be discarded. In addition $|Z| < 1.96$ indicates that the Markov Chain is converged. The results of Geweke convergence diagnostics show that the parameters are converged[3].

4. 4. Impulse Response Functions of Economic Variables to Oil Shocks

In order to capture the effect of the oil embargo on macroeconomic performance, this study classifies all mentioned embargos into 3 classes, according to the intensity of the sanctions named limited, moderate and extensive sanction, based on Hufbauer (2003) criteria. According to Hufbauer classification, the embargo on Iran has been exacerbated after 2012 up to now. Thus, this study considers the effect of the oil embargo in two periods of before and after the year 2012. Impulse response functions of real GDP, inflation, real exchange rate and money supply to oil embargo are presented in figures 2, 3, 4 and 5, respectively. The dynamic effects of oil shocks on the other variables are normalized in terms of the median response of the variables to a 1 percent decrease in oil exports as well as 16^{th} and 84^{th} percentiles of the posterior distribution of the relevant variables. In order to avoid complicated figures, just the responses in median percentiles have been presented here[4]. According to the figures, there is a clear distinction between the effects of oil shocks on the economy in two periods before and after the oil embargo. This demonstrates the importance of time variations in studying the dynamic effects of oil export shortfall on the economy. Figures 2 and 3 show the median impulse response function of real GDP and inflation to the oil shocks.

[3]. Detailed results are available from the author upon the request
[4] The 16^{th} and 84^{th} percentile confidence bands are available from the authors on request.

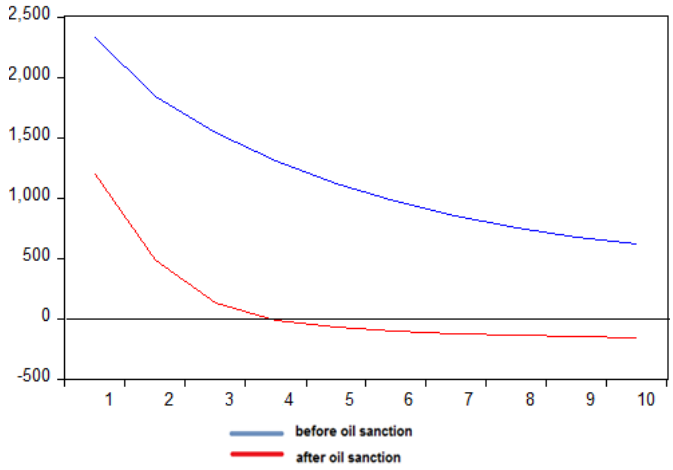

Fig. 2: Median impulse response function of real GDP

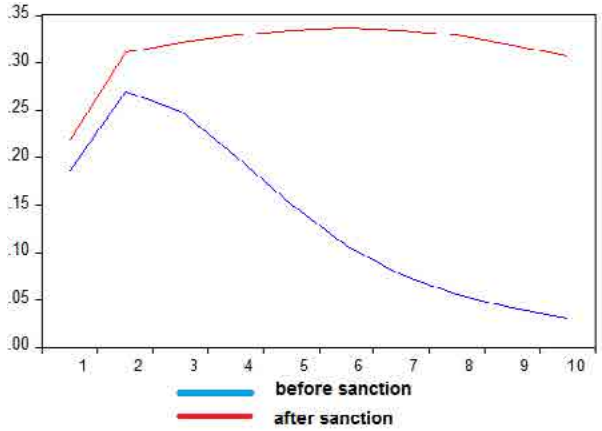

Fig. 3: Median impulse response function of inflation

As figure 2 indicates, the effect of oil shocks on real GDP is negative and it causes an immediate decline in economic activities. In the embargo period, this decline has been deeper and its effect doesn't seem to die out in the short period. It shows that oil has an important role in the Iranian economy. The dependency of the economy on oil exports also is a matter of inflationary pressures. In fact, the oil embargo reduced oil revenues and enforced the government to impose some restrictions on importing goods and services. For instance, importing capital goods and raw materials are vital for the production process constitutes a major part of imports; the restrictions on the imports have an adverse effect on domestic output. Consequently, the inevitable outcomes of this kind of policy would be

stagflation. As implied in figure 3 (inflation trend), where the shock in oil exports is measured in terms of one standard deviation, will create higher inflation in the early years. The response of inflation is more pronounced after imposing an oil embargo on rising and climbed considerably in the oil embargo period. According to figure 3, the impact of oil shocks on inflation is disappearing over time and completely wipe out after 10 periods before the oil embargo, but the effect of oil shocks on inflation is increasing in the oil embargo period and its effect doesn't vanish. This indicates the larger effect of oil shocks on inflation in the post period of the oil embargo. This is emphasizing again that the combination of a temporary fall in economic activities and a temporary rise in inflation create stagflation which is exacerbated after the oil embargo.

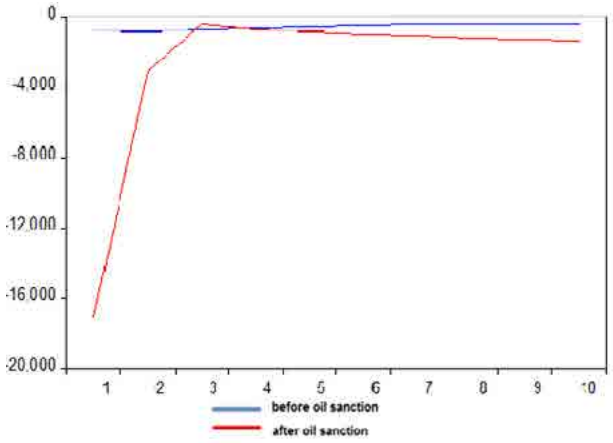

Fig. 4: Median Impulse Response Function of Real Exchange Rate

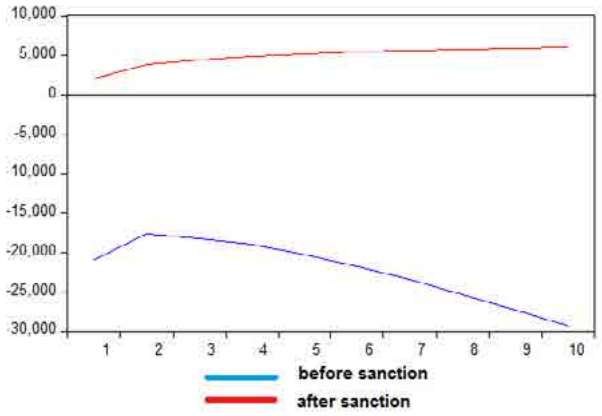

Fig. 5: Median impulse response function of money supply

Figure 4 shows the median impulse response function of the real exchange rate to oil export before and after the oil embargo. According to this figure, oil exports caused domestic currency appreciation before the oil embargo, but after a year when the oil embargo caused oil exports to reduce, the depreciation of domestic currency gradually has occurred over time. In other words, declining oil exports has created a financial deficit for the government and consequently led to large money liquidity and resulting in high inflation. This means a higher foreign exchange rate. According to figure 5, the shortfall of oil export in the oil embargo period causes an increase in the monetary base. It indicates that a reduction in oil revenues; enforce the government to borrow more money from the central bank (print more money) to finance the public expenditures.

5. Conclusion

As a result of the intensification of economic sanctions against Iran, Iran's oil exports have sharply declined and due to the high dependency of the economy, especially the state budget and foreign trades on the petro dollars, the whole economy of Iran faced a stagflation condition. Then investigating the transition mechanism of oil embargo on Iranian macroeconomic variables by considering changes in economic structure of the country over time has been the main objective of this study. In order to reach this goal, the study uses a BTVP-SVAR model that considers the time variation features in transmission mechanism. According to the results oil embargo has had an adverse effect on macroeconomic variables. The real GDP declines deeply in the oil embargo period and inflation has been intensified and this result is in line with Keshavarz et al. (2020) and Garshasbi and Yusefi (2016) findings. However, the mentioned studies just confirm a weak effect or just one period effect of sanction on inflation. To put it another way, as to our findings, the effect of oil embargo shock on inflation dose not vanished in short run and inflationary consequences are significantly positive in the post period of oil embargo. That is because declining in oil revenues forced government to borrow from banking system to finance the government expenditure and in this way the monetary supply has been expanded and caused

depreciation of domestic currency and this scenario and result is in congruence with Tayebi and Sadeghi (2017) study. Moreover, exchange rate fluctuations and a multiple exchange rate system created uncertain environment for foreign investors which has led an adverse effect on overall economic performance. It is evident that despite of Iranian efforts to reduce its dependence on oil income, the Iranian economic activities are critically depends on oil shocks, and oil revenues plays a predominant role in economy. These results are important for policy makers in central bank to set up stabilization policies to overcome difficulties in the post period of oil embargo. For example Iran could stabilize economic performance by stabilizing oil production. Iran can neutralize the effect of oil shocks by reducing the share of oil revenues in government budget or settling oil revenues to national development found can reduce oil shocks role in economic activities. The national development found also should be independent of government intervention. To conclude, preventing exchange market volatility, moderating the accelerated growth of liquidity, regulating the market for certain goods and services, and managing inflation expectations are priority targets and policies in dealing with sanctions.

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متغیرهای کلان اقتصاد ایران به تحریم‌های نفتی علیه ایران چگونه واکنش نشان داده‌اند؟
کاربردی از مدل VAR ساختاری با پارامترهای متغیر در زمان

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چکیده
هدف از این مطالعه بررسی چگونگی واکنش متغیرهای کلان اقتصاد ایران به تحریم‌های نفتی علیه ایران است. بدین‌منظور این مطالعه از متودولوژی VAR ساختاری با پارامترهای متغیر در زمان بهره گرفته و از داده‌های فصلی بین سال‌های Q۲:۱۹۹۱-Q۲:۲۰۲۰ برای پنج متغیر اساسی شامل: صادرات نفت، نرخ ارز واقعی، تورم، تولید ناخالص داخلی واقعی، و عرضهٔ پول استفاده کرده است. براساس مطالعات «نینگ» (۲۰۱۳)، «پریمیچری» (۲۰۰۵) و «بلانچارد» (۲۰۰۷) در فرآیند واکنش متغیرهای کلان اقتصادی به تحریم‌های نفتی اغلب کشورها، شکست ساختاری وجود دارد. بدین‌معنا که به‌علت بروز برخی تعدیلات و تغییرات در ساختارهای اقتصادی کشورها در طی زمان، مکانیزم انتقال در روابط بین شوک‌های نفتی و متغیرهای کلان اقتصادی ناپایدار بوده و واکنش متغیرهای کلان اقتصادی به تحریم‌های نفتی در طی زمان متغیر می‌باشد؛ درواقع بسیاری از فعالین اقتصادی سعی می‌کنند بتوانند نسبت به شوک‌های نفتی واکنشی ملایم‌تر نشان‌دهند، بدین‌منظور دست به ایجاد تعدیلاتی آهسته اما مداوم در مقابل شوک‌های نفتی زده و به مرور زمان تمهیداتی مناسب برای مقابله با شوک‌های نفتی در پیش می‌گیرند. تاکنون مطالعات زیادی در زمینهٔ بررسی آثار تحریم‌های نفتی بر متغیرهای کلان اقتصادی ایران انجام شده است، اما هنوز مطالعه‌ای که بتواند مکانیزم انتقال در واکنش متغیرهای کلان اقتصادی به شوک‌های نفتی ایران را مدنظر قرار دهد، صورت نگرفته است؛ لذا این مطالعه بر آن است تا بتواند با بهره گرفتن از متودولوژی TVP-SVAR این کمبود در مطالعات قبلی را جبران نماید.

کلیدواژگان: تحریم‌های نفتی، رکود تورمی، BTVP-SVAR، ایران.
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Estimation of Gini Coefficient with Subject to the Size of Government by Using Fuzzy Nonlinear Regression

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Abstract

This article examines the effect of government size on the high, medium and low thresholds of the Gini coefficient in Iran. For this purpose, the auto regression model of soft fuzzy logistic transfer (FLSTAR) has been used for the period of 1997-2019. One of the reasons for using this model is flexibility in its application. The main focus of this paper is to calculate the Gini coefficient bands according to the size of government in the economy. Hence, we calculate the bands (high, middle and low) of the Gini coefficient. The study show that the threshold size of the government is equal 0.499. Findings of this research are applied in a real case which reveal that with increase of government share in economy the Gini coefficient increases as well. Therefore, the government should seriously pursue privatization policies.

Keywords: Gini Coefficient, Fuzzy Regression, Size of Government.
JEL Classification: H23, H50, E42, O15.

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1. Introduction

In this paper we study the interdependence between the Gini coefficient and the size of government. This size, defined as the share of income redistributed through the fiscal policy, is increasing in the mean-to median income ratio. This implies in turn a positive relationship between the degree of income inequality (a measure of skewness of the income distribution) and the size of redistribution in the presence of majoritarian institutions (Dotti, 2020). Economic views on income distribution and support for vulnerable groups have undergone major changes over the past decades. The Gini coefficient was developed by Corrido Gini (Gini, 1912). This concept can be used, so that graphically, the density ratio of various species could be placed against density ratio of each individual or each species. The Gini coefficient is a statistical dispersion measurement index that is usually used to measure inequality in the income or wealth distribution in a statistical population (Gini, 1912). It is defined as a ratio between 0 and 1. If it is equal to 0, everyone has the same income and wealth (absolute equality); if it is equal to 1, there is absolute inequality, so that wealth is only in the hands of one person and the rest have no income. Establishing social justice is one of the most important goals of any economic system. For many centuries, economists have been thinking about economic justice. For example, the classics saw the establishment of justice through the free market system and believed that the distribution of income from the free market system, though not equal, but it's justly. Although justice is a concept with great complexity and cannot be equated with the income equality of all groups of society, but at the same time, a key element in establishing justice is the low distance between the different income deciles of society and the neutral distribution of income. So, policymakers and Govern mentalist can by identifying the factors and variables affecting income distribution and its impact to take steps to distribute desirable income and reduce class distances as part of social justice. Therefore, an important factor in the distribution of income is the type of government expenditure, and the degree of government intervention in the economy. It is also argued that there may be a positive and negative relationship between government size and income distribution depending on the extent of government involvement in the economy or the rate of economic growth and development (Afonso and Tanzi,

2010). However, there is a difference point of view between the government's involvement in the economy and the different economic doctrine. However, there is always some degree of government involvement in the economy. The extent of government intervention in the economy has a significant impact on inequality. Therefore, the desired size of the government to influence the economy can be examined from different angles. One of these aspects could be its impact on inequality in economy. Studies has been much discussion about the factors that affect the amount of inequality. Within this studies, the amount of government spending in the economy is often argued to be a key influence (Bechtel and Scheve, 2018; Gouveia, 1998; Kakwani and Pernia, 2000; Kalwij and Verschoor, 2007; Ravallion, 2001). Fuzzy sets were introduced by L. A. Zadeh (1965). After introducing this notion the use of fuzzy data for modeling uncertain information in databases were considered, and that is where the need to expand the Takagi-Sugeno-Kang (TSK) model was felt (Li-Xin, 1992; Yen and Langari, 1999; Yu, Wang and Chen, 2006). Most of the researchers in this area have been focused on the development of the basic model and query language in order to display and retrieve uncertain data. Since then, modeling and regression analysis in fuzzy environment have been considered by theoretical and applied researchers (Ghasemzadeh and Shayesteh, 2019; Hesamian and Akbari,2017; John and Innocent, 2005; Sohn and Yoon,2016). In this paper we consider an application of fuzzy logistic smooth transition autoregressive (FLSTAR) model. The importance of this paper is in comparing the estimated bounds high, low, and middle Gini coefficients attention to the size of government. The rest of this research continues in six sections as stated in the following. Section presents a review of studies on the Gini coefficient and the size of government. Section 3 focuses on theoretical foundations needed in this research. Section 4 presents the research methodology; Section 5 incorporates all the results. Section 6 has a discussion and conclusion.

2. Review of Some Studies on the Gini Coefficient and the Size of Government

Different studies are performed on income distribution (Allingham, 1972; Bulíř, 2001; Champernowne, 1974; Clements and Kim,1988; Cysne and Monteiro, 2005; Moller and Nielsen, 2009; Nixson and Walters, 2006; Perotti, 1992; Sylwester,

2002) where most of them examined the effect of a macroeconomic index on income distribution (Albanesi, 2007; Clements and Kim,1988; Cok and Verbicˇ, 2013; De Mello and Tiongson, 2006; Easterly and Fischer,1999; Ganjoei, Akbarifard, Mashinchi and Esfandabadi, 2020; Perotti,1994). Regarding the effect of foreign trade on income distribution, the studies have evaluated its commercial liberalization and globalization on income distribution (Bhagwati and Srinivasan, 2002; Clements and Kim,1988; Obiols-Homs, 2005; Salvatore, 2007). Most studies, based mostly on cross-country data, do not find any statistically significant relationship between various features of the income distribution and some measure of the size of the government (Armey, 1995; Lustig, 2015; Lustig, Pessino and Scott, 2014; Perotti, 1994; Perotti, 1996; Persson and Tabellini,1994; Ravallion, 2001; Ravallion, 2007; Son, 2004; Son and Kakwani, 2008). The recent experimental studies show that increase in income inequality tends to have increase on distribution through taxation, but its effect on the size of the government may have the adverse sign (Agranov and Palfrey, 2015; Bechtel, Liesch, and Scheve, 2018). Studies of Sub-Saharan Africa countries show that government spending on agriculture has a moderate impact on economic growth. On the other hand, government spending on health and education has a significant impact on poverty reduction (Lofgren, and Robinson, 2008; Sylwester, 2002). The results of studies in OECD countries show that there is a negative relationship between the size of government and public spending with inequality (Bandyopadhyay and Esteban, 2009). Some studies have examined the nonlinear relationship between income inequality and government spending. The results of the study in (Colletaz and Hurlin, 2006) show a nonlinear relationship between income inequality and government spending (Dotti, 2020). The results of new experimental studies show that higher income inequality implies a more progressive tax system but, in contrast with the traditional analysis, it may also result in a smaller size of government (Dotti, 2020).

3. Theoretical Foundations of the Gini Coefficient and the Size of Government

In general, government expenditures (public expenditures) have an indirect effect on income distribution, which improves the income distribution of people. The

government's investment expenses are actually expenses that will earn money in the future. In other words, it is necessary for the government to make various expenses for investment in order to fulfill its economic duties and responsibilities. Which will lead to direct and indirect income in the future. These investments include machines, buildings, research projects and various construction projects, most of the benefits of which can be obtained in the future. These types of investments also indirectly affect income distribution, but in the future, they can have a positive effect on income distribution. Transfer payments are expenditures that are unilaterally paid by the government to individuals that directly affect the distribution of income (Afonso, Schuknecht and Tanzi, 2010).

Public spending through the development of productivity and job opportunities can have indirect but significant effects on income distribution. For example: (A) An efficient public transport system will allow people to find jobs at lower travel costs (Afonso, Schuknecht and Tanzi, 2010). (B) If education spending increases their human capital stock, it may benefit the poor and improve income distribution. There are two compelling reasons why governments have significantly increased their spending on education. First, the social efficiency of this work is very high, and investment in these areas leads to increased labor productivity and, consequently, to national income and reduced income inequality (Afonso, Schuknecht and Tanzi, 2010). Second, it has been observed that girls' education has a positive effect on fertility and well-being. It has a positive impact on the distribution of income (Afonso, Schuknecht and Tanzi, 2010). (C) Free access to health facilities will maintain the health of the workforce, thereby increasing labor productivity and earning capacity (Afonso, Schuknecht and Tanzi, 2010). On the other hand, government spending and its size affect economic growth. By increasing the supply of productive public goods, the government increases the final return on investment, which has a stimulating effect on investment. Also, taxation to finance government spending has an anti-incentive effect on production and investment spending. In other words, with the increase in the tax rate, the rate of economic growth decreases. Consequently, the economic growth rate follows a reverse U relation to the relative size of the government in the economy. This nonlinear relationship between government size and economic growth is also

known as the Armey's curve (Armey, 1995). This curve also shows the nonlinear relationship between government size and economic growth. According to this curve, excessive government growth in the economy has negative effects on economic growth and slows national income growth, therefore increasing the size of the government will lead to inequality in the economy. Because of the large presence of governments and the increasing inefficiency of the economy and the exclusion of more markets, it also means narrowing the space for private sector activity. Summarizing this section, based on the studies reviewed, we can conclude the impact of government spending on economic variables has a nonlinear behavior. The purpose of this article is to investigate the effect of government size on high, medium and low threshold of Gini coefficient in Iran. To this aim, in Section 4, we first review the literature on nonlinear models and then fuzzy logic.

4. Methodology of the Research

4. 1. Autoregressive Models

Statistical modeling of time series (Aznarte, Medeiros and Benítez, 2010) is one of the oldest and most successful tools to predict the future values of a time series as a combination of past values. Box and Jenkins stated the future values of a time series as a linear combination of its past values in the form of an autoregressive (AR) model based on p ≥ 1, where p is past values y_t , defined in (1):

$$y_t = b'x_t = b_0 + b_1 y_{t-1} + \cdots + b_p y_{t-p} + \varepsilon_{t,} \quad t = 1,2,\dots,n \qquad (1)$$

Where b' is vector of parameters, $x_t = \left(1, y_{t-1,\dots,} y_{t-p}\right)'$ and $\varepsilon \sim N(0, \sigma^2)$ is usually known as white noise (or a random signal). For this model we write, $y_t \sim$ AR(p), and $\{y_t\}$ generated from this model is called the AR(p) process. The model (1) indicates the current status of y_t through the past values of $y_{t-1,\dots,} y_{t-p}$ in terms of a linear regression. This model (1) explicitly specifies the relationship between its current and past values. Box and Jenkins' method covers a wide range of scientific fields such as biology, astronomy, and econometrics. Tong (1983) proposed a linear model called the threshold autoregressive model (TAR) which is divided into several models based on space-state idea and each is modeled by the

autoregressive model, which is called self-existing threshold autoregressive. A TAR model (Aznarte, Medeiros and Benítez, 2010) with (k ≥ 2) is defined as (2):

$$y_t = \sum_{i=1}^{k} b_i' x_t I(S_t \in A_i) + \varepsilon_t = \sum_{i=1}^{k} \{b_{i,0} + b_{i,1} y_{t-1} + b_{i,p} y_{t-p} + \varepsilon_t\} I(S_t \in A_i) + \varepsilon_t , \quad (2)$$

Where S_t is threshold variable, I is indictor function with values 0 and 1, b_i' is a vector of parameters, b_i is unknown parameter, and $\{A_i\}$ are partition of the real line $\mathbb{R} = (-\infty , \infty)$, so that:

$$\cup_{i=1}^{k} A_i = (-\infty, \infty) \ \ and \ A_i \cap A_j = \emptyset, \forall_i \neq j, \quad (3)$$

Here each $A_i = (r_{i-1}, r_i)$ as a part of a partition of $\mathbb{R}$ is written in an autoregressive form. This partition is estimated by the transition variable S_t and r_i is the threshold limit, where

$$-\infty = r_0 < r_1 < \cdots < r_k = \infty, \quad (4)$$

4. 2. Smooth Transition Autoregressive Model

One of the key features of threshold autoregressive models is the discontinuous correlation of the autoregressive model (Aznarte, Medeiros and Benítez, 2010). An alternative model called smooth transition autoregressive (STAR) model was proposed by (Terasvirta, 1994). This model with k numbers of regimes is defined in (5):

$$y_t = b_0' x_t + \sum_{i=1}^{k} b_i' x_t f_i (S_t; \emptyset_i) + \varepsilon_t , \quad (5)$$

where b_i is a vector of parameters, $f_i(S_t ; \emptyset_i)$ is transition function, $\emptyset_i$ consists of two variables γ and c, where γ shows the transition velocity between two bounds,

and c is the transition point and $\{\varepsilon_t\} \sim N(0, \sigma^2)$ usually known as white noise (equivalent to a random signal with a flat power spectral density).The STAR model in (5) can be re-written as in (6):

$$y_t = \sum_{i=2}^{k} b_i' x_t \, F(s_t; \gamma_i, c_i) + \varepsilon_t \quad (6)$$

,

Where, γ shows the transition velocity and c_i is the transition point.

4. 3. Fuzzy Logic Methodology

Fuzzy logic involves a wide range of theories and techniques that are generally based on four concepts: fuzzy sets, verbal variables, membership function, and fuzzy if-then rules (Aznarte, Medeiros and Benítez, 2010; John and Innocent, 2005; Lee, 1990). The fuzzy logic consists of three stages as Fuzzification, fuzzy process (fuzzy inference) and defuzzification. In Section 4.3.1, we will review the application of fuzzy logic in prediction and modeling.

4. 3. 1. Fuzzy-based Models

Fuzzy systems are knowledge or rule-based systems. The heart of a fuzzy system is a knowledge based that is formed by fuzzy if-then rules. A fuzzy if-then rule is a conditional expression which are specified by continuous membership functions. These rules are (Aznarte, Medeiros and Benítez, 2010). fuzzy inference engine combined by a mapping of fuzzy sets in the While dealing with time series problems, the Takagi-Sugeno-Kang (TSK) model is preferred to the other types. The TSK type fuzzy rule (Aznarte, Medeiros and Benítez, 2010) is as(7):

$$\text{IF } x_1 \text{ is } A_1 \text{ AND } x_2 \text{ is } A_2 \text{ AND } \ldots \text{ AND } x_p \text{is } A_p \text{ , THEN } y = b' x_t$$
$$= b_0 + b_1 x_1 + b_2 x_2 + \cdots + b_p x_p \quad (7)$$

Where x_j is input variable and A_j is a fuzzy sets. Given the fuzzy argumentation mechanism for the TSK rules, the firing strength of the ith rule is obtained via a t-norm (usually, multiplication operator) aggregating the membership values of the premise part terms of the linguistic variables as (8):

$$\omega(x) = \prod_{j=1}^{p} \mu_{Aj}\left(x_j\right), \text{ with } x = \left(x_1, \dots, x_p\right) \quad (8)$$

The membership function μ_{Aj} can be selected from a wide range of functions (Aznarte, Medeiros and Benítez, 2010). The most common one is the Gaussian bell presented as (9):

$$\mu_A(x) = exp\frac{-(x-c)^2}{2\sigma^2}, \quad (9)$$

Therefore, it can also be a logistic function as (10):

$$\mu_A(x) = \frac{1}{1 + exp\left(\frac{c-x}{\sigma^2}\right)}, \quad (10)$$

The consequent is calculated as the average weight or total output weight of the rules. In the case of the total weight, the output is stated as in (11):

$$y_t = G(x_t; \Psi) = \sum_{i=1}^{R} b_i' x_t \, \omega_i(x_t), \quad (11)$$

where G is the general nonlinear function with parameters Ψ and r as the number of fuzzy rules in the system (Aznarte, Medeiros and Benítez, 2010; Kalwij and Verschoor, 2007; Sohn, Kim and Yoon, 2016; Son, 2004). When an infinite time series $\{y_t\}$ is used for modeling or predicting, the TSK type fuzzy-based rules are expressed as in (12). All the variables y_{t-i} are lagged values of the time series$\{y_t\}$.

$$IF\ y_{t-1}\ is\ A_1\ AND\ y_{t-2}\ is\ A_2\ AND \dots AND\ y_{t-p}\ is\ A_p\ ,\ THEN\ y_t = b_0 + b_1 y_{t-1} + b_2 y_{t-2} + \cdots + b_p y_{t-p}$$

(12)

5. Results of Estimating Threshold the Size of Government

In this study, using the annual data presented by the Central Bank of Iran (CBI) during 1997 – 2017, the effect of internal factors including:

A-The size of government is computed as $SG = \frac{G}{GDP}$. This includes the general government expenditures as a share of GDP for; general public services; defense; public order and safety; economic affairs; housing and community amenities; health; recreation, culture and religion; education; social protection. B- Inflation. C- GDP is investigated via the Gini coefficient in Iran. The size of the government is a variable that causes a nonlinear effect on the Gini coefficient as the dependent variable. The choice of transition variable (The size of government) and nonlinear tests is performed according to (Sohn, Kim and Yoon, 2016; Son, 2004).

In this section we calculate the threshold value of the size of the government in the economy, as stated in Sections 4.1 and 4.2. For this purpose, the following steps are done:

1- Using Taylor's approximation to investigate the nonlinear relationship between variables (Colletaz and Hurlin, 2006; Terasvirta, 1994), where the Wald Lagrange multiplier (LM_W) test statistics is defined in (13)

$$LM_W = \frac{T(SSR_0 - SSR_1)}{SSR_0} \quad (13)$$

In the above equations, SSR_0 is the sum of residuals squared, SSR_1 is the sum of squared residuals, T is time period.

2-The variable LM_W that has the most test statistics is selected as the transition variable $\widetilde{S}$ (Tsay, 1989).

3-We determine the transition velocity γ and the transition point c_i, using the Newton-Raphson algorithm (Enders, Walter 2004).

4- By specifying the transfer speed, point and variable, we can calculate the value of the size of government threshold (the transition function) is defined in (5).

The size of government threshold is estimated to be 0.499. The implication of this threshold is that in a small regime, as long as the size of the state is less 0.499, increasing the size of government does not affect the Gini coefficient or the inequality of income distribution. But in a big government regime, when the size of government is greater than 0.499, increasing the size of government leads to the increase in the Gini coefficient. In other words, in a large government regime, increasing the size of the government leads to increase of income inequality in the country's economy. All the relevant calculations are performed on Windows 10, 64-bit and Eviews 10.

The innovation of this study is in using the logistic smooth transition autoregressive model in the form of fuzzy-based rules and fuzzy database. Accordingly, the logistic smooth transition autoregressive model that is generalized by (Aznarte, Medeiros and Benítez, 2010; Terasvirta, 1994; Tsay, 1989) will be as in (14). For the asthmatic of fuzzy numbers refer to references (Ganjoei, Akbarifard, Mashinchi and Esfandabadi, 2020; Perotti, 1992).

$$\widetilde{Gini}_{i,t}\left(\widetilde{Gini}_{t-j}, \widetilde{GS}, \tilde{p}, \widetilde{GDP}, \tilde{S}_{it}, \tilde{c}, \tilde{v}\right)$$
$$= \sum_{j=1}^{n} \alpha_j \widetilde{Gini}_{t-j} + \sum_{j=1}^{n} \alpha_j \widetilde{SG}_{t-j} + \sum_{j=1}^{n} \alpha_j \tilde{P}_{t-j} + \sum_{j=1}^{n} \alpha_j \widetilde{GDP}_{t-j}$$
$$+\tilde{G}\left(\tilde{S}_{it}, \tilde{v}, \tilde{c}\right) * \{ \sum_{j=1}^{n} \alpha_j \widetilde{Gini}_{t-j} + \sum_{j=1}^{n} \alpha_j \widetilde{SG}_{t-j} + \sum_{j=1}^{n} \alpha_j \tilde{P}_{t-j} + \sum_{j=1}^{n} \alpha_j \widetilde{GDP}_{t-j} \} \quad (14)$$
$$\tilde{G}\left(\tilde{v}, \tilde{c}, \tilde{S}_t\right) = \frac{1}{1 + \exp\left(\tilde{v}\left(\tilde{S}_{it} - \tilde{c}\right)\right)}, \quad \mathrm{i} = 1, \ldots, \mathrm{N}, \mathrm{t} = 1, \ldots . \mathrm{T}.$$

Where Gini coefficient $\widetilde{Gini}$, Gini coefficient of the previous period $\widetilde{Gini}_{t-j}$, the size of government $\widetilde{SG}_{t-j}$, inflation $\tilde{P}_{t-j}$, Gross Domestic Product $\widetilde{GDP}_{t-j}$, transition variable $\tilde{S}$, transition point $\tilde{c}$, transition velocity $\tilde{v}$ which are all fuzzified. In this study, $\widetilde{SG}$ is the transition variable and $\tilde{G}$ is the transition function TR. Note that ~ means the notion used is fuzzified. In order to obtain the transaction function (TR) in high, low, and middle bounds, in accordance with(14), the inputs are initially analyzed based on fuzzy-rules based. The transfer function consists of three parameters as $\tilde{c}$, $\tilde{v}$, and $\tilde{S}_{it}$.

5. 1. The Results of Estimation

We used fuzzy logic to calculate the transition function values, as in Table 1, the value of transition function in three classes as high, middle, and low bounds are estimated. Accordingly, when the transition function is in the high bound, the value of the Gini coefficient is in the high bound (high width). Similarly, when the transition function is in the middle bound, the Gini coefficient is in the middle bound (front), and when the transition function is in the low bound, the Gini coefficient is in the low bound (low width).

Table 1: Calculating transition function based on input parameters

Transition function parameters (input)	bounds		
	low bound	middle bound	high bound
Transition point c	(0, 0.25)	(0.25, 0.375)	(0.375, 0.75)
Transition velocity V	(0, 0.21)	(0.21, 0.5)	(0. 5, 0.99)
Transition variable S	(0, 0.281)	(0.281, 0.65)	(0.65, 1)
Transition function (output)	(0, 0.339)	(0.339, 0.68)	(0.68, 1)

The Gaussian function is used for the membership function for the output variable of the transition function, since its covered domain can be carefully adjusted. It should be noted that in the present study, there are 3 fuzzy sets (low, middle, and high) and the number of input variables is 3 which are $\tilde{c}$, $\tilde{v}$, and $\tilde{S}_{it}$. Therefore, the number of the required rules will be 27 (Aghaeipoor and Javidi, 2019). Data on all variables are taken from the CBI website. Which Figure 1 is plotted using (14) and with MATLAB software. Figure 1 shows how the transfer variable and the transfer function affect the Gini coefficient. After determining the bounds of the transition function, in the next stage, a domain is determined on each of the input variables A, B, C and D stated in Table 2. For this purpose, all data are initially transferred to the values in [0,1]. Prior to drawing the membership functions, in order to specify the range of linguistic input variables, the mean values, mean difference from standard deviation, and total

mean and standard deviation of each input variable must be calculated. All the relevant calculations are performed on Windows 10, 64-bit and MATLAB R2019a.

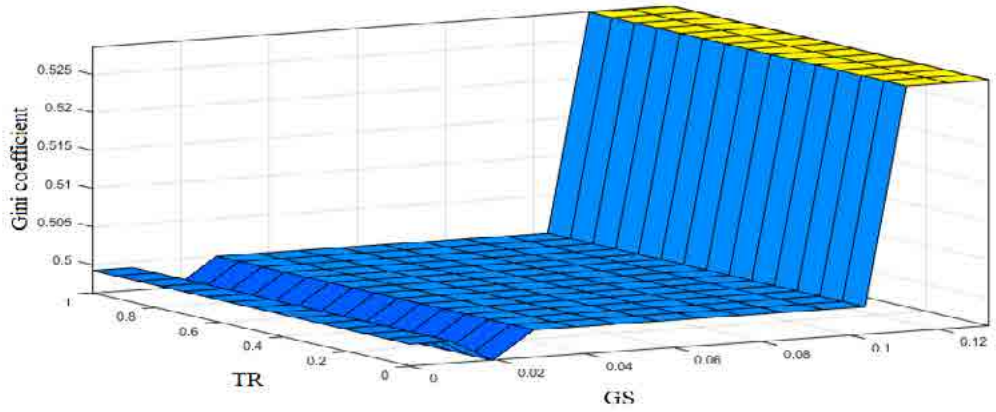

Fig. 1: Transition function (TR) in terms of the transition variable (unemployment) by using equation (14)

In this case, the range of low linguistic variable will be from the mean to 0. The range of middle linguistic variable will be from the total standard deviation and mean to the difference of standard deviation and mean. Finally, the range of high linguistic variable will be from the mean to 1. In Table 2, the values A, B, C and D are presented for the three variables. In the fuzzy inference stage, the required linguistic rules must be determined to link the input and output variables.

Table 2: Descriptive statistical indicators for input variables based on authors calculation

Descriptive statistical indicators	A: Size of government	B: Inflation	C: Gross Domestic Product	D: Gini coefficient with one the of lag (Gini t-1)
mean	0.08128971	0.281357778	0.246437012	0.39801
standard deviation	0.049904663	0.342497391	0.30066934	0.010266
total mean and standard deviation	0.131194373	0.623855169	0.547106352	0.387743

difference of standard deviation and mean	0.031385047	0.061139613	0.054232329	0.408276

In this study, following previous studies such as (Aghaeipoor and Javidi, 2019), four economic input A, B, C and D variables during 1997-2019 are identified as the most important effective variables for computing the Gini coefficient. For the fuzzification of the above variables, in the first stage, for each of the input and output variables, the low, middle, and high linguistic expressions are used. Then, for each of the linguistic expressions in each of the input variables, the Gaussian membership function is used (Dotti, 2020; Lee, 1990; Lofgren and Robinson, 2008). Then, as in Figure 2, the effectiveness of transition function and independent variables for the Gini coefficient is specified. To calculate the value of the high, low, and middle bounds (proportional to the high, low, and front width) for computing the Gini coefficient, three situations are considered for the transition function. Where is obtained based on (Lee, 1990). In the next stage, which is the defuzzification stage, the value of Gini coefficient is obtained.

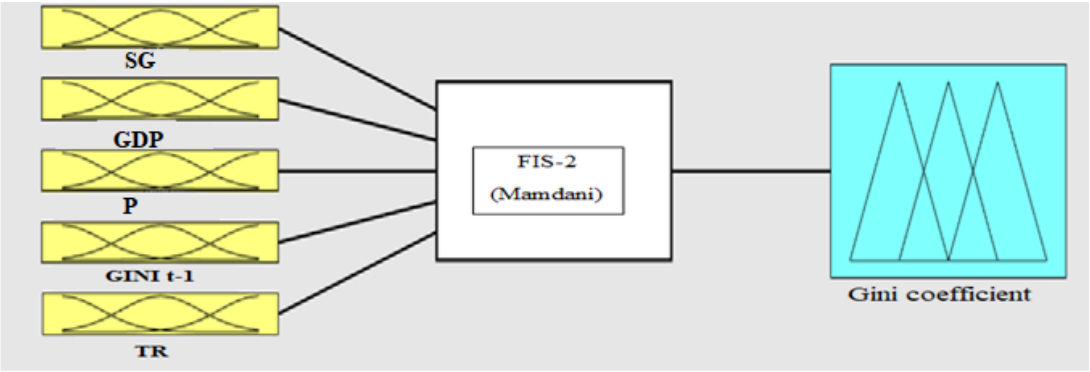

Fig. 2: Computing Gini coefficient as output via independent variables SG, GDP, P, $GINI_{t-1}$ and transition function TR. as fuzzy inputs

The results of which are presented in Table 3. The high, Low, and Middle width of the Gini coefficient is calculated.

Table 3: Gini coefficient calculations high, Low and Middle

year	Gini coefficient		
	Low width	Middle width	high width
1997	0.487	0.501	0.512
1998	0.421	0.498	0.5
1999	0.439	0.493	0.541
2000	0.431	0.451	0.485
2001	0.471	0.482	0.494
2002	0.497	0.499	0.507
2003	0.469	0.471	0.508
2004	0.401	0.495	0.509
2005	0.457	0.493	0.5
2006	0.454	0.460	0.468
2007	0.448	0.475	0.485
2008	0.461	0.470	0.485
2009	0.478	0.5	0.524
2010	0.497	0.504	0.5 07
2011	0.466	0.481	0.487
2012	0.401	0.507	0.508
2013	0.406	0.5	0.504
2014	0.457	0.481	0.487
2015	0.469	0.481	0.485
2016	0.477	0.49	0.501
2017	0.400	0.481	0.5
2018	0.417	0.440	0.501
2019	0.430	0.481	0.531

6. Discussion

We presented the FLSTAR model for estimating the relationship between the size of government and bounds of the Gini coefficients. One of the important features of this model is the flexibility and modeling of economic conditions. In this study, a threshold for the size of government is estimated. The results of this study shows that government spending and fiscal policies have a negative impact on Gini coefficients, which leads to increased income inequality. Many of these results are in the line with prior expectations, and mirror other findings in the literature. Studies in recent years have used meta-regression analyze (MRA) for investigating the relationship between government spending and income poverty by focusing on low- and middle-income countries. Results in (Anderson, Duvendack and Esposito, 2018) show that higher government spending has played a significant role in reducing income poverty in low- and middle-income countries. Also, the

relationship between government spending and poverty is on average less negative for countries in Sub-Saharan Africa, and more negative for countries in Eastern Europe and Central Asia, compared to other regions (Anderson, Duvendack and Esposito, 2018).

There are several criteria to compare the performance of the models used in this study. The most common of these are Mean Absolute Error (MAE), Mean Square Error (MSE), Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), all criteria are used in this study (Bal, Demir and Aladag, 2016), for model evaluation as well as for predictive power evaluation. Table 4 shows the result nonlinear regression of Gini coefficient estimation using fuzzy regression. Fuzzy nonlinear regression model had good results in all evaluation criteria (Anderson, Duvendack and Esposito, 2018; Cok, Urban and Verbic, 2013; Dotti, 2020; Kalwij and Verschoor, 2007; Moller, Alderson and Nielsen, 2009).

Table 4: Evaluating the results FLSTAR model estimation

Models	Membership	MAPE	MAE	RMSE	MSE
FLSTAR	Low bound	0.037	0.023	6.23	3.882
	Middle bound	0.047	0.0294	9.08	8.25
	high bound	0.001	0.000	40.000	0.000

7. Conclusion

In this paper, while presenting the application of fuzzy sets in regression, a situation was examined, where the classical regression methods could not be used to estimate dependent variables. In this study, using the fuzzy logistic smooth transition autoregressive (FLSTAR) model, the appropriate transition function was fitted to the data by using a fuzzy database and the dependent variable bounds were estimated. One of the merits of FLSTAR model is the flexibility in modeling and strong explanatory power by calculating the bounds of the Gini coefficients and comparing it in different years. In this way we can understand the impact of the size of government on the economy.

The results of this study show that the threshold of government size in Iran economy is 0.499. We calculated the Gini coefficient for when the government size is High, Meddle and Low. We found no evidence that increased government spending would lead to a decrease in income inequality. This is consistent with the view that financial policies in developing countries have no effect on reducing inequality. These results are important as they can be a guide for policy makers, because the value of Gini coefficient can be reduced until the Low width and Middle, and its current trend is not compatible with the optimal use of facilities. So it is suggested that the government consider privatization policy in order to improve the distribution of income in the country.

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برآورد ضریب جینی با توجه به اندازهٔ دولت با استفاده از رگرسیون غیرخطی فازی

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چکیده

این مقاله به بررسی تأثیر اندازهٔ دولت بر آستانه‌های بالا، متوسط و پایین ضریب جینی در ایران می‌پردازد. برای این‌منظور از مدل خود رگرسیون انتقال ملایم لجستیک فازی (FLSTAR) برای دورهٔ زمانی ۱۳۷۵-۱۳۹۷ استفاده شده است. یکی از دلایل استفاده از این مدل انعطاف‌پذیری در کاربرد آن است. تمرکز اصلی این پژوهش، محاسبهٔ باندهای ضریب جینی با توجه به اندازهٔ دولت در اقتصاد است. از این‌رو، باندهای (بالا، متوسط و پایین) ضریب جینی محاسبه شده است. این مطالعه نشان می‌دهد که اندازهٔ آستانه دولت برابر ۰/۴۹۹ است. یافته‌های این تحقیق در یک اقتصاد واقعی کاربرد دارند که بیانگر آن است با افزایش سهم دولت در اقتصاد، ضریب جینی نیز افزایش می‌یابد؛ بنابراین دولت باید سیاست‌های خصوصی‌سازی را به‌طور جدی دنبال کند.

کلیدواژگان: ضریب جینی، رگرسیون فازی، اندازهٔ دولت.
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Decomposition of the Gap of Household Electricity Expenditure Using Blinder–Oaxaca and Machado-Mata Decomposition Models

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Abstract

The efficient use of electricity in the household sector to ensure maximum welfare of households and supply of electricity required by industry as an engine of economic growth is the important goal of countries. Therefore, reducing the inefficiency of energy consumption by households is of high importance. The present study uses statistical evidence of expenditure-income of Iranian households for the period 2010–2021 to estimate the share of energy inefficiency in the households' energy consumption differences. The results of Blinder–Oaxaca decomposition show that the share of inefficiency in creating a gap in the share of household electricity costs has decreased from 87.2% in 2010 to 76.5% in 2021. The results of Machado-Mata decomposition show that in the upper quantiles of the share of electricity consumption, the share of the difference in the socio-economic characteristics of households is more than that of the lower quantiles and this share has increased in 2021 as compared to 2010. Therefore, the role of household consumption pattern is more than the rate of access to high-energy appliances, so providing a step-by-step pricing system with an exponential rate for electricity consumption is an effective policy to reduce inefficiency in electricity consumption. Furthermore, quantile regression estimation shows that household income and size have a negative effect, and ownership and size of housing and access to household appliances have a positive significant effect on the share of household electricity costs.

Keywords: Decomposition Models, Electricity Consumption Inefficiency, Quantile Regression.
JEL Classification: C10, D12, E21.

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1. Introduction

Energy is one of the most important inputs of production in the economy (Argha and Mehnatfar, 2021). The importance of energy resources, especially oil, in the economic growth of countries is such that it has created political and military conflicts between governments. Achieving higher economic growth requires increasing the use of energy, the lack of development of most economies in the production of renewable energy sources, the global economy faces the challenge of pollution with increasing economic growth. Electricity is one of the types of energy that is in a better condition than fossil fuels in terms of environmental pollution, but the nature of electricity consumption in the economy due to its relatively high use in the household sector causes the lack of proper use of this type of energy resources in the production sector. According to the statistical evidence of the Ministry of Energy of Iran in 2021, the domestic sector consumed 98 thousand gigawatt hours of electrical energy equivalent to 32% of the country's electricity consumption, while this figure in 2011 was equal to 56 thousand gigawatt hours, It was 31% of the country's electricity consumption. Over the period 2011–2021, the growth of electricity consumption in the Iranian economy was equal to 75%, while the population growth in the country was equal to 12%. Increasing electricity consumption in the household sector is due to two main reasons: First, economic growth and achieving higher living standards is one of the most important reasons for increasing electricity consumption through the use of high-energy appliances. The second reason is the incorrect patterns of energy consumption that leads to increased energy consumption inefficiency. Energy consumption inefficiency refers to the difference in consumption per the same socio-economic characteristics. If the difference in household energy consumption is due to differences in appliances used, this type of gap is efficient and indicating the welfare difference, but if difference in energy consumption exist for equal using of appliances and size of house, this gap is inefficient and indicating difference in optimal energy consumption between households that implies a waste of energy in the economy (Argha and Mehnatfar, 2021). Therefore, this study aims to investigate whether the difference in household energy consumption is due to differences in available appliances or electricity consumption

inefficiency, and to detect what factors affect household electricity consumption. The results indicate that some important policies should be implemented, which on the one hand provide the maximum welfare of households and on the other hand supply the electricity needed by high value-added sectors.

The remainder of this paper is organized as follows. Section 2 describes the theoretical foundations and research background. Section 3 explains the data collection and research method, and Section 4 provides the model estimation and results analysis. Finally, Section 5 concludes the paper, and proposes optimal policies in accordance to the results.

2. Theoretical Foundations and Research Background

Energy is one of the most important factors in increasing household welfare. Therefore, household energy demand is one of the most important economic issues that have been extensively investigated in various studies. One of the distinguishing characteristics of the studies is the different type of data used (Tighi et al (2019)). In many studies, macro-level data are used, which have a longer time dimension but fewer variables, resulting in a loss of information about individual behavior (Labandeira et al., 2012). But micro-level data is short in terms of time dimension and more in terms of the number of variables (Wiesmann et al., 2011). However, the use of individual and household level data, which contains more variables than Big Data, shows more heterogeneity between households, and meets the criteria of household energy demand (Nesbakken, 1999). Most of the micro-level studies have used household socio-demographic characteristics such as type and size of housing, education of household head, income, access to high energy appliances, etc. to explain demand. Although these variables influence energy demand, they are weak and cannot describe the internal behavioral characteristics of households (McLoughlin et al., 2012). There are several studies which show that much of the change in demand cannot be explained by the variables of housing type, housing size, and type of appliances used, and depends on the specific behavioral characteristics of individual

households (Morley & Hazas, 2011). In addition, other studies show that there is a weak relationship between energy consumption behavior and demographic-social classification (Haben et al., 2013), so consumption behavior cannot be discussed on the basis of household social class. Therefore, in general, to identify the factors affecting energy demand, not only the effect of household socioeconomic characteristics should be measured, but also a measure of the specific behaviors of each household, referred to as cultural differences (Long et al., 2018) or inefficiency differences, should be studied.

The main premise of the theory of consumer behavior and demand is that the consumer is inclined to allocate the limited available income between goods and services in a way that achieves maximum satisfaction. But indeed consumption, in addition to being a function of economic characteristics, is a function of lifestyle. Various theories have been proposed on the relationship between lifestyle and consumption. According to Max Weber, differences in consumption are based on a tendency to make differences in respect and prestige, which can be identified as social hierarchy. According to him, status groups can be identified by differences in lifestyle. Status groups seek to create a monopoly of goods, opportunities, and symbols that provide respect in order to maintain their social distance from other groups. Veblen argues that if a consumption pattern does not even have any obvious function, it should be justified in terms of raising social status. In this regard, Bourdieu believes that consumption not only does not satisfy biological needs, but also includes signs, symbols, ideas and values. According to him, consumption in the new era is a process in which the buyer of goods, by displaying the purchased goods, is actively trying to create and maintain their identity (Akbari et al., 2016).

Thus, the difference in electricity consumption between households is not only due to measurable factors such as income and type of appliances available, but also due to non-measurable factors such as household lifestyle. Papageorgiou et al. (2020) showed that household electricity consumption could not be explained by using factors such as income and housing characteristics used, and could be explained by addressing a variety of attitudes and behaviors. Studying a sample of

845 British households over the period 2011–2012, Huebner et al. (2016) showed that housing, demographic, and appliances characteristics explained 39% of changes in household electricity consumption. Boogen (2017) using Swiss statistical evidence for the period 2001–2005 showed that the technical inefficiency of electricity use in Swiss households was between 20 and 25%. Gram-Hanssen (2013), using statistical evidence from Denmark for the period of 1980–2010 came to the conclusion that for heating devices, building characteristics such as size and year of construction explained about 40 to 50% of changes in energy consumption; while the characteristics of residents such as age, income, and education explained a small percentage of changes in energy consumption. Huang (2015) using quantile regression approach and Taiwan's statistical evidence for the period 1981–2011 showed that household income and size significantly affected household electricity consumption. In fact higher-income and higher size households, and older households' members consume more electricity. Using statistical evidence from 315 British households in the period 2009 to 2010, Jones et al. (2015) showed that education level, number of residential floors, and fixed electric heating appliances did not have a significant effect on electricity consumption, but higher-income households, higher size households, and households with more children consumed more electricity.

Chen and Pitt (2017) indicated that over the period 1980–2002, changes in Indonesian household characteristics accounted for up to 26% of the observed changes in household energy demand. Salari and Javid (2017), using the statistical evidence of 560,000 American households for the period 2010 to 2012, showed that socio-demographic characteristics and building characteristics were the most important factors affecting household energy consumption. In addition, high education of the head of the household increases their energy consumption. Hasan and Mozumder (2017), using the income-cost evidence for Bangladeshi households in 2010 showed that there was a u-shaped relationship between electricity consumption and income, so that initially, as income increases, energy costs increase at a lower rate, and then as income increases, energy costs exceed revenues.

Kim (2018), using quantile regression for Korean households in 2015, came to the conclusion that the difference between energy consumption by households was due to differences in their socio-economic characteristics such as housing they used. Using the statistical evidence of British households in 2009, Trotta (2018) indicated that high- and middle-income households were less inclined to save energy than low-income ones. In addition, female household heads are more likely than men to buy high-performance appliances. Using statistical evidence of Ghanaian urban households and the multiple linear regression analysis approach, Sakah et al. (2018) showed that access to home appliances explained 57% of changes in electricity consumption. Su (2019) using the statistical evidence of Taiwan for the period 2014–2017 and the negative binomial regression model, indicated that household income and housing ownership had a positive significant effect on electricity consumption.

Gholizadeh and Barati (2011) in a study over the period 1994–2008 argued that household income had the greatest effect on the growth of residential energy consumption, and then population growth and energy efficiency were the two factors affecting the increase of household energy consumption. Amiri et al. (2012), using the smooth transition regression (STR) model over the period 1969–2009, came to the conclusion that with the increase of unit in GDP, value added of housing, and population, energy consumption in the domestic sector decreased by 0.66% .

Akbari et al. (2016) using statistical evidence of 145 households from Isfahan indicated that the socio-economic status of households did not have a significant effect on their savings from energy consumption, while culture had a negative significant effect on energy consumption. Rahimi et al. (2016) using the data of 200 urban household questionnaires and linear regression showed that income and household size had a positive effect on electricity consumption, but attitudes and mental and social norms did not have a significant effect on reducing electricity consumption.

A review of the studies revealed that no study had been conducted to quantify the share of electricity consumption efficiency in the household sector. Therefore,

this study has taken an important step towards analyzing household consumption behavior, which is innovative First-of-its-Kind.

3. Research Method and Data

This study aims to detect the factors affecting household electricity costs and quantifying the share of electricity consumption inefficiency in the difference between households' electricity costs. For this purpose, quantile regression is used that given the research background, it can be specified as Equation (1):

$$elec_i = \alpha_0 + \alpha_1 age_1 + \alpha_2 incom + \alpha_3 num + \alpha_4 siz + \alpha_5 urban + \alpha_6 gender + \alpha_7 empl + \alpha_8 mari + \alpha_9 scho + \alpha_{10} app + \varepsilon_i \quad (1)$$

Where *elec* is the share of electricity consumption costs in total costs of household *i*. The independent variables include the age of the household head (*age*), income (*incom*), household size (*num*), area of housing (*siz*), urbanization (*urban*), gender of the household head (*gender*), employment of the household head (*empl*), living with spouse (*mari*), education rate of the household head (*scho*), and home appliances (*app*), e.g. water cooler, gas, TV, washing machine, dishwasher, vacuum cleaner, etc.

The variables to the right of Equation (1) explain only part of the change in the share of household electricity costs that can be called as socioeconomic characteristics. Socio-economic characteristics depend on how well-off households are. Therefore, analysis models are used to meet the second purpose of the study. The Blinder–Oaxaca and Machado-Mata decomposition models are able to distinguish the share of differences in socioeconomic characteristics from differences in household energy inefficiency. The two-component Blinder–Oaxaca decomposition model can be specified as Equation (2):

$$R = (\bar{x}_h - \bar{x}_l)'\beta_h + x_l'(\hat{\beta}_h - \hat{\beta}_l) \quad (2)$$

Where R is the difference in the share of household electricity costs, x is the socio-economic characteristics, β is the estimated coefficient for the socio-economic characteristics, l is households with the lowest share of electricity costs, and h is households with the highest share. The first component of Equation (2) shows changes in the share of costs on electricity of the low-consumption group when they have the socio-economic characteristics of the group with higher electricity consumption. In fact, the first component shows the difference in the efficient electricity consumption by households, and this rate of the difference in household electricity consumption is efficient because it shows the difference in income and use of appliances with high-energy appliances. The second component indicates the change in the average share of electricity costs when it is offset according to the return on costs on electricity of the higher group. The second component of the difference is in inefficient electricity costs, because they have different electricity consumption for the same level of appliances.

However, in the Machado-Mata decomposition model, the total distribution of household electricity share is taken into account, and using the quantile regression, the coefficient of influence of factors on the share of electricity costs is estimated. Therefore, the Machado-Mata decomposition model in θ^{th} quantile is explained as Equation (3).

$$Q_\theta(w_h|x_h) - Q_\theta(w_l|x_l) = \left[Q_\theta(w_h|x_h) - Q_\theta(x_l\hat{\beta}_h)\right] + \left[Q_\theta(x_l\hat{\beta}_h) - Q_\theta(w_l|x_l)\right] \quad (3)$$

As can be seen in Equation (3), the first part shows the difference in electricity costs due to the difference in the socio-economic characteristics of households between the two groups, and the second part indicates the difference due to different returns for certain and equal characteristics.

Given the purpose of this study, which addresses the factors affecting electricity consumption at the household scale and quantifies the efficiency of electricity consumption, we have used data at the scale of Iranian households for the period 2010 to 2021. Evidence from measuring the share of electricity costs in household costs in Table (1) shows that the share of electricity costs in 2010

equals to 1.71% and in 2018 has increased by 2.48% and then decreased to 1.5% in 2021. Following the correction of energy carrier prices in 2010 and increase in electricity price, the share of electricity in household expenditure has increased, and in 2017 has grown to a maximum of 2.77%. Economic well-being and access to high-energy appliances, as well as diversity in the housing characteristics of households, are among the most important consequences of economic growth, which can explain the significant percentage change in the share of household costs. The size of housing is one of the factors affecting electricity consumption. Evidence shows that the size of housing has increased significantly from 93.69 square meters in 2010 to 96.74 square meters in 2021. Furthermore, the logarithm of real per capita income of households has decreased from 15.5 in 2010 to 15.25 in 2021. The increased inflation is one of the most important reasons for the decrease in real per capita income of households.

Table (1): Descriptive statistic

	2010	**2012**	**2014**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Share of electricity costs	1.71	2.36	2.39	2.75	2.77	2.48	2.14	1.9	1.5
Household income	15.5	15.45	15.35	15.29	15.33	15.32	15.24	15.19	15.25
Urbanization	0.506	0.494	0.502	0.5	0.49	0.528	0.528	0.523	0.522
Gender	0.88	0.871	0.875	0.866	0.867	0.875	0.86	0.864	0.86
Marital status	0.872	0.857	0.862	0.85	0.852	0.86	0.85	0.846	0.84
Employment	0.96	0.956	0.949	0.94	0.947	0.95	0.94	0.95	0.94
education	5.48	5.46	6.14	6.16	6.27	6.93	7.46	7.63	7.71
Household size	4	3.82	3.64	3.55	3.54	3.48	3.46	3.45	3.4
Housing ownership	0.784	0.804	0.786	0.8	0.799	0.77	0.79	0.794	0.798
Housing size	93.69	95.3	94.75	95.39	95.78	96.87	96.5	96.07	96.74

Source: Collected via the Household Income-Cost Questionnaire, Statistics Center of Iran.

According to Table (1), the rate of urbanization during the period was about 50%. 86% of the heads of households are men, of which approximately 85% live with their spouses, and 95% of them are employed. The education years of the households' heads under study has increased from 5.48 years in 2010 to 7.71 years in 2021. On the one hand, education due to the increase of social class and income of individuals may increase electricity consumption through the use of high-energy appliances, on the other hand, may reduce energy consumption due to a conscious change in consumption pattern.

The household size, as an indicator of the number of people in a household who use high-energy appliances, can play a significant role in electricity consumption. The household size in Iran has regularly decreased from 4 people in 2010 to 3.4 people in 2021. Housing ownership, due to the long-term horizon in households for permanent residence, plays an important role in equipping used housing with various appliances, so that house owners are more inclined to use high-energy appliances. Evidence shows that in 2010, the approximate of 78% of the surveyed households are house owners, and this number has increased to 80% in 2021. Regarding other research variables, approximately 23% of households have gas coolers, 51% have water coolers, 97.2% have televisions, and 73% have washing machines.

4. Model Estimation and Results Analysis

4. 1. Quantile Regression Estimation

Quantile regression model has been used to investigate the effect of socio-economic characteristics of households on the share of electricity costs in total costs. According to estimates, as the age of the head of the household increases, the share of household electricity costs in total costs increases significantly, and as we move towards the quantiles with a high share of electricity costs, the effect of age increases significantly. Given that the high share of electricity costs indicates a lower level of welfare of households, in the upper quantiles, with increasing age, household costs on access to amenities increase more than costs on other goods,

and this leads to the positive effect of age on the share of household electricity costs. The effect of education on the share of electricity costs in different quantiles is different, and in the lower quantiles the positive effect is supposed to emerge, and in the upper quantiles the effect of education is estimated to be negative. In fact, the effect of education in the upper quantiles has led to an increase in income and improved household welfare, as the share of electricity costs in their total costs has decreased, but in the lower quantiles, the tendency to use high-energy appliances increases with increasing education.

It is estimated that women consume a higher share of electricity costs than men, with other conditions being the same, and this effect has increased even more in the upper quantiles. Indeed female-headed households have lower incomes, and therefore the share of essential costs in their budgets is relatively high, and in poor households this effect is relatively higher. Income suggests the household's ability to access various appliances. It is estimated that as income increases, the share of electricity costs decreases significantly. This effect is relatively higher in the upper quantiles, as poor households have many unsatisfied needs, and as income increases, demand for other basic needs increases.

Table (2): Quantile regression estimation

Variables	10	25	50	75	90
num	-0.0879***	-0.112***	-0.142***	-0.175***	-0.217***
	(-45.04)	(-52.43)	(-47.46)	(-33.47)	(-19.43)
schooling	0.000102	0.000142	-0.00209***	-0.00738***	-0.0153***
	(0.206)	(0.261)	(-2.758)	(-5.543)	(-5.370)
empl	-0.0205***	-0.0214***	-0.0419***	-0.0847***	-0.195***
	(-3.346)	(-3.185)	(-4.475)	(-5.148)	(-5.558)
maripo	-0.0534***	-0.0731***	-0.0734***	-0.0865***	-0.0462
	(-4.769)	(-5.946)	(-4.294)	(-2.876)	(-0.721)
age	0.000615***	0.000536**	0.000335	0.00260***	0.00477***
	(2.943)	(2.336)	(1.049)	(4.628)	(3.982)
gender	0.00298	-0.00957	-0.0386**	-0.0621**	-0.135**
	(0.256)	(-0.748)	(-2.167)	(-1.986)	(-2.015)
urban	-0.00451	-0.0213***	-0.0500***	-0.116***	-0.240***
	(-0.911)	(-3.914)	(-6.601)	(-8.689)	(-8.460)
tasrf	-0.00393	0.0104	0.0290***	0.0878***	0.131***
	(-0.661)	(1.597)	(3.185)	(5.493)	(3.853)

zir	0.000482***	0.000618***	0.00107***	0.00167***	0.00263***
	(7.129)	(8.331)	(10.40)	(9.208)	(6.789)
lrpinco	-0.402***	-0.505***	-0.625***	-0.736***	-0.845***
	(-99.55)	(-114.0)	(-101.4)	(-67.90)	(-36.56)
constant	7.125***	9.086***	11.64***	14.49***	18.34***
	(112.8)	(131.0)	(120.6)	(85.43)	(50.68)

Source: Research findings.

The household size is one of the factors affecting the share of electricity costs. In fact, with the increase in the size of households, the rate of appliances required to meet the demand of households grows. Evidence from the study of the effect of household size on the share of electricity costs shows that with the increased household size, the share of electricity costs reduces significantly, and this effect is higher in households with a higher share of electricity costs. The main reason for the negative effect of the household size is due to the equivalence scale criterion. According to equivalence scale, with increased households' costs, the necessary costs on household goods do not necessarily increase proportionally. Because due to the savings from mass consumption, the expenses needed by a family of three, including housing, appliances and other items, will not be three times more than a family of one.

Housing size is one of the most important factors affecting electricity consumption. The larger is the infrastructure, the greater will be the need for heating, cooling, and lighting. The model estimate shows that as the area of housing increases, the share of electricity costs in total household costs increases significantly. In high quantiles, this effect is greater, because in poor households, due to low incomes, their required costs to provide heating, cooling, and lighting in one more meter of housing increases relatively.

Urbanization has a negative significant effect on the share of household electricity costs. Households living in cities have different behavioral characteristics from rural households. Less household size, smaller area of housing, higher income, and also less time to use high-energy appliances are the main features for urban households, so they have less energy consumption. The effect of the employment and living with a spouse is negative in all quantiles,

because for the employment variable, the increase in income from employment is more important, and the negative effect of living with a spouse is due to economies of equivalence scale. Ownership of used housing is also very important in electricity consumption. The quantity of appliances that can be used is assigned based on permanent residence, and in households that own housing, appliances with high-energy efficiency are more diverse. So, ownership of housing increases the share of electricity costs in total household costs. Finally, access to high-energy appliances such as televisions, cooling and heating appliances, etc. has a positive significant effect on the share of electricity costs in total costs. Therefore, the difference in socio-economic characteristics such as income and access to high-energy appliances is considered to be an index for the difference in the welfare of households that can play a significant role in the difference in household electricity costs.

4. 2. Blinder–Oaxaca Decomposition

The results of Blinder–Oaxaca decomposition in Figure (1) show that the difference in the share of electricity costs between households has increased significantly from 2.02% in 2010 to 1.62% in 2021. In this regard, the gap due to differences in socio-economic characteristics of households has increased from 0.25% in 2010 to 0.38% in 2021. Yet, the gap due to inefficiency in household electricity consumption has experienced limited changes, and has changed from 1.76% in 2010 to 1.24% in 2021. But the study of changes as a paradigm shows that the share of differences in socio-economic characteristics of the total gap in the share of household electricity costs has increased from 12.8% in 2010 to 23.4% in 2021. In fact, the difference in access to high-energy appliances and also in household income in 2010-2021 explains almost 22% of the gap in the share of household costs, indicating the effect of changes in the country on household electricity consumption at the macro level. It may be due to changes in household incomes, or it may be due to differences in access to high-energy appliances. However, the 78% share of the difference due to inefficiency in electricity consumption in 2010-2021 indicates the loss of energy resources in the domestic

sector, which can increase economic growth and development in the industrial sector. The high share of inefficiency in electricity consumption indicates that the pattern of energy consumption is more important than the effect of economic growth on electricity consumption, so increasing the welfare of households by increasing the use of electricity sources due to economic growth cannot prevent energy allocation to sectors with high added value.

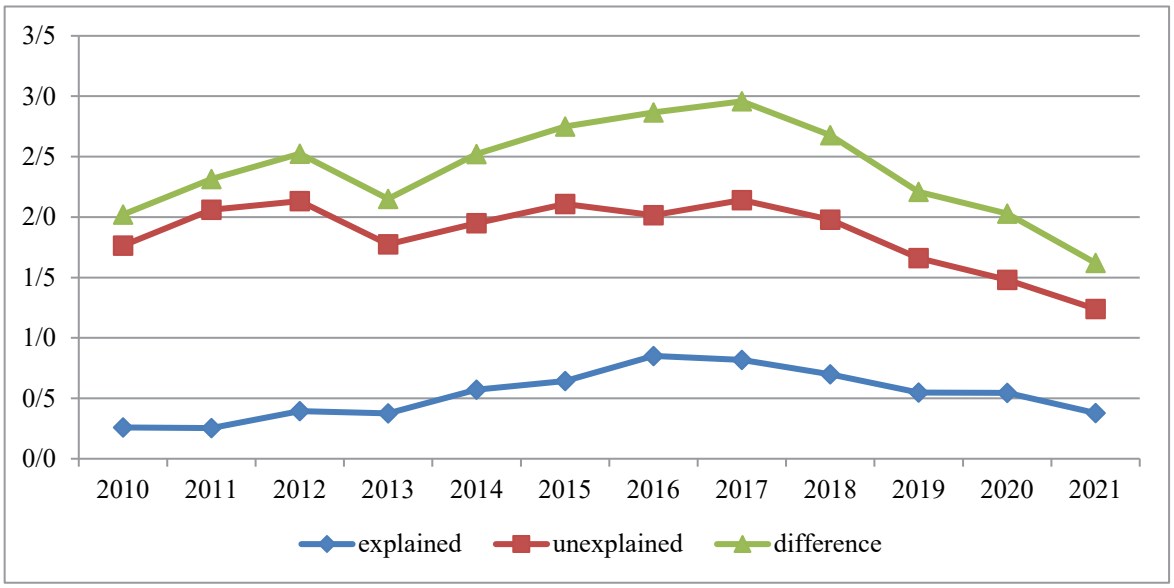


Fig. (1): Blinder–Oaxaca decomposition (Source: Research findings).

4.3. Machado-Mata Decomposition

Evidence from Machado-Mata decomposition in Figures (2) and (3) shows that the amount of difference in the upper quantiles of the share of household electricity consumption is higher than the lower quantiles, and in 2021 compared to 2010 the total gap in electricity consumption and the inefficient gap components of the difference in the share of household electricity costs have decreased significantly and efficient component gap increased. The total difference in the share of household electricity costs in the upper quantiles compared to the lower quantiles has decreased more sharply, so that the difference in the share of household electricity costs in the 10^{th} quantile in 2021 compared to 2010 has decreased by 14.4% and in 90^{th} quantile equal to 19.8%. The gap in the

share of household electricity consumption due to the difference in socio-economic characteristics has increased more than the difference due to inefficient components of electricity consumption in the upper quantiles of electricity consumption, but the decrease in inefficient components in the upper quantiles has been greater. The rate of change in the difference due to socio-economic characteristics (difference due to inefficiency) of households in 2021 compared to 2010 in the 10th quantile is equal to 33% (18.1%) and in the 90th quantile is equal to 56.3% (30.7%). In general, the higher is the poverty rate in the economy, the higher will be the share of differences in socio-economic characteristics of the household.

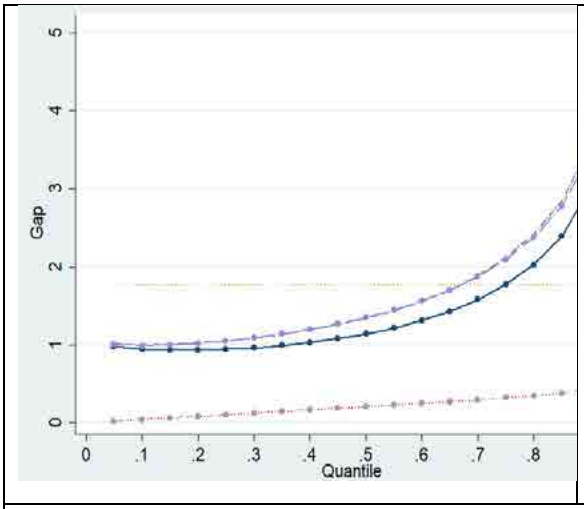
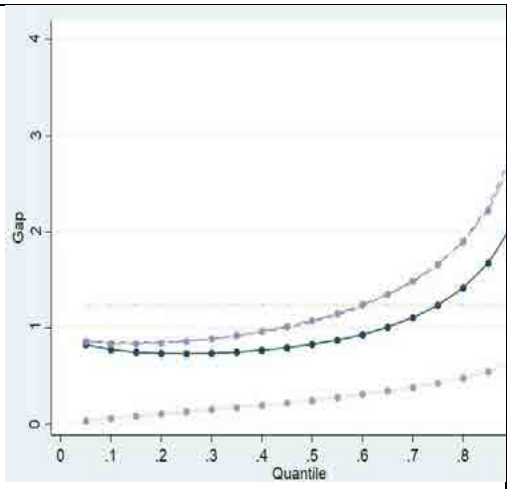


Fig. (2): Machado-Mata decomposition for 2010 (Source: Research findings).



predicted gap characteristics difference Inefficient component difference

Fig. (3): Machado-Mata decomposition for 2021 (Source: Research findings)

The Machado-Mata decomposition model is used to investigate the contribution of the causes of difference in the share of household electricity costs in the total distribution. The results of the difference in the socio-economic characteristics to the total difference in the share of household electricity costs in Figure (4) show that in 2021 compared to 2010, the share of efficient electricity consumption has increased, and in the middle quantiles this increase is more tangible, so that in the 60th quantile, the share of the efficiency difference in

household electricity costs in 2010 was equal to 16%, and this figure increased to 25% in 2021. Given that households with a relatively high share of electricity costs are poorer than other households, the rate of difference in access to high-energy appliances has a high share in the difference in the share of their consumption costs, but a high share of electricity costs of rich households can be explained by inefficiency in electricity consumption. Evidence from the Machado-Mata decomposition confirms the results of the Blinder–Oaxaca decomposition, and in general the inefficient behavior of households in electricity consumption has decreased, but the share of inefficient electricity consumption in the current state of the economy is high.

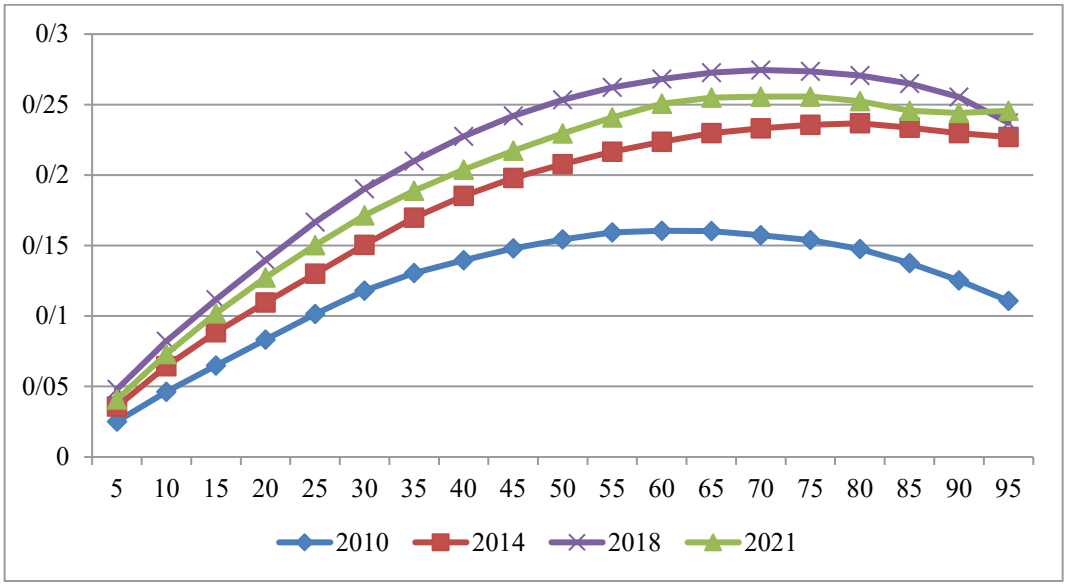


Fig. (4): The share of differences in socio-economic characteristics (Source: Research findings).

5. Conclusion and Recommendations

Electricity, on the one hand, is seen as a factor in promoting welfare for households, and on the other hand, it is considered as an effective input in production for the industrial sector. Therefore, the optimal state of the economy is such that consumption in the domestic sector is efficient and in the direction of maximum welfare, and the energy required by industry is also optimally supplied.

The present study used statistical evidence of household cost-income for the period 2010–2018, and the approach of decomposition models analyzed the factors affecting the share of household electricity costs, and assigned the inefficiency of electricity consumption. Evidence from the estimates shows that household income and size have a negative effect on the share of household electricity consumption. In addition, the results of analysis models show that at an average level, 22% of the difference in the share of household electricity can be explained by differences in socio-economic characteristics of households, and 78% of the difference in their share of electricity costs is inefficient. The results of Machado-Mata decomposition show that in the upper quantiles of the share of electricity consumption, the share of the difference in the socio-economic characteristics of households is more than the lower quantiles. Therefore, the role of household consumption pattern is more than the rate of access to high-energy appliances, so providing a step-by-step pricing system with an exponential rate for electricity consumption is an effective policy to reduce inefficiency in electricity consumption.

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تجزیهٔ شکاف مخارج برق خانوارها با استفاده از مدل‌های تجزیهٔ اکساکا-بلیندر و ماچادو-متا

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چکیده

استفادهٔ مؤثر از برق در بخش خانوارها برای افزایش سطح رفاه و تأمین برق موردنیاز صنایع تولیدی به‌عنوان موتور رشد اقتصادی مهم‌ترین هدف کشورها است؛ بنابراین کاهش جزء مصرف برق ناشی از عدم کارایی از اهمیت بالایی برخوردار است؛ در این‌راستا، پژوهش حاضر با استفاده از شواهد آماری هزینه-درآمد خانوارهای ایران برای دورهٔ زمانی ۱۴۰۰-۱۳۸۹ به برآورد سهم مصرف ناکارای برق در تفاوت مصرف برق خانوارها می‌پردازد. نتایج مدل تجزیهٔ اکساکا-بلیندر نشان می‌دهد که سهم ناکارایی در ایجاد شکاف سهم مخارج برق خانوارها از مقدار ۸۷/۲٪ در سال ۱۳۸۹ به مقدار ۷۶/۵٪ در سال ۱۴۰۰ کاهش یافته است. تجزیهٔ ماچادو-متا نشان می‌دهد که سهم تفاوت در ویژگی اجتماعی اقتصادی خانوارها در چندک‌های بالای مصرف برق بالاتر از چندک‌های پایین است و در سال ۱۴۰۰ نسبت به سال ۱۳۸۹ افزایش یافته است؛ بنابراین نقش الگوی مصرفی خانوارها مهم‌تر از نرخ دسترسی به وسایل با انرژی‌بری بالاتر است؛ بنابراین ایجاد سیستم قیمت‌گذاری پله‌ای مهم‌ترین سیاست برای کاهش مصرف برق ناکارا است؛ علاوه‌براین، برآورد رگرسیون چندک نشان می‌دهد که درآمد و بعد خانوار اثر منفی و مالکیت و اندازهٔ مسکن و دسترسی به لوازم خانگی اثر مثبت و معناداری را بر سهم مخارج برق خانوارها دارد.

کلیدواژگان: ناکارایی مصرف برق، رگرسیون چندک، مدل‌های تجزیه.
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Rational Expectation House Price Bubbles in Iran

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Abstract

Since the housing sector has an intricate relationship with other sectors of the economy, fluctuations in the price can be costly. Also, rising prices are either rooted in the underlying conditions of the economy or simply caused by the bubble, leading to different policies. Therefore, house price bubble can be considered as an early warning system to prevent adverse economic consequences. The present paper applies the theory of rational expectation bubble in the Iranian housing market during the years 2006-2020 using the Blanchard and Watson model. The theory implies that negative returns on house prices are less likely to occur if the bubbles exist. The risk assessment is, however, estimated by linear logistic function. The existence of bubble in housing market is confirmed based on 30 provinces.

Keywords: Price Bubble, Housing Market, Hazard Function.
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1. Introduction

A distinctive characteristic of housing is that it is not only an asset (the land and residential units) but also a consumption good (in the form of housing services). (Nemati et.al., 2020) From point of view of households, housing is an important asset in Iran. Also housing sector's boom and recession play an important role in GDP because of the forward and backward linkages, so that about 120 fields are related to this sector. According to Islamic Parliament Research Centre of Iran, the housing contribution of GDP was about 6% in 2020. Over the 30 past years, there has been a sharp rise in housing price in Iran. If we include rental income and capital income, then the return on housing capital exceeds that for business sectors, which raises grave concerns regarding the possible existence of price bubbles. This is a major concern for policymakers as a bubble burst can have serious consequences for Iran's economy.

The house price bubble occurs when house price increases are not justified by the housing market fundamental factors. In fact, the sharp rise in housing prices can be called the house market bubble, which is expected to increase prices in the future and cause financial and economic losses. Through comparing the present value of houses with housing market prices we can test house price bubbles in as carried out in earlier literature. In this regard, how to calculate present value is the main debate in the literature. A popular method is to discount future cash flows (rental income), but this approach is not reliable. Future rental income is difficult to predict because rental income is affected by economic variables such as GDP and population density that continue to change over time. Furthermore, it is difficult to choose an appropriate discount rate for housing assets. Some researchers consider that house price increases should be explained by changes in economic fundamentals, such as income, construction costs, population and interest rates. House price bubbles are defined as deviations from those fundamentals. (Ren et al., 2012)

According to Keynesian economists, the emergence of the bubbles is due to their irrational and sentimentally behaviors to make a profit through speculative activities, which John Maynard Keynes refers to as animal spirits. But for some neoclassical economists, bubbles can also be rational. In fact, the emergence of

asset bubbles does not mean that market participants have behaved irrationally and deluded themselves and have mistakenly evaluated the bubble prices of assets as the fundamental value of the assets and demand the asset as its fundamental value; Rather, they expect a sharper rise in asset prices and therefore expect the acquisition of capital gains on assets in the short term, and as a result they rationally join the bubble-making process.

Due to the devastating effects bubbles can have on economies, it is important for policy makers to understanding why and when asset prices can deviate from fundamental values. Historically, the issue of pricing bubbles is proposed for the first time in the seventeenth century and scientifically introduced in the US stock market from October 1929 to June 1932. In other countries, research has been conducted on price bubbles in securities markets, land, housing, and gold. First, the price bubble was examined by Schiller on the stock market in 1981, and then the scope of studies was to expand the price bubble in other assets. Batini & Nelson (2000) estimate the exogenous bubble effect in the UK currency market using econometric models from 1981 to 1998. The results show that when the exchange rate has a direct effect on inflation, the central bank's response to the exchange rate is satisfactory. Eschker (2005) confirmed the existence of housing bubble prices in Hammond, USA, using the P / E Ratio during 1989-2004. Kim and Lim (2016) examined the dynamics of the housing market in Korea. The results indicate that the bubbles are continuously accumulated by the beginning of 2000, reaching about 51 percent by the end of 2014. Using Granger causality probes and generalized analysis of the impulse response function, Hui and Yue (2006) investigates bubble prices for housing in Beijing and Shanghai during the period 1990-2003. The findings show that in 2003, there was a housing bubble in Shanghai that affected about 20 percent of the housing price, while in the same year there was no sign of a bubble in Beijing. Chen and Wu (2019) detect the housing price bubbles of eighteen OECD countries under assumptions of asymmetric adjustment and non-linearity through the momentum threshold autoregressive (MTAR) and exponential smooth transition (ESTR) approaches. The results of the modified Kilic (2011) and Park and Shintani (2005, 2016) tests are in line with the ESTR unit root tests, indicating that the bubble hypothesis is not confirmed. Bangura and Lee (2020)

adopted a sub-city approach and deployed an array of methods to detect bubbles in different regions of Greater Sydney – western, inner-west, southern, eastern and northern – from 1991 to 2016, using Westerlund error correction-based panel cointegration, backward supremum augmented Dickey–Fuller (BSADF) procedure, and dynamic ordinary least square (DOLS) tests. The formal BSADF bubble tests reveal strong evidence of explosive price bubbles in Western Sydney. The DOLS results suggest that housing investment plays a major role in the build-up of housing bubbles in Western Sydney, supporting Shiller's Psychological Theory of bubbles which posits that bubbles occur via the speculative behavior of investors.

History has shown time and again that bubbles can lead to misallocation of resources in economies and that their burst can negatively impact real economic activity. a bursting bubble can cause the collapse of major financial institutions. (Wockl, 2019) Despite the great importance, few studies have been carried out on housing bubbles and the effect of macroeconomic variables has been ignored. Most of the empirical studies in Iran used standard stationary-based, Co-Integration based and Regime-Switching based tests for bubble detection in Iran. These models do not have the ability to search and detect any bubble, so that variation in the sample size, insufficient time series data, or the specific characteristics of a series, such as its high volatility, may affect the ability of such experiments to explore the price bubble. However, given the large role of macroeconomic variables and economic conditions in examining the existence of bubbles, the present paper bridges the gap and tests macroeconomic variables for housing bubble detection during 2006-2020.

In this paper, following Ren et al. (2012), a different method is employed to test the existence of rational expectation bubbles in Iran's housing market. The method used in this study was first proposed by Blanchard and Watson (1983). This is called a rational expectation growing bubble (hereafter growing bubbles) because they grow until they burst and then begin growing again. These bubbles grow because their returns must be comparative to the average returns of other assets. Growing bubbles are characterized by asset prices that continue to grow over time and returns that surpass the average capital return in the economy. These features match the dynamic path of Iran's house prices quite well over the past 30 years. There are two important assumptions in the classical model of growing bubbles tested in this

research: representative agents and complete financial markets. In the literature, other theories of rational bubbles are examined by relaxing these assumptions. The sharp increase in housing prices can be called the bubble of the housing market, which is expected to increase in the future and cause financial and economic losses. Therefore, housing bubbles can be consulted as a primary warning system to prevent adverse economic consequences. In fact, the housing market is a major component of the country's economy, which directly affects economy.

Because the theory of rational expectation bubbles proposed by Blanchard and Watson (1983) can be applied to any risky asset, and as McQueen and Thorley (1994) derive their method based on this theory, their method can also be applied to house prices.

The remainder of paper is organized as follow: The second part deals with theoretical foundations and the model under study. In the third part, after describing the statistical data, the model presented in the second part is specified and evaluated. Finally, the paper concludes in the fourth part.

2. **Theoretical Model**

Some economists conceptualize bubbles as situations in which the price of the asset grows faster than the asset's fundamental value. Accordingly, to properly evaluate the presence of a bubble, we should compare the price of an asset to a measure approximating the stream of future dividends. In the case of stock prices, this is done by comparing prices or price indexes to earnings or earnings indexes; various measures of earnings can be used, such as current earnings, the average over the previous few years of earnings, or forecasts of future earnings. In the case of housing market, the comparison is typically between house price indexes and indexes on the amount charged to rent a similar house.

Ren et al. (2012), present a different method is employed to test the existence of rational expectation bubbles. The method used in this study was first proposed by Blanchard and Watson (1983). Blanchard and Watson (1983) proposed a definition of rational expectation bubbles based on the conditions of an efficient simple

market which states that the expected return of a house purchase is equal to the required return.

$$E_t[R_{t+1}] = r_t \tag{1}$$

Where, $E_t[R_{t+1}]$ stands for the expectation framed for the optimal return for the period t+1, based on information generally available in time *t*. The return of owning a house during *t*, t+1 is R_{t+1} and consists of the capital gain from the variation in house prices and the rental income.

$$R_{t+1} \equiv \frac{p^*_{t+1} - p^*_t + d_{t+1}}{p^*_t} \tag{2}$$

Where p_t^* and p^*_{t+1} are the unobservable true values of housing in period *t* and t+1, and d_{t+1} is the rental income of the house at period t+1. After some rearrangement, the condition for a competitive equilibrium is:

$$p^*_t = \frac{E_t[p^*_{t+1} + d_{t+1}]}{1 + r_t} \tag{3}$$

During the iteration, the fundamental value of a house is defined as:

$$p^*_t \equiv E_t \sum_{i=1}^{\infty} \frac{d_{t+i}}{\prod_{j=0}^{i-1}(1 + r_{t+j})} \tag{4}$$

Where p_t has two components: true value (p_t^*) and bubble (b_t), so that $p_t = p_t^* + b_t$. this shows that market price can be derived from the fundamental value by a rational expectative bubble factor if b_t satisfies:

$$E_t[b_{t+1}] = (1 + r_t)b_t \tag{5}$$

Equation (5) will hold as the necessary condition for the bubbles in the competitive equilibrium which indicates that as long as the b_t evolves over time and provides the optimal return of r_t,, the agents in the economy are willing to hold houses with price bubbles .

ε_{t+1} is used to define the unexpected price changes of the house according to McQueen and Thorley (1994). Since $pt_{+1}=p^*_{t+1} + b_{t+1}$ both the unexpected changes in

the true value and the unexpected changes in b_{t+1} can affect ε_{t+1}. Thus, $\varepsilon_t = \mu_{t+1} + \eta_{t+1}$,where μ_{t+1} and η_{t+1} are the unexpected changes for the true value and the bubble, respectively. The unexpected change in the true value is defined by:

$$\mu_{t+1} = p^*_{t+1} + d_{t+1} - (1+r_t)p^*_t \tag{6}$$

The unexpected change in the bubble is also defined as:

$$\eta_{t+1} = b_{t+1} - (1+r_t)b_t \tag{7}$$

Suppose that $\boldsymbol{\mu_{t+1}}$ follows a symmetric distribution with zero mean. We assume symmetry assumption because we believe the true value has the mean-reversion property. In addition, we assume that b_t follows a two-point discrete distribution. The bubble component of b_t is associated with the probability of $\boldsymbol{\pi}$, in the house price for the next period. b_t will be removed with the probability of 1-$\boldsymbol{\pi}$ and a_0 is left. In order to hold the equilibrium condition in Eq. (3), b_{t+1} must satisfy the following condition:

$$b_{t+1} = \begin{Bmatrix} \frac{(1+r_t)b_t}{\pi} - \frac{1-\pi}{\pi}a_0 with probability\ \pi \\ a_0 with probability\ 1-\pi \end{Bmatrix} \tag{8}$$

Assuming π>1-π ,that implies π>1/2. This is reasonable because it empirically shows that the probability of bursting the bubble is negligible, regardless of the type of assets. In other words, if the bubbles persist, the realized value is larger than that its value when it burst. So, we have:

$$\frac{(1+r_t)b_t}{\pi} - \frac{1-\pi}{\pi}a_0 \succ a_0 \geq 0. \tag{9}$$

By substituting $\boldsymbol{\eta_{t+1}}$ with Eq.(8), we have:

$$\varepsilon_{t+1} = \begin{Bmatrix} \mu_{t+1} + \frac{(1-\pi)}{\pi}[(1+r_t)b_t - a_0] with probability\ \pi \\ \mu_{t+1} - (1+r_t)b_t + a_0 with probability\ 1-\pi \end{Bmatrix} \tag{10}$$

Equation (10) shows that if the bubbles persist from t to t + 1, the expected abnormal return is positive and equal to $\frac{1-\pi}{\pi}[(1+r_{t+1})b_t - a_0$. If the bubbles burst, the expected abnormal return is $-(1+r_{t+1})\,b_t + a_0$, and it must be negative because the efficient market conditions requires that the expected value of abnormal return is zero. As the probability of persistence of larger is more likely than bursting, the probability of observing negative abnormal returns will be smaller than ½. And if the bubble exists, it decreases with b_t. If the price does not have a bubble, the probability of observing negative abnormal returns must be equal to ½. Consequently, when we observe a set of positive returns, it means that the bubble components persist and accumulate during the period. We define the probability of observing the negative abnormal return as follows.

$$\lambda_{t+1} \equiv prob[\varepsilon_{t+1} \prec 0] \tag{11}$$

Which can be expressed as:

$$\lambda_{t+1} = \pi F\left[-\frac{(1-\pi)}{\pi}((1+r_t)b_t - a_0\right] + (1-\pi)F[(1+r_t)b_t - a_0]. \tag{12}$$

F(.) is the cumulative density function of unexpected changes in the fundamental value μ_{t+1}. Partial derivative of λ_{t+1} with respect to b_t

$$\frac{\partial \lambda_{t+1}}{\partial b_t} = -(1-\pi)(1+r_t)[f\,(-\frac{(1-\pi)}{\pi}((1+r_t)b_t - a_0)) - f\,((1+r_t)b_t - a_0)] \tag{13}$$

Where $\pi > 1/2$ and symmetric f(.) around 0 leads to $\frac{\Delta\lambda_{t+1}}{\Delta b_t} < 0$. Therefore, there is lower probability of observing unexpected negative price changes with the increase in the bubble. As McQueen and Thorley (1994) stated, when bubbles are enlarged, they dominate the fundamental values. The probability of unexpected negative price changes is low and occur primarily when the bubbles burst. We tend to be more careful on the rates of return. If the abnormal return rate is equivalent to the following equation:

$$e_{t+1} \equiv \frac{\varepsilon_{t+1}}{p_t} \tag{14}$$

Then, the probability of $[e_{t+1} < 0]$ is equal to the probability of $[\varepsilon_{t+1} < 0]$. So,

$$\frac{\delta prob[e_{t+1} \prec 0]}{\delta b_t} \prec 0$$

The theoretical model suggests that if the bubble components continue to exist There will be a smaller probability of observing negative abnormal return rates in the assets, which grow continuously with abnormal return rates. Therefore, we need the necessary condition for the existence of the bubbles: the probability of negative abnormal return rates reduced with the number of periods observed in the positive abnormal returns. If we use h(T) to indicate the hazard rate of abnormal return rates and T to indicate the number of positive abnormal return rates (or duration of the period), the requirement for the bubble existence will be:

$$\frac{\delta h(T)}{\delta (T)} \prec 0 \qquad (15)$$

$h(T) = \text{prob}(e_t < 0 | e_{t-1} > 0, e_{t-2}$**>0,…,**$0 e_{t-T} > 0, e_{t-T-1} < 0)$

In this paper, to overcome the lack of observations, we set the model according to panel data.

The rate of the real return of house in province *i* at period *t* is calculated as follows:

$$R_t^i = \frac{(p_t^i + d_t^i)}{p_{t\_1}^i} - 1 \qquad (16)$$

Where p_t^i andd_t^i denote the price and rental income in province *i* at time *t*, respectively.

$$e_t^i = R_t^i - E_{t\_1}(R_t^i) \qquad (17)$$

Where e_t^i is the unexpected return rate in province *i* at time *t* and $E_{t-1}(R_t^i)$ denotes the expected house return rates at time *t* using the information available t-1. Then, the house returns estimate is obtained by the following model:

$$R_t^i = \beta_0 + f_i + \sum_{j=1}^{k} \beta_j x_{j,t-1}^i + e_t^i \quad (18)$$

Where f_i is unobservable characteristics of province *i* and $X_{j,t-1}^i$ is the j-th factor in province *i* at time t-1. e_t^i stands for the regression residual and measures the unexpected return rate. Then, we count the run lengths of the 30 provinces and combine them to estimate the hazard rate with a linear –logistic function as:

$$h_t = h(t) \equiv \frac{1}{1+e^{-\alpha-\beta t}} \quad (19)$$

Then, we maximize the log-likelihood function:

$$L(\theta) = \sum_{t=1}^{\infty} N_t \ln h_t + M_t \ln(1-h_t) + Q_t \ln(1-h_t) \quad (20)$$

Here, N_t is the count of completed runs of length *t* in the sample, and M_t and Q_t are the count of completed and partial runs of length greater than *t*. The necessary condition for existing bubbles is:

$$\frac{\partial h_t}{\partial t} \prec 0 \quad (21)$$

This leads to $\beta < 0$.

3. Data and Empirical Results

Following Ren et al. (2012), unemployment rate, population, GDP, bank deposit interest rates (one-year deposits), stock indices, and price-rate ratio have been used as explanatory variables. Also, the data on the purchase price of the residential unit and the rental price per square meter of the residential unit are used to calculate the real return on housing. The data were collected through Iran Ministry of Road and

Urban Development, Statistical center of Iran and the Central Bank of Iran's websites. Our panel data includes provinces during 2006-2020, where the number of observations is 450. Cross-section dependence test, Unit Root, and Kao Residual tests were used for data as reported in tables 1, 2 and 3, respectively. As Table 1 shows, we strongly reject the null hypothesis of no correlation at conventional significance levels. According to table 2, the nonstationary hypothesis of the variables is not rejected. Therefore, we consider the hypothesis of a long-term relationship through Kao test. According to Table 3, the result of this test confirms the existence of a long-term relationship.

Table 1: Cross-section dependence test

test	Statistic	d.f.	Prob
Breusch-Pagan LM	1373.867	435	0.00
Pesaran scaled LM	30.81346		0.00
Pesaran CD	24.68727		0.00

Table 2: The Ime- Pesaran- Shin Panel Unit Root Test Results

Variable	Statistic	Prob
R	-1.40	0.08**
RR	6.32	1.000**
INV	-1.32	0.09**
INF	-1.32	0.09**
SR	8.23	1.000**
GDP	7.49	1.000**
PR	2.30	0.98**
POP	4.32	1.000**
UNEM	-8.96	0.00*

* denote the variable is stationary at the 10 % level

** denote the variable is non stationary at the 10 % level

Table3: The result of Kao Residual Co integration test

Prob.	T statistic
0	-5.05

The results of the Chow test in Table 4 show that the model should be estimated with pooled data. Also, the hypothesis of the existence of a common intercepts and slope among the sections is confirmed.

Table 4: Identification Test

	Prob.	Statistic
Chow Test	0.59	0. 91

So, we estimate the following model:

$$R_{i,t} = \alpha_0 + \alpha_1 RR_{i,t} + \alpha_2 INV_{i,t} + \alpha_3 INF_{i,t} + \alpha_4 SR_{i,t} + \alpha_5 GDP_{i,t} + \alpha_6 PR_{i,t} + \alpha_7 POP_{i,t} + \alpha_8 UNEM_{i,t} \quad , \quad i=1, \ 2, \ \ldots, \ 30 \qquad t=2006, \ \ldots, \ 2020 \tag{22}$$

Where R represents the real return on housing, RR is the interest rate on deposits, INV is investment in housing, and INF, SR, GDP are inflation rate, stock index, the growth rate of gross domestic product (per capita), respectively. PR is price-rate ratio, and POP and UNEM denote population growth rate and unemployment rate.

In this regard, the real return on housing is dependent on the variable, and the other variables introduced are independent variables. The real return on housing is comprised of two parts: Expected Returns and Unpredictable Returns, which we expect to measure the expected return on the real return on housing by the independent variables in the model. In addition, we consider the amount of the remainder of the model as unexpected return. The results of model estimation are presented in Table 5.

Table 5: The results of model estimation

Variable	Prob.	Coefficient
C	0.26**	1.67
RR	0.58**	0.06
INV	0.37**	-0.89
INF	0.14**	-0.01
SR	0.07**	-1.69
GDP	0.65**	-4.00
PR	0.00*	0.70
POP	0.98**	3.62
UNEM	0.06**	0.02
		f-statistic=61.85 prob=0.00

∗ denote significance at the 5 % level
∗∗, denote insignificance at the 10 % level

The results of coefficient analysis and probability of each variable indicate that the effect of bank deposit interest rate, private sector investment, inflation rate, stock index, gross domestic product growth rate, population and unemployment rates on the real rate of housing are insignificant.

Liquidity turnover between housing-bank is much stronger than liquidity fluctuation between housing-housing and housing-dollars. Nevertheless, the negative relationship between the real rates of return on housing following the positive rate of interest on deposit is not observed in the study. This is due to the increase in housing fluctuations. At the peak of the housing fluctuation, as the prevailing behavior of economic activists, whether the applicants for both housing and investors, have turned to property purchases, the high interest rate have not been so successful in liquidity absorption. Therefore, there is no significant relationship between the interest rate on bank deposits and the actual cost of housing.

The variable price-rate ratio positively influences the actual return on housing. As we pointed out, housing returns consist of two components of rent and income resulting from house price changes, and the rate of return on housing varies with the change of these factors. According to the results, with a one percent increase in the price-rate ratio, the real yield of housing increased by 1.003, and by decreasing

this variable, the actual returns fall. After extracting the residuals from the estimate of Eq.22, we tried the linear-logistic function of the hazard rate where

$$N = \alpha + \beta.T \tag{23}$$

Here, N denotes the number of periods with unexpected positive returns and T represents the time. After estimating the linear-logistic hazard function, the beta mark will be confirmed by estimating the existence or absence of a bubble in the housing market. Table 6 shows the results of the linear-logistic hazard function estimation.

Table 6: The linear-logistic hazard function estimation

Method:ML-Ordered Logit		
Variable	Coefficient	Prob
T	-0.7	0.0029
LR statistic :9.07 Prob.(LR statistic) :0.0025		

The coefficient of the variable *t* is equal to −0.7 which is significant at $p<0.05$. On the other hand, in the logistic models of the LR statistic, the general significance of the model is examined, where the H0 hypothesis is rejected at the 5% level, and it satisfies the regularity of the model. As suggested in the theoretical framework, if the coefficient obtained from the estimation of the logistic function is negative, the hypothesis of the existence of the bubble is confirmed. Therefore, according to the results of this test, the existence of bubbles in the housing market is then confirmed.

4. Conclusion

This study tests the existence of rational expectation growing bubble in the housing market using the Blanchard and Watson (1983) model. The results show that high house prices are related to opportunistic purchases aimed at future capital gains brought by the expanding bubble components. We estimate the hazard function as

linear logistic function .the data used in this study are a combination of cross-sectional data (of 30 provinces) in the period 2006-2020. The proposed model consists of two parts: expected return and unexpected return. The effect of expected returns is studied through macroeconomic variables. Also, the residuals of the model are considered as unexpected return. In the first step, after performing diagnostic tests, the effect of macroeconomic variables on real returns.

The results show that, the effect of fundamentals like GDP growth rate, population and unemployment rates cannot significantly affect the real return of housing. The price-to-rent ratio has a significant and positive effect on the real return of housing. This finding implies that the cash flow in owning a house is high. Thus, investors are more likely to increase their investment in houses, and house prices will increase in the future, which leads to an increase in capital income from future price changes.

In the next step, the residuals obtained from the model estimation are extracted and the periods with positive unexpected returns are separated and the hazard function is estimated as a logistic function. The results of the estimation show that the coefficient of the variable t is equal to -0.7 which is negative and significant at the level of 5%. On the other side, LR statistics in logistics models examines the overall significance of the model, where Hypothesis H_0 is rejected at the 5% level and regression significance is confirmed. Based on the theoretical foundations, the hypothesis of a bubble in the housing market is confirmed.

The results of Ghasemi et al. (2013) and Khatai et al. (2014) confirm the existence of price bubble in the housing maket of Iran. Also, Rasekhi and Shahrazi (2014) indicate that the Iranian housing market has experienced explosive behavior and multiple bubbles during the period. However, they did not consider local fundamentals. Abedini et al. (2016) in a study, determined housing prices and identified the price bubble in different provinces of Iran during the period 1996-2010 using panel data and fixed effects model. The results of the study reject the hypothesis of a price bubble in the Iranian housing market and claim that the continuous increases in housing prices over the past decades are explained by structural variables such as production costs, liquidity and effective demand

growth. In addition, estimates show that land prices (with residential use) and liquidity have been the most important factors in the growth of housing prices in Iran.

Fluctuations in housing prices has been one of the main challenges of the housing market. Recognizing whether these fluctuations are rooted in the fundamental factors of the economy or due to the bubble leads to different policies and plays an important role in preventing adverse economic consequences. Therefore, considering the importance of the subject of this article, in order to fill the gaps in previous research and provide effective measures for policy makers and stakeholders in this field, it can be used as a risk warning system to eliminate the dilemma of house price bubble.

The following suggestions are made to improve the housing market in Iran:

- Use of land and investment companies with the aim of expanding justice, preventing rent rise, developing the capital market, maintaining the value of capital for those in need of housing that cannot afford one-time purchase of housing, and developing housing construction.

- Implementing policies such as facilitating the terms and conditions for granting construction permits, tax exemptions, affording cheap land for low-income households, using the potential of mass-makers to produce fast and cheap housing, propagating industrial manufacturing methods, and building more than modern construction technologies leading to a positive impact on the housing market.

- Applying punitive policies for obscuring landlords through tax: it can reduce incentives for housing and improve the market position.

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حباب انتظارات عقلایی قیمت مسکن در ایران

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چکیده

از آنجا که بخش مسکن ارتباط زیادی با سایر بخش‌های اقتصادی دارد نوسان‌های قیمت این دارایی می‌تواند هزینه‌های گزافی درپی داشته باشد؛ هم‌چنین تشخیص این‌که افزایش قیمت‌ها ریشه در شرایط بنیادی اقتصاد دارد و یا تنها ناشی از حباب است، می‌تواند منجر به اتخاذ تصمیمات و سیاست‌های متفاوتی بشود؛ بنابراین موضوع کشف حباب‌های قیمتی مسکن می‌تواند به‌عنوان یک سیستم هشداردهندهٔ اولیه جهت جلوگیری از پیامدهای ناگوار اقتصادی مورد بررسی قرار گیرد. مطالعهٔ حاضر، فرضیهٔ وجود حباب در بازار مسکن ایران در طول سال‌های (۹۸-۱۳۸۵)را با استفاده از مدل بلانچارد و واتسون مورد آزمون قرار می‌دهد. براساس تئوری، احتمال وقوع بازدهی منفی قیمت سهام در شرایط وجود حباب، کاهش می‌یابد؛ همچنین تابع مخاطره ازطریق رگرسیون لجستیک برآورد شده است و یافته‌های حاصل از آن وجود حباب در بازار مسکن در دورهٔ زمانی مورد بررسی را در استان‌های ایران تأیید می‌کند.

کلیدواژگان: تابع مخاطره، حباب قیمت، بازار مسکن، ایران.
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The Impact of Islamic Financial Development on Income Inequality in Selected Countries: A Spatial Panel Data Approach

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Abstract

Income inequality has gained prominence by exacerbating the economic stability of both developed and developing countries over the past few decades. The intensity of this issue is non-trivial with economies witnessing failure in policies, indecorous economic governance, and the challenging economic ideologies. Impact of financial development on economic growth is an important channel in economic issues on which plenty of discussions and challenges have arisen. Financial development involves various dimensions of financial systems and markets. Islamic financial development (IFD) is one of these dimensions. This research investigates the impact of IFD on income inequality in 28 countries active in the IFD area, including 14 high-income and 14 middle-income and low-income countries, over 2013-2017 by considering the Kuznets curve hypothesis, financial curve hypothesis, and Kuznets financial hypothesis and through spatial econometrics technique. Results indicate that Islamic financial development (IFD) decreases income inequality. In addition, the findings of the study reveal that there is no clear-cut evidence to support the proposition of economic development along with financial growth, which would reduce the problem of income inequality. The results show that the GDP per capita, Inflation and Trade Openness increase the income inequality. In contrast, General government final consumption expenditure, urban population and age dependency ratio, help countries reduce income inequality.

Keywords: Islamic Financial Development, Income Inequality, Kuznets Curve, Spatial Panel Data.

JEL Classification: C21, O01, O16, O57.

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1. Introduction

Inequality, the persistent issue of human society, is a challenge that lasts until the end of the world. Economic systems designed so far not only could not solve this society's issue but also income inequality and the gap between wealthy and poor population has had an increasing trend. The outbreak of COVID 19 has increased inequality and decreased social moves in many developing economies, and this issue has directed attention toward inequality. The new study by the International Monetary Fund (IMF) indicates that the Gini coefficient increases by 1.5% after each pandemic. The employment rate for high-educated people does not change significantly, but low-educated people are damaged. The COVID 19 crisis is now known as the world's largest economic catastrophe since the 1930s Great Depression. In January, the IMF forecasted a global income growth of 3%. However, it is now expected to fall 3%, a situation much worse than the global financial crisis in 2008-2009. To resolve the unfair distribution of income, we should identify associated effective factors and adopt appropriate policies.

One of the factors affecting income inequality is the financial development index. Economic and financial studies show that financial development increases productivity, economic growth, income level, and employment by deregulating the banking sector, facilitating exchanges, increasing access to financial resources for investment and loans, and reducing credit constraints (Dehejia & Gupta, 2014). Generally, there are two different views on the relationship between financial development and economic growth. The first view emphasizes the presence of a direct relationship between the development of the financial sector and economic growth (King & Levine, 1993a, b; Levine, 1997, 2002, 2005; Demirguc-Kunt & Maksimovic, 1998; Calderon & Liu, 2003; Rajan & Zingales, 2003; Demetriades & Andrianova, 2004; Honohan, 2004; James, 2008; Zhang et al, 2012; Beck et al, 2015; Batuo et al, 2017). The second view states that not only financial development and liberalization do not help economic growth, but also financial repression policy and interest rate cap should be implemented to achieve economic growth. Keynesian economists are among the proponents of this view. Meier and Seers (1984), Lucas (1988), Stern (1989), Ram (1999), Dawson (2003) have found evidence to support this view. Summarily, research on this area

indicates that no consensus exists about the effect of financial development and economic growth. Different results have been found depending on how financial development has occurred, what indicators have been selected for financial development, whether the country studied is developing or industrialized. An extensive literature also has dealt with the relationship between inflation and financial development. These studies argue that often a negative relationship exists between inflation and financial development (Rousseau & Wachtel, 2000; Hung, 2003; Gillman & Harris, 2004; Rousseau & Yilmazkuday, 2009; Kim, et al, 2010; Bittencourt, 2011; Abbey, 2012; Aboutorabi, 2012; Odhiambo, 2012; Ozturk & Karagoz, 2012; Alimi, 2014; Raheem & Oyinlola, 2015). Belke et al (2004, 2005, 2006), Feldmann (2012), Epstein and Shapiro (2019) investigate the effect of financial development on unemployment and assert that higher levels of diversity in the financial system reduce total unemployment and skilled labor.

Meanwhile, the relationship between the development of financial markets and income inequality is complex and has various dimensions (Jalilian, 2002). The development of financial markets plays a role in improving income distribution by providing resources for poor households more widely and easily and resolving the shortcomings of the capital market, and providing opportunities for poor people to invest in long-term projects (Zhicheng Liang, 2006). The existing theories on income inequality and financial development have introduced different predictions of the relationship between these two variables. For example, the model proposed by Greenwood and Jovanovich (1990) predicted an inverted U-shaped relationship between financial development and income inequality. More clearly, financial development firstly increases the inequality, and it leads to a decrease in income inequality when the average wage increases and most households get access to intermediaries and financial services. In contrast, some other models propose a negative linear relationship between financial development and income inequality and show that the development of financial markets and intermediaries helps to reduce income inequality (Banerjee & Newman, 1993; Galor & Zeira, 1993).

On the other hand, economists such as Loury (1981), Banerjee and Newman (1993), Aghion and Balton (1997) believe that having more access to credits is not

a sufficient condition for reducing income inequality. Therefore, they emphasized on redistribution of income. However, Clarke, Colin, and Zou (2003), Beck, Kunt, and Levin (2004, 2007), Liang and Teng (2006), Jeanneney and Kangni (2008) show that financial development help to reduce income inequality. In other words, they stated that financial development decreases inequality directly by increasing the income of poor people and indirectly by a positive effect on economic growth (economic growth increases the income of poor people disproportionately more than rich people. Indeed, the coefficient of financial development indicator is positive for both poor and reach people but is larger for poor people). They believe that income inequality, which is measured by the Gini coefficient or standard deviation, reduces more sharply in countries having a high level of financial development (Beck et al, 2015). As discussed, despite studies in this area, there is no consensus among the economic researchers in this regard, and studies reported different results on how financial development affects income inequality.

In addition, financial development involves different dimensions of financial systems and markets. The financial system can be divided into Islamic sharia compliance and conventional financial systems. In recent decades, the development of the Islamic financial system, as a goal performance of Islamic countries and a new solution for finance, has received the attention of financial market activists and economists. Nowadays, the Islamic financial industry is progressing in the world, particularly in the Middle East, southern Asia, and southeastern Asia, so that the worth of Islamic financial assets reached about three trillion dollars in 2019 with an increasing trend. Iran, Saudi Arabia, and Malaysia have the highest Islamic market share in terms of assets. Among different sectors of the Islamic financial industry, Sukuks have grown significantly compared with other sectors. The global issuance of Sukuks exceeded one trillion dollars in 2018 for the first time, and it will be expected to play a more important role in the future. Indeed, over recent years, many markets have revealed their interest in attracting capital through Sukuks. According to the report on Islamic financial development published annually by Thomson Reuters, 131 countries in eight different geographical regions were assessed based on different indicators of

Islamic development. Islamic financial development indicator (IFDI) investigates different Islamic financial markets around the world in terms of financial advancement by classifying effective factors into five different areas. These indicators do not merely focus on the size and general growth of Islamic financial sectors across different countries but evaluate the overall power of the ecosystem helping the development of the industry. IFDI is composed of various components, including quantitative development, governance, regulation, corporate social responsibility, knowledge, and awareness, each of which has some sub-indicators having high importance in measuring the global industry. According to this report, the development of the Islamic financial industry at the global level among 131 understudy countries has a growing trend, and the corresponding global average has increased from 9.9 in 2017 to 10.8 in 2019, mainly due to increases in the amount of three principal indicators, knowledge, governance, and awareness.

In this study, several innovations are presented regarding different dimensions of the impact of financial development on inequality. First, the effect of the development of financial institutions and financial markets on inequality is investigated from various aspects. Second, the impact of Islamic financial development on inequality from five different dimensions is examined (Quantitative development, Knowledge, CSR, Government, Awareness). Besides being innovative in the empirical literature, this investigation enables us to compare the impact of Islamic financial development versus conventional financial development in the studied countries. Third, on these grounds, the current study uses a spatial econometric model to examine the spatial characteristics of Islamic financial development on income inequality.

2. literature review

Income inequality and its relevant problems are one of the most complicated issues faced by humanity and a barrier to sustainable development. The emergence of this detrimental phenomenon has been caused by the gradual performance of existing systems in human society and affected and shaped by different factors depending on temporal and spatial conditions. Thus, the income

distribution issue has been a multidimensional problem and can be discussed from different aspects. The empirical literature has widely studied the financial-inequality supply chain. The effective work by Kuznets (1995) explains that income inequality increases firstly in response to the improvement in the financial system, stabilizes, and finally decreases. Indeed, in this study, Kuznets states a hypothesis based on which income inequality raises firstly along with the economic development and decreases gradually after being fixed at a certain level. This model was later called the inverted U-shaped curve. Kuznets defined economic development as a process of transition from the traditional economy to a new (knowledge-based) economy and believed that income distribution worsens in the early stages of the growth because few people can transit to the new sector. Therefore, this problem causes a difference between payment levels and, consequently, incomes. However, in the next stages of growth and development, income distribution improves because now more people earn an opportunity to be attracted to the new economic sector. Thus, a balance and improvement in income distribution are created in society.

Extensive literature that tested the Kuznets curve hypothesis includes Ahluwalia (1976a, b), Robinson (1976), Saith (1983), Lindert and Williamson (1985), Papanek and Kyn (1986), Adelman and Robinson (1988), Campano and Salvatore (1988), Ram (1988), Anand and Kanbur (1993), Jha (1996), Lin (River) Huang, & Weng (2006), Angeles (2010), Shahbaz (2010), Younsi and Bechtini (2018), Martínez-Navarro et al (2020), Sayed (2020) and Cinar et al (2019, 2020). Remarkably, studies like Robinson (1976), Anand and Kanbur (1993), Angeles (2010), Sayed (2020) and Cinar et al (2019, 2020). failed to support the Kuznets curve hypothesis.

Another strand of literature emphasizes that financial development economic growth by assembling savings, evaluating potential entrepreneurs, and diversifying risks (Bencivenga & Smith, 1991; King & Levine, 1993). Afterward, Levine (2005) has done a detailed review of the literature of finance and growth considering various empirical examinations supporting the same hypothesis. Piketty (2015) also challenged the Kuznets curve hypothesis and stated that forces

reducing inequality in society had not the expected influence. Among these, Greenwood & Jovanovic (1990) primarily explored whether all the social classes equally benefited from the process of financial development and the model proposed an inverted U-shaped non-linear association between financial development and income inequality. Financial development helps capital allocation; increases total growth and assist the poor during all stages of economic development. Albeit, there is the distributional influence of financial development, the net effect on the poor depends on the level of economic development. At the initial stages of economic development, the rich only enjoyed access to financial markets and the benefits from the financial services. At the higher levels of economic development, the number of persons accessing the financial market has increased subsequently, resulting in financial development assisting the public. However, the examinations by Banerjee and Newman (1993) and Galor and Zeira (1993) advocate that inequality declines linearly with increasing financial development. The studies argued that the effect of financial market imperfections prevents the efficient allocation of resources to the poor to do human and physical capital investments, indicating that financial development helps improving income inequality (Aghion & Bolton, 1997; Mookherjee & Ray, 2003, 2006). Bittencourt et al (2019) investigated the impact of financial development on income inequality in the United States using the panel model and fixed effects estimation over the period 1976-2011. They concluded that financial development increased the income inequality of 50 states linearly. However, the effect of financial development on income inequality was linear when the 50 states were divided into two separated groups, including above-average inequality and below-average inequality states relative to cross-state average inequality. There was an increasing effect for above-average inequality states in response to improving financial development, while there was an inverted U-shaped relationship for below-average inequality states.

Successively, these two theoretical controversies are subject to various empirical examinations (Levine, 1997; Li, Squire, & Zou, 1998; Rajan & Zingales, 2003; Beck, Demirguc-Kunt, & Levine, 2004; Clarke, Xu, & Zou, 2006; Claessens & Perotti, 2007; Kappel, 2010; Kim & Lin, 2011; Hamori &

Hashiguchi, 2012; Tan & Law, 2012; Nikoloski, 2013; and; Jauch & Watzka, 2016). Nikoloski (2013) tried to test the empirical evidence supporting financial Kuznets curve and suggested the existence of an inverted U shaped pattern between financial sector development and income inequality that validates Greenwood & Jovanovic (1990) hypothesis. Furthermore, Baiardi & Morana (2016) contributed a new specification of financial Kuznets curve hypothesis, by conditioning Kuznets' turning point per capita income on the level of financial development. The study postulate that the favorable influence of financial development on the turning point per capita income of the Kuznets curve enhance economic growth substantially and offer more even distribution of income. In addition to the above specification, Baiardi and Morana (2018) evidenced an EA-wide steady-state financial Kuznets curve, signifying a long-term inverse U shaped relationship between financial development and income inequality. Kavya and Shijin (2019) investigated the relationship between income inequality growth and economic and financial development using the pooled data and generalized method of moments (GMM) estimator. They considered annual data for 85 countries, including 28 high-income, 41 medium-income, and 16 low-income countries over the period 1980-2014. The results found no clear evidence to support the proposition of economic development along with financial growth in order to solve the inequality problem. In addition, most advanced countries or highly advanced countries having high income also did not benefit from the advantages of financial development.

The problem of rising inequality needs an additional check in the aspects of economic and financial development. The theoretical arguments on the distribution of income propose that the effect of economic development along with financial development deteriorate the problem of inequality. The controversy regarding the validity of the measures is still looming on the empirical findings of studies exploring the nexus of growth, finance, and income inequality. Indeed, the data samples concerning the countries and period for the analysis also significantly matter in the findings of these studies. In this regard, very few studies excepting Rehman et al. (2008), Kappel (2010) and Gallup (2012) have identified the problem concerning country classification based on the income

level. Baymul & Sen (2019, 2020) assessed the relationship between structural transformation and inequality using the panel data for 32 developing and developed economies over the periods 1950-2010 and 1960-2012 in two separate studies and asserted that Kuznets relationship between manufacturing employment share with various industrialization paths and inequality was not confirmed. Indeed, in contrast to the Kuznets hypothesis, workers' movement toward production unambiguously increased income inequality regardless of the structural transformation stage in which a specific country was.

Summarily, some research shows a positive impact of financial development on income inequality, but most studies have concluded a negative relationship between financial development and income inequality. The relationship between financial development and income inequality is linear in some studies, confirming the Banerjee and Newman (1993) hypothesis, and inverted U-shaped in some others, following the Greenwood and Jovanovich (1990) hypothesis.

The present study hence revisits inequality widening or inequality narrowing hypothesis in respect of Kuznets curve hypothesis, financial curve hypothesis and financial Kuznets curve hypothesis taking meticulous study variables and Based on selected countries. The major contribution of the present study is twofold: firstly, the study revisits inequality widening or inequality-narrowing hypothesis under financial development. Secondly, the present study introduces a Islamic financial development index.

3. Methodology and Data

3. 1. Spatial Econometric Model

According to Anselin et al. (2008), a spatial panel model could include a lagged dependent variable or follow a spatially autoregressive process in the error term. LeSage and Pace (2009) introduced the spatial Durbin model, which includes spatially lagged independent variables. The spatial lag model, the spatial error model, and the spatial Durbin model are denoted by the following formulas:

$$y_{it} = \lambda \sum_{j=1}^{N} w_{ij} \qquad (a)$$

$$y_{it} = \lambda \sum_{j=1}^{N} w_{ij}\, y_{jt} + \varphi + x_{it}\, \beta + c_i(optional) + \alpha_t(optional) + u_{it} \qquad (b)$$

$$y_{it} = \lambda \sum_{j=1}^{N} w_{ij}\, y_{jt} + \varphi + x_{it}\, \beta + \sum_{j=1}^{N} w_{ij}\, x_{ijt}\, \theta + c_i(optional) + \alpha_t(optional) + v_{it} \qquad (c)$$

Where y_{it} represents a dependent variable for crosssectional unit i = 1,2,…,N at time t = 1,2, …,T. Also, x_{it} stands for a $K \times 1$ vector of exogenous variables, while β represents a $K \times 1$ vector of parameters. It should be noted that $\sum_{j=1}^{N} w_{ij}\, y_{jt}$ accounts for the interaction effects of dependent variables in the adjacent units on the dependent one; w_{ij} denotes element i, j of an $N \times N$ matrix of spatial weights; λ denotes the endogenous interaction effect response parameter; v_{it} stands for an error term of independent and identical distribution; c_i is a particular spatial effect; and αt accounts for the time-period particular effect. A particular spatial effect accounts for all timeinvariant space-specific variables, whose omission would result in biased estimations in a typical cross-sectional study. On the other hand, a time-period-specific effect accounts for all time-specific effects, the absence of which can result in skewed estimations in common time-series research (Baltagi 2005). The error term of unit i in the spatial error model in Eq. (b) (i.e., $u_{it} = \rho \sum_{j=1}^{N} w_{ij}\, u_{jt} + v_{it}$) is considered to be dependent on the error terms of adjacent units j based on matrix W and an idiosyncratic component v_{it}. Furthermore, the spatial Durbin model contained in Eq. (c) was suggested by LeSage and Pace (2009). It would extend the spatial lag model with independent variables of spatial lagging where θ is a $K \times 1$ vector of parameters.

3. 2. Empirical Model

In order to analyze the empirical factors on income inequality, in this study, using the theoretical foundations of three hypotheses 1) Kuznets hypothesis, 2) financial curve hypothesis and 3) Kuznets financial curve hypothesis, we have tried to

investigate the effects of economic development and financial development on income inequality.

Kuznets hypothesis: Simon Kuznets (1953, 1955) introduced a hypothesis based on which income inequality raises firstly along with the economic development of each country and decreases gradually after being fixed at a certain level. This model was later called an inverted U-shaped curve. The model was then completed by Ahluwalia (1976a, b) as a mathematical formula. Accordingly, economic development was defined as a process of transition from the traditional economy to a new (knowledge-based) economy. The income distribution worsens in the early stages of the growth because few people can transit to the new sector. Therefore, this problem causes a difference between payment levels and, consequently, incomes. However, in the next stages of growth and development, income distribution improves because now more people earn an opportunity to be attracted to the new economic sector. This leads to an improvement in income distribution in society. According to the model proposed by Ahluwalia, the mathematical form of the income distribution curve is written as a linear regression model as follows:

$$GINI_{it} = \alpha + \beta_1 \ln GDPP_{it} + \beta_2 \ln GDPP_{it}^2 + \varepsilon_{it} \qquad (1)$$

Gini coefficient denotes income inequality, and GDP per capita ($GDPP_{it}$) represents economic development. The above hypothesis satisfies when coefficients β_1 and β_2 are significant, while their sign is positive and negative, respectively. Based on the discussions presented by Ahluwalia, when the traditional economic sector is converted to the new sector, it is expected that important elements play an effective role in this conversion. Based on equation (1), the effect of changes in logarithmic GDP per capita on the Gini coefficient is stated as follows:

$$\frac{d(GINI_{it})}{d(\ln GDPP_{it})} = \beta_1 + 2\beta_2 \ln GDPP_{it} \qquad (2)$$

Financial curve hypothesis: Greenwood and Jovanovich (1990), Banerjee and Newman (1993), Galor and Zeira (1993) posed the role of the development of the financial sector on income inequality. The relevant literature argues that the

development of the financial sector firstly increases inequality, and it decreases income inequality when the average wage increases and most households get access to intermediaries and financial services. In contrast, some other models suggest a negative linear relationship between financial development and income inequality and demonstrate that the development of financial markets and intermediaries helps to reduce income inequality. Based on this viewpoint, Clarke et al. (2006) presented a model to integrate financial development.

$$GINI_{it} = \alpha + \beta_1 \ln FD_{it} + \beta_2 \ln FD_{it}^2 + \delta \ln CV_{it} + \varepsilon_{it} \quad (3)$$

where, GINI represent income inequality and FD captures financial development as $\beta_1 \ln FD_{it} + \beta_2 \ln FD_{it}^2$. it consistent with the inverted U shape hypothesis where $\beta_1 > 0$ و $\beta_2 < 0$. Finally, CV includes other control variables.

Financial Kuznets hypothesis: In addition to the above discussions, Nikoloski (2013) re-examined the inequality-financial growth relationship and presented the Kuznets financial curve hypothesis.

$$GINI_{it} = \alpha + \beta_1 \ln FD_{it} + \beta_2 \ln FD_{it}^2 + \beta_3 \ln GDPP_{it} + \beta_4 \ln GDPP_{it}^2 + \delta \ln CV_{it} + \varepsilon_{it} \quad (4)$$

where, GINI represent income inequality, FD captures financial development, ED economic development and CV includes other control variables. Moreover, by conditioning the turning point per capita income on the level of financial development, Baiardi & Morana (2016) recommended a new specification to the financial Kuznets curve as follows.

$$GINI_{it} = \alpha + \beta_1 EDG_{it} + \beta_2 G_{it} + \beta_3 \ln FDG_{it} + \delta \ln CV_{it} + \varepsilon_{it} \quad (5)$$

Gini coefficient denotes income inequality, and ED represents GDP per capita. In addition, F shows economic development, and D stands for GDP growth rate. Thus, EDG represents the product of GDP per capita and GDP per capita growth rate, and FDG indicates the product of financial development and GDP growth rate. Finally, CV includes other control variables. Based on constraint $G > 0$, $\beta_1 > 0$ predicts an inverted U-shaped relationship between economic

development and inequality, and $\beta_2 < 0$ forecasts an inverse relationship between financial development and income inequality.

Besides economic development and financial development, the empirical literature has reported the effect of various factors, such as trade openness, inflation rate, government expenditure, dependency ratio, and urban population, on income inequality.

In the aftermath of a massive relaxation on trade regimes during the 1980s and 1990s, many individual economies witnessed an integration into the global economy. Consequently, the debate on the impact of trade openness on income inequality initiated owing to the growing income inequality during the same period. Empirical studies showed mixed evidence on trade openness and income inequality. Barro (2000), Ang (2010), and Jaumotte, Lall, and Papageorgiou (2013) capture the indication of the positive effect of trade openness and income inequality. Conversely, Richardson (1995), Edwards (1997), White & Anderson (2001), Kraal & Dollar (2002) and Kavya and Shijin (2019) addresses the adverse impact of trade openness.

Monetary instability measured by the rate of inflation is a crucial determinant of inequality. Inflation inhibits the real minimum wage through a decrease in purchasing power, which severely affects the poor and middle-class category in comparison with higher income group, who enjoy the benefit of access to finance (Easterly & Fischer, 2001). Frequent empirical studies have dealt with this problem, in this regard, we can refer to the studies of Blinder & Esaki (1978), Blank & Blinder (1986), Ales, Bulir (1988), Nolan (1988), Blejer & Guerrero (1990), Bulir & Gulde (1995), Cole & Towe (1996), Romer (1998), Easterly & Fischer (2000), Galli & Hoeven (2001).

The present study controlled for government expenditure as a measure of macroeconomic stability in accordance with Beck, Levine, & Loayza, 2000. The measure captures public expenditures for purchases of goods and services, the degree of marketplace intervention and the possible use of redistributive expenditures. An effective redistributive mechanism through the tax-transfer

system towards low-income category ensures greater equality, whereas the political influence of wealthy may lead to income inequality (Clarke et al., 2006). the Studies by Anderson et al (2016), Enami et al (2016), Sánchez, Pérez-Corral (2018), İlker ULU (2018) and Alamanda (2020) confirm the importance and impact of government spending on income inequality.

According to the studies by Kavya and Shijin (2019), Dong et al (2018) and Baiardi & Morana (2016), the dependency ratio is an important factor in determining a household's income. Population mix is remarkable from the economic growth viewpoint. Increased dependency ratio leads to a decrease in labor supply, change in the share of production factors from costs, productivity decline, inflation in wages, change in consumption and saving pattern (by increasing dependency burden and consequently reducing the savings of the private sector), reduction in the savings of the public sector (due to increased commitment to salary payment), and change in income distribution through the demand change. These changes affect economic growth and sustainability.

Subsequently, the study tests the urban population as a significant indicator of income inequality. As argued by Kuznets (1955) the negative association between economic development and income inequality is attributable to the positive impact of urban population and income inequality. Meanwhile, highly urbanized economies release from the problems of income inequality. In contrast, the results of the Studies by Wan et al (2022), Minh Ha et al (2019), Wu and Rao (2017) and Sagala et al (2014) show that further urbanization will reduce inequality, with other factors constant.

3. 3. Data

In this study, using data from 2013-2017 for 28 countries (Countries that, based on the Islamic financial development index used, have progress in at least one of the dimensions of Islamic financial development) including 14 high income and 14 middle-income and low-income countries, Kuznets hypothesis and financial curve hypothesis and Kuznets financial hypothesis are evaluated experimentally.

Table 2 shows the variables constructed and the data sources. Given that the value of some of the independent variables is equal to zero in some years, before its logarithmic transformation and its inclusion in model one is added to the value.

Various approaches have been introduced by economists and statisticians to assess and analyze income distribution inequality. One of the appropriate methods is the Gini coefficient, which ranges between zero (minimum inequality) and one (maximum inequality), and it is independent of the mean and symmetric (meaning that if the people exchange their incomes pairwise, this coefficient does not change). Income transfer from the rich to the poor in society reduces the index, and the value of this index is sensitive to income distribution in middle groups of society. Many studies use the Gini coefficient as an indicator of income inequality (Deininger & Squire, 1996, 1998; Li et al, 1998; Hopkins, 2004; Clarke et al, 2003, 2006; Clarke et al, 2007; Gimet & Lagoarde-Segot, 2011; Jauch & Watzka, 2016; Baiardi & Morana, 2016; Chiu & Lee, 2019; Crouch, 2019; Kavya & Shijin, 2019; Vo et al, 2019).

Furthermore, this research uses two different criteria of financial development. To understand the difference in the impact of conventional financial development and Islamic financial development on income inequality in studied countries, we use the financial development index measured by International Monetary Fund to represent conventional financial development in selected countries. In addition, ICD Refinitiv Islamic Finance Development Indicator is used as an index for the Islamic financial development index. Svirydzenka (2016) has developed an index by summarizing many indices measuring developments in financial institutions and financial markets considering their depth, access, and efficiency. Specifically, financial institutions covered banks, insurance and mutual fund companies, whereas financial markets included stock and bond market. The financial development index is thus, an overall index measure on a zero to one scale consisting of depth, access, and efficiency. The depth captures the size and liquidity of markets. The access represents the accessibility of financial services to individuals and companies. The efficiency measures the ability of institutions and capital markets ability to offer financial services at a low cost with sustainable revenues (Kavya & Shijin, 2019). In addition, The ICD Refinitiv Islamic Finance

Development Indicator is a composite weighted index that measures the overall development of the Islamic finance industry by providing an aggregate assessment of the performance of all its parts, in line with Islamic principles.

The Islamic financial development Indicator (IFDI) used in this study, unlike previous studies, which only used Islamic financial concentration (Gazdar et al, 2019) and Islamic financial depth (Law and Singh, 2014; Moradbeigi and Law, 2016; Gazdar et al, 2019) consists of different dimensions to measure Islamic Financial Development.

The different components that make up the Indicator are selected based on an outline of the key constituents of the industry as a whole and are based on key contemporary issues such as Corporate Governance, Corporate Social Responsibility, Knowledge and Awareness.

Table (3) shows the components of the Islamic Finance Development Indicator (IFDI). The different components that make up the Indicator are based on key contemporary issues such as quantitative development of international financial institutions and markets (Quantitative), the quality of governance and risk management measures to protect stakeholders (Corporate Governance), the quality of sharia governance to ensure that Islamic financial institutions and instruments comply with sharia standards (Sharia Governance), the industry's social contribution in line with Islamic principles (Social Responsibility), and the availability and quality of education to ensure that the industry's professionals are well-versed in Islamic finance principles (Education).

Table 1: List of countries.

High-income countries:	Australia, Belgium, Canada, China, Cyprus, France, Germany, Luxembourg, New Zealand, Russia, Singapore, Switzerland, England, USA.
Middle-income and Low-income countries:	Afghanistan, Albania, Djibouti, Egypt, Gabon, Indonesia, Iran, Kazakhstan, Kyrgyzstan, Nigeria, Sierra Leone, South Africa, Thailand, Turkey.

Table 2: Variables definition.

Variable	Variable constructed	Source
		WDI

$lnGDPP_{it}$	$lnGDPP_{it} = log(GDPP_{it})$ GDP_{it}= GDP per capita in 2010 prices$ in the country *i* in period *t*	WDI
$lnGOV_{it}$	$lnGOV_{it} = log(GOV_{it})$ GOV_{it} =General government final consumption expenditure (% of GDP)	WDI
INF_{it}	INF_{it}= Inflation, GDP deflator (annual %)	WDI
$lnURB_{it}$	$lnURB_{it} = \log(URB_{it})$ URB_{it}= Urban population (as a percentage of the total population)	WDI
$lnOPE_{it}$	$lnOPE_{it} = log(OPE_{it})$ OPE_{it}= Trade Openness (total exports and imports divided by GDP)	WDI
$lnAGE_{it}$	$lnAGE_{it} = log(AGE_{it})$ AGE_{it} =Age dependency ratio (% of working-age population)	WDI
$lnFI_{it}$	$lnFI_{it} = log(1 + FI_{it})$ FI_{it}= the Development of Financial Institution	IMF
$lnFM_{it}$	$lnFM_{it} = log(1 + FM_{it})$ FM_{it}= the Development of Financial Market	IMF

WDI: World Development Indicator; https://datacatalog.worldbank.org/dataset/world-development-indicators.
IMF: International Monetary Fund; https://data.imf.org/

Table 3: Islamic Finance Development Indicator (IFDI)

Quantitative Development (QDI)	Knowledge (KNI)	Corporate Social Responsibility (CSR)	Governance (GOI)	Awareness (AWI)
Islamic Banking	Education	Funds Disbursed to Charity / Zakat / Qard Hasan	Regulation	Seminars
Takaful				
Islamic Financial Institutions			Sharia Governance	Conferences
	Research	Disclosed CSR activities		
Sukuk			Corporate Governance	News
Funds				

SOURCE: The Islamic Corporation for the Development of the Private Sector; https://www.zawya.com/islamic-finance-development-indicator/#

Table (4) provides the summary statistics of data over the years 2013-2017. For most variables, the standard deviations are significantly lower than the mean, which indicates a low level of fluctuations in the model variables.

Table 4. Summary statistics over the years 2013-2017.

Variable	Mean	Median	Maximum	Minimum	Std. Dev.
High-income countries:					
GINI	35.616	35.250	64.000	26.800	8.741
$lnGDPP_{it}$	9.609	8.419	12.610	7.089	2.414
$lnGOV_{it}$	16.814	18.364	25.313	5.403	5.632
INF_{it}	5.183	2.935	37.603	-3.097	6.662
$lnURB_{it}$	100.105	63.088	409.362	21.723	94.574
$lnOPE_{it}$	71.596	75.092	101.000	36.517	18.654
$lnAGE_{it}$	53.387	52.688	89.592	28.602	13.323
IFDI	6.638	7.133	9.171	0.000	2.751
QDI	4.443	6.106	9.896	0.000	3.497
KNI	5.413	5.121	9.203	0.000	3.461
CSR	3.555	0.000	9.792	0.000	4.619
GOI	5.544	7.397	9.732	0.000	4.520
AWARE	6.553	6.941	9.229	0.000	2.724
$lnFI_{it}$	5.009	5.205	5.615	3.354	0.527
$lnFM_{it}$	3.532	4.917	5.534	0.000	2.127
Middle-income and Low-income countries:					
GINI	40.516	40.250	67.100	29.700	10.741
$lnGDPP_{it}$	13.409	13.419	15.510	10.089	5.314
$lnGOV_{it}$	19.714	20.264	28.213	8.303	9.632
INF_{it}	8.183	5.835	40.503	-6.097	9.562
$lnURB_{it}$	105.005	66.188	412.062	24.723	97.474
$lnOPE_{it}$	74.496	78.192	105.000	39.417	20.554
$lnAGE_{it}$	56.387	55.588	92.592	30.502	15.023
IFDI	9.538	10.033	13.071	0.000	5.051
QDI	8.343	9.106	13.796	0.000	5.397
KNI	8.313	9.021	13.003	0.000	5.261

CSR	6.455	0.000	13.692	0.000	6.619
GOI	8.444	10.297	13.632	0.000	6.420
AWARE	9.453	9.841	13.129	0.000	4.724
$lnFI_{it}$	9.109	9.105	9.515	6.254	1.527
$lnFM_{it}$	7.532	7.817	9.534	0.000	2.207

4. Experimental results and discussions

To assess determinants of income inequality, it is first necessary to use diagnostic tests to determine the optimal panel. In this study, 25 models have been estimated separately. All models are specified as functions of basic variables including GDP per capita, general government final consumption expenditure, inflation, urban population, trade openness, and age dependency ratio. The nested model of each model is also specified concerning the gradual inclusion of the financial development index and interaction terms. The Twenty-five estimated models are compared using two separate likelihood ratio (LR) tests so that the probability of the existence of the time-period fixed effects and spatial fixed effects in the conventional panel model was investigated and the results are reported in Table 5. The models with simultaneous spatial and time-period fixed effects were compared with the model of time-period fixed effects and/or the model of spatial fixed effects. The significance of the test statistics for examining the time-period and spatial fixed effects in Table 5 indicates the rejection of the null hypothesis for only the model of time-period fixed effects. Therefore, the spatial fixed effects model is used to estimate results. Table 5 represents the Hausman test results to examine the possibility of replacing the fixed-effect model with a random-effect model. The null hypothesis is rejected for all models and the existence of fixed effects is confirmed at a significance level of 1%.

Table 5. The likelihood ratio (LR) test and Hausman test results

	Spatial fixed effects		**Time-period fixed effects**		**Hausman test statistic**	
High-income countries						
Model A1	3.142	-(0.830)	930.438***	(0.000)	29.59***	(0.000)
Model A2	3.649	-(0.755)	932.851***	(0.000)	33.53***	(0.000)

Model A3	3.481	-(0.781)	918.312***	(0.000)	34.98***	(0.000)
Model A4	3.267	-(0.812)	938.496***	(0.000)	40.58***	(0.000)
Model A5	3.454	-(0.632)	916.710***	(0.000)	47.68***	(0.000)
Model A6	2.810	-(0.885)	920.829***	(0.000)	33.38***	(0.000)
Model A7	3.043	-(0.842)	928.315***	(0.000)	29.71***	(0.000)
Model A8	4.256	-(0.666)	908.378***	(0.000)	42.14***	(0.000)
Model A9	1.928	-(0.969)	928.167***	(0.000)	36.71***	(0.000)
Model B2	3.599	-(0.745)	919.045***	(0.000)	33.14***	(0.000)
Model B3	3.301	-(0.782)	913.014***	(0.000)	35.88***	(0.000)
Model B4	3.441	-(0.811)	940.678***	(0.000)	36.88***	(0.000)
Model B5	4.801	-(0.605)	904.001***	(0.000)	40.96***	(0.000)
Model B6	2.401	-(0.900)	920.012***	(0.000)	38.15***	(0.000)
Model B7	2.989	-(0.850)	926.986***	(0.000)	32.99***	(0.000)
Model B8	5.999	-(0.382)	896.973***	(0.000)	42.92***	(0.000)
Model B9	1.989	-(0.918)	905.127***	(0.000)	35.98***	(0.000)
Model C2	3.622	-(0.738)	919.345***	(0.000)	32.14***	(0.000)
Model C3	3.255	-(0.803)	905.814***	(0.000)	34.78***	(0.000)
Model C4	3.431	-(0.757)	933.678***	(0.000)	37.25***	(0.000)
Model C5	2.728	-(0.592)	903.527***	(0.000)	38.36***	(0.000)
Model C6	2.453	-(0.920)	918.938***	(0.000)	36.12***	(0.000)
Model C7	3.034	-(0.855)	925.226***	(0.000)	31.21***	(0.000)
Model C8	6.111	-(0.432)	896.223***	(0.000)	43.32***	(0.000)
Model C9	2.171	-(0.958)	902.169***	(0.000)	37.71***	(0.000)
Middle-income and Low-income countries						
Model A1	2.132	-(0.819)	932.438***	(0.000)	28.51***	(0.000)
Model A2	2.659	-(0.744)	933.851***	(0.000)	32.65***	(0.000)
Model A3	2.491	-(0.768)	918.312***	(0.000)	33.84***	(0.000)
Model A4	2.277	-(0.802)	966.496***	(0.000)	39.65***	(0.000)
Model A5	3.464	-(0.652)	913.710***	(0.000)	46.76***	(0.000)
Model A6	1.820	-(0.847)	920.829***	(0.000)	32.23***	(0.000)
Model A7	2.053	-(0.854)	930.315***	(0.000)	28.85***	(0.000)
Model A8	3.276	-(0.665)	910.378***	(0.000)	41.12***	(0.000)
Model A9	0.968	-(0.985)	926.167***	(0.000)	35.86***	(0.000)
Model B2	2.599	-(0.735)	921.045***	(0.000)	32.56***	(0.000)
Model B3	2.311	-(0.762)	915.014***	(0.000)	34.44***	(0.000)
Model B4	2.451	-(0.823)	936.678***	(0.000)	35.23***	(0.000)
Model B5	3.811	-(0.686)	903.001***	(0.000)	38.89***	(0.000)
Model B6	1.411	-(0.845)	920.012***	(0.000)	34.17***	(0.000)
Model B7	1.999	-(0.852)	915.986***	(0.000)	30.88***	(0.000)
Model B8	4.989	-(0.389)	887.973***	(0.000)	41.96***	(0.000)
Model B9	0.979	-(0.936)	908.127***	(0.000)	34.94***	(0.000)
Model C2	2.632	-(0.745)	917.345***	(0.000)	31.15***	(0.000)
Model C3	2.265	-(0.857)	909.814***	(0.000)	34.88***	(0.000)
Model C4	2.441	-(0.759)	935.678***	(0.000)	36.34***	(0.000)
Model C5	3.748	-(0.586)	906.527***	(0.000)	39.62***	(0.000)
Model C6	1.463	-(0.942)	917.938***	(0.000)	34.17***	(0.000)

Model C7	2.044	-(0.856)	928.226***	(0.000)	30.30***	(0.000)
Model C8	5.131	-(0.445)	891.223***	(0.000)	42.53***	(0.000)
Model C9	1.191	-(0.926)	908.169***	(0.000)	35.81***	(0.000)

Note: p-values in parentheses, ***, **, and * show significance at the 1%, 5%, and 10% level respectively **(Source: Authors' estimations).**

A subsequent test in Table 6 determines whether including the spatial lag or error in the model in the absence of spatial interaction effects results in a statistically significant improvement. Thus, Lagrange multiplier (LM) tests are performed on a spatially lagged dependent variable and spatial error autoregressive model using the residuals from a non-spatial model (Elhorst 2010). The test statistic has the chi-square distribution. If the LM test rejects the null hypothesis, the spatial lagged and spatial error models are confirmed. Due to the existence of spatial fixed effects being confirmed by the LR test, this study examines only the Lagrange multiplier (LM) statistics for this model. The results in Table 6 indicate that the test statistic values in all models are statistically significant at the 1% level. Therefore, spatial lagged and spatial error effects should be ignored in the model. As a result, the model's lack of spatial interaction effects emphasizes the importance of ignoring such effects when conducting experimental studies on the factors affecting income inequality. Based on this, the SDM model is selected.

Table 6. The LM test for the existence of the spatial lag or the spatial error in the models

		Spatial fixed effects		Time-period fixed effects		Spatial and time-period fixed effects	
High-income countries							
Model A1	LM spatial lag	0.348	(0.552)	1.056	(0.322)	0.065	(0.845)
	LM spatial error	1.396	(0.227)	0.050	(0.857)	9.945***	(0.002)
Model A2	LM spatial lag	0.235	(0.626)	0.521	(0.456)	0.345	(0.534)
	LM spatial error	0.035	(0.869)	0.023	(0.856)	12.051***	(0.000)
Model A3	LM spatial lag	2.848*	(0.092)	0.652	(0.456)	4.865**	(0.050)
	LM spatial error	1.421	(0.226)	0.328	(0.546)	28.022***	(0.003)
Model	LM spatial	0.311	(0.612)	1.476	(0.235)	0.130	(0.750)

A4	lag						
	LM spatial error	0.112	(0.761)	0.585	(0.485)	12.358***	(0.000)
Model A5	LM spatial lag	0.170	(0.709)	1.052	(0.345)	0.1258	(0.714)
	LM spatial error	0.173	(0.688)	1.059	(0.398)	14.481***	(0.023)
Model A6	LM spatial lag	0.342	(0.581)	0.645	(0.478)	0.198	(0.684)
	LM spatial error	0.151	(0.710)	0.356	(0.555)	14.662***	(0.000)
Model A7	LM spatial lag	0.485	(0.512)	0.745	(0.343)	0.357	(0.553)
	LM spatial error	3.420*	(0.056)	0.523	(0.476)	14.070***	(0.000)
Model A8	LM spatial lag	1.441	(0.221)	0.822	(0.362)	1.685	(0.223)
	LM spatial error	7.570***	(0.010)	0.192	(0.652)	3.989**	(0.043)
Model A9	LM spatial lag	5.433**	(0.030)	1.185	(0.287)	9.778***	(0.005)
	LM spatial error	24.012***	(0.000)	0.346	(0.565)	0.257	(0.656)
Model B2	LM spatial lag	0.284	(0.549)	1.482	(0.232)	0.178	(0.721)
	LM spatial error	0.111	(0.783)	0.594	(0.715)	0.999	(0.332)
Model B3	LM spatial lag	4.885**	(0.028)	0.198	(0.656)	3.078*	(0.084)
	LM spatial error	0.038	(0.865)	1.052	(0.315)	9.846***	(0.003)
Model B4	LM spatial lag	0.170	(0.713)	1.041	(0.345)	0.136	(0.712)
	LM spatial error	0.169	(0.112)	9.978	(0.279)	14.343***	(0.002)
Model B5	LM spatial lag	0.348	(0545)	1.053	(0.368)	0.089	(0.820)
	LM spatial error	1.397	(0.242)	0.061	(0.884)	9.948***	(0.007)
Model B6	LM spatial lag	2.838*	(0.086)	0.638	(0.454)	4.779**	(0.030)
	LM spatial error	1.420	(0.241)	0.321	(0.512)	27.888***	(0.005)
Model B7	LM spatial lag	0.341	(0.525)	0.645	(0.452)	0.190	(0.765)
	LM spatial error	0.147	(0.721)	0.356	(0.556)	14.603***	(0.005)
Model B8	LM spatial lag	0.285	(0.584)	1.575	(0.264)	0.189	(0.736)
	LM spatial error	0.089	(0.751)	0.581	(0.486)	12.308***	(0.000)
Model B9	LM spatial lag	0.232	(0.654)	0.579	(0.489)	0.476	(0.556)

	LM spatial error	0.040	(0.845)	0.051	(0.856)	12.068***	(0.008)
Model C2	LM spatial lag	0.342	(0.552)	0.640	(0.432)	0.178	(0.727)
	LM spatial error	0.148	(0.623)	0.362	(0.567)	14.696***	(0.000)
Model C3	LM spatial lag	5.429**	(0.019)	1.142	(0.256)	9.860***	(0.003)
	LM spatial error	23.798***	(0.000)	0.345	(0.545)	0.289	(0.668)
Model C4	LM spatial lag	0.487	(0.504)	0.756	(0.378)	0.344	(0.585)
	LM spatial error	3.376*	(0.070)	0.552	(0.496)	13.915***	(0.000)
Model C5	LM spatial lag	0.170	(0.703)	0.945	(0.335)	0.167	(0.683)
	LM spatial error	0.181	(0.684)	0.984	(0.278)	14.421***	(0.004)
Model C6	LM spatial lag	3.022*	(0.098)	0.665	(0.490)	4.878**	(0.036)
	LM spatial error	1.421	(0.240)	0.336	(0.599)	28.012***	(0.000)
Model C7	LM spatial lag	0.284	(0.590)	1.447	(0.267)	0.129	(0.754)
	LM spatial error	0.111	(0.762)	0.578	(0.446)	12.342***	(0.003)
Model C8	LM spatial lag	0.360	(0.620)	0.765	(0.335)	0.189	(0.741)
	LM spatial error	0.152	(0.718)	0.453	(0.580)	14.533***	(0.008)
Model C9	LM spatial lag	0.458	(0.461)	1.143	(0.238)	0.0622	(0.823)
	LM spatial error	1.389	(0.246)	0.112	(0.799)	10.067***	(0.006)
Middle-income and Low-income countries							
Model A1	LM spatial lag	0.338	(0.561)	1.064	(0.302)	0.054	(0.815)
	LM spatial error	1.386	(0.236)	0.02	(0.887)	9.949***	(0.001)
Model A2	LM spatial lag	0.225	(0.635)	0.510	(0.481)	0.398	(0.531)
	LM spatial error	0.025	(0.878)	0.035	(0.855)	12.041***	(0.000)
Model A3	LM spatial lag	2.838*	(0.095)	0.644	(0.422)	4.811**	(0.032)
	LM spatial error	1.411	(0.235)	0.320	(0.575)	28.012***	(0.001)
Model A4	LM spatial lag	0.301	(0.601)	1.461	(0.224)	0.130	(0.722)
	LM spatial error	0.102	(0.752)	0.566	(0.453)	12.338***	(0.000)
Model	LM spatial	0.160	(0.710)	1.051	(0.338)	0.149	(0.712)

A5	lag						
	LM spatial error	0.163	(0.686)	1.056	(0.304)	14.401***	(0.002)
Model A6	LM spatial lag	0.332	(0.572)	0.668	(0.433)	0.136	(0.699)
	LM spatial error	0.141	(0.702)	0.322	(0.587)	14.662***	(0.000)
Model A7	LM spatial lag	0.475	(0.512)	0.764	(0.388)	0.312	(0.577)
	LM spatial error	3.41*	(0.065)	0.530	(0.466)	14.010***	(0.000)
Model A8	LM spatial lag	1.431	(0.221)	0.821	(0.365)	1.685	(0.202)
	LM spatial error	7.560***	(0.005)	0.190	(0.658)	3.987**	(0.043)
Model A9	LM spatial lag	5.423**	(0.021)	1.153	(0.283)	9.771***	(0.004)
	LM spatial error	24.002***	(0.000)	0.338	(0.581)	0.212	(0.654)
Model B2	LM spatial lag	0.294	(0.588)	1.461	(0.277)	0.128	(0.720)
	LM spatial error	0.101	(0.751)	0.565	(0.753)	0.977	(0.324)
Model B3	LM spatial lag	4.875**	(0.030)	0.165	(0.684)	3.002*	(0.089)
	LM spatial error	0.028	(0.896)	1.001	(0.316)	9.812***	(0.003)
Model B4	LM spatial lag	0.160	(0.710)	1.013	(0.350)	0.154	(0.702)
	LM spatial error	0.159	(0.103)	9.986	(0.299)	14.373***	(0.000)
Model B5	LM spatial lag	0.338	(0561)	1.063	(0.304)	0.055	(0.815)
	LM spatial error	1.387	(0.239)	0.021	(0.888)	9.948***	(0.002)
Model B6	LM spatial lag	2.828*	(0.093)	0.648	(0.421)	4.790**	(0.029)
	LM spatial error	1.410	(0.234)	0.317	(0.573)	27.868***	(0.000)
Model B7	LM spatial lag	0.331	(0.565)	0.645	(0.422)	0.135	(0.713)
	LM spatial error	0.137	(0.712)	0.311	(0.577)	14.663***	(0.000)
Model B8	LM spatial lag	0.295	(0.591)	1.505	(0.228)	0.127	(0.724)
	LM spatial error	0.099	(0.747)	0.560	(0.465)	12.338***	(0.001)
Model B9	LM spatial lag	0.222	(0.636)	0.509	(0.476)	0.404	(0.531)
	LM spatial error	0.030	(0.878)	0.040	(0.859)	12.033***	(0.000)
Model C2	LM spatial lag	0.332	(0.555)	0.651	(0.420)	0.135	(0.717)

	LM spatial error	0.138	(0.698)	0.311	(0.588)	14.666***	(0.001)
Model C3	LM spatial lag	5.419**	(0.019)	1.148	(0.279)	9.862***	(0.001)
	LM spatial error	23.698***	(0.000)	0.340	(0.599)	0.202	(0.655)
Model C4	LM spatial lag	0.477	(0.504)	0.748	(0.389)	0.311	(0.579)
	LM spatial error	3.366*	(0.070)	0.530	(0.466)	13.975***	(0.000)
Model C5	LM spatial lag	0.160	(0.703)	0.971	(0.352)	0.151	(0.698)
	LM spatial error	0.171	(0.684)	0.998	(0.296)	14.421***	(0.000)
Model C6	LM spatial lag	3.012*	(0.098)	0.650	(0.420)	4.801**	(0.029)
	LM spatial error	1.411	(0.240)	0.320	(0.577)	28.012***	(0.002)
Model C7	LM spatial lag	0.294	(0.590)	1.460	(0.228)	0.128	(0.723)
	LM spatial error	0.101	(0.762)	0.570	(0.442)	12.342***	(0.000)
Model C8	LM spatial lag	0.350	(0.620)	0.705	(0.322)	0.155	(0.613)
	LM spatial error	0.142	(0.718)	0.410	(0.501)	14.553***	(0.002)
Model C9	LM spatial lag	0.448	(0.461)	1.163	(0.202)	0.066	(0.816)
	LM spatial error	1.399	(0.246)	0.102	(0.777)	10.012***	(0.000)

Note: p-values in parentheses, ***, **, and * show significance at the 1%, 5%, and 10% level respectively **(Source: Authors' estimations).**

Table (7) represents the results of estimating the Kuznets curve given by equation (1). The coefficient of the level values and quadratic form of the logarithmic GDP per capita is significant in most models. According to estimation results, the coefficient of the logarithmic GDP per capita is negative in high-income countries and middle- and low-income countries respectively for level values and positive for the quadratic terms. The coefficient is -5.3 and -4.3 for the former and 0.56 and 0.4 for the latter. The effects of economic growth on the Gini coefficient for different levels of GDP per capita are presented in Figure 1 based on the maximum and minimum amounts of GDP per capita in the studied sample and replacing two estimated coefficients in equation (2). However, its positive impact in countries with higher GDP per capita is more. According to the model

proposed in the theoretical foundation, income inequality was expected to increase in the early stages of the development along with an increase in economic growth and development, and the effects were expected to be reversed after passing the maximum point. Table (8) and (9) represents the results of estimating the Financial curve and Financial Kuznets by equation (2) and (4). In equations (2) and (4) also the coefficient of the level values and quadratic form of the logarithmic GDP per capita is significant in most models. According to estimation results, the coefficient of the logarithmic GDP per capita is negative in high-income countries and middle- and low-income countries respectively for level values and positive for the quadratic terms. In Table (8) The coefficient is -4.6 and -3.6 for the former and 0.24 and 0.34 for the latter. In Table (9) The coefficient is -4.4 and -3.4 for the former and 0.45 and 0.35 for the latter.

According to the model proposed in the theoretical foundation, proponents of the Kuznets curve hypothesis argue that during the transition from traditional to modern economy, income equality will finally be achieved after reaching the maximum point. Diverse results have been obtained in countries under study, meaning that the positive effects of economic growth on inequality are intensified with higher levels of GDP per capita. According to the results of economic development, there is no guarantee for reducing inequality in countries. On the contrary, challenges to poverty and inequality in these countries have lower priority. This result is consistent with the results reported by Robinson (1976), Saith (1983), Papanek & Kyn (1986), Ram (1988), Annand & Kanpur (1993), Angeles (2010), Shabazz (2010), Kavya & Shijin (2019), Sayed (2020) and Cinar et al (2019, 2020).

The general government final consumption expenditure is one of the effective factors in reducing income inequality. In table (7) in high-income countries and middle- and low-income countries respectively, an increase in general government final consumption expenditure by 1% leads to a reduction in income inequality by 0.052% and 0.002%. It is argued that government spending on social transfers tends to reduce income inequality, However, the size of the effect can vary substantially, depending on the extent to which transfers are targeted on lower

income groups; if most spending on transfers are captured by the middle class, for political economy reasons, the impact on inequality may be quite small. To reduce poverty and inequality, governments need to improve targeting, enhance the quality of education and health for the poor, and increase efficiency in social spending. In total, Government spending can help reduce inequality by increasing the income of individuals and households. This result is consistent with the results reported by Anderson et al (2016), Enami et al (2016), Sánchez, Pérez-Corral (2018), İlker ULU (2018), Kavya & Shijin (2019) and Alamanda (2020). In table (8) in high-income countries and middle- and low-income countries respectively, An increase in general government final consumption expenditure by 1% leads to a reduction in income inequality by 0.001% and 0.002%. in table (9) in high-income countries and middle- and low-income countries respectively, An increase in general government final consumption expenditure by 1% leads to a reduction in income inequality by 0.012% and 0.007%.

In table (7) in high-income countries and middle- and low-income countries respectively, An increase in inflation by 1% leads to an increase in income inequality by 0.003% and 0.002%. A rise in the price level will lower the purchasing power, especially the poor. Besides, the real value of government aid could be negatively affected as well since the financial aid will not be adjusted upward to compensate for inflation. In fact, an increase in the inflation rate leads to an increase in the class gap. This result is consistent with the results reported by Bulir & Gulde (1995), Cole & Towe (1996), Romer (1998), Easterly & Fischer (2000), Galli & Hoeven (2001) and Kavya & Shijin (2019). in table (8) in high-income countries and middle- and low-income countries respectively, An increase in inflation by 1% leads to an increase in income inequality by 0.003% and 0.013%. In table (9) in high-income countries and middle- and low-income countries respectively, An increase in inflation by 1% leads to an increase in income inequality by 0.001% and 0.001%.

in table (7) in high-income countries and middle- and low-income countries respectively, an increase of 1% in trade openness leads to a rise in income inequality by 0.01% and 0.004%. so that the development of globalization and

international trade can be effective in intensifying income inequality in countries. Indeed, trade openness leads to a decrease in the income of unskilled and an increase in the income of skilled and medium-skilled employees by reducing tariffs, leading to an increase in the income gap between people with different skill levels. It can be argued that an increase in foreign direct investment leads to an increase in income inequality so that the arrival of foreign direct investment to a country may improve the conditions of skilled workers and create high-income groups, but it does not increase the income of other groups necessarily. These results are in accordance with the study by Barro (2000), Ang (2010), Jaumotte, Lall & Papageorgiou (2013). in table (8) in high-income countries and middle- and low-income countries respectively, An increase of 1% in trade openness leads to a rise in income inequality by 0.001% and 0.003%. in table (9) in high-income countries and middle- and low-income countries respectively, An increase of 1% in trade openness leads to a rise in income inequality by 0.01% and 0.004%.

The urban population is one of the effective factors in reducing income inequality. in table (7) in high-income countries and middle- and low-income countries respectively, an increase in urbanization by 1% leads to a reduction in income inequality by 0.078% and 0.089%. The spectacular growth of urbanization along with the expansion of cities in terms of size and population increase has caused the creation of various administrative structures to provide services and different administrative combinations. Cities are divided into different parts due to structural, physical, social and economic differences, and administrative and social disharmony causes corruption and unequal distribution of income and class gap. Urbanization is a real result of development. This result is consistent with the results reported by Wan et al (2022), Minh Ha et al (2019), Wu and Rao (2017) and Sagala et al (2014) and contrary to Taresh et al (2021) and Kavya and Shijin (2019). in table (8) in high-income countries and middle- and low-income countries respectively, an increase in urbanization by 1% leads to a reduction in income inequality by 0.045% and 0.068%. in table (9) in high-income countries and middle- and low-income countries respectively, an increase in urbanization by 1% leads to a reduction in income inequality by 0.052% and 0.067%.

Finally, in table (7) in high-income countries and middle- and low-income countries respectively, the age dependency ratio with a significant and positive coefficient of about 0.144 and 0.146 indicates that an increase in dependent population leads to an increase in income inequality. Individuals at an old age tend to have a large dispersion in economic status because of some idiosyncratic events or shocks that have accumulated during life. In particular, the income of older individuals reflects their accumulation of human capital, saving behaviors, and capabilities of risk management. Indeed, population aging intensifies the aggregate income inequality of the total economy by increasing the proportion of older groups characterized by a large income dispersion. The increase in the dependency ratio of the population, which is due to the increase in life expectancy compared to the working age, has several consequences, one of which is the increase in government spending (such as raising pensioners' salaries), the loss of pension funds, and the transfer of the tax burden to others. Departments and people. All these things can reduce the "ability" of people, especially retirees, to face economic problems or even buy goods, and as a result, inequality will increase. These results are in accordance with the study by Kavya and Shijin (2019), Dong et al (2018) and Baiardi & Morana (2016). In table (8) in high-income countries and middle- and low-income countries respectively, the age dependency ratio with a significant and positive coefficient of about 0.181 and 0.151 indicates that an increase in dependent population leads to an increase in income inequality. in table (9) in high-income countries and middle- and low-income countries respectively, the age dependency ratio with a significant and positive coefficient of about 0.125 and 0.147 indicates that an increase in dependent population leads to an increase in income inequality.

After examining the effects of control variables on the dependent variable of GINI, we assess the impacts of financial development indices. in tables (7), (8) and (9) The results indicate that IFDI reduces income inequality in countries, but the negative coefficient is significant only for indicators of knowledge (KNI) and corporate social responsibility (CSR) among the five elements.

CSR is evaluated through two components, namely transparency of CSR activities and cash paid from corporate income in a different sector. CSR activities are measured by the information presented in annual reports of IFIs and based on AAOIFI governance standard for IFIs. In this regard, social responsibility includes cash related to charity, Zakat, and Qarz-ul-Hasna paid by IFIs. Due to the frequent use of this indicator and increased public awareness among IFIs about the disclosure of CSR activities, IFIs begin to disclose all their participation. Meanwhile, FinTechs can improve the path for Social-Islamic finance such as Zakat and charity, thus increasing transparency in resource collection, management, and distribution. In addition, digitalization is progressed to create evolutions in Social-Islamic finance. On the other hand, Islamic charities certainly act by helping the poor beyond their role in providing social services as mechanisms for income redistribution to reduce gaps and inequalities. These organizations allow the rich to have empathy with the poor and fight the income gap. These are only a small part of the positive impact of IFD on income inequality through CSR.

Islamic finance knowledge is assessed through education and research as the main elements of each knowledge-based industry. These factors allow getting access to depth and efficiency of the Islamic financial industry and consequently stimulate economic growth, thus leading to a positive effect on income inequality.

Table 7. The GINI model's estimation for Equations (1) using the spatial fixed effects model

	Model A1	Model A2	Model A3	Model A4	Model A5	Model A6	Model A7	Model A8	Model A9
High-income countries									
GDPP	-5.302*	-3.232	-5.245*	-4.356**	-3.533	-3.421*	-4.548*	-5.450*	-2.512
	(0.082)	(0.255)	(0.098)	(0.019)	(0.205)	(0.073)	(0.085)	(0.074)	(0.526)
GDPP^2	0.567**	0.525**	0.745**	0.565**	0.452**	0.356**	0.456**	0.445**	0.356**
	(0.002)	(0.012)	(0.004)	(0.002)	(0.011)	(0.001)	(0.000)	(0.001)	(0.025)
GOV	-0.052**	-0.052**	-0.002**	-0.023*	-0.052**	-0.002**	-0.010**	-0.014**	-0.042*

	(0.041)	(0.001)	(0.016)	(0.054)	(0.012)	(0.001)	(0.007)	(0.042)	(0.056)
INF1	0.003***	0.002**	0.005**	0.004**	0.004**	0.003*	0.008***	0.004*	0.003*
	(0.004)	(0.056)	(0.048)	(0.004)	(0.003)	(0.063)	(0.002)	(0.062)	(0.085)
OPE	0.010***	0.012**	0.006**	0.006**	0.006**	0.005**	0.006**	0.011**	0.009**
	(0.002)	(0.000)	(0.001)	(0.000)	(0.048)	(0.004)	(0.005)	(0.021)	(0.000)
URB	-0.078***	-0.045**	-0.055**	-0.079**	-0.056**	-0.065**	-0.054**	-0.023**	-0.053**
	(0.000)	(0.036)	(0.006)	(0.033)	(0.015)	(0.002)	(0.000)	(0.041)	(0.008)
AGE	0.144***	0.145**	0.143**	0.148**	0.139**	0.165**	0.152**	0.138**	0.147**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
IFDI		-0.085**							
		(0.047)							
QDI			0.015						
			(0.423)						
KNI				-0.065**					
				(0.000)					
CSR					-0.045**				
					(0.000)				
GOI						-0.010			
						(0.530)			
AWI							0.042		
							(0.537)		
FI								-1.623**	
								(0.001)	
FM									0.527**
									(0.021)
LogL	45.270	44.523	45.453	50.201	50.520	45.447	43.123	48.682	48.452
R^2	0.999	0.999	1.000	1.000	1.000	1.000	0.999	1.000	0.999
	Model A1	Model A2	Model A3	Model A4	Model A5	Model A6	Model A7	Model A8	Model A9
Middle-income and Low-income countries									
GDPP	-4.302*	-3.332	-4.236*	-5.388**	-3.653	-4.493*	-4.528*	-4.026*	-2.732
	(0.072)	(0.166)	(0.078)	(0.018)	(0.105)	(0.063)	(0.062)	(0.083)	(0.258)
GDPP^2	0.407***	0.345**	0.402**	0.495**	0.350**	0.420**	0.422**	0.409**	0.335**
	(0.005)	(0.018)	(0.006)	(0.000)	(0.011)	(0.004)	(0.004)	(0.004)	(0.020)
GOV	-0.002**	-0.007**	-0.002**	-0.013**	-0.019*	-0.002**	-0.001**	-0.015**	-0.030**

	(0.018)	(0.017)	(0.006)	(0.014)	(0.062)	(0.043)	(0.027)	(0.002)	(0.014)
INF1	0.002**	0.001**	0.002*	0.003**	0.001**	0.002**	0.002**	0.005*	0.001**
	(0.014)	(0.016)	(0.053)	(0.014)	(0.004)	(0.029)	(0.050)	(0.063)	(0.025)
OPE	0.004**	0.004**	0.004**	0.004**	0.003**	0.004**	0.004**	0.004**	0.005**
	(0.005)	(0.003)	(0.005)	(0.004)	(0.044)	(0.005)	(0.006)	(0.012)	(0.001)
URB	-0.089**	-0.073**	-0.090**	-0.068**	-0.068**	-0.086**	-0.091**	-0.062**	-0.090**
	(0.005)	(0.022)	(0.004)	(0.023)	(0.023)	(0.007)	(0.004)	(0.049)	(0.003)
AGE	0.146**	0.142**	0.149**	0.136**	0.151**	0.144**	0.146**	0.149**	0.157**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
IFDI		-0.072**							
		(0.037)							
QDI			0.014						
			(0.588)						
KNI				-0.085**					
				(0.000)					
CSR					-0.038**				
					(0.000)				
GOI						-0.009			
						(0.530)			
AWI							0.013		
							(0.564)		
FI								-1.454**	
								(0.003)	
FM									0.387**
									(0.010)
LogL	43.277	45.554	43.433	51.186	51.701	43.487	43.454	47.696	46.698
R^2	0.999	1.000	0.999	1.000	1.000	0.999	0.999	1.000	1.000

Note: p-value, ***, **, and * show significance at the 1%, 5%, and 10% level respectively (**Source: Authors' estimations).**

Table 8. The GINI model's estimation for Equations (2) using the spatial fixed effects model

	Model B2	Model B3	Model B4	Model B5	Model B6	Model B7	Model B8	Model B9
High-income countries								

GDPP	-4.661**	-5.485*	-5.332**	-5.030*	-2.524	-5.328*	-3.892	-2.574
	(0.045)	(0.076)	(0.030)	(0.045)	(0.325)	(0.048)	(0.109)	(0.198)
GDPP ^2	0.244**	0.501***	0.398***	0.414***	0.444**	0.521***	0.408***	0.597***
	(0.025)	(0.003)	(0.000)	(0.007)	(0.040)	(0.000)	(0.001)	(0.002)
GOV	-0.001**	-0.001*	-0.014*	-0.002**	-0.030**	-0.005**	-0.027***	-0.069*
	(0.041)	(0.084)	(0.061)	(0.023)	(0.020)	(0.036)	(0.007)	(0.065)
INF1	0.003**	0.001*	0.002*	0.001*	0.003**	0.004*	0.001**	0.000*
	(0.014)	(0.073)	(0.085)	(0.081)	(0.042)	(0.063)	(0.050)	(0.087)
OPE	0.001**	0.002***	0.007***	0.001*	0.006***	0.005***	0.008***	0.009***
	(0.034)	(0.002)	(0.000)	(0.052)	(0.000)	(0.008)	(0.007)	(0.000)
URB	-0.045**	-0.032***	-0.058**	-0.047**	-0.085*	-0.077***	-0.065*	-0.054***
	(0.021)	(0.002)	(0.017)	(0.036)	(0.001)	(0.004)	(0.091)	(0.002)
AGE	0.181***	0.148***	0.152***	0.185***	0.168***	0.155***	0.169***	0.132***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
IFDI	-0.032**							
	(0.044)							
QDI		0.045						
		(0.547)						
KNI			-0.094**					
			(0.041)					
CSR				-0.055*				
				(0.051)				
GOI					0.066			
					(0.652)			
AWI						-0.065		
						(0.762)		
FI							2.545*	
							(0.052)	
FM								0.683**
								(0.014)
LogL	45.523	51.143	50.844	49.847	43.365	45.367	49.490	45.354
R^2	1.000	1.000	0.999	0.999	1.000	0.999	0.999	1.000
	Model B2	Model B3	Model B4	Model B5	Model B6	Model B7	Model B8	Model B9
Middle-income and Low-income countries								

GDPP	-3.661***	-4.473	-5.358**	-4.230*	-2.764	-4.448*	-3.452	-2.852
	(0.002)	(0.068)	(0.020)	(0.080)	(0.260)	(0.060)	(0.124)	(0.251)
GDPP ^2	0.345**	0.422***	0.418***	0.401***	0.333**	0.421***	0.399***	0.455***
	(0.018)	(0.004)	(0.000)	(0.008)	(0.020)	(0.004)	(0.004)	(0.005)
GOV	-0.002**	-0.002*	-0.014*	-0.002*	-0.020**	-0.004**	-0.028***	-0.051*
	(0.041)	(0.085)	(0.061)	(0.053)	(0.020)	(0.031)	(0.007)	(0.065)
INF1	0.013**	0.002*	0.004***	0.007*	0.001*	0.005*	0.008*	0.000*
	(0.004)	(0.073)	(0.005)	(0.081)	(0.052)	(0.063)	(0.051)	(0.087)
OPE	0.003**	0.004***	0.005***	0.002*	0.005***	0.004***	0.003***	0.006***
	(0.044)	(0.004)	(0.000)	(0.050)	(0.000)	(0.009)	(0.009)	(0.000)
URB	-0.068**	-0.085***	-0.079**	-0.062**	-0.090*	-0.081***	-0.045	-0.082***
	(0.023)	(0.004)	(0.016)	(0.049)	(0.003)	(0.005)	(0.285)	(0.003)
AGE	0.151***	0.156***	0.142***	0.160***	0.149***	0.144***	0.146***	0.154***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
IFDI	-0.045**							
	(0.044)							
QDI		0.055						
		(0.485)						
KNI			-0.093*					
			(0.056)					
CSR				-0.053*				
				(0.051)				
GOI					0.055			
					(0.453)			
AWI						-0.021		
						(0.741)		
FI							2.545*	
							(0.068)	
FM								0.652**
								(0.012)
LogL	45.803	44.163	49.994	52.987	43.957	44.118	49.852	46.815
R^2	1.000	0.999	1.000	1.000	1.000	0.999	1.000	1.000

Note: p-value, ***, **, and * show significance at the 1%, 5%, and 10% level respectively **(Source: Authors' estimations).**

Table 9. The GINI model's estimation for Equations (4) using the spatial fixed effects model

	Model C2	Model C3	Model C4	Model C5	Model C6	Model C7	Model C8	Model C9
High-income countries								
GDPP	-4.452*	-3.945	-4.436**	-3.847*	-5.452*	-4.851*	-3.599	-2.945
	(0.053)	(0.122)	(0.011)	(0.089)	(0.058)	(0.062)	(0.235)	(0.354)
GDPP ^2	0.452**	0.357***	0.562***	0.524***	0.436***	0.745***	0.987***	0.682**
	(0.042)	(0.005)	(0.000)	(0.004)	(0.003)	(0.001)	(0.000)	(0.045)
GOV	-0.012**	-0.018*	-0.023*	-0.065**	-0.002	-0.023*	-0.053**	-0.031***
	(0.041)	(0.085)	(0.095)	(0.032)	(0.973)	(0.091)	(0.017)	(0.005)
INF1	0.001**	0.017**	0.003*	0.004***	0.004**	0.002*	0.009*	0.000***
	(0.022)	(0.023)	(0.055)	(0.009)	(0.027)	(0.001)	(0.051)	(0.007)
OPE	0.001***	0.003***	0.005***	0.006*	0.007***	0.007***	0.002***	0.001***
	(0.001)	(0.008)	(0.005)	(0.054)	(0.009)	(0.004)	(0.001)	(0.000)
URB	-0.052**	-0.056***	-0.041**	-0.012**	-0.045**	-0.021***	-0.057	-0.065***
	(0.025)	(0.005)	(0.035)	(0.041)	(0.031)	(0.008)	(0.125)	(0.000)
AGE	0.125***	0.125***	0.175***	0.186***	0.198***	0.134***	0.112***	0.136***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
IFDI	-0.063**							
	(0.035)							
QDI		0.069						
		(0.355)						
KNI			-0.090*					
			(0.052)					
CSR				-0.064*				
				(0.051)				
GOI					0.064			
					(0.342)			
AWI						-0.013		
						(0.587)		
FI							3.214*	
							(0.068)	
FM								0.521**
								(0.042)

LogL	46.842	43.123	41.196	53.148	52.321	43.988	51.248	42.864
R^2	1.000	1.000	0.999	1.000	0.999	0.999	1.000	1.000
	Model C2	Model C3	Model C4	Model C5	Model C6	Model C7	Model C8	Model C9
Middle-income and Low-income countries								
GDPP	-3.429*	-3.973	-5.428**	-3.936*	-4.364*	-4.676*	-3.432	-2.904
	(0.053)	(0.102)	(0.019)	(0.079)	(0.071)	(0.056)	(0.137)	(0.231)
GDPP ^2	0.353**	0.387***	0.498***	0.360***	0.416***	0.431***	0.386***	0.355**
	(0.015)	(0.008)	(0.000)	(0.008)	(0.004)	(0.004)	(0.005)	(0.015)
GOV	-0.007**	-0.007**	-0.014*	-0.025	-0.001***	-0.002**	-0.028***	-0.031
	(0.021)	(0.015)	(0.095)	(0.332)	(0.003)	(0.031)	(0.007)	(0.285)
INF1	0.001**	0.002*	0.003	0.001**	0.002*	0.002**	0.004*	0.000
	(0.032)	(0.073)	(0.505)	(0.019)	(0.067)	(0.021)	(0.051)	(0.987)
OPE	0.004***	0.004***	0.004***	0.003*	0.004***	0.004***	0.004***	0.005***
	(0.002)	(0.004)	(0.004)	(0.050)	(0.005)	(0.009)	(0.009)	(0.000)
URB	-0.067**	-0.090***	-0.069**	-0.066**	-0.077**	-0.092***	-0.039	-0.093***
	(0.035)	(0.004)	(0.026)	(0.026)	(0.017)	(0.004)	(0.237)	(0.002)
AGE	0.142***	0.149***	0.136***	0.158***	0.147***	0.144***	0.146***	0.157***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
IFDI	-0.028**							
	(0.035)							
QDI		0.069						
		(0.355)						
KNI			-0.090*					
			(0.052)					
CSR				-0.063*				
				(0.051)				
GOI					0.044			
					(0.342)			
AWI						-0.020		
						(0.756)		
FI							2.946*	
							(0.068)	
FM								0.536**
								(0.012)

LogL	46.503	43.763	51.194	53.548	44.257	43.618	50.052	47.215
R^2	1.000	0.999	1.000	1.000	1.000	0.999	1.000	1.000

Note: p-value, ***, **, and * show significance at the 1%, 5%, and 10% level respectively **(Source: Authors' estimations).**

5. Conclusion

Increased inequality is today's controversial discussion, mainly attributed to access to financial resources. Some experts believe that inequality is caused by individual efforts and indicates a constructive factor in society. Some others argue that inequality is created by an unfair system that only raises a few boats in a tide, thus preventing hardworking. Nowadays, the importance of income distribution in societies is so that many economic schools introduce regulating an appropriate income distribution model and trying to reduce inequality as one of the main goals of governments. Fair income distribution is one of the main economic development indicators. In this regard, financial development is a potential key to achieving a long-run economic development. There are various studies in this regard, all indicating that financial development can be a policy to enhance economic growth. Economic growth driven by financial development increases average income, while inequality can increase or decrease. In recent few decades, Islamic finance, as a substitute for conventional finance, has widely been developed to achieve sharia compliance performance in Islamic countries and as a financial development strategy along with conventional finance in non-Islamic countries. Measuring the comprehensive development of Islamic financial development is a challenge. Undoubtedly, the choice of measures as subsets and their relationships with IFD assessment is full of subjective value judgments and data resource trade-offs that are accessible easily. Here, the necessity of a direct indicator to assess IFD is posed. In the present research, it was tried to investigate the role of IFD in determining inequality over the period 2013-2017 using the Kuznets hypothesis, financial curve hypothesis, Financial Kuznets hypothesis, ICD Refinitiv Islamic Finance Development Indicator and by identifying effective factors on income inequality in 28 selected countries, Including 14 countries with

high income and 14 countries with middle and low income, and applying spatial panel data approach.

According to the results, the effect of IFD on income inequality is negative. IFD was measured by ICD Refinitiv Islamic Finance Development Indicator. This indicator has five general sub-indicators, each having several distinct components. The five main indicators for the IFDI are: Quantitative Development, Knowledge, Governance, Corporate Social Responsibility, and Awareness. The negative coefficient is significant only for indicators of knowledge (KNI) and corporate social responsibility (CSR) among the five elements. The coefficient is not significant for indicators of Quantitative Development (QDI), Governance (GOI) and Awareness (AWI). The official start of measuring the target index in the countries under review is 2013. During the period of time considered and in selected countries in this research, in the Quantitative Development (QDI) section, only the sub-sectors of Islamic banking and sukuk and in the Awareness (AWI) section, only the news sub-sector has grown significantly. In the meantime, the Governance (GOI) sector has not grown much in any of the sub-sectors. There has not been much growth in any of the sub-sectors. Since 2019, we have seen more growth in the mentioned indicators, especially in the awareness sector. However, based on the available statistical evidence, during the period of 2013-2017, the CRS sector and especially the knowledge sector have grown significantly in almost all of their sub-sectors. This issue can be one of the significant reasons for the two variables CRS and knowledge.

Summarily, according to the analysis results, economic growth alone is not enough to eliminate or reduce income inequality. Proponents of the Kuznets curve argue that industrialization is accompanied by economic equality. Nevertheless, after many years, the advancements of financial and economic sectors have not well been able to meet the expected requirements. Our results show that today's world needs to formulate more policies to resolve the inequality issue. This fact restricts the real effect of financial development, particularly Islamic finance. Economic policies should be revised to deal with this situation so that the poor will benefit from the interests of the economic and financial sectors as much as possible. This study can be further extended by having the time-series research.

Among the countries that may have long information of Islamic finance could be Iran, Sudan, Pakistan, Saudi Arabia, UAE, Egypt, Kuwait, Jordan and Bahrain by the fact that they are having Islamic financial development prior to 1980s. Another possibility is to turn into case study.

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تأثیر توسعهٔ مالی اسلامی بر نابرابری درآمد در کشورهای منتخب: رویکرد پانل فضایی

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چکیده
افزایش نابرابری، بحث‌برانگیزترین مسألهٔ روز کشورهای جهان است که دسترسی به منابع اقتصادی، ازجمله دلایل بارز این نابرابری است. برخی معتقدند که نابرابری ناشی از تلاش فردی و نمایانگر یک عامل سازنده در جامعه است. برخی دیگر استدلال می‌کنند که نابرابری از یک سیستم ناعادلانه به‌وجود می‌آید، که فقط چند قایق را در جریان جزر و مد بالا می‌برد و بنابراین، بازدارندهٔ سخت‌کوشی است. امروزه اهمیت توزیع درآمد در جوامع به‌حدی است که در بسیاری از مکاتب اقتصادی، یکی از اهداف اصلی دولت‌ها را تنظیم الگوی مناسب توزیع درآمد و تلاش در مسیر کاهش نابرابری درآمدی ذکر می‌کنند. توزیع عادلانهٔ درآمد به‌عنوان یکی از شاخص‌های اصلی و مهم در توسعهٔ اقتصادی مطرح می‌شود. در این‌راستا توسعهٔ مالی یکی از کلیدهای بالقوهٔ دست‌یابی به رشد بلندمدت اقتصادی است. مطالعات زیادی در این‌زمینه انجام گرفته است که همگی نشان می‌دهند توسعهٔ مالی می‌تواند به‌عنوان یکی از سیاست‌های ارتقادهندهٔ رشد اقتصادی مطرح باشد. رشد اقتصادی ناشی از توسعهٔ مالی، درآمد متوسط را افزایش می‌دهد، اما نابرابری می‌تواند کاهش یا افزایش داشته باشد. در چند دههٔ اخیر نظام مالی اسلامی، به‌عنوان جایگزین مالی متعارف برای دست‌یابی به عملکرد منطبق‌بر شریعت در کشورهای اسلامی و راهکار توسعهٔ مالی همراه با مالی متعارف در کشورهای غیراسلامی گسترش چشم‌گیری داشته است. خود موضوع اندازه‌گیری توسعهٔ جامع صنعت مالی اسلامی، یک چالش است. بی‌تردید، انتخاب سنجه‌های مناسب به‌عنوان زیرمجموعه‌ها و ارتباط آن‌ها با ارزیابی توسعهٔ مالی اسلامی مملو از قضاوت‌های ارزشی ذهنی و دادوستد منابع داده‌ای است که به‌راحتی قابل دسترسی هستند. در اینجا ضرورت وجود یک شاخص مستقیم برای سنجش توسعهٔ مالی اسلامی مطرح می‌شود. در این پژوهش با استفاده از داده‌های سال‌های ۲۰۱۷-۲۰۱۳ برای ۲۸ کشور (کشورهایی که براساس شاخص توسعهٔ مالی اسلامی مورد استفاده، حداقل در یکی از ابعاد توسعهٔ مالی اسلامی پیشرفت داشته‌اند) شامل ۱۴ کشور با درآمد بالا و ۱۴ کشور با درآمد متوسط و کشورهای کم‌درآمد، فرضیهٔ کوزنتس و فرضیهٔ منحنی مالی و فرضیهٔ مالی کوزنتس؛ به‌صورت تجربی اثرگذاری توسعهٔ مالی اسلامی بر نابرابری مورد ارزیابی قرار گرفته است. نتایج به‌دست آمده از مدل دوربین فضایی (SDM) بیانگر این است که نتایج برای دو گروه کشورها یکسان است و شاخص توسعهٔ مالی اسلامی منجر به کاهش نابرابری درآمدی می‌شود. با وجوداین، از میان پنج جزء تشکیل‌دهندهٔ این شاخص، تنها ضرایب منفی برای شاخص‌های دانش (KNI) و مسئولیت اجتماعی شرکت‌ها (CSR) معنادار است، درحالی‌که ابعاد مختلف توسعهٔ مالی متعارف در نمونهٔ کشورهای مورد مطالعه دارای اثرات متعارض و معنادار می‌باشد. علاوه‌براین، یافته‌های این مطالعه نشان می‌دهد که هیچ شواهد روشنی برای حمایت از پیشنهاد توسعهٔ اقتصادی همراه با رشد مالی وجود ندارد که بتواند مشکل نابرابری درآمد را کاهش دهد. همچنین، یافته‌های پژوهش بیانگر آن است که تولید ناخالص داخلی سرانه، تورم و باز بودن تجارت باعث افزایش نابرابری درآمد گردیده؛ در مقابل، هزینه‌های مصرف نهایی دولت، جمعیت شهری و نسبت وابستگی سن، به کشورها کمک می‌کند تا نابرابری درآمدی را کاهش دهند.

کلیدواژگان: توسعهٔ مالی اسلامی، نابرابری درآمد، منحنی کوزنتس، منحنی مالی، منحنی مالی کوزنتس، رویکرد پانل فضایی.
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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.

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

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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