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# The Effects of Tax Shocks on GNP and Inflation in Iran, A DSGE Approach

***Seyed-nezamuddin MAKIYAN***[1] *(https://orcid.org/0000-0002-8890-3890), Yazd University, Iran; nmakiyan@yazd.ac.ir*

***Seyed-mohamad-saleh Najafi FARASHAH*** *(https://orcid.org/0000-0002-4897-7262), Yazd University, Iran; najafi134@gmail.com*

## İran'da Vergi Şoklarının GSMH ve Enflasyon Üzerindeki Etkisinin Dinamik Stokastik Genel Denge Yaklaşımı ile Analizi

### Abstract

This study investigates indirect tax shocks' influences on GDP and inflation in Iran's economy, using a DSGE (Dynamic Stochastic General Equilibrium) model. The results indicate that a shock cause equal to one standard deviation in tax on consumption can reduce GDP by 0.006% and inflation by 0.018%. Also, a shock in the import tax causes the GDP to decrease by 0.089% due to the decrease in demand for imported goods. Moreover, imported goods reduce by 0.4% with the occurrence of import tax shock; meanwhile, inflation increases by 0.89% in the short term. Accordingly, a possible reform for indirect taxes should be more carefully considered.

**Keywords** : Tax Shock, Consumption Tax, Import Tax, Dynamic Stochastic General Equilibrium Model.

**JEL Classification Codes** : C54, E62, H24, H3.

### Öz

Bu çalışma, İran ekonomisinde dolaylı vergi şoklarının GSMH ve enflasyon üzerindeki etkilerini bir DSGD (Dinamik Stokastik Genel Denge) modeli kullanarak incelemektedir. Sonuçlar, tüketim vergisindeki standart sapmaya eşit bir şok nedeninin GSMH'yı %0,006 ve enflasyonu %0,018 azaltabileceğini göstermektedir. İthalat üzerinden alınan vergilerdeki bir şok ise, ithal mallara olan talebin azalması nedeniyle GSMH'nın %0,089 oranında düşmesine neden olmaktadır. Ayrıca, ithalat üzerinden alınan vergi şokunun meydana gelmesiyle ithal mallar %0,4 oranında azalırken; enflasyon kısa vadede %0,89 artmaktadır. Bu bağlamda, dolaylı vergiler için olası bir reform çalışması yapılırken daha dikkatli bir şekilde konu ele alınmalı ve tartışılmalıdır.

**Anahtar Sözcükler** : Vergi Şoku, Tüketim Vergisi, İthalat Vergisi, Dinamik Stokastik Genel Denge Modeli.

[1] *Corresponding Author.*

## 1. Introduction

Reliance on the oil revenues, due to the volatile and exogenous nature of a significant part of it, has imposed adverse and detrimental effects on Iran's economy. The mono-product economy, steady inflation, the devaluation of the national currency, the inefficient expansion of the public sector, and the weakening of the private sector are examples of these harmful effects. Accordingly, it is necessary to replace other revenues with oil revenues. Tax revenues are one of these types of revenues. Taxes are not only a means of providing government budget expenditures but also play a regulatory role in implementing macroeconomic policies and strategies (Chapardar & Geraeinejad, 2012: 82).

In Iran, the tax rate index to GDP has always been less than 10 % during the past years, so the goal of the Fifth Development Plan was to reach 10 %, which still needs to be achieved. The Sixth Development Plan for the years 2017, 2018, 2019, and 2020 was equal to 7.4, 8, 8.7, and 9.4, respectively, and the year 2021 was considered at 10%. The unfavourable situation of the country's tax system is well determined by comparing this ratio in Iran with other developed countries and countries with similar economic structures.

The ratio of taxes to GDP, or in other words, tax effort in Iran, is significantly lower than in other countries (below 8%). In this ratio, the average global performance is estimated at least twice that of Iran. Also, the average performance of European and Asian countries is estimated to be about three times that of Iran. Iran ranks 135$^{th}$ out of 140 countries ranked by the World Bank. This ratio is 12% in countries that are less developed than Iran, such as Azerbaijan, Nigeria, and Cameroon, and 17% for economies on the same level as Iran, such as Pakistan, Egypt, and Indonesia, and in developed European countries this rate is over 30% (Pajooyan & Darwish, 2010: 37). Corporate tax, individual income tax, goods and services tax (including value-added tax), import and wealth tax are currently considered the main parts of the country's tax revenue, which are included in a category with two general headings: direct tax (corporate tax and individual income tax) and indirect tax (tax on goods and services and import tax).

On the one hand, the lack of a comprehensive tax information system, the multiplicity of tax rates in different sectors of the economy and broad and varied tax exemptions, the application of personal opinions in the tax collection process, failure to consider parts of the economy in the tax inclusion process, inadequate technical supervision over the tax assessment and collection processes and the subsequent spread of corruption in some tax areas are among the most significant harms and shortcomings of Iran's tax system. Meanwhile, the study of the effects of tax policies on macroeconomic variables in the country is significant. In other words, studying the effects of tax shocks on macroeconomic variables will be one of the most important prerequisites for examining and analysing the impact of a tax policy on the economic system. This is a study of how these policies affect the behaviour of economic agents or taxpayers.

In addition to the direct effects on tax revenues, the composition of tax bases or rates will also affect other economic variables such as consumption, savings, and investment. In this article, we examine the impact of indirect tax changes on GDP growth and inflation. For this purpose, a Dynamic Stochastic General Equilibrium Model will be used to understand and analyse the effects of these shocks. This article has been compiled into five sections. Theoretical foundations and research background are presented in the second part after the introduction. The research method in the third part, analysing and estimating the model in the fourth part, and finally, the conclusion and highlights in the fifth part will be presented.

## 2. Theoretical Foundations and Research Background

In this section, we will review the research background of this issue inside and outside of the country after a brief statement of theoretical foundations:

### 2.1. Theoretical Foundations

Taxes are the most acceptable and appropriate type of government revenue from an economic point of view. They are considered effective for macroeconomic goals such as economic stabilisation, job creation, improving social welfare, and economic growth. A comparison of this source with other sources shows that the higher the share of taxes in financing government expenditures, the significantly less the adverse economic effects. Thus, to achieve economic growth, an efficient tax system is essential.

During the twentieth century, tax levels increased dramatically in most developed countries. Taxes have risen from about 5 and 10 per cent of GDP at the beginning of the last century to 30 and 40 per cent in developed countries today. This significant increase in taxes has raised questions about the impact of taxes on economic growth and other macroeconomic variables. Taxes affect the labour supply, the amount of investment in human capital, and households' decisions about savings. They influence firms' production, job creation, investment, and innovation decisions. Economic growth is one of the critical macroeconomic goals of any country and has an undeniable effect on improving the welfare of society. Therefore, economists have always been interested in determining the factors affecting economic growth and how different policies affect the growth rate and inflation.

Exogenous growth models were proposed before the second half of the 1980s. Traditional neoclassical growth theories such as Solo and Ramsey-Cas-Kopmans attributed the long-term economic growth rate to population growth rates and technological change, all of which were considered exogenous. Therefore, the effects of tax policies on growth in these models could not be examined. Economists like Roemer and Lucas and other researchers such as King and Reblo (1989), Grossman and Helpman (1991), Aghion and Howitt (1996), and Jones (1995) provided literature related to the endogenous growth patterns in response to those exogenous ones. In these models, the steady growth rate depends on economic parameters such as utility functions, production, tax policy, etc. The theories of endogenous growth rate were proposed by optimising the decisions of economic

agents and policymakers after the era of exogenous growth models. Therefore, it was possible to examine the role of economic policies such as tax policy in such models with the long-term endogenous rate of economic growth and inflation. So, this study aims to analyse the effect of tax shocks on economic growth and inflation.

### 2.2. Research Background

The following works are the most important studies conducted in the field of research:

Zhou (1992) extended the inclusive model to government and technology spending by arranging disruptive shocks. In his model, there is no assumption that the capital tax rate should be zero in the long run. Zhou's findings indicate a negative effect of income tax on a human capital-based growth model without the effect of knowledge overflow. In his view, the impact of income tax on human capital growth models with the effect of knowledge overflow and innovation-based growth models, the public infrastructure-based growth models needed to be more apparent. In the field of consumption tax, Zhou believes that when the supply of labour depends on the choice between work and leisure, the effect of consumption tax on growth depends on the characteristics of the instantaneous utility function.

The economy's long-term growth rate depends on the current leisure utility growth rate. This, in turn, depends on the level of leisure and the consumption tax, which also affects leisure. In their paper, Mendoza et al. (1997) tested Harberger's theory that direct and indirect taxes affect investment and economic growth but have little effect. They analysed the impact of taxes on long-term growth in an endogenous growth model based on Human capital. The production uses human capital (H) and physical capital (K). In their work, return relative to scale is also assumed to be constant. In this model, the effect of taxes on physical capital and human capital based on the extracted equations is investigated separately. On the one hand, the physical capital tax reduces human capital growth (negative effect on growth) and, on the other hand, reduces the ratio of capital to manpower in the production process. In the allotted time between work-education and leisure, the total return on capital increases after tax (positive effect on production). The human capital tax increases the ratio of capital to labour in production at the time allotted between education and leisure and reduces the return on capital after tax, which affects the ratio of capital to labour in production. It should be noted that if the succession elasticity is high enough, it may have a negative effect on growth.

Heidari and Saeedpour (2015), with the help of analysing the impact of fiscal policy shocks and the increasing financial coefficient of the economy in the framework of the new Keynesian model, showed that the shock of increasing consumption taxes leads to reduced production in the short term. They also found that the shock of increasing government spending improves output in the short run and increases inflation in the long run.

Fotros and Dalaie (2016) have studied tax evasion in the context of a Random Dynamic Stochastic General Equilibrium Model. According to the results of their study, a positive productivity shock in the formal sector increases the production of the formal sector and reduces underground production, thus reducing tax evasion.

Mirmohamadi and Janati (2016) have reviewed the experience of tax reform in different countries and compared them with Iran's tax system reform. Accordingly, tax reform approaches generally focus on reducing the distorting effects of taxation to maintain the economy's competitiveness, reducing the diversity of tax rates to overcome unwanted distortions in relative prices, and extending VAT to lessen the tax burden on the manufacturing sector. These approaches have focused on vertical justice instead of horizontal justice, i.e., a broad, simple and transparent tax base and reducing administrative costs and tax compliance. The reform of tax organisations is one of the pillars of tax reform and includes a wide range of measures to improve tax enforcement processes. Modernisation of tax processes is one of the aspects of tax reform. According to this study, the move towards using information and communication technology in this sector, providing online services to taxpayers, facilitating online payment of taxes, etc., has accelerated in many countries. Some of these countries have even resorted to using mobile-based technologies in taxation.

The need to reform tax policies before the start of the tax reform program and, consequently, the modernisation of the administrative system is something that can be seen in examining the experience of tax reform programs in the world illustrated in this article. In other words, the relevant policies, laws, and regulations must be formulated for an IT-based. Regardless, tax-process mechanisation is accompanied by internal resistance and external opposition and may have little effect.

### 2.3. Empirical Studies

Experimental studies offer a wide range of tax effects on growth. Some empirical evidence is also presented in this section. Table 1 lists some of the studies relative to the impact of taxation on economic growth.

**Table: 1**
**Selected Empirical Studies on the Economic Effects of Taxation**

| Case Study | Method | Country or Region | Summary of Results and Findings |
|---|---|---|---|
| Mertens & Ravn (2013) | Structural Vector Autoregressive | Changes in consumption and import taxes - America after World War II | A 1% decrease in the average consumption tax rate increases the GDP growth by 1.5% in the first quarter and 1.9% after the three quarters. A 1% decrease in the average import tax rate increases the GDP growth by 0.42% in the first quarter and by 0.66% after one year. |
| Dahlby & Ferede (2012) | Panel Data | The Canadian States 1997-2006 | A 1% reduction in consumption tax increases the economic growth rate between 0.15 and 0.25. |
| Gemmell, Kneller & Sanz (2011) | Panel Data | 17 OECD Countries 1970-2004 | Income and consumption taxes have a negative impact on economic growth in the long run. |
| Arnold et al. (2011) | Panel Data | 21 OECD Countries 1971-2004 | Income tax reduces investment and productivity growth. A 1% transfer of tax revenue from income tax (individuals and companies) to consumption and asset taxes increases per capita GDP by 0.25% to 1% in the long run. |
| Alesina & Ardagna (2010) | Panel Data | OECD Countries 1970-2007 | Tax incentives based on tax cuts are more likely to increase economic growth than incentives based on increased spending. |
| Barro & Redlick (2011) | Time Series | USA 1912-2006 | A 1% reduction in the average final tax rate will increase next year's GDP by about 0.5% next year. |

## 3. Analysis of Research Method

Like other General Equilibrium models, the structure of a Dynamic Stochastic General Equilibrium (DSGE) model is designed to describe the behaviour of the whole economy and to use the analysis of micro-decisions interactions at different levels. The decisions considered in most dynamic stochastic equilibrium models are related to the macro quantities studied in economics. These quantities include consumption, savings, investment, and labour supply and demand. Decision makers in this model are called brokers, which can consist of households, businesses, governments and even the central banks of different countries.

### 3.1. Household

In the context of a Stochastic Dynamic General Equilibrium Model, it is assumed that the economy is composed of a large number of homogeneous households (with index i) seeking to maximize the discounted interim expectation utility[2]:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left( \frac{\left(C_{T,t}^i\right)^{1-\sigma_c}}{1-\sigma_c} - \frac{\chi}{1+\eta}\left(L_t^i\right)^{1+\eta} + \frac{\zeta}{1-b}\left(\frac{M_t^i}{P_{T,t}}\right)^{1-b} \right) \quad (1)$$

$C_{T,t}^i$ is the consumption index of all goods consumed by the household and is considered as a combination of domestic consumer goods $C_{d,t}$ and imported consumer goods $C_{m,t}$ as follows:

$$C_{T,t} \equiv \left[ (1-\alpha_c)^{\frac{1}{\eta_c}} \left(C_{d,t}\right)^{\frac{\eta_c-1}{\eta_c}} + (\alpha_c)^{\frac{1}{\eta_c}} \left(C_{m,t}\right)^{\frac{\eta_c-1}{\eta_c}} \right]^{\frac{\eta_c}{\eta_c-1}} \quad (2)$$

Where $\eta_c$ is the Elasticity of Intertemporal Substitution of consumption between domestically traded goods and imported goods. Also, $\alpha_c$ and $(1-\alpha_c)$ are the share of imported goods and domestic goods in the household consumption basket, respectively.

Household expenditure for purchasing consumer goods is a combination of imported and domestically produced goods and can be written as follows:

$$P_{T,t}^c C_{T,t} = \left(1+\tau_{d,t}^c\right) P_{d,t}^c C_{d,t} + \left( \left(1+\tau_{d,t}^c\right)\left(1+\tau_{m,t}^c\right) \right) P_{m,t}^c C_{m,t} \quad (3)$$

Where $P_{T,t}^c$ is Total Consumer Price Index (CPI), $P_{d,t}^c$ , is Domestic Consumer Price Index (equal to the price index of domestically produced goods) and $P_{m,t}^c$ is the Price index of imported consumer goods. Domestic consumer goods are taxed at the rate of $\tau_{d,t}^c$ (consumption tax rate on domestic goods) at the time of purchase. In addition to the rate

[2] *Details of the equations have been omitted for brevity. Readers can contact authors.*

$\tau_{d,t}^{c}$t) imported consumer goods are also subject to tax on the import of consumer goods at the rate of $\tau_{m,t}^{c}$.

### 3.2. Business Section

#### 3.2.1. A Business Producing Final Product

In each period, there is a business that produces $Y_{j,t}$ units of the final commodity by purchasing $Y_{j,t}$ units of intermediate goods produced by the intermediate goods-producing businesses, at the price of $P_{j,t}$ and combining them that produce $Y_t$ of final good.

#### 3.2.2. A Business Producing Domestic Intermediate Goods

A group of monopoly businesses produce distinctive goods in the production unit of intermediate goods. These firms have intermediate goods using household labour and capital. They pay $W_t$ ,nominal wages to households and pay actual income or the real rate of return on capital $R_t^k$ in return for capital rent.

#### 3.2.3. Pricing of Domestic Producers

In addition to minimising costs, pricing and price adjustments are another issue facing domestic manufacturing businesses. In this research, it is assumed that the prices of domestic businesses are not entirely flexible, and the rigidity of price levels in this sector is modelled by using the Calvo model.

### 3.3. Government and Central Bank

Due to the dependency of the central bank on the government in Iran, the government and the central bank have been considered in the modelling of the present study in one framework. Therefore, the government and the central bank are not modelled as two separate parts. The government's goal is to keep its budget balanced. Accordingly, the central bank also acts so that the government can maintain its budget in equilibrium. The government finances its expenditures through revenues from the consumption tax on domestic goods, the consumption tax on imported consumer goods, the corporate tax, the labour income tax, the co-tax, the sale of participation bonds and the income from the sale of oil.

### 3.4. Estimation of Model Parameters

The Bayesian method, which is a method between calibration and maximum likelihood, and the Metropolis-Hastings model have been used to estimate the parameters. Using the Metropolis-Hastings algorithm, five parallel chains with a volume of five hundred thousand samples are extracted to obtain the posterior density of the parameters.

Eleven visible variables of GDP (at base price 2011), the effective tax rate on the consumption of domestic consumer goods, the effective tax rate on the consumption of

imported consumer goods, the effective tax rate on companies and the effective tax rate on income tax, government expenditures, Private consumption expenditures, total investment, monetary base growth rate, consumer price inflation (CPI), nominal exchange rate growth in the open market and foreign inflation used to estimate the model.

The time-series database of the Central Bank of the Islamic Republic of Iran, the Statistics Center of Iran, the Ministry of Economy, the Tax Affairs Organization and the World Bank Data Base have been used to collect data. The data used are related to the period 1990: 1 to 2020: 4 and are seasonally adjusted so that first, the logarithm of the data is taken and, in the next step, declassified using the Hedrick-Prescott filter with $\lambda = 677$.

Parameters that need not be estimated should be identified and calibrated before estimating the parameters. Some parameters are derived from the steady-state values of the variables and do not need to be estimated. Some other parameters are the ratio of variables in the model's steady state. Accordingly, Table 2 lists the parameters that can be calibrated based on Iran's economic data.

**Table: 2**
**Calibrated Parameters of the Model Based on Iran's Economic Data**

| Parameter | Parameter Definition | Symbol | Parameter Value | Resource |
|---|---|---|---|---|
| $\bar{\gamma}_d^c$ | The ratio of the producer price index to the consumer price index | gamadbar | 0.979 | Research Findings |
| $\bar{\gamma}_m^c$ | The ratio of the imported price index to the consumer price index | gamambar | 1.2863 | Research Findings |
| $\bar{\tau}_d^c$ | Auto-regression coefficient of tax shock on domestic consumption | taudbar | 0.03618 | Hasanzadeh Jozdani (2016) |
| $\bar{\tau}_m^c$ | Auto-regression coefficient of tax shock on imported consumption | taumbar | 0.4551 | Hasanzadeh Jozdani (2016) |
| $\bar{\tau}^l$ | Auto-regression coefficient of tax shock on income | taulbar | 0.0485 | Hasanzadeh Jozdani (2016) |

## 4. Estimation of Parameters Based on the Bayesian Method

The model parameters' distribution, mean, and standard deviation must be specified in the Bayesian estimation. Parameters can be estimated using the Bayesian method by considering the initial values for their mean and standard deviation. Model estimation is done by Matlab software in the Dynare program space. For this purpose, the Metropolis-Hastings Algorithm with five blocks and a sampling of five hundred thousand per block has been used. The prior distribution for each parameter was selected based on that parameter's characteristics and the desired distribution's characteristics. The acceptance rate of the model should be between 0.25 to 0.4. Diner runs the Hastings Metropolis Algorithm several times. The behaviour of these chains should be similar or converge towards each other if the results of these chains are logical.

The parameter estimation results are presented in Table 3 according to the above and using the Bayesian method.

**Table: 3**
**Estimation of Model Parameters Based on the Bayesian Method**

| Parameters | Prior Distribution | | | | Posterior Distribution | | | |
|---|---|---|---|---|---|---|---|---|
| | Type | Average | Standard Deviation | Source | Average | Standard Deviation | Confidence Interval 90% | |
| β | Beta | 0.969 | 0.0125 | Tavakolian (2015) | 0.9564 | 0.0125 | 0.9302 | 0.98 |
| $\alpha_c$ | Beta | 0.15 | 0.05 | Hassanzadeh Jozdani (2018) | 0.0854 | 0.05 | 0.0403 | 0.1292 |
| $\sigma_c$ | Gamma | 1.571 | 0.09 | Tavakolian (2012) | 1.8324 | 0.09 | 1.6871 | 1.978 |
| $\eta$ | Gamma | 2.17 | 0.1 | Tavakolian (2015) | 2.665 | 0.1 | 2.4865 | 2.846 |
| $\tau_\pi$ | Beta | 0.511 | 0.07 | Hassanzadeh Jozdani (2018) | 0.5173 | 0.07 | 0.4033 | 0.632 |
| $\theta$ | Beta | 0.375 | 0.03 | Hassanzadeh Jozdani (2018) | 0.3126 | 0.03 | 0.272 | 0.35 |
| $w_1$ | Normal | -2.9 | 0.29 | Hassanzadeh Jozdani (2018) | -2.4811 | 0.29 | -2.9563 | -1.98 |
| $\rho_a$ | Beta | 0.926 | 0.01 | Tavakolian (2015) | 0.952 | 0.01 | 0.941 | 0.964 |

Also, the estimation of shocks in the model based on the Bayesian method is presented in the Table below:

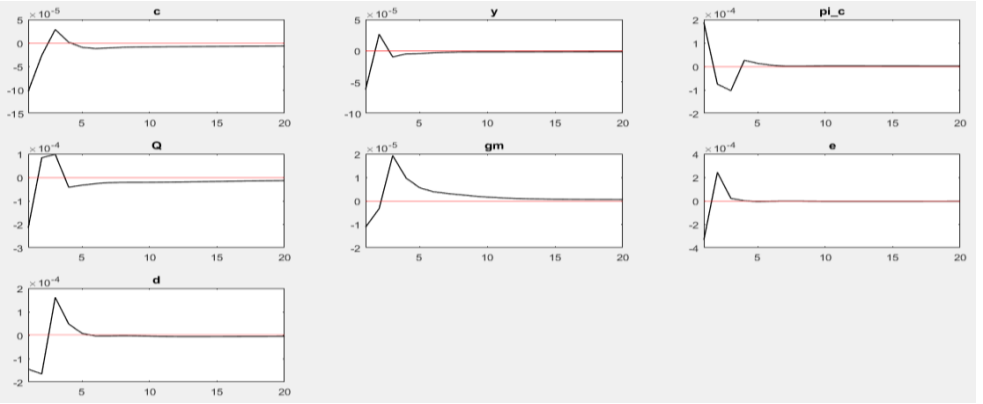
**Table: 4**
**Estimation of Model Shocks Equal to One Standard Deviation**

| Parameters | Prior Distribution | | Posterior Distribution | | |
|---|---|---|---|---|---|
| | Type | Average | Average | Confidence Interval 90% | |
| $\sigma_a$ | Inverse Gamma | 0.01 | 0.059 | 0.05 | 0.06 |
| $\sigma_g$ | Inverse Gamma | 0.01 | 0.079 | 0.069 | 0.089 |
| $\sigma_p$ | Inverse Gamma | 0.01 | 0.125 | 0.1 | 0.14 |
| $\sigma_d$ | Inverse Gamma | 0.01 | 0.13 | 0.11 | 0.14 |
| $\sigma_m$ | Inverse Gamma | 0.01 | 0.189 | 0.165 | 0.21 |
| $\sigma_l$ | Inverse Gamma | 0.01 | 0.025 | 0.022 | 0.028 |
| $\sigma_{y^*}$ | Inverse Gamma | 0.01 | 0.052 | 0.045 | 0.058 |
| $\sigma_o$ | Inverse Gamma | 0.01 | 0.13 | 0.11 | 0.14 |
| $\sigma_\pi$ | Inverse Gamma | 0.01 | 0.07 | 0.062 | 0.079 |

*Source: Research Findings.*

Impulse response function diagrams obtained from the estimated model, which are important tools of economic analysis, are used to study the dynamics of economic variables concerning different shocks.

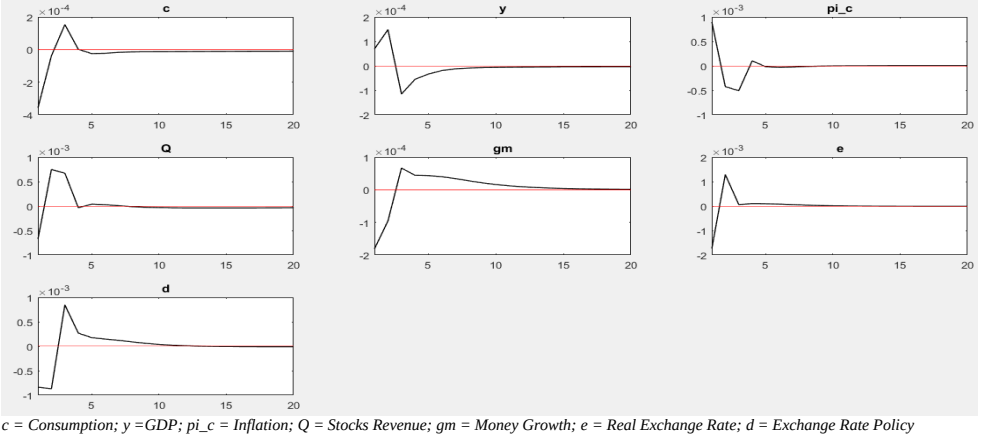
**Figure: 1**
**Impulse Responses of Some Variables to Consumption Tax Shock**




*c = Consumption; y =GDP; pi_c = Inflation; Q = Stocks Revenue; gm = Money Growth; e = Real Exchange Rate; d = Exchange Rate Policy*

GDP decreases by 0.006% with a shock based on consumption tax equal to one standard deviation. The consumption rate also drops to 0.01% with the consumption tax shock, and the shock effect of GDP disappears after four annual periods. In the short run, inflation increases by 0.018 per cent and then decreases and returns to a stable value in less than one year.

**Figure: 2**
**Impulse Responses of Some Variables to Import Tax Shock**




*c = Consumption; y =GDP; pi_c = Inflation; Q = Stocks Revenue; gm = Money Growth; e = Real Exchange Rate; d = Exchange Rate Policy*

As can be seen in Figure 2 for the impulse responses, we examine the effect of a shock by a standard deviation on this tax base to examine the impact of the import tax. Such a shock will cause a decrease of 0.089 per cent in GDP and a decrease of 0.89 percentage points in inflation. Increasing the import tax will reduce the consumption of imported goods by 0.4% by affecting consumption.

## 5. Conclusion

According to this study, tax bases, including consumption and import taxes, have small but significant effects on GDP and inflation. However, in the first phase, inflation increases, but this increase adjusts over time. This confirms the low share of taxes in Iran's economy. Among the tax bases examined, import taxes have the most significant impact on changes in GDP. Considering the results, the lowest share of differences in GDP between the tax bases is related to consumption tax. Moreover, the largest share in inflation changes is related to import taxes, while the lowest percentage is related to consumption tax. Based on the results of this study, considering consumption tax and import tax under indirect taxes, the effect of such taxes on changes in GDP and inflation is significant. Therefore, the implementation of a possible reform by policymakers in the form of indirect taxes should be considered carefully due to their effect on inflation.

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