Real Exchange Rate and Exports in a Rich Resource Economy

Reza Boostani and Pouya Jabal Ameli[1]

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Abstract

In this paper, we show how oil exports cause the real exchange rate to appreciate in a small open economy. The appreciation is mainly due to increase in relative price of non-tradable to tradable goods. Lower relative price in tradable sector pushes away the production factors from the sector while non-tradable sector accommodates them. Real exchange appreciation and factors moving away from tradable sector put pressure on non-oil exports. Not only the current oil exports, but also the expectation about future exports may affect non-oil exports by the impact on the current real exchange rate. In order to stimulate non-oil exports, the institutional framework on oil resources should consider this mechanism. Having a sovereign wealth fund using oil exports to finance infrastructure projects does not fulfill the task, it has to accept non-oil exports growth as a target.

Keywords: Real Exchange Rates; Oil-Exporting Country; Non-oil Export; SWF; Iran.
JEL classification: E00, F31, F41

[1] *Reza Boostani* (corresponding author): Economic Research and Policy Department, the Central Bank of Iran; *r.boostani@cbi.ir*. *Pouya Jabal Ameli*: International Organization and Studies Department, the Central Bank of Iran; *p.jabalameli@cbi.ir*.
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1 Introduction

In an open economy, foreign demands for local goods and services could spur production. However, export in resource rich economies does not seems to enhance the inclusive growth. In this regard, policies to boost non-resource exports has a key role to play in engineering growth in developing countries. In this paper, we investigate the impact of oil exports on the non-oil exports through the real exchange rate.

Crude and other oil-driven products have considerable shares of exports in an oil-exporting country like Iran. As the oil sector needs less labor force compared to other sectors, the sector can not make inclusive job opportunity. On the other hand, the government owns oil resources and decides about the allocation of oil revenues. Furthermore, as the value chain of oil industry is too short (which is the case in Iran), the oil sector can not stimulate other sectors. As a result, only non-oil exports may create job opportunities and inclusive growth.

The exchange rate is a key element to stimulate non-oil exports. Since prices are given for small open economies, local currency depreciation makes export more profitable for domestic firms in term of local currency. Real exchange rate which is adjusted by domestic and foreign price indexes is the measure showing relative prices of domestic and foreign goods. Figure 1, illustrates historical data of nominal and real exchange rates in Iran over last three decades.[2] It is clear that Iranian Rial appreciated considerably from 1999 to 2011. Figure 2 also indicates that real exchange rate appreciation was associated with the decline in relative price of services to goods. This paper examines the reason of exchange appreciation and the relative price fall over the last three decades.[3]

To explain why Rial has appreciated, we use a dynamic general equilibrium model for a small open economy. The model has two sectors producing tradable and non-tradable goods. Firms need capital and labor to produce final output. Part of resources is obtained by selling natural resources (*e.g.* oil) in international markets. Households consume both tradable and non-tradable goods and use their income to purchase goods in every period. The results show that any rise in oil exports leads to an appreciation in local currency. Oil exports affect the real economy through changing relative prices in favor of non-tradable goods. Oil exports make the non-tradable sector more profitable, and the sector absorbs more labor force. The tradable sector shrinks and it affects sector employment negatively. As a result, non-oil exports also decrease. Trend of macroeconomic variables of Iran's economy backs the idea that exports of natural resources influence the real exchange rate. After the Iran-Iraq war, oil and gas exports increased significantly which caused the real exchange rate to decline and non-tradable goods became more expensive simultaneously. Zamanzadeh and Shadrokh (2014) and Karimzadeh et al. (2009) insist on this mechanism in Iran's economy.

There are two approaches in the literature of exchange rate economics in resource based countries. Some researchers focus on effects of volatility in natural resources prices on exchange rate risks (see Chen and Rogoff (2003), Cashin et al. (2004), Clements et al. (2008), Bodart et al. (2012)) and others assess long-run effects of natural resources on the economy through the exchange rate channel. We follow the latter approach.

Kuralbayeva and Stefanski (2013) shows that countries with huge natural resources have small

[2] In this paper the difinition of exchange rate is the price of one unite of foriegn currency in term of domestic currency, here Iranian Rial. So increase in exchange rate means depreciation of domestic currency. Moreover, exchange rate masured as the price of one dollar in term of Iranian Rials. We did not use the effective exchange rate since doller is the dominant currenct in Ianian external sector.

[3] The Iran-Irag war ended in August, 1988. After war, the volume of oil production and export increased, but they have never reached the pre-war levels.

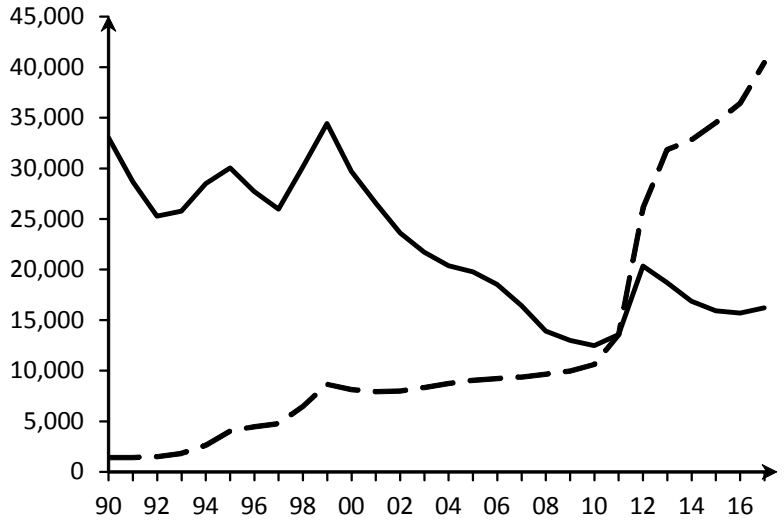

Figure 1: Nominal (dashed line) and Real (solid line) Exchange Rates. Iranian Rial has appreciated in real terms against US Dollar by around 50 percent. In 2012, international sanctions imposed on Iranian financial system and energy sector (including oil).

Figure 2: Real Exchange Rate and Relative Price of Services. The dark line is the real exchange rate (left axes) and the dashed line is the relative price of services to goods (right axes).

but productive manufacturing sectors and large but unproductive non-manufacturing sectors. The researchers believe that natural resources make this picture through a process of specialization. In this process, windfall revenue spurs non-skilled labor to move from the manufacturing to the non-manufacturing sector.Arezki et al. (2017) indicates that new oil field discoveries affect macro-economic variables. After an oil discovery, the current account and the saving rate decline for five years and then rise significantly. Thus, they insist that expectations about future oil exports have current economic effects. Harding et al. (2016) estimates the effect of giant oil and gas discoveries on real exchange rates. Like Arezki et al. (2017), they use oil and gas discoveries to identify the effect of natural resources on the economy. They illustrate that a giant discovery with the value of a country's GDP increases the real exchange rate by 14% within 10 years, and changing in the prices of non-tradable goods leads to the appreciation.

Appreciation in Rial driven by exporting natural resources is not the only obstacle for non-oil exports. The other problem is distortions in distribution of resources by interventions in the market mechanism. When oil exports decline, depreciation could help non-oil exports but the government does not allow market-driven depreciation and puts an official rate. Multiple exchange rate system, closing the free exchange market, setting official rate and forcing non-oil exporters to exchange at the official rate are other hinders for expanding non-oil exports. Hence policymakers should neutralize the effect of natural resources on the real exchange rate and the government interventions in the foreign exchange market.

The rest of the paper is organized as follows. Section 2 focuses to the relation between non-oil exports and real exchange rate. Section 3 presents the model. Institutional framework to manage oil income in Iran is described in section 4. Section 5 discusses about the exchange rate policy implemented by the government, and section 6 concludes.

2 Non-oil Exports and Real Exchange Rate

The volume of exports depends on the supply and the demand for exporting commodities. Relative price of exporting goods and income of foreigners are demand factors for exporting goods. The supply side includes capital accumulation in the tradable sector and relative prices. The real exchange rate is a measure of relative prices. An increase in the real exchange rate leads to cheaper domestic goods regarding international ones and induces more exports. Thus, the growth of exports $\triangle x$, depends on changes in foreign income $\triangle y^*$, local capital accumulation in the tradable sector $\triangle k$, and relative price $\triangle q$:

$$\triangle x = f(\triangle q, \triangle k, \triangle y^*)$$

Any rise in the right hand variables causes more exports.[4]

Before estimating the above equation, it worth mentioning the frequent change in exchange regime. Figure 3 illustrates the growth of non-oil exports after the war. In the period there are many external and internal shocks such as economic sanctions, currency crisis in 1994 and 2012 and multiple exchange rates regime. As oil income jumped through 2002-2010, Iran was able to have unified exchange rate regime. Iran's exchange market has suffered by official pricing, temporary decisions in trade arrangements and other actions which destabilize the external sector. In this regards, it is not surprising that exports have not been booming.

[4]See Ahmed (2011) for deriving the equation.

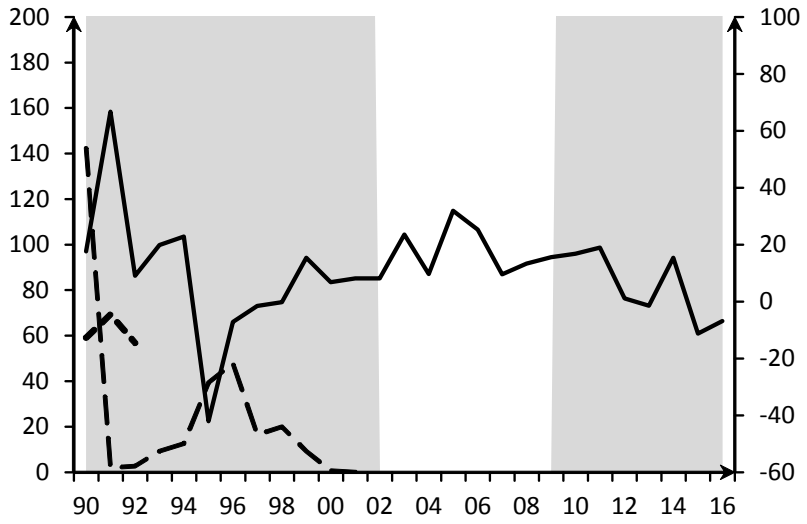

Figure 3: Frequent Changes in Exchange Rare Regime. Solid line is non-oil export growth rate (right axes). Dashed line is the gap between export exchange rate and free market rate (left axes) and dark dashed line is the gap between competitive rate and free market rate (left axes). Dark area is period of multiple exchange rate regime.

Post-war data has been used to estimate the above function.[5] The nominal non-oil export is adjusted by the US consumer price index. The real exchange rate has been calculated based on the free exchange rate (USD/Rial) and the consumer price index in Iran and the US. Foreign income is captured by both global and emerging markets productions which are gathered from the IMF database. The private investment in machinery is considered as the alternative for capital accumulation in the tradable sector. Due to the instability of the foreign exchange regime, it is very difficult to find a stable period with no intervention by the government in order to estimate the export function accurately. An accurate estimation of the real exchange impact on exports needs that all effective factors to be controlled.[6] To control currency crises in 1994 and 2012 and multiple exchange rates regime, we introduce three dummy variables. Growth in variables is calculated by the log difference approach.

Table 1 shows the estimation results. All specifications of the model have positive coefficient for the real exchange rate which is according to the economic theory. The economy does not hit by significant shock in external sector between 2000 to 2010. Interestingly, the coefficient of real exchange rate is greater than unit meaning any rise in the growth of the real exchange rate has more gain in non-oil exports. From 1992 to 2016, the real exchange rate coefficient remains positive and significant, but its value has almost halved compared to the previous estimates. For the period 1996-2016, all the coefficients of the model are consistent with the economic theory and show that

[5] Time series are from the Central bank of Iran, unless mentioned otherwise.

[6] For example, after the 1994 currency crisis, exporters were forced to sell foreign exchange earnings to domestic banks at a command rate, and the banks also provided these resources to importers. This policy was implemented until 2000.

global consumption and real exchange rate are the main determinants of non-oil exports.

3 Model

We borrow the model of small open economy from Harding et al. (2016), in order to study the factors affecting real exchange rates. There are two agents in this economy: households who consume goods and provide labor force and capital, and firms that need labor and capital to produce final goods. The market and price mechanism conduct the economy. The economy also trade with the outside world.

A representative household consumes tradable goods c_t^T and non-tradable goods c_t^N, and maximizes the following utility function:

$$\max \sum_{t=0}^{\infty} \beta^t (\gamma \ln c_t^T + (1-\gamma) \ln c_t^N) \tag{1}$$

where β is a discount factor, $0 < \beta < 1$, and γ is the weight of tradable goods in household's consumption. In each period, t, the representative household rents out a unit of labor for a wage rate, w_t and gives a unit of capital to tradable and non-tradable sectors by rental rates, r_t^T and r_t^N. The household faces the following budget constraint:

$$p_t^T c_t^T + p_t^N c_t^N + p_t^T b_{t+1} \leq w_t + r_t^T + r_t^N + R_t p_t^T b_t + p_t^o e_t^o + T_t \tag{2}$$

which, b_t is a stock of foreign bonds held from the previous period in domestic terms, e_t^o is the natural resource (e.g. oil) endowment which is sold for exogenous price, p_t^o, and T_t denotes transfer payments by the government. Also, p_t^T and p_t^N are the local price of tradable and non-tradable goods, and R_t is the gross return on a foreign bond. It is assumed that the revenue from the natural resources is exogenous; it means that natural resource production does not need any labor and capital. The household allocates her resources to purchase tradable goods, non-tradable goods and foreign bonds (or foreign asset).

Oil exports and changes in household's foreign assets make the inflow of cash from abroad, f_t. So, we have

$$f_t \leq R_t p_t^T b_t - p_t^T b_{t+1} + p_t^o e_t^o \tag{3}$$

The Household maximizes the utility function (1) subject to i) the budget constraint (2) and ii) the non-ponzi condition, $b_{t+1} \succeq -\bar{B}$, while b_0 is given. The first order conditions for household problem are

$$\gamma = \lambda_t p_t^T c_t^T \tag{4}$$

$$1 - \gamma = \lambda_t p_t^N c^N \tag{5}$$

$$\lambda_t p_t^T = \beta \lambda_{t+1} p_{t+1}^T R_{t+1} \tag{6}$$

where λ_t is the Lagrangian multiplier for the budget constraint, (2).

Using (4) to (6), the cost of purchasing a constant basket of consumption goods which is the aggregate price index is

$$p_t = (p_t^T)^{\gamma} (p_t^N)^{1-\gamma} \tag{7}$$

In the supply side there are two competitive firms in the tradable and non-tradable sectors. By using Cobb-Douglas production technology, the representative firm in the tradable sector uses labor and capital to make final tradable goods

$$Y_t^T = A_t^T (L_t^T)^{1-\alpha} (K_t^T)^{\alpha} \tag{8}$$

where L_t^T and K_t^T are labor force and capital in the tradable sector. A_t^T denotes productivity in the tradable sector that grows at constant exogenous rate, $g_T = A_{t+1}^T / A_t^T - 1$. Also α indicates the share of capital in production. The firm's profit is,

$$\max p_t^T Y_t^T - w_t L_t^T - r_t^T K_t^T \tag{9}$$

The firm maximizes (9) with respect to (8), so the first order conditions show demand for labour and capital in the tradable sector,

$$(1-\alpha) p_t^T Y_t^T = w_t L_t^T \tag{10}$$

$$\alpha p_t^T Y_t^T = r_t^T K_t^T . \tag{11}$$

Firms in non-tradable sector are using the same technology employed by the firms in tradable sectors. So, we do not repeat the firm's maximization problem in non-tradable sector.

As we have an open small economy, domestic price of tradable goods is pinned down by the international price. Assume that there is a wedge between the domestic and the international price of the traded good, which is a form of tax, so we have $p_t^T = (1+\tau_t) p_t^{T*}$. For simplicity suppose that $p_t^{T*} = 1$.The government transfers the tax to consumers in a way that the its budget is balanced. The money transfer is denoted T_t, so $T_t = \tau_t p_t^{T*} c_t^T$. We allow the wedge to take into account all differences in prices of tradable goods across countries.

Supposing the international aggregate price level is one, and the tax is fixed, the real exchange rate showing relative domestic price to international one is

$$\epsilon_t = p_t^{-1} = (1+\tau)^{-1} (p_t^T / p_t^N)^{1-\gamma}. \tag{12}$$

Equation (12) illustrates that the real exchange rate depends on the relative price of tradable to non-tradable goods. The more expensive non-tradable good, the more appreciation in local currency.

As financial markets are integrated, the local interest rate is determined by the international rate. There is a risk premium depending on the level of foreign asset.

$$R_t = R_t^* + \varphi(e^{\bar{b} - (b_t / A_t^T)} - 1) \tag{13}$$

In (13), as level of foreign bonds falls, the premium increases and the gap between local interest rate and the international interest rate widen. Bond holdings are normalized by growth of the tradable sector to capture the fact that a larger economy is able to borrow more.

The trade is not necessarily balanced for each period. Oil exports or changing in level of foreign bonds can be used for imports of tradable goods, m_t; so, we have $p_t^T m_t = f_t$.[7] All markets clear

[7] The current account, ca_t, in this economy is

$$ca_t = p_t^o e_t^o - p_t^T m_t + (R_t - 1)\, p_t^T b_t = p_t^T (b_{t+1} - b_t)$$

which indicates any current account surplus can transfer to the next period in form of increase in foreign assets.

period-by-period so that $c_t^T = Y_t^T + m_t$, $c_t^N = Y_t^N$, $L_t^T + L_t^N = 1$, $K_t^T = 1$and $K_t^N = 1$. The equilibrium in this model is a set of prices and allocations so that labor, tradable goods, non-tradable goods and capital markets clear.

Solution: tradable and non-tradable sectors have productivity growth, so we de-trend variables to solve model in the steady state: $\tilde{c}_t^T = c_t^T/A_t^T$, $\tilde{c}_t^N = c_t^N/A_t^N$ and $\widetilde{b}_t^T = b_t^T/A_t^T$. These variables are constant in the long-run. In Appendix, we solve the model for 8 variables and 8 equations.

The Euler equation for consumption of the tradable goods is captured by equations (4) and (6)

$$g_T \tilde{c}_{t+1}^T = \beta \tilde{c}_t^T R_{t+1}. \tag{14}$$

The above presents that the interest rate in steady state depends on the productivity growth in the tradable sector: $R = g_T/\beta$. Given $\beta = g_T/R^*$, then domestic and international interest rates are equal ($R = R^*$) and holding foreign bonds is in equilibrium ($\widetilde{b} = \overline{b}$).

Relative price of non-tradable goods to tradable ones is derived from markets clearing conditions and equations (4) and (5)

$$\frac{p_t^N}{p_t^T} = \frac{1-\gamma}{\gamma}\frac{c_t^T}{c_t^N} = \frac{1-\gamma}{\gamma}\frac{Y_t^T + f_t/p_t^T}{Y_t^N}. \tag{15}$$

As price of tradable goods is determined by the international price, a rise in foreign resources, f_t, causes more expensive non-tradable goods relative to tradable ones and it results a fall in the real exchange rate (13) which means an appreciation in local currency.

Finally, allocation of labor emerges from labor demands in tradable and non-tradable sectors

$$\frac{L_t^N}{L_t^T} = \left(\frac{A_t^T}{A_t^N}\frac{p_t^T}{p_t^N}\right)^{\frac{1}{-\alpha}}. \tag{16}$$

The above shows that the share of labor in each sector is directly related to the relative price of goods in sectors. In other words, a rise in the relative price of goods in the non-tradable sector leads to an increase in the share of employment for the sector. Also, given the direct relationship between the relative price of tradable to non-tradable goods and the real exchange rate, an increase in oil exports causes a rise in relative prices in the non-tradable sector and an appreciation in local currency.

In this model the inflow of cash from abroad can be changed for two reasons. First, a sudden change in oil exports will alter the inflow of cash from abroad. Second, expectations can change foreign resources, for instance when the household expects a reduction in future oil exports, it increases holding foreign bonds and decreases current consumption to smooth it in next periods. An increase in current foreign assets leads to depreciation in local currency.

Calibration: we use the national accounts of Iran to calibrated the model. In national account, gross domestic products, GDP, is derived from the total value added in groups of *i*) agriculture, *ii*) industries and mining (including industry, electricity, gas and water, construction and mining), *iii*) oil and *iv*) services. According to the model presented, the value added of these groups can be classified into three categories: tradable, non-tradable, and natural resources. Following Kuralbayeva and Stefanski (2013), production of the natural resources sector is calculated from the total value added of the oil and mining groups, production of the non-tradable sector from the total value added of agriculture, "electricity, water and gas", buildings and services groups, and production of the tradable sector from value added of the industry group. Also, the price index of tradable and non-tradable sectors is calculated from the ratio of the nominal value added to the fixed price. Time

series are gathered from national accounts statistics from 1990 to 2014 published by the Central Bank of Iran. During this time, shares of tradable, non-tradable and natural resources sectors in GDP are 14, 64 and 22 percent, respectively.

Each period in the model is equivalent to one year. Productivity growth rates for the tradable and non-tradable sectors are 6% and 4.5% respectively. The amount of foreign asset is set based on the ratio of the current account to non-oil GDP in the steady state ($\bar{b}$= 0.015).[8] Also we follow Madanizadeh and Ebrahimian (2018) and set the share of capital in output to 66%.

The discount rate should be set to hold $R = g_T/\beta$. As the tradable sector growth rate is 6 percent, the discount rate is set to 0.98 to have 8.2 percent for the interest rate in the equilibrium. The share of tradable goods in household's consumption is set to have 18 percent for the share of tradable sector in employment. The statistical Center of Iran published the share of employment in the tradable sector for 1996 and 2016 as 19% and 17% respectively. Exports of natural resources are set to have the ratio of natural resources output to GDP as 22 percent. The elasticity of risk premium considers as 0.1. It should be noted that the elasticity of risk premium does not affect the value of variables in the steady state, but it determines the dynamics of the economy in the foreign sector. The value of this parameter is slightly larger than the conventional value chosen in other studies to reflect the limited access of Iran's economy to financial markets. Under such circumstances, the change in exports of natural resources will have less effect on foreign assets and will have a greater impact on macro variables, because the economy cannot shift the impact of change in natural resources to distant future periods by adjusting its foreign assets. Table 2 shows the values and calibration method of parameters.

Results: an expected temporary increase in natural resources exports causes change in the long-term trend of macro-variables. Figure 4 illustrates the trend of simulated variables, given a 10% increase in natural resource exports in period t_0. To observe the effect of expectations, the model is solved given perfect insight, in other words agents' expectations about an in crease in oil exports will be fully realized. An increase in natural resource exports will rise households income and they will spend income in multiple periods which can be called consumption smoothing. As a result, when the household expects an increase in future oil exports, it increases its consumption by a decline in foreign assets. When oil exports rise at t_0, foreign assets jump and return to the long-term trend again.

When oil exports rise, non-traded goods become relatively expensive respect to tradable ones, and the real exchange rate declines (local currency appreciates). Thus, labor moves to the non-tradable sector, so employment and output in the tradable sector decrease. However, as local currency appreciates, imported tradable goods are cheaper and households consume more tradable goods too. Finally, it causes a decline in non-oil net exports.

Figure 5 shows effects of a unexpected temporary increase in oil exports. As it can be seen there is no difference in direction of change in variables, but in the unexpected scenario, variables alter more intensely. A sudden 10% increase in oil exports causes more severe appreciation in local currency. The employment in the tradable sector declines more rapidly. Other variables also are affected more intensely compared to scenario when the change in oil exports was predictable.

If oil exports increase permanently, the long-run economic trend will change. Non-traded goods become relatively expensive; local currency appreciates permanently; and consumption jumps. In other words, we have a permanent change in the steady state of all variables, except in interest rate and foreign asset.

Policymaking: policymakers should limit the effect of natural resources exports on relative

[8] Non-oil GDP is the sum of total value added in all groups except oil.

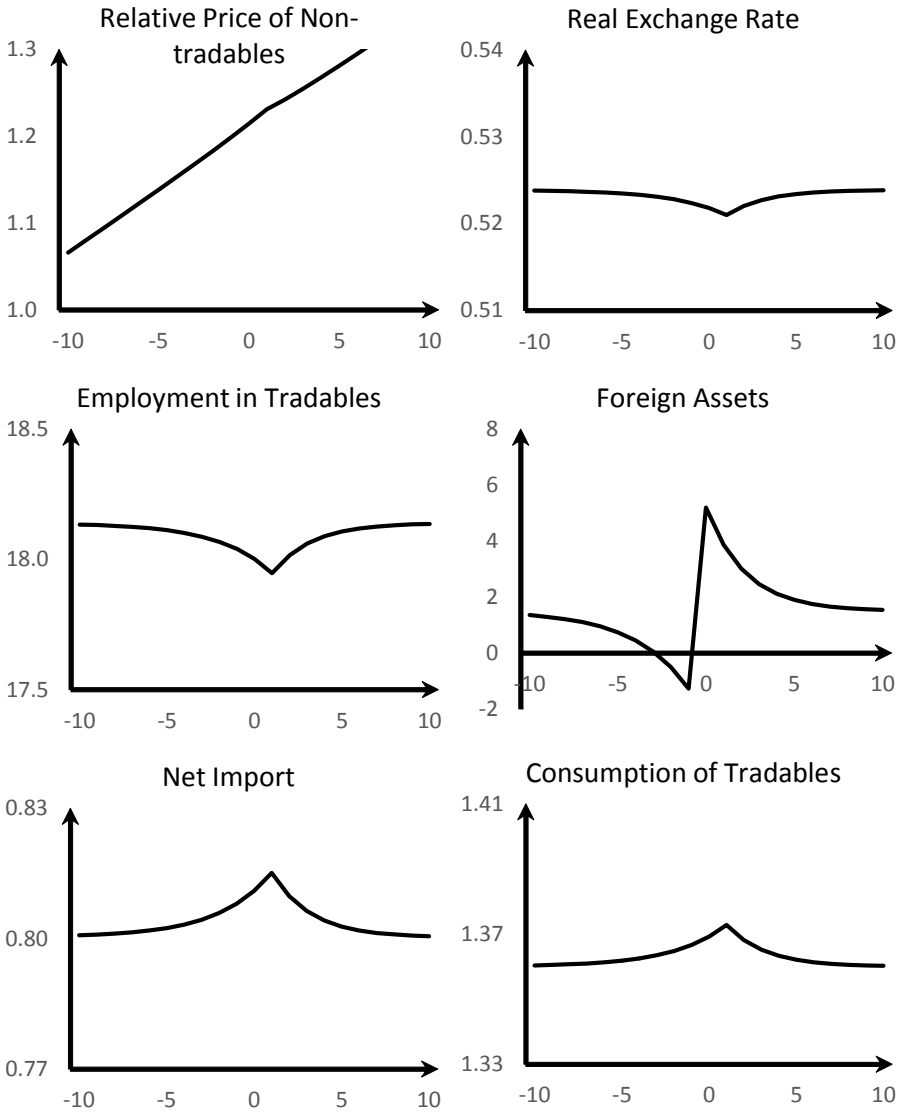

Figure 4: Expected Increase in Export of Natural Resources.

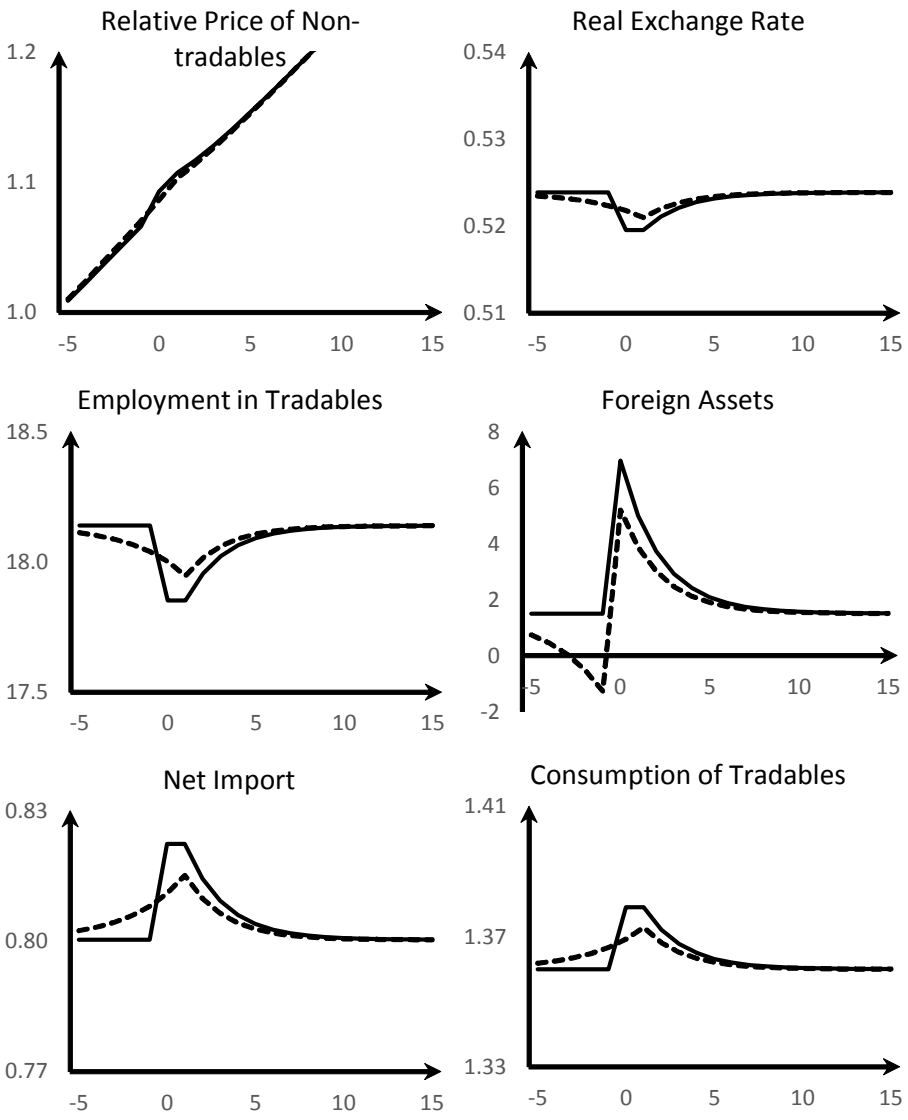

Figure 5: Unexpected Increase in Export of Natural Resources, compared to expected increase (dashed line).

prices and the real economy. As an increase in oil exports may cause import of more tradable goods, instead it is reasonable to buy foreign bonds (foreign assets). This policy is similar to have a sovereign wealth fund (SWF), used to make a portfolio of foreign assets by natural resources exports. In this regard, any increase in natural resources exports will rise foreign assets permanently. As a result the permanent change in foreign assets will alter the steady state of variables.

If oil exports increase for $\Delta\widetilde{e}_t^o$ at period t, and the government invests it in foreign bonds (which could be a reasonable case in oil-exporting countries), the level of foreign assets will increase. When this level is held, the steady state of the model will change.

$$\begin{aligned} \widetilde{m}_t &= R_t\widetilde{b}_t - g_T\widetilde{b}_{t+1} + \widetilde{e}_t^o + \Delta\widetilde{e}_t^o \\ &= R_t(\widetilde{b}_t + \Delta\widetilde{e}_t^o/R_t) - g_T\widetilde{b}_{t+1} + \widetilde{e}_t^o \end{aligned} \tag{17}$$

Figure 6 illustrates effects of establishing a SWF. The government uses a 10% increase in oil exports to buy foreign assets. The rise in foreign assets will increase purchasing power in future. The sovereign wealth fund makes consumption of natural resources slower and increases gains from foreign assets. Thus, households revenue will increase permanently and the rise in consumption is limited but continually. Figure 6 indicates that when the economy has no sovereign wealth fund, volatilities in relative prices and real variables are severe. Hence, introducing a SWF mitigates fluctuations and generations benefit from gains of its investments.

Evidence from Iran's economy: although nominal exchange rate has been increasing for two decades in Iran, real exchange rate has been declining (Figure 1). Figure 7 shows that the trend of relative price of traded to non-traded goods is in the same direction of real exchange rate. We explained in the model that the affecting channel of oil exports on the economy is through the real exchange rate and the relative price of traded to non-traded goods. More oil exports will rise aggregate demand and will increase prices of non-tradeable goods while their markets are less competitive respect to tradable goods markets. The real exchange rate and the relative price of tradable goods decrease 54% and 42% respectively between 1990 and 2014.

Figure 7 illustrates that the real exchange rate and the relative price of tradable goods increased in 2012 following the international sanctions hit oil exports. The real exchange rate soared by 54% and the relative price of traded goods raised by 13%.

Figure 8 shows oil and gas exports adjusted by the consumer price index in the US and the relative price of non-tradable goods to tradable ones. As it can be seen there is a positive correlation between the two variables. The oil expost has increased since early 2000s and countinued until 2012 when sanctions imposed on Iran energy sector. The permanent high oil income is look like a shift in the steady stae of the economy. In this period, more oil exports cause more consumption and the non-tradable goods become more expensive compared to tradable goods because the non-tradable sector is less competitive. This event leads that resources are directed to the non-tradable sector and the growth rate in the tradable sector is limited.

Figure 9 illusterates the simulated relative price of non-tradable to tradable good from the model. Although the model is very abstract, it could closely produce the correlation between oil exports and relative price of non-tradable goods.

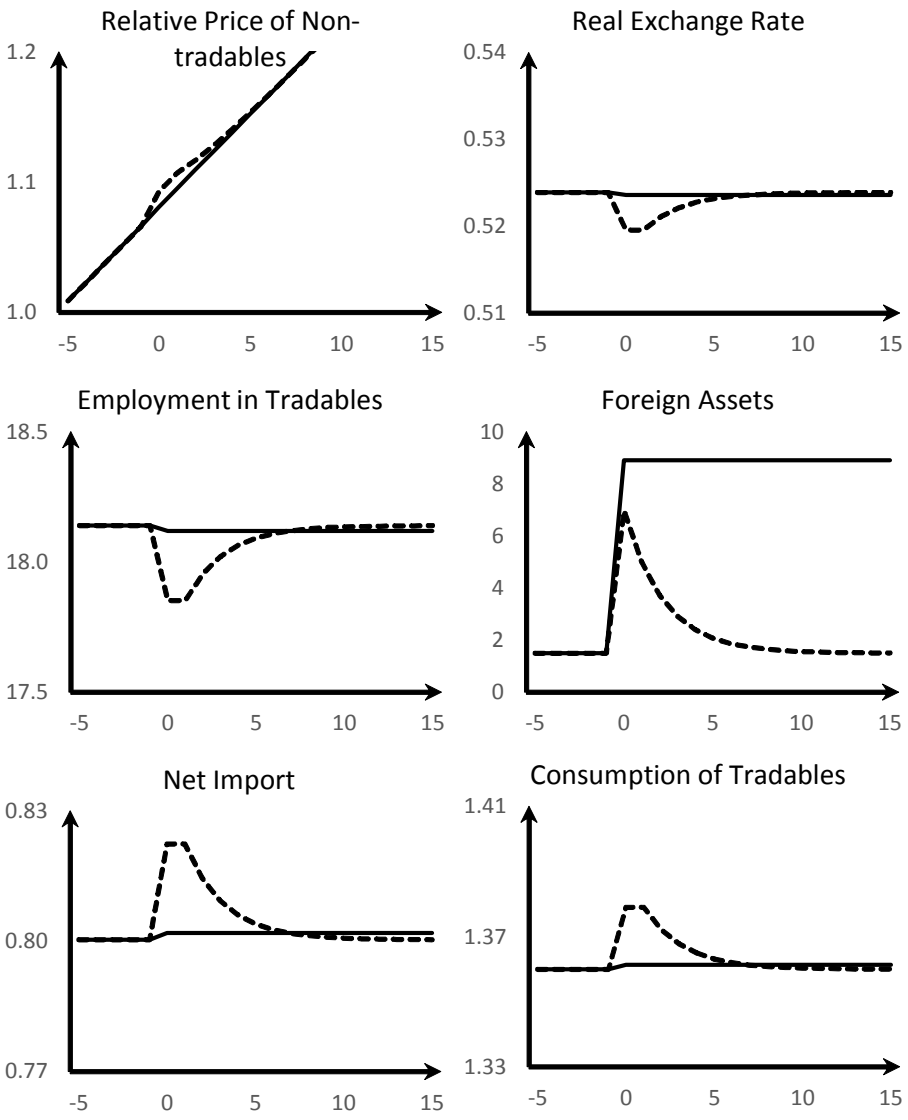

Figure 6: Model with SWF, compared to an unexpected increase in export of natural resources (dashed line).

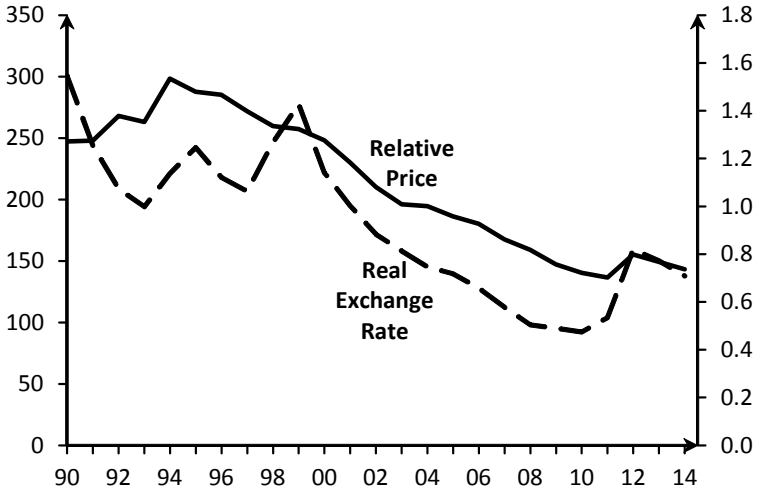

Figure 7: Relative Price of Tradable Goods and Real Exchange Rate. The relative price of tradable to non-tradable goods is shown by dark line (left axes) and real exchange rate is shown by dash line (right axes). From early 90s, Rial has appreciated and relative price of tradable has declined. The increase in real exchange rate and the relative price in 2012 is corespondent with international sanctions.

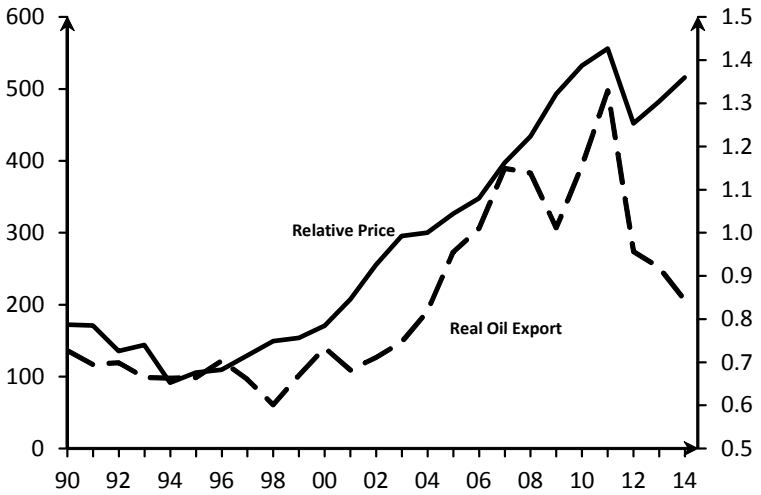

Figure 8: Relative Price of Non-tradable Goods and Real oil Export. The relative price of non-tradable to tradable goods is shown by dark line (right axes) and real oil export is shown by dash line (left axes). From early 90s, relative price of non-tradable has increased. In 2012, oil exports declined due to international sanctions on oil sector.

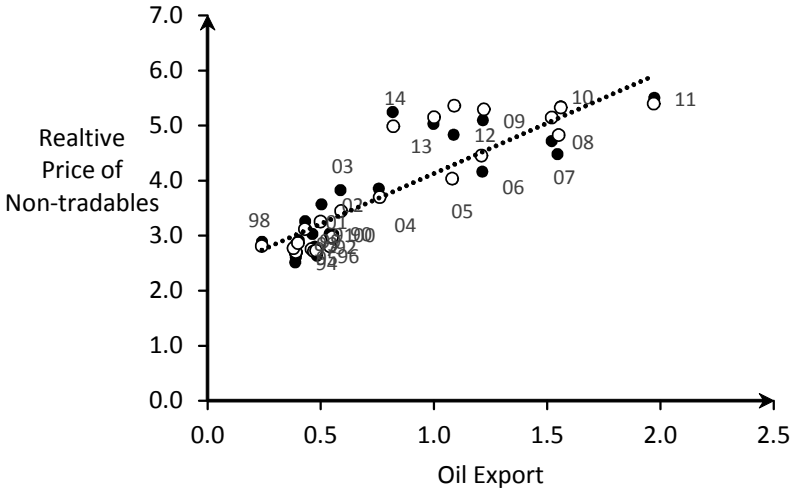

Figure 9: The Oil Export and Relative Price of Non-tradables. The dark dots are Iran data and the white dots are stimulated relative price from the model.

4 Institutions for Oil Exports

Iran's government recognizes its oil revenue in the budget. This revenue covers a considerable part of its expenditure. Financing government's expenditure by oil income causes that volatilities in the global oil market tunnel to the economy. The Oil Stabilization Fund was established in 2000 to smooth government oil income so that fluctuations in oil price could not hit the economy. This fund enabled the government to save the surplus of oil income when oil price is high for years that the government faced with a budget deficit because of low oil price. However, the government failed to save the oil income in boom periods. As a result the fund could not play significant role in Iran's economy. It has to be mentioned even if the fund was successful, there was a problem as the oil income financing the expenditure through the budget.

The National Development Fund of Iran (NDFI) was launched to limit the budget dependency on oil and to use natural resources for financing infrastructure projects. Oil income currently is divided between the government budget and the NDFI. The NDFI can, by financing investment projects, lead to capital accumulation and increase production capacity in the economy. However there are two problems with this approach. First the government sometimes gets permission from the parliament to use the NDFI resources for its expenditures(Boostani and Salavitabar (2017)). Second, spending oil resources for the NDFI or the government budget has the same effect on the real exchange rate.

When the NDFI approves an investment project and its cost in foreign currency, the central bank provides the Rial equivalent and then it sells exchanges in the market. In other words, even when oil exports are used for investment projects, foreign currency has to be sold in the market and the real exchange rate decreases. Hence, the NDFI mechanism for using oil exports is similar

to the government budget; both will appreciate the Rial and decrease non-oil exports. Figures 7 and 8 indicate that the local currency appreciated between 2001 and 2011 as oil price rised in international market and the existing institutions have not been able to prevent the destructive effects of the injection of oil exports into the economy.

It is important to introduce a new objective for NDFI to boosting non-oil exports. We explained that when the NDFI utilizes oil resources for investment projects it appreciates the local currency. When the NDFI has to care about the non-oil exports, so it considers the effect of using oil resources on the real exchange rate, and it avoids to appreciate the Rial in a way that the non-oil exporters give up their business.

5 Exchange Rate Policy

We explained that the real exchange rate is determined by real variables in the long run, but its short-term fluctuations are related to monetary measures. The monetary authorities are not independent in Iran, so they cannot pursue their main aim, *monetary stability*. Thus, the money supply growth and inflation are high and policy makers try to limit inflation by a pegged exchange rate. An effort that definitely fails in the long run.

Theory of impossible trinity gives that whenever the capital account is open, it is impossible to have independent monetary policies and a fixed exchange rate simultaneously. As the capital account is not closed in Iran, a fixed exchange rate and independent monetary policies cannot be implemented simultaneously. At the end, policy makers should choose one of them and release the other one.

The experience of foreign exchange policy in Iran includes repeated failures to peg the exchange rate. The reason is that the central bank tries to fix the exchange rate in an expansionary framework of monetary policy. Hence, after a short-term period of stability, the currency shock hits the economy and the result is a dual (or multi) exchange rate regime (Boostani and Ameli (2015)). In the past three decades, Iran experienced a unified exchange rate regime only between 2002 and 2010. In this period, the government uses a large amount of oil income to unify the exchange rate and also causes an appreciation in Rial damaging non-oil exports. However when oil income decreases, the government does not accept a higher exchange rate in the market and the economy experiences a dual exchange rate regime (Figure 1). In this system, non-oil exporters are forced to return and sell their foreign earnings by the official rate which is lower than the market rate. As a result, the government intervention in the foreign exchange market harms non-oil exports in either oil boom or bust.

The point is the government forces the monetary authorities to use the nominal exchange rate as a nominal anchor to control inflation. The economy needs a hybrid regime, so two independent instruments have to be used for two aims (Ghosh et al. (2016)). Inflation target should be accomplished by the monetary instrument which is short-term interest rate and the intervention in the exchange market to have a competitive exchange rate to help non-oil exports and economic growth. Currently, policymakers use the exchange rate instrument to control inflation and monetary instrument to finance investment projects and to create economic growth.

6 Conclusion

As the model shows oil revenue in Iran causes that relative price of non-tradable goods to tradable ones increases and the Rial appreciates which is damaging to non-oil exports. This has been the main reason for limited non-oil exports for decades. Long-run appreciation in local currency also moves resources to the non-tradable sector and it reduces competitiveness and hurts economic growth.

To overcome these obstacles, it is important that the government that is financing its expenditure by oil exports and the NDFI which is using oil resources to finance investment projects have another goal which is boosting non-oil exports. Currently the fund can smooth the flow of foreign income to the economy after a positive shock in oil income but as the foreign assets of the fund are sold in the exchange market, the local currency appreciates damaging non-oil exports. Introducing non-oil exports target tightens the NDFI to use its foreign assets if it does not impact the value of Rial.

When oil income decreases, the government intervenes the exchange market to block any depreciation. It introduces a dual exchange rate regimes and limits business of exporters by new regulations forcing them to sell their foreign earnings by the official rate. Thus, the government intervention does not allow the exporters to use the depreciation opportunity to boost their business.

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7 Appendix

The model can be presented as a system of 8 equations and 8 unknowns. Variables include two prices $\{R_t, p_t^r\}$ and 6 quantities $\{\tilde{c}_t^T, \tilde{c}_t^N, L_t^T, L_t^N, \widetilde{m}_t, \widetilde{b}_t\}$.

$$g_T \tilde{c}_{t+1}^T = \beta \tilde{c}_t^T R_{t+1} \tag{18}$$

$$\tilde{c}_t^T + (p_t^r)^{(-1)} \tilde{c}_t^N = (1-\alpha)(L_t^T)^{\alpha} + \alpha (L_t^T)^{1-\alpha} + \alpha (p_t^r)^{(-1)} (L_t^N)^{1-\alpha} + \widetilde{m}_t \tag{19}$$

$$R_t = R_t^* + \varphi(e^{\bar{b}-\widetilde{b}_t} - 1) \tag{20}$$

$$\widetilde{m}_t = R_t(\widetilde{b}_t + \Delta \widetilde{e}_t^o / R_t) - g_T \widetilde{b}_{t+1} + \widetilde{e}_t^o \tag{21}$$

$$\tilde{c}_t^N = (L_t^N)^{1-\alpha} \tag{22}$$

$$\tilde{c}_t^N = \frac{1-\gamma}{\gamma} p_t^r \tilde{c}_t^T \tag{23}$$

$$L_t^T = (p_t^r)^{(1/\alpha)} L_t^N \tag{24}$$

$$L_t^T + L_t^N = 1 \tag{25}$$

In the system we have $p_t^r = A_t^T p_t^T / A_t^N p_t^N$ which is relative price of tradable goods to non-tradable ones. It is also assumed that the external price level is constant at 1, and import tax is zero. Level of natural resources is constant and exogenous, $\widetilde{e}_t^o = p_t^o e_t^o / A_t^T p_t^T$.

Table 1: Non-oil export and real exchange rate

Dependent variable: growth rate of real non-oil exports									
real exchange rate	1.1*	1.25*	1.09*	1.18**	1.08*	0.62*	0.6	0.71*	0.6**
	(0.45)	(0.53)	(0.41)	(0.54)	(0.46)	(0.33)	(0.38)	(0.26)	(0.31)
global production	-0.05	0.00							
	(1.09)	(1.29)							
emerging markets production				0.48	0.06	1.55	1.98	1.07	1.34
				(1.28)	(1.10)	(1.22)	(1.51)	(1.23)	(1.56)
investment in machinery	-0.003**		-0.003**		-0.003**	-0.00	0.00		
	(0.002)		(0.002)		(0.002)	(0.001)	(0.002)		
lag of non-oil production								0.71	0.89
								(0.67)	(0.83)
currency crisis in 1994						-0.63*		-0.62*	
						(0.10)		(0.10)	
multi exchange rates						-0.15**	-0.14	-0.15*	-0.14*
regime 1996-1999						(0.07)	(0.10)	(0.06)	(0.07)
currency crisis in 2012						-0.42*	-0.38	-0.46*	-0.40*
						(0.16)	(0.19)	(0.15)	(0.18)
R^2	0.65	0.43	0.65	0.44	0.65	0.72	0.40	0.72	0.43
period	2000-10	2000-10	2000-10	2000-10	2000-10	1992-2015	1996-2015	1992-2015	1996-2015

Note: The figures in parantesis are the standard errors. Cofficients with * and ** are significant at 5 and 10 percent respectively. In different models, the coefficent of real exchange rate is positive and significant, while the magnitute varies considerably. coefficent of dummies for instability in exchange regim are getative nad significant.

Table 2: Calibrated Parameters

to non-oil GDP at 22% between 1990 and 2014*Parameter*	*Values*	*Description*
Growth of Tradable Sector	g_T= 1.060	Annualized average growth rate between 1990 and 2014
Growth of Non-tradable Sector	g_N= 1.045	Annualized average growth rate between 1990 and 2014
Share of Labor in Output	$1-\alpha = 0.34$	Madanizadeh and Ebrahimian (2018)
Ratio of Foreign Asset to Output	$\overline{b}$= 0.015	Data between 1990 and 2012
Discount Rate	$\beta = 0.98$	Interest rate hold at 8.2%
Elasticity of Risk Premium	$\varphi = 0.1$	Harding et. al. (2016)
Tax	$\tau = 0$	For simplicity it is assumed there is no tax
Share of Traded Goods in Consumption	$\gamma = 0.35$	Target: Share of Industry in employment at 17% in 2016
Natural Resources Output	$\widetilde{e}_t^o$= 0.8	Target: Average ratio of natural resources to non-oil GDP at 22% between 1990 and 2014