TRADE LIBERALIZATION AND ECONOMIC DIVERSIFICATION: A DYNAMIC CGE MODEL FOR THE ECONOMY OF QATAR

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ABSTRACT

This paper develops a dynamic computable general equilibrium (CGE) model for Qatar with the view of getting some insights into the working of this a small open oil dependent economy. The model addresses three important issues that will determine the future path of Qatar economy. First, the issue of the oil price and its impact on the economy. Second, the issue of economic diversification away from oil. Third, the issue of trade liberalization in view of WTO agreement, the custom union within the GCC block, the planned GCC bilateral free trade agreement (FTA) with the EU and the US and the Greater Arab FTA. The impact of oil is simulated by an increase in the world price of oil. Economic diversification is simulated by an introduction of a value added tax (VAT) that diversifies government revenue and makes it less dependent on oil. Trade liberalization is simulated by a reduction of the external import tariff. The model results indicate that the increase of the price of oil and trade liberalization lead to a substantial favorable outcome in term of both GDP and wealth. On the contrary, the introduction of the VAT has an adverse impact on both GDP and wealth. As the aim of the VAT is to make the governments less dependent on oil, it turns out that the VAT decreases the tax base as it leads to the shrinking of the economy and, overall, the government collects even less taxes. This paper is the first attempt of its kind to address these issues in a dynamic general equilibrium context for Qatar and the Arab Gulf region. In addition, the data collected to calibrate the model provides a consistent set of data for the Qatar economy that is not being developed before.

I . INTRODUCTION

Qatar economy is a small economy that is dependent on the production and export of oil and natural gas. Qatar enjoys a relatively high per capita income due to the high value of oil and gas output relative to the small size of its population. The economy is characterized by an open trade regime, with a standard 5 percent import tariff for most imported goods. Regarding the foreign exchange regime, the Qatari riyal is pegged to the U.S. dollar at 3.64 Qatari riyals per U.S. dollar since July 2002. This peg helps keep inflation relatively low and therefore maintains price stability. The capital account is liberalized, and foreign investment is encouraged. Foreign workers

and expatriates comprise a substantial part of the labor force.

For the short and medium terms, oil and gas remain the backbone of the Qatar economy. Therefore, the changes in oil and gas price can have far reaching impact on the economy. Therefore, a rising oil and gas price is expected to have favourable impact on the economy. Another issue that is important for Qatar is trade liberalization and regional and international trade integration. Regionally, trade integration with the GCC is underway with the establishment of the GCC customs union with a unified external tariff. Internationally, the Free Trade Agreements (FTAs) with the EU and US are still under discussion. This is in addition to Qatar commitments under WTO to liberalize its trade. Therefore, trade liberalization is essential for the integration of the Qatar in the world economy. A challenge that faces the Qatar economy is the diversification away from oil and gas. One diversification measure, among others, is the broadening of the government fiscal revenue base beyond taxes on oil and gas by introducing a value added tax (VAT). VAT as a viable source of government revenue, was first introduced in Europe and gradually spread to other countries of the world. More recently, a large number of developing and transitional countries have adopted it. The VAT is now a key component of the tax system in more than 120 countries. It is estimated that VAT raises more than one-fourth of the world's tax revenue. VAT creates a reliable alternative revenue source, especially in countries that rely heavily one a single revenue source such as oil which can be volatile. In most countries that have adopted it, VAT contributes about 12 to 30 per cent of government revenue. If VAT is well designed and implemented, it can be an efficient way to raise revenue for government and modernize a country's taxation system. Other economic diversification measures include the pursuance of an economic growth strategy that is based on human capital (i.e. health and education), the development of the private sector and the development of tourism infrastructure.

In the GCC region, the issues of oil price, trade liberalization and government revenue diversification are crucial factors that will determine the current and future path of the GCC economies. Therefore, addressing these issues is in dynamic CGE modeling framework is timely and highly relevant for the region. This paper is a pioneer attempt and contributes significantly to the economic literature in this field. The impact of oil and gas on the Qatar economy is simulated by an increase in the world price of oil (when we talk of oil in the sequel we implicitly also mean natural gas). Trade liberalization is simulated by the reduction of the import tariff. Economic diversification is simulated by the introduction of a value added tax (VAT) that diversifies government revenue and makes it less dependent on oil and gas.

Hassanain (2002) developed a static computable general equilibrium (CGE) model for another oil-rich Gulf country, the UAE. This paper focuses on the Qatar economy by developing a dynamic CGE model. Others have used recursive dynamic models to study economies as a whole. See for instance Andersen and Faris (2002) with a model for Bolivia. A model for Brazil has been developed by Bugarin et al. (2003). The present model is not a recursive

model, but a model where consumers are maximizing utility and producers are maximizing net income. The model is more appropriate as it explicitly models dynamic efficient decisions made by consumers and producers. For similar models, see Diao et al. (1998) for the Turkey's economy, Annabi and Rajhi (2001) for the economy of Tunisia, and Mabugu (2003) for the South African economy. The model developed in this paper is based on Devarajan and Go (1998). The model of Devarajan and Go has also been applied to Bangladesh, Jordan and Poland; see respectively Piazolo (1999), Feraboli (2003) and Raihan (2004). Various others have also applied intertemporal consistent dynamic CGE models like the Devarajan and Go model. Examples of such models are the models looking at macroeconomic policies by Dogruel, Dogruel and Yeldan (2003). Models aimed at analyzing international trade issues are by Diao and Somwaru (2000), Kouparitsas (2001), Ghosha and Rao (2002), Mai, Adams, Fan, Li and Zheng (2005), Mai and Adams (2005), and Jean-Marc (2006). Models extended with environmental issues are analyzed by Bye (2000), Kemfert and Welsch (2000), Dissou, Wendner (2001), Mac Leod and Souissi (2002), Böhringer (2004), and finally, Dellink and van Ierland (2006).

The present paper focuses in the first part on providing a complete picture of the Qatar economy. This is done by assembling a social accounting matrix (SAM) of Qatar for the year 2003. Various economic agents are considered and the channels through which they interact can be read off from the SAM.

Section 2 presents the description of Qatar dynamic CGE model. Section 3 discusses the calibration and the SAM on which the calibration is based, together with the base run solution of the model. In Section 4, three policy experiments are simulated and these are namely: a simulation where the world export price increases as a result of the increase in the world oil price, a simulation where the import tariff is reduced, and a simulation where a value added tax (VAT) is introduced. Finally, Section 5 concludes the paper and identifies the agenda for future research.

II. MODEL DESCRIPTION

The model we are setting up for Qatar is a dynamic CGE model. The economy is assumed to consist of four types of agents and they are: a representative household as consumer, a representative firm, the government and the rest of the world. Each of them will be discussed separately. All accounting rules are discussed together with the terminal conditions to guarantee that the economy is in a steady state in the final time period.

Consumers

A representative consumer maximizes discounted utility subject to the intertemporal budget constraint describing the evolution over time of wealth (consisting of the physical capital stock and net foreign assets):

$$\max_{C_t} \sum_{t=0}^{\alpha} \frac{1}{(1+\rho)^t} \frac{C_t^{1-\upsilon}}{1-\upsilon}$$

$$s.t. \quad W_{t+1} = W_t + r_t^c . W_t + Income_t^{Net} - PC_t . C_t$$

The variable $Income_t^{Net}$ represents net income from various sources, including labour income, foreign transfers, government transfers, and the like. The income is net as consumers have to pay income tax for instance. As these components are not important for deriving an equation describing

the behaviour of consumers we will not present these details. Utility depends on consumption C_t and we assume a constant elasticity of intertemporal substitution. The reciprocal of this elasticity is the parameter υ and its value is between zero and one. It is assumed that consumers give less weight to future levels of consumption and this is represented by the rate of time preference ρ. The budget constraint describes the evolution over time of consumers' wealth W_t. It includes the interest rate that consumers face r_t^c. The first order conditions of this maximization problem are transformed into the following equation:

$$\frac{C_{t+1}}{C_t} = \left(\frac{PC_{t+1}}{PC_t} \cdot \frac{1+\rho}{1+r_t^c} \right)^{-\frac{1}{\upsilon}} \quad (1)$$

Consumers' total income (YH_t) is partly labor income (wage rate time the amount of labor supplied, or $w_t \cdot L_t$), capital income (the reward for capital times the size of the capital stock, or $r_k(t) \cdot K_t$), government transfers ($GTRS_t$) appropriately priced, and foreign transfers in domestic currency ($FTRS_t$ is the level of foreign transfers in foreign currency, so we have to multiply this figure by the exchange rate er, which is the amount of Qatari Riyal (QR) per US dollar) minus the interest received on the net foreign assets of Qatar. The latter being equal to the world interest rate i^* times the size of the net foreign assets NFA_t in foreign currency, times the exchange rate.

$$YH_t = w_t . L_t + r_k(t) . K_t + GTRS_t . P_t + FTRS_t . er + i^* . NFA_t . er \quad (2)$$

Part of their income is saved and another ($PC_t . J_t - B_t . er - SAV_t^{Gov}$) part is used to pay income taxes. The income tax rate is ty_t. Net income after taxes is represented by Y_t and it is equal to:

$$Y_t = (1 - ty_t) . \left[YH_t - \left(PC_t . J_t - B_t . er - SAV_t^{Gov} \right) \right] \quad (3)$$

Consumers spend their net income after taxes on consumption priced at PC_t:

$$Y_t = PC_t . C_t \quad (4)$$

Firms

The representative firm is assumed to maximize the present value of their net income subject to the familiar capital build up constraint:

$$\max_{J_t} V_0 = \sum_{t=0}^{\alpha} \frac{1}{\left(1 + r_t^p\right)^t} \left[r_k(t) . K_t - w_t . L_t - PC_t . J_t \right]$$
$$s.t. \quad K_{t+1} = K_t + I_t - \delta . K_t$$

Adjustment costs are added to the model to prevent the dynamics of the model to degenerate. Investment outlays of J_t will lead to gross accumulation of capital in the amount of I_t due to adjustment costs in the amount of $\theta(I_t / K_t)$, or:

$$J_t = I_t \left[1 + \theta \left(\frac{I_t}{K_t} \right) \right] \quad (5)$$

Where:

$$\theta(x_t) = \left(\frac{\beta}{2} \right) . \frac{(x_t - \alpha)^2}{x_t} \quad (6)$$

and

$$x_t = \frac{I_t}{K_t} \quad (7)$$

Adjustment costs are assumed to be a function of the ratio of gross investment to the size of the capital stock with positive parameters α and β.

The solution of the firm's maximization problem is (set up the Hamiltonian, derive the first order condition and manipulate them):

$$\frac{I_t}{K_t} = \alpha + \frac{1}{\beta} . Q_t^T \quad (8)$$

$$Q_t^T = \frac{q_t}{PC_t} - 1 \quad (9)$$

$$r_t^p \,.\, q_t = R_k(t) + (q_{t+1} - q_t) - \delta \,.\, q_{t+1} \quad (10)$$

$$R_k(t) = r_k(t) + PC_t \,.\, \left(\frac{I_t}{K_t}\right)^2 \,.\, \theta'\left(\frac{I_t}{K_t}\right) \quad (11)$$

$$K_{t+1} = (1-\delta).K_t + I_t \quad (12)$$

Government

The government collects various taxes. We have an import tariff (tax rate tm_t), export taxes (tax rate te_t), indirect taxes on goods (tax rate tx_t), and, finally, an income tax with tax rate ty_t: (13)

$$TAX_t = tm_t \,.\, (M_t \,.\, pm_t^* \,.\, er) + te_t \,.\, (E_t \,.\, pe_t^* \,.\, er) + tx_t \,.\, [P_t \,.\, (C_t + G_t + J_t)] + ty_t \,.\, [YH_t - (PC_t \,.\, J_t - B_t \,.\, er - SAV_t^{Gov})]$$

The government also imposes a tax on firms (which for the UAE is negative, so in effect it is a subsidy – the corresponding tax rate is denoted by ts_t). Government revenues are used to finance government spending G_t and government transfers $GTRS_t$, each of them appropriately priced. The excess of revenues over expenditures is government savings which are transferred to consumers to pay for investment:

$$SAV_t^{Gov} = TAX_t + ts_t \,.\, PV_t \,.\, Q_t - G_t \,.\, PC_t - GTRS_t \,.\, P_t \quad (14)$$

Rest of the world

The budget constraint for the rest of the world has the import revenues on the income side. Expenditures by the Rest-of-the-World (ROW) are on Qatar exports, the interest payments to Qatar on the net foreign assets position of Qatar and foreign transfers to Qatar ($FTRS_t$). The savings of the ROW are represented by B_t.

$$pm_t^* \,.\, M_t = pe_t^* \,.\, E_t + i^* \,.\, NFA_t + FTRS_t + B_t \quad (15)$$

The evolution over time of the net external assets position of UAE is governed by:

$$NFA_{t+1} = NFA_t \,.\, (1 + d_{adj}) - B_t \quad (16)$$

The net external assets position increases if export expenditures, together with the interest payments by the ROW and the foreign transfers are larger than imports receipts. We also have an exogenous adjustment of the net external assets position represented by the parameter d_{adj}.

Labour market

The supply of labour (LS_t) is exogenously given (indicated by a bar) and it is assumed that there is full employment. The equilibrating variable is the average wage rate w_t. So labour employed L_t equals:

$$L_t = \overline{LS_t} \quad (17)$$

Goods market equilibrium

Total composite supply X_t is equal to total composite demand, which is consumption by the private sector and the government, and investment:

$$X_t = C_t + G_t + J_t \quad (18)$$

Interest rates

The interest rate affecting the producer (r^p_t) is defined as the world interest rate (i^*) and the forward percentage change in the real exchange rate:

$$r_t^p = i^* + \frac{e_{t+1}^p - e_t^p}{e_t^p} \quad (19)$$

A dot over a symbol indicates the time derivative. The real exchange rate facing producers is the relative price between exports and domestic goods as they are the goods sold by producers:

$$e_t^p = \frac{PE_t}{PD_t} \tag{20}$$

For consumers, the interest rate they face is determined by the opportunity cost of savings, which is the cost of foreign borrowing. The latter is defined as the world interest rate plus the forward percent change in the real exchange rate ( ):

$$r_t^c = i^* + \frac{e_{t+1}^c - e_t^c}{e_t^c} \tag{21}$$

Where:

$$e_t^c = \frac{PM_t}{PD_t} \tag{22}$$

Prices

We can define the following prices. First, the price of exports is the world price of exports in foreign currency pe^*_t times the exchange rate *er*. The price of exports is net of any export tax (tax rate is te_t), so we end up with:

$$PE_t = pe_t^* . (1 - te_t) . er \tag{23}$$

The price of imports is the world price of imports in foreign currency pm^*_t times the exchange rate *er* . The price of imports is including any import tariffs (import tariff rate is tm_t), or:

$$PM_t = pm_t^* . (1 + tm_t) . er \tag{24}$$

The domestic price level is equal to the price level of domestic supply P_t, including the indirect tax on products with tax rate tx_t:

$$PC_t = P_t . (1 + tx_t) \tag{25}$$

We make use of the Armington assumption whereby goods of the same type, but with different countries of origin, are treated as imperfect substitutes. Each country produces a unique set of goods, which, to a varying degree, are substitutes for, but not identical to goods produced in other countries. The following CES function is used to capture the Armington assumption ($\rho_c > -1$, $\alpha_c > 0$ and $0 < \delta_c < 1$):

$$X_t = \alpha_c . \left[\delta_c . M_t^{-\rho_c} + (1 - \delta_c) . D_t^{-\rho_c}\right]^{-1/\rho_c} \tag{26}$$

The zero profit assumption amounts to:

$$PX_t = PD_t . D_t + PM_t . M_t \tag{27}$$

Here, each of the variables is multiplied by its corresponding price. The optimal allocation of imported goods and domestically produced goods is governed by:

$$\frac{M_t}{D_t} = \left[\frac{\delta_c}{1 - \delta_c} . \frac{PD_t}{PM_t}\right]^{1/(1+\rho_c)} \tag{28}$$

This equation can be derived as the solution of a revenue maximization problem where for a given output level of X_t the supply function as given above can be derived.

Domestic output Q_t is modeled as a CET function between domestically consumed goods D_t and exports (where $\rho_e > 1$, $\alpha_e > 0$ and $0 < \delta_e < 1$):

$$Q_t = \alpha_e . \left[\delta_e . E_t^{\rho_e} + (1 - \delta_e) . D_t^{\rho_e}\right]^{1/\rho_e} \tag{29}$$

The zero profit condition with domestic output is:

$$PQ_t \,.\, Q_t = PD_t \,.\, D_t + PE_t \,.\, E_t \qquad (30)$$

Again, each variable is multiplied by its corresponding price. The optimal supply of the exported good and the domestically consumed goods is given by:

$$\frac{E_t}{D_t} = \left[\frac{1-\delta_e}{\delta_e} \cdot \frac{PE_t}{PD_t}\right]^{1/(\rho_e - 1)} \qquad (31)$$

Value added is assumed to be dependent on capital and labor according to a CES production function ($\rho_v > -1$, $\alpha_v > 0$ and $0 < \delta_v < 1$):

$$Q_t = \alpha_v \,.\left[\delta_v \,.\, L_t^{-\rho_v} + (1-\delta_v).\, K_t^{-\rho_v}\right]^{-1/\rho_v} \qquad (32)$$

The zero profit condition is now:

$$PV_t \,.\, Q_t = w_t \,.\, L_t + r_k(t).\, K_t \qquad (33)$$

The price of value added is dependent on the tax rate on firms, according to:

$$PV_t = PQ_t / (1 + ts_t) \qquad (34)$$

The optimal allocation of labour and capital is given by the following equation:

$$\frac{L_t}{K_t} = \left[\frac{\delta_v}{1-\delta_v} \cdot \frac{r_k(t)}{w_t}\right]^{1/(1+\rho_v)} \qquad (35)$$

Exogenous Variables

Government behavior is assumed exogenous in the model. So government consumption and government transfers are given. Additionally, the implicit tax rates for each of the taxes are considered exogenous and constant. Foreign transfers are also assumed given. Furthermore, world prices for imports and exports are dictated on the world market outside the influence of the country.

Walras' Law and the Numéraire

Because of Walras' law we can omit the equation for equality of consumption and net income available to consumers to spend on consumption. As the model is homogeneous of degree one in prices we can make one price the Numéraire. We choose this price to be the exchange rate ***er*** and its value is set to its historical value.

Terminal condition

The discrete time model will be solved using the numerical optimization software tool GAMS (see Brooke, Kendrick, and Meeraus 1998). In theory, we would have to take an infinite number of time periods as only at $t = \infty$ will the model have reached the steady state. This is of course not possible because it would require an infinite number of calculations. There is an adjustment needed to make sure that the numerical outcome of the model with a finite horizon is equivalent to the outcome with an infinite horizon. This is termed steady state invariance; see Mercenier and Michel (1994a and 1994b). For the current model this means that an additional term is added to the objective function, which is the utility function of consumers, representing the value of the objective function for all remaining time periods that are not considered. By assuming that from the last time period onward the economy is in a steady state we know that consumption in the utility function is constant. Then the additional term is simply the infinite sum of discounted utility levels. Following the argument by Mercenier and Michel, we have to impose the following conditions to the model. First, the capital stock in the steady state is constant, or depreciation is equal to investment:

$$\frac{I_{tf}}{K_{tf}} = \delta \qquad (36)$$

The final time period is represented by the time index ***tf***. Also, we must have that the

discount rate for producers, and consumers, is equal to the world interest rate:

$$r_{tf}^{c} = i^{*} \quad (37)$$

$$r_{tf}^{p} = i^{*} \quad (38)$$

The net external assets position has to be constant which means that foreign borrowing is equal to the adjustment of net foreign assets:

$$B_{tf} = NFA_{tf} \cdot d_{adj} \quad (39)$$

Additionally, because of the equation describing the evolution over time of consumption we must have:

$$\rho = r_{tf}^{c} \quad (40)$$

This follows from Equation 1 and replacing all time periods with the final time period ***tf***:

$$\frac{C_{tf}}{C_{tf}} = \left(\frac{PC_{tf}}{PC_{tf}} \cdot \frac{1+\rho}{1+r_{tf}^{c}} \right)^{-\frac{1}{\nu}}$$

III. MODEL CALIBRATION

The model is calibrated using publicly available data for the year 2003 from official sources. Data from the Planning Council of Qatar is used to arrive at a social accounting matrix (SAM) as a database for calibrating the model. The SAM with the actual figures can be found in Table 8 in the Appendix. The values in the SAM are all nominal values, but we will be working with real per capita values. All values in the sequel are in millions Qatari Riyal and this is abbreviated as QR.

Usually, to come up with a consistent macroeconomic data set is a daunting task and is not easy to bring about because of the data problems in the GCC region. The economic data is scattered here and there without any consistency and usually it does not add up to a consistent macroeconomic accounting framework. The lack of data availability and its poor quality have discouraged many people to pursue interesting modeling projects that could have shed light on crucial economic issues that face the GCC region. This paper has managed to overcome this serious obstacle and assembled a consistent set of economic data for calibrating the model.

What is meant by data consistency here is that at the macroeconomic level, the national accounting identity $Y = C + G + I + X - M$ must be satisfied. In other worlds, total supply which is represented by domestic output (Y) and imports (M) must equal total demand which is represented by nominal private consumption (C), government consumption (G), investment (I) and exports (X). Also, government revenue must equal its expenditure otherwise the government must run either budget surplus or deficit. Further, exports must equal imports otherwise the country must run either current account surplus or deficit. Moreover, households income must equal their spending otherwise they must save or borrow. In a nut shell, the macroeconomic accounting framework of the economy is satisfied by the model equations.

Gross domestic product (GDP) at market prices in 2003 is 86,273. Nominal private consumption is 14,723 and government consumption is 14,580. Investment in capital and in the stock of inventory amounts to 30,700. The level of exports is 52,852 and

imports are 26,582. The values of nominal private and government consumption, and investment are values including the indirect tax on goods. We have to separate out the amount of indirect tax for all these three variables and we do that by assuming that the revenue of indirect tax on goods is a fixed tax rate (*tx*) times the value of the goods. The total revenue due to the indirect tax on goods is 89 million QR. We divide the total revenue of the tax by the value of the goods excluding the tax revenue and arrive at the following tax rate:

$$tx = \frac{89}{14{,}723 + 14{,}580 + 30{,}700 - 89} = 0.00149$$

The levels excluding the indirect tax for consumption and investment can be found by dividing the values including the tax by one plus the tax rate, i.e. by 1 + *tx*, or C = 14,701, G = 14,588, and I = 30,654. The tax for each expenditure item is calculated by subtracting the value without the tax from the value including the tax and we arrive at: *tax*(C) = 22 , , and *tax*(I) = 46. The total amount of intermediate consumption amounts to 28,990. Total capital income is equal to 69,784 and the sum of all wages in is 15,926. The size of the labor force is 428,456 persons, while the total size of Qatar population is 717,766 persons. Depreciation of the capital stock is equal to 7,807. The government does not levy export taxes, but it levies an income tax on the profits of foreign banks and oil and gas producing companies, and this is 26,481. Import tariffs total 532, and the subsidies provided by the government to firms are 58. The net tax to firms is the difference between the latter two values, or 474. We assume that the import tax (*tm*) is a constant tax rate times the value of imports. For the import tax we find that it is equal to:

$$tm = \frac{532}{26{,}582} = 0.02001$$

The total amount of government transfers to consumers is 6,461 and it includes various subsidies to the local population, but also payments from consumers to the government, such as the income on government investments which are channeled first to the consumers and then to the government. As the level of subsidies is larger than the payments to the government, this value is positive. The government deficit is –6,003 and this is equal to minus the level of government savings.

The exchange rate that will be used in the model is the exchange rate of the QR against the US dollar. Its level is constant at 3.6400 QR per US Dollar; the Riyal is pegged to the US dollar. The total net external assets position (in millions US Dollar) of the Qatar is 25,819. In the Qatar currency the total net external asset position is equal to 93,981 million QR. The interest received (in millions US Dollar) on the net external assets position of the Qatar is equal to 5,164. The value of interest received on the net external assets position is an estimate as no official data is available for this value. The level of net foreign transfers in is equal to –24,123. So the direction of this flow is towards the rest of the world (ROW). The latter value combined with the interest received (or 5,164 million US Dollar, which is 18,796 million QR) from the Rest-of-the-World equals –5,327 and this value can be found in the SAM. The savings by the Rest-of-the-world are in the amount of –20,943, or we can also say that the current account balance is 20,943. As the Qatar exports are larger, and taking into account the net current transfers, the current account balance

denotes the influx of foreign currency into the Qatar. We conclude the discussion of the SAM by noting that the net savings by households are 37,833; together with the saving of the Rest-of-the-World and the saving by the government, this is used to finance net investment.

Table 1: Calibrated parameters values for Qatar.

Parameter	Symbol	Value
Import tariff rate	tm_t	0.02001
Tax rate for companies	ts_t	-0.00068
Income tax rate	ty_t	0.6427
Indirect tax rate on goods	tx_t	0.00149
Exchange rate	er_t	3.640
Capital depreciation rate	δ	0.274
Coefficient in utility function	υ	0.900
Parameter adjustment cost function	α	0.000
Parameter adjustment cost function	β	0.04685
Shift parameter (CES)	α_c	1.986
Shift parameter (CET)	α_e	2.114
Shift parameter (CES)	α_v	1.173
Share parameter (CES)	δ_c	0.424
Share parameter (CET)	δ_e	0.2781
Share parameter (CES)	δ_v	0.5372
Exponent parameter (CES)	ρ_c	0.600
Exponent parameter (CET)	ρ_e	3.000
Exponent parameter (CES)	ρ_v	0.600
Rate of time preference	ρ	0.200
External assets adjustment parameter	d_{adj}	0.223
World interest rate	i^*	0.200
World price of exports	pe^*_t	0.275
World price of imports	pm^*_t	0.269

Parameters values

Table 1 below gives the set of parameters values that are calibrated for the model and are used for the base year solution of the model.

Base run solution

With the calibrated parameters values, we now trace out the time path for various variables over time. This is termed the base run and the results are presented in Table 2. The values in the table are all in nominal and in nominal per capita terms.

IV. POLICY EXPERIMENT

Using the Qatar model that is developed and discussed in the previous sections, we can now perform some policy experiments to find out the impact of certain government economic policies on the future path of the Qatar economy. These policy experiments are relevant for the Qatar current situation and future prospects. The impact of each of these polices is appraised in terms of wealth and welfare. The level of wealth

Table 2: Base run for Qatar economy (nominal values in million QR, per capita values in QR, or indicated otherwise).

	Nominal value	Per capita value
Gross domestic product	86,273	-
Consumption	14,723	20,512
Investment	30,700	42,772
Government consumption	14,580	20,313
Exports	52,852	73,634
Imports	26,582	37,034
Import tariffs	532	741
Subsidies	-58	-81
Indirect tax on goods	89	124
Government transfers	6,461	9,002
Tax on income	26,481	36,894
Labour income	15,926	22,188
Capital income	69,784	97,224
Current account	-20,943	-29,178
Net foreign assets (US Dollar)	25,819	35,971
Interest received on external assets (US Dollar)	5,164	7,194
Foreign transfers	-24,123	-33,609
Labour force size (x1000)	428,456	0.597
Population size (x1000)	717,766	1

The actual time horizon of the model runs from 2003, the base year, to the year 2103.

is the infinite sum of discounted levels of consumption; see the difference equation of the consumer maximization problem.

The first policy experiment looks at the consequences of a 1% increase in the world price of oil. The second policy experiment revolves around the issue of economic diversification away from oil to non-oil revenues. This policy is pertinent to the Qatar situation given the recent endeavors of Qatar to reduce its dependency on oil. This policy is simulated by the imposition of value added tax (VAT) to diversify government revenue and make it less dependent on oil proceeds. This policy becomes even more relevant considering the Gulf Co-operation Council (GCC), of which Qatar is a member, and its intention to introduce a value added tax with the view of harmonizing the tax procedures among its members. The third policy experiment focuses on the issue of trade liberalization. This policy is relevant for Qatar situation given its commitment to WTO agreement and the several free trade agreements (FTAs) that are currently being negotiated with a number of countries such as the US. This policy is simulated by the reduction of Qatar import tariff to reflect the impact of a free trade agreement that leads to a partial or complete lifting of the import tariff. The results of each policy experiment are presented as percentage change with respect to the corresponding base run value.

a. Increase in the World Oil Price

We assume that the world oil price rises by 1%, say for example, as a result of the

Table 3: Policy outcome of oil price increase (percentage change with respect to the base run).

	2007	2008	2009	2011	2013	2023	2037	2060	2103
C_t	4.603	4.618	4.632	4.657	4.68	4.763	4.824	4.861	4.875
J_t	0.207	0.22	0.232	0.253	0.273	0.343	0.395	0.427	0.437
E_t	-0.234	-0.217	-0.201	-0.171	-0.144	-0.047	0.024	0.068	0.083
M_t	2.065	2.072	2.078	2.09	2.1	2.138	2.166	2.184	2.189
B_t	-2.198	-2.38	-2.551	-2.866	-3.147	-4.152	-4.859	-5.253	-5.341
K_t	0.087	0.106	0.124	0.157	0.186	0.293	0.372	0.42	0.437
RK_t	1.391	1.382	1.373	1.356	1.342	1.288	1.249	1.226	1.217
WL_t	1.532	1.553	1.573	1.611	1.644	1.764	1.853	1.907	1.925
TAX_t	5.89	5.899	5.908	5.924	5.938	5.991	6.029	6.053	6.062
NFA_t	-1.115	-1.356	-1.584	-2.003	-2.377	-3.72	-4.669	-5.208	-5.341
GDP_t	1.005	1.016	1.028	1.048	1.066	1.133	1.182	1.212	1.222
CPI_t	1.314	1.308	1.303	1.294	1.286	1.256	1.235	1.221	1.217

The full names of the abbreviated variables in table 3 above are spelled out below in this section. And these names of the variables also apply for tables 4 and 5 in the next two sections.

increased oil demand by the fast growing economies of India and China. As the export of the Qatar consists for 80% of oil we assume that the world export price rises by 0.8% to 0.277 QR per unit export good. Table 3 below shows the outcome of this policy experiment. The results of the policy experiment are presented as percentage change with respect to the corresponding base run value.

Because of the high export price, the country wants to export (E_t) more goods to the ROW. As the production capacity is constraint in the short-term, the level of investment (J_t) will go up to increase the level of physical capital (K_t). Exports will initially go down to provide enough resources to increase investment. As this extra capital becomes available, the output increases and exports will increase too. All spending components go up, like consumption (C_t) and investment and this lead to a higher level of gross domestic product (GDP_t). Imports (M_t) go up as well and the current account (B_t) deteriorates, leading to a lower level of net foreign assets (NFA_t). As labor becomes more scarce compared to capital, the wage rate (WL_t) increases more than the reward for capital (RK_t).Government tax revenue (TAX_t) increases because the economy is growing and the tax base for the various taxes increase also. Domestic inflation increases as show by the increase in the consumer price index (CPI_t).

The impact of this policy on the level of per capita wealth is shown by the second row in Table 6 of Section 4.3. As the table shows, wealth is (almost 6%) higher than the level of wealth in the base run. We can also look at compensating variation. It measures in money terms how much consumers are willing to pay to do without the policy

measure (in this case an increase in the world oil price). The compensating variation turns out to be negative –4,779 QR. One can also say that the negative of the compensating variation is the amount of money that this policy measure is worth to them. As the compensating variation is measured with respect to the new price and the initial indifference curve, we can also take the inital price and the new indifference curve and end up with the equivalent variation of –4,724 QR. Its value is, as can be expected, comparable to the compensating variation. Apparently, the consumers want to receive (i.e. compensated) quite a substantial amount of money if the world export prices would not rise. In other words, they are willing to give up this policy measure only if they are sufficiently compensated.

b. Reduction of import tariff

This policy is simulated by the reduction of the Qatar import tariff from its base run value to reflect the impact of a free trade agreement. There are several import tariffs on different imported goods and some goods are exempted. Therefore, we calculate an average rate for all imported goods. On average, there is a 2.001% import tariff rate on all imported goods (see Table 1 in Section 3). The consequences of a free trade agreement are determined by looking at the outcome for the Qatar economy of lowering the import tariff to 1.401%, or equivalently, reduce its value by 30%. Table 4 below gives the results of this policy experiment. It shows the movement of the major set of variables over time for a selected number of time periods and relative to the base run. The results of the policy experiment are presented as percentage changes with respect to the corresponding base run values.

By making imports less expensive the level of imports increases. As imports and domestic goods are complementary, also consumption and investment go up. Additionally, the capital stock increases relative to labor and the reward for capital increases at a lesser rate than the wage rate increases. The levels

Table 4: Policy outcome of import tariff reduction (percentage change with respect to the base run.

	2007	2008	2009	2011	2013	2023	2037	2060	2103
C_t	2.35	2.37	2.388	2.423	2.453	2.565	2.647	2.697	2.716
J_t	0.285	0.302	0.319	0.349	0.375	0.473	0.544	0.588	0.602
E_t	-0.051	-0.028	-0.005	0.036	0.073	0.207	0.306	0.366	0.387
M_t	1.194	1.203	1.212	1.228	1.242	1.294	1.332	1.356	1.363
B_t	-3.018	-3.267	-3.503	-3.936	-4.322	-5.706	-6.679	-7.223	-7.345
K_t	0.12	0.146	0.17	0.216	0.256	0.404	0.512	0.579	0.602
RK_t	0.262	0.249	0.237	0.215	0.195	0.122	0.07	0.037	0.025
WL_t	0.453	0.482	0.51	0.56	0.606	0.771	0.891	0.966	0.991
TAX_t	1.883	1.895	1.907	1.928	1.948	2.018	2.069	2.1	2.111
NFA_t	-1.53	-1.862	-2.175	-2.75	-3.264	-5.11	-6.417	-7.161	-7.345
GDP_t	0.213	0.229	0.245	0.273	0.298	0.39	0.457	0.498	0.512
CPI_t	0.157	0.15	0.143	0.13	0.119	0.079	0.049	0.031	0.025

of Qatar imports increase, even to a larger extent than exports rise. The current account deteriorates and this leads to a decrease in net foreign assets, as this is used to finance the increase in net imports. As the economy grows, the tax base expands and the total government tax revenues increase despite the fact that import tariffs go down. This is because the economy grows and hence the tax base expands as a result.

The impact of this policy on the level of wealth is shown by the third row in Table 6 at the end of Section 4.3. As the table shows, wealth is higher than the level of wealth in the base run by 2.5%. The compensating variation and equivalent variation are both negative and again almost comparable in size, –2,415 QR and –2,415 QR respectively. Therefore, people are better of with this policy measure and they are only ready to give it up when they are compensated.

c. Introduction of value added tax (VAT)

One way to make the government less dependent on oil revenues is to introduce a VAT. In Qatar, there is already an indirect tax that is comparable to a VAT, which is imposed on the so-called harmful products, like alcohol and tobacco. We simulate this policy experiment by increasing the VAT tax level on all goods, see Table 1 in Section 3. The VAT tax rate in the base run is 0.149% and it is increased to 0.193%, or an increase of 30%. Table 5 below shows the outcome of this policy experiment. The results of the policy experiment are presented as percentage change with respect to the corresponding base run value.

The VAT makes domestic goods more expensive and less of them are consumed. Therefore, both consumption and investment fall relative to the base run. Less investment

Table 5: Policy outcome of VAT increase (percentage change with respect to the base run).

	2007	2008	2009	2011	2013	2023	2037	2060	2103
C_t	-0.335	-0.337	-0.34	-0.345	-0.349	-0.364	-0.375	-0.382	-0.385
J_t	-0.04	-0.042	-0.045	-0.049	-0.053	-0.066	-0.077	-0.083	-0.085
E_t	0.015	0.012	0.009	0.003	-0.002	-0.021	-0.035	-0.044	-0.047
M_t	-0.154	-0.155	-0.156	-0.159	-0.161	-0.168	-0.173	-0.176	-0.178
B_t	0.428	0.464	0.498	0.559	0.614	0.811	0.951	1.029	1.047
K_t	-0.017	-0.02	-0.024	-0.03	-0.036	-0.057	-0.072	-0.081	-0.085
RK_t	-0.053	-0.051	-0.049	-0.046	-0.043	-0.033	-0.026	-0.021	-0.019
WL_t	-0.079	-0.083	-0.087	-0.094	-0.101	-0.124	-0.141	-0.151	-0.155
TAX_t	-0.269	-0.271	-0.272	-0.275	-0.278	-0.288	-0.295	-0.299	-0.301
NFA_t	0.217	0.264	0.309	0.391	0.464	0.727	0.913	1.02	1.047
GDP_t	-0.041	-0.043	-0.045	-0.049	-0.053	-0.066	-0.075	-0.081	-0.083
CPI_t	-0.038	-0.037	-0.036	-0.034	-0.033	-0.027	-0.023	-0.02	-0.019

results in a lower capital stock over time and as there is a lower level of capital compared to labor, the return on capital decreases less then the wage rate. As domestic goods and imports are complementary, the level of imports goes down as well. Imports are falling and exports increase initially and are falling too eventually, but to a lesser extend. So the current account improves leading to a build up of net foreign assets. Overall, the government collects less taxes as the tax base decreases as a result of the shrinking economy. If one looks at *GDP* it is clear that it is falling.

The impact of this policy on the level of wealth is shown by the fourth row in the Table 6 below. As the table shows, wealth is lower than the level of wealth in the base run.

Looking at the compensating variation, we see that it is 343 QR. This time this value is again comparable to the equivalent variation 344 QR. Both money amounts are positive as these are the amounts consumers are willing to pay to not have the indirect tax rate raised. This time consumers are worse off with this policy measure. That is why they are willing to pay to avoid it. The objective of the introduction of this VAT tax is to increase the government tax revenues, yet it has the opposite effect because of the shrinking economy and the consequent narrowing of the tax base. The following table shows the compensating and equivalent variation for each of the simulations in an overview:

V. CONCLUDING REMARKS

This paper is the first attempt to develop a dynamic CGE model for the economy of Qatar. A consistent database, in the form of an aggregate social accounting matrix, has been constructed for the first time for Qatar to the best of our knowledge. The model is

Table 6: Levels of wealth in base run and percentage change with respect to base run for the three experiments (in QR).

Simulation	Level of wealth	Percentage change of wealth with respect to base run
Base run	102,561	-
Increase in the oil price	108,645	5.93
Decrease import tariff rate	105,073	2.45
Increase indirect tax rate	102,188	-0.36

Table 7: Compensating and equivalent variation for each of the simulations in Qatari Riyal.

Simulation Compensating variation Equivalent variation	Compensating variation	Equivalent variation
Increase in the oil price	-4,779	-4,724
Decrease import tariff rate	-2,415	-2,415
Increase indirect tax rate	343	344

calibrated based on the data from the SAM and then it is used to simulate some policy experiments that are relevant for the present and the future of the Qatar economy. The first policy experiment is one where the world price of oil increases. The second one is trade liberation policy, which is simulated by the reduction of import tariff. The third one is economic diversification, which is simulated by the introduction of a value added tax. The model results indicate that the oil price increase and the import tariff reduction both have a favorable impact on the economy and wealth. The latter measured by the present value of all future per capita consumption. On the other hand, the introduction of the VAT has adverse impact on wealth. As the aim of the VAT was to make the governments less dependent on oil, it turns out that the VAT decreases the tax base as it leads to the shrinking of the economy and, overall, the government collects even less taxes.

The current model can be extended in various directions to study several issues that are pertinent to the Qatar economy. One possible extension is to include imported intermediate and capital goods. A second possible extension is to disaggregate labor into different skill levels and/or make a distinction between expatriates and Qatar nationals. Also, the exploitation of the finite exhaustible resource oil could be modeled explicitly and then the government behavior, which aims at making the Qatar economy less dependent on oil, could be studied. The current model has only one sector; another extension would be to consider more sectors to captures each sector's specific characteristics.

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Appendix: SAM for Qatar

Table 8: Actual SAM for Qatar in 2003.

		Production	Income Creation		Income distribution			Institutions					
		Firms	Wages	Capital income	Labour income	Government subsidies	Government taxes	Households	Capital	Government	ROW current	ROW capital	Total
Production	Firms	28,990						14,701	30,654	14,558	52,852		141,756
Income Creation	Wages	15,926											15,926
	Capital income	69,784											69,784
Income Distribution	Households		10,599	61,977						6,461			79,037
	Government subsidies	-58											-58
	Government taxes	532			26,481			22	46	22	0		27,102
Institutions	Households				52,556								52,556
	Capital			7,807				37,833		6,003			51,643
	Government					-58	27,102						27,044
	ROW current	26,582	-5,327									20,943	52,852
	ROW capital								20,943				20,943
Total		141,756	15,926	69,784	79,037	-58	27,102	52,556	51,643	27,044	52,852	20,943	