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MODIFYING EDWARD'S MODEL FOR REAL EXCHANGE RATE AND STRUCTURE OF ECONOMY IN OIL EXPORTING DEVELOPING COUNTRIES

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Abstract

After six years of ending my PhD in economics, it is still important to modifying Edward model for oil exporting developing countries in order to diversifying economy from oil dependency to less depends on one product to export, this case is known in economic literature as single commodity exports in oil exporting developing countries. This paper is extracted from my PhD thesis which is about the problem of depending on one product to export. This paper is also concentrated theoretical analyses only. In addition it contributes to literature via modifying Edwards's model which is related to the problem of Dutch disease. The modification of Edwards's model is one of the most important steps for researchers whose research is about the diagnosing of problems related to significant dependency on oil revenue. The modification of Edwards's model is severely needed in order to more suitable for oil exporting developing countries to find the best outcomes of diagnosing and solving problems of "Dutch Disease".

***Keywords**: Oil Price, Edward's Model, Tradable Goods, non-Tradable Goods.*

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1. INTRODUCTION

This paper, a model will be presented to examine theoretically and modifying Edwards's model about the impact of a commodity export boom on the rest of the economy, under the assumption of a small open economy. In this case, changes in the real exchange rate occur via changes in the nominal price of non-tradable goods, (Edwards 1983), assuming that the price of tradable goods will be relatively constant during a booming period, or at least the rate of change in the price of tradable goods is less than the rate of change in the price of non-tradable goods. The model also assumes that the oil sector is owned by the government. This assumption corresponds closely to what we observe in developing nations. In this thesis, the assumption is made that the fixed exchange rate is chosen only during booming period, most of which follow a fixed rate regime with respect to the US dollar (i.e., Saudi Arabia, Kuwait, Venezuela, and Iraq).

However, with slumping oil revenues the monetary authority may not be able to continue with a fixed exchange rate regime, and a black market for the exchange rate may appear due to the inability of the monetary authority to provide enough foreign currencies into the domestic market. This happens when a government budget faces a severe deficit.

This research paper develops and presents a model of the interactions among commodity export prices, money creation, inflation, the real exchange rate and the output of the tradable and non-tradable goods sector. The mechanisms of effecting high (low) oil price on relative price, real exchange rate, and the structure of the economy will be through those variables that have been defined in the model, such as oil price, real government expenditure, money supply and real income, in addition to other factors such as nominal exchange rate and world inflation rate.

According to this model, the increased price of oil leads to an increase in the price of non-tradable goods to tradable goods through variables such as real government expenditure, real income and real money supply. By assumption, these variables increase the relative price of non-tradable goods to tradable goods. According to the model, these changes in the relative price of non-tradable and tradable goods will be the main factor of appreciation (depreciation) of the real exchange rate, and then increased (decrease) production of non-tradable goods and decrease (increase) in production of, and employment in, the tradable sector.

The plan of the study is as follows: Section two will be briefly about Justification of choosing Edwards model and its adjustment and why Edwards's model need to be modified then applying for oil exporting developing countries. Section 3 will analyse the detail of the model. It is divided into three main parts: monetary growth, inflation and real exchange rate block, and the output of tradable goods and non-tradable goods sectors. In section, four summarised specifications of equations will be presented. Section 5 will provide a general conclusion to the study.

2. JUSTIFICATION OF CHOOSING EDWARDS MODEL AND ITS ADJUSTMENT

There are many previous models that have been built to examine the consequences of increasing commodity export price on domestic economics. Although these previous models have made a significant contribution to the literature, but they focus mainly on oil-exporting developed countries rather than oil-exporting developing countries (Ali 2024). The theoretical context of the Dutch disease model, built by Corden and Neary (1982), is a helpful framework to improve our knowledge regarding the side effects of the natural resource sector in less developed nations. However, the characteristics and structures of oil-exporting developed countries are significantly different to oil-exporting developing nations, so the application of the Dutch disease model (See; Corden and Neary, 1982) on developing nations may not be appropriate. Below, it can be seen some limitations of the implications of the Dutch disease model in developing countries.

First, the Dutch disease model assumes that the economy benefits from full employment (all factors of production employed). However, in most of oil exporting developing countries, there is large unemployment rate. Before the discovery oil, most people from these countries were engaged and working in the agriculture sector, which is characterised as a low productive sector. Those in the urban areas were engaged with some traditional jobs, while others were unemployed urban job seekers. Thus, it can be expected that those workers would have been engaged in the non-tradable sector, as a result of resource movement and spending effects. These two factors lead to the increased relative price of non-tradable goods and, thus, the appreciation in the RER.

Second, the model assumes that both domestically produced commodities and imported commodities in the same sector are perfect substitutes. However, this assumption is very hard to sustain in almost all developing nations. At the very least, there would be differences in quality between domestic products and imported commodities, or "substitutes". Therefore, it is reasonable that the two commodities will not command the same price.

Third, the Dutch model assumed that the de-industrialisation phenomena emerging from natural resource discoveries (exploitation natural resource field) and increase its prices in developed countries such as UK and Netherlands. However, the case of the oil exporting developing countries is totally different with regard to developed countries. Before increasing the oil price (oil revenue) in 1973, the manufacturing sector in oil exporting developing countries was limited and the contribution of manufacturing in GDP was insignificant. Therefore, the side effect of high oil revenue had not adversely affected the manufacturing sector. However, the agriculture sector was the main sector that the economy depended on. Therefore, it would have been more likely for de-agriculturalisation, instead of de-industrialisation, to occur (Timer, 1982; Roemer, 1985). The sharp shrinking of the output in the agricultural sector in oil exporting developing countries (like Iraq and Nigeria) can be found throughout the date from these countries.

Fourth, in many developing countries including Iraq and Nigeria, the natural resource sector is considered as an enclave sector. Most of its factor of production, such as capital, labour, and even intermediate goods, are imported. Therefore, the resource movement effect cannot be observed. Only the spending effect remains.

Fifth, the Dutch disease model ignored the role of government in economic activities (government intervention), since the impact of government on economic activities is significantly high, particularly for oil-exporting developing countries. Moreover, the short-run financial effects of the changes in oil revenue, functioning through the government budget constraints, were also ignored. This kind of assumption is not appropriate for most of oil exporting developing countries since, in most developing countries, including Iraq, the role of the private sector is negligible in economic activities. Therefore, the consequences of increasing oil prices or an emergent booming sector will differ between these two groups. Therefore, the assumptions of Dutch disease may be more suitable for developed countries rather than developing.

On the other hand, some studies have recognised certain features which differ from oil-exporting developing nations, e.g. Warr (1986), Morley (1989), Looney (1990) Woo et al.; (1994), Usui (1997) in several African countries, Mogotsi (2002), Akpan (2009) research in Nigeria, and Égert and Leonard (2006) research in Kazakhstan Abdlaziz et al.; (2022). The most significant difference is the existence of a successful manufacturing and agricultural sector before the oil discovery and dominant oil activity in the domestic economy. However, in most oil exporting developing countries, before the emerging oil sector, the manufacturing sector was limited and, therefore, the de-industrialisation phenomena as defined by the Dutch disease theory did not occur in the same way. Prior to the booming sector, most of oil exporting developing economy was mainly dependent on the agricultural sector, and then the de-agriculturalisation phenomena occurred, in addition to a slower growth rate of the manufacturing sector (Ahmed et al.; 2023). Thus, in order to analyse the reaction that an economy might have to an increase or decline in oil revenue as a result of fluctuation in the international oil price, a simple model will be developed to examine the export boom and bust phenomenon.

Most of the previous studies used models that had been designed for developed or emerging countries. It is argued that these models are difficult to apply for developing countries, particularly for the very least developing ones. However, this paper the Edward's model (Edward, 1983, Edward, 1984 and Edward 1985), will be modified which is a more suitable model for developing countries, since Edwards' model (1983, 1984 and 1985) was originally designed for the study of the implications of the coffee boom in the Colombian economy. Edwards's model analyses in some detail the relationship between exogenous changes in the price of coffee, money growth, inflation and the real exchange rate in Colombia. The basic hypothesis being investigated is that an increase (decrease) in prices of coffee (oil in our case) will tend to increase the relative price of non-tradable goods to tradable goods via monetary and real factors. This, in turn, will lead to a reduction (an appreciation) of the real exchange rate, with the consequent loss of competitiveness in the tradable goods sectors.

The traditional Dutch disease theory is more concentrated on the real factor, while the monetary consequence of an export boom was ignored. However, Edwards's model was extended to add a monetary side in the model. The model shows that a high commodity export price (high oil price in our case) affects the monetary side. Moreover, during low oil revenue, the government faces a deficit in budget; most governments from developing countries try to fund their deficits by printing money (money creation). This point is the most important issue in this model, since it is more suitable for most other developing countries.

Although Edwards' model is a more appropriate model for most oil-exporting developing countries, it still needs some modification. Thus, the model will be adjusted accordingly to suit oil exporting developing countries. Edwards' model, for instance, allows for a fairly general exchange rate policy, ranging from a fixed exchange rate to a crawling peg based on a PPP rule. Since 1967, the monetary authority in Colombia has changed the exchange rate regime from a fixed exchange rate regime to a crawling peg based on a PPP rule. However, in this study, the exchange rate regime is a fixed rate regime (peg to US dollars), thus equations related to the nominal exchange rate will be modified to suit our case.

Moreover, despite the role of real government expenditure (as a known spending effect in Dutch disease theory), it is vital to determine the relative price of non-tradable goods to tradable goods and real exchange rate as mentioned by several studies such as Corden and Neary (1982), Bond and Knöbl (1982), Neary and Wijnbergen (1984), Gelb (1988), Looney (1990), Fardmanesh (1991), Hutchison (1992), Akpan (2007), Ismail (2010) and others. However, in

Edwards' model, the real government expenditure has not been entered into the equation as an independent variable. Instead of real government expenditure, Edward (1985) entered real income per capita as an independent variable that affects RER.

Although Edwards did not provide any justification for including real income per capita and excluding real government expenditure as an independent variable, a plausible justification for this is related to the nature of the commodity export boom in Colombia. In the case of Colombia, the commodity export boom is coffee, which is owned by the private sector rather than the government. This means that the price of coffee tends to increase real income per capita (increase private sector revenue), rather than increase government revenue (government only gains some taxes). In this case, the role of real income per capita is more important than real government expenditure, while, in oil-exporting countries, the oil sector is owned by the government. Therefore, any increase in the price of oil leads to an increase in real government revenue, which in turn leads to an increase in real government expenditure. In this case, the role of real government expenditure is important, thus it cannot be ignored. Edwards and Aoki (1983) also mentioned that real government expenditure is one of the main factors that affect relative price, real exchange rate and the production of tradable and non-tradable goods sector. Therefore, as long as the oil exporting developing countries commodity export boom is oil, the role of real government expenditure is very important to our model, and the Edwards model will be modified via entering real government expenditure into equations.

Moreover, most developing countries have a centralised system and the rent gained by the government has very little to do with the productive efforts of the community as a whole. In addition, external rents are defined as stream revenue, of which is not necessary to reward a factor of production, such as labour and capital (Daniel 1990). Besides this, the cost of exploiting the natural resource sector is unrelated to the price of oil. The cost of oil production does not determine the price of oil in the international markets; rather, there are some other factors that can affect the price of oil.

In most of countries from oil exporting developing countries, because of the high quality of its oil and the relatively low cost of extraction, the oil cost at its peak capacity is of an average of 11 US$ per barrel. The weak relationship between the domestic economy and the level of oil production in terms of participation in domestic capital (both physical and human capital) and labour in the process of oil production can be seen from the negligible effect of oil extraction cost on determining its price. For these reasons, the total revenue for oil-exporting countries, particularly developing ones, will be much bigger than the Colombian case, since the nature of the producing coffee is totally different with producing natural resource sector in terms of production cost, ownership and determined prices in the international market.

In general, there are some characteristics of the oil sector that can be distinguished from other economic sectors: (i) the oil is priced and sold in U.S. dollars; (ii) the price of oil is determined in the global market rather than in domestic economic policies; (iii) the cost of extraction natural resources in general and oil in particular is insignificant compared with its revenue; therefore, the depletion cost is neglected in the model; (iv) the oil revenue accrues directly to the state rather than to the factors of production, since the oil sector is entirely owned by the government. It is accepted that, in net oil exporting countries, particularly developing ones, the government plays a significant role in the economic activities.

On the other hand, it is important to indicate that Edwards (1986) empirically investigated only the consequences of an increase in the price of coffee on money growth, inflation and real exchange rate. However, in terms of theoretical framework, Edwards strongly supported the idea (see; Edwards and Aoki, 1983) that the increase (decrease) price of oil tends to cause the loss (gain) of competitiveness in the tradable goods sector in the international market, which in turn leads to a decrease (increase) in the output of tradable goods and increase (decrease) in the output of non-tradable goods sector as predicted by Dutch disease theory (Edward and Aoki, 1983). Eventually, the structure of the economy will be changed toward the non-tradable goods sector from the tradable goods sector during high oil revenue. Conversely, during low oil revenue, the structure of the economy will be changed toward the tradable goods sector from the non-tradable goods sector.

In general, the main purpose of the model is to examine whether changes in the price of commodity exports (oil price) are indeed related to the relative price of non-tradable goods to tradable goods. The final aim is to examine how these consequences (consequence of real exchange rate) affect the output of non-tradable and tradable goods in the domestic economy. The model is simple and based on Edwards' model.

3. THE CORES MODEL

The model concentrates on the effects of changes in exogenous oil prices and (or) changes oil production on the relative price of non-tradable goods to tradeable goods and real exchange rate adjustment. In other words, the model considered that the boom is produced by an increase in the price of oil, but it could easily be adapted to the case of a boom generated by new oil discoveries and vice versa for slumping period (see; Edward and Akoi 1983 p. 228).

The model also considers how the output of tradable and non-tradable goods will be affected by appreciation (or depreciation) of the real exchange rate during an increase (or decrease) in international oil price. In this model, it is assumed that the economy is open and small with no domestic financial market, and with a fixed exchange rate equal to one only during a booming period. While, during the slump period, it is assumed that the monetary authority will not be able to follow a fixed exchange rate since their international reserves decline and they will not be able to supply enough foreign currencies into the domestic economy. In other words, in a slump period the black market of nominal exchange rate appears. In this model, the economic sectors are divided into three sectors: the booming traded sector (oil sector), the non-booming traded sector (agricultural and manufacturing sectors), and the non-traded sector (services and construction sector). Both the booming sector and the non-booming traded sector (tradable sector) contain all exportable and importable goods, whose prices are determined exogenously in the global markets, whereas the prices of non-tradable goods are determined endogenously via interactions between domestic demands and supply (Edward 1983, 1985, 1986; Edwards and Akoi 1983). It is considered that the oil sector is owned by the government, as is the case for most oil-producing developing countries. all above assumption is based on Edward's model (see; Edwards 1983 and Edwards and Akoi 1983). The model is shown in the following equations:

- **Monetary block**

$$\widehat{M}_t = \alpha\, \widehat{R}_t + (1-\alpha)\, \widehat{DCR}_t \quad (1)$$

$$\widehat{DCR}_t = \beta DEF_t + z_t \quad (2)$$

$$\widehat{R}_t = \gamma_0 [\![\widehat{M}_t^d - \widehat{M}_{t-1}]\!] + \gamma_1\, \widehat{P}_t^O \quad (3)$$

$$\widehat{P}_t^O = \widehat{E}_t \widehat{P}_t^{O*} \quad (4)$$

$$\widehat{M}_t^d = \widehat{P}_t + \widehat{\alpha y}_t \quad (5)$$

As is customary, the "hat" operator ($\widehat{X}$) denotes the percentage change in variable X. The following notation is used:

$\widehat{M}_t$= the rate of growth of nominal money in period *t*.

$\hat{R}_t$= the rate of change of international reserves (in US dollars)

$\widehat{DCR}_t$ = the rate of change of domestic credit.

DEF_t= the fiscal deficit in period *t* as a proportion of the stock of high-powered money in period *t* – 1.

z_t = Other variables influencing domestic credit policy,

E_t =is the nominal exchange rate

$\widehat{M}_t^d$ = the nominal quantity of money demanded.

$\hat{P}_t^O$ = the domestic price of oil.

y_t = real income

The letters $\alpha, \gamma, \varepsilon, \varphi, \theta$ and ϑ denote parameters in the above equations.

In order to have a complete model, it is important to discuss the process of money creation. Equations (1) to (5) denote the monetary approach of this simple model (see; Edwards 1983, p. 2). Equation (1) describes the process of creation of money in the economy. $\widehat{X}$ denotes the percentage change in variable X. $\widehat{M}_t$ then represents the growth rate of nominal money; both $\hat{R}_t$ and $\widehat{DCR}$ represent the percentage change in international reserve and domestic credit, respectively (Edwards 1983, p.2). Equation (2) represents the growth rate of domestic credit. Here, it is important to mention that domestic credit creation is assumed to depend on the fiscal deficit (DEF). This assumption captures the fact that, in most developing countries, money creation is a vital source of financing for government expenditure, and occurs in most of oil-exporting countries during periods of declining oil price (Edwards, 1983).

Regarding the international reserve, Equation (3) describes the behaviour of international reserves over time (during booming and slumping period). According to Equation (3), reserves respond to two factors. First, changes in the domestic price of the export goods ($\hat{P}_t^O$) in period t will be translated, in the same period, into corresponding changes in reserves. Second, an excess demand for money ($\widehat{M}_t^d$) will be reflected in the accumulation of reserves and an excess supply of money will be reflected in the de-accumulation of reserves (see, Edward 1983, p.3). Equation (3) clearly allows, in the short run, for international reserve oil shocks to be a major source of money creation. In other words, a resource-based commodity export boom usually results in a balance-of-payments surplus and an accumulation of international reserves. If this increase of international reserves is not fully sterilized, the monetary base will increase, and then inflation takes place (Edwards 1983, p.3 and Edwards 1986, p. 237).

The price of export goods can be converted into local currency via equation (4): Where P_t^{*O} represents the price of commodity export (international oil price) where E_t is the nominal exchange rate, expressed as units of domestic currency per unit of foreign currency . This is one of the significant mechanisms that affect whole domestic economic activities. Equation (5) depicts the rate of nominal quantity of demand for money, where it is assumed that the real money demanded is a function of real income (Edwards 1983, p.3).

Let us analyse the impact of a high (low) oil price on processing money creation. When the price of oil increases (booming period), the amount of international reserve will increase, which gives the monetary authority the ability to supply and print more money in the domestic economy (see equation 1). On the other hand, during periods of declining oil price (slumping period), the government budget faces a deficit. In this case, in order to finance government expenditure, most oil-exporting developing nations depend on printing money (see equation 2). These two factors affect the growth rate of money in the economy (Edwards 1983 and 1986).

The following equation for the growth rate of money is obtained through combining equations (1) to (5):

$$\widehat{M}_t = \alpha_0 \widehat{M}_{t-1} + \alpha_1 \hat{P}_t + \alpha_2 \hat{y}_t + \alpha_3 \hat{p}_t^{O*} + \alpha_4 DEF_t \qquad (6)$$

Since 0< α_0<1 the convergence of equation (6) will be oscillatory. Equation (6) depicts an increase in exogenous oil price (that is, $P_t^O > 0$) which will cause an increase in the rate of growth of money, including factors such as deficit, money supply in previous time, rate of inflation and real income. All above analyses (from equation 1 to 5) are theoretical justification to explain how the money supply is changed during fluctuation oil revenue. The effectiveness of money growth will be explained during booming and slumping periods. It is shown how growth of money affects the rate of inflation, real exchange rate and then how it affects the structure of the economy.

Inflation and Real exchange rate block

$$\widehat{P}_t = (1-\varphi)\,\widehat{P}_{Nt} + \varphi \widehat{P}_{Tt} \quad (7)$$

$$\widehat{P}_{Tt} = \widehat{E}_t + \widehat{P}^*_{Tt} \quad (8)$$

$$\widehat{P}_{Nt} = \emptyset \hat{y}_t + \vartheta(\widehat{M}_t - \widehat{M}^d_t) + \omega \widehat{GE}_t \quad (9)$$

$$\widehat{E}_t = \varepsilon_1 \widehat{P}_{Tt} - \varepsilon_2 \widehat{P}^{O*}_t \quad (10)$$

$$\hat{y}_t = g_t + \tau(\hat{p}^{O*}_t - \widehat{P}^*_{Tt}) \quad (11)$$

$$RER_t = (E_t \widehat{P}^*_{Tt})/P_t \quad (12)$$

E = the nominal exchange rate, defined as units of domestic currency per unit of foreign currency.

$\widehat{P}^{O*}_t$= international price of oil.

y_t= real GDP per capita in period *t*.

P_t The level of domestic price in period *t*.

P_T= the domestic price of tradable goods.

P_N= the domestic price of non-tradable.

GE_t= real government expenditure.

P^*_T= the world price of tradable.

$\widehat{P}^*_T$= the world rate of inflation.

RER = the real exchange rate.

Before analysing the impact of an increase in oil price on real exchange rate, we first define the inflation block (see Edwards 1983) through equations (7) to (9). According to equation (7), the rate of inflation in the domestic economy is a weighted rate of change in the domestic prices of non-tradable and tradable goods. It is noted in equation (7) that the relative price of oil is not included in the argument, since it is considered that output of oil is only for exports rather than for home consumption, and domestic residents do not consume oil, or that there is negligible domestic consumption of oil, and that factors of production used in oil production are constant in the short term and long term (Edwards and Akoi 1983, p. 221).

Let us consider equation (8). This concerns factors which affect the price of tradeable goods; in a closed small economy (characteristic with restriction of free trade), the rate of change in the domestic price of tradable goods is determined by the interaction between domestic supply and demand. However, as long as it is assumed that the home country is a small open economy, where the law of one price holds due to the flow of goods across global boundaries, with no trade restriction, the domestic price of tradeable goods follows the international price of tradable goods (see; Edward, 1983 and Edward, 1986). In other words, if we consider that the home country is a small open economy, where the law of one price holds due to the flow of goods across global boundaries, then foreign prices of tradable goods (P_T^*) converted by the nominal exchange rate (E), give a measure of domestic prices of tradable goods (P_T) (Edwards 1983, p. 242). In this case, there are only two factors that affect the price of domestic tradeable goods (see equation 8): first, the rates of appreciation or depreciation of nominal exchange rate; second, the world rate of inflation.

Regarding the variables that affect the price of non-tradable, equation (9) which is the most important equation in this model since the increase (decrease) price of oil is significantly affect the non-tradable goods price via three channels which are real GDP per capita, money supply and government expenditure. Equation (9) shows that the rate of change of the price of non-tradable will depend on the change in the real GDP per capita, the excess flow of money supply and real government expenditure (see equation 9). Here it is important to mention that the real government expenditure added to the equation (9), since the original equation from Edward's model did not include government expenditure into equation non-tradable goods. Unlike the oil sector, which is owned by the public sector, while the production of coffee in Colombia is typically in the hands of the private sector? The manners in which these gains are distributed are crucial due to their effect on fiscal policy and income allocation. In Colombia's case, even though it imposed an export tax on coffee, most of the gains from the seventies boom were passed on to private producers. This is a reasonable justification that Edwards did not include real government expenditure into non-tradable goods price.

Equation (9) shows the consequences of the change of money supply, real GDP per capita and government expenditure on the price of non-tradable goods during high and low oil price. Let us start with the consequences of money supply in both booming and slumping periods. According to this model (Edward's model 1983 and 1986), during both periods (booming and slumping periods) the monetary authority increases money supply either because the government receives higher international reserves, which can increase money supply during a boom, or the government faces a severe deficit and then prints money to finance its expenditure (Yaqub el a,: 2024).

In booming periods (with fixed exchange rate) the increase in money supply leads to an excess demand for non-tradable goods which, in turn, leads to an increase in the price of non-tradable goods (since it is assumed that the price of non-tradable goods is determined endogenously via the interaction between the supply and demand curves). Excess demand for tradable goods (due to excess supply of money) does not affect its price, since the price of tradable goods is exogenously determined and any extra-domestic demand for tradable goods can be satisfied only by increasing net imports rather than by increasing the domestic price of tradable goods (Yaqub 2024). Therefore, an increase in supply of money during booming periods leads to an increase in the relative price of non-traded goods to tradable goods.

On the other hand, the monetary authority during the slumping period cannot respond to high demands on foreign currencies due to the fall in international reserves and high budget deficit. In this situation, in order to fund the deficit, the monetary authority will print money (see; Edwards 1986: p. 251), this creates an imbalance between the domestic money supply and international reserves in the domestic market (excess money supply). This, in turn, leads to a depreciation of the nominal exchange rate (Zalduendo, 2006). Once the nominal exchange rate depreciates, this directly leads to an increase in the price of tradable goods via equation (8). On the other hand, the impact of excess money supply also affects the price of non-tradable goods during slumping periods; however, the rate of change of tradable goods price would be more than the rate of change in the non-tradable goods price.

Regarding GDP per capita and real government expenditure, during booming periods, both variables (the real GDP per capita and real government expenditure) will increase. This leads to an increased demand for both tradable and non-tradable goods, according to Walras' Law (Drèze, 1997). However, an increase in real GDP per capita and real government expenditure will only lead to an increase in price of non-tradable goods. In other words, any increase in demand for non-traded goods has to be satisfied through an increase in its price; otherwise, with a constant price, the domestic economy will experience a disequilibrium condition; this is because the output of non-tradable goods will be less than the consumption of non-traded goods. In order to get back to equilibrium, the extra demand needs to diminish via increases in the price of non-traded goods. Therefore, an increase in real GDP per capita, money supply and government expenditure (due to increase in oil price) leads to an increased price of non-tradable goods via excess demand (Corden and Neary, 1982 and Edward, 1988). However, if we assume, for instance, that the extra revenue (which comes from high oil price) is invested abroad or saved, then the elasticity of income is equal to zero and the slope of the relative price between tradable and non-tradable goods is unchanged. In this situation, the internal balances as well as the external balances are in equilibrium, meaning that output is equal to consumption and the surplus on the capital account is equal to the deficit current account. Here, it is noticed that the changing of non-tradable goods is the main factor that affects the real exchange rate in this type of economy (economies that depend heavily on one product to export).

On the other hand, an increase in real GDP per capita and real government expenditure does not affect the price of tradable goods, since prices are determined exogenously and the extra-domestic demand for tradable goods can be satisfied by increased net imports rather than an increase in price. Therefore, an increase in real GDP per capita and real government expenditure affects only the price of non-tradable goods. The situation is vice versa during bust period for both real GDP per capita and real government expenditure.

In order to determine the inflation rate, it is necessary to combine equations (7), (8) and (9), to obtain equation (15), which is the domestic rate of inflation:

$$\widehat{\mathrm{P}}_{\mathrm{t}} = b_0\, \widehat{M}_t + b_1(\widehat{\mathrm{E}}_t+\widehat{P}_{\dot{T}t}) + b_2\, \hat{y}_t + b_3\, \mathrm{GE}_t \qquad (13)$$

It is seen in equation (13) that an excess supply of money in this period, nominal exchange rate plus world inflation, growth of real GDP per capita and real government expenditure, affect the rate of inflation.

Equation (10) depicts some factors that affect the nominal exchange rate; for instance, an increase in the international price of tradable goods and a decrease in oil price may bring about depreciation of the nominal exchange rate. If we consider the price of international tradeable goods as a control variable, then any change in the price of oil leads to a change in international reserves and government budget (Yaqub, 2018). For example, some oil-exporting developing countries, particularly those whose national income depends mainly on oil revenues, have low international reserves and a big budget deficit when international oil price declines. This, in turn, pushes the monetary authority to finance the government expenditure, which then leads to depreciation of the nominal exchange rate (we have already explained this mechanism).

Equation (11) depicts the growth rate of real income. It is formed of two components: a term (g) is the long-term trend rate of growth of output**,** and the second term $(\hat{p}_t^{O*} - \hat{P}_{Tt}^*)$ which depends on oil prices. An increase in the price of oil and growth of output in economy (g) causes an increase in real GDP per capita and vice versa. Finally, equation (12) depicts the definition of the real exchange rate (*RER)*. This precise definition of RER has been chosen since it has a close empirical counterpart. There are some studies that define the real exchange rate (*RER)* as the nominal exchange rate (*E*) multiplied by the ratio of foreign price level (P_T^*) to the domestic price level (P_t). Examples of these studies are those of Edwards (1985), Zietz (1996), Flug et al. (1998); Kuralbayeva, et al. (2001), Ebrahim-Zadeh (2003), Beine, et al. (2009), Ruehle and Kulkarni (2011), (Yaqub, 2018) among others.

From the equation (12), the real exchange rate is a measure of the ratio of the domestic currency price of foreign prices (EP_T^*) to domestic price level. In this regard, it can be said that, if the international price of tradable goods (P_T^*) is constant, and having a constant nominal exchange rate (*E)*, any increase in domestic price takes place leads to a decrease in the *RER* (appreciation *RER*). Similarly, for fixed P_T^* and P_N, a decrease in E triggers an appreciation of the real exchange rate and vice versa.

The relative price of traded to non-traded goods (after multiple nominal exchange rates to the international price of tradable goods) as a measure to define RER is the most popular and identifies more willingly the incentives that guide domestic resource allocation. Its focus on allocation of domestic resources has made this definition of RER a favourite tool for analysing the competitiveness of a home country relative to a foreign country, particularly for developing countries (Zietz 1996). In this case, the decrease in Pt/Pn means an appreciation in RER of domestic currency and a loss of international competitiveness, and reflects an increase in the domestic cost of producing tradable goods (Edwards 1986, p. 236-237). Similarly, any increase in Pt/Pn means depreciation in RER and also brings about an improvement in international competitiveness (Yaqub, 2018).

In general, in this model both real and monetary sides have been combined and analysed. Therefore, the complete model works in the following way. Let us start by discussing the real approach which is contained in equations (9) and (11). In this situation, this model becomes similar to the Dutch disease model, which has traditionally focused on real aspects rather than monetary aspects. It is assumed that, E = 0, replacing (11) with (9), the change in the RER causes changes only in the price of commodity export:

$$RER_t = -\emptyset\rho\, \hat{P}_t^{O} < 0 \qquad (14)$$

According to equation (15), a permanent increase in the oil price will lead to a real appreciation (decrease) of the domestic currency. It is important to mention that equation (14) is the spending effect of a commodity export boom, as emphasised in the Dutch disease theory (Corden, 1984). As in the real side model, an increase in the price of the commodity export causes an increase in real GDP per capita (through equation 11), which then causes an increased demand for non-tradable goods via the spending effect. This higher demand on non-tradable goods, in turn, leads to increases (through equation 9) in the price of non-tradable goods generating the spending effect (Yaqub 2024). It is noted from equation (15) that the extent of the appreciation of RER depends on the value of $\emptyset$, the real GDP per capita elasticity of demand for non-tradable goods. If we assume that the value of $\emptyset$ = 0, for example if none of the increased real GDP per capita is spent on non-tradable goods, then the increase in the price of commodity exports will have no effect on the RER.

In light of what has been analysed above, and based on the definition of RER (see equation 12), as long as the RER depends on the relative price of tradable goods (international price of tradable goods) times nominal exchange rate divided by price of non-tradable goods (domestic price), Thus the RER equation is defined in equation (15).

$$RER = b_0 MS + b_1 GE + b_2 y + b_3 P_{Tt}^{*} \qquad (15)$$

It can be seen from equation (15) that four variables are affected the appreciation and depreciation RER. Although this equation (equation 15) is built to large extend based on (Edward's model 1983), but, form the Edwards's RER equation, the price of coffee is also included into the RER equation, despite, he argued that, in principle, changes in the price of coffee affects the real exchange rate through disposable income and money supply (see Edward, 1983 and Edward, 1986, p. 237).

Although Edwards did not provide any explanation for including price of coffee in RER equation, but the reasonable explanation may be related to not having a strong multicollinearity between price of coffee in one hand and money supply and real GDP per capita in other hand. While, for oil exporting developing countries and even most of oil exporting developing countries, the correlation between oil revenue in one hand and money supply, GDP per capita and government expenditure is relatively strong and oil revenue cannot be employed with money supply, GDP per capita and government expenditure in the same equation as equation (15).

Equations (1) through (15) formally capture the main features of the model discussed in the preceding section. The model can be formally solved for the real exchange rate as a function of some endogenous (Government expenditure, GDP per capita and money supply) and exogenous variables (international price of tradable goods). In this section equations (6), and (13) are first solved then, the definition of the real exchange rate is used to find relative price of non-traded goods against traded goods and real exchange model. These solutions can be done via combining equation Money supply (equation 6) and inflation equation (equation 13). For simplifying, it is assumed that international price of traded goods $P_{Tt}^{*} = 0$, because this variable considers as an exogenous variable. The following expression for the actual change in the real exchange rate in period t is obtained: (the reduced forms for *MS and P* are provided in appendix 1):

$$RER = \beta_0\, \pi_1\, (\gamma_0 - 1)\partial^{-1}\, M_{t-1} + \beta_0\, \pi_2(\gamma_0 - 1)\partial^{-1} y_t\; + A_1 g_t - (A_1 + A_2)\, \hat{P}_t^{O*} + P_{Tt}^{*} \quad (15\text{ A})$$

$$A_1 = [\gamma_2\,(1 - \beta_0\,(\pi_2 + \pi_4) - \beta_1) + \beta_2(\gamma_0 - 1) + \beta_0\pi_3(1 - \gamma_0)]\, \partial^{-1}$$

$$A_2 = [\gamma_1\,(1 - \beta_0\pi_2) + \beta_0\pi_4(1 - \gamma_0) - \gamma_1(\beta_1 + \beta_0\pi_5)]\, \partial^{-1}$$

and

$\beta_0 = \frac{(1-\delta)\lambda}{1-\lambda\ (1-\delta)}$; $\beta_1 \frac{1}{1-\lambda\ (1-\delta)}$; $\beta_2 \frac{(1-\delta)\ (\lambda\eta\ -\rho)}{1+\lambda\ (1-\delta)}$;

$\pi_1 = \omega\theta; \pi_2 = \omega\theta;\ \pi_3 = \omega\theta\mu;\ \pi_4 = \omega\varphi; \pi_5 = \omega\varphi$

$\pi_5 = (1-\omega)\phi; \Delta = 1 - [\beta_0\pi_2 + \gamma_0(\beta_0\pi_{5+}\beta_1)]$.

From equation (15 A) it is possible to find out, among other things, how an increase in the international price of oil will affect the actual real exchange rate in period t. Let us first look at the term $\boldsymbol{A_1}$**.** This term captures the spending effect (government expenditure) of a change in the price of oil on the real exchange rate. Since stability requires that A > 0, the spending effect will, as expected, generate a real appreciation.

$\boldsymbol{A_2}$ Captures the domestic inflation in period *t*, as can be seen from this expression, there are three different channels, in addition to the spending effect, through which changes in oil prices will affect RER. Two of these channels indicted that a higher price of oil will generate a real appreciation. The third channel, however, suggests that RER and $\hat{P}_t^{O*}$ are negatively related.

Let is first look at the forces that suggest that there is a negative effect of oil price and RER. First, a higher world price of the commodity results in an increase in international reserves and money growth in the same period ($\beta_0\ \pi_1\ (\gamma_0 - 1)\partial^{-1}\ M_{t-1}$). Assuming that, as a consequence, an excess flow supply for money results, this will generate inflation and, with other things given, a real appreciation. Second, according to expression ($\beta_0\ \pi_2(\gamma_0 - 1)\partial^{-1}y_t$), an increase in the world price of this commodity (oil) will lead to increase GDP per capita then create high inflation rate in domestic economy, this also works towards generating a real appreciation.

In the previous discussion the inflation and real exchange rate has been analysed, the next block will be about how the non-tradable and tradable goods output are affected via the change of real exchange rate.

Non-tradable and Tradable goods output block

Non-tradable goods output sector:

$$H_N^S = H_{N^,}^S(W, RER) \quad \text{Supply,} \quad (16)$$

$$\partial H_N^S/\partial W < 0 \ \text{ and } \partial H_N^S/\partial RER < 0$$

Tradable goods output sector:

$$H_T^S = H_T^S, (W, RER) \quad \text{Supply} \qquad (17)$$

$$\partial H_T^S / \partial \text{W} < 0 \text{ and } \partial H_T^S / \partial RER > 0$$

H_N^S = output of non-tradable sector.

H_T^S = output of tradable sector.

W = real wage.

Equation (16) and (17) depict the output of non-tradable and tradable goods. According to these equations, factors of real wage and the real exchange rate affect the output of non-tradable and tradable goods. The non-tradable goods and tradable goods output is negatively related to the real wage, since when the real wage increases (with constant price level for tradable and non-tradable goods sector), the output of tradable and non-tradable goods decreases because of shrinking their profits and the circumstance is vice versa when the real wage decreases.

The real exchange rate however is negatively related to the output of non-tradable goods and but positively related to the output of tradable goods. In other words, it is expected that the real exchange rate appreciation (decrease RER) tends to increase the output of non-tradable goods sector and vice versa. At the same time, it is expected that the real exchange rate appreciation (decrease RER) tends to decrease the output of tradable goods and vice versa. The theoretical justification behind the negative relationship between RER and non-tradable goods output, and the positive relationship between RER and tradable goods output, is related to the fact that the appreciation (decrease) in RER means that the rate of increase in the non-tradable goods price is larger than the rate of increase in the tradable goods price. This, in turn, leads to an increase in the output of non-tradable goods, while the output of tradable goods decreases. This scenario is vice versa during depreciation (increase) of RER (see Corden and Neary, 1982; Edward, 1983, Edward, 1984; Edward, 1986 and Edward and Akoi, 1983).

We shall now analyse how the increase (decrease) in oil price affects the output of tradable and non-tradable goods via adjusting real wages, and real exchange rate. During a time of high oil prices, the GDP per capita, money supply and government expenditure will increase, which this leads to an increase in the price of non-tradable goods without increasing price of tradable goods. At the same time, the increase in government expenditure and money supply leads to an increase in real wages in both public and private sectors and vice versa. The following equations express the output of non-tradable and tradable goods in a booming period.

Tradable goods output sector:

$$H_T^S = P_T^* - W \qquad (18)$$

$$\frac{\partial H_T^S}{\partial (P_T^* - W)} < 0$$

Non-tradable goods output sector:

$$H_N^s = \ P_N - W \qquad (19)$$

$$\frac{\partial H_N^S}{\partial (P_N^* - W)} > 0$$

A rise in the real wage level is expected during a booming period with a constant price of tradable goods leading to a reduction in employment in the tradable sector, and then bringing about a reduction in the production of tradable goods. On the other hand, an increase in price of non-tradable goods will be the main factor that positively influences the output of non-tradable goods. This stimulates the labour migration from the traded sector into the non-traded sector (resource movement effect). With an absence of government subsidy, firms may not be able to pay higher wages, which increases output costs because the price of tradable goods is linked with the global market instead of the local market. Therefore, the expression (18) is a negative result and means a decline in the output of tradable goods, while the positive result in expression (19) means an increase in the output of non-tradable goods.

On the other hand, in a slumping period, the government budget faces a severe deficit and, as we have explained in the model, the deficit is covered by printing money (Edward 1986, p. 251). In these circumstances, low international reserves (low amount of foreign currencies) and an increased money supply lead to a devaluation of the nominal exchange rate. In this case, the price of tradable goods increases via equation (8) and the real government expenditure, and then the real price of non-tradable goods declines. At the same time, the real wage declines due to the devaluation of the nominal exchange rate. Therefore, the relative price of tradable goods to non-tradable goods increases. Any depreciation of the real exchange rate and decline in real wage leads to an increase in the power of competitiveness for tradable goods in the international market.

As a result, the expression (18) is a positive outcome. This means an increase in the output of tradable goods when the result of price mines wage ($P_T^* - W$) is positive. The positive result is due to an increase in the price of P_T^* and decrease in real wage, while a negative outcome in expression (19) means a decrease in the output of non-tradable goods. The negative result was due to a greater decrease in the real price of non-tradable goods compared to that of real wages. Based on what we have analysed in this chapter, the output of the traded and non-tradable goods sector can be specified as a function of RER. On the other hand, the RER is a function of GDP per capita, money supply, real government expenditure and the real exchange rate.

Tradable goods output sector:

$$H_T^S = H_T^S(\mathrm{RER}_t) \qquad (20)$$

$$\frac{\delta H_T^S}{\delta \mathrm{RER}_t} > 0$$

$$\mathrm{RER}_t = y_t, MS_t, \mathrm{GE}_t, P_{Tt}^* \quad \text{(Based on equitation 15)}$$

$$\frac{\delta \mathrm{RER}_t}{\delta y}, \frac{\delta \mathrm{RER}_t}{\delta MS}, \frac{\delta \mathrm{RER}_t}{\delta \mathrm{GE}_t} < 0 \; and \; \frac{\delta \mathrm{RER}_t}{\delta P_{Tt}^*} > 0$$

Non-tradable goods output sector:

$$H_N^s = H_N^s(\mathrm{RER}_t) \qquad (21)$$

$$\frac{\delta H_N^s}{\delta RER} < 0$$

$$\mathrm{RER}_t = y_t, MS_t, \mathrm{GE}_t, P_{Tt}^* \quad \text{(Based on equitation 15)}$$

$$\frac{\delta RER}{\delta y}, \frac{\delta RER}{\delta MS}, \frac{\delta RER}{\delta \mathrm{GE}_t}, < 0 \; and \; \frac{\delta RER}{\delta P^*_{Tt}} > 0$$

From equation (20), it can be said that the real exchange rate (*RER*) is positively related to the output of tradable goods. While the real exchange rate (*RER*) from equation (21) is negatively related to the output of non-tradable goods.

4. SUMMARISED SPECIFICATIONS OF EQUATIONS

In the previous section, the model has been built and it explained the mechanisms of the changing macroeconomic variables due to a changing oil price. Therefore, the structural equation system has been built and four equations are constructed. Model 1 explains the relative price of non-tradable goods against tradable goods; model 2 explains real exchange rate (RER); model 3 explains non-tradable goods output; model 4 explains the output of tradable goods.

4.1 Relative price

The first research question is related to how the fluctuation oil revenue affect the relative price of non-tradable goods against tradable goods. Now, based on the model, which was presented in the previous section, the independent variables that affect relative price is via three endogenous variables namely government expenditure (GE), real GDP per capita (y), and money supply (MS). The international price of tradable goods (${P^*_T}_t$) is included as an exogenous variable.

(Model 1)

$$\mathrm{RP}_t = \alpha_0 + \alpha_1 GE_t + \alpha_2 y_t + \alpha_3 MS_t + \alpha_4 {P^*_T}_t + \varepsilon_t \quad (22)$$

$$\frac{\delta \mathrm{RP}}{\delta \mathrm{GE}}, \frac{\delta \mathrm{RP}}{\delta \mathrm{y}}, \frac{\delta \mathrm{RP}}{\delta \mathrm{MS}} > 0 \qquad \frac{\delta \mathrm{RP}}{\delta {P^*_T}_t}, < 0$$

4.2 Real exchange rate

Real exchange rate (RER) is a second research question in this thesis. Now, based on the model, in this chapter, the independent variables that affect real exchange rate is similar to the relative price one, which are namely government expenditure (GE), real GDP per capita (y), money supply (MS) and the international price of tradable goods (${P^*_T}_t$).

(Model 2)

$$\text{RER}_t = \beta_0 + \beta_1 GE_t + \beta_2 y_t + \beta_3 MS_t + \beta_4 P^*_{T\,t} + \varepsilon_t \quad (23)$$

$$\frac{\beta\text{RER}}{\beta\text{GE}}, \frac{\beta\text{RER}}{\beta\text{y}}, \frac{\beta\text{RER}}{\beta\text{MS}} < 0 \qquad \frac{\beta\text{RER}}{\beta P^*_{T\,t}} > 0$$

Theoretically, it is expected that the sign of each GE, y, MS is negatively correlated against RER, while each of variable $P^*_{T\,t}$, *is* expected positively correlated against RER.

4.3 Non-tradable goods output

The Dutch disease model by Corden and Neary (1982) and the Edwards and Aoki model (1983) predict many consequences of an oil-led boost (slump), in oil exporting countries lead to loss of competitiveness in non-oil tradable goods and enlarge the non-tradable goods output via RER channel. Thus, RER is a main variable that affect the output of noon-tradable goods sector. As the theory of Dutch disease predicts, the output of non-tradable goods is expected to be negatively correlated to the RER.

(Model 3)

$$\text{NT}_t = \gamma_0 + \gamma_1 RER + \varepsilon_t \qquad (24)$$

$$\text{RER} = \varphi_0 + \varphi_1\, GE_t + \varphi_2\, y_t + \varphi_3\, MS_t + \varphi_4\, P^*_{T\,t} \quad \text{(based on Equation 23)}$$

$$\frac{\gamma\text{NT}}{\gamma RER} < 0$$

4.4 Tradable goods output

As with the discussion of explanatory variable that affect the output of the non-traded goods, a RER is a main variable that affect the output of tradable goods. Therefore, based on what we have analysed in this chapter, the output of the traded goods sector can be specified as a function of the real exchange rate.

(Model 4)

$$\text{T}_t = \pi_0 + \pi_1 RER + \varepsilon_t \qquad (25)$$

RER = $\varphi_0 + \varphi_1\, GE_t + \varphi_2\, y_t + \varphi_3\, MS_t + \varphi_4\, P^*_{T\,t}$ (based on Equation 23)

$$\frac{\pi \mathrm{T}}{\pi RER} < 0$$

In summary, all variables used in the thesis are expressed in real terms by deflating them by suitable indices (see chapter 5), and all variables are transformed into natural logarithmic forms. the definition of all variables are explained below:

- Relative price of non-tradable goods against tradable goods (RP) implies the domestic price of GDP deflator for the service and construction sector (non-tradable goods) against the domestic price for the agricultural and manufacturing sectors (tradable sector).
- Real Government Expenditure (GE) is total government expenditure based on 2005 constant prices, adjusted for inflation. Government expenditure can be defined as recurrent and capital (investment) expenditure, which has been explained in Chapter Three.
- GDP per capita (y) implies real GDP per capita.
- Real money supply (MS) implies the broad money supply.
- Real exchange rate (RER) measures the nominal exchange rate time's price of tradable goods divided by price of non-tradable goods.
- Tradable goods (T) measure the contribution of the manufacturing and agriculture sector to non-oil GDP.
- Non-tradable goods (NT) measure the contribution of the service and construction sector to non-oil GDP.
- International price of tradable goods ($P^*_{T\,t}$), the US wholesale price index used as a measurement of international price of tradable goods.

5. SUMMARY

This paper has analysed and modifying the Edward's model that explains the effect of the external shocks (either positive or negative shocks) of a specific boom sector on relative prices and the real exchange rate and how they affect the rest of the domestic economy (in terms of changing the structure of the economy). Although the model in this chapter has been based mainly on Edwards's series of paper (1983, 1984, 1986) and on Edwards and Akoi (1983), the model is adjusted and modified in order to suit for the case of oil exporting developing countries. For example, adding government expenditure into the equation is one of the modifications, since the oil revenue in oil-exporting countries accumulates to government. This model started to analyse how the commodity export boom (the oil sector) affects the money supply, GDP per capita and government expenditure, which in turn affect the price of tradable goods and the non-tradable goods sector. It is found that changing the price of tradable and non-tradable goods is a key issue that affects the RER and then affects the structure of the economy (Khan 2024).

With increasing regularity, the exchange rate is singled out as one of the most vital economic variables in developing countries, particularly for oil-exporting developing countries. In fact, nowadays it is impossible to discuss macroeconomic policy problems without addressing exchange-rate issues. For almost all oil-exporting developing countries, the real exchange rate is affected by increasing or decreasing the international price of oil and the consequences of this appreciation or depreciation will have a significant impact on the structure of the economy (as explained by the Dutch-disease model).

A virtue of this model is that it highlights some economic variables that affect the price of tradable and non-tradable goods. These economic variables include real government expenditure (in the Dutch-disease model, this is called spending effect), excess money supply and real income. Apart from these variables, changing the nominal exchange rate, particularly during a slump in the oil price, can have a significant impact on the relative price of tradable goods and the real exchange rate and can alter the structure of the economy towards the tradable goods sector.

Based on what we have analysed, the key conclusions about the effect of an external shock can be summarised in the case of the boom as: (i) an increase in the price of non-traded goods versus traded goods; (ii) an increase in relative price (Pn/Pt) leading to appreciation in the real exchange rate; (iii) an appreciation in the real exchange rate leading to an expansion in the output of non-traded goods and a contraction in the output of traded goods, since the domestic product loses competitiveness in the international market.

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