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**Oil Prices and Remittances: Impacts of Oil Price Shocks on the Macroeconomy of a Small,
Oil Importing, and Labor Exporting Country**

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Abstract

We examine the dynamic effects of an oil price shock on a small open economy that imports oil and exports labor to the oil exporting countries. We find that the reduction in output resulting from the oil price shock is at least partially mitigated by an accompanying increase in remittances from the expatriated labor. We also show that with a jump in oil price, domestic labor use decreases and labor export increases, oil consumption falls, and steady-state capital and consumption fall. However, consumption may initially jump up depending on the relative sizes of the negative supply effect and the positive remittance effect. Although consumption will eventually fall below the pre-shock level as steady state is approached, the initial consumption increase may be sufficiently large and long lasting to make the shock scenario welfare improving.

JEL Classification: O12, O16, J23, J43, D13, D52

Keywords: Oil Price Shock, Remittances, Economic Welfare

1 Introduction

Can an oil importing country benefit from an oil price shock? In this paper we try to answer this question and derive conditions under which this can happen. The oil price shocks of 1973 and 1979, and the consequent recessions in the United States and other developed countries prompted researchers to examine the effects of the shocks on the macroeconomy more rigorously. Researchers agree that an oil price shock is a negative supply shock but recently, some authors (for example, Barsky and Kilian, 2004) have argued that the magnitude of the effects of an oil price shock becomes smaller and the shock loses some of its power to drive down the economies of the developed countries as the oil content of these economies decreases. In a recent comprehensive study, Blanchard and Gali (2007) argue that the effects of an oil shocks are different today than they were in 1970s, due to a number of factors including better monetary policy, more flexible labor markets, and lower oil content in production. On the other hand, some authors (for example, Hamilton, 2003) argue that even though the oil content in modern economies is decreasing steadily, the oil shock can create negative expectations effect and thus have a large macroeconomic impact. Researchers have found similar impacts in developing countries (see Mitra,1995). Oil prices remain a sensitive issue in political discourse in the US and in many other countries.

It is also interesting to note that as higher oil prices significantly increased national incomes in the oil exporting countries (most of which were developing countries before the 1970s), a huge expansion of consumption took place in those countries. Consumption of traded and nontraded good increased dramatically along with the emergence of a construction boom. As a result, a large number of skilled and unskilled workers from the neighboring developing countries migrated to the oil-rich countries and have been working in traded and nontraded sectors. Since the immigration policies of the oil-rich countries are restrictive, the migrant workers had to keep close ties to their home countries and send as much money as possible back home. This created large remittance flows in the late 1970s that continue to date. Researchers have examined extensively the effects of remittances on the economic growth and welfare of the recipient countries (e.g., Lucas and Stark, 1985; Ilahi and Jafarey, 1999; Chami, Fullenkamp, and Jahjah, 2005, Giuliano and Ruiz-Arranz, 2005). It is also observed that when oil prices increase in the world market, the remittances flows from the oil-rich countries increase significantly (Lueth and Ruiz-Arranz, 2007).

We incorporate the remittance response as well as the output response to an increase in oil price in an intertemporal optimizing model of a small, oil importing, labor exporting country. Oil, along with capital and labor, is a productive input in the importing country. We show that an increase in the price of oil will reduce the steady-state capital in the country and thus a negative supply shock will be realized. However, the movement of consumption rates depends on a host of factors including production structure (specifically, oil intensity of the production process), elasticity of the oil demand, and also oil price sensitivity of the wage rate in the oil exporting countries. We derive conditions under which oil price shock can be welfare improving for an oil importing country!

2 The Model

We construct an intertemporal optimizing model of two countries. Both countries are small open economies, one country imports oil and exports labor, and the other country does the opposite. We analyze the effects of an oil price shock and consequent changes in the remittance flow on growth and welfare of the oil importing country. We assume that labor is perfectly mobile between oil exporting and labor exporting countries. Later we discuss potential ramifications of imperfect mobility of labor.

2.1 Oil Exporting Country

We assume that the firms in the oil exporting country use only imported labor (L_m) to extract oil, using a concave production function $f(L_m)$, and they maximize their profits. Total profit from oil production is

$$\pi = pf(L_m) - wL_m \tag{1}$$

where p is the price of oil, w is the wage rate. The first order condition to maximize the profit is

$$pf_{L_m}(L_m) = w \tag{2}$$

which would yield the demand for labor curve in the oil exporting country.

2.2 Labor Exporting Country

The representative household in the labor exporting country maximizes the following utility function

$$\int_0^{\infty} U(C)e^{-\beta t} dt \quad (3)$$

The household uses capital, labor, and oil as inputs to produce output, using a concave production function, $F(K, L, N)$. L is the fraction of labor used in domestic production (the remaining, $L_m = 1 - L$ is the fraction sent to work in the oil exporting country), K is the capital stock, and N is the amount of oil used in production. Thus, wL_m is the total amount of remittances in each period. The total income (domestic production plus remittances) is used for consumption, payments for oil import, and to create additional capital. Thus, the capital accumulation equation is:

$$\dot{K} = F(K, L, N) - C - pN + wL_m \quad (4)$$

Consumption C includes consumption by household members both at home and abroad.

The Hamiltonian for this problem is

$$H = U(C)e^{-\beta t} + \lambda e^{-\beta t} (F(K, L, N) - C - pN + w(1 - L)) \quad (5)$$

The optimality conditions are

$$U_C = \lambda \quad (6)$$

$$F_L(K, L, N) = w = pf_{L_m}(L_m) \quad (7)$$

$$F_N(K, L, N) = p \quad (8)$$

$$F_K(K, L, N) = \beta - \frac{\dot{\lambda}}{\lambda} \quad (9)$$

and the transversality condition is

$$Lt_{t \rightarrow \infty} \lambda K e^{-\beta t} = 0 \quad (10)$$

Now using equations (8) and (7) we can derive L and N as functions of K and p .

$$L = L(K, p) \quad (11)$$

and

$$N = N(K, p) \quad (12)$$

Taking total differential of equations (7) and (8), we derive the following

$$\begin{pmatrix} F_{LL} + pf_{L_m L_m} & F_{NL} \\ F_{NL} & F_{NN} \end{pmatrix} \begin{pmatrix} dL \\ dN \end{pmatrix} = \begin{pmatrix} -F_{LK} & f_{L_m} \\ -F_{NK} & 1 \end{pmatrix} \begin{pmatrix} dK \\ dP \end{pmatrix} \quad (13)$$

where

$$D = \begin{vmatrix} F_{LL} + pf_{L_m L_m} & F_{NL} \\ F_{NL} & F_{NN} \end{vmatrix}$$

It can be shown that $D > 0$. From (13), we obtain:

$$\begin{aligned} \frac{dN}{dp} &= \frac{1}{D}(F_{LL} + pf_{L_m L_m} - f_{L_m} F_{LN}) < 0 \\ \frac{dL}{dp} &= \frac{1}{D}(f_{L_m} F_{NN} - F_{LN}) < 0 \\ \frac{dN}{dK} &= \frac{1}{D}(-F_{NK}(F_{LL} + pf_{L_m L_m}) + F_{LK} F_{LN}) > 0 \\ \frac{dL}{dK} &= \frac{1}{D}(-F_{KL} F_{NN} + F_{LN} F_{NK}) > 0 \end{aligned} \quad (14)$$

These results are as expected. $dN/dp < 0$ implies a downward sloping oil demand curve. Also, when the oil price increases, the return from working abroad increases, and therefore, the labor exporting country exports more labor and uses less labor in home production, thus yielding $dL/dp < 0$. In addition, since all inputs in the production function of the labor exporting country are complementary inputs, an increase in capital will increase the marginal productivity of both labor and oil use and thus more of these two factors will be used in production, i.e., $dN/dK, dL/dK > 0$.

2.3 Macroeconomic Equilibrium

Using equation (6), we can derive the following

$$\frac{U_{CC}\dot{C}}{U_C} = \frac{\dot{\lambda}}{\lambda}$$

and using equation (9), we obtain

$$\dot{C} = \frac{U_C}{U_{CC}} (\beta - F_K(K, L, N)) \quad (15)$$

We also have

$$\dot{K} = F(K, L, N) - C - pN + w(1 - L) \quad (16)$$

At steady state $\dot{C} = \dot{K} = 0$. Since L and N are functions of K and p , we derive the steady state values of K (\tilde{K}) and C (\tilde{C}) from (16) and (15) for a given value of p .

2.3.1 Steady-state Responses

The steady-state relationships are

$$\beta = F_K(\tilde{K}, L(\tilde{K}, p), N(\tilde{K}, p)) \quad (17)$$

and

$$F(\tilde{K}, L(\tilde{K}, p), N(\tilde{K}, p)) + F_L(\tilde{K}, L(\tilde{K}, p), N(\tilde{K}, p))(1 - L(\tilde{K}, p)) = \tilde{C} + pN(\tilde{K}, p) \quad (18)$$

Equation (17) imply that in equilibrium the marginal product of capital should be equal to the exogenously given rate of time preference. The equation (18) shows the long-run goods market clearing condition. For a given value of the price of oil p , equation (17) yields the equilibrium values of \tilde{K} and we use this \tilde{K} to get the equilibrium values of \tilde{C} from equation (18).

In order to examine the effects of a permanent increase in the oil price on equilibrium \tilde{K} , we totally differentiate equations (17,18) and obtain the following

$$\frac{\partial \tilde{K}}{\partial p} = \frac{-(F_{KL} \frac{\partial L}{\partial p} + F_{KN} \frac{\partial N}{\partial p})}{F_{KK} + F_{KL}L_K + F_{KN}N_K}$$

where

$$sgn\left(\frac{\partial \tilde{K}}{\partial p}\right) = sgn(F_{KK} + F_{KL}L_K + F_{KN}N_K)$$

F_{KK} is the direct effect of a change in capital on marginal product of capital (negative) where $(F_{KL}L_K + F_{KN}N_K)$ is the indirect effect of a change in capital on the marginal product of capital through changes in L and N (positive, since the inputs are complementary inputs in the production process), we expect that the negative direct effect will dominate (it is certainly true for Cobb-Douglas production functions),

we expect that an increase in oil price will lower the equilibrium capital stock.

In order to examine the effects of a permanent increase in the oil price on equilibrium \tilde{C} , we totally differentiate equations (17,18) and obtain the following

$$\frac{\partial \hat{C}}{\partial p} = [F_K + (F_{LK} + F_{LL} \frac{\partial L}{\partial K} + F_{LN} \frac{\partial N}{\partial K})(1 - L)] \frac{\partial \tilde{K}}{\partial p} - N \quad (19)$$

where $F_{LK} > 0$ is the direct effect of a change in capital K on the marginal product of labor and $F_{LL} \frac{\partial L}{\partial K} + F_{LN} \frac{\partial N}{\partial K}$ is the indirect effect of K on the marginal product of labor through changes in labor allocation L and N . Moreover, one component of this indirect effect, $F_{LN} \frac{\partial N}{\partial K}$, is also positive. This implies that the total effect of an increase in capital on the marginal product of labor $F_{LK} + F_{LL} \frac{\partial L}{\partial K} + F_{LN} \frac{\partial N}{\partial K}$ would be positive. Incorporating this result in equation (19), we can argue that

$$\text{sgn}\left(\frac{\partial \hat{C}}{\partial p}\right) = \text{sgn}(F_{KK} + F_{KL}L_K + F_{KN}N_K) < 0$$

Thus an increase in oil price will eventually decrease the steady-state level of consumption. However, the transitional path of consumption may include some temporary jump in consumption since higher price of oil will increase the amount of labor allocated to the oil rich country and also the use of oil will decline. This results in a decline in output in the oil importing country but an increase in remittances per worker measured as the value of marginal product in the oil rich country and it would work in the opposite direction. The net effect on consumption may turn out to be positive. Labor mobility between these countries thus may allow a temporary increase in consumption for some labor exporting countries.

2.4 Equilibrium Dynamics

Linearizing equations (15) and (16) around steady state values (\hat{C}, \tilde{K}) , the dynamics of C and K can be approximated by:

$$\begin{pmatrix} \dot{C} \\ \dot{K} \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} C - \hat{C} \\ K - \tilde{K} \end{pmatrix} \quad (20)$$

where

$$\begin{aligned} a_{11} &= 0; \quad a_{12} = -\frac{U_C}{U_{CC}} (F_{KK} + F_{KL}L_K + F_{KN}N_K) \\ a_{21} &= -1; \quad a_{22} = F_K + F_N N_K - pN_K + (1 - L) (F_{LK} + F_{LL}L_K + F_{LN}N_K) \end{aligned}$$

Equation (20) describes a two variable linear dynamic system and the determinant of the coefficient matrix is $-\frac{U_C}{U_{CC}}(F_{KK} + F_{KL}L_K + F_{KN}N_K)$. With a concave $F(\cdot)$, we can show that the determinant is negative, implying that the equilibrium is a saddlepoint. Since consumption rate C is free to jump instantaneously and capital K is constrained to move sluggishly, so the equilibrium yields a unique stable saddle path.

We denote the stable eigenvalue by μ , so that the (linearized) stable solution may be written in the form:

$$C - \tilde{C} = A_1 e^{\mu t} \tag{21}$$

$$K - \tilde{K} = \frac{\mu}{a_{12}} A_1 e^{\mu t} \tag{22}$$

The constant A_1 can be determined by inserting $t = 0$ in equation (22) to obtain:

$$A_1 = \frac{(K_0 - \tilde{K})a_{12}}{\mu}$$

3 Calibration Results

Since our production functions and utility functions are nonlinear, we conducted a numerical analysis by adopting the following utility and production functions:

$$U = \frac{1}{\gamma} C^\gamma \text{ where } -\infty < \gamma < 1 \tag{23}$$

$$F(K, L, N) = AK^\alpha L^\epsilon N^{1-\alpha-\epsilon} \tag{24}$$

$$f(L_m) = BL_m^\delta \tag{25}$$

The simulations below are based on the following standard parameter values, characterizing the benchmark economy:

$$A = 1.5, B = 1.1, \beta = 0.06$$

$$\alpha = 0.25, \epsilon = 0.65, \delta = 0.5$$

$$\gamma = -1.5, p = 1$$

where $\frac{1}{1-\gamma} = 0.4$ is the intertemporal elasticity of substitution. The extant empirical evidence suggests that the intertemporal elasticity of substitution is small and so our choice of parameter $\gamma = -1.5$ is a reasonable one¹. The aggregate productivity parameters for home production and production of oil exporting country are A and B , respectively. The share of labor in home production is about 65% and the rate of discount is chosen to be 6%. We also assume the initial oil price equal to 1. These parameters yield a reasonable benchmark equilibrium with capital output ratio 4.17, initial labor allocation at home 86%, and remittance to GDP ratio 11%.²

We compute steady state ratios before and after permanent oil price shocks of various magnitudes (10%, 25%, and 50% increase in oil price), as shown in Table 1. The time paths of consumption and capital from the initial equilibrium to the new equilibrium can then be plotted (only the consumption path is shown in Figure 1). The consumption path allows us to compute the welfare effects using (3), shown in the last row of Table 1.

Table 1

Steady-State Responses to Permanent Oil Price Shocks

<i>Increase in Oil Price</i> →	<i>Benchmark</i>	<i>10% Increase</i>	<i>25% Increase</i>	<i>50% Increase</i>
$\frac{K}{Y}$	4.17	4.17	4.17	4.17
L	0.861	0.826	0.767	0.645
$\frac{Remit}{GDP}$	0.105	0.137	0.198	0.358
<i>%Change in Welfare</i>		-0.98	-2.15	-3.27

From this table, it is clear that an oil price increase will increase the proportion of work force migrating to oil exporting countries (resulting in smaller L , the proportion left at home) and thus the ratio of remittances over GDP increases. However, the rate of decline in welfare declines as the size of the oil price

¹For detail discussion on empirical evidence please see Guvenen (2006).

²Chami et al. (2005) in their Table 2 report that the ratios of remittances and GDP for countries like Lebanon, Yemen, Jordan, Samoa and others are above 0.16.

shock becomes larger. Since the higher oil price yields some positive benefit through higher remittances, the welfare decline due to the supply shock is somewhat neutralized by this channel. A country with no remittances channel would face a larger decline in welfare.

It is also important to examine the dynamic path of the rate of consumption, C , to understand the total effect of negative supply shock and positive remittances shock. The following Figure 1 shows the dynamic path of the rate of consumption when we have oil price shock of three different sizes.

We observe that for all three shocks the long run equilibrium consumption declines and the larger the shock, the larger is the decline. For smaller shocks, consumption jumps down to a lower level than the pre-shock steady state consumption and then gradually further declines to new low equilibrium levels of consumption. However, for a larger oil price shock, the consumption level jumps up a little from the pre-shock steady state consumption and then gradually comes down to a level lower than the previous equilibrium level of consumption. Larger the size of the shock, the larger is the overshooting of consumption. Also, as the size of the shock becomes larger, the rate of convergence becomes smaller. For a moderate (25%) jump in oil prices for the simulated economy, the increase in remittances outweighs the increased payment for oil and thus we have an increase in consumption for a while. Since the long run consumption level is much lower than the pre-shock steady state consumption and the rate of convergence is about 3.6 percent³, we observe a decline in welfare shown in Table 1.

³Absolute value of the negative eigenvalue of the coefficient matrix

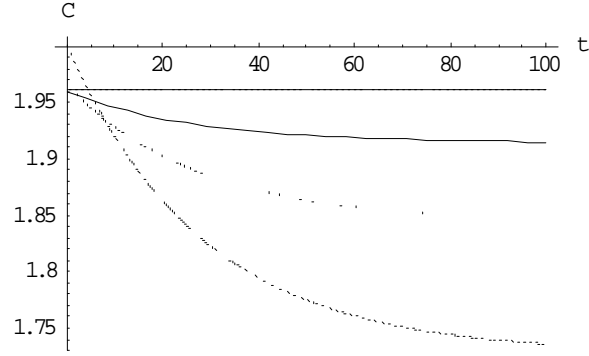


Figure 1

Consumption Paths in Response to the Oil Price Shocks of Different Sizes

We also conduct sensitivity analysis by allowing changes in initial parameters and computed the welfare changes thereafter. Results are given in Table 2.

Table 2

Percentage Changes in Welfare and Changes in the Structure of Production.

<i>Increase in Oil Price</i> →	<i>10% Increase</i>	<i>25% Increase</i>	<i>50% Increase</i>
<i>Benchmark</i>	-0.98	-2.15	-3.27
<i>10% increase A</i>	-1.016	-2.286	-3.780
<i>10% increase B</i>	-0.944	-2.005	-2.691
<i>5% increase ϵ</i>	-0.640	-1.417	-2.217
<i>10% increase δ</i>	-0.971	-2.095	-2.953

The results reported in Table 2 show that a smaller share of oil in the production process will yield a smaller decline in welfare for an oil price shock of a given size. An increase in the overall productivity in the labor exporting country will make the negative welfare effect of an oil price shock more pronounced since the proportion of labor migrating to the oil exporting country would be smaller as the marginal product of labor at home has now been increased and the positive effect through remittances would be small. However, an overall productivity increase in the oil exporting country will have the opposite effect. Then, a larger fraction of workers will migrate. Moreover, an increase in labor's share in production (a larger ϵ) in the labor exporting country or an increase in labor's share in output in the oil exporting country (an increase in δ) will yield a smaller decline in welfare. The increase in ϵ keeping all other parameters constant is equivalent

to reducing the contribution of oil in the production process in the labor exporting country if we have a production function that exhibits constant returns to scale.

4 Conclusions

A sharp rise in oil price is essentially a negative supply shock. There is voluminous literature on this topic. But the oil price increase allows the oil exporting countries to expand their output. This generally results in an increase in expenditures on construction and other nontraded goods, accompanied by an increased labor import that can increase remittances to the labor exporting countries. We find significant literature focusing on the effects of remittances on business cycle, welfare, and growth in labor exporting and labor importing countries. However, we do not find these two effects (a negative supply effect and a positive remittances effect) of an oil price increase in the same macroeconomic model. In this paper, we include both effects in a dynamic macro model. Results from our theoretical model suggest that an increase in oil price may increase the level of consumption of a labor exporting and oil importing country for a while and then it comes back to the long run equilibrium level which is lower than the initial level of consumption. This allows for the possibility of a positive welfare effect in response to an oil price shock.

The positive remittances effect should not be limited to remittances from exporting labor. If countries exporting capital (foreign direct investment) invest in oil exporting countries then with a production structure that incorporates capital in the oil exporting countries would generate similar effect and thus the negative supply shock would be somewhat neutralized for the capital exporting countries. Recent weaker effects of oil price increase on the U.S. economy may have some relationship to this compensating channel.

The model also allows us to examine how the effects of oil price changes may differ at different oil intensities of production. This is especially interesting because the oil intensities in both developing and developed countries have been changing over time. The labor mobility and oil content in the output have been the main channel through which these effects are realized. With imperfect labor mobility these results will still hold qualitatively as we will still have to equate marginal products of labor in both countries, though allowing for imperfect mobility.

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