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Endogenous Private Transfer and Real Exchange Rate Dynamics in a Two-Sector Dependent Economy

by

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Abstract

Government to government transfers are treated understandably as exogenous in open economy macro models. Even private transfer like remittances are treated as exogenous in the extant literature. In this paper we examine the effects of endogenous private transfer (remittances) on the real exchange rates using a dynamic two-sector dependent economy model. We examine the effects of demand and supply shocks and found that the dynamic patterns for real exchange rates depends on endogeneity of the transfer and the factor intensity of the traded and nontraded sectors.

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1 Introduction

The transfer problem has been receiving attention since the great debate of Keynes (1929) and Ohlin (1929) regarding excess burden of German reparation payment after the World War I. There have been great deal of discussion about the possibility of adverse real exchange rate movements resulting from income transfer. Researchers obtained similar results in relation to foreign aid (for example, see Djajic et al, 1999). The "Dutch Disease" literature examine the effects of resource discovery and its corresponding adverse impact on the real exchange rates (Corden and Neary, 1982). Brock (1996) and Turnovsky and Sen (1995) discussed this transfer issues in a dynamic dependent economy model.

All these transfers are government to government transfers. However, we have been observing a new trend in transfer of income from migrants to recipients at home. The size of remittances is growing rapidly and it is surpassing the official development assistance for many developing countries (for details see Chami et al, 2008). Researchers have examined the effects of remittances on the real exchange rates, the economic growth and welfare of the recipient countries (e.g., Lucas and Stark, 1985; Ilahi and Jafarey, 1999; Chami, Fullenkamp, and Jahjah, 2005; Acosta et al, 2007; and Lopez et al, 2007). However, all these papers assume that the size of the remittances is exogenous. Researchers found that remittance flows are in general countercyclical (Lucas and Stark, 1985) since the main motive for remittances is altruism. Some, however, found examples of procyclical remittances (Lueth and Ruiz-Arranz, 2007). Although understandably the official transfers in open economy macro models are treated exogenous to the model, we believe that the private transfers like remittances should be treated as an endogenous outcome of the decisions of the agents in the economy. We also believe that endogenous private transfer (remittances) should be treated as the result of the labor allocation decision of the household in labor-exporting country.

The national income of the oil exporting countries increased due to a large increase in oil price. Consequently, the expansion of traded and nontraded good sectors in these countries attracted a large number of skilled and unskilled workers from the neighboring developing countries. Thus countries like Pakistan, Bangladesh, Yemen, and others have been receiving large remittance flows since the late 1970s and it has become very significant in size now. The impact of oil price shocks on the real exchange rates received attention (for example, Amano and van Norden, 1998) but researchers deal with only the supply shock side of the increase in energy prices. They do not take into account the income flow from the oil rich countries (remittances or other factor rewards) resulting from such a rise in the price of oil. Researchers also discuss real exchange rate behavior in a two sector dependent economy (for example, Brock and Turnovsky, 1994; Morshed and Turnovsky, 2004) but they did not account for the income flow (remittances) from the rest of the world. Also, some researchers examine the effects of remittances on the real exchange rates using two sector models (Acosta et al, 2007; Lopez et al, 2007) but they treat remittances as exogenous[1]. In this paper we incorporate these three strands of literature in a simple framework and it allows us to examine the effects of both demand and supply shocks (including oil price shock) on the real exchange rates in a rich environment. We include endogenous remittances in an intertemporal optimizing model of a small, oil-importing, and labor-exporting country. Oil is treated as an input in the production function[2]. This is a two sector dependent economy model where both traded and nontraded goods are produced by capital, labor, and oil.

We found that the effects of endogenous and exogenous transfers on the real exchange rates are significantly different. While the effect of endogenous transfer (remittances) does not depend on the sectoral factor intensities, the effects of exogenous transfer crucially depends on the factor intensity of the traded and nontraded sectors. If these structural differences are not taken into account then we expect different empirical results from different countries and country groups. And Chami et al (2008) report that there is no consensus in empirical research about the impact of remittances on the real exchange rate.

The remainder of the paper is structured as follows. Section 2 sets out the basic model and derives the macroeconomic equilibrium. In Section 3 we calibrate the economy and simulate numerically the transitional dynamics of the economy. Section 4 contains some concluding comments.

2 Model

We construct an intertemporal optimizing model to analyze the effects of the oil price shocks and consequent changes in the remittance flow on the real exchange rates of an oil-importing and labor-exporting

[1] Amuedo-Dorantes and Pozo (2004) showed using Latin and Carribbean countries data that remittances result in real exchange rate appreciation and thus shifting resources from traded to nontraded sectors.

[2] Blanchard and Gali (2007) is a recent attempt to include oil as an input in the production function and they argue that the recent subdued response for large oil price shocks in the USA is the manifestation of the lower oil content in the economy.

country. Morshed and Pitafi (2008) have a similar but one sector model where remittance is an endogeneous outcome of the decision of the agents in the economy. They discuss the dynamic effects of oil price increase on welfare while here we have a two-sector dependent economy model and we focus on the dynamics of the real exchange rates and examine the effects of both demand and supply shocks.

2.1 Firms in Oil Exporting Country

We assume that the firms in oil exporting country use imported labor[3] (L_m) to extract oil and they maximize their profit. Total profit from oil production is

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

and the first order condition is

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

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

2.2 Economy of the Labor Exporting Country

The representative houshold in a dependent economy consumes both traded good and nontraded good and maximizes the following utility function

$$\int_0^\infty U(C_T, C_N)e^{-\rho t}dt \tag{3}$$

subject to the constraint

$$\dot{B} = \tau + F(K_T, L_T, N_T) - C_T + \sigma[H(K_N, L_N, N_N) - C_N - I] - T_L + rB + w(1 - L_T - L_N) - p(N_T + N_N) \tag{4}$$

The agent accumulates net foreign bond, B, and earns a given world interest rate, r. Production of both traded and nontraded good requires in addition to capital and labor, some amount of oil, N. Here $F(K_T, L_T, N_T)$ is the production function of traded good and $H(K_N, L_N, N_N)$ is the production function of nontraded goods. These production functions have all the neoclassical properties i.e. all factors have

[3] All factors other than imported labor are suppressed in the production function as they do not change our analysis. For further discussion please see Obstfeld and Rogoff (1996)

positive, but diminishing, marginal product and also these production functions exhibits constant returns to scale. T_L is the lumpsum tax to finance the government expenditure on both traded and nontraded goods, and I is investment. Since agents use oil as a productive input in both traded and nontraded goods production, agents have to pay for oil at price p which is exogenous to the model. This exogeneity of p will allow us to examine the effects of oil price shock on the real exchange rate in this economy. All prices are normalized by the price of traded good. Here σ represents the relative price of nontraded good in terms of traded good. We assume that the law of one price holds for the traded good and thus σ can be treated as real exchane rate. Also, τ is the government to government transfer (exogenous transfer).

The representative household allocates its given one unit of labor time in production of traded good, nontraded good (L_T and L_N), and sends the remaining amount of labor $(1 - L_T - L_N)$ as migrant labor to oil rich countries. The migrant labor earns wage w and send the earnings back home. Labor is perfectly mobile and so in equilibrium wages should be equal in three productive activities (production of traded good, nontraded good, and wage in oil rich countries). We treat the total amount of remittances, $w(1 - L_T - L_N)$, equal to the total earnings of the migrants in the oil exporting country for the following three reasons. First, total consumption, C, includes consumption of the migrants. Second, the very restrictive immigration policies in the oil exporting countries provide huge incentives to workers to send most of their income to home. Third, the remittances flow eases the foreign exchange constraint of the poor developing countries and thus for the poor country one unit of income received as remittances (foreign exchange) is effectively more than one unit of income sent by the migrants.

We assume that only nontraded good can be converted into capital without any adjustment costs. This assumption is not too restrictive as it may appear as Brock and Turnovsky (1994) showed that the dynamic properties of a dependent economy crucially depends on whether some amount of nontraded good is being converted into capital or not, since the amount of investment is now bounded by the productive capacity of the economy. They also showed that the dynamic properties remain qualitative the same even if we assume that both traded and nontraded goods can be converted into capital. There is no depreciation in this model. Capital is assumed to be perfectly mobile across sectors.

The capital accumulation in the economy can be described by

$$\dot{K} = \dot{K}_T + \dot{K}_N = I \tag{5}$$

where

$$I = H(K_N, L_N, N_N) - C_N - G_N \tag{6}$$

where G_N is the government purchase of nontraded goods.

The optimality conditions are

$$U_T(C_T, C_N) = \lambda \tag{7}$$

$$U_N(C_T, C_N) = \lambda\sigma \tag{8}$$

$$F_K(K_T, L_T, N_T) = \sigma H_K(K_N, L_N, N_N) \tag{9}$$

$$F_L(K_T, L_T, N_T) = w = \sigma H_L(K_N, L_N, N_N) \tag{10}$$

$$F_N(K_T, L_T, N_T) = p = \sigma H_N(K_N, L_N, N_N) \tag{11}$$

$$\frac{\dot{\sigma}}{\sigma} = r - H_K(K_N, L_N, N_N) \tag{12}$$

$$r = \rho - \frac{\dot{\lambda}}{\lambda} \tag{13}$$

and also the transversality conditions are

$$Lt_{t\to\infty}\lambda K e^{-\rho t} = 0; \text{ and } Lt_{t\to\infty}\lambda B e^{-\rho t} = 0. \tag{14}$$

These are standard results. Using equations (9),(10),(11) and using w from equation (2) and

$$K = K_T + K_N \tag{15}$$

we can derive

$$V_i = V_i(K, \sigma, p) \tag{16}$$

where $V_i \in \{\ K_T,\ K_N,\ L_T,\ L_N,\ N_T,\ N_N\}$.

The equation (13) implies that to obtain a steady-state finite consumption, since world interest rate, r, and rate of time preference, ρ, both are assumed to be constant, we require $\rho = r$. This means the marginal utility λ remains constant over all time, i.e. $\lambda = \bar{\lambda}$[4].

We have a passive government in this model. It finances its expenditure on traded and nontraded good by imposing lump-sum taxes, so that $T_L = G_T + \sigma G_N$. Also for simplicity we assume that government spending yield no utility.

2.3 Macroeconomic Equilibrium

Using equations (7) and (8) we obtain traded and nontraded consumption C_T and C_N in the form:

$$C_T = C_T(\bar{\lambda}, \sigma) \tag{17}$$

$$C_N = C_N(\bar{\lambda}, \sigma) \tag{18}$$

The macroeconomic equilibrium can be summarized by the following autonomous system in two variables K and σ:

$$\dot{\sigma} = \sigma r - \sigma H_K(K_N(K, \sigma, p), L_N(K, \sigma, p), N_N(K, \sigma, p)) \tag{19}$$

and we also have

$$\dot{K} = H_K(K_N(K, \sigma, p), L_N(K, \sigma, p), N_N(K, \sigma, p)) - C_N(\bar{\lambda}, \sigma) - G_N \tag{20}$$

[4] For a detailed discussion about the implications of this condition please see Turnovsky(1997).

together with the current account condition

$$\begin{aligned}\dot{B} &= \tau + F(K_T(K,\sigma,p), L_T(K,\sigma,p), N_T(K,\sigma,p)) - C_T(\bar{\lambda},\sigma) - G_T + rB \\ &\quad + F_L(K_T(K,\sigma,p), L_T(K,\sigma,p), N_T(K,\sigma,p))(1 - L_T(K,\sigma,p) - L_N(K,\sigma,p)) - p(N_T(K,\sigma,p) + N_N(K,\sigma,p)) \qquad (21)\end{aligned}$$

2.4 Equilibrium Dynamics

Linearizing equations (19) and (20) around steady state values $(\tilde{\sigma}, \tilde{K})$, the dynamics of σ and K can be approximated by:

$$\begin{pmatrix} \dot{\sigma} \\ \dot{K} \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} \sigma - \tilde{\sigma} \\ K - \tilde{K} \end{pmatrix} \qquad (22)$$

where

$$\begin{aligned} a_{11} &= -\tilde{\sigma}[H_{KK}\frac{\partial K_N}{\partial \sigma} + H_{KL}\frac{\partial L_N}{\partial \sigma} + H_{KN}\frac{\partial N_N}{\partial \sigma}];\ a_{12} = -\tilde{\sigma}[H_{KK}\frac{\partial K_N}{\partial K} + H_{KL}\frac{\partial L_N}{\partial K} + H_{KN}\frac{\partial N_N}{\partial K}] \\ a_{21} &= H_K\frac{\partial K_N}{\partial \sigma} + H_L\frac{\partial L_N}{\partial \sigma} + H_N\frac{\partial N_N}{\partial \sigma} - \frac{\partial C_N}{\partial \sigma};\ a_{22} = H_K\frac{\partial K_N}{\partial K} + H_L\frac{\partial L_N}{\partial K} + H_N\frac{\partial N_N}{\partial K} \end{aligned}$$

With a reasonable structure of production we can show that the determinant is negative, implying that the equilbrium is a saddlepoint. Since real exchange rate σ is free to jump instantaneously and capital K is constrained to move sluggishly, 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:

$$\sigma - \tilde{\sigma} = Ae^{\mu t} \qquad (23)$$

and

$$K - \tilde{K} = \frac{\mu - a_{11}}{a_{12}}Ae^{\mu t} \qquad (24)$$

The constant A can be determined from plugging in $t = 0$ in equation (24) and we obtain

$$A = \frac{(K_0 - \tilde{K})a_{12}}{\mu - a_{11}}$$

2.5 Current Account Dynamics

We derive the (linearized) current account dynamics by following Turnovsky (1997). We first linearize the equation (21) around its steady state and then substitute the linear equations (23) and (24). By imposing the transversality condition we then obtain

$$B_0 - \tilde{B} - \frac{Z}{\mu - r} = 0 \tag{25}$$

where

$$\begin{aligned}
Z &= \Omega_1 A + \Omega_2 \frac{\mu - a_{11}}{a_{12}} A \text{ and} \\
\Omega_1 &= F_K \frac{\partial K_T}{\partial \sigma} + F_N \frac{\partial N_T}{\partial \sigma} - \frac{\partial C_T}{\partial \sigma} - F_L \frac{\partial L_N}{\partial \sigma} + (1 - L_T - L_N) \left(F_{KL} \frac{\partial K_T}{\partial \sigma} + F_{LL} \frac{\partial L_T}{\partial \sigma} + F_{LN} \frac{\partial N_T}{\partial \sigma} \right) \\
\Omega_2 &= F_K \frac{\partial K_T}{\partial K} + F_N \frac{\partial N_T}{\partial K} - F_L \frac{\partial L_N}{\partial K} + (1 - L_T - L_N) \left(F_{KL} \frac{\partial K_T}{\partial K} + F_{LL} \frac{\partial L_T}{\partial K} + F_{LN} \frac{\partial N_T}{\partial K} \right)
\end{aligned}$$

Using these results we can derive the path of bond as

$$B(t) = \tilde{B} + \frac{Z}{\mu - r} e^{\mu t} \tag{26}$$

2.6 Steady State

At steady state $\dot{\sigma} = \dot{K} = \dot{B} = 0$ and these conditions yields the steady-state relationships:

$$H_K(K_N(\tilde{K}, \tilde{\sigma}, p), L_N(\tilde{K}, \tilde{\sigma}, p), N_N(\tilde{K}, \tilde{\sigma}, p)) = r \tag{27}$$

$$F_K(K_T(\tilde{K}, \tilde{\sigma}, p), L_T(\tilde{K}, \tilde{\sigma}, p), N_T(\tilde{K}, \tilde{\sigma}, p)) = \tilde{\sigma} r \tag{28}$$

$$H(K_N(\tilde{K}, \tilde{\sigma}, p), L_N(\tilde{K}, \tilde{\sigma}, p), N_N(\tilde{K}, \tilde{\sigma}, p)) = C_N(\bar{\lambda}, \tilde{\sigma}) + G_N \tag{29}$$

$$\begin{aligned}
&F(K_T(\tilde{K}, \tilde{\sigma}, p), L_T(.), N_T(.)) + \tau = \\
&C_T(\bar{\lambda}, \tilde{\sigma}) + G_T - r\tilde{B} + p(N_T(.) + N_N(.)) - (1 - L_T(.) - L_N(.)) F_L(K_T(.), L_T(.), N_T(.))
\end{aligned} \tag{30}$$

These equations (27,28,29,30) alongwith equations (10,11) at the steady state values and also the intertemporal solvency condition equation(25) jointly determines the equilibrium values of $\tilde{K}_T$, $\tilde{K}_N$, $\tilde{L}_T$, $\tilde{L}_N$, $\tilde{N}_T$, $\tilde{N}_N$, $\bar{\lambda}$, $\tilde{B}$ and $\tilde{\sigma}$ for a given value of p.

3 The Dynamics of the Real Exchange Rates: A Numerical Analysis

Since the model is highly nonlinear we conducted numerical analysis adopting the following utility and production functions:

Utility function:

$$U = \frac{1}{\gamma}\left(C_T^{\theta} C_N^{1-\theta}\right)^{\gamma} \text{ where } -\infty < \gamma < 1;\ 0 < \theta < 1 \tag{31}$$

Production functions at home for traded and nontraded goods are

$$F(K_T, L_T, N_T) = AK_T^{\alpha} L_T^{\beta} N_T^{1-\alpha-\beta} \tag{32}$$

$$H(K_N, L_N, N_N) = MK_N^{\delta} L_N^{\phi} N_N^{1-\delta-\phi}$$

and the production function in oil exporting country is

$$f(L_m) = CL_m^{\psi} \tag{33}$$

where $L_m = 1 - L_T - L_N$.

Our simulations are based on the following standard parameter vaules, characterizing the benchmark economy:

$$\begin{aligned} A &= 1.5,\ M = 1,\ C = 1; \rho = 0.06, \alpha = 0.35,\ \beta = 0.62,\ \delta = 0.25,\ \phi = 0.72 \\ \tau &= 0,\ \psi = 0.5,\ \theta = 0.5,\ \gamma = -1.5,\ p = 1, G_T = 0.12,\ G_N = 0.3 \end{aligned}$$

These parameters yield a benchmark equilibrium where traded good sector is more capital intensive. We also switch the values of parameters α and β as well as δ and ϕ and keep all other parameters the same to obtain another benchmark equilibrium where nontraded good sector is more capital intensive. In Table 1 (A & B) we report results for both the cases when oil price is increased. The steady-state effects in response to demand and supply shocks are reported in Table 2. Here $\frac{1}{1-\gamma} = 0.4$ 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 one[5]. The aggregate productivity parameters for home production of traded good and nontraded good are A and M, respectively, while the aggregate productivity parameter in oil exporting country is C. The share of labor in traded good production is about 31%, while the share of labor in nontraded good is about 63%. The share of oil in traded good production is about 3% while the same is for the nontraded sector is about 5%. The share of labor in oil production in oil exporting country is assumed to be 50%. The rate of discount is chosen to be 6%. We also assume the oil price to be equal to 1 to obtain the benchmark equilibrium. The government purchases of traded good G_T, and nontraded good G_N are chosen in such a way that the share of government purchase out of traded good at the benchmark is about 12.6% while the share of government purchase of nontraded good is about 33%[6]. These parameters yield a reasonable benchmark equilibrium with capital output ratio 3.81, initial labor allocation at home 93%, and remittance to GDP ratio 5%[7] when traded sector is more capital intensive. However, the benchmark equilibrium for the case when nontraded sector is more capital intensive yields capital output ratio 4.86, initial labor allocation at home 91%, and remittances to GDP ratio 6.3% (shown in Table 1.B).

We compute steady state ratios and then examine the steady-state responses to permanent shocks in oil price by allowing oil price increase by 10%, 20%, and 40%. The dynamic paths of real exchange rates (RER) are shown in Figure 1. We obtain the time paths of consumptions of traded and nontraded goods and this allows us to examine the welfare effects. Results from welfare calculations are given in the last row of the Table 1.A and 1.B . Following Turnovsky and Sen (1995) we study the effects of both demand and supply shocks by increasing the size of transfer, government purchases of traded good and nontraded good (demand shocks), and increase in productivity of traded good and nontraded good (supply shocks). The

[5]For detail discussion on empirical evidence please see Guvenen (2006).

[6]Empirically these are reasonable proportions (see Morshed and Turnovsky, 2004).

[7]Chami et al. (2005) report that the ratios of remittances and GDP for countries like Lebanon, Yemen, Jordan, Samoa and others are above 0.16. For a recent update see Chami et al (2008).

dynamic paths of the RER in response to these shocks are shown in Figure 2 and Figure 3.

3.1 Endogenous Transfer

An increase in oil pirce increases the value of marginal product of migrant labor. Since labor is perfectly mobile, this oil price increase will increase the rate of migration of labor to oil-exporting countries. Thus a larger flow of remittances would be realized. We consider this flow of remittances as endogenous transfer. Table 1 shows the effects of permanent increase in oil price on a number of macroeconomic variables. It is clear from these results that an oil price increase will increase the proportion of work force migrating to oil exporting countries and thus the ratio of remittances to GDP increases.

[Table 1]

The steady-state RER remains the same in response to oil price shocks of different size. Since labor is perfectly mobile between sectors and between countries, the burden of adjustment rests on the labor movement and we observe no change in the steady-state RER. However, the dynamic paths of the RER (shown in Figure 1) depend on the size of the shock. For example, an increase in oil price by 10% will drop the RER immediately from 1.84 to 1.80 and then gradually it will go back to the long-run equilibrium level when traded sector is more capital intensive. The results are qualitatively similar in the case where nontraded sector is more capital intensive (see Figure 1.B). The size of the drop would be more pronounced for a larger increase in oil price. For an increase in oil price by 40%, the RER drops to 1.57 and then gradually increases. An increase in oil price increases the value of marginal product of labor in oil exporting countries and thus more labor would go abroad and this will bring in more remittances. However, an increase in oil price reduces the use of oil in both traded and nontraded good sectors and since oil is a complementary input, the labor use in the traded sector declines immediately. We assume that only the nontraded good can be converted into capital and thus nontraded output has atleast one more use (in capital formation) than that of traded output. Thus the relative production of nontraded good increases. Consequently, the price of nontraded good relative to traded good declines initially. Note that the capital stock in the production processes is a sluggish variable. Once capital deccumulation starts after an oil price increase, we observe that the marginal product of labor and marginal product of oil declines, then it further reduces the labor use and oil use in both traded and nontraded good production. As a result, the RER starts rising. The drop in the RER is more pronounced if the size of the oil price increase becomes larger. The dynamic paths are qualitatively similar even when the sectoral capital intensity is reversed because oil is used as a complementary input in both sectors.

A permanent increase in oil price yields negative impacts on the production of both traded and nontraded goods but more labor is sent to the oil producing countries and these workers bring in more remittances. The net effect of these two opposing forces determines which way the total welfare will change. In our simulation we observe a decline in welfare in response to an increase in oil price. But the size of the decline is not proportional. For example, an increase in oil price by 10 percent reduces the welfare by 0.65% while an increase in oil price by 40% reduces the total welfare by 1.51%. The positive remittance effect neutralizes some part of the negative supply shock resulting from a permanent increase in oil prices.

[Figure 1]

3.2 Demand Shocks

We examine the effects of demand and supply shocks on the RER and found that sectoral factor intensity is crucial for the RER dynamics only for the demand shocks. We report the steady-state effects on labor allocation, capital-output ratios, remittances-GDP ratios, shares of government expenditures, and the RER in response to the demand and supply shocks in Table 2 A (when traded sector is more capital intensive) and Table 2 B (when nontraded sector is more capital intensive).

(a) Increase in Transfer, τ.

An increase in exogenous transfer (from 0 to 4% of GDP) is essentially an increase in long run wealth of the economy and so it lowers the shadow value of wealth. Consequently, consumption of both traded and nontraded good increases amd capital moves to nontraded good sector from the traded good sector immediately. Since other inputs in the production functions are complementary inputs, more labor and more oil will be used in the production of nontraded good. As the traded good sector is more capital intensive than the nontraded good sector, there will be a sharp increase in the production of nontraded good and also a sharp decrease in the production of traded good. Thus initially we observe a drop in the RER and then as the economy starts accumulating more capital, capital would be allocated to traded sector and will attract labor and oil into the traded sector. The RER will start rising gradually to the equilibrium level of the RER. A demand shock does not change the long run RER. Nonetheless, an increase in transfer certainly increases welfare.

Figure 2 , A(i) shows the time path of the RER in response to an increase in transfer when traded good sector is more capital intensive while Figure 2, B(i) shows the same when when nontraded good sector is more capital intensive. The RER jumps down to 1.82 (steady state is 1.84) immediately in response to an increase in transfer when traded good sector is more capital intensive. The RER then increases gradually as more capital is being accumulated. An increase in transfer will increase demand for both traded and nontraded good. Since the nontraded good sector requires propotionately higher labor per unit of capital (traded good more capital intensive), proportionately higher fraction of labor will move to nontraded sector from traded sector. Capital will be relatively abundant. Since capital and labor are complementary input, this also increases the marginal productivity of capital in nontraded sector. These dual positive effects immediately increase the nontraded output more than the long-run level and we observe an initial large decline the RER. As capital accumulation starts (note that nontraded good can be converted into capital) and the capital reallocation between traded and nontraded sector starts attracting labor to traded sector and thus it changes the product mix and we observe a gradual rise in the RER to the long run equilibrium level of the RER.

When nontraded good is more capital intensive (Figure 2, B(i)), an increase in transfer will increase demand for both traded and nontraded goods but the factor movement will have opposite results than what happened when traded good is more capital intensive (discussed above). Since the nontraded sector is more capital intensive, relatively more capital is required to move from traded good sector to nontraded sector and since capital will be relatively scarce and thus its movement would be constrained and so the increase in nontraded output will not be very large. As a result, initially the price of nontraded good will rise and so would be the RER. But once the capital accumulation will start, more capital will be available and the RER will start falling and will eventually approach to long run equilibrium level. Note that Trunovsky and Sen (1995) found no transitional dynamics in a similar dependent economy model. The presence of remittances and labor allocation in three uses (traded sector, nontraded sector, and foreign country) allows this to happen.

In order to examine the contrasting effects of endogenous transfer (remittances resulting from oil price increase) and exogenous transfer, we need to focus on Figure 1 and Figure 2 A(i) and B(i). An endogenous transfer (remittances) reduces immediately the relative price of nontraded goods irrespective of capital intensity of the sectors while an exogenous transfer τ, reduces the relative price of nontraded good when traded sector is more capital intensive (Figure 2 A(i)) but it increases the relative price of nontraded good when nontraded good sector is more capital intensive (Figure 2 B (i)). Thus, the effect of transfer on the real exchange rate depends not only on the nature of the transfer (endogenous vs exogenous) but also on the factor intensity of the sectors.

(b) Increase in G_T

We examine the effects of an increase in government purchase of traded good by 25 percent on the real exchange rate. Like Turnovsky and Sen (1995), we observe no change in the RER in the long run. However, an increase in government expenditure on the traded good by 25 percent will yield a very small changes in the pattern of labor use and so the remittances-GDP ratio remains virtually the same. An increase in the government purchase requires financing of the government by an equal amount of lump-sum tax. Thus the shadow value of wealth increases and as a result consumption of traded and nontraded good declines (since both goods are normal good). But the increase in direct demand for traded good from the government would outweigh the decrease in demand for traded good emanating from income effect (indirect effect). As a result, we find that output in the traded sector increases while it declines in the nontraded sector. Since the traded sector is more capital intensive, the RER jumps above the long run RER and then gradually comes back to the long run equilibrium (initial level). The transitional paths of RER are shown in Figure 2 A(ii) for the case when traded good sector is more capital intensive while it is shown in Figure 2 B (ii) when the capital intensity is reversed. While in a similar model Turnovsky and Sen (1995) and Morshed and Turnovsky (2004) observed no change in RER in response to an increase in government purchase of traded good (irrespective of the factor intensity), we observe an initial jump in the real exchange rate when traded good sector is more capital intensive and an initial drop in the RER when the factor intesity is reversed. This is due to the fact that when the production conditions at home change, households can reallocate their labor and, if required, household can send more labor abroad or can bring back home some migrated labor. An increse in the demand for traded good will attract resources to traded good sector from nontraded good sector and thus the relative abundace of factors (capital and labor) depends on the sectoral intensity of the two sectors. In terms of welfare calculation, we find that a 25% increase in government purchase on traded good reduces welfare by 1.45 percent when traded good sector is more capital intensive while welfare reduction would be 1.58 percent when nontraded good sector is more capital intensive.

[Table 2]

(C) Increase in G_N

An increase in the government purchase of nontraded good will yield a different result. The excess demand for nontraded good originating from the additional government purchase would increase the price of nontraded good relative to traded good when traded good is more capital intensive and thus the RER will decline. This purchase does not change the RER in the long run. Also regarding welfare, an increase in the purchase of nontraded good by the government would not only reduce the consumption of nontraded good but also some of it could have been converted into capital (only nontraded output can be converted to capital) and thus the welfare loss would be very large and it is about 7.01 percent when traded sector is more capital intensive while it would be 4.5% when the factor intensity is reversed.

[Figure 2]

Unlike Turnovsky and Sen (1995) and Morshed and Trunovsky (2004) who observed no change in the RER in response to demand shocks when traded sector is more capital intensive, we, however, observe that the demand shocks (government purchases of traded and nontraded goods) generate transitional dynamics even when traded sector is more capital intensive.

3.3 Supply Shocks

The effects of supply shocks on the RER are also examined. The dynamic paths of the RER are shown in Figure 3.

(A) Increase in A.

An increase in the productivity of the traded sector, A, will make more traded output available and thus the relative price of nontraded good will increase when traded good is more capital intensive. The new steady-state RER would be higher. An increase in traded output increases welfare (9.55 percent increase when traded sector is more capital intensive). These results are qualitatively similar (9.86% increase) for the case where nontraded good is more capital intensive.

(B) Increase in B

An increase in productivity in nontraded sector will increase nontraded output. As the price of nontraded good is determined by the demand and supply situation at home and due to increased availability of nontraded output, the price of nontraded output declines significantgly and so is the steady state RER. As a result, we observe the welfare gain of about 10.3% in response to an increase in productivity of the nontraded sector by 10 percent. Since aggregate capital K is the sluggish variable, the burden to adjsut to these productivity shock rests on the RER and so initially the RER jumps up but later it gradually drops to new equilibrium RER which is lower than the initial equilibrium RER. The results shown in Fogure 3 are qualitatively similar irrespective of the factor intensity ordering of the traded and nontraded sectors.

[Figure 3]

We observe overshooting of the RER in response to supply shock (both in response to increase in productivity of traded and nontraded sector) irrespective of the factor intensity of the two sectors. However, Turnovsky and Sen (1995) observe instantaneous jump in the RER when traded sector is more capital intensive. Also, they report transitional dynamics of the RER when nontraded good is more capital intensive.

4 Conclusions

Income transfers are generally government to government transfer and in dynamic models these are treated as exogenous. Recently, private transfers like remittances have been gaining importance as it is becoming a dominant source of income transfer and also it is endogenous in nature. However, remittances are treated as exogenous in the extant literature. We incorporate the endogenous transfer (remittances) in a two-sector dependent economy model and found that the dynamics of the real exchange rates are very different from the models that treat transfer as exogenous. Moreover, the sectoral capital intensity is crucial to the nature of the dynamics.

We also examine the effects of demand and supply shocks and observed marked differences in the dynamic paths than those noted in the literature. Recently, Chami et al (2008) found that there is no clear consensus about the effects of remittances on the real exchange rates and we find that the nature of the dynamics depends on the sources of the shocks (demand and supply shocks), the structure of production (sectoral factor intensity), and the endogeneity of the transfer.

Rodrik (2007) showed that undervaluation of the real exchange rate (a low P_{NT}/P_T) is instrumental to boosting economic growth in the developing countries. The results from our more general model allow policy makers to identify which shock will yield under what circumstances a growth friendly undervaluation. Moreover, how a dependent economy can absorb a supply shock like oil price shock can be easily deduced from this model.

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Table 1

Effects of Oil Price Increase on Macro Variables

A.Traded Sector is More Capital Intensive

Variable	Benchmark	Price Increase 10%	Price Increase 20%	Price Increase 40%
$\frac{K_T}{L_T}$	9.855	9.816	9.780	9.717
$\frac{K_N}{L_N}$	6.062	6.038	6.016	5.977
$\frac{K}{Y}$	3.805	3.814	3.823	3.846
L_T	0.306	0.294	0.281	0.251
L_N	0.627	0.624	0.621	0.613
L_m	0.067	0.082	0.098	0.136
$\frac{Remittance}{GDP}$	0.049	0.061	0.075	0.108
$\frac{G_T}{Y_T}$	0.126	0.132	0.138	0.156
$\frac{G_N}{Y_N}$	0.329	0.332	0.335	0.341
RER	1.842	1.841	1.840	1.839
RER at $t = 0$		1.798	1.741	1.566
% Change in Welfare		-0.650	-1.156	-1.506

B. Nontraded Sector More Capital Intensive

Variable	Benchmark	Price Increase 10%	Price Increase 20%	Price Increase 40%
$\frac{K_T}{L_T}$	8.262	8.224	8.190	8.129
$\frac{K_N}{L_N}$	13.433	13.371	13.315	13.217
$\frac{K}{Y}$	4.864	4.884	4.908	4.968
L_T	0.416	0.398	0.380	0.337
L_N	0.497	0.495	0.492	0.487
L_m	0.087	0.107	0.128	0.176
$\frac{Remittance}{GDP}$	0.063	0.079	0.097	0.141
$\frac{G_T}{Y_T}$	0.123	0.129	0.136	0.154
$\frac{G_N}{Y_N}$	0.262	0.265	0.267	0.272
RER	1.184	1.185	1.185	1.186
RER at $t = 0$		1.157	1.125	1.040
% Change in Welfare		-0.523	-0.959	-1.557

Table 2

Effects of Demand and Supply Shocks on Macro Variables

A. Traded Good Sector is More Capital Intensive

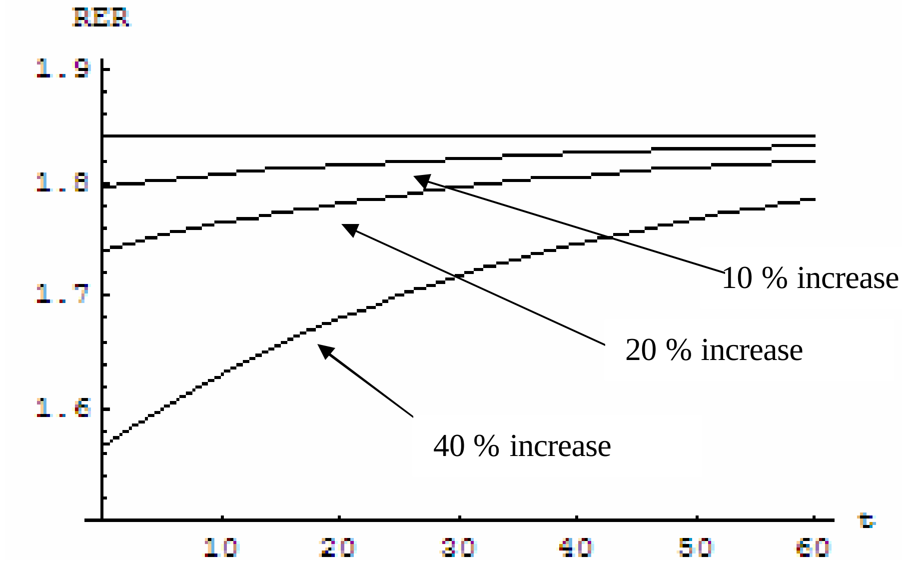
Variable	Benchmark	τ (0 to 0.1)	G_T (0.12 to 0.15)	G_N (0.3 to 0.375)	Productivity Traded (1.5 to 1.75)	Productivity Nontraded (1 to 1.1)
$\frac{K_T}{L_T}$	9.855	9.855	9.855	9.855	9.919	11.211
$\frac{K_N}{L_N}$	6.062	6.062	6.062	6.062	6.101	6.896
$\frac{K}{Y}$	3.805	3.827	3.799	3.829	3.649	3.889
L_T	0.306	0.287	0.312	0.285	0.307	0.326
L_N	0.627	0.646	0.621	0.648	0.644	0.613
L_m	0.067	0.067	0.067	0.067	0.049	0.061
$\frac{\text{Remittances}}{GDP}$	0.049	0.049	0.049	0.049	0.030	0.044
$\frac{G_T}{Y_T}$	0.126	0.134	0.155	0.135	0.107	0.113
$\frac{G_N}{Y_N}$	0.329	0.319	0.332	0.398	0.318	0.296
RER	1.842	1.842	1.842	1.842	2.150	1.696
RER at $t = 0$		1.824	1.847	1.821	2.192	1.892
% Change in Welfare		4.855	-1.452	-7.011	9.552	10.304

B. Nontraded Good Sector is More Capital Intensive

Variable	Benchmark	τ (0 to 0.1)	G_T (0.12 to 0.15)	G_N (0.3 to 0.375)	Productivity Traded (1.5 to 1.75)	Productivity Nontraded (1 to 1.1)
$\frac{K_T}{L_T}$	8.262	8.262	8.262	8.262	8.324	9.584
$\frac{K_N}{L_N}$	13.433	13.433	13.433	13.433	13.533	15.581
$\frac{K}{Y}$	4.864	4.914	4.848	4.906	4.668	4.995
L_T	0.416	0.395	0.422	0.399	0.422	0.438
L_N	0.497	0.517	0.491	0.514	0.515	0.481
L_m	0.087	0.087	0.087	0.087	0.063	0.081
$\frac{\text{Remittances}}{GDP}$	0.063	0.063	0.063	0.063	0.038	0.059
$\frac{G_T}{Y_T}$	0.123	0.129	0.151	0.128	0.103	0.112
$\frac{G_N}{Y_N}$	0.262	0.252	0.265	0.317	0.251	0.234
RER	1.184	1.184	1.184	1.184	1.381	1.061
RER at $t = 0$		1.197	1.181	1.195	1.428	1.203
% Change in Welfare		5.246	-1.578	-4.524	9.856	8.451

Figure 1
Dynamic Response of Real Exchange Rates to Endogenous Transfer Resulting From A Permanent Increase in Oil Price

A. Traded Sector More Capital Intensive



B. Nontraded Sector More Capital Intensive

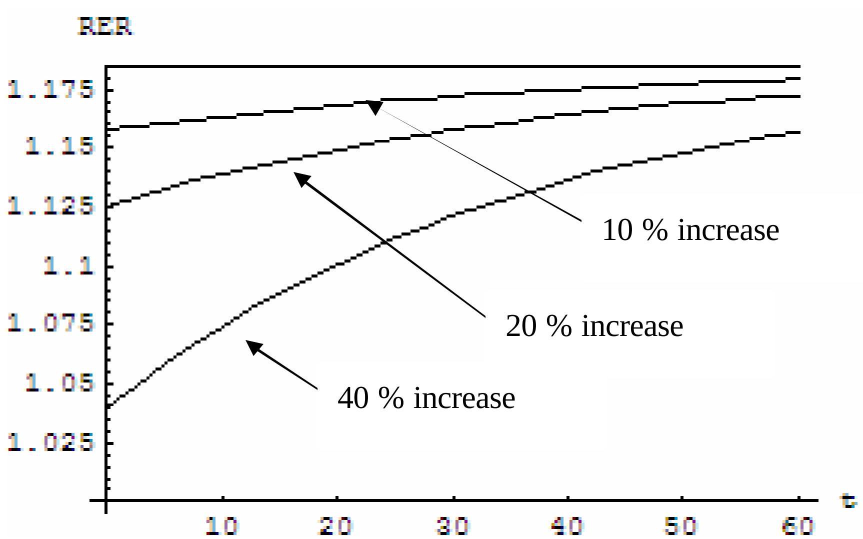
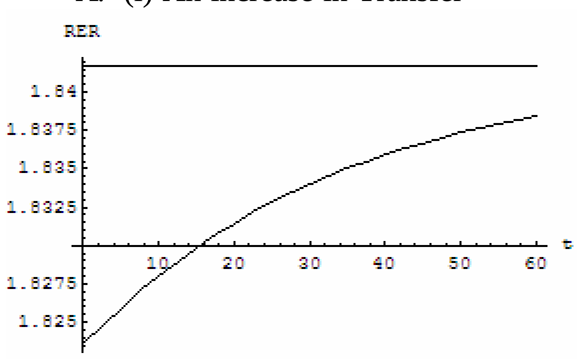


Figure 2
Time Path of Real Exchange Rates in Response to Demand Shocks

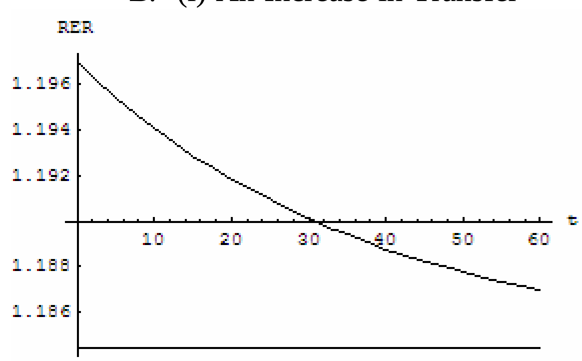
A. Traded Sector More Capital Intensive

A. (i) An increase in Transfer

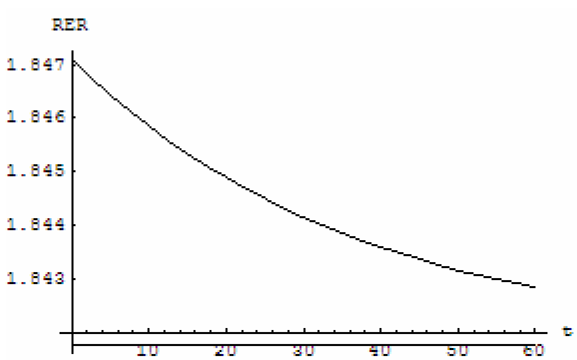


B. Nontraded Sector More Capital Intensive

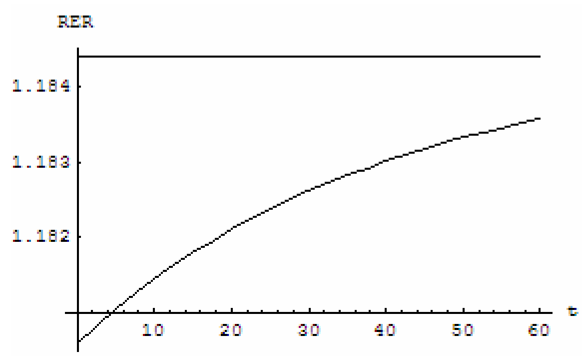
B. (i) An Increase in Transfer



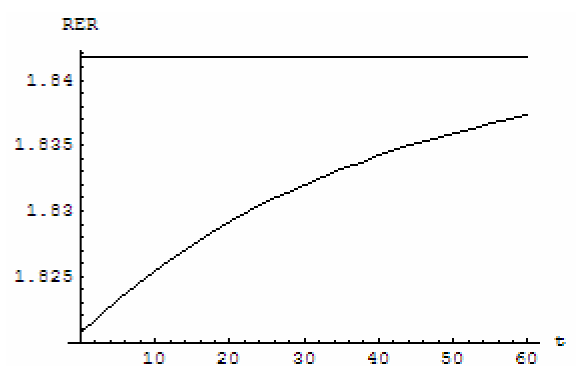
A. (ii) An Increase in Government Purchase of Traded Goods



B. (ii) An Increase in Government Purchase of Traded Goods



A. (iii) An Increase in Government Purchase of Nontraded Good



B. (iii) An Increase in Government Purchase of Nontraded Goods

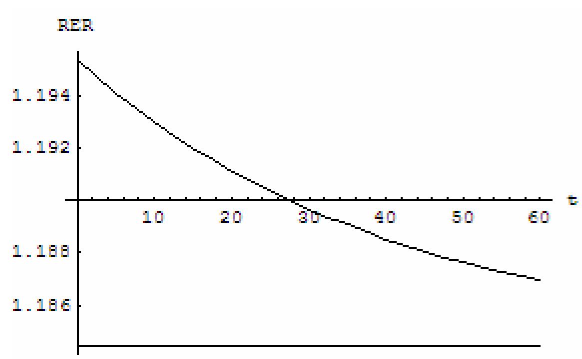
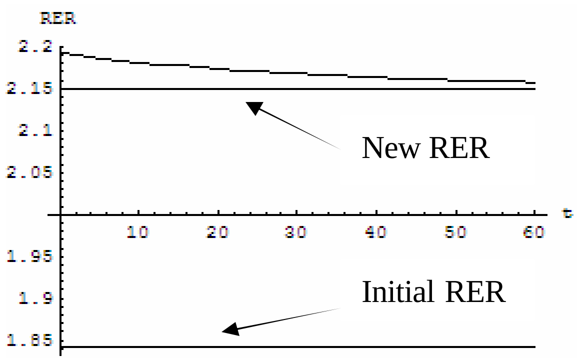


Figure 3
Dynamic Path of Real Exchange Rates in Response to Supply Shocks

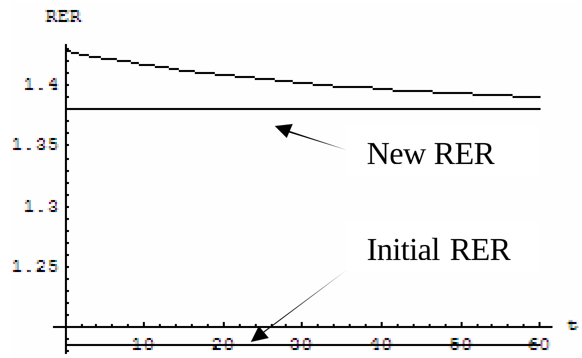
A. Traded Sector More Capital Intensive

B. Nontraded Sector More Capital Intensive

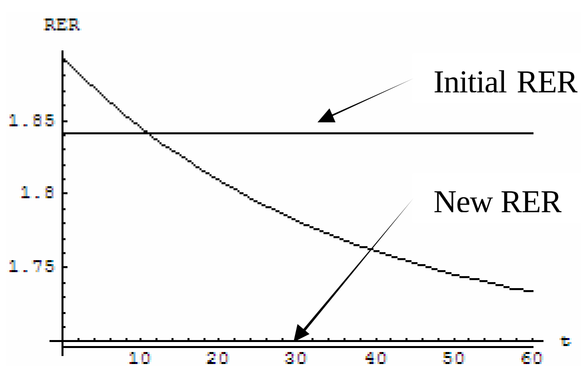
A. (i) An Increase in Productivity of Traded Sector



B. (i) An Increase in Productivity of Traded Sector



A. (ii) An Increase in Productivity of Nontraded Sector



B. (ii) An Increase in Productivity of Nontraded Sector