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REAL SHOCKS, UNEMPLOYMENT AND THE EQUILIBRIUM REAL EXCHANGE RATE*

HEE-HO KIM**

We develop a model of exogenous shocks on the real exchange rate between two large countries. We alter the model by introducing unemployment to consider the issue of how unemployment in a country can significantly change the effects of real shocks on the exchange rate. Introducing unemployment adds flexibility in production that can alter the magnitudes and even signs of shocks to the real exchange rate. These changes occur because of intersectoral differences in labor demand elasticities, as well as from differences between consumption shares in the two sectors. We explore the comparative statics demonstrating the various real shock effects on the exchange rate in the presence of unemployment. A few policy implications are drawn from the comparative statics results.

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I. INTRODUCTION

We consider the issue of how unemployment in a country can significantly change the effects of real shocks on the exchange rate. This question, which has received fairly scant attention, was initially treated by Edwards and Ostry (1990) using a small country model and addressing the question of how tariff changes affect the real exchange rate in the presence of unemployment. Another paper by Hazari, Jayasuriya, and Sgro (1991) addresses the effects of unemployment on exchange rate determination using a Harris-Todaro model with urban and rural sectors. Our paper follows the general approach of Edwards and Ostry, but with a large country model with endogenous prices.

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** Assistant professor, Department of Economics, Kyungpook National University, Dae-Gu, Korea: Tel) 82-53-950-5438 E-mail) kimhh@knu.ac.kr

We also analyze additional sources of shock not considered in their approach -exogenous international capital flows, government expenditure changes, capital augmentation, labor market changes as well as tariff changes. In each case the presence of unemployment in a country modifies the magnitude and possibly the sign of the shock effect on the real exchange rate. These changes occur because of intersectoral differences in labor demand elasticities, as well as from differences between consumption shares in the two sectors. We provide results from the comparative statics model demonstrating the various real shock effects in the presence of unemployment.

This paper employs a model of the exchange rate in which purchasing power parity (PPP) holds and real shocks alter the PPP real exchange rate value. This type of model has been used in such papers as Neary (1988), Edwards (1990), Connolly and Devereux (1992), and Stein (1996). In their studies, the non-traded goods plays a key role in determining the real exchange rate, defined as the relative prices of the non-traded goods to the traded goods. Given the prices of the traded goods, real shocks influence the domestic goods price and, thus, the real exchange rate in the small economy.

However, application of this approach is quite limited in the large country context theoretically and technically. Theoretically, because the sources of the traded goods price changes are not specified in these models, exchange rate behavior is independent of changes in the terms of trade (TOT) by assumption. This is not the case in the large country model where relative price changes resulting from different shocks are associated with the different exchange rate movements. Technically, working the system with the traded and non-traded goods both could not provide the unique solutions for the equilibrium prices, but does provide the too complicated solutions for interpreting the price changes in an economic manner because of the recursive solving problems in the large country model.

Our paper explores exchange rate movements in the large economy with two traded goods, the imported and exported goods. Changes in the real exchange rate facilitate the required changes in the traded goods prices to maintain equilibrium in the international goods markets. Likely the goods price changes, changes in the real exchange rate depend on the sources of disturbances and market conditions. Especially, we focus on the role of different consumption shares on the traded goods between two large countries and on the role of labor market conditions in determining the magnitude and sign of exchange rate changes responding to real shocks.

The paper is organized into four sections. This introduction is the first. Development of the model comprises the second. The third provides comparative statics model results. The last is the concluding section.

II. THE MODEL

Consider two large countries, each producing and consuming two goods. Country a (home) exports good 1 to country b (the foreign country) and imports good 2 from country b. Utility functions in the two countries are homogenous of degree one (in some cases with Cobb-Douglas functional form) but with different parameters across countries. There are assumed to be no monetary disturbances under assumption of monetary neutrality. For simplicity, we set the marginal expenditure required for one unit of utility to equal one ($E_u = 1$[1]). The benchmark model follows.

$$E^a(p_1^a, p_2^a, G^a, u^a) - R^a(p_1^a, p_1^a, G^a, V^a) + G^a - (p_2^a, Z_2^a, \alpha_2^G, G^a) \frac{\tau}{1+\tau} = T \tag{1}$$

$$E^b(p_1^a, p_2^a, G^b, u^b) - R^b(p_1^b, p_1^b, G^b, V^b) + G^b = -sT \tag{2}$$

In country a, private consumption expenditure E minus private net-of-tax revenue generation R plus government expenditure G minus tariff revenues equals net transfers required from the rest of the world. The equation for country b is similar, but with no tariff revenue and with amounts expressed in foreign currency.

$$p_1^a - \frac{p_1^b}{s} = 0 \tag{3}$$

$$p_2^a - \frac{p_2^b(1+\tau)}{s} = 0 \tag{4}$$

$$(p_1^a)^{\alpha_1}(p_2^a)^{\alpha_2} = p^a \tag{5}$$

$$(p_1^b)^{\beta_1}(p_2^b)^{\beta_2} = p^b \tag{6}$$

$$E_2^a - R_2^a + E_2^b - R_2^b + \frac{\alpha_2^G G^a}{P_2^a} + \frac{\beta_2^G G^b}{P_2^b} = 0 \tag{7}$$

E^i and R^i are expenditure and revenue functions. The price of good j for country i is p_j^i and the utility level and factor endowment of country i are u^i and V^i. T is a transfer (possibly a capital flow) to home abroad expressed in the home country's currency. The exchange rate, (s), represents foreign

[1] From an assumption of first degree homogeneity of the utility function, we obtain $E = u * e(p_1\ p_2)$, where u is a level of utility and e is an exact price index (Deaton and Muellbauer (1980, pp. 168-179)). At an initial set of prices, we normalize utility so that $E_u = e(p_1\ p_2) = 1$.

currency per unit of the home currency. The home country is assumed to impose an ad valorem tariff (τ) on imports of good 2. $Z_2^a = E_2^a - R_2^a$ is the home country's net private demand for good 2. E_j^i and R_j^i are the Hicksian demand and supply of good j in country i.

G^i is government spending in country i, which is totally financed by tariff revenues plus a lump-sum tax under a balanced budget constraint.[2] Following Ahmed (1986), government spending is assumed to substitute for a fraction (E_G^i) of private spending and also to be directly productive, with a marginal product R_G^i. α_j and β_j are consumer expenditure shares for good j at home and abroad, $\alpha_1 + \alpha_2 = \beta_1 + \beta_2 = 1$. α_j^G and β_j^G are consumption shares of government spending on good j by both countries, $\alpha_1^G + \alpha_2^G = \beta_1^G + \beta_2^G = 1$. P^i is a price level for country i.

Equation (1) and (2) are the two countries' resource constraints. Equation (3) and (4) show arbitrage conditions between the two countries. A geometric price index from the properties of the homothetic utility function is given for each country in equation (5) and (6).[3] We normalize the price level (P^i) to equal one in order to utilize the relative price changes. This assumption has the advantage that the nominal exchange rate, (s), becomes the purchasing power parity real exchange rate. Normalization of price level does not really imply sticky prices. It just utilizes the theoretical assumption of monetary neutrality, so only relative prices matter. Alternatively, we could normalize one of the goods prices and allow price level to be flexible under a fixed nominal exchange rate. Changes in the real exchange rate depend on four prices movements of goods derived by real shocks, adhering to law of one price and a fixed price level. Here we define the real exchange rate as the nominal exchange rate adjusted to price level; that is, the purchasing power parity version of the real exchange rate.

The goods markets are assumed to clear continuously. By Walras' law, we need consider the market-clearing condition of only one of the two goods markets. That condition is shown in equation (7). $\frac{\alpha_2^G G^a}{P_2^a}$ and $\frac{\beta_2^G G^b}{P_2^b}$ in (7) are real consumption of government spending in terms of good 2 for country a and b. Equations (1) through (7) make up a simple benchmark structural model.

It is notable that under monetary neutrality and a fixed price level, only relative prices matter. A change in the exchange rate facilitates the required changes in relative prices necessary to maintain equilibrium in the domestic as well as the international goods markets while adhering to the law of one price. This real role of the exchange rate arises from a divergence of changes in

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[2] See Frenkel and Razin (1987) for a reference on the effects of government spending in an open economy.

[3] Refer Deaton and Muellbauer (1980, pp.168-179) for an exact price index.

relative goods prices from changes in price level under the multi-good market framework (Chipman(1980)). Below we modify this benchmark model to incorporate unemployment effects.

Suppose that unemployment exists in the home country because of a fixed real wage caused by a minimum wage law. Since the price level and nominal wage are constant, the real wage is fixed. According to Neary (1985), all the properties of the flexible-factor price revenue function continue to apply when factor-price rigidity causes labor factor to be excess supply, provided that the employment level of labor is interpreted as negative output which are sold at a fixed wage. Then we can modify the flexible-factor price revenue function in equation (1) by the following restricted revenue function for the home country:

$$\tilde{R}^a(p_1^a, p_s^a, G^a, w^a, V'^a) = Max(p_1^a x_1^a + p_2^a x_2^a - w^a L'^a) \tag{8}$$

where V'^a is non-labor input and X_j^a represents production of good j at home. w^a represents a fixed real wage and L'^a is the corresponding level of employment:

$$L'^a = -R_w^a(p_1^a, p_2^a, G^a, W^a, V'^a) \tag{9}$$

where R_w^a is the partial derivative of the revenue function with respect to the real wage in the home country. With these modifications, equation (1) becomes:

$$\begin{aligned} E^a(p_1^a, p_2^a, G^a, u^a) - R^a(p_1^a, p_2^a, G^a, w^a, V'^a) \\ - w^a L'^a(p_1^a, p_2^a, G^a, w^a, V'^a) + G^a \\ - (p_w^a\ Z_2^a + a_2^G\ G^a)\frac{\tau}{1+\tau} = T \end{aligned} \tag{1a}$$

The third term, indicating wage payments, reflects redefinition of the revenue function R to equal revenue net of labor payments. Labor demand becomes an additional endogenous variable in the system when wages are sticky. The actual labor demand is a function not only of the fixed wage, but also of the endogenous relative prices.

The key difference between this model and the benchmark model is that real shocks affect the employment level. The mechanism at work is straightforward; relative price changes initiated by real shocks cause labor demand to adjust between sectors and/or in aggregate. A change in labor demand, in turn, affects real output of each sector. This results in additional income and production effects.[4] A larger production effect than income effect in a sector tends to drive

[4] Edwards and Ostry (1990) show that the wealth effect due to labor demand change plays a key role in determining the effects of different shocks on the exchange rate in a small economy with wage rigidity.

down that sector's price, thus changing the relative prices. Like other prices in the system, the exchange rate too is affected by these production and income effects, and in a manner different from that of the benchmark model.

III. REAL SHOCKS TO THE EXCHANGE RATE

In this section, the effects of real shocks on the real exchange rate are discussed and compared in models with and without full employment. We assume that real disturbances occur only at home.

1. Transfer Effect

For simplicity, the initial value of transfer (T) is assumed to be zero. Transfers affect the relative prices and the exchange rate mainly through income effects in a static model. Suppose that a transfer occurs from abroad to the home country. Real expenditure increases at home and decreases abroad.[5] These changes in expenditure exert pressure on relative prices (*the terms of trade*). The TOT change also has a feedback effect on real expenditure through a second income effect in the large country model. It may reinforce or counteract the initial income change caused by transfer. This secondary income effect of TOT change is well-known as the Lausen-Metzler effect in the studies by Svensson and Razin (1983), and Sen and Turnovsky (1989). The exchange rate moves in such a way that these price movements at home and abroad maintain the law of one price as well as a fixed price level in each country.

To establish the benchmark effects of a transfer on the real exchange rate, we totally differentiate equations (1) through (7). (See the mathematical appendix for computational detail.) The first result, indicating the effects on the real exchange rate of transfer (T) from abroad to home, is in equation (10).

$$\hat{s} = \frac{(\alpha_2 - \beta_2)(E^a_{2u} - sE^b_{2u})}{\Delta}\hat{T} \tag{10}$$

where $$\Delta = -\left[(p^a_2 \tilde{Z}^a_{22}) + (p^b_2 \tilde{Z}^b_{22}) - E^a_{2u}\alpha_2 G^a - E^b_{2u}\beta_2 G^b - \left(\alpha_1 \frac{\alpha^G_2 G^a}{p^a_2} + \beta_1 \frac{\beta^G_2 G^b}{p^b_2}\right)\right] \tag{11}$$

E^i_{2u} is the income effect of Hicksian demand on good 2. Its magnitude is positive, depending on the utility functional form. $\tilde{Z}^i_{jj}$ is the Marshallian own-price effect of import demand for good j in country i, and a " ^ " indicates a percentage change. We assume for analysis that $\Delta > 0$, not unreasonable since

[5] See Stockman and Svensson (1987) for the case in which capital flows arise from exogenous changes that alter the level and location of world wealth.

the $\tilde{Z}^i_{jj}$ and other terms will be negative. Δ in the denominator of equation (10) implies a generalized stability condition. The first two terms in $\Delta(p^a_2 Z^a_{22} + p^b_2 \tilde{Z}^b_{22})$ turn out to be the Marshall-Lerner condition $(Z^a_2[1+\eta^a_{22}+\eta^b_{11}])$ by homogeneity and symmetricity of homogenous degree one of utility. (η^a_{22}) and (η^b_{11}) are the imported demand elasticities of country a and b. Then, we can generalize the stability condition by adding negative price effect of government spending to the Marshall-Lerner condition as in Δ.

Equation (10) indicates that the exchange rate depends on the price effects in Δ for both countries, the expenditure shares of goods at home and abroad, the income effects on good 2 consumption at home and abroad. If both countries have identical taste $(\alpha_2=\beta_2)$, or the identical real income effects of demand on good 2 $(E^a_{2u}=sE^b_{2u})$, then a transfer has no effect on the exchange rate.

Under conditions of Cobb-Douglas utility in both countries, equation (10) can be further simplified to:

$$\hat{s} = \frac{(\alpha_2-\beta_2)^2}{p^a_2 \Delta}\hat{T} \qquad \text{(10-CD)}$$

Assuming that each country has different taste for each goods $(\alpha_2 \neq \beta_2)$ and Marshall-Lerner conditions hold $(\Delta>0)$, then a transfer from abroad to home raises the real value of the home currency, no matter which country has a higher consumption share for good 2.[6] These results are equivalent to the transfer problem in the literature such as Samuelson (1952), Johnson (1961) and Jones (1970). Traditionally, a transfer to home would appreciate the real value of the home currency when the Marshall-Lerner condition holds. Our results, however, indicates that transfer between countries with identical tastes will not change the real exchange rate even when the Marshall-Lerner condition holds.

To assess the impact of a minimum wage and attendant unemployment in the home economy, we compute the same effects with the alternative model (see mathematical appendix). The results for the general and the Cobb-Douglas cases are in equation (10') and (10'-CD).

$$\hat{s} = \frac{(\alpha_2-\beta_2)(E^a_{2u}-sE^b_{2u})}{\Delta'}\hat{T} \qquad \text{(10')}$$

$$\hat{s} = \frac{(\alpha_2-\beta_2)^2}{p^a_2 \Delta'}\hat{T} \qquad \text{(10'-CD)}$$

The difference from the benchmark model is in the value of Δ' of denominator.

[6] See Backus, Kehoe, and Kydland (1992) for a proof that the Marshall-Lerner condition has no bearing on the correlation between transfers and the exchange rate when two countries have identical homothetic preferences.

$$\Delta' = \Delta + [E_{2u}^{a} w^{a} L^{'a} (\alpha_2 \eta_{L1}^{a} - \alpha_1 \eta_{L2}^{a})] \quad (11')$$

The denominator in (10') contains the last term on the right, reflecting labor market conditions. In particular, the term is proportional to the difference between the total labor demand elasticity with respect to output prices in the two sectors (η_{Lj}^{a} is the elasticity of total labor demand in the home economy with respect to the price of good j).

The intersectoral difference in labor markets changes the magnitude and possibly the sign of the denominator. The sign of Δ' is most likely to differ from the sign of Δ if sector 2 is relatively labor-intensive, so that price effects of labor demand are greater for that sector ($\eta_{L2}^{a} > \eta_{L2}^{1}$), if the expenditure share of good 1 is greater than the good 2's expenditure share at home ($\alpha_2 + \alpha_1$), if labor income ($w^{a} L^{a}$) is relatively large, and if the effect of real income on consumption of good 2 (E_{2u}^{a}) is large.

Compared to the transfer effect on the exchange rate in the benchmark model, this effect in the unemployment economy can be different in size or even in sign.[7] A transfer at home could **depreciate** the real value of the exchange rate when the additional effects of labor demand change are large enough to dominate the goods market price effects in Δ.

2. Government Expenditure Effect

Government spending is real consumption by government not available to the private sector. A rise in government spending at home implies a reduction in private real consumption, assuming capital flows are fixed.[8] Following Ahmed (1986), however, we assume some fraction of government spending ($E_{G}^{a} < 0$) substitutes for private consumption and another fraction ($R_{G}^{a} > 0$) serves as an input into private production. The total substitution effect is $Z_{G}^{a} = E_{G}^{a} - R_{G}^{a} < 0$. A net real consumption change of a dollar of government spending is negative one dollar (the tax cost), adjusted for the two government spending effects. The total effect is generally negative but smaller in absolute value than one dollar. ($0 < 1 + Z_{G}^{a} < 1$)[9] In other words, a dollar of government spending reduces welfare, but by less than one dollar.

[7] See Stockman and Svensson (1987) for a reference on the ambiguous effect of transfer on TOT.

[8] In the standard view presented by Branson (1988) and Feldstein (1986), a budget deficit is not offset by an increase in private saving (reduction in private consumption). Instead, it is partly financed by foreign borrowing through a rise in the interest rate under a perfect capital mobility assumption.

[9] Kormendi (1983) estimates $|E_{G}^{a}|$ to be between 0.2 and 0.4 in the United States. Ahmed (1986) estimates the value of R_{G}^{a} as 0.4 in the United Kingdom.

In addition to the net income effect, government spending has an effect on relative demand for the two goods.[10] Thus, a change in government spending at home affects relative prices and the exchange rate through the net income effect and its direct effect on demand for goods. Changes in the exchange rate depend on the relative magnitude of these two opposing effects.

$$\hat{s} = \frac{(\alpha_1 - \beta_1)\left[E_{2u}^a(1+Z_G^a) - \left(Z_{2G}^a + \frac{a_2^G}{p_2^a}\right)\right]}{\Delta} dG^a \qquad (12)$$

$$\hat{s} = \frac{(\alpha_1 - \beta_1)\left[E_{2u}^a(1+Z_G^a - w_a L_G^a) - \left(Z_{2G}^a + \frac{a_2^G}{p_2^a}\right)\right]}{\Delta'} dG^a \qquad (12')$$

where Z_{2G}^a represents the direct effect of government spending on the excess demand of good 2. Here, we assume that a factor substitutability (L_G^a) between labor and government spending as an input for production is nil. $E_{2u}^a(1+Z_G^a)$ in the numerator of (12) represents the net income effect of government spending and $(Z_{2G}^a + \frac{a_2^G}{p_2^a})$ is a direct effect of government spending on demand of good 2 in equation (12).

Equation (12) for the benchmark model indicates that when $\alpha_1 > \beta_1$, the income effect of government spending tends to drive up the real value of home currency. The demand shift effect on the real exchange rate depends on whether government spending more than compensates for private spending on good 2 or not. In the extended model (12'), the denominator contains the labor market term and may switch signs, reversing the effect of G^a on the real exchange rate.

3. Capital Factor Augmentation Effect

In the benchmark model, exogenous capital factor augmentation affects relative prices through a wealth effect and a production effect. The production effect tends to increase supply, whereas the wealth effect, because of capital income augmentation, raises the demand for a good. These combined effects of capital factor augmentation influence relative prices and the exchange rate ambiguously as shown in the equation (13).

$$\hat{s} = \frac{(\alpha_1 - \beta_1)(R_2^a \eta_{2v}^a - r^a V^a E_{2u}^a)}{\Delta} \hat{V}^a \qquad (13)$$

[10] See Frenkel and Razin (1987) for a reference on the effect of government spending on the demand of goods.

$$\hat{s} = \frac{(\alpha_1 - \beta_1)(R_2^a \eta_{2v}^a - (r^a V^a - L_v^{'a} V^a) E_{2u}^a)}{\Delta'} \hat{V}^a \tag{13'}$$

where η_{2v}^a is the supply elasticity of good 2 with respect to capital factor (v^a) and r^a is reward of capital factor, embodying the production and income effects on net demand for good 2 respectively. The effect of changes in capital factor endowment on the exchange rate depends on the relative magnitude of these two effects and on $(\alpha_1 - \beta_1)$. Assuming $\alpha_1 > \beta_1$, then when the second term in parentheses is positive, capital factor augmentation raises the supply of good 2 faster than demand, driving down its price and thus improving the home country's currency value. The exchange rate does not change when the production and income effects on good 2 balance each other (or when the two countries have identical consumption shares).

In the alternative model (13'), the denominator contains the additional labor market terms and can potentially change the sign of the whole expression. $L_v^{'a}$ in (13') is a factor substitutability between labor and capital for production.

4. Tariff Effect

In addition to the effects of transfer, government spending and factor endowment, the model can be used to analyze price distortions such as the tariff effect. We assume that the home country imposes an ad valorem tariff (τ) on imports of good 2, abstracting from problems of retaliation. For simplicity, the initial tariff is assumed to be zero. The tariff effects on the exchange rate in the benchmark and unemployment models are in equations (14) and (14').

$$\frac{\hat{s}}{\hat{\tau}} = -\frac{[(\beta_2 p_2^a \tilde{Z}_{22}^a + \alpha_2 p_2^b \tilde{Z}_{22}^b) + \alpha_2 \beta_2 (E_{2u}^a (T - G^a) - E_{2u}^b (sT + G^b))}{\Delta}$$
$$\frac{-\left(\alpha_1 \beta_2 \frac{\alpha_2^G G^a}{p_2^a} + \alpha_2 \beta_1 \frac{\beta_2^G G^b}{p_2^b}\right) + E_{2u}^a (\alpha_1 - \beta_1)(p_2^a Z_2^a + \alpha_2^G G^a)]}{\Delta} \tag{14}$$

$$\frac{\hat{s}}{\hat{\tau}} = -\frac{[(\beta_2 p_2^a \tilde{Z}_{22}^a + \alpha_2 p_2^b \tilde{Z}_{22}^b) + \alpha_2 \beta_2 (E_{2u}^a (T - G^a) - E_{2u}^b (sT + G^b))}{\Delta'}$$
$$\frac{-\left(\alpha_1 \beta_2 \frac{\alpha_2^G G^a}{p_2^a} + \alpha_2 \beta_1 \frac{\beta_2^G G^b}{p_2^b}\right) + E_{2u}^a (\alpha_1 - \beta_1)(p_2^a Z_2^a + \alpha_2^G G^a)]}{\Delta'}$$
$$-\frac{\beta_2 E_{2u}^a w^a L^a (\alpha_2 \eta_{L1}^a - \alpha_1 \eta_{L2}^a)}{\Delta'} \tag{14'}$$

In both models, the influence of the home tariff on the real exchange rate(s) is a complex set of income and price effects. The tariff effects to the real exchange rate are generally ambiguous, depending on each country's expenditure shares for goods and the intersectoral differences between labor effects. In the benchmark model of (14), the denominator Δ is likely to be positive. The numerator, with a negative sign in front, is also likely to be positive. Given these signs, the tariff causes the real value of home currency to rise in the benchmark model.

In the alternative model (equation (14')), an additional labor market effect in both the denominator and the numerator raises the possibility of a sign change in either or both. The real exchange value of home currency, therefore, may actually be driven down by introduction of a tariff on imports. Because labor usage is endogenous, additional income effects can occur from changes in production at home. The magnitude and direction of these changes depends on how relative price shifts move demand between the two sectors.

A counterintuitive effect is more likely if the effect of income on consumption of good 2 is large, if labor income is large, and if labor demand responds more to the price of good 1 than to the price of good 2. A larger value of α_2 also raises the likelihood. Our results are closely related to the tariff effects in the literature such as Clague (1986), Edwards and van Wijnbergen (1987), and Connolly and Devereux (1992) using the small economy model. Unlikely in traditional proposition, they indicate that a rise in tariff and the external TOT improvement may depreciate the real exchange rate in some cases. Their argument is valid even in our large country context where the relative prices are endogenously determined. However, this reverse effect of tariff on the exchange rate arises from the difference consumption shares between two countries, or from the labor market conditions or from both.

5. Rigid Wage and Labor demand

In the presence of a non market-clearing wage, labor used in production is no longer equivalent to the country's endowment. Actual labor use depends on aggregate labor demand, which is a function not only of the fixed real wage, but also of relative goods prices in the two sectors. At an initial relative price, change in the real wage causes labor demand to adjust between industries and/or in aggregate. A change in labor demand, in turn, influences each industry's real output, as well as total national income. These in turn influence relative prices, including the exchange rate. Equation (15') shows the effect of a real wage change on the exchange rate.

$$\hat{s} = \frac{(\alpha_1 - \beta_1)(R_2^a \eta_{2L}^a - w^a L^a E_{2u}^a)}{\Delta} \hat{L}^a \tag{15}$$

$$\hat{s} = \frac{w^a L^a(\alpha_1 - \beta_1)(p_2^a E_{2u}^a \eta_{Lw}^a - \eta_{L2}^a)}{p_2^a \Delta'} \hat{w}^a \tag{15'}$$

where η_{Lw}^a is an aggregate labor demand elasticity and represents the effect of real wage changes on labor demand in equation (15'). η_{L2}^a represents the relative price effect on labor demand and w^a is a real wage.

Equation (15) is the effect of labor factor change to the real exchange rate in the benchmark model. A labor factor increase affects relative prices ambiguously, depending on the relative magnitude of the wealth and production effects. These effects of labor factor changes are similar to those of capital factor changes as shown in (13). η_{L2}^a and w^a embody the production and income effects on net demand for good 2.

Equation (15') is not strictly comparable to (15), as the wage has replaced the labor endowment as the exogenous variable. In the alternative model, equilibrium in the labor market will typically be off the labor supply curve but on the labor demand curve. Changes in the wage and in labor usage will be inversely related. For that reason we can compare the two effects. We would typically expect a positive labor-exchange rate relationship to be accompanied by a negative wage-exchange rate relationship.

Equation (15') indicates more sources of indeterminacy in the sign of any relationship than are present in (15). The denominator contains the additional labor market term. That additional term can be either positive or negative and can potentially change the sign of the whole expression.

As relative goods prices change, the effect of a change in actual labor demand becomes more complicated because of the resource reallocation effect of relative price changes. Change in the real exchange rate generally is ambiguous, depending on each country's expenditure shares for goods and the intersectoral differences between labor effects.[11] In case that the intersectoral difference is nil, a rise in the real wage depreciates the home currency when $\alpha_1 > \beta_1$. If, on the other hand, the price of good 1 has a large effect on labor demand, then the real exchange rate effects may differ in the alternative model.

IV. CONCLUSIONS AND POLICY IMPLICATIONS

We explore exchange rate movements in the large economy with two traded goods, the imported and exported goods. Changes in the real exchange rate facilitate the required changes in the traded goods prices to maintain equilibrium in the international goods markets. Especially, we focus on the role of different consumption shares on the traded goods between two large countries and on the

[11] See Katseli (1985) for a discussion of the ambiguous effects of the real wage on the TOT and the real exchange rate.

role of labor market conditions in determining the magnitude and sign of exchange rate changes responding to real shocks.

We analyze the various real shock effects on the exchange rate such as international transfer, government expenditure changes, capital augmentation, labor market changes as well as tariff changes. In each case the presence of unemployment in a country modifies the magnitude and possibly the sign of the shock effect on the real exchange rate.

A few policy implications can be drawn from results from the comparative statics model demonstrating the effects of unemployment. Firstly, transfer effect on the exchange rate depends on the expenditure shares of goods at home and abroad, and the income effects on the imported goods consumption at home and abroad. Traditionally, a transfer to home would appreciate the real value of the home currency when the Marshall-Lerner condition holds. Our results, however, indicates that transfer between countries with identical tastes will not change the real exchange rate even when the Marshall-Lerner condition holds. Furthermore, changes in the real exchange rate and the relative prices may be opposite in sign when considering labor market conditions.

Secondly, a change in government spending at home affects relative prices and the exchange rate through the net income effect and its direct effect on demand for goods. Changes in the exchange rate depend on the relative magnitude of these two opposing effects. When the expenditure share of home on the exported goods is greater than that of abroad, the income effect of government spending tends to drive up the real value of home currency. The demand shift effect on the real exchange rate depends on whether government spending more than compensates for private spending on the imported goods or not. In the extended unemployment model, the labor market term conditions may switch signs, reversing the effect of government spending on the real exchange rate.

Thirdly, factor augmentation affects relative prices through a wealth effect and a production effect. The production effect tends to increase supply, whereas the wealth effect, because of factor income augmentation, raises the demand for a good. These combined effects of the factor endowment change influence relative prices and the exchange rate ambiguously. When the expenditure share of home on the exported goods is greater than that of abroad, and when the production effect is larger than the wealth effect, capital augmentation raises the supply of the imported goods faster than demand, driving down its price and thus improving the home country's currency value. The exchange rate does not change when the production and income effects on the imported goods balance each other (or when the two countries have identical consumption shares). In the alternative model, the additional labor market terms and can potentially change the sign of factor augmentation effects.

Lastly, in both models, the influence of the home tariff on the real exchange rate is a complex set of income and price effects. The tariff effects to the real exchange rate are generally ambiguous, depending on each country's expenditure shares for goods and the intersectoral differences between labor effects. In general, tariff tends to raise the real value of home currency in the benchmark model. In the alternative model, an additional labor market effect raises the possibility of a sign change in either or both. Because labor usage is endogenous, additional income effects can occur from changes in production at home. The magnitude and direction of these changes depends on how relative price shifts move demand between the two sectors.

Unlikely in traditional proposition, our paper indicates that a rise in tariff and the external TOT improvement may depreciate the real exchange rate in some cases. However, this reverse effect of tariff on the exchange rate arises from the difference consumption shares between two countries, or from the labor market conditions or from both.

Mathematical Appendix

Comparative static equations for benchmark model with market-clearing wage rate at home:

$$p_1^a Z_1^a \hat{p}_1^a + p_2^a Z_2^a \hat{p}_2^a + E_u^a du^a = dT - (a + Z_G^a) dG^a + R_v^a dV^a + (p_2 Z_2^a + \alpha_2^G G^a) d\tau$$

$$p_1^b Z_1^b \hat{p}_1^b + p_2^b Z_2^b \hat{p}_2^b + E_u^a du^a + sT\hat{s} = sdT$$

$$p_1^a = \hat{p}_1^b - \hat{s}$$

$$p_2^a = \hat{p}_2^b - \hat{s} + d\tau$$

$$\alpha_1 \hat{p}_1^a + \alpha_2 \hat{p}_2^a = 0$$

$$\beta_1 \hat{p}_1^b + \beta_2 \hat{p}_2^b = 0$$

$$p_1^a Z_{21}^a \hat{p} + \left(p_2^a Z_{22}^a - \frac{\alpha_2^G G^a}{P_2^a} \right) \hat{p}_2^a + p_1^b Z_{21}^b \hat{p}_1^b + \left(p_2^b Z_{22}^b - \frac{\beta_2^G G^b}{P_2^b} \right) \hat{p}_2^b + E_{2u}^a du^a$$

$$+ E_{2u}^b du^b = - \left(Z_{2G}^a + \frac{\alpha_2^G}{p_2^a} \right) dG^a + R_{2v}^a dV^a$$

Here, $Z^j = E^j - R^j$, $Z_i^j = E_i^j - R_i^j$, etc. From numbers 3-6 above we can solve for each of the four price changes:

$$\hat{p}_1^a = \frac{\alpha_2}{\alpha_1 - \beta_1} \hat{s} - \frac{\beta_2 \alpha_2}{\alpha_1 - \beta_1} d\tau$$

$$\hat{p}_2^a = \frac{\alpha_1}{\alpha_1 - \beta_1} \hat{s} - \frac{\beta_2 \alpha_1}{\alpha_1 - \beta_1} d\tau$$

$$\hat{p}_1^b = \frac{\beta_2}{\alpha_1 - \beta_1} \hat{s} - \frac{\beta_2 \alpha_2}{\alpha_1 - \beta_1} d\tau$$

$$\hat{p}_2^b = \frac{\beta_1}{\alpha_1 - \beta_2} \hat{s} - \frac{\beta_1 \alpha_2}{\alpha_1 - \beta_1} d\tau$$

Substitute these four equations into numbers 1, 2, and 7 above to find:

$$\frac{\alpha_2 p_1^a Z_1^a - \alpha_1 p_2^a Z_2^a}{\alpha_1 - \beta_1} \hat{s} + E_u^a du^a = dT - (1 + Z_G^a) dG^a + R_v^a dV^a$$

$$+ \left[\beta_2 \left(\frac{\alpha_2 p_1^a Z_1^a - \alpha_1 p_2^a Z_2^a}{\alpha_1 - \beta_1} \right) + p_2^a Z_2^a + \alpha_2^G G^a \right] d\tau$$

$$\left[\frac{\beta_2 p_1^b Z_1^b - \beta_1 p_2^b Z_2^b}{\alpha_1 - \beta_1} + sT \right] \hat{s} + E_u^b du^b = - sdT + \alpha_2 \left(\frac{\beta_2 p_1^b Z_1^b - \beta_2 p_2^b Z_2^b}{\alpha_1 - \beta_1} \right) d\tau$$

$$\left(-\frac{1}{\alpha_1-\beta_1}\right)\left[(p_2^a Z_{22}^a + p_2^b Z_{22}^b) - \left(\alpha_1 \frac{\alpha_2^G G^a}{p_2^a} + \beta_1 \frac{\beta_2^G G^b}{p_2^b}\right)\right]\hat{s} + E_{2u}^a du^a + E_{2u}^a du^b =$$

$$-\left(Z_{2G}^a + \frac{\alpha_2^G}{p_2^a}\right) dG^a + R_{2v}^a dV^a - \left(\frac{1}{\alpha_1-\beta_1}\right)\left[(\beta_2 p_2^a Z_{22}^a + \alpha_2 p_2^b Z_{22}^b)\right.$$

$$\left. -\left(\alpha_1\beta_2 \frac{\alpha_2^G G^a}{p_2^a} + \beta_1 \alpha_2 \frac{\beta_2^G G^b}{p_2^b}\right)\right] d\tau$$

These equations form a set with three endogenous variables. To solve them, we need the determinant of the matrix of coefficients of the endogenous variables. That determinant is:

$$\bar{\Delta} = \left(-\frac{1}{\alpha_1-\beta_1}\right)\left[(p_2^a Z_{22}^a + p_2^b Z_{22}^b) - \left(\alpha_1 \frac{\alpha_2^G G^a}{p_2^a} + \beta_1 \frac{\beta_2^G G^b}{p_2^b}\right) + E_{2u}^a(\alpha_2 p_1^a Z_1^a\right.$$

$$\left. - \alpha_1 p_2^a Z_2^a) + E_{2u}^b(\beta_2 p_1^b Z_1^b - \beta_1 p_2^b Z_2^b) + E_{2u}^b sT \right]$$

$$= \left(-\frac{1}{\alpha_1-\beta_1}\right)\left[\begin{array}{l}(p_2^a Z_{22}^a - E_{2u}^a p_2^a Z_2^a) + (p_2^b Z_{22}^b - E_{2u}^b p_2^b Z_2^b) \\ \quad + E_{2u}^a \alpha_2 (p_1^a Z_1^a + p_2^a Z_2^a) + E_{2u}^b \beta_2 (p_1^b Z_1^b + p_2^b Z_2^b) \\ \quad + E_{2u}^b sT(\alpha_1 - \beta_1) - \left(\alpha_1 \frac{\alpha_2^G G^a}{p_2^a} + \beta_1 \frac{\beta_2^G G^b}{p_2^b}\right)\end{array}\right]$$

$$= \left(-\frac{1}{\alpha_1-\beta_1}\right)\left[\begin{array}{l}(p_2^a \tilde{Z}_{22}^a) + (p_2^b \tilde{Z}_{22}^b) + E_{2u}^a \alpha_2 (T - G^a) \\ \quad - E_{2u}^b(\alpha_2 sT + \beta_2 G^b) - \left(\alpha_1 \frac{\alpha_2^G G^a}{p_2^a} + \beta_1 \frac{\beta_2^G G^b}{p_2^b}\right)\end{array}\right]$$

Here the tilde (~) terms indicate uncompensated (Marshallian) excess demand. Almost all terms in the square brackets are negative. We assume the whole expression is positive if $\alpha_1 > \beta_1$. Let $\Delta = \bar{\Delta}(\alpha_1 - \beta_1)$.

We compute exchange rate effects using matrix calculations. Thus:

$$\frac{\hat{s}}{dT} = \frac{(\alpha_1 - \beta_1)(sE_{2u}^b - E_{2u}^a)}{\Delta}$$

$$\frac{\hat{s}}{dG^a} = \frac{(\alpha_1 - \beta_1)[E_{2u}^a(1 + Z_G^a) - (Z_{2G}^a + \alpha_2^G / p_2^a)]}{\Delta}$$

$$\frac{\hat{s}}{d\tau} = -\frac{\left[\begin{array}{l}(\beta_2 p_2^a Z_{22}^a + \alpha_2 p_2^b Z_{22}^b) + \alpha_2 \beta_2 (E_{2u}^a (T - G^a) - E_{2u}^b (sT + G^b)) - \\ \left(\alpha_1 \beta_2 \frac{\alpha_2^G G^a}{p_2^a} + \alpha_2 \beta_1 \frac{\beta_2^G G^b}{p_2^b}\right) + E_{2u}^a (\alpha_1 - \beta_1)(p_2^a Z_2^a + \alpha_2^G G^a)\end{array}\right]}{\Delta}$$

$$\frac{\hat{s}}{\hat{V}^a} = \frac{(\alpha_1 - \beta_1)(R_2^a \eta_{2v}^a - r^a V^a E_{2u}^a)}{\Delta}$$

Comparative static equations for alternative model with minimum wage rate at home:

For this model, we alter the first equation of the model and add an eighth equation treating labor demand as endogenous.

$$E^a(p_1^a, p_2^a, u^a, G^a) - R^a(p_1^a, p_2^a, w^a, G^a, V'^a) - w^a L'^a(p_1^a, p_2^a, w^a, G^a, V'^a)$$
$$+ G^a - (p_2^a Z_2^a + a_2^G G^a)\frac{\tau}{1+\tau} = T$$
$$L'^a = -R_w^a(p_1^a, p_2^a, w^a, G^a, V'^a)$$

Differentiating the system of eight equations results in:

$$p_1^a Z_1^a \hat{p}_1^a + p_2^a Z_s^a \hat{p}_s^a + E_u^a du^a - w^a dL^a = dT - (1 + Z_G^a)dG^a$$
$$+ (p_2^a Z_2^a + a_2^G G^a)d\tau$$
$$p_1^b Z_1^b p_1^b + p_2^b Z_2^b p_2^b + E_u^b du^b + sT\hat{s} = sdT$$
$$\hat{p}_1^a = \hat{p}_1^b - \hat{s}$$
$$\hat{p}_2^a = \hat{p}_2^b - \hat{s} + d\tau$$
$$\alpha_a \hat{p}_1^a + \alpha_2 p_2^a = 0$$
$$\beta_a \hat{p}_1^b + \beta_2 p_2^b = 0$$
$$p_1^a Z_{21}^a \hat{p}_1^a + \left(p_2^a Z_{22}^a - \frac{a_2^G G^a}{p_2^a}\right)\hat{p}_2^a + p_1^b Z_{21}^b \hat{p}_1^b + \left(p_2^b Z_{22}^b - \frac{\beta_2^G G^b}{p_2^b}\right)\hat{p}_2^b + E_{2u}^a du^a$$
$$+ E_{2u}^b du^b = -\left(Z_{2G}^a + \frac{a_2^G}{p_2^a}\right)dG^a + R_{2w}^a G$$
$$p_1^a R_{w1}^a \hat{p}_1^a + p_2^a R_{w2}^a \hat{p}_2^a + dL_a = -R_{wG}^a dG_a - R_{ww}^a dw^a$$

Substituting the last equation into the first, we can simplify by eliminating dL^a.

$$(p_1^a Z_1^a - w^a L^a \eta_1^a)\hat{p}_1^a + (p_2^a Z_2^a - w^a L^a \eta_2^a)\hat{p}_2^a + E_u^a du^a$$
$$= dT - (1 + Z_G^a - w^a L_G^a)dG^a + (p_2^a Z_2^a + a_2^G G^a)d\tau + w^a L^a \eta_{LW}^a \hat{w}^a$$

Here η_i^a is the elasticity of labor demand with respect to p_i^a and η_{LW}^a is the elasticity of labor demand with respect to the wage. Further substitution, using the 3rd through 6th equations in the group above to solve for changes in prices, results in:

$$\frac{(\alpha_2 p_1^a Z_1^a - \alpha_1 p_2^a Z_2^a) - w^a L^a(\alpha_2 \eta_{L1}^a - \alpha_1 \eta_{L2}^a)}{\alpha_1 - \beta_1}\hat{s} + E_u^a du^a$$

$$= dT - (1 + z_G^a - w_a L_G^a)dG^a + \left[\frac{\beta_2}{\alpha_1 - \beta_1}(\alpha_2 p_1^a Z_1^a - \alpha_1 p_2^a Z_2^a)\right.$$

$$\left. - \frac{\beta_2 w^a L^a}{\alpha_1 - \beta_1}(\alpha_2 \eta_{L1}^a - \alpha_1 \eta_{L2}^a) + (p_2^a Z_2^a + \alpha_2^G G^a)\right]d\tau + w^a L^a \eta_{LW}^a \widehat{w}^a$$

$$\frac{(\beta_2 p_1^b Z_1^b - \beta_1 p_2^b Z_2^b) + (\alpha_1 - \beta_1)sT}{\alpha_1 - \beta_1}\hat{s} + E_u^b du^b$$

$$= -sdT + \frac{\alpha_2}{\alpha_1 + \beta_1}(\beta_2 p_1^b Z_1^b - \beta_1 p_2^b Z_2^b)d\tau$$

$$\left(-\frac{1}{\alpha_1 - \beta_1}\right)\left[(p_2^a Z_{22}^a + p_2^b Z_{22}^b) - \left(\alpha_1 \frac{\alpha_2^G G^a}{p_2^a} + \beta_1 \frac{\beta_2^G G^b}{p_2^b}\right)\right]\hat{s} + E_{2u}^a du^a + E_{2u}^b du^b$$

$$= -\left(Z_{2G}^a + \frac{\alpha_2^G}{p_2^a}\right)dG^a - \frac{w^a L^a}{p_2^a}\eta_{L2}^a \widehat{w}^a - \left(\frac{1}{\alpha_1 - \beta_1}\right)\left[(\beta_2 p_2^a Z_{22}^a + \alpha_2 p_2^b Z_{22}^b)\right.$$

$$\left. - \left(\alpha_1 \beta_2 \frac{\alpha_2^G G^a}{p_2^a} + \beta_1 \alpha_2 \frac{\beta_2^G G^b}{p_2^b}\right)\right]d\tau$$

As with the benchmark model above, we must compute the determinant of the coefficients in this 3-equation system.

$$\bar{\Delta}' = \left(-\frac{1}{\alpha_1 - \beta_1}\right)\left[\begin{array}{l} (p_2^a Z_{22}^a + p_2^b Z_{22}^b) + E_{2u}^a(\alpha_2 p_1^a Z_1^a - \alpha_1 p_2^a Z_2^a) \\ + E_{2u}^b(\beta_2 p_1^b Z_1^b - \beta_1 p_2^b Z_2^b) + E_{2u}^b sT(\alpha_1 - \beta_1) \\ - \left(\alpha_1 \frac{\alpha_2^G G^a}{p_2^a} + \beta_1 \frac{\beta_2^G G^b}{p_2^b}\right) - E_{2u}^a w^a L^a(\alpha_2 \eta_{L1}^a - \alpha_1 \eta_{L2}^a) \end{array}\right]$$

$$= \left(-\frac{1}{\alpha_1 - \beta_1}\right)\left[\begin{array}{l} (p_2^a Z_{22}^a - E_{2u}^a p_2^a Z_2^a) + (p_2^b Z_{22}^b - E_{2u}^b p_2^b Z_2^b) \\ + E_{2u}^a \alpha_2(p_1^a Z_1^a + p_2^a Z_2^a) + E_{2u}^b \beta_2(p_1^b Z_1^b + p_2^b Z_2^b) \\ - E_{2u}^a w^a L^a(\alpha_2 \eta_{L1}^a - \alpha_1 \eta_{L2}^a) \\ + E_{2u}^b sT(\alpha_1 - \beta_1) - \left(\alpha_1 \frac{\alpha_2^G G^a}{p_2^a} + \beta_1 \frac{\beta_2^G G^b}{p_2^b}\right) \end{array}\right]$$

$$= \left(-\frac{1}{\alpha_1-\beta_1}\right)\left[\begin{array}{l} (p_2^a \tilde{Z}_{22}^a) + (p_2^b \tilde{Z}_{22}^b) + E_{2u}^a \alpha_2 (T - G^a) \\ - E_{2u}^b (\alpha_2 sT + \beta_2 G^b) - \left(\alpha_1 \dfrac{\alpha_2^G G^a}{p_2^a} + \beta_1 \dfrac{\beta_2^G G^b}{p_2^b}\right) \\ - E_{2u}^a w^a L^a (\alpha_2 \eta_{L1}^a - \alpha_1 \eta_{L2}^a) \end{array}\right]$$

Note that this expression differs from the corresponding expression for the benchmark model in containing a term reflecting labor market responses. In particular, the last term depends on the difference in labor market demand elasticities with respect to prices of the two goods.

As before, we compute exchange rate effects using matrix calculations. Again, let $\Delta' = \bar{\Delta}'(\alpha_1 - \beta_1)$. Thus:

$$\frac{\hat{s}}{dT} = \frac{(\alpha_1 - \beta_1)(sE_{2u}^b - E_{2u}^a)}{\Delta'}$$

$$\frac{\hat{s}}{dG^a} = \frac{(\alpha_1 - \beta_1)[E_{2u}^a(1 + Z_G^b - w^a L_G^a) - (Z_{2G}^a + \alpha_2^G / p_2^a)]}{\Delta'}$$

$$\frac{\hat{s}}{d\tau} = -\frac{[(\beta_2 p_2^a Z_{22}^a + \alpha_2 p_2^b Z_{22}^b) + \alpha_2 \beta_2 (E_{2u}^a (T - G^a) - E_{2u}^b (sT + G^b))}{\Delta'}$$

$$\frac{-\left(\alpha_1 \beta_2 \dfrac{\alpha_2^G G^a}{p_2^a} + \alpha_2 \beta_1 \dfrac{\alpha_2^G G^a}{p_2^a}\right)]}{\Delta'}$$

$$-\frac{\beta_2 E_{2u}^a (\alpha_1 - \beta_1)(p_2^a Z_2^a + \alpha_2^G G^a) - \beta_2 E_{2u}^a w^a L^a (\alpha_2 \eta_{L1}^a - \alpha_1 \eta_{L2}^a)}{\Delta'}$$

$$\frac{\hat{s}}{\hat{w}^a} = \frac{w^a L^a (\alpha_1 - \beta_1)(p_2^a E_{2u}^a \eta_{LW}^a - \eta_{L2}^a)}{p_2^a \Delta'}$$

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