An Exploration of the Interdependencies Between the Real Exchange Rate and the Size of the Tradable Sector in a Small Open Economy

Fernando Zarzosa Valdivia[1] and Eric J. Pentecost[2]

Abstract

The complex interdependences between structural real exchange rates and the size of the tradable goods sector have not been thoroughly explored in the existing literature. This paper develops a micro-based neo-classical, general equilibrium model to examine these linkages. It shows that in addition to the well-known spending and resource movement effects, that there are also separately identifiable extraordinary profit effects, price effects, expenditure movement effects and substitution effects; the strength of which help to determine the size of the tradable goods sector in a small open economy.

It is also shown that the response of the equilibrium structural real exchange rate and the tradable goods share in GDP depends on the economic structure of a country (the sector and factor income distribution and the external debt servicing and transfers as a share of GDP)

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[1] Faculty of Applied Economics, University of Antwerp, Prinstraat, B-2000 Antwerp, Belgium

[2] School of Business and Economics, Loughborough University, Loughborough, Leicestershire, LE11 3TU, UK and the Faculty of Applied Economics, University of Antwerp, Prinstraat, B-2000 Antwerp, Belgium

1. Introduction

Although there is no accepted definition of economic structure, “the idea that economic structure matters for the macroeconomics of developing countries achieved great importance through the seminal work of Lewis (1954); the many contributions of Simon Kuznets, Hollis B. Chenery, and Moshe Syrquin; and especially the contributions of Lance Taylor” (Branson, Guerrero, & Gunter, 1998, p. 1). From the wide variety of characteristics that can reflect the economic structure of a country, this paper considers it by the sectoral composition of output, the factor income distribution and the external debt servicing and transfers.[3]

Of particular interest is whether different types of shocks could cause a real exchange rate appreciation, and consequently depress the tradable sector and de-industrialize the manufacturing sector; the so-called Dutch disease.[4] A key factor in promoting the development of the tradable sector, which ‘is usually very dynamic and contributes to innovations and productivity increases’ (Gala, 2008, pp. 273-274), is a competitive exchange rate. Theoretical analyses of the channels through which real exchange rates affect the size of the tradable sector, and which are in turn affected by it, are however, very scarce. Neary and Purvis (1982) postulates that the capital stock of the manufacturing sector and the real exchange rate are simultaneous determined. Lartey (2008) suggests a trade-off between resource reallocation and the degree of real exchange rate appreciation; in particular, the less labor the tradable sector loses to the non-tradable sector, the greater is the real exchange rate appreciation. Rodrik (2008) suggests two-way linkages between the structural real exchange rate (defined as the price of tradable to non-tradable goods) and the share of capital allocated to tradable goods production, while van der Ploeg (2010, 2011) postulates interdependences between the structural real exchange rate and the labour share in the non-tradable sector. No distinction is made, however, between exportable and importable goods and hence potential important interdependencies are overlooked by the analyses.

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3 Branson, Guerrero and Gunter (1998, pp. 5-6) provide a set of macroeconomic variables characterizing economic structure; e.g. the sectoral composition of output, shares of investment to GDP, shares of savings and consumption to GDP, shares of government expenditures and revenues to GDP, inflation and money supply, overall trade- and import related variables, export-related variables, export product concentration, market power in world export markets, and financial market development.

4 Originally, “the term Dutch disease refers to the adverse effects on Dutch manufacturing of the natural gas discoveries of the 1960s, essentially through the subsequent appreciation of the Dutch real exchange rate” (Corden W. M., 1984, p. 359). More recently, the term is also used to describe the negative effects on exports induced by foreign aid, remittances, capital inflows, or an improvement in the terms of trade (Lama & Medina, 2012).

In contrast, this paper by closely looking at the distinction between importable (manufacturing), exportable (primary) and non-tradable goods sectors of a stylized small open economy, contributes to the theoretical understanding of the relationships between the structural real exchange rate and the tradable goods share in GDP. It also explains how these linkages influence the channel by which sector productivity differentials, factor endowments, the terms of trade and debt service (minus transfers) affect the equilibrium structural real exchange rate and the tradable goods shares in GDP.

This paper also proposes that exogenous changes in productivity, factor endowments, terms of trade and debt service minus transfers do not only generate the well-known resource movement and spending or income effects, (see for example, Corden and Neary (1982), Neary and Purvis (1982), Corden (1984)) but also what we refer to as the extraordinary profit effect, the price effect, the expenditure movement effect and the substitution effect. Specifically, the e*xtraordinary profit effects*, reflect the increment of the income of the sector favoured by any exogenous shock, the *price effects*, measure the reallocation of resources due to increments of the tradable goods prices, the *expenditure movement effects*, measure the reallocation of resources compatible with the equilibrium of the current account when the external debt servicing minus transfers diminishes, and the *substitution effects*, reflect the reallocation of resources originated by excess of demand of tradable goods when the external debt servicing minus transfers diminishes. The novelty of this research is that, measuring changes in the allocation of resources by changes in the tradable goods share in GDP, it identifies and measures separately each of the effects mentioned previously.

This paper contributes to the literature, as theoretical models developed so far have not taken into account the influence of the economic structure on the magnitude of the response of an economy to exogenous shocks. It also suggests that terms of trade and external transfer improvements, and reductions of the external debt service give rise to a Dutch Disease.

The rest of this paper is set out as follows. Section 2 develops a dependent economy model based on the pioneering work of Swan (1955) and Salter (1959), where there are two traded goods and a non-traded good and fully-specified micro-theoretic household and production sectors of the economy. Section 3 shows how this more general model can be used to identify the various effects of changes to factor endowments and terms of trade on the size of the traded goods sector and the structural real exchange rate. Section 4 concludes.

2. The Equilibrium Model

This model is a theoretical Salter-Swan neo-classical micro-founded model for small open economies, in which the real exchange rate is a key variable not only in the process of adjustment, but also in determining which goods will end up as exports, which as imports, and which as non-tradable. That is, the real exchange rate becomes the arbiter determining how a country's comparative advantage changes.

Following the guidelines of the Australian models, this model deals with non-tradable goods, whose price should be set by the local supply and demand conditions, and tradable goods highly traded in the world markets (commodities), a situation where the law of one price should work pretty well. The presence of non-tradable goods would therefore affect the feature of our economy, from price determination, to the structure of the output, to the effects of the macroeconomic policy.

We assume a world with three goods: two of these goods are supposed to be tradable goods and the other one is assumed to be a non-tradable good. "Tradable goods are those with prices determined in the world markets. They consist of *primary* goods, of which the surplus over home consumption is exported; and *manufactured* goods,[5] of which the deficiency between consumption and home production is imported," (Salter, 1959, p. 226). The prices of both tradable goods are assumed to follow the law of one price. The household and production sectors are considered in turn.

2.1 The household sector and macroeconomic conditions

We start assuming that the representative consumer purchases three different types of goods - primary (X), manufacturing (M) and non-tradable (N) goods and ranks different bundles following a two-level constant elasticity of substitution (CES) preferences.[6] Equation (1) in Table 1, shows that total consumption (C) is divided into consumption of primary (C_x), manufacturing (C_M) and non-traded goods (C_N) respectively, according to their preferences, denoted by γ_p and δ_p.

[5] In this model, like in the Salter-Swan model, "home produced manufactured goods are treated as a special class of exportables: goods which could be sold on world markets, but in fact are not, for we should only have to buy them back".

[6] CES preferences have also been postulated by Devarajan, Lewis and Sherman (1991), De Gregorio and Wolf (1994), Cerda (2001), Calderon (2002), and Gubler and Sax (2012). Different structure of preferences have been assumed by other authors, e.g. *cuasi-convex preferences*, (Krugman, 1988), *non-homothetic* preferences, (Garcia, 1999) and *Cobb-Douglas preferences* (Lane and Galstyan (2008), Lartey (2008) and Soto and Elbadawi (2008)).

Table 1: Consumer Problem and the structural real exchange rate (SRER)

$$C = \left\{ \gamma_p^{1-\beta} \left[\left[\delta_p^{1-\rho} C_X^{\rho} + (1-\delta_p)^{1-\rho} C_M^{\rho} \right]^{\frac{1}{\rho}} \right]^{\beta} + (1-\gamma_p)^{1-\beta} C_N^{\beta} \right\}^{\frac{1}{\beta}} \tag{1}$$

$$P_X C_X + P_M C_M + P_N C_N \leq E \tag{2}$$

$$C_T = \gamma_p \left(\frac{P_T}{P} \right)^{\frac{1}{\beta-1}} C \tag{3}$$

$$C_T = \left[\delta_p^{1-\rho} C_X^{\rho} + (1-\delta_p)^{1-\rho} C_M^{\rho} \right]^{\frac{1}{\rho}} \tag{4}$$

$$P_T = \left[\delta_p P_X^{\frac{\rho}{\rho-1}} + (1-\delta_p) P_M^{\frac{\rho}{\rho-1}} \right]^{\frac{\rho-1}{\rho}} \tag{5}$$

$$P = \left[\gamma_p P_T^{\frac{\beta}{\beta-1}} + (1-\gamma_p) P_N^{\frac{\beta}{\beta-1}} \right]^{\frac{\beta-1}{\beta}} \tag{6}$$

$$\frac{E_T}{E} = \gamma_p \left(\frac{P_T}{P} \right)^{\frac{\beta}{\beta-1}} = \frac{1}{\gamma_p + (1-\gamma_p) \mathrm{SRER}^{\frac{\beta}{1-\beta}}} \tag{7}$$

where:

C refers to the representative consumer's utility level

C_X, C_M and C_N are primary, manufactured and non-tradable goods consumption levels, respectively

P_X, P_M and P_N are the prices of primary, manufactured and non-tradable goods, respectively

E (= PC) is the representative consumer's total expenditure

E_T (= $P_T C_T$) is the expenditure on tradable goods, respectively

SRER (= P_T / P_N) is the structural real exchange rate

γ_p and δ_p are preference weight parameters that reflect the tradable goods bias and primary goods bias, respectively

β and ρ are elasticity parameters; $\beta, \rho < 1$

The representative consumer chooses the most preferred bundle from her set of affordable consumption bundles (see equation (2) in Table 1) and thus maximizes utility subject to her budget constraint. Due to the characteristic of the CES utility function and in line with Dixit and Stiglitz (1977, p. 299), all goods are normal goods, as their demand increases when their budget increases, e.g. the demand for tradable goods as a whole depends negatively on the *SRER*, but positively on the consumer's overall demand, see equation (3).

The relationship on which we focus is the optimal representative consumer's tradable expenditure share, which is negatively related to the *SRER*, as in equation (7).

Table 2 shows the principal macroeconomic relations. Consumers in open economies can consume more tradable goods than their economy produces, but the consumption of non-tradable goods is always equal to their domestic production ($N=C_N$), see equation (8). Equation (9) displays the condition for the consumers' tradable expenditure share when the non-tradable market and the current account ($CA=0$) are in equilibrium: the share of the consumer's expenditure on tradable goods can increase when the tradable goods share in the gross domestic product (GDP) increases and the debt service minus transfers-to-GDP ratio (DS) diminishes.

Table 2: Current account bounds and the structural real exchange rate

$$\begin{aligned} CA &= GDP - E + r^{*}F + Tr \\ &= \left(P_X X + P_M M\right) - E_T + r^{*}F + Tr \end{aligned} \qquad (8)$$

$$\frac{E_T}{E} = \frac{\theta_T - DS}{1 - DS} \qquad (9)$$

$$\hat{SRER} = \frac{1}{1-\gamma}\left(\frac{1-\beta}{\beta}\right)\left(\frac{1}{\theta_{\mathrm{T}} - DS}\right)\left[-d(\theta_{\mathrm{T}}) + \frac{1-\theta_{\mathrm{T}}}{1-DS}d(DS)\right] \qquad (10)$$

where:

r^{*} is the international interest rate

F refers to the net foreign asset position

Tr reflects the external transfers

CA is the current account surplus

X and *M* are the levels of primary and manufacturing goods, respectively

GDP ($= P_X X + P_M M + P_N N$) is the gross domestic product

DS= $\left(\left(-r^{*}F - Tr\right)/GDP\right)$ refers to the debt service minus transfers-to-GDP ratio

θ_{T} ($=\left(P_X X + P_M M\right)/GDP$) is the tradable goods share in GDP

γ is the initial tradable expenditure share

d() and (^) refer to the first differential and percentage variation operators, respectively;

The variable *DS* is positively related to the external debt service (*-r*F/GDP*), but negatively to the international grants or transfers; debt service reductions result from a fall in the international interest rate or an increase in the net foreign asset position. The non-tradable market clearing condition implies that the value of the tradable production plus the transfers can be used to pay external debt services or to satisfy the demand for tradable good. Thus, if there are no corner solutions, the tradable expenditure share is always positive.

When the consumer decision process fulfils the restrictions imposed by the equilibrium of the current account and the non-tradable market, equation (7) and (9) are equivalent; equation (10) shows the structural real exchange rate produced by equivalence of equations (7) and (9).

2.2 Producers optimum

The economy is divided into three internally homogeneous and perfectly competitive sectors: primary (*X*), manufacturing (*M*) and non-tradables (*N*) goods sectors. It is also assumed that there are two production factors, labour and capital (although they could equally be unskilled and skilled labour), which are perfect substitutes in the non-tradable sector, but imperfect substitutes in the tradable sectors. Equations (11)-(13) postulate a linear technology for the non-tradable sector, but a Cobb Douglas one for the tradable sectors following the work by De Gregorio and Wolf (1994), Garcia (1999) and Rodrik (2006).[7] In this case, however, we assume that the aggregate tradable output elasticities are less than one (ϕ_X + ψ_X < 1 and ϕ_M + ψ_M < 1). In doing we suppose that diminishing returns to scale prevail in both tradable sectors or that there are other sector-specific factors of production employed in each sector that are fixed in supply.

When the first order condition of the non-tradable producer's maximization problem – $w = P_N TFP_N Z_{N_L}$ and $r = P_N TFP_N Z_{N_L}$ – are included in the supply functions of both tradable goods, the resource allocation between tradable and non-tradable goods depends on the SRER, while resource allocation within the tradable sector depends on the terms of trade; see equations (14) and (15).

[7] Different tradable and non-tradable technologies have been assumed by different authors; for instance, Krugman (1988) postulates linear technologies in both sectors, Dornbusch (1989) assumes linear (or Leontief) technology in the production of non-tradable goods, Alberola (2003), Lane and Galstyan (2008) and Soto and Elbadawi (2008) are based on Cobb-Douglas technologies in both sectors, Calderón (2002), Gay and Pellegrini (2003) and Aguirre and Calderón (2006) assume linear technologies in the non-tradable sector but endowed tradable goods and Razmi, Rapetti and Skott (2009) postulate Leontief technologies in the tradable sector but Cobb-Douglas in the non-tradable sector. Devarajan, Lewis and Sherman (1991) go further assuming a transformation curve between tradable and non-tradable goods with CES structure.

Table 3: Producers' decisions and the tradable goods share in GDP

$$X\,(L_X\,,K_X\,) = TFP_X\,L_X^{\phi_X}\,K_X^{\psi_X} \tag{11}$$

$$M\,(L_M\,,K_M\,) = TFP_M\,L_M^{\phi_M}\,K_M^{\psi_M} \tag{12}$$

$$N(L_N\,,K_N\,) = TFP_N\,(Z_{N_L}\,L_N + Z_{N_K}\,K_N\,) \tag{13}$$

$$X = \left[\frac{TFP_X}{\left(TFP_N\right)^{\phi_X+\psi_X}}\left(SRER\right)^{\phi_X+\psi_X}\left(\frac{P_X}{P_T}\right)^{\phi_X+\psi_X}\left(\frac{\phi_X}{Z_{N_L}}\right)^{\phi_X}\left(\frac{\psi_X}{Z_{N_K}}\right)^{\psi_X}\right]^{\frac{1}{1-\phi_X-\psi_X}} \tag{14}$$

$$M = \left[\frac{TFP_M}{\left(TFP_N\right)^{\phi_M+\psi_M}}\left(SRER\right)^{\phi_M+\psi_M}\left(\frac{P_M}{P_T}\right)^{\phi_M+\psi_M}\left(\frac{\phi_M}{Z_{N_L}}\right)^{\phi_M}\left(\frac{\psi_M}{Z_{N_K}}\right)^{\psi_M}\right]^{\frac{1}{1-\phi_M-\psi_M}} \tag{15}$$

$$L = L_X \ + L_M + L_N \tag{16}$$

$$K = K_X \ + K_M + K_N \tag{17}$$

$$\theta_T = \frac{P_X X + P_M M}{wL + rK} \tag{18}$$

$$\begin{aligned} d(\theta_T) = {} & \frac{\theta_X}{1-\phi_X-\psi_X}\widehat{TFP}_X + \frac{\theta_M}{1-\phi_M-\psi_M}\widehat{TFP}_M + \left[\frac{\theta_X}{1-\phi_X-\psi_X} + \frac{\theta_M}{1-\phi_M-\psi_M}\right](\widehat{SRER} - \widehat{TFP}_N) \\ & -\theta_T\theta_L\hat{L} - \theta_T\theta_K\hat{K} + \left[\frac{(1-\delta)\theta_X}{1-\phi_X-\psi_X} - \frac{\delta\theta_M}{1-\phi_M-\psi_M}\right]\widehat{TT} \end{aligned} \tag{19}$$

$$d(\theta_T) = (1-\theta_T)\left[\left(\theta_X\,\widehat{TFP}_X + \theta_M\,\widehat{TFP}_M - \theta_T\,\widehat{TFP}_N\right) + \left(\theta_X(1-\delta) - \theta_M\delta\right)\widehat{TT} + \theta_T\,\widehat{SRER}\right] \tag{20}$$

where:

X, M and N are the outputs of primary, manufacturing and non-tradable goods, respectively,

ϕ_X and ϕ_M (ψ_X and ψ_M) are the primary and manufacturing output elasticities with respect to the labour (capital) factor, respectively. ϕ_X, ϕ_M, ψ_X and ψ_M are lying between zero and one

TFP_X, TFP_M and TFP_N are the total factor productivities of the production factors employed in the primary, manufacturing and non-tradable sectors, respectively.

Z_{N_L} and Z_{N_K} are the specific productivities of labour and capital employed in the non-tradable sector, respectively. They are assumed to be constant;

L and K are the labour and capital endowments, respectively

L_i and K_i are the labour and capital employments for sector i, respectively

w and r are the domestic wage and interest rate, respectively

TT are the terms of trade,

δ is the initial tradable expenditure share and θ_X and θ_M (θ_L and θ_K) are the primary and manufacturing (labour and capital) shares in GDP, respectively, Throughout the analysis, there is full employment of a constant supply of labour (*L*) and capital (*K*) as well as perfect mobility of both factors between all sectors; see equations (16) and (17). The equilibrium of an economy with perfectly competitive markets and full employment of its resources implies no profits, which means that the income generated by all sectors (*GDP*) and the factor rewards ($wL + rK$) are equal. As a result, the tradable goods share in *GDP* is re-expressed by equation (18).

Equation (19), which is the total differential of equation (18) - the tradable goods share, shows how sector TFPs, factor endowments, the SRER, and the terms of trade influence the tradable producers' decision process.[8] Assuming that initial changes in the sector outputs reflect their TFP variation, equation (20) displays the initial impact of TFPs, the SRER, and the terms of trade on the tradable goods share in GDP. It is worth nothing that the impact of sector TFPs, SRER, factor endowments and TT on the tradable goods share in GDP are larger (in absolute value) than their initial impact.

The procedure of reflecting the behaviour of the primary and manufacturing sectors as a single sector (tradable sector) is legitimate so long as the terms of trade are unaffected by events inside our small economy. The reason is that any quantity of primary goods may be exchanged for manufacturing at the relative price determined by the given terms of trade (Salter, 1959, pp.226-227). Therefore, since trade allows primary goods to be transformed into manufactured goods and vice versa, it is a matter of indifference whether an increased tradable production is achieved by means of greater production of primary or manufacturing goods.

2.3 The Equilibrium

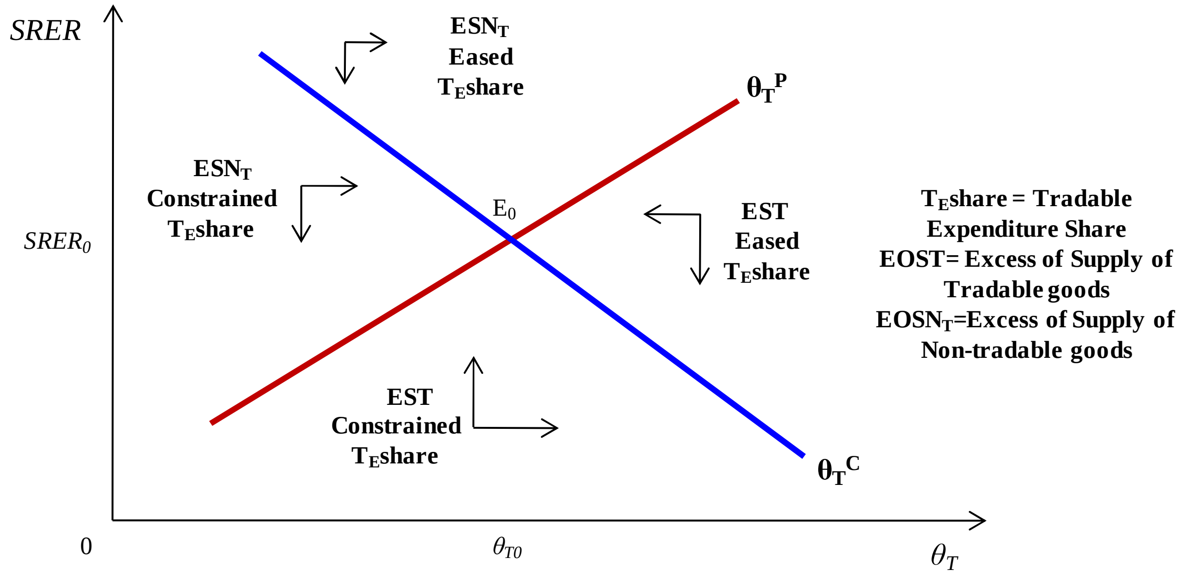
In equilibrium, producers' response to exogenous shocks generates a feedback with the SRER compatible with the consumer decision process.

The θ_T^C line of Figure 1 shows the negative relationship between the SRER and tradable goods share in GDP postulated by equation (10): a larger tradable goods share in GDP creates excess supply of tradables and excess demand for non-tradables. The SRER must appreciate in order to switch expenditure from non-tradables to tradables and restore equilibrium in the non-tradable market and current account. The θ_T^P line of Figure 1 illustrates the relationships of equation (19) and its slope is positive since, *ceteris paribus*, resources would be re-

[8] Note that the percentage variation of the price indices of equations (5) and (6) can be expressed as follows: $\hat{P} = \gamma \hat{P}_T + (1-\gamma)\hat{P}_N$ and $\hat{P}_T = \delta \hat{P}_X + (1-\delta)\hat{P}_M$.

allocated to the tradable sectors as the SRER increases. Along the θ_T^P line, producers reach their optimum and the economy works efficiently along the production possibility frontier. Points above such a line reflect an excess supply of non-tradable goods, while there is an excess of supply of tradable goods below it.

Figure 1: Equilibrium SRER and tradable goods share in GDP



Given the initial values of sector TFPs, TT, DS and factor endowments, the intersection of the θ_T^P and θ_T^C lines in Figure 1 determines the equilibrium SRER and θ_T at point E_0. The regions around E_0 represent four types of disequilibrium. Points in the right quadrant correspond to a position where the tradable production exceeds the optimal production and the conditioned tradable expenditure share exceeds the consumers' optimal tradable expenditure share. Producers' interaction pushes the tradable shares downwards via higher factor prices, while the consumers' optimal decision pushes the SRER downwards until the equilibrium is reached at point E_0. The left quadrant shows the opposite combination: excess of supply of non-tradable goods and constrained tradable expenditure share, points at which the non-tradable prices are above their equilibrium level and the tradable expenditure share constrained.

Points in the upper quadrant also reflect excess of supply of non-tradable goods, but in this case, it is combined with an eased tradable expenditure share. The equilibrium is reached via lower factor prices. The adjustment towards the equilibrium occurs via depreciated SRER and higher factor prices when the economy is in the lower quadrant.

Changes in sector total factor productivities, terms of trade, external debt service minus transfers and factor endowment displace the θ_T^P and θ_T^C lines of Figure 1 and, therefore, influence the equilibrium SRER and tradable goods share in GDP.

The substitution of equation (19) into equation (10) determines the equilibrium movement equation for the SRER, while the substitution of such equilibrium equation into equation (10) determines the equilibrium movement equation for the tradable goods share in GDP. Formally:

$$SR\hat{E}R = -\Phi_1 T\hat{F}P_X - \Phi_2 T\hat{F}P_M + \Phi_3 T\hat{F}P_N + \Phi_4 \hat{L} + \Phi_5 \hat{K} - \Phi_6 (\widehat{TT}) + \Phi_7 d(DS) \tag{21}$$

$$d(\theta_T) = \Gamma_1 T\hat{F}P_X + \Gamma_2 T\hat{F}P_M - \Gamma_3 T\hat{F}P_N - \Gamma_4 \hat{L} - \Gamma_5 \hat{K} + \Gamma_6 (\widehat{TT}) + \Gamma_7 d(DS) \tag{22}$$

where

$$\Phi_0 = \frac{\frac{1-\beta}{\beta}\left(\frac{1}{\theta_T - DS}\right)}{1-\gamma+\left[\frac{1-\beta}{\beta}\left(\frac{1}{\theta_T - DS}\right)\left(\frac{\theta_X}{1-\phi_X-\psi_X}+\frac{\theta_M}{1-\phi_M-\psi_M}\right)\right]} \geq 0$$

$$\Phi_1 = \Phi_0 \frac{\theta_X}{1-\phi_X-\psi_X} \quad 0 \leq \Phi_1 \leq 1 \qquad\qquad \Gamma_1 = \frac{\Phi_1}{\Phi_0}(1-\Phi_3)$$

$$\Phi_2 = \Phi_0 \frac{\theta_M}{1-\phi_M-\psi_M} \quad 0 \leq \Phi_2 \leq 1 \qquad\qquad \Gamma_2 = \frac{\Phi_2}{\Phi_0}(1-\Phi_3)$$

$$\Phi_3 = \Phi_1 + \Phi_2 \quad 0 \leq \Phi_3 \leq 1 \qquad\qquad \Gamma_3 = \Gamma_1 + \Gamma_2$$

$$\Phi_4 = \Phi_0 \theta_T \theta_L \qquad\qquad \Gamma_4 = \frac{\Phi_4}{\Phi_0}(1-\Phi_3)$$

$$\Phi_5 = \Phi_0 \theta_T \theta_K \qquad\qquad \Gamma_5 = \frac{\Phi_5}{\Phi_0}(1-\Phi_3)$$

$$\Phi_6 = (1-\delta)\Phi_1 - \delta\,\Phi_2 \ \substack{\geq \\ \leq}\ 0 \qquad\qquad \Gamma_6 = \frac{\Phi_6}{\Phi_0}(1-\Phi_3)$$

$$\Phi_7 = \Phi_0 \frac{1-\theta_T}{1-DS} \geq 0 \qquad\qquad \Gamma_7 = \frac{\Phi_7}{\Phi_0}\Phi_3$$

Existing models of real exchange rate determination 'imply a role for tastes and technology, as well as the conditions under which one might be more relevant than the other, in particular the inter-sector and international mobility of capital' (Garcia, 1999, p. 3). In contrast to the model developed here (and Zarzosa Valdivia (2008)), previous models do not take account of the fact that different economies may respond asymmetrically to similar exogenous shocks as a result of their heterogeneous economic structure. In this paper the structure of the economy is considered by including income distribution ratios (θ_X, θ_M, θ_T, θ_L and θ_K) and the *DS* ratio in the model.

Table 4 summarizes the static comparative results derived so far; e.g. the signs in the first column indicate that TFP improvements in the primary sector: a) have initially a positive impact on the tradable goods share in GDP, b) appreciate the equilibrium SRER and c) increase the equilibrium tradable goods share in GDP. Table 4 displays also how exogenous shocks, via their impact on the SRER, affect the allocation of resources within the tradable sector; e.g. the last two rows of the first column suggest that TFP improvements in the primary sector increase the size of the primary sector, but reduce the size of the manufacturing sector.

Table 4: SRER and the tradable goods share responses to shocks

	Exogenous shocks							***Linkages***	
Variables	Sector TFP shocks			Factor endowments		Terms of trade	Debt service minus transfers	SRER	θ_T
	Primary	Manu-facturing	Non-tradables						
	TFP_X	TFP_M	TFP_N	L	K	TT	DS		
SRER							+		-
θ_T	+	+	+	-	-	$?_+$		+	
SRER	-	-	+	+	+	$?_-$	+		
θ_T	+	+	-	-	-	$?_+$	+		
θ_X	+	-	-	?	?	+	+		
θ_M	-	+	-	?	?	-	+		

The first two rows correspond to the relationships of equations (10) and (19), respectively.

The third and fourth row are the equilibrium relationships corresponding to equations (21) and (22), respectively

The last two rows shows the response of the equilibrium share in GDP of the primary and manufacturing sectors to exogenous shocks

A "+" indicates a positive effect, a "-" a negative one and a "?" an ambiguous effect; signs in subscripts are valid relationships when TT improvements appreciate the SRER

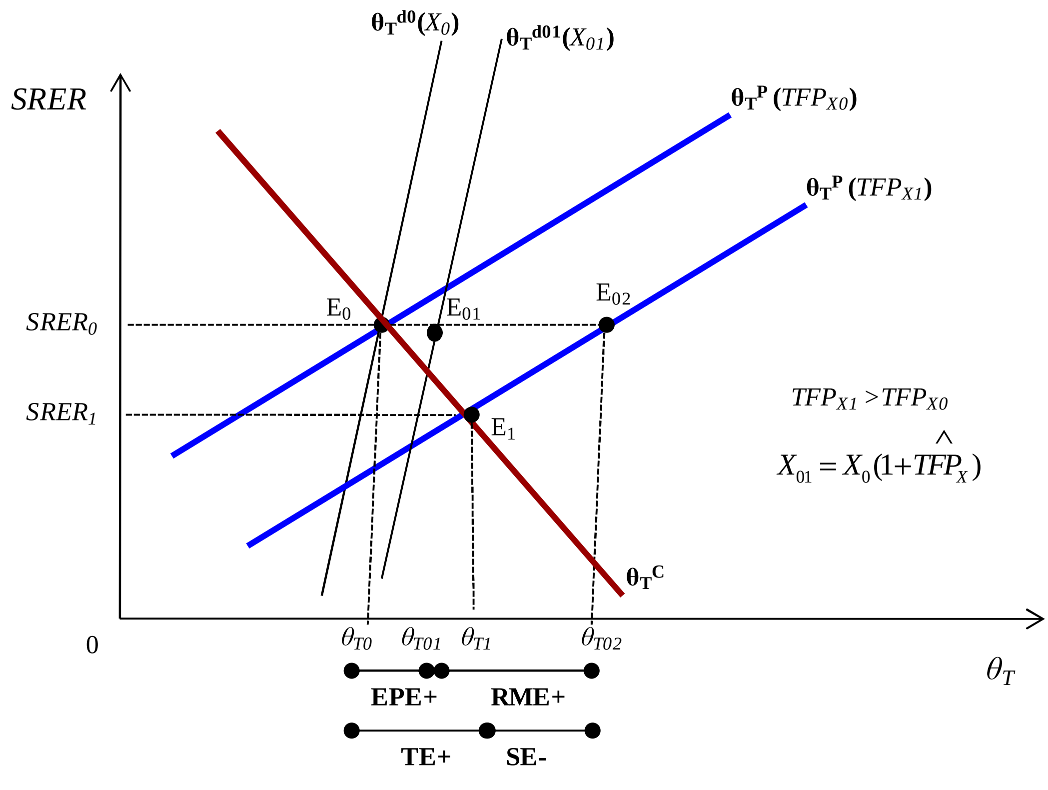
3. Experiments with the model

The model can now be used to examine the impact of various shocks and in particular to identify the new channels of interaction between the structural real exchange rate and the size of the traded goods sector. These shocks are: improvements in TFP, factor endowments, terms of trade and debt service, respectively.

3.1 Improvements in TFP_X

Figure 2 displays the effects of TFP_X improvements in the SRER and tradable goods share in GDP; the θ_T^d line depicts the SRER-θ_T relationship of equation (20). TFP_X improvements diminish the relative cost of producing primary goods and shift the θ_T^P and θ_T^d lines downwards. The additional income of the primary producers increases their profits and generates *Extraordinary Profit Effects* (EPE), which are reflected by an increment of the tradable sector size equal to E_0E_{01}.

Figure 2: SRER and TFP_X improvements



At the initial *SRER*, TFP_X improvements re-allocate resources to the primary sector and thus cause a *direct de-industrialisation* of the manufacturing sector. The increased productivity drives up the value of the marginal product of both factors employed in the primary sector and increase their demand. It pushes factor prices up, pushing labour and capital out of the manufacturing and the non-tradable sector. At the initial SRER producers reach their optimum at point E_{02}; the consequent *Resource Movement Effects* (RMEs) are measured by the distance $\theta_{T01}\theta_{T02}$.

Due to the full employment conditions, factor price increments increase GDP and the demand for all goods. A higher non-tradable demand pushes non-tradable prices and the factor prices upwards. This also has the effect of drawing production factors out of both of the tradable sectors; which is the so-called *indirect de-industrialisation* of the manufacturing sector. The equilibrium point is reached at point E_1, where the SRER has appreciated and the tradable goods share in GDP has increased. *Spending Effects (SEs)*, and *Total Effects* (TEs) are equal to the distances $\theta_{T1}\theta_{T02}$ and $\theta_{T0}\theta_{T1}$, respectively.

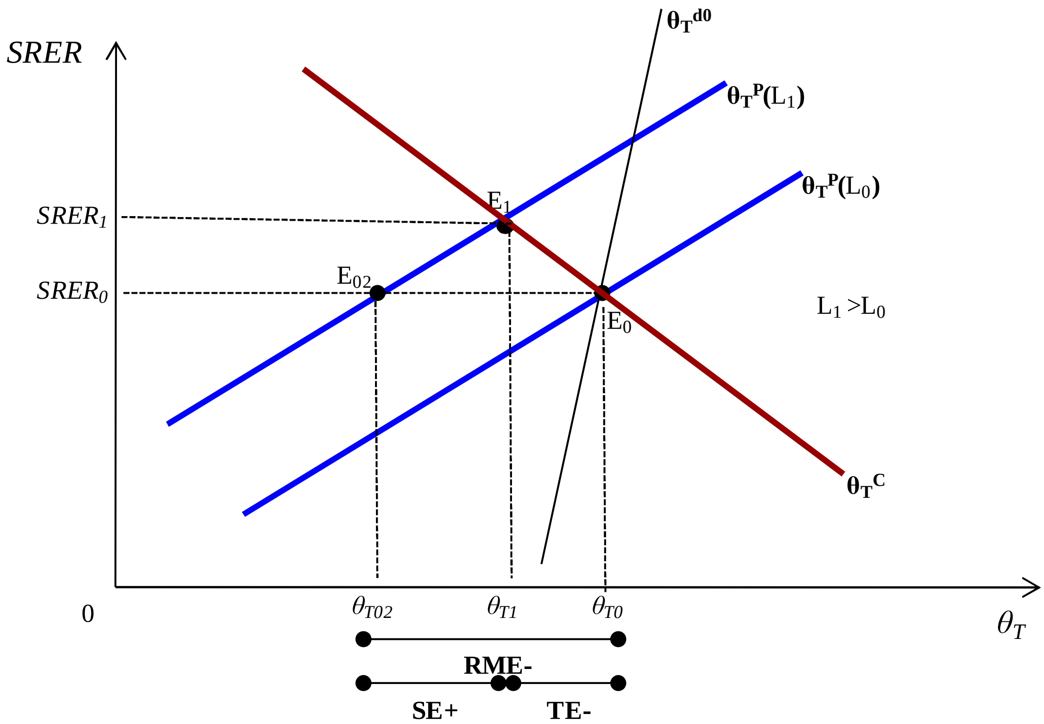
Increases in TFP in the manufacturing sector have similar effects to the ones explained above, but in this case, the *de-industrialization* occurs in the primary sector. The impact of TFP improvements in the non-tradable sector operates in the opposite way to TFP improvements in any of the tradable sector, but in this case, a *de-industrialization* of both tradable sectors occurs.

Following Baumol and Bowen (1966, p. 171), the faster the general pace of technological advance, the higher will be the wage level, and the greater will be the upward pressure on costs in other industries which do not benefit from rising productivity. Consequently, if productivity in the tradable goods sector grows faster than in the non-tradable sector, but the demand for non-tradable goods is more income-elastic, the relative price of non-tradable goods would rise and the SRER would appreciate; the subsequent appreciation is known as the Baumol-Bowen effect. In our model, larger TFP improvements in the tradable sector perform the Baumol-Bouwen effects, but symmetric TFP changes across sectors do not affect the SRER and tradable goods share in GDP; note that $\Phi_1 + \Phi_2 = \Phi_3$ and $\Gamma_1 + \Gamma_2 = \Gamma_3$.

3.2 SRER and factor endowments

A rise in the factor endowments increases the output levels of all sectors. At the initial factor prices, it increases the retribution of all factors, but, at the initial SRER, the income of the tradable sector does not change and therefore the tradable goods share in GDP diminishes. Consequently, the θ_T^P line of Figure 3 shifts to the left and the corresponding resource movement effects are measured by the distance $E_{02}E_0$ in Figure 3.

Figure 3: SRER and factor endowments



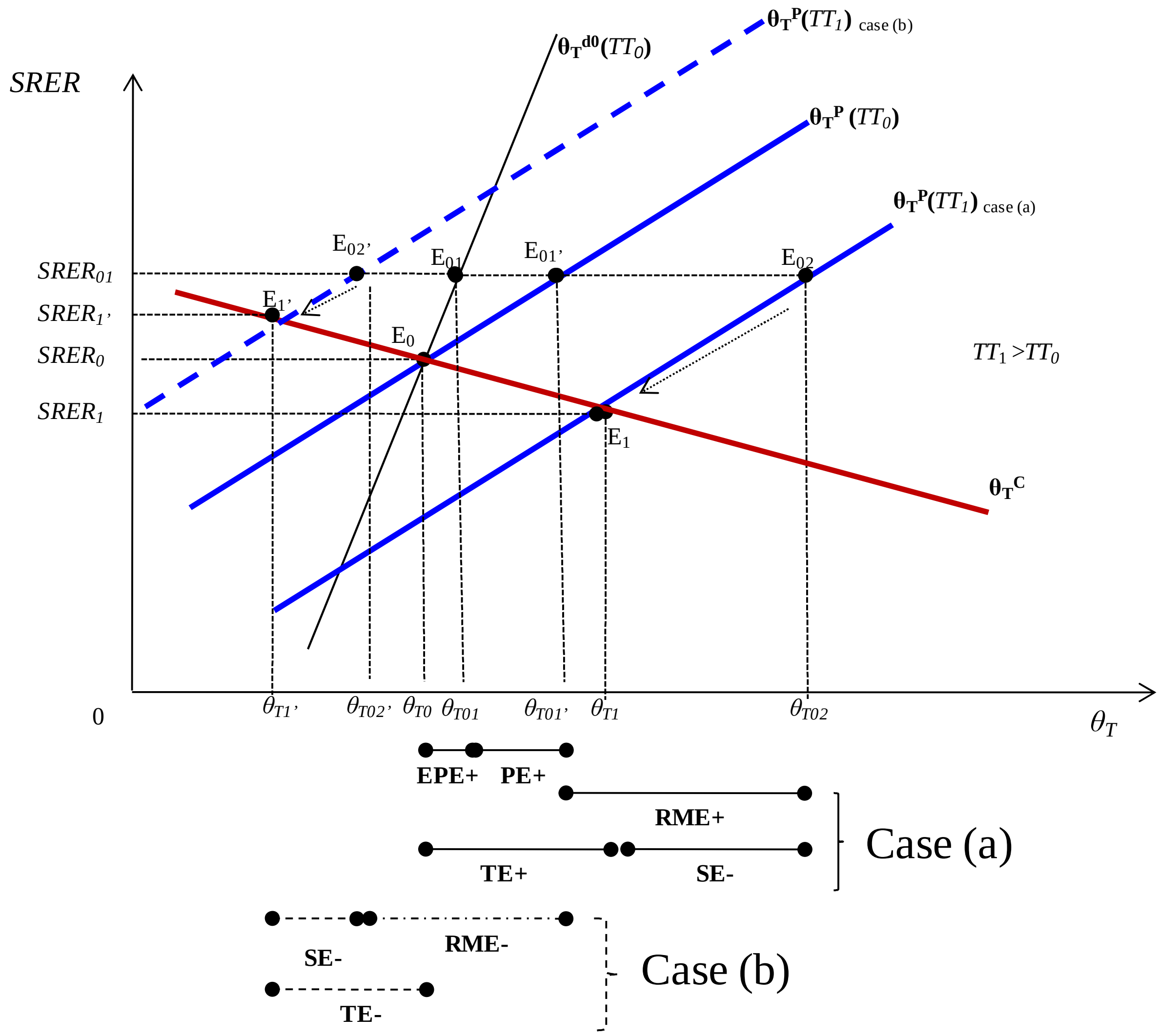
The resulting excess supply of non-tradable goods pushes non-tradable prices and consequently factor prices down. GDP and the demand for all goods increase; the excess supply of non-tradable goods, however, persists. The consequent spending effects are reflected by a higher SRER ($SRER_1$-$SRER_0$) and tradable goods share in GDP (θ_{T1}- θ_{T02}). Thus, a rise in factor endowments depreciates the SRER, but diminishes the tradable goods share in GDP from θ_{T0} to θ_{T1}.

3.3 SRER and terms of trade shocks

Terms of trade improvements increase the primary producers' income and profits; θ_{T01}-θ_{T0} of Figure 4 measures the subsequent extraordinary profits effect. These improvements give rise also to price effects (PEs) because their direct and positive impact on the SRER reallocates resources shifting both production factors to the primary sector and the tradable sector as a whole. Graphically, the economy moves along the initial θ_T^P line up to the point $E_{01'}$ and the price effects of terms of trade are measured by the distance $\theta_{T01}\theta_{T01'}$.

The reallocation of resources as a result of price effects occurs only via higher factor prices. Subsequently, the relevant θ_T^P line is the one corresponding to the higher terms of trade. Thus, production factors would again be re-allocated via resource movement effects favorable to the primary sector only.

Figure 4: SRER and terms of trade



The overall effect on the tradable sector is however ambiguous. If a) the increase in θ_X outweighs the θ_M reduction, the line θ_T^P line shifts to the right (see the $\theta_T^P(TT_1)_{case\ (a)}$ line in Figure 4) or b) the increase in θ_X is offset by the reduction of θ_M, the θ_T^P line shifts to the left (see the $\theta_T^P(TT_1)_{case\ (b)}$ line in Figure 4). The distances θ_{T02}-$\theta_{T01'}$ or $\theta_{T01'}$-θ_{T02} measure the corresponding resource movement effects to case (a) and (b), respectively.

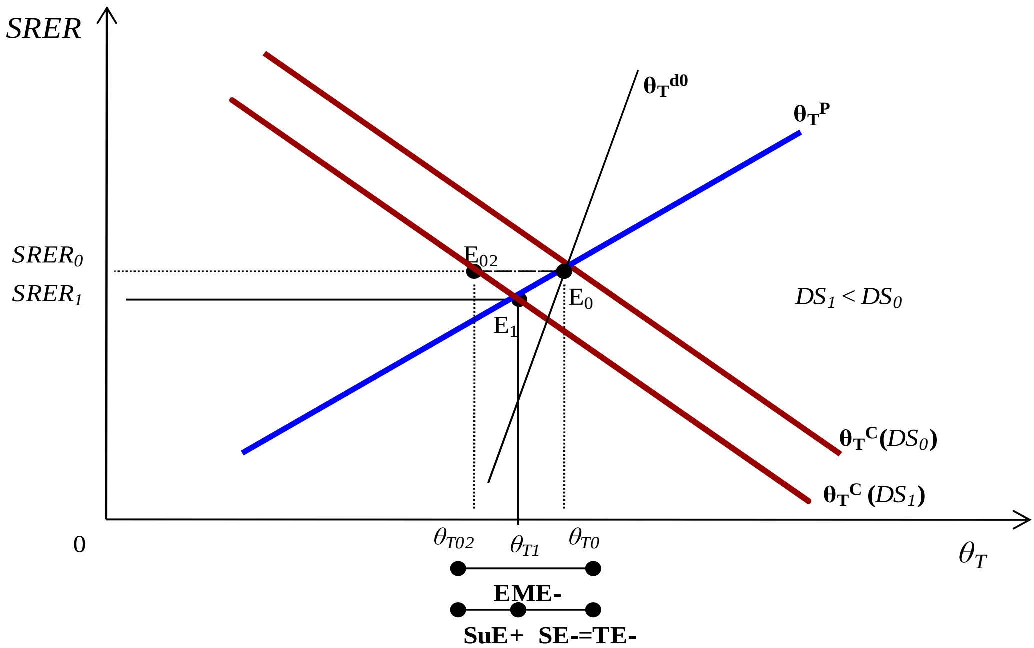
At point E_{02} of both figures, the income of the economy has increased as well as the demand for all goods. There is, therefore, an excess of demand for non-tradable goods that pushes the SRER and the tradable goods shares in *GDP* downwards. The *SRER* appreciation generates spending effects since it attracts resources to the non-tradable sector, represented by the shift of θ_{T02} to θ_{T1}. Point E_1 in both figures is the new equilibrium point.

Note that larger primary goods expenditure in the total tradable expenditure ($\delta \rightarrow 1$) or larger manufacturing sector ($\theta_M \rightarrow \theta_T$) could lead to SRER depreciations, while a larger primary sector ($\theta_X \rightarrow \theta_T$) or a small expenditure share in primary goods could lead to appreciations. To sum up, the impact on the SRER is ambiguous since terms of trade shocks change tradable and non-tradable prices in the same direction. In any case, terms of trade improvements give rise to *direct and indirect de-industrialisation* on the manufacturing sector (Dutch Disease) through resource movement effects to the primary sector and spending effects to the non-tradable sector.

3.4 SRER and debt service

A decline in *DS* eases the tradable expenditure shares and shifts the θ_T^C line down as in Figure 5. At the initial *SRER*, the tradable goods share in *GDP* that satisfy the new macroeconomic restrictions should diminish at point E_2; the consequent expenditure movement effects (EMEs) are equal to the distance E_0E_{02}.

Figure 5: SRER and external debt service



Producers, however, do not adjust their production levels at the initial *SRER*. As a result, the excess of demand for non-tradable goods pushes non-tradable prices upwards. The resulting *SRER* appreciation induces substitution effects favourable to the tradable sector; see the distance $\theta_{T02}\theta_{T1}$. At the new equilibrium point (point E_1): the *SRER* appreciates, spending effects reduce the size of the tradable sector in a distance equal to $\theta_{T1}\theta_{T0}$ and both tradable goods production (consumption) levels diminish (increased). *DS* reduction performs Dutch disease effects since it reduces the share of the manufacturing sector in *GDP*.

This model also allows the incorporation of aid flows: a) if they increase the transfers-to–GDP ratio, they will reduce the size of both tradable sectors in the economy and perform Dutch Disease effects, b) if they improve *TFP* in a particular sector, they would induce an allocation of resources to that sector, and c) if they increase consumption and cause *TFP* improvements, their effect on the *SRER* and the share of the tradable sector would be ambiguous.

3.5 Overvalued structural real exchange rates and economic growth

According to this model, movements of the equilibrium structural real exchange rate and the tradable share of output, due to a change in the underlying fundamentals, should not need to be a cause of concern and no economic policy response would be required.

The export-led growth supporters would claim that there is always a role for economic policy to keep the currency undervalued so as to spur economic growth (Magud & Sosa, 2010, p. 7).[9] Williamson (2008, p. 480), however, quotes that the contention of a misaligned exchange rate –particularly an overvalued rate, although also a seriously undervalued rate-impedes growth receives strong empirical support in a recent study of Aguirre and Calderon (2006). In our model, the GDP equilibrium movement equation is presented as follows:

$$\begin{aligned} G\hat{D}P &= \Phi_1 T\hat{F}P_X + \Phi_2 T\hat{F}P_M + (1-\Phi_3)T\hat{F}P_N + (\theta_L - \Phi_4)\hat{L} \\ &\quad + (\theta_K - \Phi_5)\hat{K} + \Phi_{6X}\hat{P}_X + \Phi_{6M}\hat{P}_M - \Phi_7 DS \end{aligned} \tag{23}$$

where Φ_i were defined by equation (21), $\Phi_{6X} = \Phi_6 + \delta$ and $\Phi_{6M} = (1-\delta) - \Phi_6$

Equation (23) implies that, in our model, an overvalued structural real exchange rate increases the tradable share and GDP, but it does it only temporarily. If the economy is initial in equilibrium and policymakers choose deliberately to devaluate, the tradable prices will increase, while the factor prices will exceed (fall behind) the value of the marginal product of the factors employed in the tradable (non-tradable) sector. The subsequent excess of demand

[9] For instance, a) Rodrik (2008) finds that an undervaluation has a positive impact on the size (and share) of output of the tradable sector in general and the industrial sector in particular, b) Galindo, Izquierdo and Montero (2001) and Frenkel and Ros (2006) find that real exchange rate depreciations boost industrial employment in samples of Latin American countries and c) Prasad, Rajan and Subramanian (2007) conclude that foreign capital inflows tend to be associated with exchange rate overvaluation, which in turn has a detrimental effect on sector allocation, manufactured exports and growth (a form of the Dutch disease phenomenon).

(supply) for resources in the tradable and non-tradable sectors increases the GDP and the tradable goods share in GDP. The additional GDP will increase the demand for all goods in such a manner that the SRER and tradable goods share in GDP will return to their equilibrium position. Note, however, that the economy reaches its equilibrium position through inflation since the price of all goods has increased at a rate equal to the initial devaluation.

Equation (23) tells us also that if the total factor productivity in the tradable sectors is lower due to market imperfections, as in Rodrik (2008), economic growth will be lower than in the perfect competitive case. Also, if following Rodrik (2006) we assume that the primary sector produces commodities and the manufacturing goods sector produces goods that are also imported, the evolution of the TFP of the manufacturing sector will be the main driver of economic growth if TFP grows faster in this sector than others.[10] Thus, rapidly growing countries would be those with larger manufacturing sectors.

4. Conclusions

The model developed in this paper analyses the linkages between the structural real exchange rate and the relative size of the tradable sector in order to investigate how sector productivities, terms of trade, factor endowments and debt service payments impact on the equilibrium structural real exchange rate and the size of tradable goods sector in GDP of a small economy; see Table 4.

Measuring changes in the allocation of resources by changes in the size of the tradable goods sector, Table 5 shows the impact of an exogenous shock to the tradable goods share in GDP via: (a) the extraordinary profit effect (EPE), which is reflected by a rise in the income of the sector favoured by the corresponding shock; (b) the resource movement effect (RME), which is related to the reallocation of resources, at the initial SRER, generated by the subsequent exogenous shocks; (c) the spending effect (SE), which refers to re-allocation of resources and expenditures due to SRER movements; (d) the price effect (PE), the re-allocation of resources corresponding to increments of the tradable goods prices, (e) the expenditure movement effects (EME), which measure the reallocation of resources

[10] According to equation (23) and the relationships of Table 4, the GDP response to TFP shocks in a specific tradable sector may be larger in countries where the sector is larger. Formally:

$$\text{If } \Delta TFP_M\big|_{t=t} > 0 \Rightarrow \Phi_2\big|_{t=t+1} > \Phi_2\big|_{t=t} \;\; \text{since} \quad \frac{d\Phi_2}{d\theta_M} \wedge \frac{d\theta_M}{dTFP_M} \geq 0$$

compatible with the equilibrium of the current account when the external debt servicing minus transfers increases, and the *substitution effects*, reflect the reallocation of resources originated by excess of demand of tradable goods when the external debt servicing minus transfers increases.

Table 5: Effects of exogenous shocks in the tradable goods share in GDP

	EPE	PE	RME	EME	SuE	SE	TE	Tradable share	SRER
TFP_X	+		+			-	+	Inc.	App.
TFP_M	+		+			-	+	Inc.	App.
TFP_N	-		-			+	-	Dim.	Dep.
TT	+	+	+			-	+	Inc.	App.
			-			+	-	Dim.	Dep.
DS				+	-	+	+	Inc.	Dep.

A plus (minus) indicates that the corresponding shock increases (decreases) the tradable share
Inc. and Dim. indicates that the tradable share increases or diminishes, respectively
App. and Dep. refer to appreciation and depreciation, respectively

This paper contributes to the literature, as theoretical models developed so far have not taken into account the influence of the economic structure (sector and factor income distribution and external debt servicing and transfers) on the magnitude response of an economy to exogenous shocks. It also suggests that terms of trade improvements and reductions of the external debt service (minus transfers) give rise to a "Dutch Disease" effect; which "is a source of concern for policymakers to the extent that a smaller tradable sector might undermine future possibilities of growth and employment creation". (Lama & Medina, 2012, p. 6)

The structural real exchange rate and the tradable goods share in GDP are not directly controlled by policymakers. Nonetheless, economic policies designed to raise the sector productivity and control the evolution of a country's external debt should be evaluated by their impact on the interdependent relationships as well as on the equilibrium relationships.

Economic policies can affect total factor productivity through investment in physical and human capital, for example see Diewert (2006), specialization in "s*ophisticated*" goods (goods that present greater room for technological catching up and face higher prices and limitless demand) and improvements in the functioning of markets, property rights and infrastructure in transport and telecommunications.

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