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Abstract

This paper develops a model of long-run real exchange rates based on a New Economic Geography framework that compares two determinants of relative price levels. The first one is a standard Balassa-Samuelson mechanism, that explains relative prices in the non-traded good sector by productivity differentials. The second determinant, the “Variety Supply effect”, explains PPP deviations in the traded good sector by the endogenous distribution of firms across countries. Calibrating the model with OECD data, one shows that the relative magnitude of the Variety Supply effect is generally small and that both effects can either play in opposite direction, or strengthen each other. This ambiguity is explained in a general equilibrium framework by the sensitiveness of location decisions to the structure of preferences. When the share of traded good is large enough, the entry of firms leads to a real depreciation because local consumers benefit from a trade cost saving. However, if the share of non-traded goods in consumption is high, this effect is more than compensated by a wage adjustment and the real exchange rate appreciates.

Résumé

Ce papier développe un modèle de taux de change réel d’équilibre à partir du cadre de la Nouvelle Economie Géographique, pour comparer deux déterminants des prix relatifs. Le premier est un effet Balassa-Samuelson standard, expliquant le prix relatif des biens non échangés par des différentiels de productivité. Le second déterminant mis en évidence, l’effet “Offre de Variétés”, justifie les déviations à la PPA dans le secteur des biens échangés par la répartition endogène des firmes entre pays. Lorsque l’on calibre le modèle à partir de données de l’OCDE, on montre que l’ampleur relative de l’effet “Offre de Variétés” est en général faible et que les deux effets peuvent soit agir dans le même sens sur le taux de change réel, soit se compenser partiellement. En équilibre général, on explique cette ambiguité par la sensibilité des décisions de localisation des firmes à la structure des préférences. En effet, lorsque la part des biens échangés dans la consommation est suffisante, l’entrée de firmes sur un marché se traduit par une dépréciation réelle grâce à des économies réalisées sur les coûts de transport. Cependant, lorsque le ménage consomme beaucoup de biens non-échangés, cet effet est plus que compensé par l’ajustement du salaire si bien que le taux de change s’apprécie.

Keywords : Equilibrium Real Exchange Rate, Balassa-Samuelson effect, Home Market effect, New Trade Theory
J.E.L. Classification : F1, F2, F4

1 Introduction

The failure of the Purchasing Power Parity (PPP) relation is one of the main empirical "puzzles" in Open Macroeconomics (see Obstfeld and Rogoff [2000]) : despite a strong integration of good markets at the international level, the connection between exchange rates and national price levels is still surprising weak and real exchange rates regularly deviate from one.

A well-accepted explanation of those international price differentials, popularized by Harrod [1933], Balassa [1964] and Samuelson [1964], lies in the existence of cross-country and cross-sector productivity differentials in a perfectly competitive world where labor is immobile and some goods are not traded internationally. In this framework, an increase in a country's relative productivity in the traded good sector leads to a real exchange rate appreciation because of its positive effect on the equilibrium wage passed on the price of non-traded goods. This Balassa-Samuelson effect has been revisited recently by Bergin *et al.* [2004] to explain the reinforcement of the phenomenon that they observe in a data sample covering the last fifty years. In their model, this tendency is explained by the endogeneity of goods' tradability to productivity shocks : a positive shock pushes the most productive firms of the non-traded good sector to start exporting their production so that the Balassa-Samuelson effect is magnified.

Recently however, two papers based on the New Trade Theory framework have questioned the direction of this link. In both models, productivity gains lead to a real exchange rate depreciation because of the entry and exit of firms in response to technological shocks. Moreover, those papers suggest that empirical evidence consistent with the Balassa-Samuelson effect may be biased by the fact that real exchange rate measures do not take into account changes in the consumption structures following this "Variety Supply " effect.

The first paper, by Ghironi and Melitz [2004], is a micro-funded model of trade and macroeconomic dynamics, where PPP deviations come from the existence of a fixed cost to export that endogenously determines the equilibrium share of traded goods. In this model, a positive aggregate productivity shock in the domestic market decreases the relative effective labor cost, as well as forces the less productive foreign exporters to leave the domestic market : as a consequence, both the price of non-traded goods and the import price decrease and the real exchange rate depreciates[1]. On the other hand, Corsetti *et al.*'s [2005] model emphasizes the role of "intensive" vs. "exten-

[1]Depending on the steady state equilibrium, this effect can be reinforced or mitigated by the impact of productivity shocks on the relative number of foreign exporters with regards to domestic producers in each market.

sive" margins in a New Economic Geography (NEG) framework. In their model, PPP deviations also come from the existence of trade costs but those trade barriers affect the marginal cost to produce, rather than the fixed cost, so that all goods are traded in equilibrium. The real exchange rate depreciation that follows a positive productivity shock is then no more attributable to the endogenous tradability of goods but either to the decline of domestic marginal costs, or to the increased number of produced varieties[2].

Those two papers thus emphasize a "Variety Supply" effect that may partly counteract the Harrod-Balassa-Samuelson effect. From an applied perspective, such a contradiction is embarrassing as one is unable to predict which of those influences will dominate the determination of international price levels. The objective of this paper is thus to introduce both those effects in a single framework to compare their potential power in explaining PPP deviations. To keep the model as simple as possible, the Balassa-Samuelson effect is generated by the combination of an exogeneously-sized non-traded good sector and productivity differentials across sectors and countries. Like in Corsetti *et al.*'s model, national supplies of traded good varieties are endogenously determined by the relative cost to produce in each country and the size of national demands. However, the fixed cost to produce is the same everywhere and productivity gains only influence operational profits.

In partial equilibrium, the model exhibits a Balassa-Samuelson and a Variety Supply effects that alter the equilibrium real exchange rate in opposite direction : an increase in a country's relative labor productivity in the traded good sector tends to appreciate its real exchange rate whereas a raise in its share in the world supply of traded goods depreciates it. Calibrating the model with OECD data for the 1988-2003 period, one shows that the magnitude of the predicted Variety Supply effect is generally too low to counteract the Balassa-Samuelson effect. However, results suggest that neglecting the first effect can lead to over- or underestimate the second one.

Going further in the analysis and taking into account the endogeneity of location decisions permits to explain this ambiguity. First, both effects are then correlated as productivity gains in the traded good market lead to an entry of firms that partly counteracts their Balassa-Samuelson influence. Moreover, changes in the relative size of countries have an ambiguous effect on the relative supply of varieties, which direction depends on the share of traded goods in consumption : if this share is large enough, the entry of firms

[2]In the latter case, Corsetti *et al.* show that measuring the real exchange rate without taking into account the endogeneity of variety supplies, as usually done in the empirical literature, would lead to conclude to a negative link between the shock and the foreign relative price.

in the large market leads to a real depreciation through trade costs savings but this effect reverses for a low share of traded good in consumption because of a positive wage adjustement.

The rest of the paper is organized as follows. Section 2 describes the theoretical framework used to compare the Balassa-Samuelson and the Variety Supply determinants of long-run real exchange rates. Those effects are then studied in partial equilibrium in section 3, which also provides simulation results that use OECD labor productivity and productive structure data to calibrate the potential magnitude of those influences on long-run real exchange rates. Section 4 solves the model in general equilibrium so as to determine the structural determinants of long-run real exchange rates, studied in section 5. Last, section 6 concludes.

2 Theoretical Framework

The general framework used in the following is largely inspired by Baldwin *et al.*'s [2005] "Footlose Capital Model". One considers a static model with two countries (H and F), two productive factors (labor L and physical capital K) and two sectors, respectively producing a differentiated good T and a homogeneous good N.

Each country is endowed with a stock of labor and capital, that determines the relative size of their demand in general equilibrium, when factor owners are immobile internationally. More precisely, world stocks of labor (L_W) and capital (K_W) are shared in proportions θ and $(1-\theta)$ between H and F. In the following, θ is supposed larger than one half and is thought as the "size" of the (large) domestic country.

If the ownership of factors is exogeneously fixed, services of those factors can be rent to firms against an endogeneously determined reward. Labor is assumed to be immobile internationally but perfectly mobile across sectors. Domestic (foreign) firms of both sectors thus compete to share the domestic (foreign) labor stock. As a result, the labor market equilibrium determines a single nominal wage rate by country ($W_c,\ c = H, F$). Despite those uniform national wage rates however, cross-sectorial and cross-country productivity differentials lead to labor cost differentials in the traded and non-traded good sectors.

In contrast to the labor market, capital is perfectly mobile internationally so that the (endogeneous) share of capital employed in each country does not necessarily match the (exogeneous) share of capital owners living in each location. More precisely, capital owners from both countries sell their endowments on an integrated world market against the equilibrium unit price

R. This factor is then rent by firms located either in H or in F. Moreover, capital serves only to pay for the fixed costs of differentiated good producers, whose capital needs determine the world demand.

2.1 Preferences

In each country, the representative consumer draws her utility from the consumption, allocated in fix proportions between sectors :

$$C_c = T_c^{\mu} N_c^{1-\mu}, \ c = H, F \tag{1}$$

with μ the share of differentiated goods in the total consumption expenditure[3], N_c the consumption of non traded good and T_c the consumption basket of all existing varieties of the traded good. Assuming a constant elasticity of substitution between varieties ($\sigma > 1$), one can write T_c as :

$$T_c = \left(\int_0^{n_W} x_c(s)^{\frac{\sigma-1}{\sigma}} ds \right)^{\frac{\sigma}{\sigma-1}}$$

with $x_c(s)$ c's consumption of the variety s, and n_W the total number of varieties produced in equilibrium.

In each country, the supply of labor (L_c^s) and capital (K_c^s) is exogenous. The consumer maximizes her utility (1) under her budget constraint :

$$\int_0^{n_W} p_c(s) x_c(s) ds + P_c^N N_c \ \leq \ W_c L_c^s + R\ K_c^s + \Pi_c \equiv E_c$$

with :

- $p_c(s)$ the price of variety s in country c,
- P_c^N the price of the non traded good in country c,
- $W_c L_c^s$ and $R\ K_c^s$ the labor and capital incomes paid to the representative consumer in c,
- Π_c the residual profit, equal to zero in the free-entry equilibrium,
- E_c the consumer's total income.

Solving this problem leads to the optimal demands for each type of goods,

[3] In the following, I suppose that the share of traded good in the consumption is the same everywhere. However, when solving the model numerically, it will be interesting to authorize preferences to differ in H and F ($\mu_H \neq \mu_F$). See Sections 3 and 4.

as a function of incomes and prices :

$$N_c = (1-\mu)\frac{E_c}{P_c^N} \tag{2}$$

$$T_c = \mu\frac{E_c}{P_c^T} \tag{3}$$

$$x_c(s) = \left(\frac{p_c(s)}{P_c^T}\right)^{-\sigma} T_c \tag{4}$$

$$c = H,\ F$$

where P_c^T is the expenditure-minimizing price index for traded goods in country c :

$$P_c^T = \left[\int_0^{n_W} p_c(s)^{1-\sigma} ds\right]^{\frac{1}{1-\sigma}}$$

2.2 Technology

The sector N features constant returns and perfect competition and produces a homogeneous good that is not traded in equilibrium (because of its prohibitive trade cost). Labor is the only input in the linear production function. The equilibrium price is then equal to the marginal cost :

$$P_c^N = \frac{W_c}{A_c^N},\ c = H, F \tag{5}$$

with A_c^N the labor productivity in the sector N of country c.

As in the Footlose Capital model, the technology in the traded good sector exhibits increasing returns. The total cost to produce the variety s is separated into a fixed cost of f capital units and a linear cost in labor[4]. Finally, the trade cost is written in a "iceberg" form : to sell one unit abroad, the individual firm has to produce $\tau(> 1)$ units because of a real loss occurring during the transport.

In such a framework, a firm located in c that produces a variety s generates the following profit :

$$\Pi_c(s) = p_{cc}(s)x_c(s) + p_{cc'}(s)x_{c'}(s) - \frac{W_c}{A_c^T}(x_c(s) + \tau x_{c'}(s)) - R\ f, \quad c \neq c'$$

[4]The fixed cost is supposed to be large enough to ensure that, in equilibrium, each firm produces its own variety in a given location. This implies that the number of existing firms in equilibrium is equal to the number of produced varieties (n_W). Indeed, with CES preferences, the market share when producing a new variety is always higher than the market share that would be obtained by duplicating an existing one (cf Dixit and Stiglitz [1977]).

where A_c^T is the labor productivity in the sector T of country c, $p_{cc}(s)$ and $p_{cc'}(s)$ are the chosen prices, for respective sales in the domestic and the foreign markets.

Maximizing with the demand functions (4) leads to the optimal prices set by an individual firm from c :

$$p_{cc}(s) = \frac{\sigma}{\sigma-1}\frac{W_c}{A_c^T} \tag{6}$$

$$p_{cc'}(s) = \frac{\sigma}{\sigma-1}\frac{W_c}{A_c^T}\,\tau \tag{7}$$

$$c = H,\ F \quad c \neq c'$$

Firms optimally discriminate their domestic and foreign markets by passing the transport cost on to the foreign consumer. This price gap generates a "Home Market Effect", that pushes firms under increasing returns to locate in the largest market to benefit from maximum scale economies where they are more competitive.

As firms in a given location are homogeneous[5], one can suppress the index s in the following. Calling λ $(1-\lambda)$ the (endogenous) share of firms located in $H(F)$, one can rewrite price indices in the traded good sector as :

$$P_H^{T\,1-\sigma} = \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} n_W \left[\lambda\left(\frac{W_H}{A_H^T}\right)^{1-\sigma} + (1-\lambda)\phi\left(\frac{W_F}{A_F^T}\right)^{1-\sigma}\right] \tag{8}$$

$$P_F^{T\,1-\sigma} = \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} n_W \left[\lambda\phi\left(\frac{W_H}{A_H^T}\right)^{1-\sigma} + (1-\lambda)\left(\frac{W_F}{A_F^T}\right)^{1-\sigma}\right] \tag{9}$$

Those price indices are not symmetric because of the presence of trade costs. As in Ghironi and Mélitz [2003] or Corsetti *et al.* [2005], the price level of traded goods is not the same everywhere, as long as the spatial repartition of firms is not symmetric. The model thus exhibits two determinants of PPP deviations, the Balassa-Samuelson effect through the relative price of non-traded goods and the Variety Supply effect through the traded good prices.

In the next section, the interaction between those effects is studied in partial equilibrium. Indeed, as the reduced form of the model is not linear, it is convenient to understand the mechanisms under play before endogeneizing location decisions in section 4.

[5]Indeed, productivity gaps are supposed here to be country- rather than firm-specific, contrary to Ghironi and Mélitz [2003].

3 Real Exchange Rates in Partial Equilibrium

3.1 Balassa-Samuelson versus Variety Supply effects

In this framework, the long-run real exchange rate, in units of H's consumption by unit of F's, can be written as :

$$RER \equiv \frac{P_H}{P_F} = \left(\frac{P_H^T}{P_F^T}\right)^{\mu} \left(\frac{P_H^N}{P_F^N}\right)^{1-\mu}$$

Calling $\rho = \frac{W_H/A_H^T}{W_F/A_F^T}$ H's relative cost to produce the traded good and $BS = \frac{A_H^T/A_H^N}{A_F^T/A_F^N}$ the double productivity ratio, and using the optimal prices (5), (6) and (7), one verifies that, in partial equilibrium :

$$RER = \left(\frac{\lambda\rho^{1-\sigma} + (1-\lambda)\phi}{\lambda\phi\rho^{1-\sigma} + (1-\lambda)}\right)^{\frac{\mu}{1-\sigma}} (\rho \; BS)^{1-\mu} \tag{10}$$

As expected, the Balassa-Samuelson effect measured by BS and the Variety Supply effect reflected in λ alter the real exchange rate in opposite directions[6]. Indeed, a higher concentration of firms in H, by increasing the national supply of domestically produced varieties, leads to a purchasing power gain for local consumers, that save on trade costs. On the other hand, the real exchange rate is higher, the higher is H's relative productivity in the traded good sector, through the Balassa-Samuelson effect. Last, as wages do not necessarily fully adjust to productivity gains in the traded good sector, because of the imperfect substituability between traded goods, RER is also sensitive to the relative producing cost in the traded good sector (ρ), through the relative price of both traded and non-traded goods[7].

In this framework then, PPP deviations reflect the interaction of two distinct effects, influencing the relative price of traded and non-traded goods. To disentangle those effects, one needs information concerning the path of relative productivity gains and changes in the spatial distribution of the production. In the following, those influences are compared using data for OECD countries, to obtain intuitions about their relative magnitudes.

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[6]
$$\frac{\partial RER}{\partial BS} > 0 \quad whereas \quad \frac{\partial RER}{\partial \lambda} < 0$$

[7] The influence of the relative cost to produce (i.e. of the relative wage and the relative productivity) on the relative price of traded goods is consistent with Zachariadis [2005] that uses a micro-level dataset of absolute prices and finds evidence that productivity affects deviations from the Law of One Price in traded good markets.

Before confronting the theoretical relation with real data, it is however convenient to relax the simplifying hypothesis of identical preferences in both countries. Indeed, the share of traded goods in consumption (μ) strongly varies across countries as shown in Figure 1. Taking into account this heterogeneity of preferences ($\mu_H \neq \mu_F$), the equilibrium real exchange rate (10) can be rewritten as :

$$RER = \left(\frac{A_F^T}{A_F^N}\right)^{\mu_F-\mu_H} \left(\frac{\sigma}{\sigma-1}\right)^{\mu_H-\mu_F} n_W^{\frac{\mu_F-\mu_H}{\sigma-1}}$$

$$\times \frac{\left[\lambda\rho^{1-\sigma}+(1-\lambda)\phi\right]^{\frac{\mu_H}{1-\sigma}}}{\left[\lambda\phi\rho^{1-\sigma}+(1-\lambda)\right]^{\frac{\mu_F}{1-\sigma}}} (\rho BS)^{1-\mu_H} \tag{11}$$

This expression is rather close to (10), except for the presence of the first three terms : when the share of traded goods in consumption is not the same across countries, the relative productivity in the traded good sector, the mark-up and the total number of produced varieties also influence the relative price level.

3.2 Magnitude of both effects in OECD countries

In this section, data for 24 OECD countries from 1988 to 2003[8] are used to evaluate the relative influences of the Balassa-Samuelson (BS) and the Variety Supply (VS) effects on the long-run real exchange rates. From an applied perspective however, it is not convenient to work on real exchange rates in levels. Indeed, this variable is typically measured by a ratio of price indices which level depends on the base year. The relation we will confront to the data is thus the growth equivalent of (11)[9].

Several technical difficulties make tricky the conduct of a true econometric analysis based on this relation. First, as the relation is non-linear, one cannot

[8] All details concerning data sources and the construction of variables are provided in the data appendix at the end of the paper.

[9]

$$\frac{dRER}{RER} = (\mu_F - \mu_H)\frac{d(A_F^T/A_H^T)}{A_F^T/A_H^T} + \mathbf{A}\frac{d\lambda}{\lambda} + \mathbf{B}\frac{d\rho}{\rho} + (1-\mu_H)\frac{dBS}{BS}$$

where

$$\mathbf{A} = \frac{\lambda}{\sigma-1}\left(\frac{\mu_F(\phi\rho^{1-\sigma}-1)}{\lambda\phi\rho^{1-\sigma}+(1-\lambda)} - \frac{\mu_H(\rho^{1-\sigma}-\phi)}{\lambda\rho^{1-\sigma}+(1-\lambda)\phi}\right)$$

$$\mathbf{B} = \frac{\mu_H\rho^{1-\sigma}\lambda}{\lambda\rho^{1-\sigma}+(1-\lambda)\phi} - \frac{\mu_F\lambda\phi\rho^{1-\sigma}}{\lambda\phi\rho^{1-\sigma}+(1-\lambda)} + (1-\mu_H)$$

easily disentangle the influence of the location of firms (λ) and of the relative cost to produce the traded good (ρ). Moreover, as the model bears on a long-run equilibrium, one needs to clean real exchange rate series from their short-run variations. Usually, a cointegration analysis is conducted, that explains the equilibrium real exchange rate by various determinants, such as relative real interest rates or relative net foreign assets. Estimating the real exchange rate would thus require to enhance the model with those variables, with a cost in terms of clarity. Last, measuring real exchange rates in an accurate way is not a simple task, as emphasized by Ghironi and Melitz [2004] or Corsetti *et al.*[2005]. Indeed, the standard way-of-doing is to measure relative price levels using consumption price indices. However, those proxies do not take well into account the endogeneity of consumption baskets, in particular with respect to changes in the supply of varieties (see Broda and Weinstein [2004]). Testing the significativity of the "Variety Supply" effect using as dependent variable this mismeasured relative price is thus likely to bear unsignificant results.

As a consequence, I will not try in the following to conduct an empirical analysis of the determinants of real exchange rates, this task being left for future research. Instead, I will use simulation techniques to isolate the potential influence that each of the Balassa-Samuelson and the Variety Supply effects may have had on the considered countries' long-run real exchange rates, during the period under consideration. To this aim, I consider successively each country relatively to the 23 others[10] and compute the theoretical response of its effective real exchange rate to the observed mean annual growth of its relative productivity in the traded versus non-traded good sector ($\bar{g}_{BS}$) and of changes in the share of traded goods produced in its own territory ($\bar{g}_{\lambda}$). This is done using the theoretical relation (11) from which I calculate the theoretical real exchange rate when BS (alternatively λ) vary at the observed pace of growth (See the corresponding summary statistics in Table 1). In order to isolate the BS and the VS influences, A_F^T/A_H^T and ρ are maintained fixed at their initial value, the elasticity of substitution (σ) is supposed to be equal to five and the iceberg cost is set at 1.25[11].

Results of those simulations are summarized in Table 2. For each country of the sample, the column named "Balassa-Samuelson effect" gives the predicted annual growth rate of its effective real exchange rate attributed by the model to the observed evolution of its relative productivity in the

[10] Economic variables concerning the foreign country (F in the model) are thus the aggregates of variables relative to the 23 partners of each "domestic" country (H). This aggregation is based on geometric averages, with a weighting scheme relying on the structure of trade of the domestic country. See details in the Data Appendix.

[11] Those values are taken from Venables [1996].

traded versus non-traded good sector ($\bar{g}_{BS}$). Similarly, the "Variety Supply effect" column gives the theoretical annual growth rates of real exchange rates attributable to the observed changes in the repartition of the traded good production ($\bar{g}_{\lambda}$). The third column, that just sums the previous two, thus corresponds to the theoretical real exchange rate appreciation (or depreciation if negative) predicted by the model[12].

As expected, the model reproduces a strong positive Balassa-Samuelson effect in emerging countries like Poland, Korea or Hungary, attributable to strong productivity gains in their traded good sector. The BS effect is also strongly positive in the United States but this is because of the high share of non-traded goods in this country's consumption that magnifies small productivity gains. The strongest effect is obtained for Poland and implies a real exchange rate appreciation of more than 4% per year. As for the Variety Supply effect, its simulated magnitude is on average lower than that of the BS effect. The strongest effect is obtained for Hungary, which productive expansion in the traded good sector allows to explain an annual depreciation of its long-run real exchange rate of around 0.5% per year. In the case of this country, the VS effect counteracts the BS effect so that the total predicted appreciation of the Hungarian real exchange rate is half that predicted by the BS effect alone.

In eleven countries, the model predicts that both effects influence the real exchange rate in the same direction, either because those countries benefit from productivity gains in the traded good sector but nevertheless reduce their relative production in this sector (as in France for instance) or because their relative productivity vanishes but they expand their production of traded goods (as in the United Kingdom or Mexico). In that case, neglecting the Variety Supply effect would lead to overestimate the Balassa-Samuelson effect, at least if both effects are correlated. In the other thirteen countries on the contrary, both effects influence the real exchange rate in opposite direction : countries that benefit from productivity gains also expand their production of traded goods (and inversely). Under this configuration, the Balassa-Samuelson could thus be underestimated in a test that does not take into account the endogeneity of productive structures.

This partial equilibrium analysis thus allows to contrast the determinants of equilibrium real exchange rates that we have introduced in the model. However, it is obviously insufficient as location decisions, that determines λ,

[12]Of course, this theoretical effect is far from the observed mouvements summarized in the second column of Table 1. Indeed, the model solely focuses on the effect of trade on long-run real exchange rates, thus neglecting numerous other determinants, working through monetary or financial markets for instance.

have not been taken into account. Yet, as shown in the following section, endogeneizing λ is crucial as those productivity differentials in the traded good sector that generate the Balassa-Samuelson effect also influence firms entry decisions.

4 Solution in General Equilibrium

4.1 Free Entry and Firms Location

In the long run, firms are free to enter a national market. This drives profits towards zero in equilibrium. For an individual firm, that sells its production at the optimal prices (6) and (7), the zero profit condition implies (respectively for firms located in H and in F) :

$$Rf = \frac{1}{\sigma - 1}\frac{W_H}{A_H^T}y_H \tag{12}$$

$$Rf = \frac{1}{\sigma - 1}\frac{W_F}{A_F^T}y_F \tag{13}$$

with y_c the equilibrium production, including trade costs, of an individual firm located in c :

$$y_c = t_c + \tau t_{c'}, \quad c = H, F, \quad c \neq c'$$

At this point, three situations must be distinguished with regards to the equilibrium spatial repartition of firms :

– two corner equilibria with a total concentration of the production in a single country, one with all the traded good produced in H ($\lambda = 1$ and (12) applies), one of full concentration in F ($\lambda = 0$ and (13) applies),
– an interior equilibrium where some traded good is produced in each country ($\lambda \in]0, 1[$, jointly determined by (12) and (13)).

In the interior equilibrium, long-run operational profits are equalized across countries, at a level that just covers the fixed cost Rf. Using the expressions for profits (12) and (13) and demands (4), one obtains the repartition of firms λ as a function of the relative cost to produce ρ, the size of trade barriers ϕ and the repartition of expenditures across countries ($s_E = \frac{E_H}{E_H+E_F}$) :

$$\lambda = \frac{s_E}{1 - \phi\rho^{1-\sigma}} - \frac{1 - s_E}{\phi^{-1}\rho^{1-\sigma} - 1} \tag{14}$$

From this, one verifies that, in an interior equilibrium, the concentration of firms in the country H is higher, the higher is H's relative demand and the lower its relative cost to produce[13]. In this model then, two types of comparative advantages emerge :

- an advantage in terms of demand, linked to the Home Market Effect, that makes the "large" country specialize in the production of differentiated goods,
- a comparative advantage *à la* Heckscher-Ohlin, that pushes the country with a high labor cost (in effective terms) to specialize in capital exports and import the differentiated good.

The "Zero Profit Condition" (14) is only valid in the interior equilibrium, i.e. when $\lambda \in]0;1[$. As detailed in the Technical Appendix, one can verify that this implies the following restriction :

$$\frac{1}{\phi s_E + \phi^{-1}(1-s_E)} < \rho^{\sigma-1} < \phi^{-1}s_E + \phi(1-s_E)$$

The interior equilibrium is thus only tenable for a small enough wage gap. Outside this interval, firms are all located in the low-cost country, the production on the other one being unprofitable. In that case, one country is entirely specialized in capital exports and solely produces non-traded goods, whereas the other one produces its consumption of non-traded goods and the world production of traded goods.

Having characterized productive patterns, the next step consists in endogeneizing the relative cost to produce (ρ) and H's relative demand (s_E), that both depend on λ.

4.2 Market equilibrium, national incomes and the relative wage

In the long-run equilibrium, all the markets clear. From the world capital market equilibrium, one obtains the total number of firms (and produced varieties) in the traded good sector :

$$n_W = \frac{K_W}{f}$$

Moreover, under the zero-profit conditions (12) and (13), the equilibrium price of capital is :

$$R = \frac{\mu}{\sigma}\frac{E_H + E_F}{K_W}$$

[13]Indeed :

$$\frac{\partial \lambda}{\partial s_E} > 0 \quad and \quad \frac{\partial \lambda}{\partial \rho} < 0$$

The equalization of labor supply with labor demand, on each national market, can be written as :

$$W_H \theta L_W = \lambda n_W (\sigma - 1) R f + (1 - \mu) E_H \quad (15)$$
$$W_F (1 - \theta) L_W = (1 - \lambda) n_W (\sigma - 1) R f + (1 - \mu) E_F \quad (16)$$

Those equilibrium conditions yield the equilibrium distribution of world expenditure, that depends on the location of firms :

$$s_E \equiv \frac{E_H}{E_H + E_F} = \frac{\lambda(\sigma - 1) + \theta}{\sigma} \quad (17)$$

The more firms are concentrated in H, the more local workers benefit from the monopolistic rent of the traded good sector and the higher is H's share in the world demand[14].

Last, (15) and (16) lead to the equilibrium relative labor cost in the traded good sector :

$$\rho = \frac{1 - \theta}{\theta} \frac{A_F^T}{A_H^T} \frac{\lambda(\sigma - 1) + \theta(1 - \mu)}{(1 - \lambda)(\sigma - 1) + (1 - \theta)(1 - \mu)} \quad (18)$$

This relation defines ρ as an increasing function of λ. Indeed, the concentration of firms in H exerts pressures on its relative wage. In comparison with the Footloose Capital Model, this wage adjustment plays as a centripetal force that counterbalances the Home Market Effect, thus explaining why, for reasonable parameter values, the final outcome is always an interior equilibrium[15].

Together (14), (17) and (18) form a system of 3 equations in 3 unknowns $\{\lambda,\ \rho,\ s_E\}$, that characterizes the long-run interior equilibrium, from which one obtains the real exchange rate (10). Because of the non-linearity of those equations, one has to rely on numerical simulations to solve it. However, one straightforward analytical result is that any variable entering (14), (17) or (18) is likely to affect the equilibrium real exchange rate.

[14]This effect only plays through workers's income. Indeed, as the capital market is perfectly integrated, the monopolistic rent paid to capital owners is strictly proportional to their relative endowments.

[15]This is in sharp contrast with the Footloose Capital Model in which the interior equilibrium only exists for similar enough countries (in terms of their size). Indeed, in the FC model, the concentration of differentiated firms in a given country does not push up the national wage since their production substitutes itself to the production of homogeneous good to keep the current account balanced. In our model, on the contrary, the centrifugal impact created by a high national demand is counteracted by a wage adjustment, that limits the Home Market Effect.

In the following section, I will more particularly focus on the sensitivity of RER with respect to the countries relative size (θ) and their relative labor productivities, two structural parameters at the root of the Variety Supply and the Balassa-Samuelson effects.

5 Structural determinants of the real exchange rate

To see the role of the relative size of countries and of the relative productivity in the traded good sector in this non-linear model, one calculates the equilibrium real exchange rate using (10) for different values of θ between 0.5 (symmetric countries) and 1 (strong size asymmetry) and when $RelA^T = A_H^T/A_F^T$ varies between 0.2 and 5. Each of these computations is conducted for different values of i) the transport cost τ (set between 1.05 and 1.45 so as to cover Hummels [2001] estimates), ii) the elasticity of substitution (fixed between 3 and 7 as in Venables [1996]), iii) the share of traded goods in consumption[16].

5.1 Productivity gap and the real exchange rate

In this subsection, one studies the sensitivity of the equilibrium real exchange rate to H's relative productivity in the traded good sector. This link is then illustrated in Figures 2 and 3, for different sets of parameters. Moreover, table 3 gives the simulated magnitude of this effect, measured by the elasticity of the real exchange rate to a one percent change in H's relative productivity, for several sets of parameters[17].

As already explained, the real exchange rate appreciates when H's relative productivity in the traded good sector increases because of a wage adjustment. As in a standard Balassa-Samuelson model, the strength of this effect is positively linked to the share of non-traded goods in consumption (Figure 2). Moreover, as H's relative productivity in the traded good sector enters location decisions, the intensity of this effect slightly varies with location determinants. Thus, the real exchange rate is a bit higher when H's relative size increases (see Figure 3) or when trade costs decrease (see Table 3). This sensitivity confirms the importance of taking into account the Variety Supply effect when testing the Balassa-Samuelson hypothesis, the

[16]To replicate the multiplicity of situations observed in OECD countries, illustrated in Figure 1, this parameter is authorized to vary between 0.1 and 0.9.

[17]When the relation is not linear, the table gives the interval in which the elasticity varies for $RelA^T$ between 0.2 and 5.

correlation between both effects being a potential source of omission bias. Those effects are however quantitatively small and the model globally reproduces the standard Balassa-Samuelson mechanism : a 1% improvement of H's relative productivity in the traded good sector leads to an appreciation of its real exchange rate of around $(1-\mu)$%.

5.2 Relative Size and the real exchange rate

We now turn to the influence of the relative size of countries by making θ vary between 0.5 and 1, thus increasing the firms incentive to enter H through the Home Market Effect.

As illustrated in Figure 4, the direction of the induced exchange-rate effect depends on the share of traded goods in price levels. When the share of traded goods is large enough ($\mu > 0.5$), the size effect is negative : the more firms are concentrated in H to benefit from a large local demand, the lower is H's relative price level because of the trade cost saving implied by the substitution of local products to imported ones. On the other hand, when the consumption of non-traded good is important, this HME is more than compensated by the pressure that the strong labor demand exerts on H's relative wage. As a consequence, when $\mu < 0.5$, H's relative price level increases with H's share in world factor endowments[18].

As the influence of θ on the real exchange rate comes from the endogenous repartition of firms (λ), any factor affecting location decisions is liable to modify the intensity of this link. Thus, the magnitude of this effect depends on the size of trade frictions : high trade costs make more crucial the market access, from the firm's viewpoint, so as the size effect is reinforced by a raise in trade costs (see Figure 5). In the same way, the intensity of this effect is also affected by the substituability between varieties, as illustrated in Figure 6 : it is increasing with the elasticity of substitution between goods. Indeed, when the demand is little sensitive to price changes, the agglomeration effect that pushes firms to locate near the largest demand is strong, as shown by Baldwin *et al.* [2005].

The quantitative importance of this size effect is measured in Table 4 through the elasticity of RER to θ, for different sets of parameters. As shown by the convexity of curves in Figures 4-6, this sensitivity increases when countries become more asymmetric. Moreover, the real exchange rate is more sensitive to the relative size of countries as i) preferences between traded and non traded goods are more biased, ii) trade costs are high, iii) H's relative

[18] Such a wage adjustment effect could explain why some countries of the simulations in section 3.2 benefit from productivity gains in the traded good sector but nevertheless reduce their relative production of traded goods.

productivity in the traded good sector is low, iv) the elasticity of substitution between varieties of the traded good is high. Depending on the entire set of parameters, the simulated elasticity of the real exchange rate to the relative size of countries varies between -0.85 and 1.04.

Confronting results of those simulations thus put in evidence a rich variety of situations. By modifying a small number of parameters in a realistic interval, one is indeed able to contrast situations where i) the Balassa-Samuelson and the Variety Supply effects reinforce together or play in opposite direction, ii) the Balassa-Samuelson effect dominates or is dominated by the Variety Supply effect. In particular, when the share of traded goods in consumption is low ($\mu < 0.5$), one can expect the Balassa-Samuelson effect to be strong, and reinforced by a size effect if the country that is relatively more productive also owns a large part of world factor endowments. On the contrary, in large but highly open countries, that consume many imported goods, the Balassa-Samuelson effect should be somewhat compensated by the Home Market Effect.

6 Conclusion

By combining aspects of the traditional real exchange rate modelization with NEG assumptions, the model developed in this paper contrasts two determinants of PPP deviations working through the price of non-traded goods as well as through deviations from the Law of One Price in the traded good sector. First, as in a standard Harrod-Balassa-Samuelson model, cross-sectorial productivity differentials are introduced, that generate price differentials in the non-traded good sector : the more a country is productive in the traded relative to the non-traded good sector, the higher is its real exchange rate. As traded good prices are not perfectly substitutable in this model, wages however do not fully adjust to productivity gaps in the traded good sector, so that the relative price of traded goods also depends on the relative productivity in the traded good sector. Moreover, the introduction of NEG hypotheses (namely increasing returns and trade costs) permits to generate a second "Variety Supply" effect explaining discrepancies in national traded good prices. In such a framework, location decisions indeed affect the relative prices of traded goods : an increase in the share of domestically produced differentiated goods decreases relative prices because of savings on trade costs. Calibrating those effects with OECD data, one shows that the magnitude of the Balassa-Samuelson effect has dominated that of the Variety Supply effect during the last 20 years. Moreover, results suggest that standard tests of the Balassa-Samuelson hypothesis may be biased by the omission of a control for the endogeneity of productive structures, in a sense that depends on general equilibrium effects.

Solving the model in general equilibrium allows to study the structural determinants of those effects. As expected, a country's real exchange rate increases with its relative productivity in the traded good sector[19]. On the other hand, a country's relative price level also depends on its relative size, an important determinant of location decisions in a model with a Home Market Effect. The direction of this effect is however ambiguous as it depends on the structure of preferences. When the share of traded goods in consumption is large enough, the relation is negative because a size increase leads to a magnified entry of firms, that reduces the share of traded good prices incurring a trade cost. However, when a large part of consumption goods are not traded in equilibrium, the pressure exerted on wages by the entry of firms leads to a dominant cost effect affecting traded and non-traded goods that more than compensates the positive effect linked to the trade cost saving.

Those results are interesting for several reasons. First, they show that using a model of trade under imperfect competition can be highly instructive for macroeconomists. Indeed, whereas the impact of location decisions on trade flows has been extensively studied by the New Trade literature, their influence on global variables such as price levels has not been much studied. Yet, this simple model emphasizes some structural determinants of long-run real exchange rates that neo-classical frameworks neglect. As the New Trade Theory has received strong empirical support, such an approach could be useful to understand some Open Macroeconomic empirical "puzzles" as the PPP puzzle. From an applied perspective, results suggest that neglecting the Variety Supply effect when estimating long-run real exchange rates can lead to biased estimates, notably of the Balassa-Samuelson effect. On this point however, the empirical difficulty discussed by Ghironi and Melitz [2004] or Corsetti *and al.* [2005] persists. Indeed, constructing real exchange rate series from price indices without taking into account the endogeneity of national variety supplies amounts to neglect the impact of location decisions, thus introducing a measurement bias that could be embarassing when trying to identify a Variety Supply effect.

[19] In this model however, the elasticity of the exchange rate with respect to the relative productivity in the traded good sector is not exactly equal to the share of non-traded goods in consumption, as in the BS framework, because the relative productivity affects location decisions.

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FIG. 1 – Share of traded goods in consumption and in value added
Sources : Author's calculations

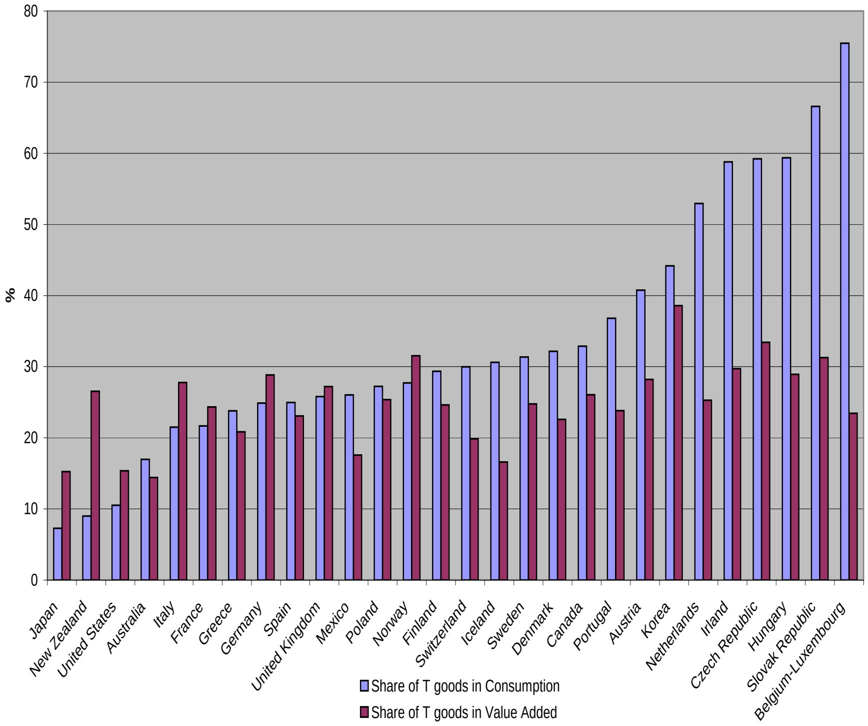


Fig. 2 – RER influence of productivity gaps in the traded good sector and the share of traded goods

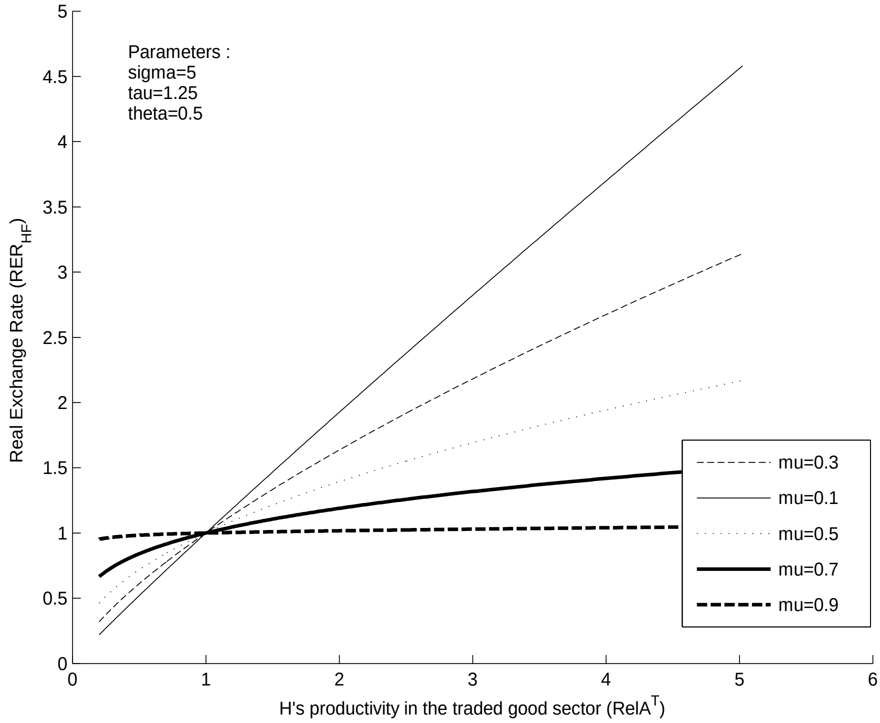


Fig. 3 – RER influence of productivity gaps in the traded good sector and the Relative Size of Countries

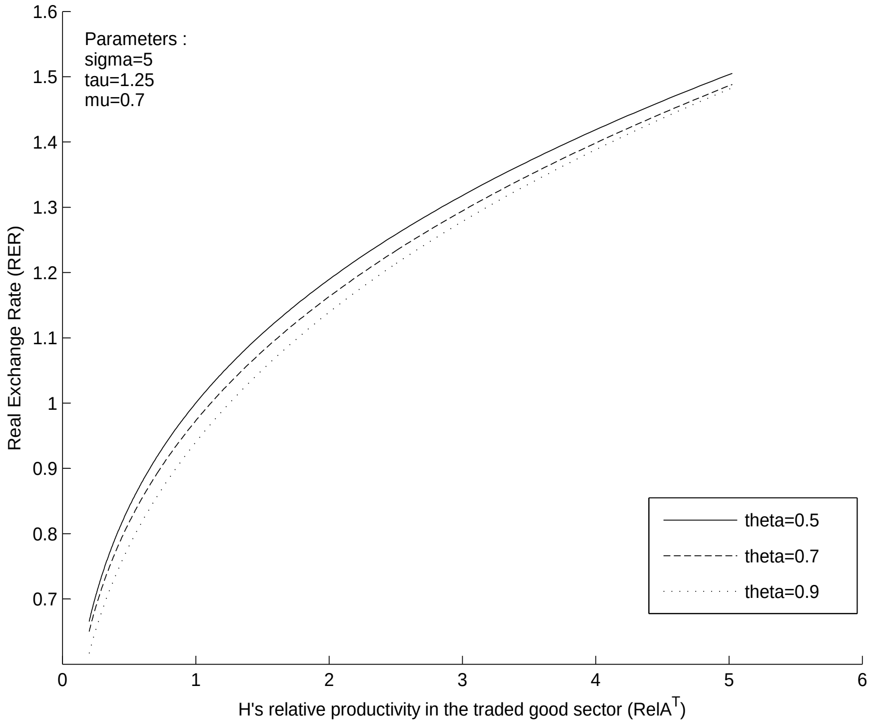


Fig. 4 – Home Market Effect and the share of traded goods

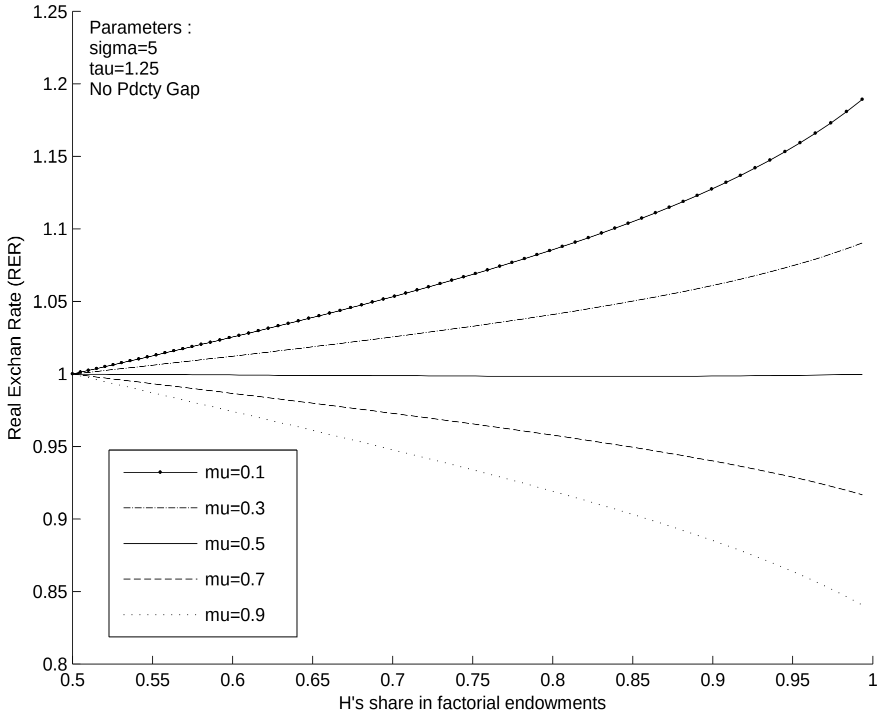


Fig. 5 – Home Market Effect and the size of trade costs

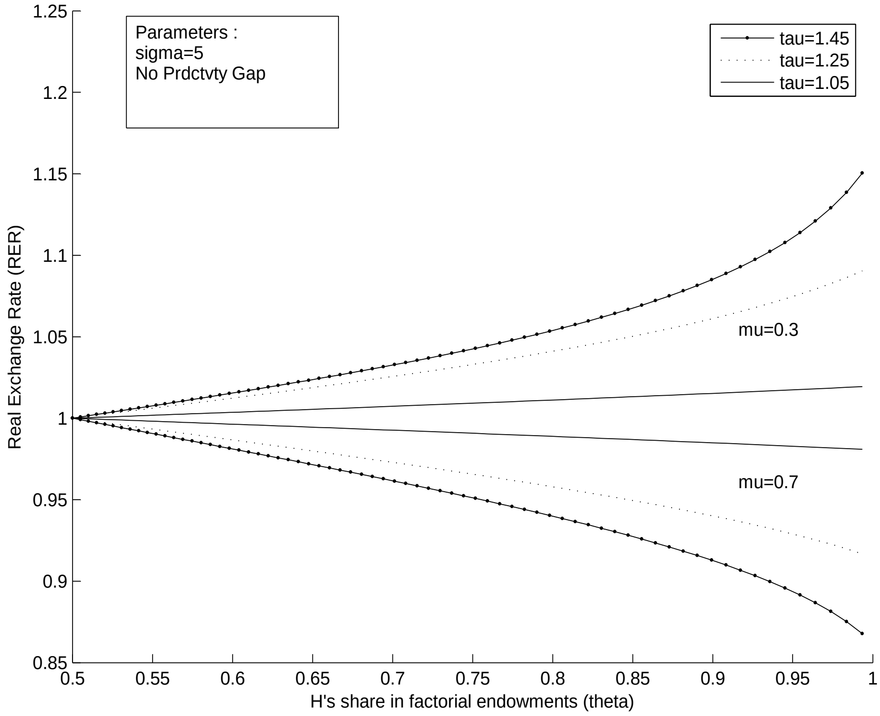
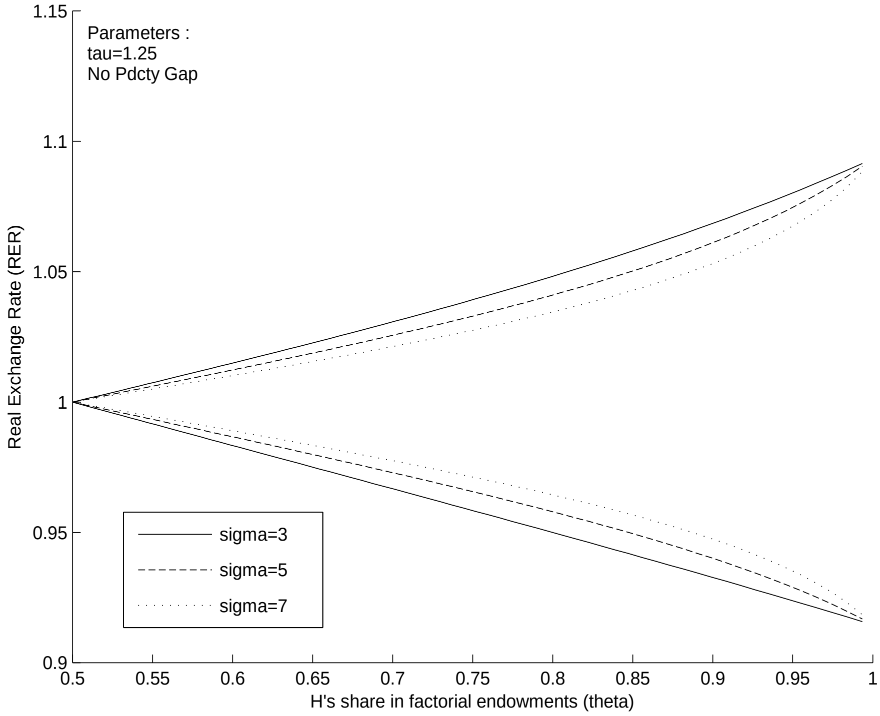


FIG. 6 – Home Market Effect and the elasticity of demand



Technical Appendix : Productive patterns in partial equilibrium

The geographical distribution of firms in the interior equilibrium is determined by equalizing operational profits, at the previously determined optimal prices and individual demands :

$$\begin{aligned} \frac{1}{\sigma-1}\frac{W_H}{A_H^T}(x_H+\tau x_F) &= \frac{1}{\sigma-1}\frac{W_F}{A_F^T}(x_F+\tau x_H) \\ \Rightarrow \frac{s_E}{\Delta_H}(\rho^{1-\sigma}-\phi) &= \frac{1-s_E}{\Delta_F}(1-\phi\rho^{1-\sigma}) \end{aligned}$$

with :

$$\begin{aligned} \rho &= \frac{W_H/A_H^T}{W_F/A_F^T} \\ \Delta_H &= \lambda\rho^{1-\sigma}+(1-\lambda)\phi \\ \Delta_F &= \lambda\phi\rho^{1-\sigma}+(1-\lambda) \end{aligned}$$

The interval of existence of this interior equilibrium is obtained using a transformation of this condition :

$$\lambda = \frac{s_E}{1-\phi\rho^{1-\sigma}} - \frac{1-s_E}{\phi^{-1}\rho^{1-\sigma}-1}$$

The interior equilibrium is defined as a productive pattern such that some traded good is produced in each country : $\lambda \in]0;1[$. The interval on which this interior equilibrium is defined comes immediately :

$$0<\lambda<1 \;\Rightarrow\; \frac{1}{\phi s_E+\phi^{-1}(1-s_E)} < \rho^{\sigma-1} < \phi^{-1}s_E+\phi(1-s_E)$$

Outside this interval, the traded good is entirely produced in a single country ($\lambda = 0$ or $\lambda = 1$), the external equilibrium being achieved through the compensation of the trade imbalance by the opposite flow paid by firms from the producing country to the foreign capital owners. Which country concentrates the whole production depends on the relative profitability. For $\lambda = 0$ to be a stable equilibrium, the production in H has to be unprofitable. The profit that an individual firm would obtain when entering H, starting from a situation where all firms are concentrated in F, is[20] :

$$\Pi_{H|\lambda=0} = \frac{\mu}{\sigma}\frac{f(E_H+E_F)}{K_W}\left[\frac{\phi^{-1}s_E+\phi(1-s_E)}{\rho^{\sigma-1}}-1\right]$$

which is negative (thus making this entry unprofitable) as long as :

$$\rho^{\sigma-1} > \phi^{-1}s_E+\phi(1-s_E)$$

In the same way, one verifies that $\lambda = 1$ is a stable equilibrium if

$$\Pi_{F|\lambda=1} = \frac{\mu}{\sigma}\frac{f(E_H+E_F)}{K_W}\left[\rho^{\sigma-1}(\phi^{-1}(1-s_E)+\phi s_E)-1\right] < 0$$

that is to say if

$$\rho^{\sigma-1} < \frac{1}{\phi^{-1}(1-s_E)+\phi s_E}$$

The following table summarizes patterns of specialization in the traded good sector, as a function of the cost gap :

$\rho^{\sigma-1}$		$\rho_l^{\sigma-1\ (a)}$	$\rho_h^{\sigma-1\ (a)}$
Productive structure	FS in H[(b)]	IE	FS in F

(a) $\rho_l^{\sigma-1} = (\phi s_E + \phi^{-1}(1-s_E))^{-1}$ and $\rho_h^{\sigma-1} = \phi^{-1}s_E + \phi(1-s_E)$

(b) FS = "Full Specialization", IE = "Interior Equilibrium".

[20]Here, we use the standard result featuring the Dixit-Stiglitz model according to which, in equilibrium, the total amount paid to cover the fixed costs is proportional to the world expenditure with a factor μ/σ :

$$RK^W = \frac{\mu}{\sigma}(E_H+E_F)$$

Data appendix

Sources

The data used to calibrate our parameters have been obtained from various OECD databases, constructed on a uniform sectorial classification in 99 industries, that makes data merging easier. Data generally cover the OECD members over a maximum period from 1988 to 2003. In the paper, we only use data concerning 24 countries : Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Italy, Japan, Korea, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Spain, Sweden, the United Kingdom and the United States.

To determine which sectors are exposed to international competition and which can be considered as "non-traded sectors", one uses a criterium combining data on the import penetration of each sector and the share of exports in the value added : an industry is seen as producing non-traded goods if both its import penetration and the share of value added exported abroad are less than 10%[21]. Sectorial value added series are drawn from the "STAN International Trade"database. As this database does not cover trade in services, the corresponding sectors are considered as non-traded. The subsample of non-traded good sectors thus always includes the following activities : "Construction, Wholesale and Retail Trade", "Restaurants and Hotels", "Transport and Storage", "Communication", "Finance, Insurance, Real Estate and Business Services", "Community Social and Personal Services". In addition, the "Electricity, Gas and Water Supply"sector is generally considered as a non-traded good sector.

Measure of variables

From this classification of sectors into traded and non-traded good industries, one can calculate the share of traded goods in consumption. This is done using data from the "STAN Bilateral Trade" database that gives details

[21]De Gregorio *et al.* [1994] use the same type of criteria to separate traded from non-traded goods. They however restrict this criterium to the share of value added that is exported, without taking into account the import penetration. In our model however, in the case of a corner equilibrium, the traded good may be entirely produced in a given country, in which case, in the partner country, the exported share of value added will be zero whereas its import penetration will be unitary. Alternatively, Crucini *et al.* [2005] measure this by the ratio of exports and imports over output corrected by a measure of local input content.

on each country's sectorial imports, whatever the origin of products[22] :

$$\mu_{it} = \frac{\sum_{s \in T} \sum_j IMP^s_{ijt}}{\sum_s \sum_j IMP^s_{ijt}}$$

with IMP^s_{ijt} the value of i's imports from j in the sector s at time t (in current international dollars) and T the set of traded good sectors. The time dimension is then dropped by computing the simple mean of $\{\mu_{it}\}$ at the country-level ($\bar{\mu}_i$). As shown in Figure 1, this proportion widely varies across countries, much more than the share of traded sectors in the total value added : the richest countries (Japan and United States), or the more isolated ones (New Zealand or Australia) appear to consume a higher share of non-traded goods than developing or smaller countries. The time-variance of this indicator is smaller, except in some countries as Poland or Mexico, that consumed very few tradable goods at the beginning of the period but opened themselves and reached similar shares of traded goods in their consumption as middle-income countries.

Statistics on the labor productivity by type of goods (A^T or A^N) are obtained using the STAN sectorial labor productivity indicators, computed as the value added per worker in each industry. The aggregation in the "traded/non-traded" classification is done by averaging those industry-specific labor productivities, with a weighting scheme based on the share of each sector in the total value added in traded or non-traded sectors :

$$A^b_{it} = \sum_{s \in b} A^s_{it} \frac{VA^s_{it}}{VA^b_{it}}, \quad b = T, N$$

with A^s_{it} the labor productivity in the industry s of country i at time t and VA^s_{it} the value added (at current prices) in the sector s relative to the total value added for all industries. The ratio of A^T_{it} on A^N_{it} is then i's relative productivity in the traded good sector, with respect to the non-traded one ($RelA^T_{it}$). As labor productivity indicators provided by the OECD are indices[23], the level of this variable is not really interesting, unlike its evolution. As expected, the annual growth rate of labor productivity is on average higher in traded than in non-traded good sectors (see Figure 7).

Last, from this, one can compute the Balassa-Samuelson term entering in (10) :

$$BS_{ijt} = \frac{A^T_{it}/A^N_{it}}{A^T_{jt}/A^N_{jt}}$$

[22]This database also includes "imports" from the country itself so that the global imports correspond to the country's total consumption.

[23]The reference year being 1995, as for all indices used in this paper.

Wages are measured by the unit labor cost indice in the whole economy, also provided in the STAN database[24]. Using those labor cost data and the labor productivity series, one can calibrate the relative cost to produce in the traded good sector (ρ_{ijt}) as :

$$\rho_{ijt} = \frac{w_{it}/A_{it}^T}{w_{jt}/A_{jt}^T}$$

λ is measured indirectly through the ratio of the nominal traded good productions in the considered countries :

$$\nu_{ijt} = \frac{n_{it}p_{it}^T y_{it}^T}{n_{jt}p_{jt}^T y_{jt}^T}, \quad \lambda_{ijt} = \frac{\nu_{ijt}}{1+\nu_{ijt}}$$

To measure each country's nominal production of traded goods, one uses the series of GDP at current prices provided by the OECD's "Main Economic Indicators", multiplied by the share of value added in traded good sectors :

$$n_{it}p_{it}^T y_{it}^T = GDP_{it} * VA_{it}^T$$

When simulating the theoretical real exchange rate, changes in $\{BS_{ijt}\}$ and $\{\lambda_{ijt}\}$ are summarized by their initial value and their mean annual growth rate whereas $RelA_i$ and ρ_{ij} are maintained fix at their initial value.

Aggregation into "effective" statistics

When simulating (11) to evaluate the potential impact of the Balassa-Samuelson and the Variety Supply effects on real exchange rates (see Section 3.2), it is convenient to work in effective terms, i.e. to consider each country with respect to all its OECD partners.

As a consequence, when simulating (11) for a given country i, one needs a measure of its partners's relative productivity in the traded good sector relative to the non-traded sector ($RelA_{-it}^T = A_{-it}^T/A_{-it}^N$ where $-i$ is the set of i's partners). One calculates it through a trade-weighted geometric average of its partners relative productivity :

$$RelA_{-it}^T = \prod_{j\in -i} RelA_{jt}^{T\,\omega_j}$$

[24]The unit labor cost relative to the whole economy is prefered to the unit labor cost in the traded good sector in order to match our assumption of a perfect labor mobility between sectors driving wages to equality in each country.

In this expression, ω_j is the share of country j in i's total trade during the base year (1995) :

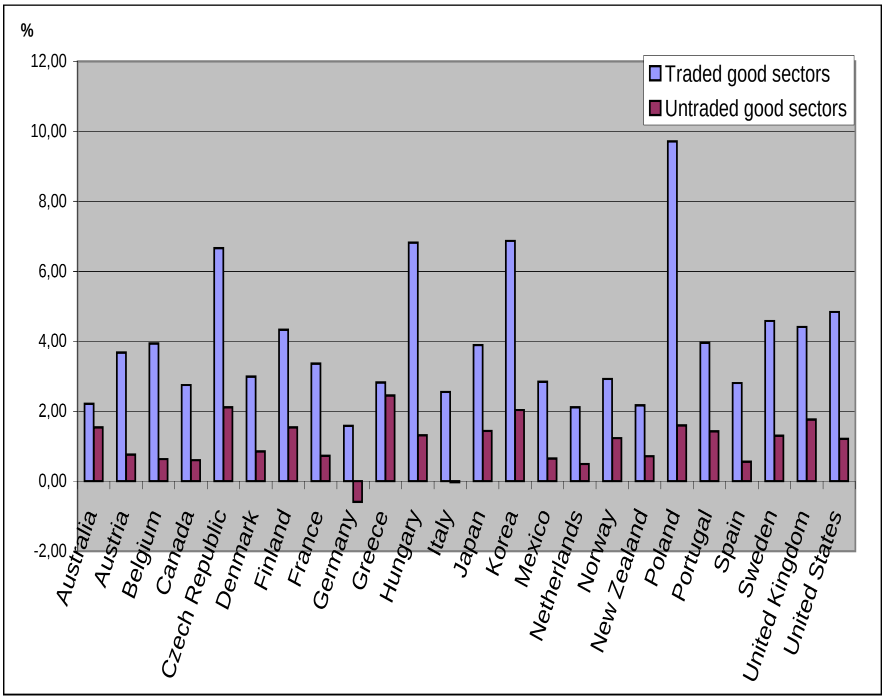
$$\omega_j = \frac{X_{j1995} + M_{j1995}}{\sum_{j\in -i}(X_{j1995} + M_{j1995})}$$

where X_{j1995} is the value of i's exports to j in 1995 and M_{j1995} the value of its imports from j.

An equivalent weighting scheme is used in the simulations to average the country's relative cost to produce in the traded good sector ($\rho_{it} = \frac{W_{it}/LBPDCTY^T_{it}}{W_{-it}/LBPDCTY^T_{-it}}$), its relative share in the production of traded goods (λ_{it}) and its relative productivity in the traded good sector, compared to its partners ($BS_{it} = \frac{A^T_{it}/A^N_{it}}{A^T_{-it}/A^N_{-it}}$).

Once obtained those effective variables, one can compute, for each country, the growth rate series of its "effective" Balassa-Samuelson term (g^{BS}_{it}) as well as of its share in the traded good production (g^{λ}_{it}) and average them using a simple mean ($\bar{g}^{BS}_i = T^{-1}\sum_t g^{BS}_{it}$ and $\bar{g}^{\lambda}_i = T^{-1}\sum_t g^{\lambda}_{it}$). Those mean growth rates are used in section 3.2 as measures of the Balassa-Samuelson and the Variety Supply effects.

Fig. 7 – Mean annual labor productivity growth in traded and non-traded sectors



Tab. 1 – Descriptive Statistics of the Variables of Interest in a sample of OECD countries

	Period	$\bar{g}_{RER}(\%)^{(a)}$	$\bar{\mu}(\%)$ $^{(b)}$	$\bar{\mu}^{*}(\%)$ $^{(c)}$	$\bar{g}_{BS}(\%)$ $^{(d)}$	$\bar{g}_{\lambda}(\%)$ $^{(e)}$
Australia	88-01	0.68	17	14	-2.31	-2.16
Austria	88-02	-0.87	41	26	0.39	9.31
Belgium	88-02	-0.54	75	26	0.15	5.55
Canada	88-00	-0.80	33	12	-1.42	-0.01
Czech Republic	95-00	4.37	59	27	1.99	4.05
Denmark	88-02	-4.00	32	22	0.75	10.30
Finland	88-02	-0.47	29	25	0.03	7.62
France	88-01	-1.24	22	27	0.79	-0.25
Germany	88-01	-0.83	25	27	0.47	-0.37
Greece	95-02	2.30	24	27	-0.99	7.76
Hungary	92-02	12.98	59	27	2.75	15.62
Italy	88-02	0.95	22	25	-0.84	3.41
Japan	88-01	-2.28	7	18	-0.89	-0.59
Korea	89-99	2.97	44	12	3.04	1.91
Mexico	88-01	14.94	26	12	-1.16	7.26
Netherlands	88-02	-0.30	53	27	-0.28	5.82
New Zealand	89-98	-0.52	9	15	-0.72	-1.13
Norway	88-02	-0.35	28	27	-1.79	7.46
Poland	92-01	15.58	27	28	5.56	4.17
Portugal	88-99	3.20	37	24	0.06	3.17
Spain	88-01	1.07	25	25	-0.82	0.50
Sweden	88-01	0.56	31	24	1.18	-0.74
United Kingdom	88-02	0.83	23	28	-0.94	4.41
United States	88-01	-1.04	11	21	1.37	-0.18

Sources : Author's calculations

For each country, calculations are done considering the rest of the sample as its partners, with a weighting scheme based on the share of each partner in the country's total trade (exports plus imports).

(a) Mean annual growth rate of the effective real exchange rate (CPI based). A positive value means that, on average, the country's relative price level has increased.

(b)(c) Mean share of traded goods in the nominal consumption of the considered country (b) and of its partners (c).

(d) Mean annual growth of the double productivity ratio : $BS = \frac{A^T/A^N}{A^{T*}/A^{N*}}$. Measure of the Balassa-Samuelson effect.

(e) Mean annual growth of the country's relative production of traded growth : $\lambda = \frac{GDP_t^T}{GDP_t^T + GDP_t^{T*}}$.

TAB. 2 – Predicted annual growth rate (in %) of the effective RER, attributable to the Balassa-Samuelson effect, the Home Market effect and a combination of both

	BS effect	HME effect	Total effect
Australia	-1.92	0.02	-1.90
Austria	0.23	-0.16	0.07
Belgium	0.04	-0.28	-0.24
Canada	-0.96	0.00	-0.96
Czech Republic	0.81	-0.06	0.75
Denmark	0.51	-0.31	0.20
Finland	0.02	-0.12	-0.10
France	0.62	0.01	0.63
Germany	0.35	0.02	0.37
Greece	-0.75	-0.10	-0.85
Hungary	1.11	-0.58	0.53
Italy	-0.66	-0.20	-0.86
Japan	-0.83	0.02	-0.81
Korea	1.69	-0.09	1.60
Mexico	-0.86	-0.27	-1.13
Netherlands	-0.13	-0.20	-0.33
New Zealand	-0.65	0.00	-0.65
Norway	-1.30	-0.11	-1.41
Poland	4.01	-0.13	3.88
Portugal	0.04	-0.10	-0.06
Spain	-0.61	-0.02	-0.63
Sweden	0.81	0.01	0.82
United Kingdom	-0.70	-0.31	-1.01
United States	1.22	0.02	1.24

Sources : Simulation of (14) using OECD data

TAB. 3 – Elasticity of RER with respect to H's relative productivity in the traded good sector($\xi_{RER}^{RelA^T}$)

Parameters		$\xi_{RER}^{RelA^T\,(a)}$
$\sigma = 5,\ \tau = 1.25,$	$\mu = 0.1$	0.94
$\theta = 0.5$	$\mu = 0.3$	0.71
	$\mu = 0.5$	0.48
	$\mu = 0.7$	0.25
	$\mu = 0.9$	0.03
$\sigma = 5,\ \tau = 1.25,$	$\theta = 0.5$	0.25
$\mu = 0.7$	$\theta = 0.7$	[0.25 ; 0.28][(b)]
	$\theta = 0.9$	[0.25 ; 0.30]
$\sigma = 5,\ \mu = 0.5,$	$\tau = 1.05$	0.50
$\theta = 0.6$	$\tau = 1.15$	0.49
	$\tau = 1.25$	0.48
	$\tau = 1.35$	0.47
	$\tau = 1.45$	0.45

(a) $\xi_{RER}^{RelA^T} = \frac{\partial RER}{\partial RelA^T}\frac{RelA^T}{RER}$ with $RelA^T = A_H^T/A_F^T$. $\xi_{RER}^{RelA^T}$ measures the sensitivity of the real exchange rate to a one percent change of H's relative productivity in the traded good sector.

(b) Interval in which $\xi_{RER}^{RelA^T}$ varies when $RelA^T = A_H^T/A_F^T$ increases from 0.2 to 5.

TAB. 4 – Elasticity of RER with respect to H's relative size (ξ^{θ}_{RER})

Parameters		ξ^{θ}_{RER} $^{(a)}$
$\sigma = 5,\ \tau = 1.25$,	$\mu = 0.1$	[0.12 ; 0.72]
No Prcdvty Gap	$\mu = 0.3$	[0.06 ; 0.37]
	$\mu = 0.5$	$\simeq 0$
	$\mu = 0.7$	[−0.07 ; −0.33]
	$\mu = 0.9$	[−0.13 ; −0.64]
$\sigma = 5,\ \mu = 0.3$,	$\tau = 1.05$	[0.02 ; 0.04]
No Prcdvty Gap	$\tau = 1.25$	[0.06 ; 0.37]
	$\tau = 1.45$	[0.08 ; 1.04]
$\sigma = 5,\ \mu = 0.7$,	$\tau = 1.05$	[−0.02 ; −0.04]
No Prcdvty Gap	$\tau = 1.25$	[−0.07 ; −0.33]
	$\tau = 1.45$	[−0.09 ; −0.85]
$\tau = 1.25,\ \mu = 0.3$,	$RelA^T = 0.5^{(b)}$	[0.06 ; 0.57]
$\sigma = 5$	$RelA^T = 1$	[0.06 ; 0.37]
	$RelA^T = 2$	[0.06 ; 0.25]
$\tau = 1.25,\ \mu = 0.7$,	$RelA^T = 0.5$	[−0.06 ; −0.70]
$\sigma = 5$	$RelA^T = 1$	[−0.07 ; −0.33]
	$RelA^T = 2$	[−0.06 ; −0.12]
	$RelA^T = 5$	[−0.04 ; 0.02]
$\tau = 1.25,\ \mu = 0.3$,	$\sigma = 3$	[0.07 ; 0.25]
No Prcdvty Gap	$\sigma = 5$	[0.06 ; 0.37]
	$\sigma = 7$	[0.05 ; 0.57]
$\tau = 1.25,\ \mu = 0.7$,	$\sigma = 3$	[−0.08 ; −0.20]
No Prcdvty Gap	$\sigma = 5$	[−0.07 ; −0.33]
	$\sigma = 7$	[−0.05 ; −0.52]

(a) Interval in which $\xi^{\theta}_{RER} = \frac{\partial RER}{\partial \theta}\frac{\theta}{RER}$ varies when θ increases from 0.5 to 1.
(b) $RelA^T = A^T_H / A^T_F$ is H's relative productivity in the traded good sector.