The real exchange rate (another look)

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Introduction

- Let us consider the real exchange rate in log form (where lower case letters mark logs)

$$q_t = s_t + p_t^* - p_t \tag{1}$$

- If the PPP holds, q_t will be constant and equal to zero.
- In the short run this is false. E.g. fig. 4.1. However, there exists a tendency of the real exchange rate to converge towards zero in the long-run? If so, how long does it take for the real exchange rate to reach its long-run value?

Introduction

- These questions are important because fluctuations in the real exchange rate can have important allocative effects
  - a long-run tendency towards appreciation can increase domestic prices with respect to the foreign ones, making the tradable sector to shrink and the non-tradable one to expand. Consumers might however benefit from this development. A depreciation could have an opposite effect.
  - the foreign debt of many developing countries is in dollars. An exchange rate appreciation entails a reduction in the cost of the debt.
- One of the theories that tries to explain why the real exchange rate is not constant is the Harrod-Balassa-Samuelson one, according to which the real exchange rate depends on productivity growth differentials.

Some preliminary issues

- Data on the price level are not in general available. What is usually available are data on price indexes. As a consequence (1) becomes

$$\begin{aligned} q_t &= s_t + (p_t^* - p_0^*) - (p_t - p_0) = s_t + (p_t^* - p_t) + (p_0 - p_0^*) = \\ &= s_t + (p_t^* - p_t) + k \end{aligned}$$

- Recall the distinction between
  - absolute PPP in (1)
  - relative PPP $\Delta s_t + \Delta p_t^* - \Delta p_t = 0$
- What index to use?
  - CPI includes a wide set of tradable and non-tradable goods
  - PPI concerns a basket that can be considered as a rough measure of tradable goods
  - the GDP deflator can be used in studies about aggregate production.

The Isard's and the Engle and Rogers' studies

- The Isard's study
  - The considered data are those on unit prices of manufacturing imports and exports of the US, Germany, Japan from 1970 to 1975 at a fine disaggregation level in the international trade classification (SITC).
  - The relative price of an exported good is defined as the ration between the dollar unit prices of German and American exported goods.
  - From 1970 to 1975 the dollar exchange rate decreased by 55.2%, however the relative price of internal combustion engines, of computing equipment and pallet trucks increased by 48.1%, 47.7% and 39.1%, respectively

The Isard's and the Engle and Rogers' studies

- The Isard's study
  - The following model was estimated

$$R_t = a_0 + a_1 S_t + a_2 D_t + e_t + \rho e_{t-1}$$

where R_t is the relative import-export prices, S_t is the nominal exchange rate of the dollar, D_t is a dummy variable splitting the sample in two parts.

  - If the law of one price held, $a_1 = 1$. Instead

Import from Germany			Import from Japan		
Soap	Cables	Wallpaper	Soap	Cables	Wallpaper
0.094	0.04	0.03	15.49	6.28	6.79
(0.04)	(0.02)	(0.01)	(13.8)	(1.04)	(1.28)

  - Possible shortcoming: short time-series.

The Isard's and the Engle and Rogers' studies

- The Engle and Rogers' study
  - The aim of the study is to understand what are the determinants of the volatility of percentage changes in the consumer prices of 14 categories in various American and Canadian cities from September 1978 to December 1994.
  - Volatility is measured as the standard deviation, σ_{ijk}, of the time series of $\Delta \ln \left(p_{ijt} / p_{ikt} \right)$ where p_{ijt} is the price of good i, in city j at time t.
  - The adopted model is

$$\sigma_{ijk} = \alpha D_{jk} + \beta B_{jk} + \mathbf{X}_i' \gamma_i + u_{ijk}$$

    where D_{ijk} is the log of the distance between cities j and k (to capture transport costs), B_{jk} is a dummy equal to 1if cities j and k are separate by a border, $\mathbf{X}_i'$ is a vector of control variables.
  - The result is that there is a strong border effect: international deviation of PPP are of a greater magniture than intranational ones.

The Isard's and the Engle and Rogers' studies

- The Engle and Rogers' study
  - Possible explanations
    - barriers to international trade (tariffs, non-tariff barriers, quotas)
    - greater market integration within countries than between countries
    - price nominal rigidity
    - pricing to market: firms, with monopolistic power, charge different prices in different markets depending on the demand elasticity of each of them.

The Balassa-Samuelson model

- Let us consider a small two-sector economy: tradable and non-tradable goods.
- The terms of trade (the relative price of exports with respect to imports) are fixed.
- Let us decompose the real exchange rate in the following way
  - P_T and P_N respectively are the price of tradable and non-tradable goods.
  - The internal and foreign general level of prices are respectively given by

$$\begin{aligned} P &= (P_T)^{\theta} (P_N)^{1-\theta} \\ P^* &= (P_T^*)^{\theta} (P_N^*)^{1-\theta} \end{aligned}$$

  - the real exchange rate in logs is

$$q = (s + p_T^* - p_T) + (1-\theta)(p_N^* - p_T^*) - (1-\theta)(p_N - p_T)$$

  - let us assume that the law of one price holds for tradable goods: $s + p_T^* - p_T = 0$

The Balassa-Samuelson model

- Let us focus on the dynamics of the relative price of tradable and non-tradables
- Let us assume that
  - there is perfect competition on the markets for production inputs and for the final good
  - there exist constant returns to scale
  - capital is perfectly mobile between countries
  - labour is not mobile between countries, but it so between sectors
  - preferences do not have any role in the definition of the relative price of two goods.
  - there exists only one tradable good and only one non-tradable good.

The Balassa-Samuelson model

- Let us assmue that
  - the two goods are produced with a Cobb-Douglas production function

$$\begin{aligned} Y_T &= A_T L_T^{1-\alpha_T} K_T^{\alpha_T} \\ Y_N &= A_N L_N^{1-\alpha_N} K_N^{\alpha_N} \end{aligned}$$

  - the trade balance is zero.
  - the tradable good is the numeraire $P_T = 1$
  - firms maximize profits that, in the two sectors, are given by

$$\begin{aligned} \pi_T &= A_T L_T^{1-\alpha_T} K_T^{\alpha_T} - (WL_T + RK_T) \\ \pi_N &= P_N A_N L_N^{1-\alpha_N} K_N^{\alpha_N} - (WL_N + RK_N) \end{aligned}$$

The Balassa-Samuelson model

- Let us call $k \equiv \frac{K}{L}$. First order conditions are

$$
\begin{aligned}
R &= A_T \alpha_T k_T^{\alpha_T - 1} && (2)\\
R &= P_N A_N \alpha_N k_N^{\alpha_N - 1} && (3)\\
W &= A_T \left(1 - \alpha_T\right) k_T^{\alpha_T} && (4)\\
W &= P_N A_N \left(1 - \alpha_N\right) k_N^{\alpha_N} && (5)
\end{aligned}
$$

- $(2) - (5)$ is a four equations system with four unknowns P_N, W, k_N, k_T given that R is exogenous and given by the international market for capital.

The Balassa-Samuelson model

- We solve $(2)-(5)$ in the following way

$$
\begin{aligned}
k_T &= \left[\frac{A_T \alpha_T}{R}\right]^{\frac{1}{1-\alpha_T}} \\
W &= A_T\left(1-\alpha_T\right)\left[\frac{A_T \alpha_T}{R}\right]^{\frac{\alpha_T}{1-\alpha_T}} \\
k_N &= \left(\frac{\left(1-\alpha_T\right)}{\left(1-\alpha_N\right)}\frac{A_T^{\frac{1}{1-\alpha_T}}\left(\frac{\alpha_T}{R}\right)^{\frac{\alpha_T}{1-\alpha_T}}}{P_N A_N}\right)^{\frac{1}{\alpha_N}} \\
P_N &= \frac{A_T^{\frac{1-\alpha_N}{1-\alpha_T}}}{A_N} C R^{\frac{\alpha_N-\alpha_T}{1-\alpha_T}} \qquad (6)
\end{aligned}
$$

where C is a positive constant.

The Balassa-Samuelson model

- Taking logs of (6)

$$p_N = \left(\frac{1-\alpha_N}{1-\alpha_T}\right) a_T - a_N + \left(\frac{\alpha_N - \alpha_T}{1-\alpha_T}\right) r + c$$

- If $\frac{\dot{a}_T}{a_T} = \frac{\dot{a}_N}{a_N}$ or $\frac{\dot{a}_T}{a_T} > \frac{\dot{a}_N}{a_N}$ and $\alpha_N < \alpha_T \Longrightarrow \frac{\dot{p}_N}{p_N} > 0$, $\frac{\dot{q}}{q} < 0$ and if PPP holds in the long run.
- If a_T and a_N are non-stationary, p_N and q will be non-stationary.
- Note: when taking the Balassa-Samuelson model to the data, one often makes the hypothesis that services are nont-tradable goods and that they are more labour intensive, though it is not always so. For instance, there exists an international market for financial services and transport services intensively use capital.

Long-run analysis of real exchange rate

- Univariate tests of PPP
  - Table 7.2 shows the results of unit root tests (the augmented Dickey-Fuller test, hereafter ADF) using quarterly data on the real exchange rate from 1973.1 to 1997.4 for 19 high-income countries
  - 4 lags of Δq_t and a constant were included in the model
  - note
    - the high persistence of the real exchange rate
    - persistence is lower considering Germany as numeraire country: the dollar had peculiar trends moving from real appreciation into a real depreciation in 1980.

Long-run analysis of real exchange rates

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  - Univariate tests of PPP in long time periods
  - ADF tests not rejecting the presence of a unit root in the real exchange rate could be due to their low power in small samples (i.e.: they reject less often than what they should theoretically do)
  - Lothian e Taylor (1996) then considered data on the real exchange rate between the US and the UK from 1791 to 1990 and between the UK and Frances from 1803 to 1990 using wholesale prices
    - Fig. 7.1 here
    - Table 7.3 (here) also presents results considering consumer price indexes from 1871 to 1997. In some cases the non-stationarity hypothesis was not rejected, but depending on how many lags of Δq_t are included.
- Using panel tests the evidence against PPP is less strong, but the persistence of the real exchange rate remains high.

The Canzonieri et al. (1999) test of the Balassa-Samuelson model

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  - Sectoral data for the US, Canada, Japan, France, Italy, the UK, Belgium, Denmark, Sweden, Finland, Austria and Spain are considered
- Manufacturing goods and those of primary activities are defined tradable goods, whereas wholesale trade, restaurants, hotels, communication and transport, financial services, personal services and non-market services are considered non-tradable goods.
- Equating (4) and (5) one can write

$$\frac{P_N}{P_T} = \frac{1-\alpha_T}{1-\alpha_N}\frac{A_T}{A_N}\frac{k_T^{\alpha_T}}{k_N^{\alpha_N}} \tag{7}$$

The Canzonieri et al. (1999) test of the Balassa-Samuelson model

- Considering a Cobb-Douglas production function one can write $A_i k_i^{\alpha_i} = \frac{Y_i}{L_i} \equiv x_i$ with $i = N, T$. Taking logs of (7) one obtains

$$p_N - p_T = \ln\left(\frac{1-\alpha_T}{1-\alpha_N}\right) + x_T - x_N$$

- One finds that $p_N - p_T$ and $x_T - x_N$ are non-stationary, but cointegrated and that PPP is valid for tradable goods.