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REAL EXCHANGE RATES AS INDICATORS
OF PURCHASING POWER PARITY*

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ABSTRACT: This paper deals with real exchange rates (RE) as indicators of purchasing power parity (PPP).
PPP does not hold in the short run even in the context of a fixed exchange rate regime. Real exchange rates are generally used as measures of deviations from PPP. In this paper we study whether RE's are good measures of such deviations.
We study the properties of RE in the context of the Scandinavian model. We also study the problems of constructing and interpretating RE's as indices.
In the study we found that RE's are often rather unreliable measures of deviation from PPP. In context of the Scandinavian model we show how the equilibrium value of RE may change according to structural changes (e.g. productivity) in the economy. There may also be bias in the measurement depending on the construction of RE's (e.g. weighting problems).
Thus when interpreting RE's we have to take into account possible changes in the levels of the equilibrium exchange rate, and we have to be aware of possible biases in measurement.

KEY WORDS: Purchasing power parity, Real exchange rate, Scandinavian model, Index problems.

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1. Introduction

There has been a very long debate on the validity of Purchasing Power Parity (PPP) theory. The interest for PPP resurged when it was introduced as a central building block of monetary theory of balance of payments or exchange rate determination.

In the 1970s and 1980s there has been a huge amount of empirical and theoretical studies on the validity of PPP. The results have been partly mixed, but they have shown that PPP is not a valid short run relationship in case of flexible exchange rates. However, many authors still consider it as a valid long run approximation, which means that real exchange rate should fluctuate around a stable value. Fluctuation may e.g. be due to monetary shocks, which are not handled in this study.

Our aim differs from most studies in the 1970s and 1980s. We try to look at the changes in the equilibrium real exchange under pegged exchange rate. Furthermore, we discuss about the possible biases in measuring real exchange rates. This attempt is closely related to the problems of measuring price competitiveness for countries which peg their exchange rate indices.

In chapter two we clarify the concept of PPP. In chapter three we explain mainly by the "Scandinavian model" why the equilibrium real exchange rate may change. This chapter also includes a short discussion of real exchange rate as a time series process. In part four we try to identify methodological problems when measuring deviations from equilibrium exchange rate (PPP). Finally, we review our results.

2. Purchasing Power Parity

2.1. The concept of purchasing power parity

In the case of flexible exchange rates PPP may be a theory of exchange rate determination. With fixed rates PPP can be seen as an inflation transmission mechanism. It is useful to look at two versions of purchasing power parity: absolute and relative PPPs.

Absolute version of PPP simply says that prices of a commodity are the same everywhere if expressed in the same currency. As a formula

$$P = eP^{+}$$

P = price at home
e = exchange rate

Throughout this paper a^{1} over a variable denotes percentage change and a^{+} the variable for the foreign country. The relative version of PPP looks at the price changes over time in both countries. The basic idea is that distortions of the absolute PPP which stay constant over time cancel out. So according to the relative version of PPP changes in relative prices between countries are related to changes in exchange rates. If $P = k.eP^{+}$, then in procentage changes

$$P^{1} = e^{1} + P^{+1} \quad \text{or} \quad P^{1} - P^{+1} - e^{1} = 0$$

1 denotes a procentage change
k = constant distortions
$k^{1} = 0$

Real exchange rate can now be defined as a deviation from PPP. Real exchange rate is usually measured as nominal effective exchange rate index deflated by indicators of relative prices (Maciejewski, 1983).[1)] Relative version of PPP holds, with constant distortions, if real exchange rate equals unity. These two versions of PPP are equal, of course, if the absolute version holds in comparison period.

According to McKinnon (1980) the absolute version of PPP can hold only if

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1) Some writers define real exchange rate as a totally different concept - as relative internal prices.

- all goods are perfectly tradable with zero transport costs
- there exists no tariffs or other artificial barriers to foreign trade, such as exchange controls
- foreign and domestic goods are perfectly homogeneous within each commodity category.

These assumptions are clearly very extreme and empirical evidence does not support this view of PPP. Therefore, we concentrate on the relative version of PPP theory. But even if PPP should hold for all single tradable goods it will usually not hold for indices of tradable goods if the weights for goods differ in different countries. Thus even the relative version of PPP cannot solve the weight problem. This problem is discussed more in chapter four.

There are at least three various economic interpretations of PPP relations:

- commodity-arbitrage relationship
- an imposed assumption in monetary models
- reduced form relation between endogenous variables.

The oldest interpretation relies on commodity arbitrage to eliminate the price differences. It can also be thought to be a result of the functioning of the economic forces (reduced form relation) (Katseli-Papaefstratiou, 1979). Second interpretation in context of efficient market theory means that PPP holds on an expected basis (see Junge, 1984; Roll, 1979). The efficient market interpretation is, however, especially important in case of flexible exchange rates. These interpretations are described more accurately in chapter 3.

2.2. Some policy problems

In the literature there have been many suggestions that purchasing power parity should be used as a measure of the long-run equilibrium level of exchange rates. One possibility is that central banks manage nominal exchange rates according to some kind of a purchasing power rule. One specific country where the

concept of PPP plays a role in exchange rate management is Norway. The main characteristic of exchange rate policy in Norway is to stabilize the value of Norwegian krone against a weighted average of fourteen other currencies. The policy is described in Brekk (1986). A crucial intermediate target is to have a constant relative unit labour cost in manufacturing sector.

$$(1) \quad e^{1} + (W_m^1 - W_m^{1+}) + (q_m^{1+} - q_m^1) = 0.$$

(The subscript m refers to manufacturing sector. This additive formula holds only for small changes).

As the exchange rate, e, is viewed as fixed, the general economic policy must be geared towards the wage (W) and productivity development (q) so that

$$(W_M^1 - W_M^{1+}) + (q_M^1 - q_M^{1+}) = 0.$$

However, if this is not achieved (which seems to be the case now and then) and the change in the real exchange rate is viewed as incompatible with a satisfactory development in the manufacturing sector and in the current account, the nominal exchange rate may be altered so that a "better" value of the cost competitiveness is restored.

3. Explanations of changes in equilibrium real exchange rate

3.1. One crucial reason for changes in the equilibrium real exchange rate

We will investigate the price indeces of two interconnected countries. We assume, for simplicity, the following price index for one country, which produce tradeables and non-tradeables. Subscript T refers to tradeable sector, and subscript N to non-tradeable sector.

$$(2)\quad p = p_T^{\alpha} p_N^{1-\alpha} = \left\{\frac{p_N}{p_T}\right\}^{1-\alpha} p_T ,$$

$$\text{then } p_T = \left\{\frac{p_T}{p_N}\right\}^{1-\alpha} p.$$

Then we get (3):

(3) $p_T = \theta p$. By analogous reasoning for the foreign country we get

(1^+) $p_T^+ = \theta^+ p^+$. The change in the real exchange rate is then defined as

$$(4)\quad p^1 - p^{1+} - e^1 = p_T^1 - p_T^{1+} - e^1 + (\theta^{1+} - \theta^1).$$

With commodity arbitrage for tradeables ($p_T^1 - p_T^{1+} - e^1 = 0$), we get (5) for the real exchange rate:

$$(5)\quad p^1 - p^{1+} - e^1 = \theta^{1+} - \theta^1.$$

The real exchange rate is stable if the change in the internal relative price of tradeables is equal in both countries. This is the argument from Balassa (1964) that systematic divergences of internal price ratios due e.g. differences in productivity growth across countries change the equilibrium real exchange rate. (5) is based only on the formulas of the price indeces in the two countries.

3.2. The Scandinavian model and PPP

3.2.1. The basic model

The Scandinavian model emphasizes the supply side of the economy. Aggregate demand and fiscal and monetary policies do not matter, or are always accommodating to cost developments. The basic feature of the Scandinavian model is that prices of tradeables follow the world market price, that there are constant factor income shares in both the tradeable and the non-tradeable sector and that wages in the non-tradeable sector follow wages in the tradeable sector.

We look upon a two country model with one small and one big country (rest of the world). For the small country (home country) the model (equation (6) to (10)) is with minor modifications by Lindbeck (1978). However, in order to evaluate the PPP relationship for broader price aggregates than tradeables, we add a very simple explanation of the foreign price development. We have also added other costs than labour costs (C_N, C_T) to the model.

(6) $P_T^1 = P_T^{1+} + e^1$ $\qquad$ (2^+) $P_T^{1+} = W_T^{1+} - q_T^{1+} + C_T^{1+}$

(7) $W_T^1 = P_T^1 + q_T^1 - C_T^1$

(8) $W_N^1 = W_T^1$ $\qquad$ (3^+) $W_N^{1+} = W_T^{1+}$

(9) $P_N^1 = W_N^1 - q_N^1 + C_N^1$ $\qquad$ (4^+) $P_N^{1+} = W_N^{1+} - q_N^{1+} + C_N^{1+}$

(10) $P^1 = \alpha P_T^1 + (1-\alpha) P_N^1$ $\qquad$ (5^+) $P^{1+} = \alpha^+ P_T^{1+} + (1-\alpha^+) P_N^{1+}$

The equations (2^+) - (5^+) say that in the big country prices in both sectors are based on unit costs and that there is a homogenous labour market. Thus, at the same time we explain relative, internal price development in both countries. We assume that the PPP is always valid for tradeable goods.

The model has the following exogenous and endogenous variables:

Exogenous variables are: e^1, q_T^1, q_N^1, W_T^{1+}, q_T^{1+}, q_N^{1+}, C_N^1, C_T^{1+}, C_N^{1+}, C_T^1

Endogenous variables are: P_T^1, W_T^1, W_N^1, P_N^1, P^1, P_T^{1+}, W_N^{1+}, P_N^{1+}, P^{1+}

We have nine equations between nine endogenous variables so the endogenous variables can be solved as functions of the exogenous variables. In order to compute the PPP relationship we solve for P^1 and P^{1+}

$$(11)\quad P^1 = P_T^{1+} + e^1 + (1-\alpha)(q_T^1 - q_N^1) - (1-\alpha)(C_T^1 - C_N^1)$$

$$(6^+)\quad P^{1+} = \alpha^+(W_T^{1+} - q_T^{1+} + C_T^{1+}) + (1-\alpha^+)(W_T^{1+} - q_N^{1+} + C_N^{1+}).$$

As mentioned we assume PPP for tradeable goods, and will now investigate the determinants of the equilibrium real exchange rate in the context of a broader price aggregate including non-tradeables. The change in the equilibrium real exchange rate is calculated as $P^1 - P^{1+} - e^1$.

$$(12)\quad P^1 - P^{1+} - e^1 = (W_T^1 - W_T^{1+}) - (\alpha q_T^1 - \alpha^+ q_T^{1+}) - \left[(1-\alpha) q_N^1 - (1-\alpha^+) q_N^{1+}\right] + (\alpha C_T^1 - \alpha^+ C_T^{1+}) - \left[(1-\alpha^+) C_N^{1+} - (1-\alpha) C_N^1\right] - e^1$$

In (12) we see that the terms $(W_T^1 - W_T^{1+}) - (\alpha q_T^1 - \alpha^+ q_T^{1+}) - e^1$ is about the same as equation (1) if manufacturing sector is an approximation for tradeable sector. However, the real exchange rate target which the Norwegian and Finnish authorities follow, is generally not the same as a PPP-rule in this model.

In the case of a small country compared to its trading partners, it is realistic to assume that α is large and that α^+ is small. If in addition $q_N^{1+} = q_T^{1+}$ and $C_T^1 = C_N^{1+} = 0$, we get the limiting case (13),

$$(13)\quad P^1 - P^{1+} - e^1 = (W_T^1 - W_T^{1+}) - (q_T^1 - q_T^{1+}) - e^1 = 0.$$

(13) is identical to (1), if we can assume, as is usually done, that manufacturing sector is a good approximation for the tradeable sector. (Foreign variables are weighted averages of main trading partners.) Only in this case is a constant relative unit labour cost in the manufacturing sector equivalent with a constant real exchange rate. In this case, the model (6) - (10) collapse to (6) and (7) and PPP is always constant as the economy only consists of the tradeable sector.[1)]

But W_T^1 is endogenous variable in our model and W_T^{1+} can be solved from (2^+). Substituting for these variables we get the expression (14) for the real exchange rate in the basic Scandinavian model.

$$(14)\quad P^1 - P^{1+} - e^1 = (1-\alpha)(q_T^1 - q_N^1) - (1-\alpha^+)(q_T^{1+} - q_N^{1+}) + (1-\alpha^+)(C_T^{1+} - C_N^{1+}) + (1-\alpha)(C_N^1 - C_T^1) - e^1.$$

In the limiting case where α approaches one and α^+ approaches zero, we get

$$(15)\quad P^1 - P^{1+} - e^1 = (q_N^{1+} - q_T^{1+}) + (C_T^{1+} - C_N^{1+}) - e^1.$$

Equation (14) tells us that the real exchange rate is a function of weighted differences in productivity changes between the trade-

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1) When arbitrage is far from perfect in short-run, authorities should also follow the behaviour of relative prices of tradeables between countries.

able and the non-tradeable sector in both countries and the weighted differences in changes in unit costs (other than labour costs) between the tradeable and non-tradeable sectors in both countries. The weights reflect the degree of openness of the countries. So, in this model there is no reason to expect the real exchange rate to be constant. The equilibrium rate will easily deviate from constant and following a rule of constant real exchange when changing the nominal exchange rate would thus be misleading. Two examples is the oil discoveries in United Kingdom and Norway in the beginning of 1970's. This can be interpreted as a rise in q_T^1, which cause a rise in the equilibrium real exchange rate according to formula (14).

The productivity effect on the real exchange rate in (14) is a similar result as Balassa introduced in 1964. If the home country enjoys a faster (weighted) productivity growth in the tradeable sector relative to the non-tradeable sector than the outside world $[(1-\alpha)(q_T^1 - q_N^1) > (1-\alpha^+)(q_T^{1+} - q_N^{1+})]$ the real exchange rate seems overvalued when compared with a simple PPP rule. But in reality it is not overvalued. The equilibrium real exchange rate, measured with broad aggregates has changed. PPP hold for tradeables, and profit margins have not changed. Balassa provided empirical support for his hypothesis, but Officer (1976b) could not confirm this point in a cross-section study. However, later on Officer (1980) also found support for the productivity hypothesis in a time series study.

3.2.2. Modifications of the Scandinavian model

According to Lindbeck (1978) the Scandinavian model can be modified in several respects. One possibility is to introduce variable factor income shares and non-parallel wage paths in the small country. We will now, for simplicity, omit the unit costs of other factors than labour. This facilitates the mathematical expressions without destroying any argument. In the equations for the real exchange rate we can just add $[(1-\alpha^+)(C_T^{1+} - C_N^{1+}) + (1-\alpha)(C_N^1 - C_T^1)]$ on the right hand side if we want to take these factors into consideration.

With these modifications, equation (11) for price change in the home country is replaced by (16)

$$(16)\quad p^1 = p_T^1 + (1-\alpha)(q_T^1 - q_N^1 + \mu_T^1 - \mu_N^1 + \eta^1).$$

μ_T and μ_N are the labour income shares in the tradeable and non-tradeable sector, respectively, and η is the ratio of the wage rates between the two sectors. Combined with (6^+) we get (17)

$$(17)\quad p^1 - p^{1+} - e^1 = (1-\alpha)(q_T^1 - q_N^1 + \mu_T^1 - \mu_N^1 - \eta^1) - (1-\alpha^+)(q_T^{1+} - q_N^{1+}) - e^1.$$

According to Lindbeck the assumption of $\mu_T^1 \neq 0$ is the empirically most relevant of these three modifications. In the long term there has been a tendency towards higher employee income shares $(\mu_T^1 > 0)$. One reason for this trend in μ_T could e.g. be labour biased technological change which gives an upward shift in the marginal productivity of labour. This would tend to increase the real exchange rate, and make it irrelevant to follow a simple PPP rule, also in the long run.

The higher labour income share is equivalent with higher growth rates for wages in tradeable goods sector than prescribed by equation (7). As a result profit margins are squeezed and the authorities may try to restore them by a devaluation of the exchange rate. But according to (17) this is not a proper reaction. A devaluation of e may add to the inflationary pressure and lead to devaluation-inflation cycles.

Next Lindbeck introduces heterogenous tradeables. Arbitrage relation (6) is then replaced by (18) and price equation in home country (11) by (19).

$$(18)\quad p_T^1 = \beta_1 p_T^{1+} + \beta_2 e^1 + \beta_3 (w_T^1 - q_T^1)$$

$$(19)\quad p^1 = [\alpha(\beta_1+\beta_3)+1-\alpha]\, p_T^{1+} + [\alpha(\beta_2+\beta_3)+1-\alpha]\, e^1 + (1-\alpha)(q_T^1 - q_N^1)$$

p_T^{1+} now represent prices of tradeables produced in foreign countries. Prices of tradeables produced in the small home country are now also influenced by labour costs. Wages in

home country (W_T^1) is assumed to follow prices of tradables in the other country ($W_T^1 = P_T^{1+} + e^1 + q_T^1$).

Our expression (20) for real exchange rate is rather complicated:

$$(20)\quad P^1 - P^{1+} - e^1 = \left[\alpha(\beta_1+\beta_3) + 1 - \alpha - \alpha^+\right](W_T^{1+} - q_T^{1+}) + \left[\alpha(\beta_2+\beta_3) - \alpha\right]e^1 + (1-\alpha)(q_T^1 - q_N^1) - (1-\alpha^+)(W_T^{1+} - q_N^{1+})$$

In (20) real exchange rate is a function of unit labour costs in both tradeable and non-tradeable sector in the large country and the internal productivity difference in the small country. Again, it is difficult to imagine that the real exchange rate could be constant, even if the economies are in equilibrium.

In the long run it is, however, likely that $\beta_1 = \beta_2$ and that $\beta_1 + \beta_3 = 1$. Then (20) is equal to the basic real exchange rate equation (14) if we also take non-labour unit costs into account.

The last modification we will introduce is to take into account the aggregate demand, via a short-term Phillips relation. Then wage relation (2) is replaced by (21).

$$(21)\quad W_T^1 = a_1 + b_1 u + c_1 p^{1e} \qquad b_1 < 0 \text{ and } c_1 > 0,\ a_1 > 0$$

u is the unemployment rate and p^{1e} is the expected inflation rate. The basic price relationship (11) is then replaced by (22) and (23) is our new expression for the real exchange rate.

$$(22)\quad P^1 = \alpha(P_T^{1+} + e^1) + (1-\alpha)(a_1 + b_1 u + c_1 p^{1e} - q_N^1)$$

$$(23)\quad P^1 - P^{1+} - e^1 = (\alpha-1)W_T^{1+} + (\alpha^+ - \alpha)q_T^{1+} + (1-\alpha^+)q_N^{1+} + (1-\alpha)(a_1 + b_1 u + c_1 p^{1e} - q_N^1) + (\alpha-1)e^1$$

Here we introduce two new factors which influence the real exchange rate. An unemployment level different from $(-a_1/b_1)$ and changing inflationary expectations will, ceteris paribus, change the real exchange rate.

According to (23) a shift to a higher unemployment, e.g. because of structural changes in the labour market, lead to a decline in the real exchange rate. If the authorities react with a revaluation of the nominal exchange rate, profit margins in the tradeable sector would be squeezed and eventually lead to even higher unemployment. (23) says that following a simple PPP rule in this case would be misleading.

Equations (14), (17), (20) and (23) point to several real disturbances on the supply side and demand factors which make the equilibrium real exchange rate change over time. A simple PPP rule, stabilization of the real exchange rate, cannot be expected to be valid. We should allow changes in real exchange rate.

The transmission mechanism of price changes in the Scandinavian model go mainly from wages to prices. It is a cost push model.

3.2.3. PPP and the asset market approach

The PPP hypothesis is a central building block in the monetary approach to exchange rate or balance of payments determination. The following simple model by Bilson (1978) is a good illustration:

(24) $M = p\ L(i,y)$

(25) $M^{+} = P^{+}\ L^{+}(i^{+},y^{+})$

(26) $P = e\ P^{+}$

In (24) and (25) the partial derivatives of the real money demand functions have the usual properties. In the foreign country, (25) the price level is determined as function of exogenous real interest rate and real income and the money supply. With a fixed exchange rate,(26) determines the domestic price level, while (24) determines the domestic money supply. The role of the PPP assumption (26) is that through commodity arbitrage a monetary disturbance abroad is transferred into the domestic price level and money supply. Monetary disturbances cannot affect the real exchange

rate because they have symmetrical influences on the price level in both countries. In this general equilibrium framework we could instead of the money market concentrate on other markets, e.g. the labour market. Then we replace (24) and (25) by equilibrium conditions (27) and (28) for the labour market, where MPL is marginal productivity for labour.

$$(27)\quad \frac{W}{P} = MPL$$

$$(28)\quad \frac{W^+}{P^+} = MPL^+$$

Any disturbance in the labour market in the foreign country (28) will be transformed through the PPP relation (26) into the domestic labour market (27).

A simple PPP model (only equation (26)) view the exchange rate as determined only by the ratio of the price levels, or in the case of fixed exchange rate it is a model for domestic price development. We can get a more realistic model by assuming that PPP holds only for tradeable goods.

$$(29)\quad P_T = eP_T^+$$

Our monetary model now consists of (24), (25), (29) and price indices like (3) and (1^+). The change in the domestic price level is then given by (30)

$$(30)\quad P^1 = e^1 + (\theta^{1+} - \theta^1) + (M^{1+} - \{\frac{\partial L^+}{\partial i^+}\, i^{1+} + \frac{\partial L^+}{\partial y^+}\, y^{1+}\})$$

P^1 is no longer only determined by foreign monetary developments. Real domestic and foreign factors which influence θ and θ^+ must be taken into account. Again, the real exchange rate shifts with different internal, relative prices in the two countries.

Within a framework of portfolio-balance model the long-run equilibrium real exchange rate is the rate which is consistent with a zero current account balance. The value will depend on all the real determinants of the current account. According to Katseli-Papaefstratiou (1979) there is no a priori reason to believe that this is the PPP value of unity. This view is in contrast with e.g. Artus (1978) which argues that the exchange rate in the asset-market view in the longer run is essentially determined by the PPP.

However, according to Katseli-Papaefstratiou (1979) this will depend on the nature of external disturbances. PPP could be reestablished in the long run after a neutral, monetary disturbance. However, e.g. wealth effects may hinder such a development. Structural changes would, as in the models in section 3.2.1. and 3.2.2., cause long-run changes in the real exchange rate.

3.3. Real exchange rate as a time serie process

There are several studies which show that real exchange rates follow simplest ARMA-process (random walk) under flexible exchange rates (f.ex. Roll, 1979) or fixed (Junge, 1984) rates regimes. Under flexible exchange rates this may be due to "innovations" or "news" (Frenkell, 1981) which happen randomly and immediately change the nominal exchange rate. In context of fixed exchange rates this may be due to the real shocks which change real exchange rate as discussed earlier. Thus testing whether the real exchange rate follows unstationary random walk gives us information of the importance of real shocks.

The stationarity of a time serie (real exchange rate) can be tested according to (+) as suggested by Nelson and Plosser (1982).

$$(+)\quad RE = a + b.RE_{-1} + c.t + \sum_{i=1}^{n} d_i \left[RE_{t-1} - RE_{t-(i+1)}\right] + u_t$$

a, b, c, d_i = parameters
RE = real exchange rate in period t
u_t = random process

Real exchange rate follows random walk-process if b = 1 and c = 0. If this is the hypothesis it cannot be tested by usual statistics without modifying the tables (unit root problem).

Fuller (1979) has, however, simulated tables for t-tests under the unstationary case. Accordingly, Dickey and Fuller (1981) have constructed tables for likelihood-ratio tests for the whole model. According to ($^{+}$) it is possible to test whether real exchange rate follow random walk or whether it fluctuates randomly around a constant or a trend.

4. Methodological problems

After the collapse of Bretton-Woods system some countries f.ex. Finland, Norway and Sweden have sooner or later adopted the pegged exchange rate system.[1] This means that the central banks of these countries stabilize a certain index, which is calculated on the basis of the nominal bilateral exchange rates. This means that a certain average of exchange rates is constant if not adjusted (revalued or devalued).

However, under pegged exchange rate index regime countries cannot affect on the cross rates of other countries and so bilateral rates fluctuate. One advantage of this system is that fluctuation of bilateral rates is smaller than under free float. Pegging system is functioning "automatically" and it also diminishes the currency risk. There are, however, numerous ways to choose the weights and the development of indices may differ considerably in unnormal circumstances (Suni-Vartia, 1985).

In context of Finland, Norway and Sweden the baskets are also interconnected because the currency of each country is included in the index of others (see f.ex. Grønvik, 1983). Section 4 will clarify whether these features of a pegged exchange rate system have influence on possible measuring procedures of PPP. We discuss also the questions of how we should choose the weights, index formulas, base year and price indices? These latter problems are common in context of both pegged and flexible exchange rates.

4.1. Multilateral or bilateral testing

In the theoretical part we looked at only two countries: big and small country. Those hypothesis we introduced are suitable for any pair of small and big country. Hypothesises are not suitable for equally large countries, because structural equations do not include any repercussion effects.

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[1] We prefer the name pegged exchange rate system instead of the illustrative but strictly speaking often false name basket pegging system.

Usually multilateral testing gives out better results than bilateral testing procedures (McKinnon, 1980) under simple PPP-testing. Referring to our modified PPP hypothesises we regard this as reasonable, because the different disturbances between home country and various foreign countries are handled at the same time. However, Officer (1980) gets the opposite result when he takes real disturbances into account.

4.1.1. Effect of pegging on bilateral real exchange rates

Bilateral nominal exchange rates of a country which pegs the exchange rate index are determined with the aid of crossrates and the pegging rule (Suni, 1985). If the pegging rule is according to (31) then simple PPP testing equation in relative form can be expressed as (32)

$$(31)\quad \prod_j \left[e_{ij}^t / c_{ij}^{to}\right]^{w_j} = k^i \Rightarrow \frac{e_{ik}^t}{e_{ik}^{to}} = w_k \sqrt{k^i \cdot \prod_{j \neq k} (e_{ij}^t / e_{ij}^{to})^{-w_j}}$$

e_{ij} = nominal bilateral exchange rate between countries i and j

k = constant t = time to = base period

w_j = weight

$$(32)\quad P_i^t = E_{ij}^t \cdot P_j^t$$

E_{ij} = bilateral exchange rate index

P_i^t, P_j^t = price indices of countries i and j at period t.

Bilateral exchange rates are interconnected through the pegging system. Thus if one dominant currency, say, USD have a long trend away from its parity then the pegging system forces other currencies to the opposite direction. Thus in the early 1980s the strengthening of USD in PPP sense necessarily got a counterpart in the weakening of other currencies in the three Nordic countries, ceteris paribus.

Thus even on bilateral basis there may be considerable divergences from the PPP-value originating from the pegging system and inefficient arbitrage in the short run.

4.1.2. Multilateral testing under pegged exchange rate

In multilateral context there are no problems originating from pegged exchange rate system if the weights in the exchange rate index are suitable for measuring PPP. The weights in the exchange rate index may be selected in numerous ways and only one (some) of them can be regarded as suitable for measuring prices.

If the weights differ between exchange rate index and the appropriate PPP measure, then pegging may cause even considerable divergence from PPP. This was probably the case in Finland in early eighties (Suni -Vartia, 1985). The exchange rate index had deficiencies in theoretical sense (Vartia-Vartia, 1984) and the index formula and the weights were changed in the beginning of 1984.

Let us assume the central bank pegs exchange rate index according to (31) and that the appropriate measure for effective nominal exchange rate index for PPP calculation is also (31) with different weights w_j^1. Then

$$\Pi (e_{ij}^t / e_{ij}^o)^{w_j} = k_i^t \qquad \text{pegging rule}$$

$$\Pi (e_{ij}^t / e_{ij}^o)^{w_j'} = k_i^t \cdot x \qquad \text{multilateral exchange rate index for PPP-calculation}$$

if $k_i^t = (1+a)k_i^o$, then

$$x = 1/(1+a)\ \Pi (e_{ij}^t / e_{ij}^o)^{w_j' - w_j} \qquad x = \text{difference between indices}$$

then in percentage changes

$$x^1 = \sum (w_j' - w_j) e_{ij}^1 = \sum w_j' e_{ij}^1 - \sum w_j e_{ij}^1 = \sum w_j' e_{ij}^1$$

Thus if weightsdiffer in indices then pegging system may cause deviations in PPP measures. This deviation may be considerable as mentioned in bilateral case. This may happen if an important currency, e.g. US dollar have long substantial deviations from it parity.

The currency baskets of Finland, Norway and Sweden are all interconnected as each index contains the other two currencies. However, each country's weights are derived without taking this point into consideration. Even if the official weights are derived from some optimization procedure, the "final" weights will differ from the "optimal" weights. Thus when comparing effects of differences in weights we should, in principle, use "final" weights.

4.2. Weighting problem in constructing real exchange rates

Weights of the price indices are usually value shares of commodity groups in each country. Value shares naturally differ very easily between countries. Thus relative version of PPP cannot hold with indices even if the absolute version of PPP were correct.

One example of weight problem in price indices is the case of terms of trade. Terms of trade can be introduced by the division between exportables and importables in tradeable goods. We can assume that PPP holds always between foreign and home prices of our exportables ($P_X = e\,P_X^+$) and our importables ($P_I = e\,P_I^+$). If we assume that tradeable goods' prices (e.g. wholesale price-indices) follow

$$P_T = P_I^{\beta} \cdot P_X^{1-\beta} \iff P_T = \left\{\frac{P_I}{P_X}\right\}^{\beta} P_X$$

in home country and respectively abroad. Now, we get

$$P_T = eP_T^+ \iff \delta P_T = e\,\delta^+ P_T^+ \qquad \delta = \left\{\frac{P_X}{P_I}\right\}^{\beta}$$

By analogous reasoning we get δ^+ as weighted terms of trade in the foreign country,

and thus $P_T^1 - P_T^{1+} - e^1 = \delta^{1+} - \delta^1$.

However, if the "world" consists of only two countries, then it is easily shown that $\delta^{1+} - \delta^{1} = 0$. This is due to the symmetry. The case is different if we assume several countries and try to study PPP in subgroup of countries. Then even when we have similar increases in the prices of the same products, the weights differ and thus relative tradeable goods price-indices change. For example, the effect of the oil price change on real exchange rate in oil importing country is

$$P_T^1 - P_T^{1+} - e^1 = \beta \cdot P_I^1 - \beta^+ \cdot P_I^{1+} = \beta \gamma P_{oil}^1 - \beta^+ \gamma^+ P_{oil}^{1+} =$$

$$P_{oil}^1 (\beta \gamma - \beta^+ \gamma^+)$$

γ = share of oil in importables.

Respectively (5) can be written like (5')

(5') $P^1 - P^{1+} - e^1 = \theta^{1+} - \theta^1 + \delta^{1+} - \delta^1$.

In the case (5') θ^1's are also affected by changes in terms of trade. In equation (5') the term $(\theta^{1+} - \theta^1)$ represent a shift in the equilibrium real exchange rate, while the term $(\delta^{1+} - \delta^1)$ represent bias due to a measurement problem (see picture 1). In chapter three we assumed always only two countries and that is why $\delta^{1+} = \delta^1$.

Another question is how we should weight the price indices of foreign countries (look f.ex. Maciejevski, 1983).
The traditional way is to use export, import or trade weights because of their simplicity. In case of these weights we assume that competition (arbitrage) happens only between ourselves and our bilateral competitors. According to OECD (Durand, 1986) we should also take into account the competition from the third countries with so-called double weighting system.

It is also possible to derive model dependent optimal weights according to our target variable. However, with every target you usually get different weights and different real exchange rates, too.

Figure 1. Two Sources of Change in "Long Run Real Exchange Rate". An Example.

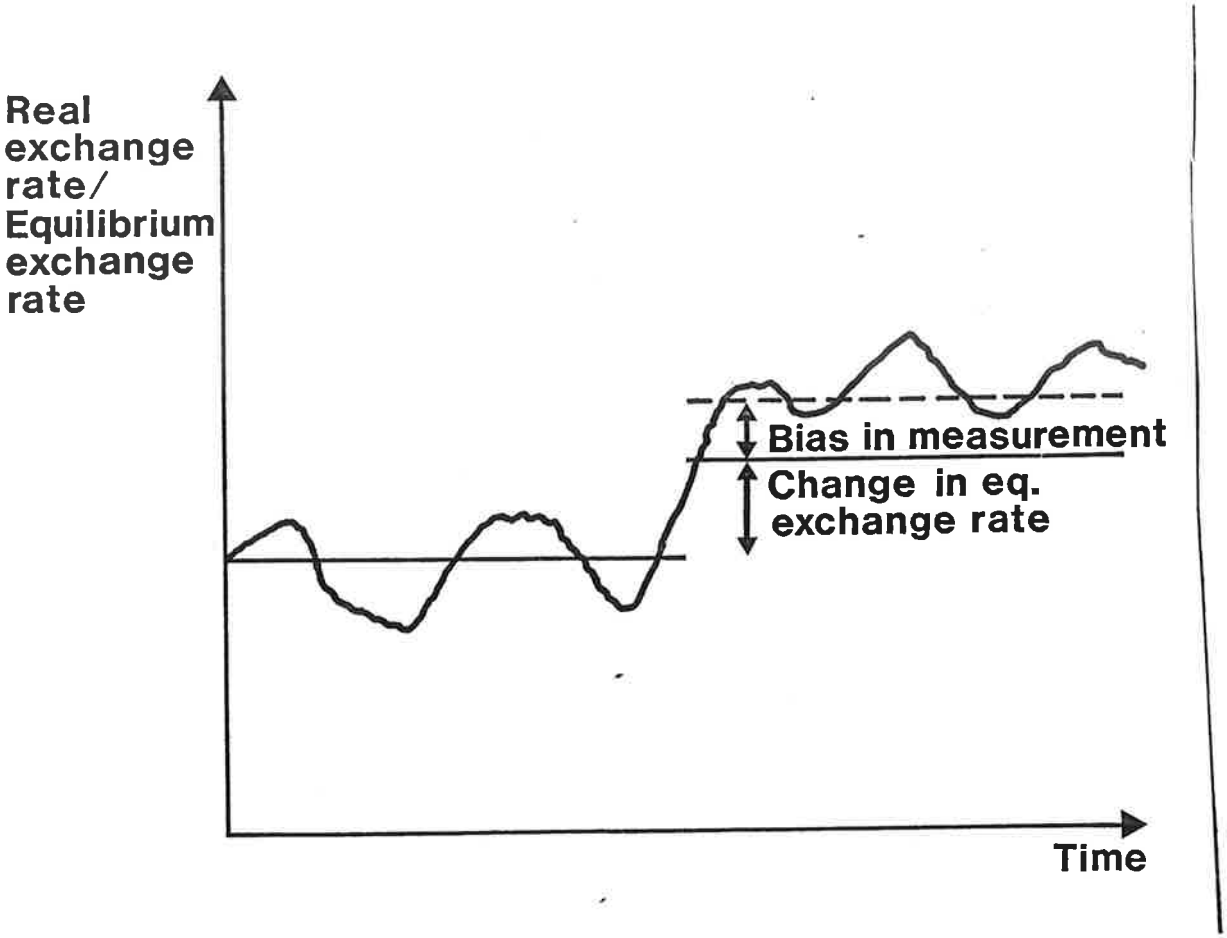
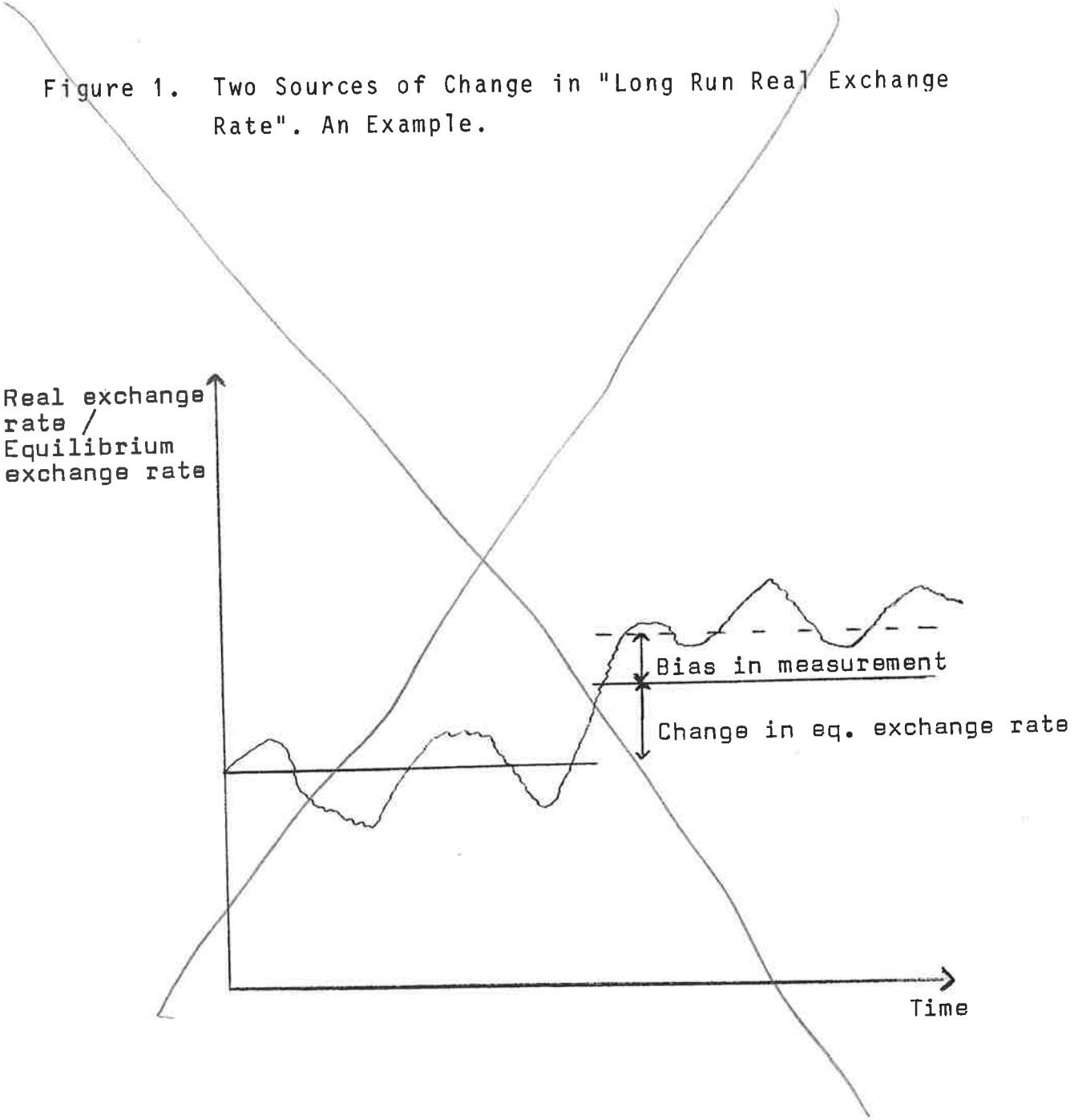


Figure 1. Two Sources of Change in "Long Run Real Exchange Rate". An Example.



4.3. Selection of price (cost) indices

Selection of the price index depends on the PPP hypothesis we want to test and it depends partly also on personal judgement. In principle the choice is easy. If you want to test tradeable goods PPP then you can use tradeable goods price indices. In practice, however, there are no pure tradeable goods price indices available. According to McKinnon (1980) wholesale price indices are best indices for testing tradeable goods PPP.

When testing PPP with broader price indices then we also have non-tradeables included in the indices. According to an analysis in chapter three it is quite unprobable that PPP can hold with these indices even in longer run, if we do not take productivity differences, etc. into account. Thus when we select consumer price indices or gross domestic product deflators we have to take into account also structural changes in the whole economy.

When testing whether the "cost"-equations (1) and (13) hold then we should in principle take account of all the costs of the tradeable sector firms. However, in practice the only information which we can get on a comparable basis is unit labour costs (ULC). That is why they are always used in cost comparisons.

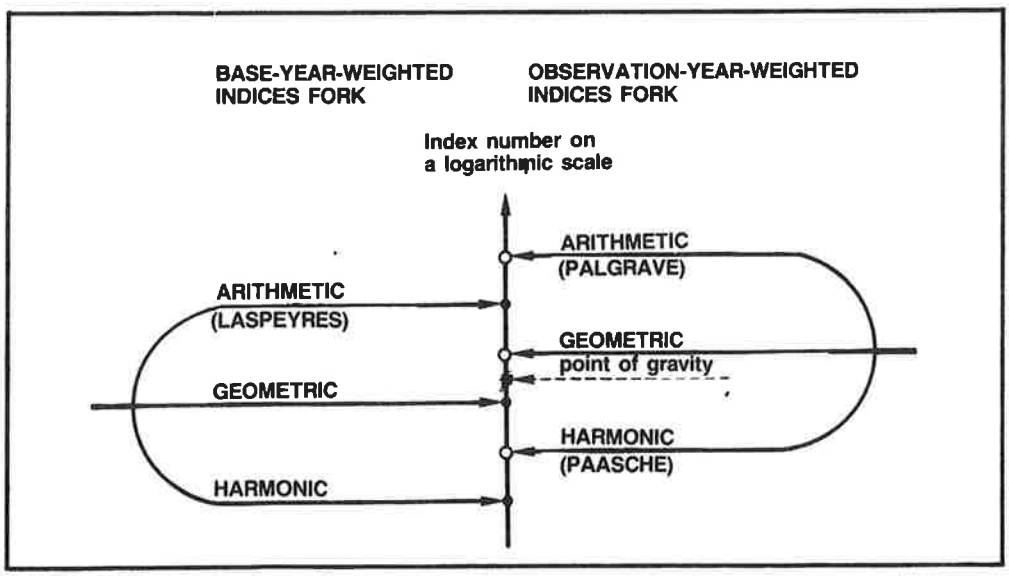
4.4. Selection of the base year

Selection of the base year when calculating the real exchange rate is a very important and difficult problem. The usual hypothesis is that real exchange rate equals one if PPP holds. This result is, however, crucially dependent on whether the comparison period is in equilibrium or not. Equilibrium exchange rate can be defined as a rate consistent simultaneously with full employment of domestic resources and the overall balance of payments target (Maciejewski, 1983). This is not a very practical guide for measuring and so the selection of the base period depend also on personal judgement.

Real exchange rate may vary rather much and so selection of the base year is important for econometric testing, too. If the base period had been chosen correctly then PPP hypothesis for testing is that real exchange rate should equal unity. However, if base period is e.g. about 10 percent overvalued then the PPP hypothesis should be about 0.9. Best solution is, of course, to choose the correct base year and be aware that correct base period may change due to real shocks.

4.5. Selection of an index formula [1)]

Many price index formulas that are in common use represent the average values of price relationships in a base year and and observation year. An arithmetic mean is always greater than a geometric mean, which in turn is greater than a harmonic mean. The means can be calculated by using the weights of the base year or the observation year, and their relative differences are of the same order of magnitude. The base-year-weighted and the observation-year-weighted means can therefore be illustrated in the form of two "forks" as shown in the figure (see Vartia-Vartia, 1984).



1) This section is based on Suni-Vartia (1985).

Although the forks can in principle be in any arbitrary position in relation to each other, their common point of gravity can be obtained by connecting those tines of the forks which are symmetrical. The values of unbiased and so-called superlative indices are close to this point of gravity: for example the Fisher index is obtained as an average of the Laspeyres and Paasche indices and the Törnqvist index as an average of the base-year-weighted and observation-year-weighted geometric means. The use of indices based exclusively on the weights of the base year or the observation year cannot be recommended from the point of view of index theory. In practice the base year weighted indices are most popular because of their computational easiness.

5. Conclusions

In this paper we have discussed the problems connected to interpretation and measurement of the purchasing power parity. One crucial conclusion is that real exchange rate is an inadequate measure of deviation from equilibrium exchange rate. One main reason for this are the changes in equilibrium exchange rate, as is illustrated in Figure 2.2.. The other main problem is the probable bias in real exchange rate as a measure of deviation from equilibrium real exchange rate, as is illustrated in Figure 2.3..

We agree with McKinnon that conditions for the PPP are so strong that PPP can be considered only as a long run benchmark even under pegged exchange rates.

Real exchange rates, defined as the nominal exchange rate adjusted for relative inflation, are measures of deviations from PPP. It is most likely that PPP can hold between tradeable goods. However, we showed with index manipulation that even then the changes in terms of trade may have considerable impact on tradeable goods real exchange rates (RE) even though PPP were valid on commodity basis. Terms of trade effect came through weight problem. If we define RE with broader prices indices then also internal price ratios change the equilibrium real exchange rate.

In theoretical part we studied PPP mainly in Scandinavian model, but also in asset market models. We showed that the "normal" practice to measure cost competitiveness in Nordic countries can be viewed as an extreme case of a PPP-rule in the Scandinavian model. The normal case is that the deviations from PPP should follow equation (12) and thus equilibrium RE is a function of the structural changes in the economies.

In monetary theory PPP is an assumption concerning all goods or just tradeable goods. In the first case real exchange rate is equal to one. In the latter case it is a function of internal price ratios in both countries.

Measurement of the PPP is difficult. The selection of the base period of the real exchange rate is a crucial problem if we want to test the relative PPP. The differences in weights in price indices cause bias in the real exchange rate as a measure of the PPP. Effects of terms of trade on the real exchange rate are partly connected to this problem. Also, if the weights in the currency index pegged by the central bank are not chosen from the viewpoint of PPP measurement, then we can get also a "technical" deviation from PPP in real exchange rate.

Figure 2. Real Exchange Rate as Measure of Equilibrium Exchange Rate

Figure 2.1. Real exchange shows, in principle, the deviation from eq. exchange rate ("PPP"), (ch. 2)

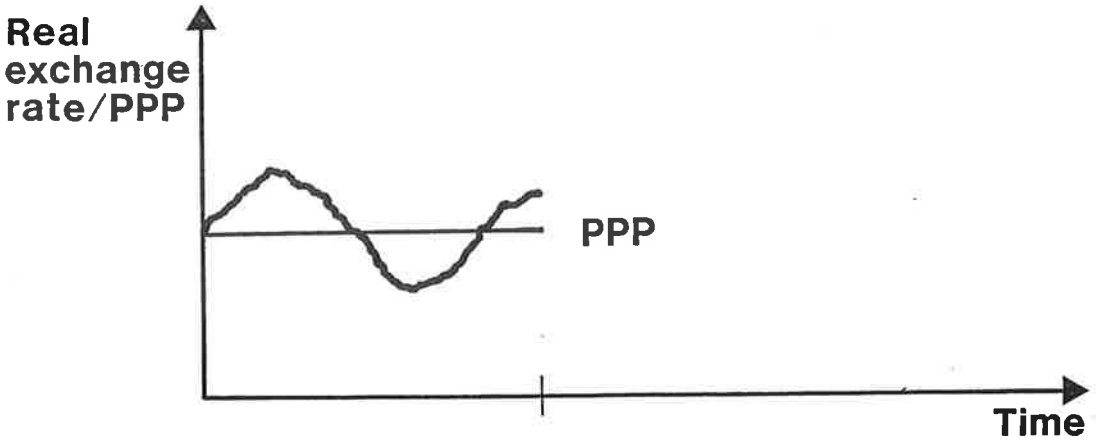


Figure 2.2. Changes in equilibrium exchange rate must be taken into account. Comparison must be done to the correct equilibrium rate (ch. 3)

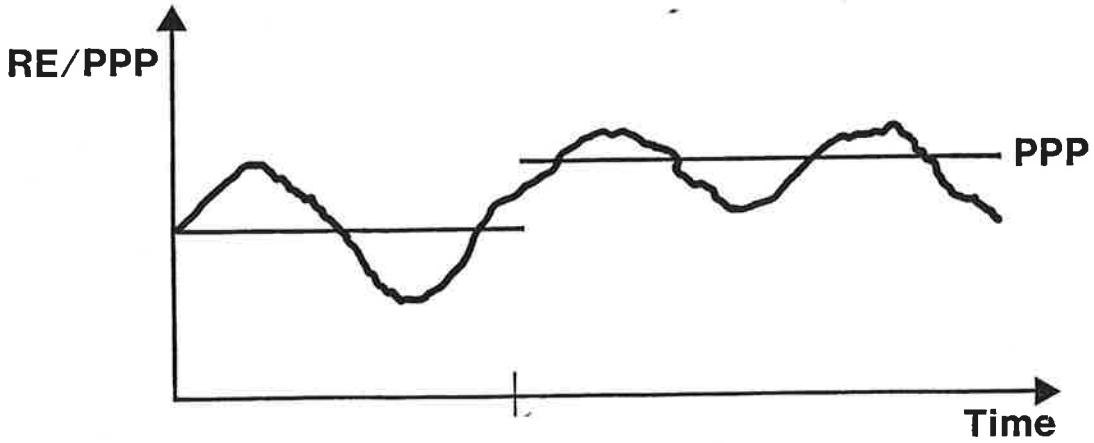
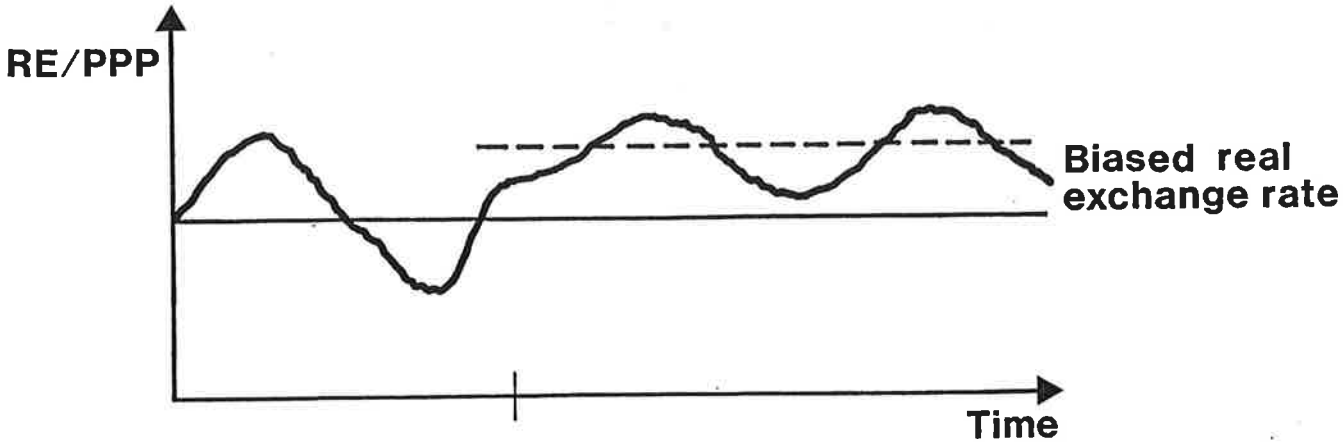


Figure 2.3. Real exchange rate may change also because of the bias in the measurement (ch. 4)



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