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Estimation of Real Equilibrium Exchange Rates

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1. Introduction

The purpose of this paper is to provide a consistent and transparent theoretical and empirical framework to analyse real effective equilibrium exchange rates for a large number of industrial countries. The theoretical and empirical model, as well as the applied methodology, are closely related to a recently published working paper by the IMF (Alberola et.al (1999)).

In the theoretical part, a macroeconomic model of internal and external equilibrium is presented (chapters 2, 3 and 4). The empirical part estimates a simplified version of the theoretical model and results are thereafter reported and evaluated on a country by country basis (chapter 5). The purpose of the empirical part is not to arrive at point estimates for equilibrium exchange rates, but rather to provide some basic econometric evidence as a complement and illustration of the theoretical analysis. The empirical model and statistical methodology is kept simple and uniform for all countries in order to facilitate interpretation and evaluation of the results.

The study of equilibrium exchange rates is an important part of overall macroeconomic analysis. A large body of evidence indicates that exchange rates can get seriously misaligned with economic fundamentals, thereby creating substantial macroeconomic imbalances. Moreover, exchange rate misalignments can be a consequence of inappropriate macroeconomic policies and thus indicate the necessity of a shift in monetary or fiscal policy. Within EMU, exchange rate and competitiveness surveillance is particularly important, because adjustment mechanisms other than monetary and exchange rate policy have to be employed in order to manage competitiveness problems and maintain internal and external balance.

Different kinds of equilibrium exchange rates can be defined depending on the time horizon of the analysis. The exchange rate will be in medium-term equilibrium when the economy is in internal balance and the current account is on a path that brings external debt into equilibrium within a specified time horizon. Internal balance is represented by full employment and price stability, i.e. actual output equals potential. The exchange rate will be in long-term equilibrium when the economy is in external equilibrium. This means that net foreign assets have stabilised relative to GDP. However, the "desired" level of net foreign assets is highly uncertain and depends on various structural factors such as demography, long term saving and investment and potential growth in the country relative to its partners.

This study focuses on medium term equilibrium exchange rates. One important implication is that estimated deviations from trend must not automatically be regarded as "misalignments", calling for policy actions, but may rather be warranted due to cyclical factors. High domestic demand pressure, for example, may require a temporary exchange rate appreciation in order to divert demand towards foreign goods and services and to maintain internal balance.

The theoretical analysis is based on an extended open economy macro model with perfect international capital mobility. The model allows for wealth effects, thus net foreign assets are an important determinant of real equilibrium exchange rates. A distinction is made between a tradable and a non tradable sector in order to capture the effects of productivity trends in these sectors on the exchange rate. This extension also allows for a more detailed analysis of the effects of structural measures on the exchange rate.

The model makes predictions concerning the trend behaviour of the real exchange rate and net foreign assets conditional on various structural factors. Given the stochastic nature of exchange rates, cointegration analysis is the appropriate tool for testing hypotheses on factors influencing exchange rate trends and estimating the strength of certain relationships. In addition a decomposition of the exchange rate into temporary and permanent components is

required. In line with Alberola et.al (1999), this study uses a method of extracting permanent components from cointegrated variables in order to perform decomposition into permanent and temporary components as suggested by Gonzalo, Granger (1995).

2. The Model

The model is a conventional open economy macro model with a sectoral extension. A distinction is made between a tradable and a non-tradable sector. We first discuss the sectoral specification and then present the macro framework.

Sectors :

It is assumed that each country produces tradable and non tradable goods and services. Prices in each sector are determined by cost and market conditions. Costs are influenced by input prices and total factor productivity and are summarised by the variable k_i, $i \in \{T, N\}$. The variable k should be interpreted as the inverse of marginal cost. Firms set prices via a mark up over marginal cost. Therefore factors affecting mark-ups, like the state of demand or market structure are also relevant. These factors are summarised by the variable z_i, i. e. z_i must be interpreted as a mark-up indicator. Therefore prices of tradables p_T and non tradables p_N can be characterised as a positive function of z_i and a negative function of k_i. In the following, a simple linear specification is chosen for sectoral prices[1]:

(1a) $p_T = p_T(\underset{(+)}{z_T}, \underset{(-)}{k_T}) = z_T - k_T$

(1b) $p_N = p_N(\underset{(+)}{z_N}, \underset{(-)}{k_N}) = z_N - k_N$.

In order to facilitate the dynamic analysis below it is assumed here that sectoral prices adjust immediately to *z* and *k*. Alberola et al. (1999) assume sluggish price adjustment, though this is more realistic it complicates the dynamic analysis. For analysing *equilibrium relationships* nothing is lost by assuming instantaneous relative price adjustment. Equation (1a,b) imply that the price differential between tradables and non-tradables is given by

(2) $p_N - p_T = z + k$ with $z = z_N - z_T$, $k = k_T - k_N$

where *z* represents the mark-up differential between non-tradables and tradables and *k* is the cost differential between tradables and non-tradables.

Let p_T*[2] be the price of foreign tradables and *s* the nominal exchange rate, then the relative international price of tradables is given by

(3) $q_X = p_T - (s + p_T*)$

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[1]   An important simplification is made at this point, since it is assumed that imported intermediates and therefore the exchange rate does not influence these prices. This assumption is made here in order to simplify the exposition. In the empirical analysis a feedback between sectoral prices and the exchange rate is allowed. In general the impact of the exchange rate on the sectoral price ratio will depend on the difference in the share of intermediate imports in the two sectors. Especially in smaller countries the relative price of tradables to non tradables will depend strongly on the exchange rate.

[2]   In general an asterisk denotes a foreign variable.

and the international sectoral price ratio is

(4) $q_I = (p_N - p_T) - (p_N * - p_T *) = (z - z*) + (k - k*).$

The real exchange rate is given by

(5) $q = p - (s + p*).$

Using the definition of the CPI in the domestic and the foreign economy (p and $p*$) defined as

(6a) $p = (1 - \alpha_N - \alpha_T) p_T + \alpha_N p_N + \alpha_T (s + p_T *)$

(6b) $p* = (1 - \alpha_N * - \alpha_T *) p_T * + \alpha_N * p_N * + \alpha_T * (p_T - s),$

where α_T and α_N is the share of tradables and non tradables in the consumption basket, the real exchange rate can also be written in terms of q_X and q_I

(7) $q = (1 - 2\alpha_T) q_X + \alpha_N q_I.$

i. e. the real exchange rises if either the relative international price of tradables increases or the international sectoral price ratio increases. It must be kept in mind that q_I only depends on "fundamental" economic conditions like relative preferences and relative technologies, while q_X also depends on the nominal exchange rate. This constitutes the link to the macro framework.

Macro Framework :

In this section we set up a fairly general macro model with standard behavioural relations for consumption, investment and the trade balance. Consumption is a positive function of current income, and a negative function of the gap between the desired stock of wealth (*F*) and actual financial wealth (*f*) and the real interest rate (*i*) relative to the long run equilibrium level (*i**)[3]. To simplify the theoretical analysis it is assumed that the real interest rate of the foreign country is at its equilibrium level.

(8a) $C = C(Y, (F - f), (i - i*)).$[4]

Investment is given as a function of income, the real interest rate and the tax rate

(8b) $I = I(Y, (i - i*), tax)$

and the trade balance depends on relative income and the international price of tradables

(8c) $TB = TB(Y */ Y, q^X)$

(8d) $G = G(Y, gshock).$

For our purposes we need to distinguish explicitly between (private and public) consumption and investment of domestic goods and services and of imported goods and services. Let *Z* be any one of the three demand components $Z \in \{C, I, G\}$ then it can be decomposed into a domestic and an imported component

(9) $Z = Z^d (Z, q_X) + Z^{im} (Z, q_X) / q_X.$

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[3]   To facilitate exposition of the model it is assumed that the foreign country is always in long run equilibrium.
[4]   Consumption depends also on other wealth categories, their dynamics are neglected in this analysis.

Finally the output potential of the economy is given by the NAIRU (which itself is a function of various structural factors) and the level of technology (T), including capital

(10) $Y = Y(L^{nairu}, T)$.

Given these behavioural and technological relationships, the model is closed by adding an equation for the current account and a national income identity

(11) $\dot{f} = CA = if + TB(.)$

(12) $Y = C + G + I + TB$.

Finally, asset markets ensure that interest parity holds, but we allow for the existence of a relative risk premium on domestic bonds

(13) $\dot{q} = i * - i + risk$.

The model described here adopts a medium term perspective, that means the economy is operating at the NAIRU and the output gap is closed, i. e. the economy is in a *medium term equilibrium* position. However the medium term equilibrium in goods and labour markets can be associated with changing interest rates and trade imbalances in the sense that the economy is accumulating or decumulating net foreign assets. Therefore a *long run equilibrium* can be defined as a position where no forces operate which would change f and q (for given values of the exogenous variables). The long run equilibrium of the economy can be decomposed into an external and an internal equilibrium position. In fact there is in general no single external or internal equilibrium position but a locus of combinations of q and f which would be consistent with either external or internal equilibrium.

External Equilibrium :

The external equilibrium locus is the set of all q-f combinations such that the net foreign asset position is not changing ($\dot{f} = 0$). This locus can be characterised using the current account identity (11). An economy can be in external equilibrium with a low/negative level of foreign assets if the exchange rate is sufficiently low such that it can generate sufficient trade surpluses in order to cover the interest payments from foreign debt. Also a high net foreign asset position can be an (external) equilibrium if it is accompanied with sufficiently high real exchange rates such that the trade deficit is large enough to compensate for the interest payments from abroad. Consequently, the external equilibrium is upward sloping in the q-f space.

Internal Equilibrium :

The internal equilibrium can be characterised as a set of all q-f combinations, such that the real exchange rate does not change ($\dot{q} = 0$) or the domestic real interest rate is equal to its long run level. Again, there are many possible combinations of q and f for which internal equilibrium is possible. This can be seen by using (12) and (13) and substituting the behavioural relations (8a, - 8d)) for the individual demand components and the production function for Y. Two interpretations for internal equilibrium are possible.

Interpretation 1: Internal equilibrium is a level of supply and demand for domestic goods such that for a given level of foreign wealth there is no pressure on interest rates either in an upward or downward direction. Using (8), the national income identity (12) can be represented as an equilibrium condition for domestic goods

$$(12') \quad Y(.) = C^d(f, q,.) + I^d(q,.) + G^d(q,.) + EX(q,.) .$$
$$ (+) \ (-) \qquad (-) \qquad (-) \qquad (-)$$

Analogous to the definition of external equilibrium there exist various combinations between q and f for which the market for domestic goods is in long run equilibrium, i. e. in a position of goods market equilibrium at the long run equilibrium level of interest rates (or unchanged exchange rates). Such an equilibrium can occur at a low/negative level of foreign assets if the exchange rate is sufficiently low such that the negative wealth effect on consumption demand is compensated by real exchange rate induced domestic and foreign demand for domestic goods. Also a high net foreign asset position can be an (external) equilibrium if it is accompanied by sufficiently high real exchange rates such that the high consumption demand is compensated by an exchange rate induced switch towards foreign goods. This suggests that the internal equilibrium locus is also upward sloping in the *q-f* space.

Interpretation 2: A second interpretation of internal equilibrium can be given in terms of a savings and investment balance. Again, starting from the GDP identity and adding net factor income from abroad, yields

$$(12'') \quad S - I = CA .$$

Dividing total savings into private and public savings yields

$$S = S^P + S^G$$

$$S^P = Y + if - T - C$$

$$S^G = T - G .$$

In this interpretation one can again define the locus of all *f-q* combinations such that the identity (12'') holds *without* a change in q (or no deviation of *i* from *i**). Again, this locus would be upward sloping in the q-f space. A low/high level of foreign wealth and therefore high/low savings and a lack of domestic demand/(excess domestic demand) would need to be compensated by high/low external demand or a low/high level of q.

Of course, both interpretations are equivalent. In the Alberola et al. paper reference was made to the savings investment balance therefore we continue our presentation along the lines of the second interpretation of internal equilibrium.

Collecting all behavioural equations and the production function (and linearising) one can write the savings minus investment balance in terms of its underlying determinants as suggested by the model in the following way

$$(14) \quad S - I = \eta(F - f) + \mu(i - i^*) + (1 - \varepsilon)(L^{nairu} + T) + \psi tax + \upsilon S^G .$$

The savings investment balance depends positively on the gap between desired foreign asset holdings and the actual level of those holdings, positively on the real interest rate because consumption and investment both depend negatively on interest rates and finally positively on taxes since investment depends negatively on taxes. How the savings/investment balance responds to the labour market and aggregate technology depends on the (weighted average of the) income elasticity of investment, consumption and trade (ε).

Most theoretical specifications (growth models) assume an elasticity equal to one in the long run. This elasticity assumption is consistent with roughly constant consumption and investment to GDP ratios. Consequently, the state of the labour market and aggregate technology would not influence the savings-investment balance. Alternative views are possible. If one assumes that both investment and consumption respond sluggishly to improvements in labour market conditions and technology, then the effect of a positive supply

shock on *S-I* will be positive (i. e. there is excess supply). In contrast, if one assures that consumers and especially investors respond quickly, then the weighted average of the elasticities can also be larger than one. In a forward looking model this would especially be the case if there is a permanent technology shock or a permanent improvement in labour market conditions.

Similarly, linearising the current account equation allows us to express the change in foreign assets in terms of the determinants of the trade balance

(15) $\dot{f} = if + TB + tr = if - \gamma q_X + \kappa(Y^* - Y) + tr$.

By using the interest parity condition, the dynamics for the real exchange rate and net foreign assets can now be characterised. Substituting (13) for *i-i** in the savings minus investment equation (14) and using the linearisation of the trade balance yields

(14') $\dot{q} = \dfrac{\eta}{\mu} F - \dfrac{\eta + i}{\mu} f + \dfrac{\gamma}{\mu} q_X + \dfrac{1-\varepsilon}{\mu}(L^{nairu} + T) + \dfrac{\psi}{\mu} tax + \dfrac{\kappa}{\mu} S^G + risk - \dfrac{1}{\mu} tr$.

Substituting (6) for q_X allows to write (14') and (15) as a dynamic system in q and f
(14'')

$$\dot{q} = \dfrac{\eta}{\mu} F - \dfrac{\eta + i}{\mu} f + \dfrac{\gamma}{\mu}\left(\dfrac{1}{(1-2\alpha_T)}\right)[q - \alpha_N q_I] + \dfrac{1-\varepsilon}{\mu}(L^{nairu} + T) + \dfrac{\psi}{\mu} tax + \dfrac{\kappa}{\mu} S^G + risk - \dfrac{1}{\mu} tr$$

(15') $\dot{f} = if + TB = if - \gamma\left(\dfrac{1}{(1-2\alpha_T)}\right)[q - \alpha_N q_I] + tr$

with q_I as an exogenous variable. Notice, from (4), that q_I only depends on relative sectoral preferences and technology shocks and therefore q_I is truly exogenous in this model. Equations (14'') and (15') give a formal representation of exchange rate and foreign asset dynamics but they also allow us to characterise external and internal equilibrium. By setting $\dot{f} = 0$, (11') defines all the combinations between *f* and *q* which are consistent with external equilibrium. Similarly, by setting $\dot{q} = 0$, (12') gives all combinations between *q* and *f* which are consistent with internal equilibrium :

External Equilibrium Locus :

(16) $q = \dfrac{i(1-2\alpha_T)}{\gamma} f + \alpha_N q_I + \dfrac{\kappa}{\gamma}(Y^* - Y) + \dfrac{1}{\gamma} tr$

Internal Equilibrium Locus :

(17)

$$q = \dfrac{(\eta + i)(1-2\alpha_T)}{\gamma} f + \alpha_N q_I - (1-2\alpha_T)\left(\dfrac{\eta}{\gamma} F + \dfrac{1-\varepsilon}{\gamma}(L^{nairu} + T) + \dfrac{\psi}{\gamma} tax + \dfrac{\kappa}{\gamma} S^G + risk - \dfrac{1}{\gamma} tr\right)$$

The following figure gives the phase diagram in the $q - f$ space. Both equilibrium loci are upward sloping in the $q - f$ space. In the case of internal equilibrium the economic intuition is as follows: When net foreign assets are low/high, a long run internal equilibrium (with $i = i^*$) could only be sustained if foreign demand is high/low, or in other words, q is low/high. An external equilibrium with a low/high level of net foreign assets and therefore low/high interest payments, requires a low/high level of q in order to generate the required trade surplus/deficit such that *f* remains unchanged. Notice also, the slope of the internal

equilibrium locus exceeds that of the external equilibrium locus whenever there is as positive wealth effect ($\eta > 0$). This is because the internal equilibrium not only gets affected by the interest payments but also by the additional domestic demand induced by higher foreign wealth. Since q is a forward looking variable, i. e. it is largely determined by expectations of future changes in the exchange rate, the system exhibits saddle path stability. This means, stability, or a "no Ponzi game" condition requires that – after a shock has occurred - the exchange rate jumps on to the saddle path which defines the only point (for a given stock of net foreign assets) which puts the economy onto a stable trajectory towards the new long run equilibrium position.

Intuitively, the stability properties of the model (14'') and (15') can be characterised as follows. Equation (14'') tells us that the exchange rate will appreciate when (for given q) f is smaller than a value consistent with internal equilibrium. In other words q will rise whenever f is to the left of the internal equilibrium locus ($\dot{q} = 0$) and it will fall whenever f is to the right of the internal equilibrium locus. This follows from the interest parity condition and the savings-investment balance equation[5]. The current account equation predicts that net foreign assets will fall, whenever q is above the external equilibrium line and will rise whenever it is below. Hence the arrows point to the left, north-west of the external equilibrium locus and to the right south-east of the internal equilibrium equation. Combining the arrows one can see stable and unstable regions. Now one has to use the fact that q can in principle jump to any value immediately, while f is a slowly moving stock variable. Stability requires that for any given value of f, q always jumps to the convergent path which is indicated by the thick line going from south-west to north-east of the phase diagram[6].

Figure 1 **- Phase Diagram for q and f**
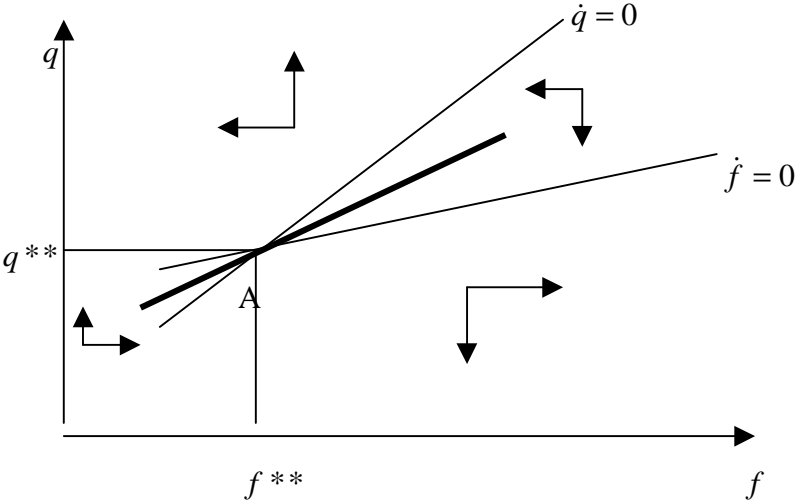
[5]   A low f would indicate more consumption in the future (higher savings today) and therefore the expectation of an appreciation.
[6]   From the phase diagram it follows that stability requires that the slope of the internal equilibrium locus exceeds the slope of the external equilibrium locus.

Many combinations between f and q are consistent with either external or internal equilibrium but there is generally only one combination between q and f that is consistent with both external and internal equilibrium. This point is given by the intersection of the two equilibrium loci. The corresponding real exchange rate can be interpreted as the *equilibrium exchange rate* (q^{**}) and the long run (sustainable) level of net foreign assets (f^{**}). From (16) and (17) it is clear that the values for q^{**} and f^{**} depend crucially on the levels of the exogenous determinants, i. e. on the level of risk, budget deficits, investment tax incentives, foreign transfers, desired net foreign asset positions and relative sectoral prices[7].

In the following section we discuss the impact of various permanent exogenous shocks on the equilibrium exchange rate. The dynamic adjustment of the exchange rate to its long run level is also assessed in order to point out that the adjustment of the real exchange rate generally follows an overshooting path.

3.   Factors affecting the Equilibrium Exchange Rate

3.1   Fiscal Policy

An increase in the government deficit increases domestic demand and leads to an upward shift of the internal equilibrium locus. The intersection with the (unchanged) external balance equation or the new equilibrium position of the economy is at a lower level of the real exchange rate and a lower level of net foreign assets (at point C in Figure 2). This position is reached via an overshooting adjustment process. First, excess demand leads to an increase in domestic interest rates and a capital inflow. Capital inflows will continue and the exchange rate will appreciate until capital markets expect the domestic interest rate and the future expected devaluation to be equal to the world interest rate. (point B in the figure).

Figure 2: Adjustment of the RER to a Fiscal Expansion
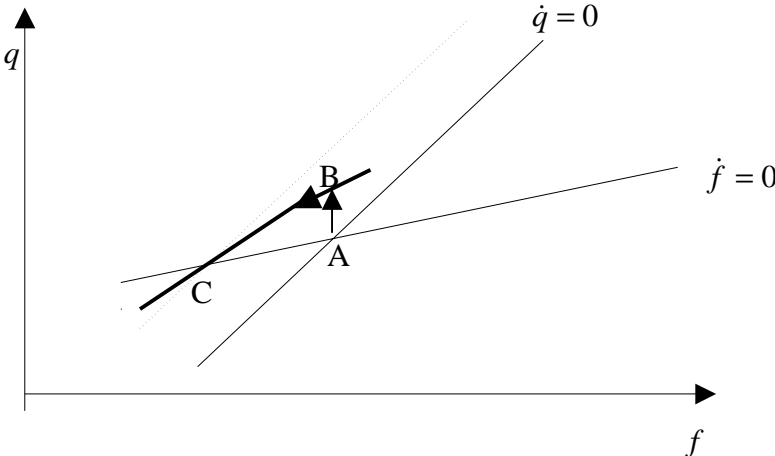
With this level of the exchange rate the current account balance cannot be sustained since the economy is running a trade deficit. This leads to a reduction in net foreign wealth, with private demand gradually falling because of this wealth effect. Eventually the economy reaches an equilibrium where the net foreign wealth position is lower than the historically given level (at point C). In order to sustain this new equilibrium (with lower interest income from abroad) the real exchange rate must be permanently lower in order to compensate for the loss of foreign income via a higher trade surplus.

3.2   Technological Change

Within our framework, technological change (occurring in one country only) can be distinguished between the tradable and the non tradable sector. We first discuss a technological innovation that affects both sectors equally. In the next section a sector biased technology shock is discussed, i.e. a technology improvement that predominantly affects the tradable sector. A good example of such a shock might be the computer revolution originating and concentrated in the US and some Scandinavian countries.

3.2.1   Aggregate Technology Shock

If we adopt a true long run perspective, i.e.; assume that the output and income elasticity of the shock is identical, then in terms of the two equilibrium loci, the only effect of a permanent technology improvement is a downward shift in the external equilibrium locus, because (ceteris paribus) domestic income and therefore import demand is growing more strongly than export demand. Current account sustainability requires a depreciation of the domestic currency. In other words in a world where there is some country specialisation a relative increase in the supply of goods produced in the domestic country requires an (international) price decline.

Figure 3: Adjustment of the RER to Aggregate Technical Progress
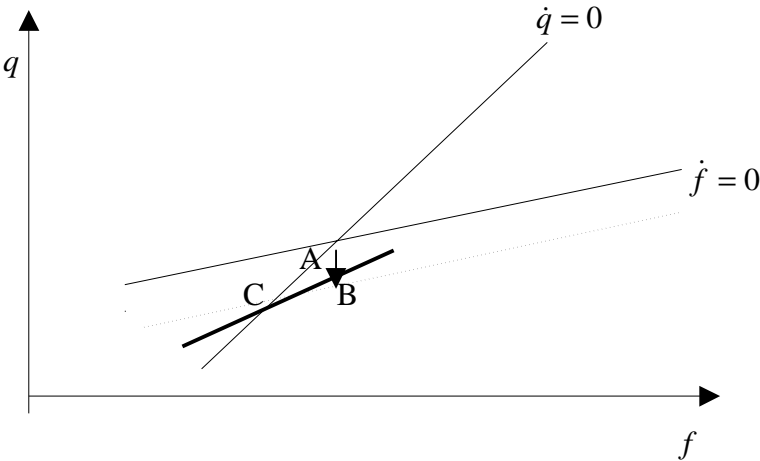
As this may sound counterintuitive, some qualifications are therefore required. Firstly, improvements in supply conditions can for a long time be associated with an appreciation, i. e; a movement of the exchange rate in the opposite direction, therefore pure observation may give the wrong impression concerning trends. In particular, this development can also be accompanied by an initial appreciation. This will especially be the case when the technology shock is expected to get stronger in the future and firms start to invest and (forward-looking) consumers expand consumption in expectation of higher income and higher returns. Current

consumption spending may be increased because households expect higher labour income in the future and/or the expected future technology gains are reflected in current stock prices. Then by the standard mechanism, excess domestic demand drives up real interest rates, this leads to a capital inflow and an appreciation of the domestic currency until the point is reached where investors regard the interest rate differential to be equal to the expected depreciation of the domestic currency.

Secondly, this analysis assumes that the technological innovation is only occurring in one country and there is no international technology diffusion. To the extent that there is diffusion, foreign income and therefore export demand increases as well. In the case of complete diffusion, the long run equilibrium exchange rate would not change.

Thirdly, here it is assumed that technical innovations do not shift export demand. However, as noted by Krugman (1989) it is likely that technical progress is accompanied by product innovations or an increase in the range of products which can be sold in the world market. If this is the case then technical progress leads to an upward shift in both the internal and external equilibrium locus and the long run exchange rate effect of technological innovations will depend on the size of the output and export expansion.

Finally, it is likely that technology shocks are asymmetric, i. e. concentrated in the tradable goods sector.

3.2.2. *Technology Shock in Tradable Sector*

A positive technology shock in the tradable sector will be associated with a relative price decline for tradables (for a given real exchange rate expressed in terms of consumer prices) That means that the relative price change generates a trade surplus and an increase in demand for domestically produced goods (both tradables and non tradables) for the given real exchange rate. The second effect occurs because the relative price not only changes the structure of demand of domestic residents but also increases export demand. Therefore both equilibrium loci equally shift upwards by the relative price shock and a relative productivity improvement of tradables unambiguously leads to a long run appreciation of the domestic currency. This real exchange rate response is also known as the Balassa Samuelson effect. Notice however, that a positive technology shock to the tradable sector which is not compensated by a negative shock to the non tradable sector, will have implications for aggregate productivity. Our discussion in section 3.2.1 suggest, however, that exchange rate effects from aggregate technology shocks will be small, but there exists the theoretical possibility that aggregate effects could dampen the real appreciation of the domestic currency.

Figure 4: Effect of a Relative Productivity Improvement in the Tradable Sector

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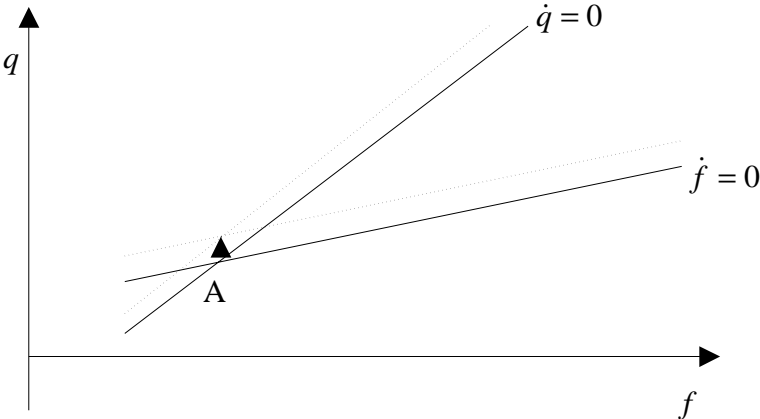
A different rate of technological change in the tradable vs. non-tradable sector has long been recognised as a cause of sustained movements in real equilibrium exchange rates (Balassa Samuelson effect). This phenomenon is often advanced as an important factor underlying the long-term appreciation of fast-growing relative to slow-growing economies (catching-up). Fast growing countries with a low capital labour ratio experience most relative productivity gains in the tradable sector, where the potential for capital accumulation, efficiency improvements, high growth and catching up is higher than in the non-tradable sector.

3.3   Structural Reforms

Structural change can occur in very different ways, therefore we select a few aspects in the following discussion.

3.3.1   Increasing Innovative Activity

If there are structural barriers which prevent the realisation of technological innovations (capital markets, mobility, regulations etc.), then removing these barriers could lead to technology improvements and/or an increased supply of domestic goods as described in the previous section. The exchange rate effect depends crucially on where the innovation takes place. For example, if additional innovations are concentrated in the tradable sector, an appreciation is to be expected. However, if structural reforms lead to innovations in the non tradable sector, then a depreciation is likely.

3.3.2   Labour/Goods Market Reform

If structural reforms in the labour market would lead to a reduction in the NAIRU then the effect on the exchange rate is similar to the effect of an aggregate technology shock (capacity shock). If it is an aggregate shock the long run effect for the exchange rate is either zero or slightly negative. A labour market reform that lowers the price of non tradables (for example, by lowering the price of low skilled labour in services) would lead to a depreciation in the long run.

Similarly, increasing competition in the non tradable sector would lead to a price decline for non tradables and would therefore require a long run depreciation of the domestic currency. If it had positive aggregate supply effects it would reinforce the long run depreciation of the currency.

Lowering corporate tax rates which would lead to an increase in domestic investment would lead to a typical overshooting reaction of the exchange rate. Increased investment and therefore demand would firstly increase domestic interest rates and cause an appreciation. The economy would run a current account deficit and foreign assets would decline. The pressure on interest rates would be reduced gradually as investment leads to an increase in productive capacity via capital accumulation. Thus the economy, after an initial appreciation, would end up with a lower real exchange rate than before in order to service the increased interest payments to foreigners.

## 3.4.   Changing Membership in a Currency Union

The framework described above can be used to analyse the likely effects of increasing an existing currency union (German Unification, increasing Euro membership). The model suggests that the fiscal implications and the technology trends of a country that joins monetary union are crucial for the movement of the exchange rate in the extended currency union. If the country that joins a monetary union experiences a relative price decline of tradables to non tradables that exceeds the decline of the incumbents (stronger relative productivity increase in the tradable sector) then it is likely that the extended monetary union

will experience an appreciation. Such a situation seems likely if a less developed country with good growth prospects in the tradable sector joins at an exchange rate which correctly reflects international competitiveness at the entry date. If on the other hand a country joins which requires fiscal transfers in order to maintain its membership, then both a higher risk premium and an increased budget deficit will eventually cause a real depreciation.

3.5.   Ageing/Changes in Desired Wealth Target

The exchange rate effects of ageing are ambiguous. Though it is likely that the savings rate declines in the long run, it may nevertheless increase in the short and medium term in anticipation of lower pension payments and higher contributions. Here we concentrate on the long run effects of ageing, i. e. a reduction in the long run wealth target F. The dynamic adjustment of the exchange rate to this kind of shock can be characterised as follows: initially, lower savings leads to an increase in domestic interest rates. This is associated with a capital inflow and an appreciation of the domestic currency to a point high enough such that expectations of future depreciation are consistent with the current interest differential. Future depreciation are expected by capital markets since they expect a decline in demand as the economy is running down its assets. Finally, long run external balance requires more exports/less imports and therefore a depreciation. The adjustment of the real exchange rate is therefore given by Figure 5.

Figure 5: Effects of Ageing on RER
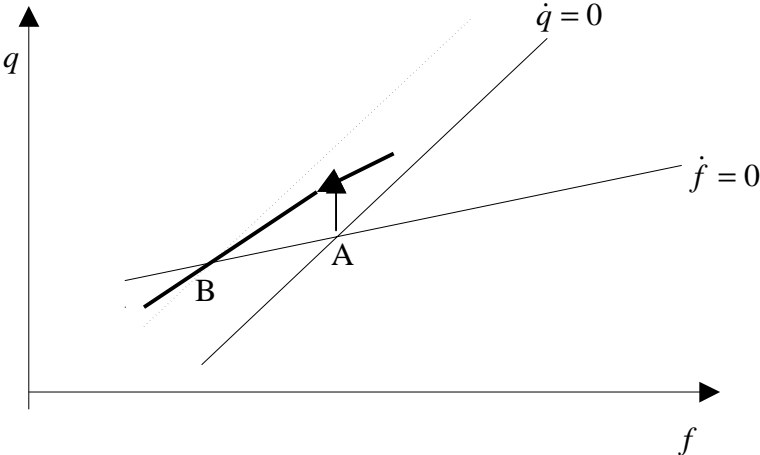
4.   Empirical Specification

The theoretical analysis outlined in the previous section defines a long run equilibrium, which is the intersection between the internal and the external equilibrium locus (eq. (11'') and (12'')), and an equilibrium trajectory of the exchange rate or an adjustment path that leads to long run equilibrium. The empirical estimates try to identify the latter in a specific sense, namely as the path of the exchange rate, generated by eliminating all temporary shocks on the exchange rate based on a decomposition suggested by Gonzalo and Granger (1995). The distinction between temporary and permanent shocks is important in this context. If all exogenous shocks were only of a temporary nature, the equilibrium exchange rate would always return to its initial equilibrium level. In this case, deviations of the actual from the (long run) equilibrium exchange rate could always be calculated by looking at the deviation of the current exchange rate from its historical mean value. In the presence of non stationary

shocks (or more precisely, forcing variables which are themselves non stationary), the equilibrium exchange rate can only be represented *conditional* on the level of the non stationary driving variables of the model. In order to clarify the equilibrium concept in the presence of non-stationary driving forces it is useful to define the vector of all exogenous variables in the model $X = (q_I, L^{nairu}, T, tax, S^G, risk, tr)$ and denote the sub-vector of all non stationary and all stationary elements as X^{ns} and X^s respectively. For the moment we leave unspecified which variables are contained in each sub-vector. The full dynamic representation for *f* and *q* is given by

$$(16) \qquad f_t = df_{t-1} + \gamma^{ns} X_{t-1}^{ns} + \gamma^s X_{t-1}^s + \omega \sum_{j=0}^{\infty} \lambda^j E_{t-1}(b^{ns} X_{t+j-1}^{ns} + b^s X_{t+j-1}^s)$$

$$(17) \qquad q_t = af_t + \sum_{j=0}^{\infty} \lambda^j E_t (b^{ns} X_{t+j}^{ns} + b^s X_{t+j}^s) \ .$$

The non stationary exogenous variables are given by a random walk

$$(18a) \qquad \Delta X_t^{ns} = v_t$$

and the stationary processes are given by an MA process

$$(18b) \qquad X_t^s = \varphi(L)u_t \ .$$

It should be kept in mind that both *f* and *q* are endogenous variables but nevertheless *f* has a different status, it is a state variable that is largely *predetermined* or influenced by past developments (i.e. it summarises the whole history of current account imbalances). This predetermined status renders *f* as a quasi explanatory variable for *q*. As can be seen from (17), the evolution of *q* depends on *f* and expectations on the present value of the exogenous variables. It is important to distinguish the two types of shocks: v_t has a permanent effect on X^{ns} while u_t only has a temporary effect on X^s. Therefore, *u* shocks do not have a permanent effect on *q* and *f*. The trend extraction procedure suggested by Gonzalo and Granger (1995) removes the transitory fluctuations from the data. In the context of the model the permanent component would be given by

$$(17') \qquad q_t^p = af_t^p + b^{ns} X_t^{ns}$$

where f_t^p is the value of f_t, purged from temporary shocks. This relationship fulfils the following properties :

1. the real exchange rate will only deviate in a stationary fashion from given levels of *f* and non stationary exogenous variables,

2. the permanent component of the real exchange rate is free from shocks which do not affect the long run level of the exchange rate.

The first task of the empirical analysis therefore is to select the non stationary forcing variables. Alberola et al. only regard the variable q_I as relevant, i. e. included in X^{ns}. This hypothesis can be checked via a *cointegration test*. From (17) it follows immediately that under this hypothesis, a regression of the form

$$(18) \qquad q_t = a_f f_t + a_x q_{I,t} + z_t$$

should yield a stationary residual z_t [8]. Our cointegration tests confirm that result (see section 5.2). The cointegration regression itself is, however, not sufficient to determine the permanent components of the exchange rate. Alberola et al. apply a decomposition suggested by Gonzalo and Granger to extract the permanent components from the data. This procedure not only uses the cointegrating vector but also the adjustment coefficients for determining the common trends for the three variables. For the interpretation of the empirical results it is important to explain in some detail the intuition which lies behind the procedure.

If q, f, q_I are cointegrated then their dynamics can be represented by the following VAR model[9]

$$
\begin{bmatrix} \Delta q_t \\ \Delta q_{I,t} \\ \Delta f_t \end{bmatrix} = \begin{bmatrix} \gamma_q \\ \gamma_{q_I} \\ \gamma_f \end{bmatrix} \left(q_{t-1} - \beta_1 q_{I,t-1} - \beta_2 f_{t-1} \right) + A(L) \begin{bmatrix} \Delta q_{t-1} \\ \Delta q_{I,t-1} \\ \Delta f_{t-1} \end{bmatrix} + \begin{bmatrix} u_{1,t-1} \\ u_{2,t-1} \\ u_{3,t-1} \end{bmatrix}.
$$

The elements of the vector γ give information on the speed of adjustment of the corresponding variable to a (stationary) deviation from long run equilibrium as defined by the cointegrating relationship. Notice, for a long run equilibrium to exist it is not necessary that all variables adjust to a disequilibrium, i. e. not all elements of γ must be non zero. What the Gonzalo Granger trend decomposition method singles out as the permanent or trend component of q, q_I and f depends strongly on the adjustment speeds. The following examples are supposed to clarify this.

Case 1

Suppose, that relative productivity can be regarded as independent of the exchange rate and entirely determined by technological conditions. In this case, q_I would be exogenous relative to net foreign assets and the real exchange rate. Also q_I would be the only non stationary driving variable of the system and q and f would respond to shocks coming from q_I. The adjustment coefficients would be given by $\gamma_q < 0, \gamma_{q_I} = 0, \gamma_f < 0$. The Gonzalo Granger method uses the "orthogonal complement ($\gamma_\perp'$)" to the vector γ to determine the permanent or non stationary component of q, q_I and f. In this case the permanent components would be given by

$$
\begin{bmatrix} q_t^p \\ q_{I,t}^p \\ f_t^p \end{bmatrix} = A_1 \begin{bmatrix} 0 & \eta_1 & 0 \\ 0 & \eta_2 & 0 \end{bmatrix} \begin{bmatrix} q_t \\ q_{I,t} \\ f_t \end{bmatrix} \quad with: \gamma_\perp' = \begin{bmatrix} 0 & \eta_1 & 0 \\ 0 & \eta_2 & 0 \end{bmatrix} and \ A_1 : (3 \times 2) \ Matrix .
$$

As can be seen from this expression, the permanent component of q, q_I and f would be identical to q_I itself. This is intuitively plausible given the underlying model and the assumptions made. Both q and f respond to q_I and there is no independent (permanent) contribution from f on q.

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[8] Notice, however, even if we accept cointegration this does not imply that the regression captures all non stationary driving forces for the real exchange rate.

[9] To simplify the presentation we assume there is only one cointegrating relationship.

<u>Case 2</u>

As we have seen in Case 1, if there are non stationary exogenous variables, then the trend component of the exchange rate will be strongly determined by the trend components of these explanatory variables. In models with prices determined in (forward looking) financial markets a complication arises, since the prices themselves have a random walk property in the sense that prices only respond to news that is available in period t. Take for example equation (17) and assume that the wealth effect is small ($a_f = 0$), then the exchange rate would be entirely driven by expectations of future exogenous variables. In other words, q itself summarises permanent exogenous shocks hitting the economy. Suppose further that q_I cannot be regarded as exogenous[10]. In that case q itself summarises all unobservable exogenous shocks. Under this constellation the adjustment parameters could for example be given by $\gamma_q = 0, \gamma_{q_I} > 0, \gamma_f < 0$ and the Gonzalo/Granger decomposition would represent the permanent component as follows:

$$
\begin{bmatrix} q_t^p \\ q_{I,t}^p \\ f_t^p \end{bmatrix} = A_1 \begin{bmatrix} \mu_1 & 0 & 0 \\ \mu_2 & 0 & 0 \end{bmatrix} \begin{bmatrix} q_t \\ q_{I,t} \\ f_t \end{bmatrix}
$$

In this case, the permanent component of the exchange rate (as well as for q_I and *f*) would correspond to the exchange rate itself. Therefore a relatively good fit for the permanent component must be interpreted with caution. Firstly, it can signal misspecification of the underlying model, i. e. the presence of important unobservable explanatory variables. Second, even if one regards the exchange rate as responding efficiently to news this would still imply potentially large current account imbalances. Therefore it might be advisable to put more emphasis on the cointegrating vector for interpreting the current level of the exchange rate. This could be useful since the "equilibrium error" as represented by the variable *z* (see eq. 18) summarises the deviations of the three variables from their long run equilibrium irrespective of any causal interpretation. For example a positive *z* could still be interpreted as a situation where the exchange rate is too high given q_I and *f*. Notice however that the empirical estimates would nevertheless suggest that it is not the exchange rate that will bring about the adjustment but other variables such as aggregate demand for example.

Both cases are of course extreme cases, in general the permanent component will be a linear combination of all three variables where the weights are functions of the cointegration vector and the loading matrix, with more weight given to the "exogenous" variables.

5. *Estimation and Results*

Equation (18) forms the basis for the subsequent country by country analysis. As a general principle, q_I and *f* represent supply and demand effects on the real exchange rate. As shown in the theoretical section, permanent improvements in productivity in the tradable sector (relative to non-tradables) should lead to a real appreciation of the real exchange rate. The net foreign asset position on the other hand is an indicator of future demand conditions in an economy. A low/high value of *f* puts downward/upward pressure on domestic demand which leads to a depreciation/appreciation of the domestic currency.

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[10]   For example, very different import shares for the tradable and non tradable sectors.

Section 5.1 describes the data set. The first step of the estimation process is to test for cointegration (section 5.2). The second step is to estimate the cointegration vector and by that the trend or equilibrium real effective exchange rates for each country (section 5.3). Estimations are carried out by applying the Johannsen and Gonzalo-Granger trend decomposition methodology. An alternative set of estimates is produced by applying cointegration technique alone.

5.1 The Data

Relative productivity of a certain country towards its trading partners is modelled by the ratio of domestic non tradable to tradable prices in relation to the weighted ratio for the trading partners.[11] The trade weights of the Commission Services are used to calculate weighted price indices for trading partners of the individual countries.

The data sources for this study are basically the same as in Alberola et.al (1999). The major exception is that trade weights based on Commission calculations rather than TCW weights from the IMF are used for deriving effective exchange rates and weighted price levels.[12] The GDP deflator is chosen as the preferred deflator, in accordance with the Commissions Quarterly Competitiveness Report (rather than consumer prices in Alberola et.al (1999)).[13] Indices for consumer and producer prices are taken from the International Financial Statistics (IFS) database. Some minor gaps exist for a few countries for producer prices which have been filled by interpolation. Current account data is taken as well from the IFS database. However, major gaps exist for a couple of countries (Greece, Portugal among others). These have been filled by comparable data from the OECD Main Economic Indicators (MEI) database, which actually uses IFS as their source, and in the case of non-availability from national statistical sources. Data for net foreign assets are supplied in the OECD publication Economic Outlook, December 1996. Data for Greece have been taken from the Greece National Bank and data for Portugal and Ireland have been calculated by adding up historical current account balances.[14] The evolution of the net foreign asset position for each country is then obtained by adding up the current account balances. The resulting time series for net foreign assets stocks should be interpreted very cautious. In order to adjust for the size of the country, net foreign assets were normalised by GDP.

5.2 Cointegration Tests

Our cointegration testing strategy follows Alberola et al (1999).[15] We firstly conducted both ADF and PP cointegration tests for equation (18). When compared with the MacKinnon critical values they suggest stationarity or borderline stationarity for most countries. While these results do not appear to provide overwhelming support for stationarity, it should be borne in mind that these tests are not very powerful when the number of observations used are small, as in the present case. Recently, attempts have been made to increase the power of cointegration tests by taking into account the cross section dimension in cases where the time series are not very long but similar data are available across countries. The most general formulation of a panel cointegration test to date is the one from Pedroni (1997, 1999) which

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[11] In detail, the domestic ratio of consumer price index CPI to the wholesale price index WPI relative to the foreign ratio is used. The CPI contains a large share of non-tradables (mainly services), whereas the wholesale index contains mainly tradables. Thus, the ratio of CPI to WPI is an increasing function of the relative price of non-tradable goods.

[12] Quarterly report on the price and cost competitiveness of the European Union and its Member States (European Commission). Before the launch of the monetary union, the effective euro exchange rate has been calculated as the trade weighted average of member countries exchange rates.

[13] Consumer prices include a large share of non-tradable prices.

[14] This data is probably of very poor quality due to the simplistic calculation method.

[15] No unit root tests have been performed for three reasons. Firstly, theoretical considerations argue for unit roots in all variables. Secondly, the power of unit root tests (DF-test, ADF-test) is low which means that unit roots can rarely be rejected in most cases. Thirdly, rejection of unit roots can often easily be explained away as sample problems.

Box 1 - Construction of the explanatory variables

The construction of the data for net foreign assets (as a percentage of GDP) and relative productivity is subject to a variety of data problems.

Stock data for net foreign assets and current account balances are denominated in US dollars. GDP data is originally denominated in domestic currency and converted to dollars by multiplying them with prevailing exchange rates. The rational behind this procedure is to take account of valuation effects of foreign exchange rate changes on net foreign asset positions, as the dollar is the single most important currency for both real and financial transaction in the world economy.

One problem with this procedure is the emergence of spurious correlation between the dependent and the independent variables. A change in the dollar exchange rate alters GDP and the net foreign asset to GDP ratio accordingly. Besides distortions to net foreign asset data due to high short-term dollar exchange rate volatility, this introduces spurious positive correlation with real exchange rate data and may contribute to an overstated "goodness of fit" for the regression.

The opposite procedure to exclude valuation effects of foreign exchange rate changes is to convert all figures into domestic currency. However, this implies that no adjustment is made for differences in inflation rates and subsequent exchange rate changes which deflates (inflates) the net foreign asset position (as a percentage of GDP) of high (low) inflation countries. This creates unreasonable results, if a substantial part of net foreign debt is denominated in foreign currency, which should be the case for an overwhelming number of countries in the sample.

A third way to proceed is to make assumptions about the shares of different currencies in the denomination of foreign debt for the individual countries. This appears (at least theoretically) as a workable procedure, but may be rather tedious in practice and moreover associated with a host of subjective assumptions.

A forth alternative is to convert GDP data with the trend in the dollar exchange rate instead of the actual dollar exchange rate. The advantage of this procedure in an economic sense is to disregard high dollar exchange rate volatility which probably does not effect economic behaviour. The advantage in a statistical sense is to remove spurious correlation with the dependent variable. However, trend calculations are generally subject to a large extend of subjectivity in choosing the smoothing parameter.

A corresponding problem with spurious correlation exists for the relationship between the real effective exchange rate and the productivity variable. Nominal exchange rate changes feed rapidly through in wholesale prices and produce spurious correlation between real exchange rates and our chosen measure of productivity.

The existence of spurious correlation and an inflated goodness of fit of the estimations varies between countries, but appears to be more pronounced for small economies. For some countries, application of the Gonzalo-Granger trend decomposition method adds to the inflated goodness of fit. This must be born in mind, when the empirical results are assessed, and unreasonably small deviations between actual and fitted values should be judgementally adjusted for perceived spurious correlation.

allows both fixed effects and heterogeneous coefficients across cross sectional units. Pedroni develops various panel cointegration tests and especially extends the ADF and PP tests. He shows that these panel cointegration statistics approximately follow a standard normal distribution after appropriate standardisation. As can be seen from the results of the panel cointegration test shown below, the hypothesis of no cointegration can be rejected at the 5% level for the panel of 17 countries. In the light of the discussion above, this result suggests that the variable "relative productivity" may indeed be an important factor concerning the long run trend of the real exchange rate. Indirectly this result suggests that other variables like government savings, while possibly important for medium term developments of the exchange rate are not likely to have a permanent influence on the real exchange rate.

RESULTS of Panel Cointegration tests:
■■

■■

country estimations can easily be improved by including additional explanatory variables in the regressions or control for certain, country-specific events. However, we refrained from this approach, in order to present simple and uniform estimations for all country and facilitate the evaluation of the results.

It has been argued in chapter 4 that the Gonzalo-Granger trend decomposition methodology in certain cases produces an exaggerated "goodness of fit" of the cointegration estimation. For this reason, estimation results are reported relying on both the application of the trend decomposition methodology and cointegration technique alone.

The next section reports and evaluates the empirical results of the study on a country by country basis.

Box 2 - Different approaches to estimate real equilibrium exchange rates

The most basic approach of real equilibrium exchange rate analysis, based on the concept of purchasing power parity (PPP), is the assessment of international competitiveness indicators (see Turner and Van't Dack (1993)). This involves comparing past movements in prices or costs at home and abroad, taking into account changes in nominal exchange rates; the focus is thus on developments in a country's real exchange rate. If such an examination reveals a substantial gain or loss in competitiveness relative to a base period in which the external position was regarded as in equilibrium, there is a presumption that the exchange rate is no longer consistent with the underlying external position of the country. While a country's international competitive position is clearly one important determinant of its current account, since it is a key relative price determining the choice between domestic and foreign goods and services, other factors are also relevant. More specifically, this approach assumes an unchanged equilibrium real exchange rate and ignores future developments that effect the rate, and thus it provides only a partial and incomplete analysis. A full assessment of exchange rates, therefore, requires a more general framework suitable for the analysis of the determinants of equilibrium real exchange rates.

To overcome the deficiencies of an indicator based approach, it is necessary to relate the discussion and analysis of exchange rates more directly to the notion of a sustainable or equilibrium exchange rate. The probably most influential approach is the "underlying balance" approach to equilibrium exchange rates which was developed by the International Monetary Fund (IMF) staff during the 1970s. It is based on a macroeconomic approach of internal and external balance that abstracts from short-term, cyclical fluctuations in output, inflation and interest rates and focuses on exchange rates that are consistent with economic fundamentals over the medium term. Internal balance means a situation in which real output is at its potential level and inflation is at a low and non-accelerating rate. External balance means a current account position that would be generated by the economic fundamentals of national saving and investment when the economy is in internal balance, with the additional requirement that the resulting path of net foreign assets must be sustainable.

The macroeconomic balance approach encompasses the indicators approach but is more comprehensive, since a broad range of economic fundamentals enter the calculation via their effects on the levels of internal and external balance (see Clark et al. (1994)). The calculation of real exchange rates consistent with internal and external balance provides a framework for assessing the consistency of the actual exchange rate with economic fundamentals, which are those key variables underlying the macroeconomic balance position.

Two methods for making the calculations have been adopted in the literature: a comparative static, partial-equilibrium approach by estimating trade equations and a dynamic macroeconomic approach using fully specified macroeconomic models. In the first approach, the functional relationship between the current account and its determinants, namely domestic output, foreign output and the real exchange rate is specified and estimated in the form of a trade equation. It is then straightforward to calculate the level of the real exchange rate that is consistent with estimated equilibrium values of the current account, domestic output and foreign output. Large macroeconomic models, on the other side, provide a better framework to take account of mutual interactions between key variables, but can be expected to produce less robust estimations (see Williamson (1990) and Bayoumi (1994)).

The approach in this paper is closely related to the macroeconomic balance approach. Both the theoretical and empirical analysis are based on an open economy macroeconomic model of internal and external balance. However, the concept of external balance is somewhat different. Instead of assuming or estimating values for the equilibrium current account and desired net foreign assets, a functional relationship between net foreign assets and real exchange rates is theoretically derived and estimated. External equilibrium is defined as stable net foreign asset ratio of GDP. A certain real exchange rate is required for each net foreign asset position in equilibrium in order to generate current account balances that stabilise the net foreign assets ratio of GDP. The relationship between net foreign assets and the real exchange rate is estimated using historical data. Hence, every historical observation of net foreign assets is statistically treated as an equilibrium position. In case of perceived external imbalances this procedure may be regarded as doubtful. In contrast, the macroeconomic balance approach simulates an estimated trade equation (macroeconomic model) under the assumption of various equilibrium values for current account and/or the net foreign asset ratio of GDP. The possibility to assume different target values for current account and net foreign assets and to carry out sensitivity analysis may be seen as a main advantage of this approach.

However, it is often perceived that economies can experience periods of significant external imbalances where actual net foreign assets are judged to have fallen below their "desired" level, due to certain shocks as the emergence of budget deficits, asset price bubbles or the breakaway of important export markets. If net foreign assets have fallen substantially below their "desired" level, a prolonged period of high competitiveness, alternatively a weaker (medium-term) equilibrium exchange rate, is required to restore external balance. In this case of significant external imbalances, the methodology of cointegration will produce questionable results.

In contrast, the macroeconomic balance approach simulates estimated trade equations (macroeconomic model) under the assumption of various equilibrium values for current account and/or the net foreign asset ratio of GDP (see Isard and Faruqee (1998)) . The possibility to assume different target values for current account and net foreign assets and to carry out sensitivity analysis may be seen as a main advantage of this approach.

The theoretical and empirical model for the real equilibrium exchange rate, applied in this study, includes a further explanatory variable from the supply side of the economy, namely relative productivity of the non-tradable versus the tradable sector (Balassa Samuelsson hypothesis) across countries. This variable is supposed to explain trends in real exchange rates which are not related to external development trends. The existence of various structural variables in the theoretical and empirical model offers the opportunity to analyse a wider range of economic issues. In contrast, estimations and simulations of simple trade equations can potentially have problems to deal with trends in real exchange rates that are considered to depend on supply side developments.

5.4 Presentation and Evaluation of the results

In the **United States**, the net foreign asset ratio of GDP has practically fallen throughout the sample period which can be explained by a combination of high domestic demand pressure and favourable supply side developments. Domestic demand has been buoyant in the past two decades due to increases in public expenditure in the 1980s, strong private consumption bolstered by tax cuts, rising asset prices, substantial employment growth and high consumer confidence. Private investment has been fostered by tax cuts. In terms of our model, rising domestic demand implies an upward shift of the internal equilibrium schedule. In the short run, the exchange rate will appreciate in order to hold back net exports and prevent the economy from overheating. In the medium-term, a falling net foreign asset ratio of GDP will depress private consumption and the exchange rate has to depreciate below its original level in order to keep actual GDP at potential.

The US economy has probably experienced various favourable supply side developments during the past two decades. Structural reforms, a fall in the NAIRU, technological innovations and thus an increased potential growth rate has implied a downward shift in the external equilibrium schedule as import demand has grown more strongly than export demand. Moreover, higher actual and expected productivity growth has probably induced an even higher surge in private demand, particularly via rising asset prices and increased confidence, driven up interest rates and by attracting capital flows put upward pressure on the exchange rate. In the medium term, current account sustainability and a stabilisation of the net foreign assets ratio of GDP requires a depreciation of the exchange rate. However, technical innovations in the US economy may have changed world export demand in favour of US export goods which would alleviate the pressure on current account, net foreign assets and the exchange rate.

The falling net foreign asset ratio of GDP has caused a downward trend in the estimated real equilibrium exchange rate, especially in the 1980s. This in turn was somewhat counteracted by slowly rising relative tradable vs. nontradable sector productivity sector which has exerted upward pressure on the exchange rate.

The equilibrium estimations for the dollar are not sensitive to the application of the Gonzalo-Granger decomposition method. In line with expectations, the dollar is estimated to have been strongly overvalued in the mid 1980s. In the mid 1990s when US growth started to outpace growth in other major economic regions, the real dollar exchange rate appreciated by around 20%, while the equilibrium rate was held down by falling net foreign assets. The estimated dollar overvaluation in the third quarter of 1999 is around 10%. At least part of this medium-term overvaluation is explained by relative business cycle positions and a positive growth and interest rate differential towards the rest of the world.

One important question concerning the current valuation of the dollar is probably the relationship between the actual and desired net foreign asset ratio of GDP. If US productivity and potential growth have permanently increased relative to their main trading partners, the desired net foreign asset ratio of GDP should have fallen. However, if high aggregate demand pressure has been driven by temporary factors, such as high liquidity or an asset price bubble, desired net foreign assets may be above their current level and the estimated overvaluation would probably be understated.
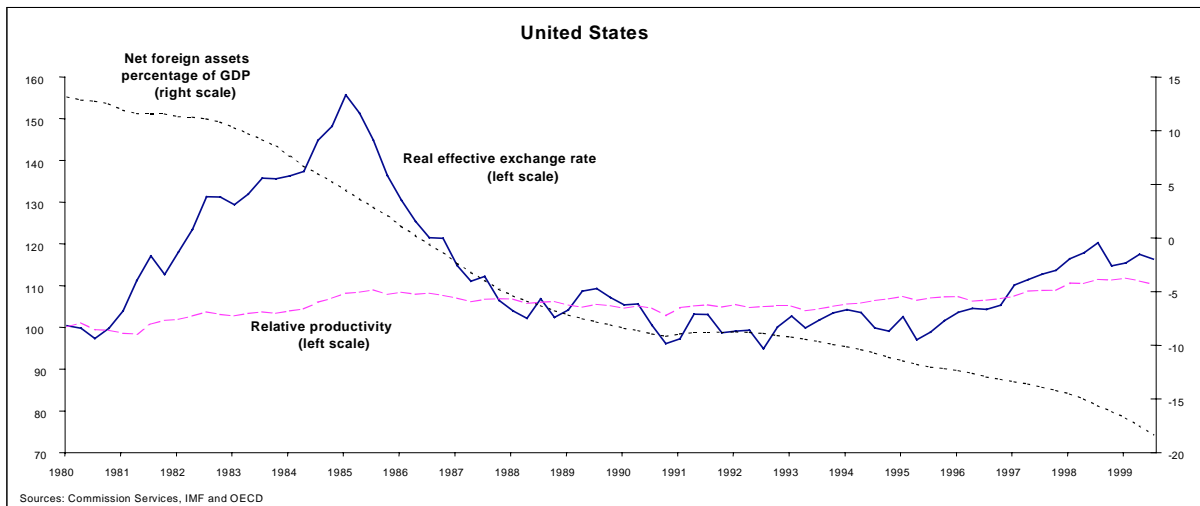
Figure 6 - The data

United States

Net foreign assets
percentage of GDP
(right scale)

Real effective exchange rate
(left scale)

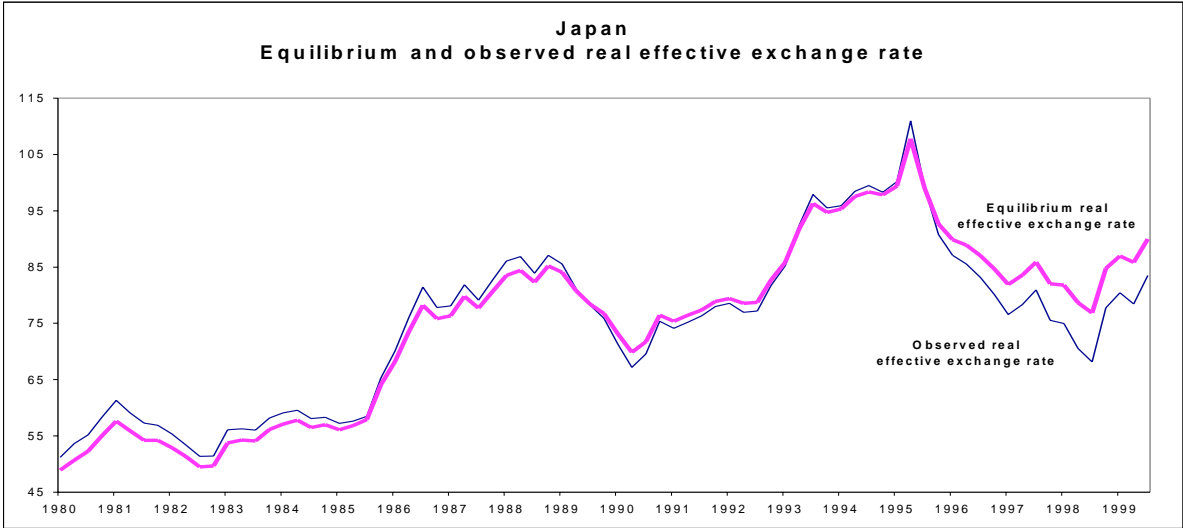Relative productivity
(left scale)

Sources: Commission Services, IMF and OECD

Figure 7 - Estimation results with trend decomposition method

U S A
Equilibrium and observed real effective exchange rate

Observed real
effective exchange rate

Equilibrium real
effective exchange rate

U S A
Deviations from equilibrium
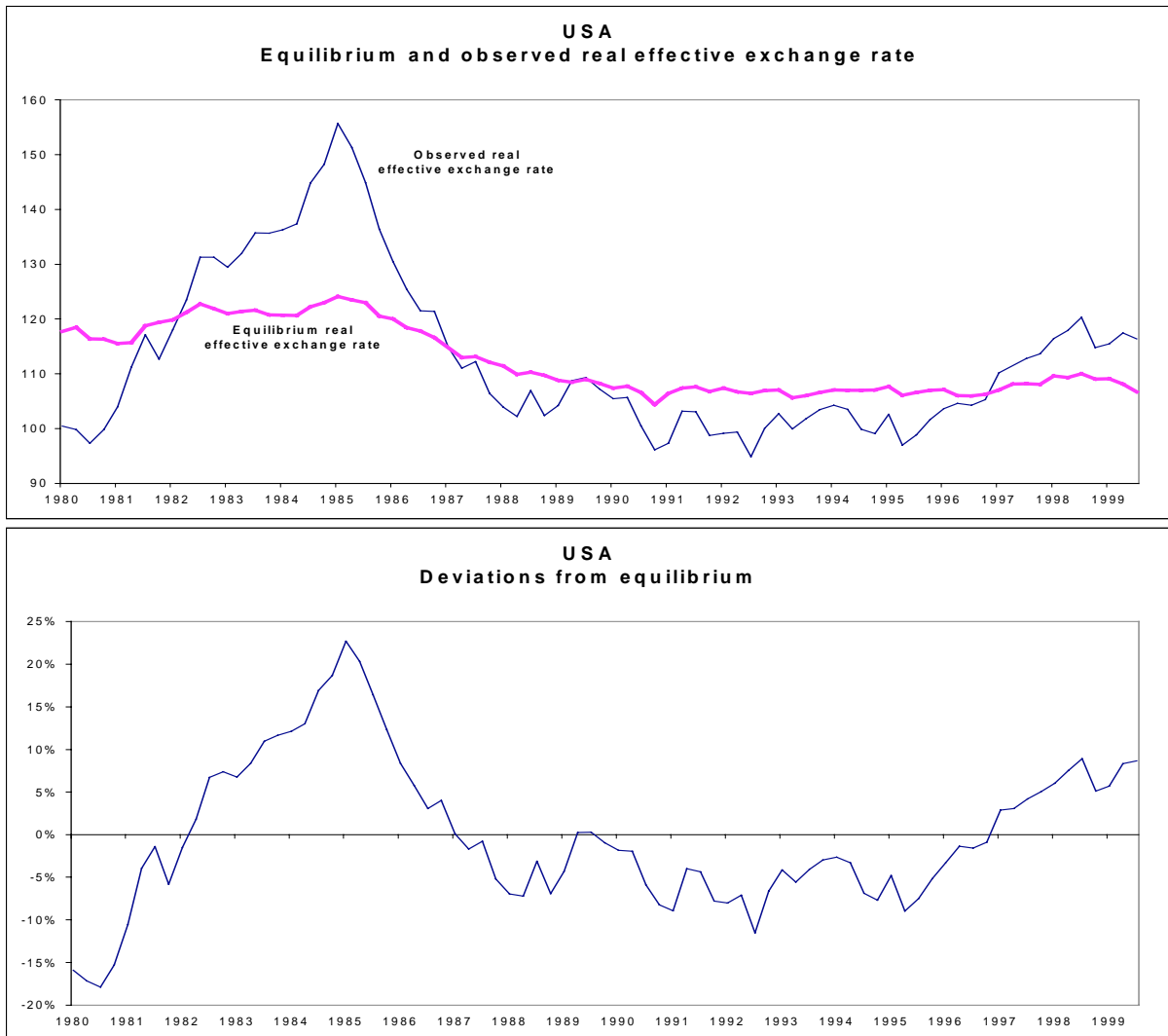
Figure 8 - Estimation results without trend decomposition method

USA
Equilibrium and observed real effective exchange rate

Observed real effective exchange rate

Equilibrium real effective exchange rate

USA
Deviations from equilibrium
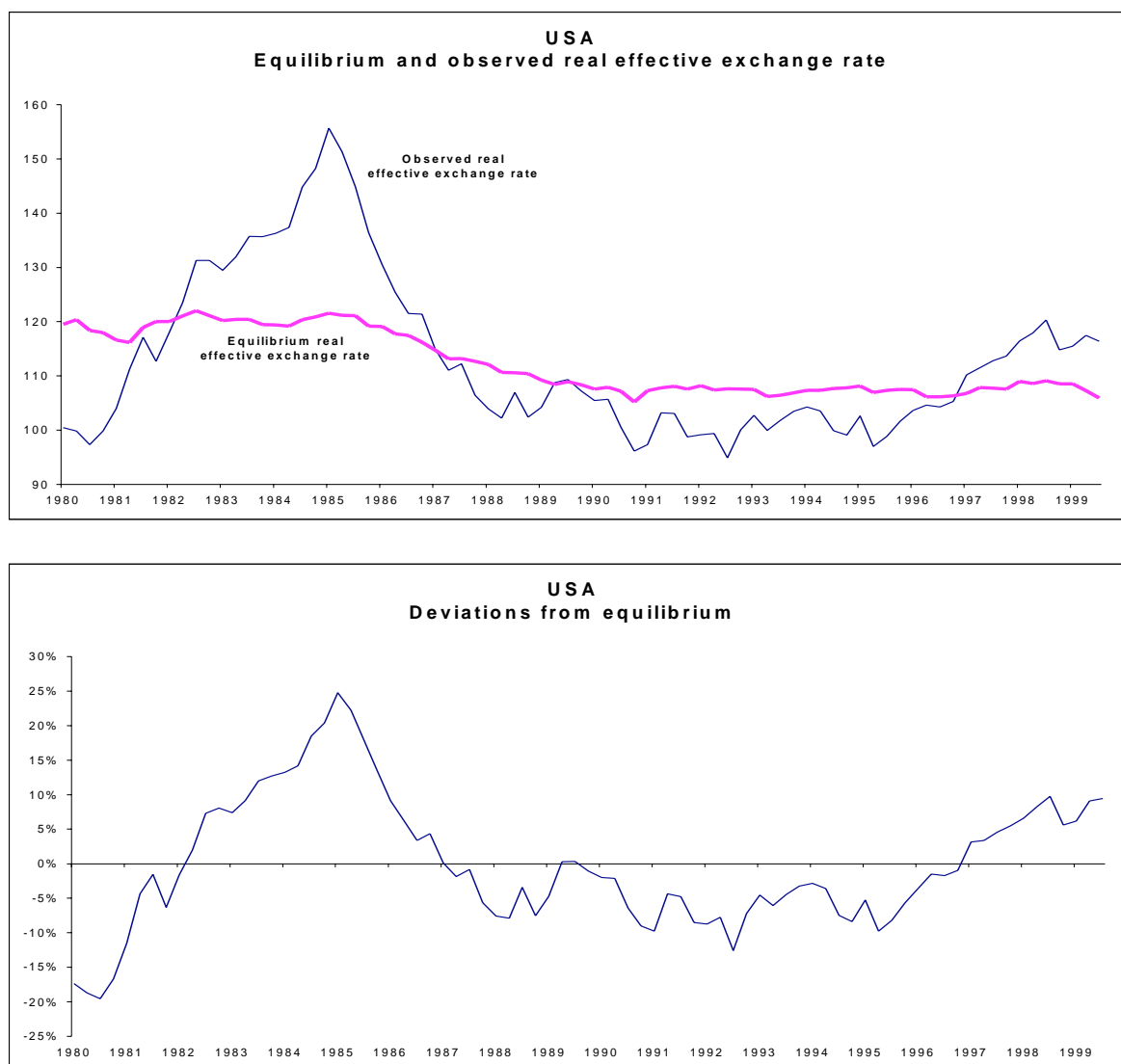
The **Japanese** real equilibrium exchange rate has experienced a long period of appreciation, driven by increasing relative tradable vs. nontradable sector productivity throughout the 1980s and an improving net foreign asset ratio of GDP.

The economy went through an asset price driven boom period in the late eighties which was succeeded by a period of stagnation and large budget deficits, as well as the emergence of structural problems, in the nineties. Neither the boom period in the 1980s, nor the deep recession in the 1990s in connection with worsening structural problems have changed the rising trend in net foreign assets. However, relative tradable vs. nontradable sector productivity has levelled out in the second half of the nineties.

The estimation results are substantially effected by the applied methodology. If the trend decomposition method is used, the estimated real equilibrium exchange rate fell in the second half of the 1990s and a current undervaluation of the yen by about 10 per cent is indicated. However, estimated deviations from trend appear unreasonably small. Relying on cointegration technique alone, the indicated undervaluation is around 20 per cent. The

undervaluation of the yen should, at least partly, be explained by a large output gap and the need to restore internal balance.

Despite their steady increase during the sample period and their currently high level, net foreign asset developments are probably desired and sustainable in light of future demographic developments. On the other hand, structural reforms of the economy increase the potential growth rate and drag down net exports which ceteris paribus requires a depreciation of the real exchange rate.

Figure 9 - The data
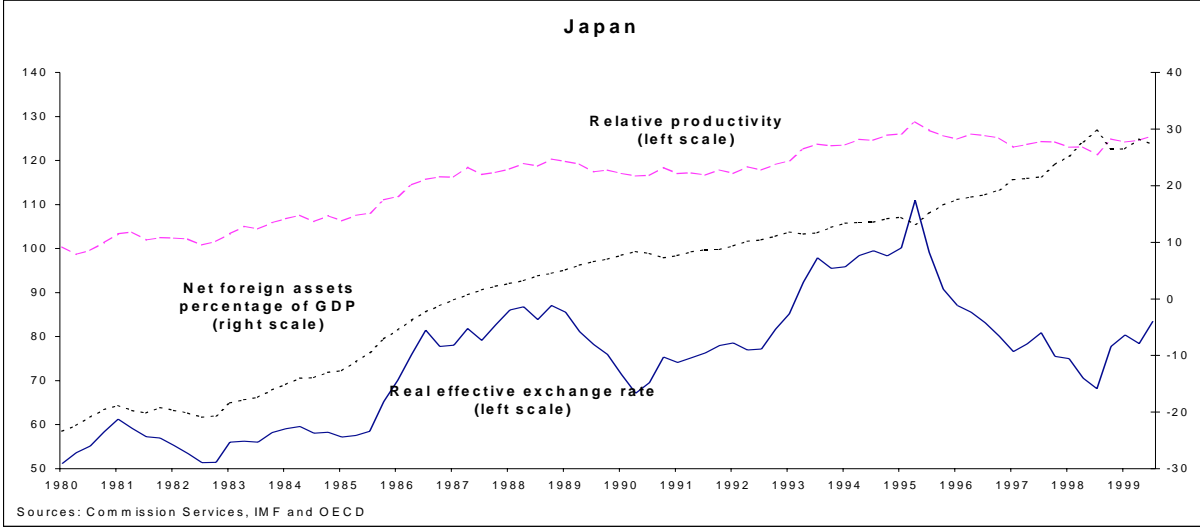
Figure 10 - Estimation results with trend decomposition method

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Japan
Deviations from equilibrium
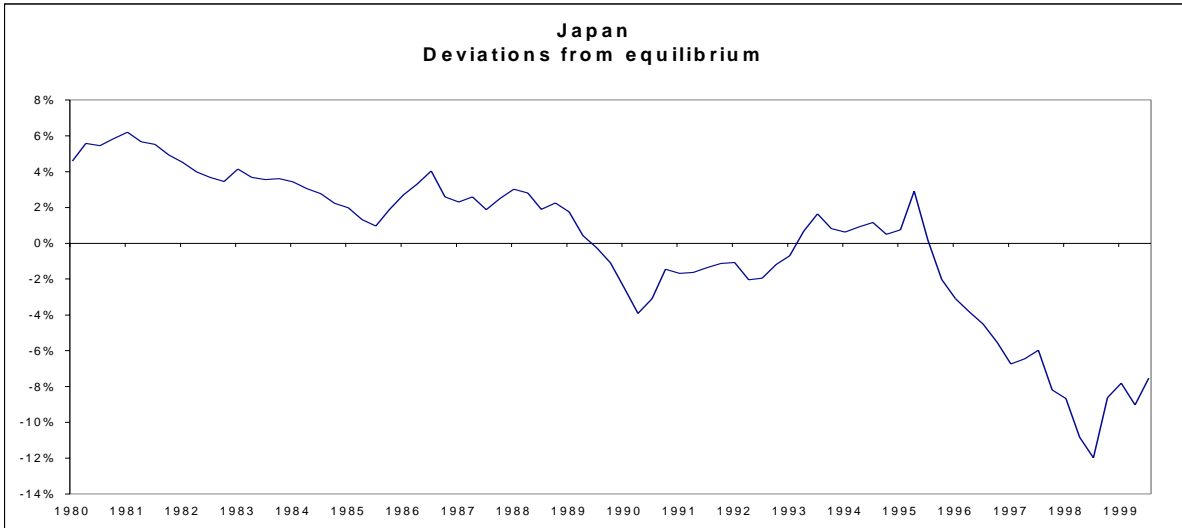
Figure 11 - Estimation results without trend decomposition method
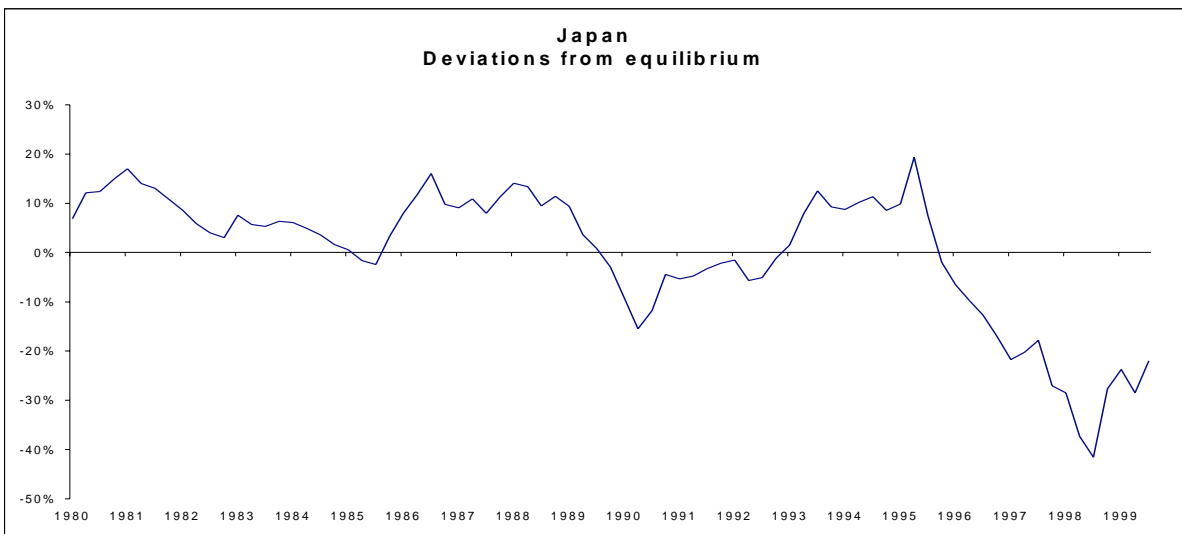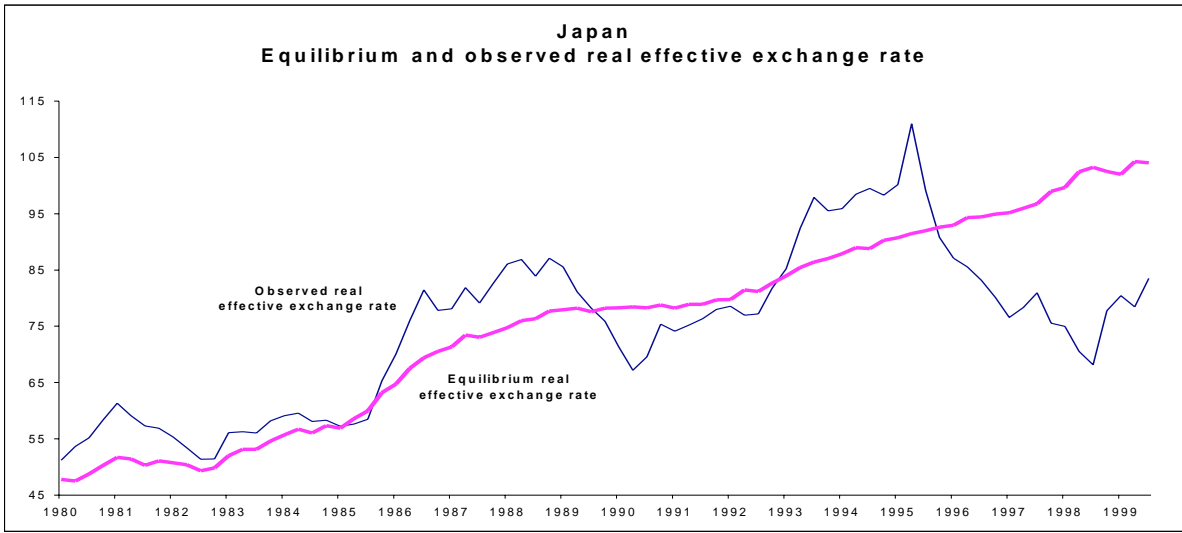
Japan
Equilibrium and observed real effective exchange rate

Japan
Deviations from equilibrium

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Canada's real exchange rate has closely followed trends in relative tradable vs. nontradable sector productivity and the net foreign asset ratio of GDP. The estimates do not indicate periods of substantial deviations between actual and equilibrium exchange rates. Canada's net foreign asset ratio of GDP is very low in an international perspective, but competitiveness appears to have improved in line with higher foreign debt service requirements. According to our estimates, the Canadian real exchange rate has been below its medium-term equilibrium in the third quarter of 1999. Economic growth has been rapid in the recent years, but unemployment is still high, and output is judged to be close to potential. The current account shows modest deficits.

Canada has a very high foreign debt ratio in an international comparison and the full employment current account still appears to be negative. If the actual net foreign assets ratio is substantially below its desired level, a period of surplus in the full employment current account and a lower real equilibrium exchange rate would be required.

Figure 12 - The data
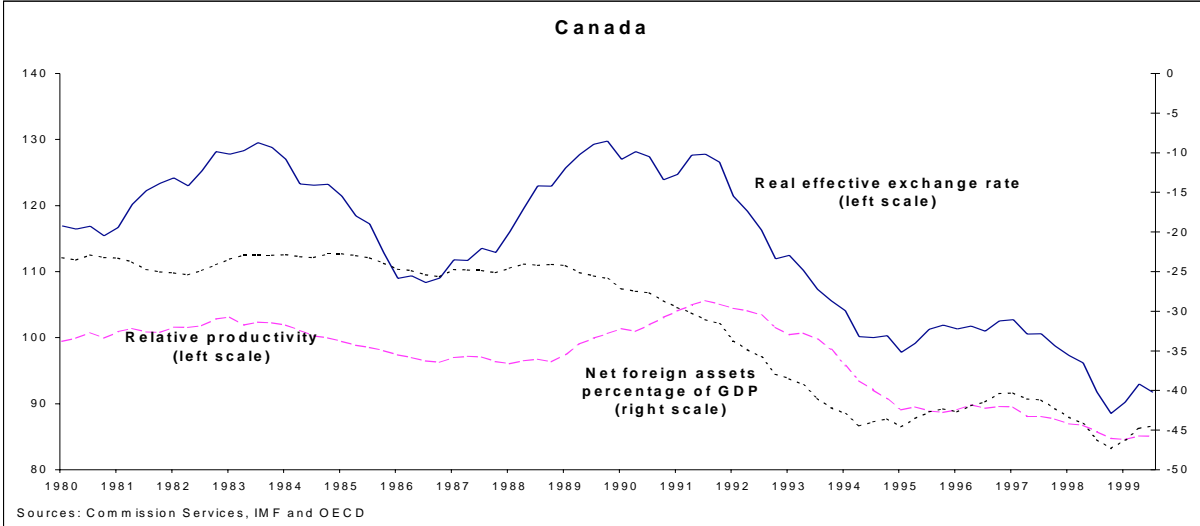
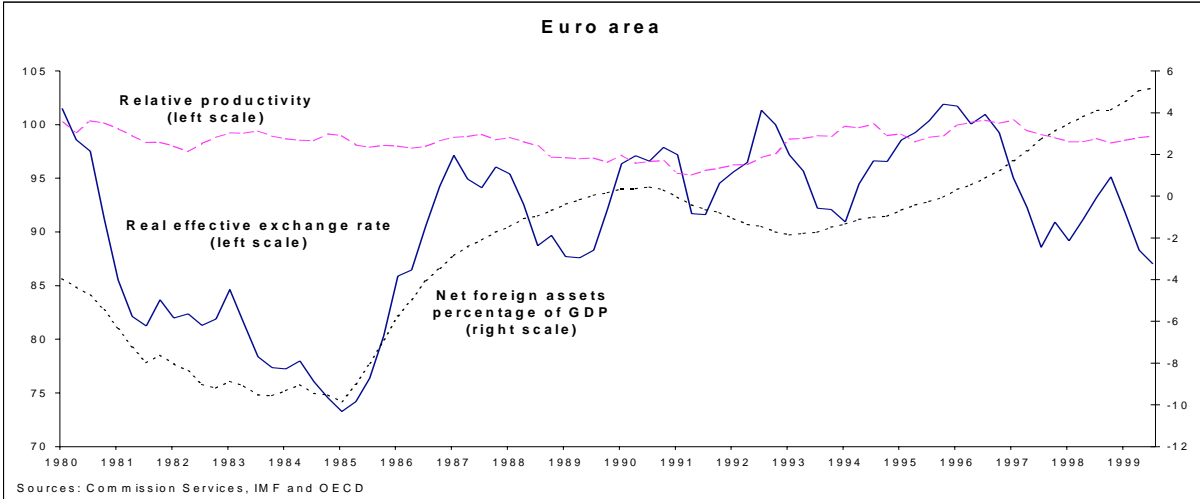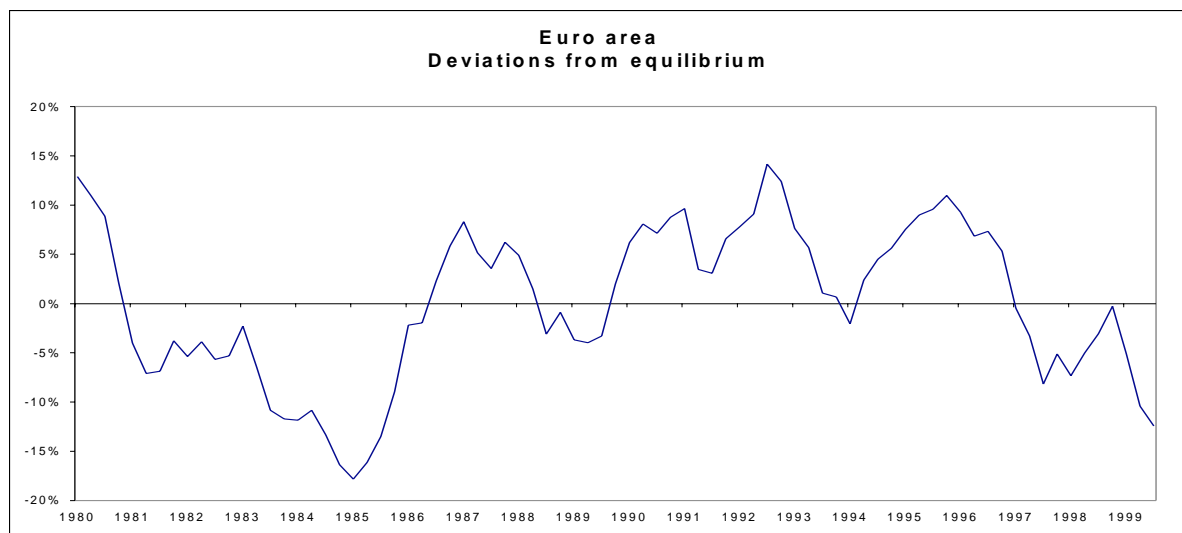*Figure 13 - Estimation results with trend decomposition method*

31
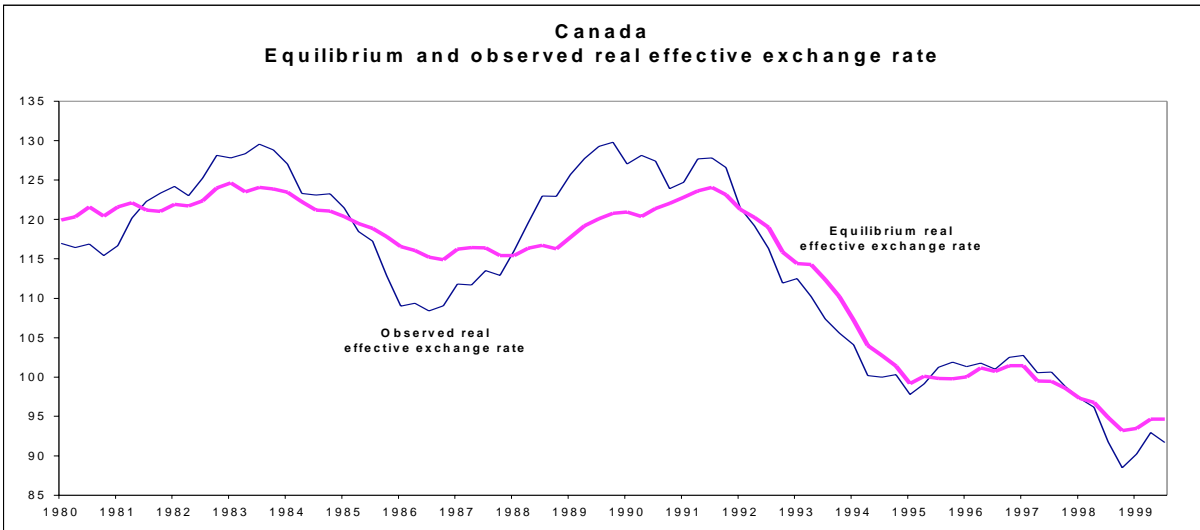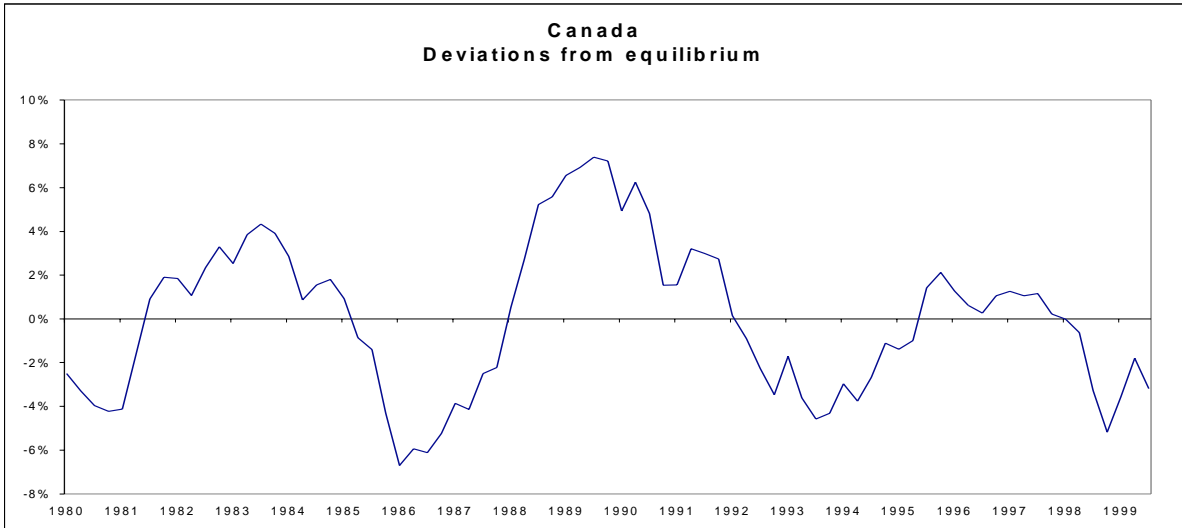
Figure 14 - Estimation results without trend decomposition method
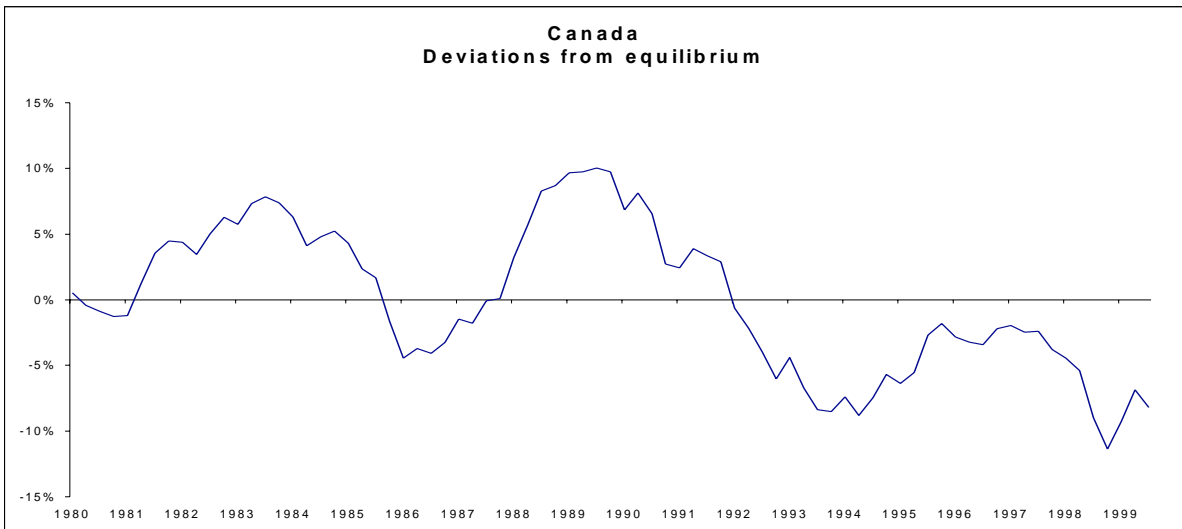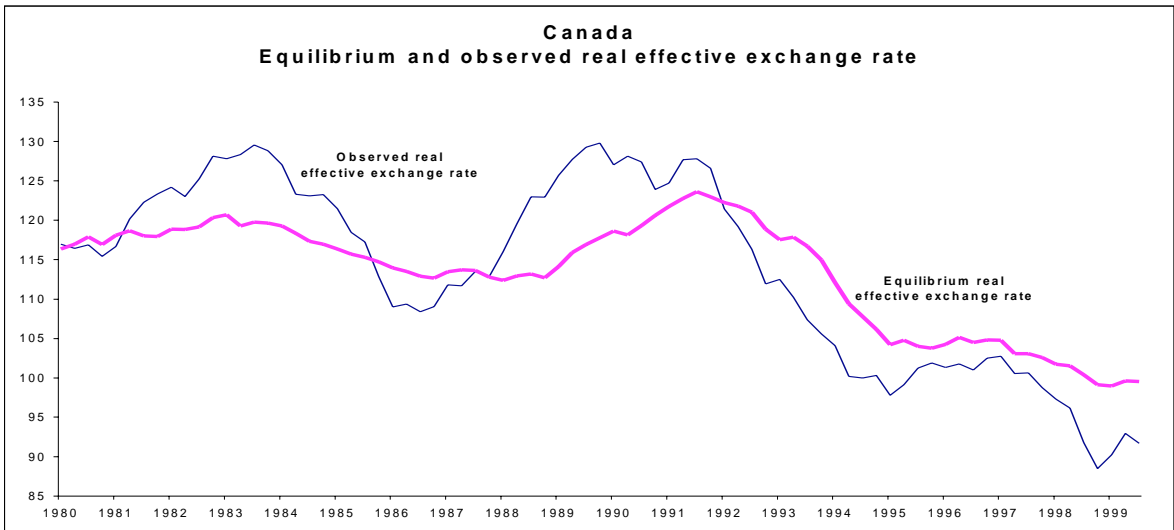
The estimated real equilibrium exchange rate for the **Euro** has appreciated throughout the 1990s as a result of rising net foreign assets, while relative tradable vs. nontradable sector productivity growth has been more or less flat.

Domestic demand in the 1990s has been subdued in the euro area, due to fiscal consolidation, increased private pension savings and suppressed business and consumer confidence. Further upward pressure on the net foreign asset ratio of GDP may, in contrary to developments in the US, have originated from a general lack of reform and structural change as well as productivity and overall potential growth improvements. In terms of our model, the internal equilibrium schedule has shifted downwards due to the demand and the external demand schedule has shifted upwards due to the supply effect. Both effects tend to increase net foreign asset ratio of GDP and the equilibrium exchange rate. The full employment current account of the euro area appears to be weakly positive. The estimation indicates an undervaluation of the euro by around 15% in the third quarter of 1999. Both estimation methodologies arrive at fairly similar results.

The future path of the real equilibrium exchange rate will depend on supply side developments. Both actual, and probably also equilibrium unemployment are high and faster employment growth than in the past will ceteris paribus require a lower equilibrium exchange rate, as well as future catching up in productivity and overall potential growth against the US economy. A further important issue concerning the net foreign asset position, particularly compared to the US, are pension liabilities. Conventional statistics on foreign debt exclude the development of pension liabilities, resulting from demographic developments and funding issues. If estimations of pension liabilities are taken into account, the US net foreign assets position turns considerably more positive compared with the euro area.

Figure 15 - The data

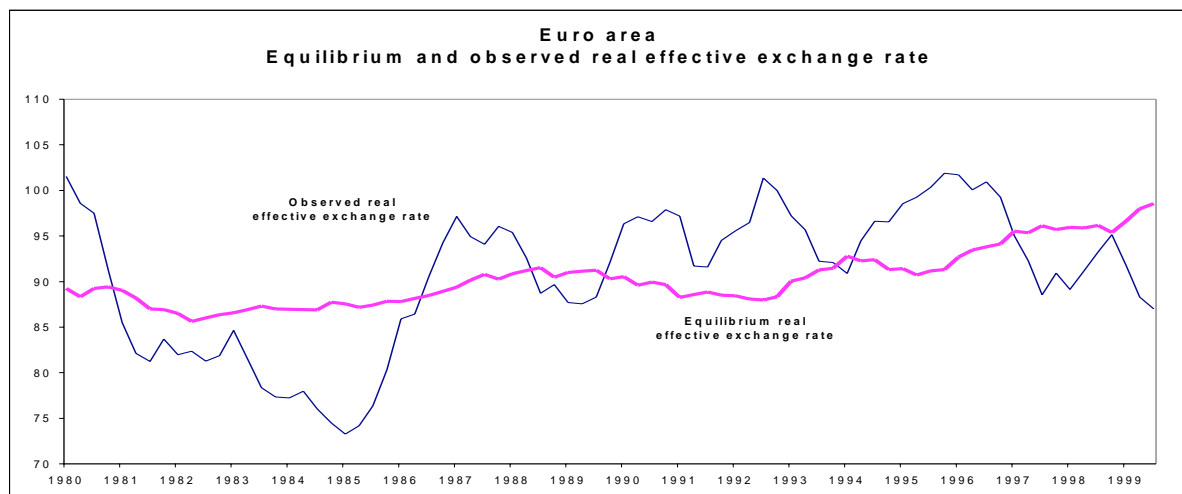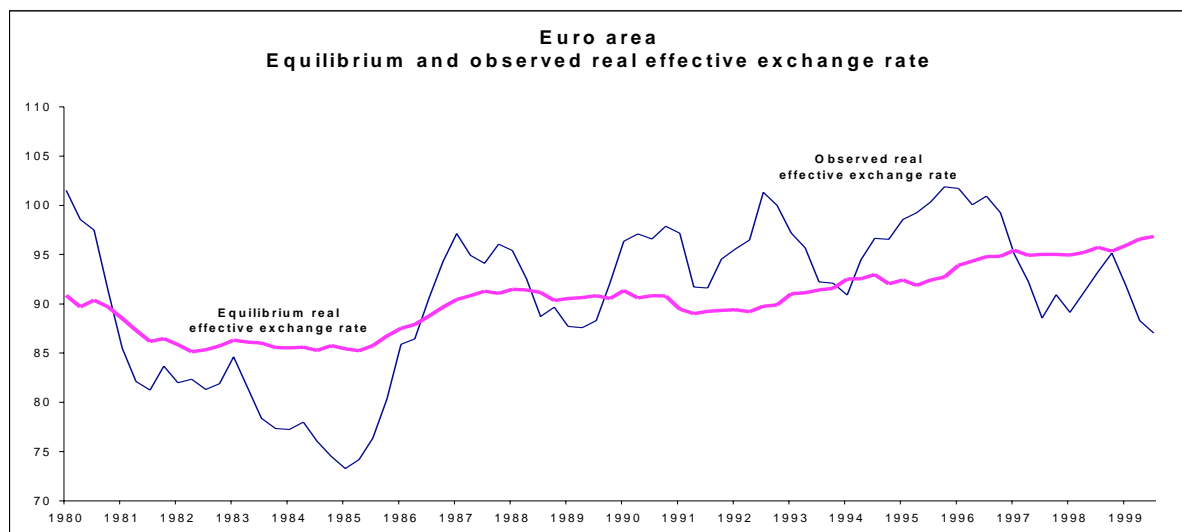*Figure 16: Estimation results with trend decomposition method*

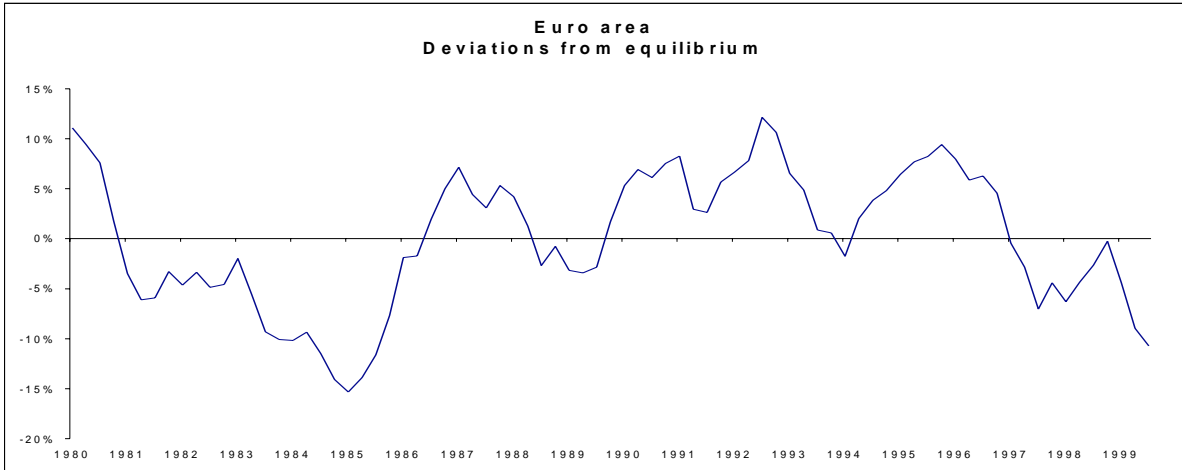**Euro area**
Equilibrium and observed real effective exchange rate

Observed real
effective exchange rate

Equilibrium real
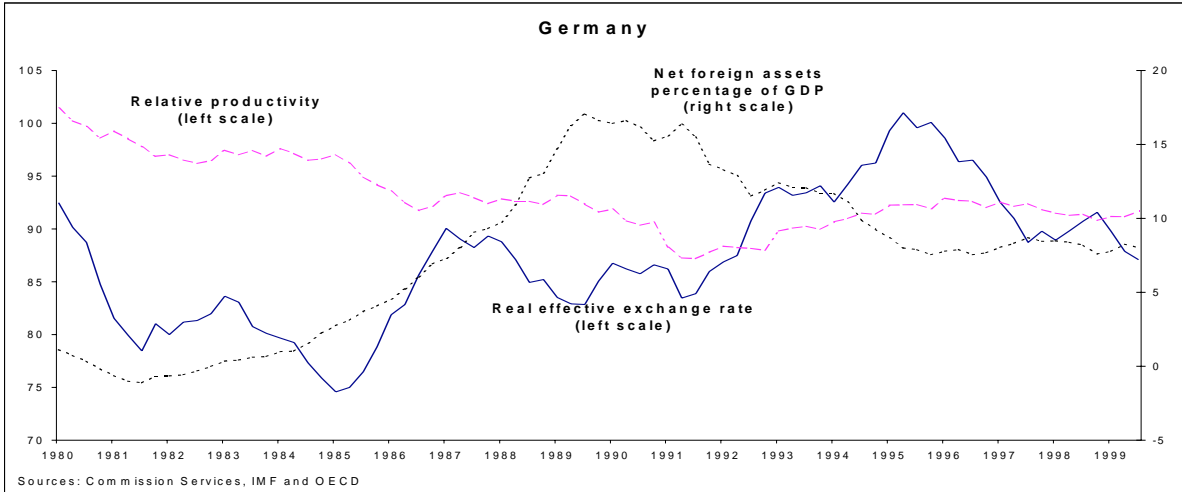effective exchange rate
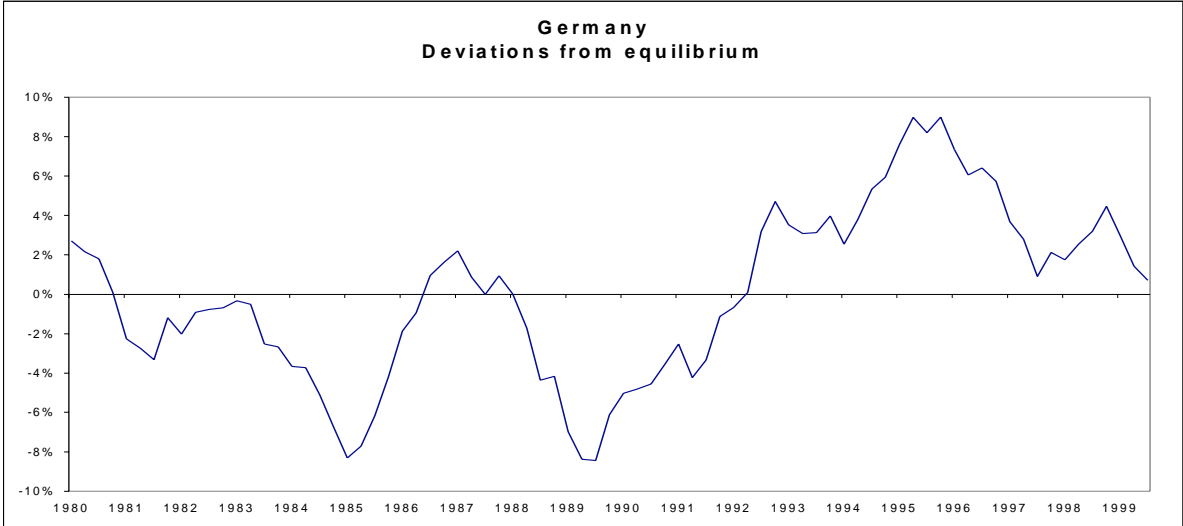
Euro area
Deviations from equilibrium

Figure 17 - Estimation results without trend decomposition method

Euro area
Equilibrium and observed real effective exchange rate

Observed real
effective exchange rate

Equilibrium real
effective exchange rate

34

Euro area
Deviations from equilibrium

The estimated trend of the **German** real effective exchange rate has been positive during the 1990s as the result of a rising net foreign asset ratio of GDP, counteracted by falling relative tradable vs. nontradable sector productivity. Since the beginning of the 1990s, a falling net foreign asset ratio of GDP due to expansionary fiscal policy in the wake of unification has driven down the equilibrium exchange rate, despite slightly rising relative tradable vs. nontradable sector productivity. However, productivity data for the 1990s is particularly unreliable for Germany, because the very low productivity level of East German manufacturing is difficult to capture. Proper adjustment for the assumed data deficiencies would probably lower the equilibrium exchange rate and hence increase the estimated current overvaluation.

The estimates indicate that the German real effective exchange rate became overvalued by between 10-15% after the unification and the currency turmoil which hit the Exchange Rate Mechanism (ERM) in 1992/93. Weak domestic demand in the following years exerted downward pressure on costs and prices which together with a recovery in the Italian lira led to a gradual restoration of intra-EUR11 competitiveness in the years after 1995. However, the full employment current account is probably still negative. Our estimates indicate a small, current overvaluation of the German real effective exchange rate, which after taking account of the weak euro would imply substantial competitiveness problems within the euro area (internal competitiveness). Both estimation methodologies produce fairly similar results.

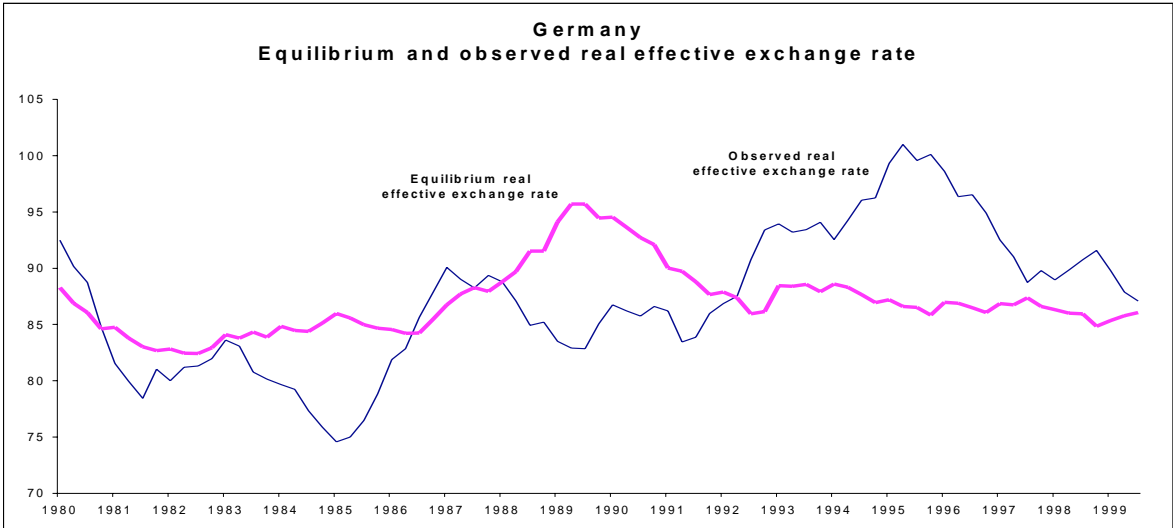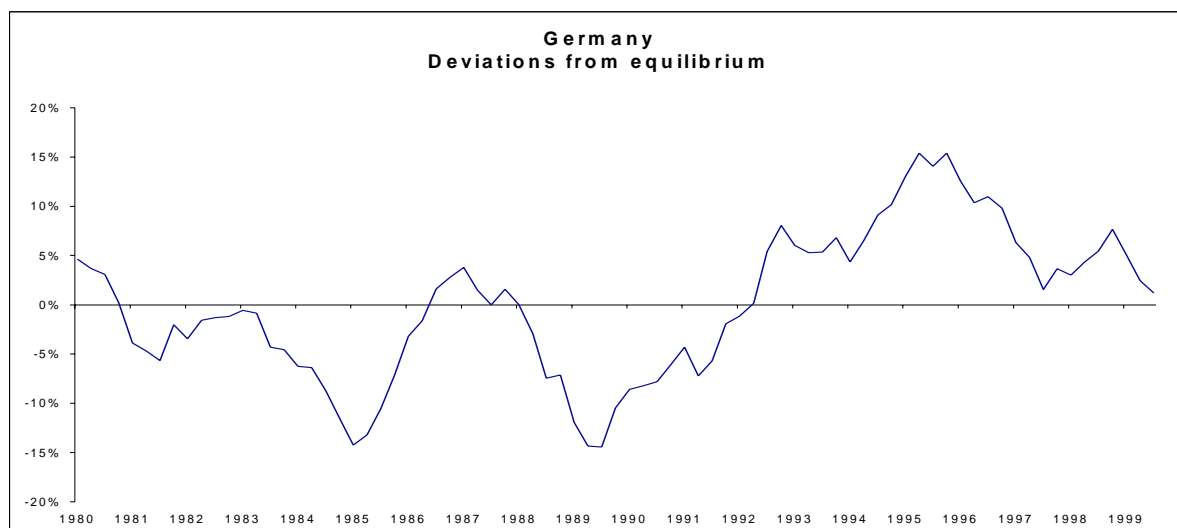*Figure 18 - The data*

Germany

Sources: Commission Services, IMF and OECD

35

Figure 19 - Estimation results with trend decomposition method

Germany
Equilibrium and observed real effective exchange rate

Observed real
effective exchange rate

Equilibrium real
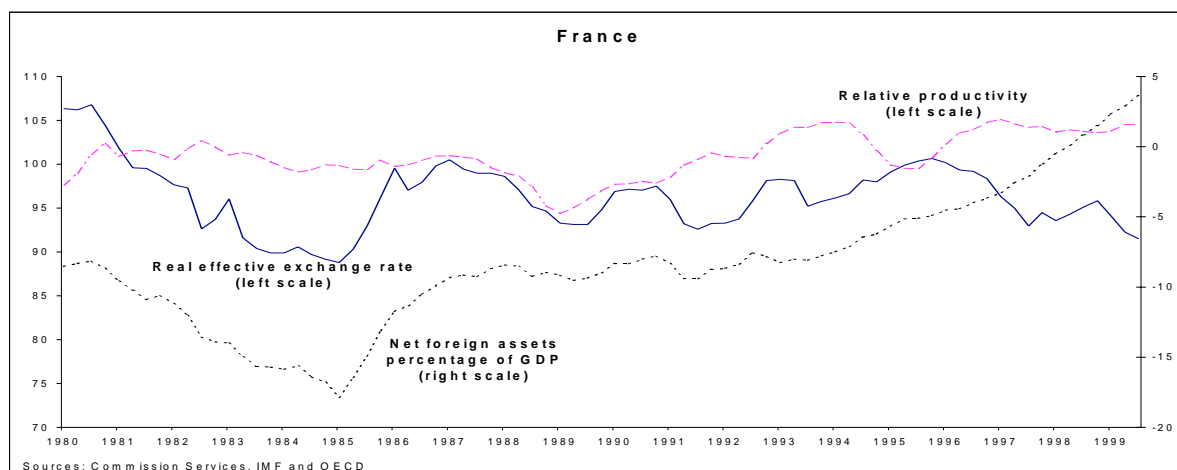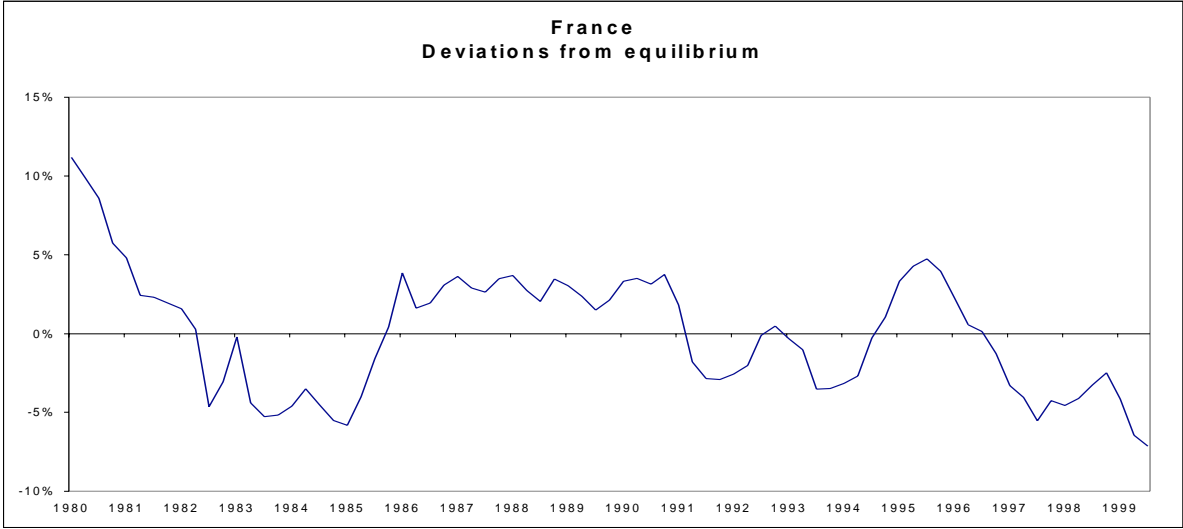effective exchange rate

Germany
Deviations from equilibrium
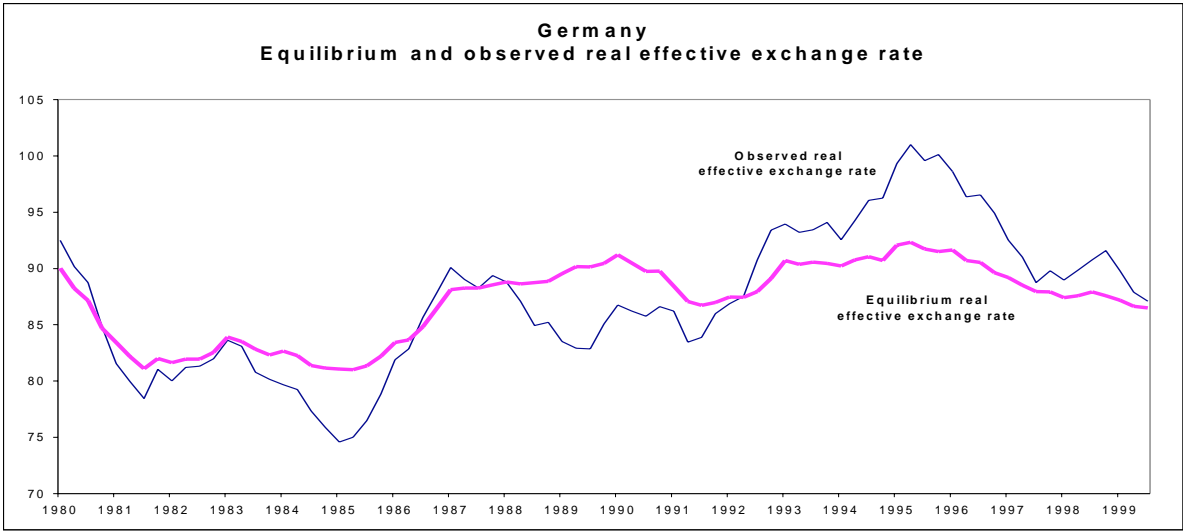
Figure 20 - Estimation results without trend decomposition method

Germany
Equilibrium and observed real effective exchange rate

Equilibrium real
effective exchange rate

Observed real
effective exchange rate

Germany
Deviations from equilibrium

The interpretation of the result for **France** is difficult due to the zero restriction on the net foreign asset ratio of GDP (which is imposed for statistical reasons). Relative tradable vs. nontradable sector productivity and the estimated real equilibrium exchange rate have been broadly stable throughout the sample period. The net foreign asset ratio of GDP was low and falling during the first half of the 1980s due to expansionary economic policy, but has steadily risen since then as fiscal and monetary policy were substantially tightened. The estimates indicate an undervaluation of the French franc by between 5-10% in the third quarter of 1999. Both estimation methodologies arrive at very similar results. A rising equilibrium exchange rate for France in the second half of the 1990s in relation to a falling for Germany indicates a currently higher competitiveness of the French economy despite constant nominal exchange rates.

The inclusion of the net foreign asset ratio of GDP would argue for a stronger appreciation of the equilibrium rate in the 1990s and possibly a larger current undervaluation. However, the net foreign asset ratio of GDP may have come closer to its desired level in the 1990s which is limiting this effect.

Figure 21 - The data

France

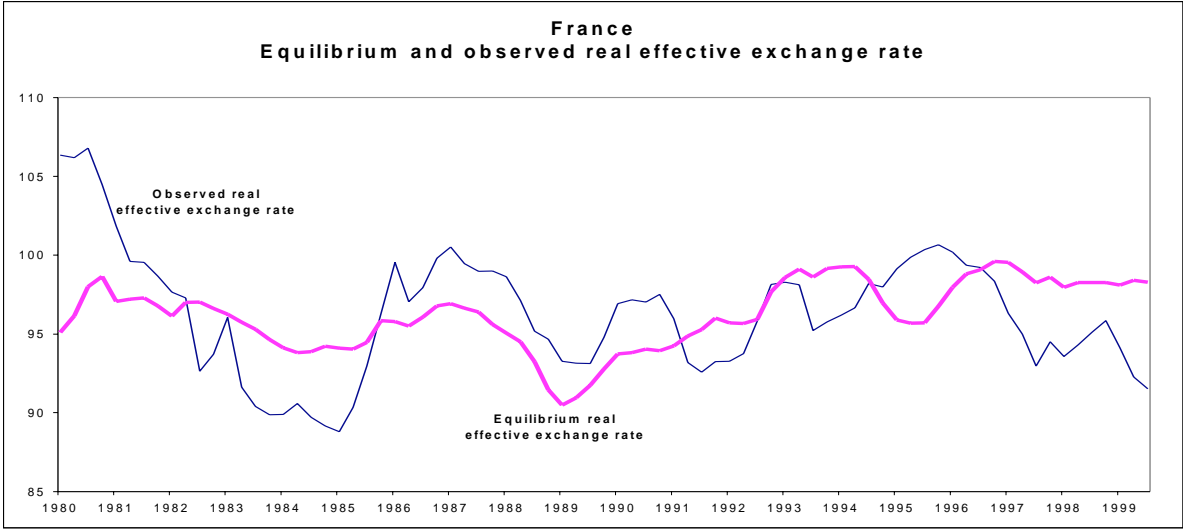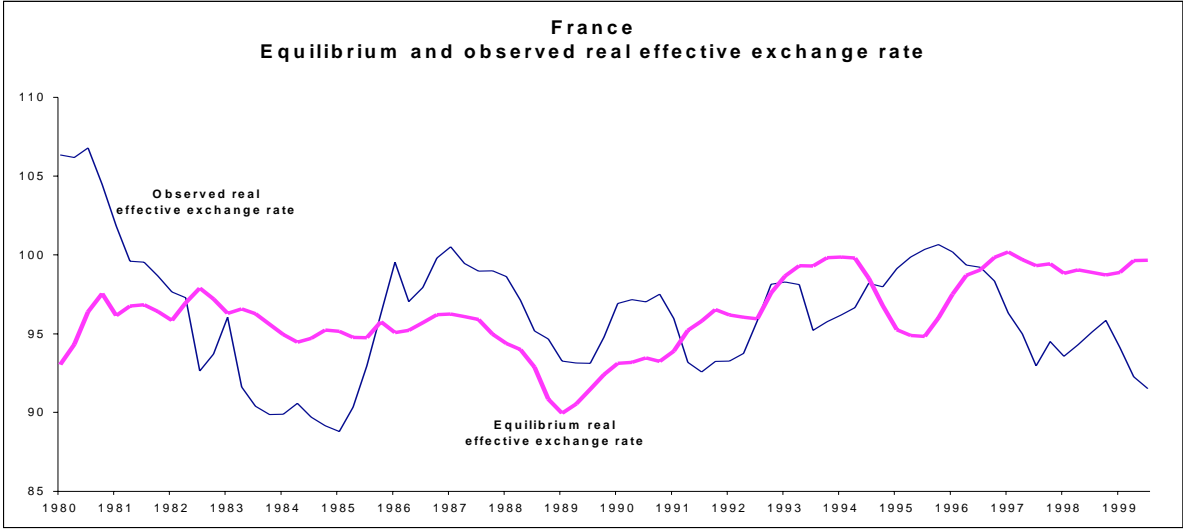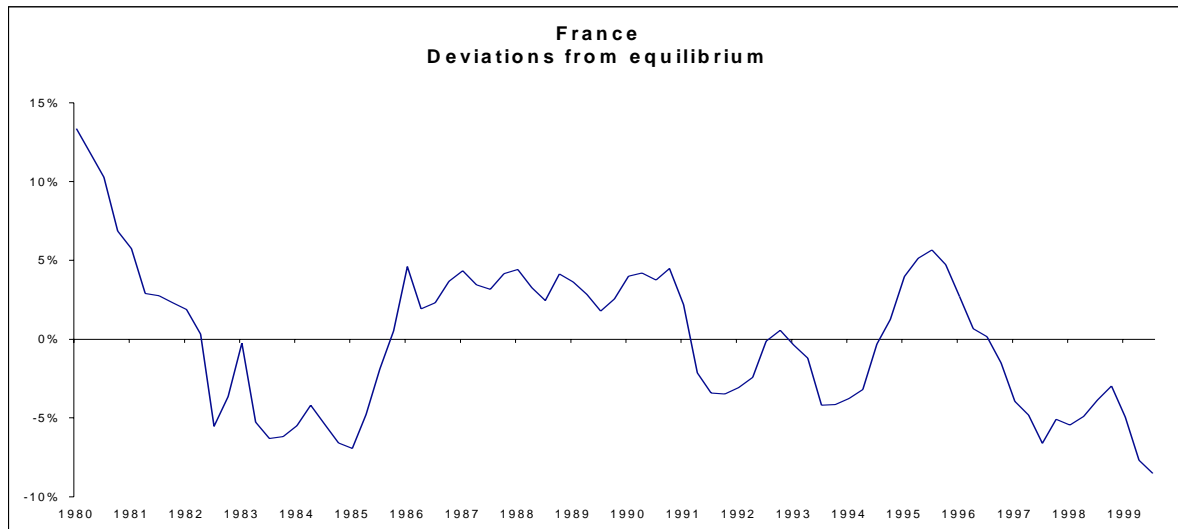*Figure 22 - Estimation results with trend decomposition method*

France
Equilibrium and observed real effective exchange rate

Observed real
effective exchange rate

Equilibrium real
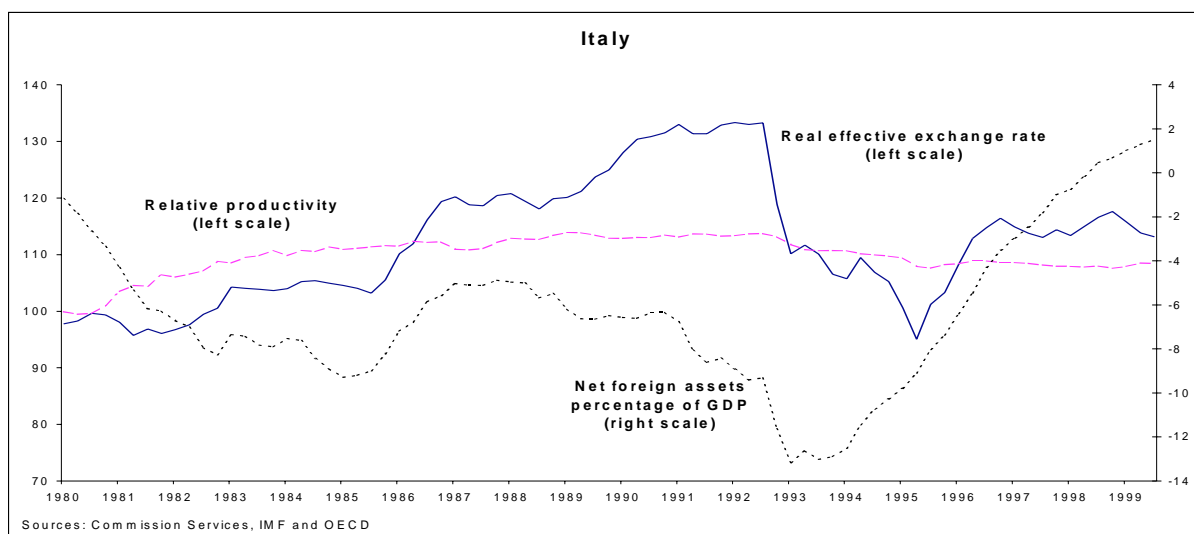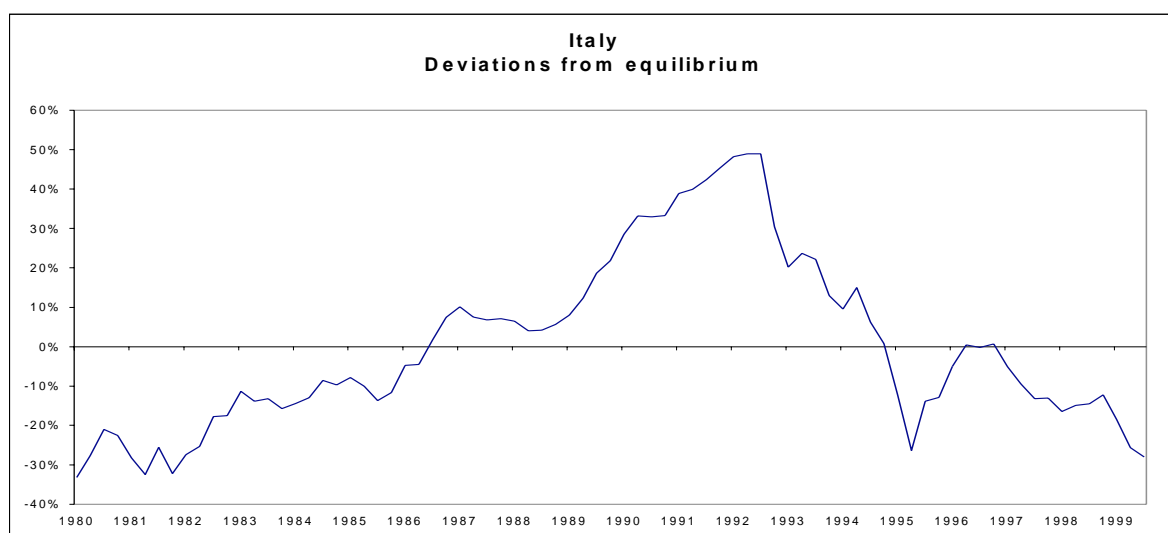effective exchange rate

France
Deviations from equilibrium

Figure 23 - Estimation results without trend decomposition method

France
Equilibrium and observed real effective exchange rate

Observed real
effective exchange rate

Equilibrium real
effective exchange rate

France
Deviations from equilibrium

According to our estimates, the path of the **Italian** real equilibrium exchange rate appears to be mostly driven by trends in the net foreign asset ratio of GDP, while relative tradable to nontradable sector productivity has been broadly flat. The net foreign asset ratio of GDP fell substantially during the eighties due to expansionary fiscal and monetary policy. The estimated equilibrium exchange rate fell rapidly, creating a large overvaluation of the lira before the breakdown of the Exchange Rate Mechanism (ERM). The rising net foreign asset ratio of GDP after 1992 explains the subsequent real equilibrium exchange rate appreciation. The estimates indicate an undervaluation of the Italian lira by between 10-30% in the third quarter of 1999 which may partly be explained by the probably substantial negative output gap. On the contrary, comprehensive structural reforms, lower structural unemployment and funding the large stock of pension liabilities would require a lower equilibrium exchange rate.
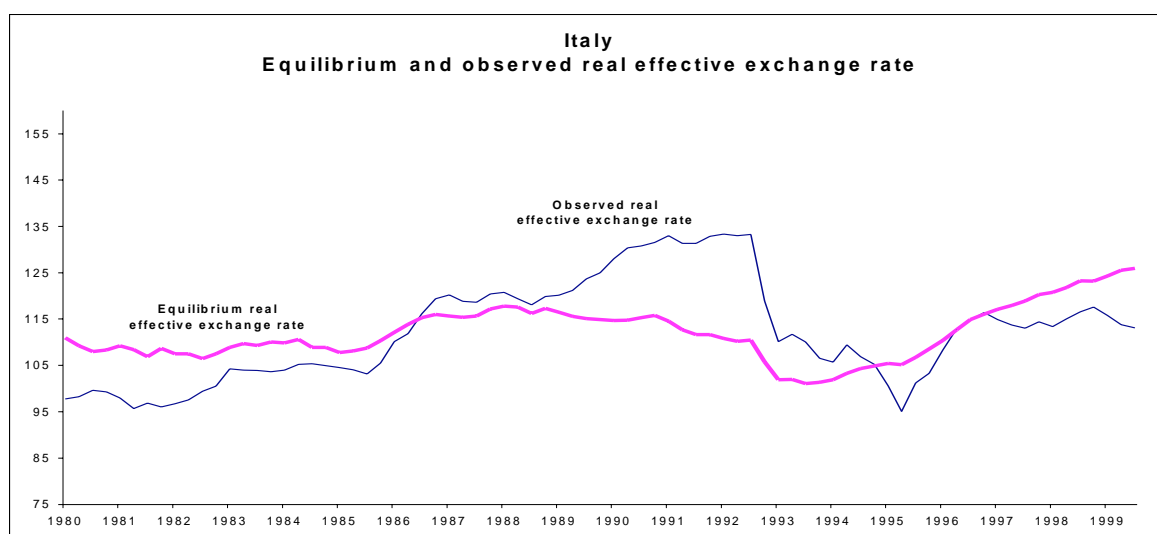
Figure 24 - The data

Italy

Real effective exchange rate (left scale)

Relative productivity (left scale)

Net foreign assets percentage of GDP (right scale)

Sources: Commission Services, IMF and OECD
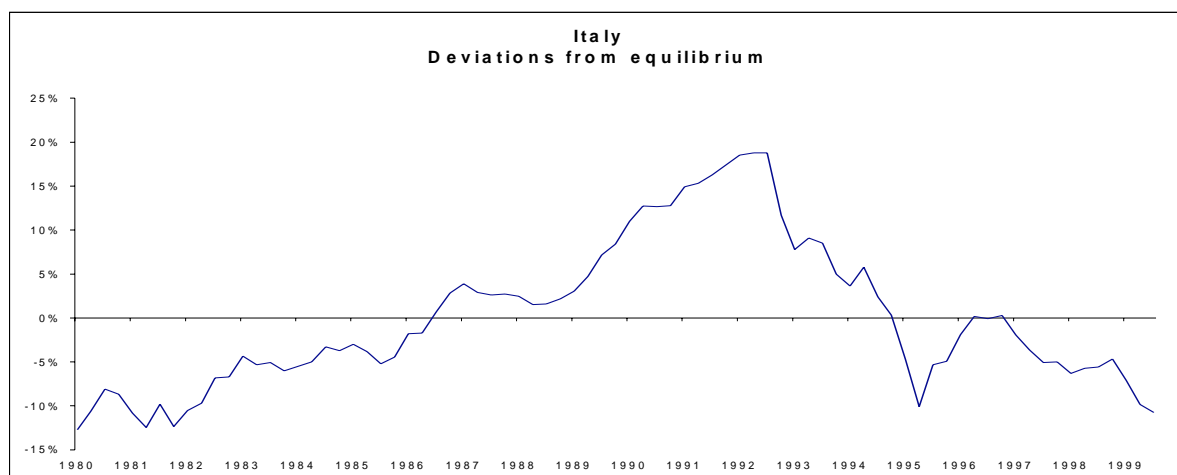
39

Figure 25 - Estimation results with trend decomposition method

Italy
Equilibrium and observed real effective exchange rate

Italy
Deviations from equilibrium
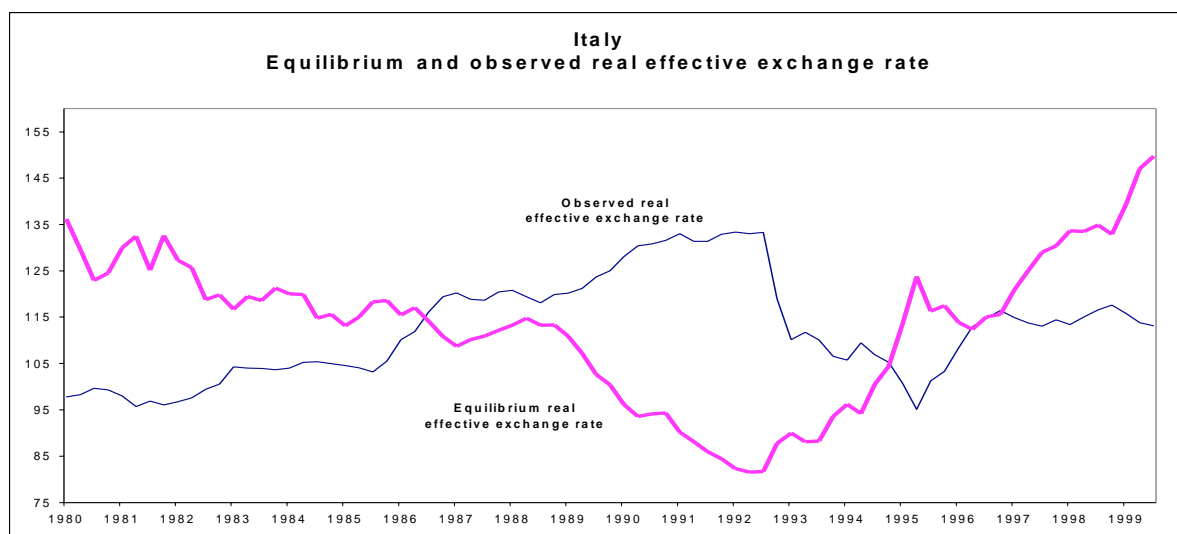
Figure 26 - Estimation results without trend decomposition method

Italy
Equilibrium and observed real effective exchange rate

Italy
Deviations from equilibrium

The estimated **Spanish** real equilibrium exchange rate appreciated during the second half of the 1980s and the first half of the 1990s due to rising relative tradable vs. nontradable sector productivity. The zero restriction which for statistical reasons is imposed on the net foreign asset ratio of GDP may be justified by the catching up process of Spain towards economically more developed countries within the European Union which may have implied a fall in the desired net foreign asset ratio of GDP. The real exchange rate depreciation between 1992-95 brought about a considerable improvement in price and cost competitiveness and the net foreign asset ratio of GDP stabilised in the second half of the 1990s. Relative tradable vs. nontradable sector productivity levelled off and consequently the estimated equilibrium exchange rate also stabilised. Actual GDP is judged to be somewhat below potential and unemployment remains one of the highest in the EU. The current account balance has turned negative last year and is expected to deteriorate further which indicates a negative full employment current account. However, in light of the comparably high actual and probably also potential growth rate, the modest foreign debt ratio and current account deficit appear to be sustainable in the medium-term. This is also indicated by a an estimated modest undervaluation of the Spanish peseta in the third quarter of 1999. Both estimation methodologies generate fairly similar results.

However, when the proposed adjustment to a lower desired net foreign asset ratio of GDP is finished and capital inflows and domestic demand taper off, there may be a need to improve competitiveness in order to restore internal and external demand.
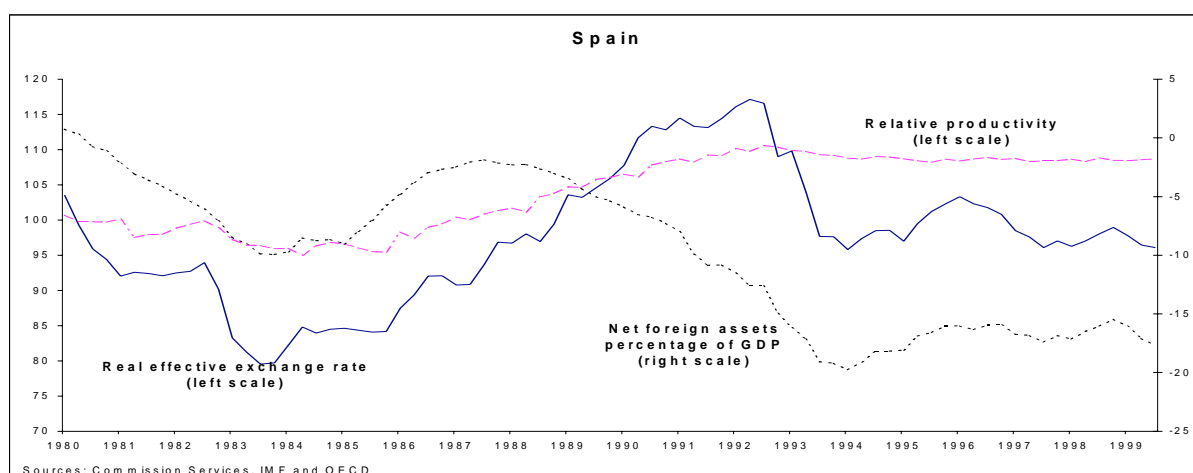
Figure 27 - The data

Spain

Sources: Commission Services, IMF and OECD

41

Figure 28 - Estimation results with trend decomposition method

Spain
Equilibrium and observed real effective exchange rate

Observed real
effective exchange rate

Equilibrium real
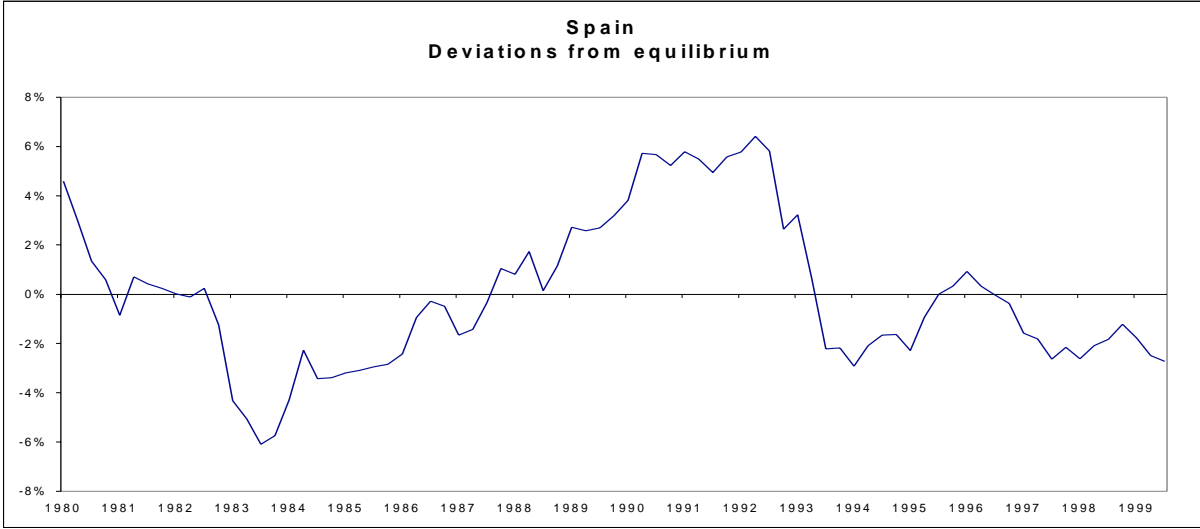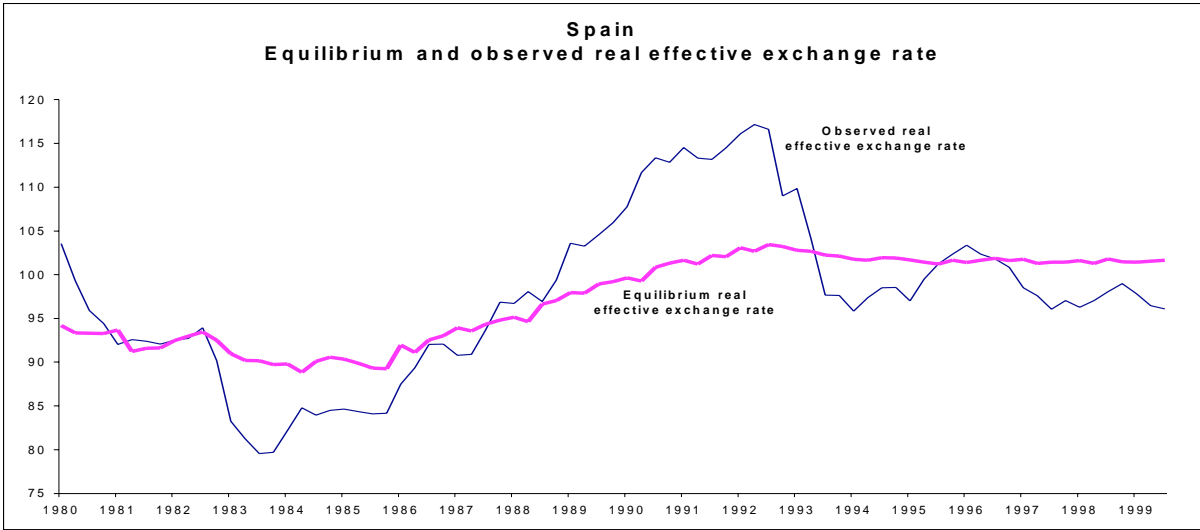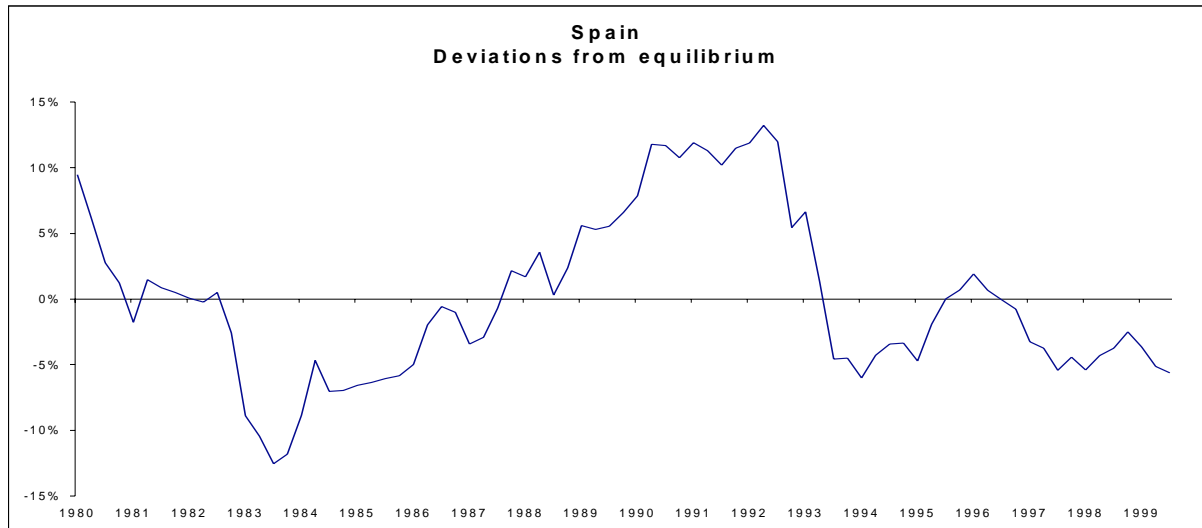effective exchange rate

Spain
Deviations from equilibrium
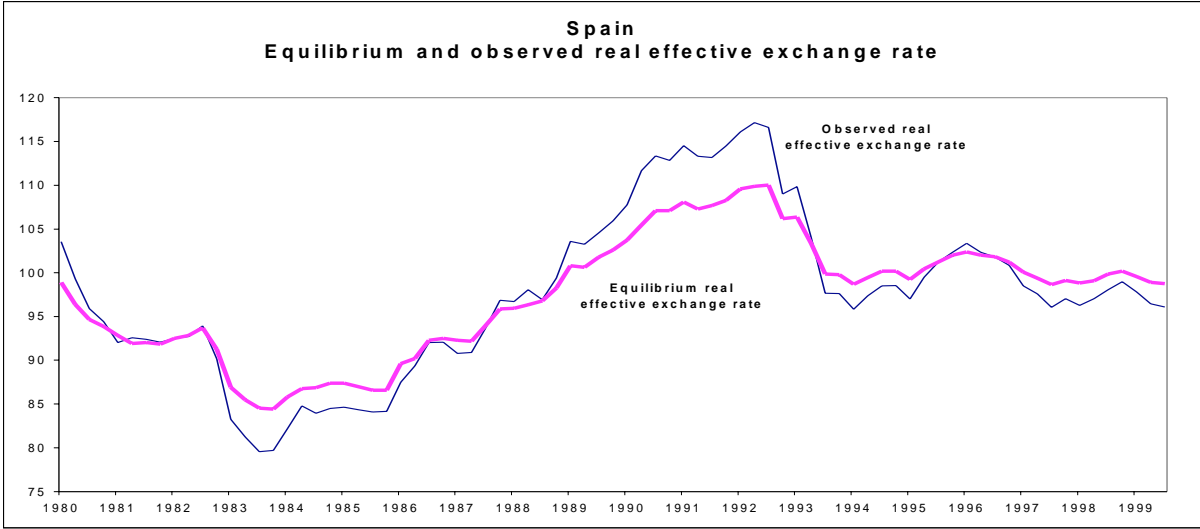
Figure 29 - Estimation results without trend decomposition method

Spain
Equilibrium and observed real effective exchange rate

Observed real
effective exchange rate

Equilibrium real
effective exchange rate

Spain
Deviations from equilibrium

The **Austrian** actual and estimated real effective exchange rate have appreciated until the mid nineties in line with rising relative tradable vs. nontradable sector productivity. The net foreign asset ratio of GDP had been broadly flat. Due to its fixed exchange rate link with Germany, Austria experienced a real appreciation at the time of the currency turmoil in the ERM in 1992/93 and when the lira depreciated in 1994/95. The net foreign asset ratio of GDP fell strongly in the second half of the 1990s, but levelled off recently. Relative tradable vs. nontradable sector productivity has been flat, which according to our estimates led to a fall in the real equilibrium exchange rate. The output gap is judged to be broadly closed and the current account shows moderate deficits. This indicates that the Austrian real exchange rate is close to its medium-term equilibrium which is supported by our estimation results. Both estimation methodologies generate fairly similar results, but the "goodness of fit" of the estimations appears to be inflated. The unreasonably small deviations between actual and estimated equilibrium exchange rates should therefore be judgementally adjusted and probably magnified.
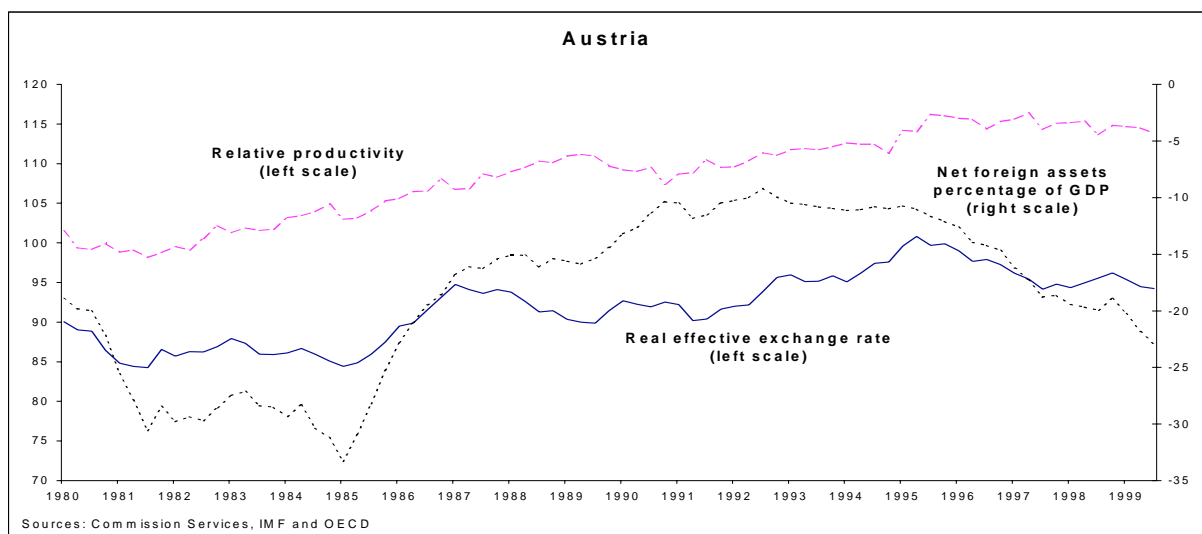
Figure 30 - The data

Austria

Relative productivity (left scale)
Net foreign assets percentage of GDP (right scale)
Real effective exchange rate (left scale)
Sources: Commission Services, IMF and OECD

43

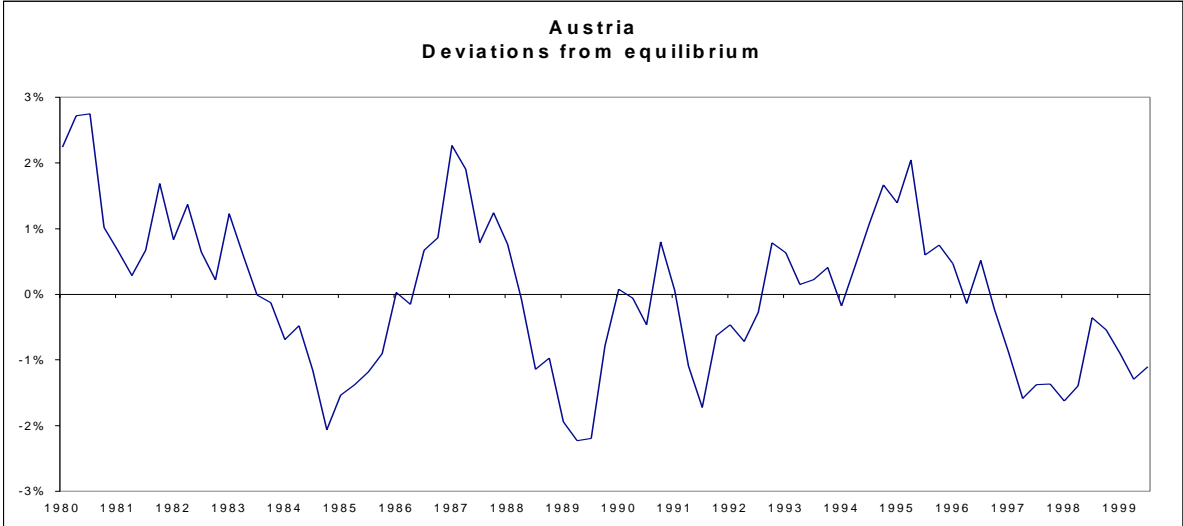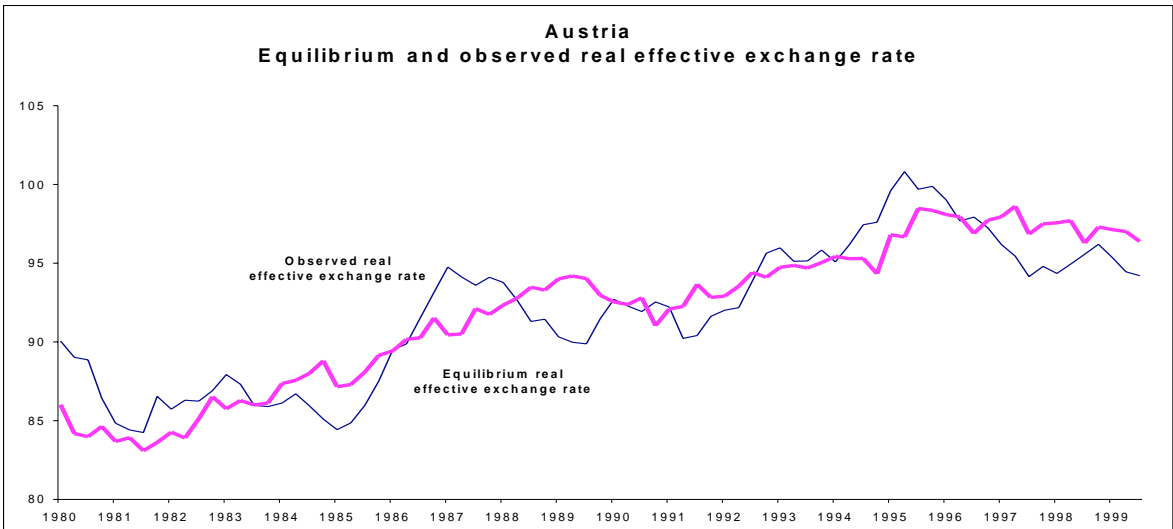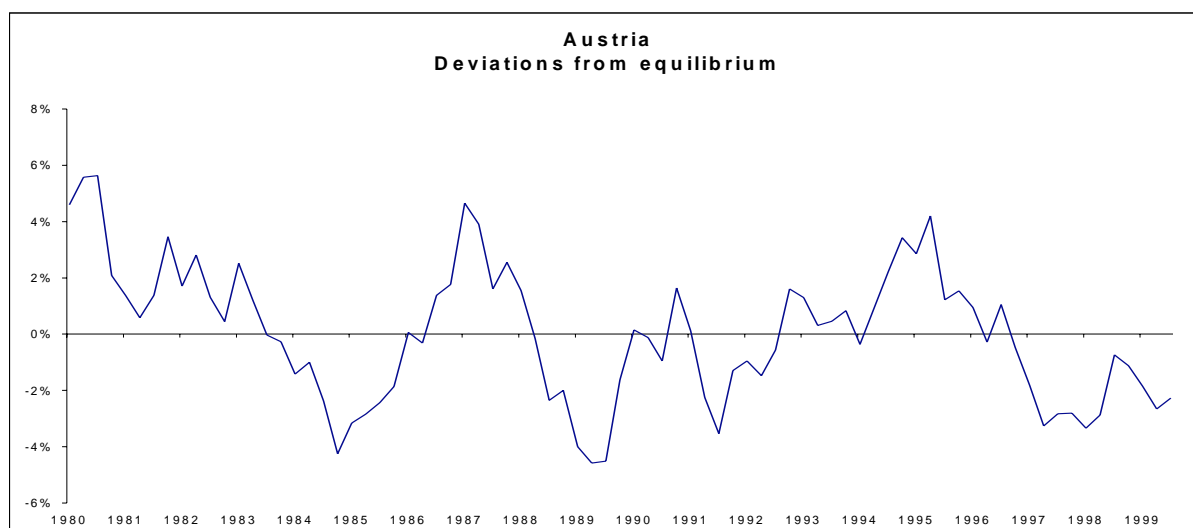*Figure 31 - Estimation results with trend decomposition method*
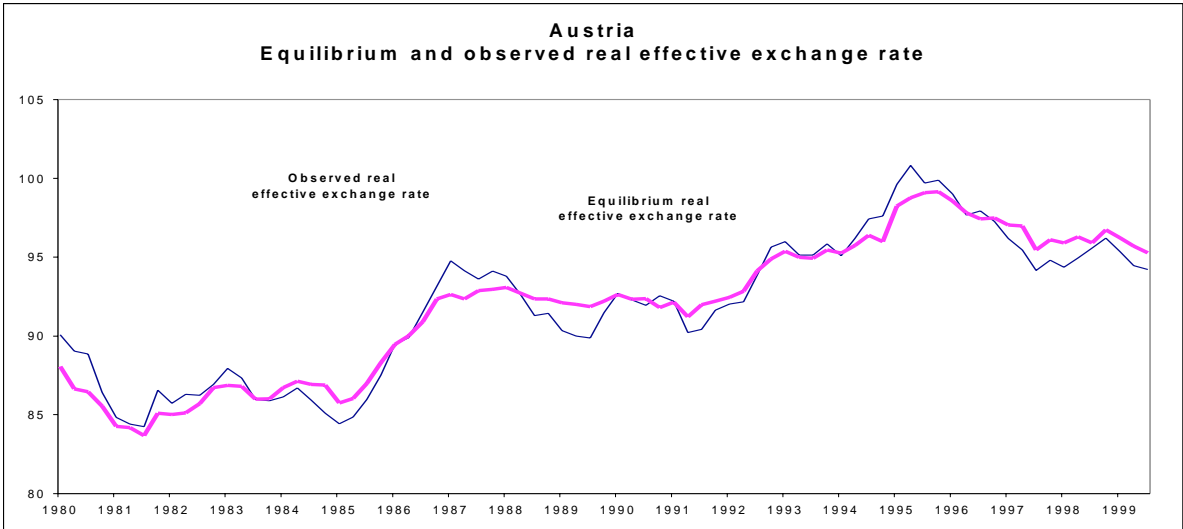
Figure 32 - Estimation results without trend decomposition method

Austria
Deviations from equilibrium

The real equilibrium exchange rate of the **Netherlands** has been affected in different directions by a rising net foreign asset ratio throughout the sample period and falling relative tradable vs. nontradable sector productivity until the mid 1990s.

Unemployment has decreased substantially since 1980 due to moderate wage increases and the actual (and probably even the equilibrium) unemployment rate is down to very low levels compared to other EU-countries. High employment growth in the tradable sector and probably a fall in the NAIRU may lie behind the weak relative and overall productivity performance of the Dutch economy and explain the estimated downward trend in the equilibrium exchange rate until the beginning of the 1990s.[18] The foreign debt ratio of GDP was high at the beginning of the 1980s due to expansionary economic policy in the 1970s, but recovered steadily throughout the sample period and may, together with flat relative tradable vs. nontradable sector productivity, explain a rising equilibrium exchange rate in the second half of the 1990s.

The Netherlands experienced strong domestic demand and economic growth in the second half of the 1990s and output is judged to exceed potential, but the current account still shows substantial surpluses, which indicates an undervalued real exchange rate. Our estimates show an undervaluation of between 4%-8% in the third quarter of 1999 which rather appears to be at the lower end of our expectations.

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[18]   Falling relative productivity in the tradable vs. nontradable sector in the Netherlands should not be seen as the outcome of a weak potential growth rate, but rather high employment growth in response to wage moderation. If employment growth occurs in both the tradable and nontradable sector and productivity is assumed to react more in the tradable sector, relative productivity in the tradable vs. nontrable sector will fall.
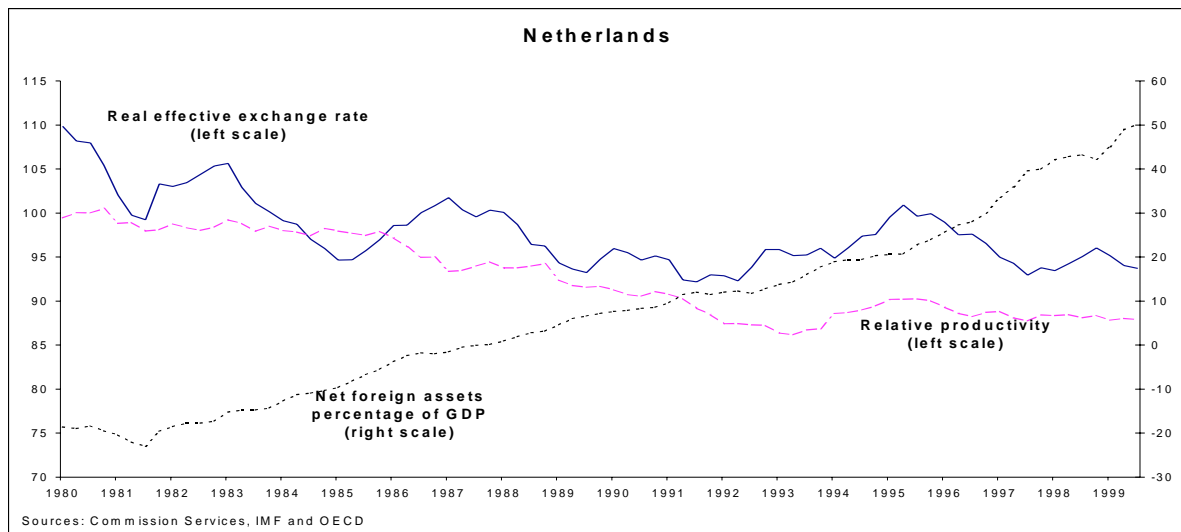
45

Figure 33 - The data

Netherlands

Sources: Commission Services, IMF and OECD

Figure 34 - Estimation results with trend decomposition method

Netherlands
Equilibrium and observed real effective exchange rate

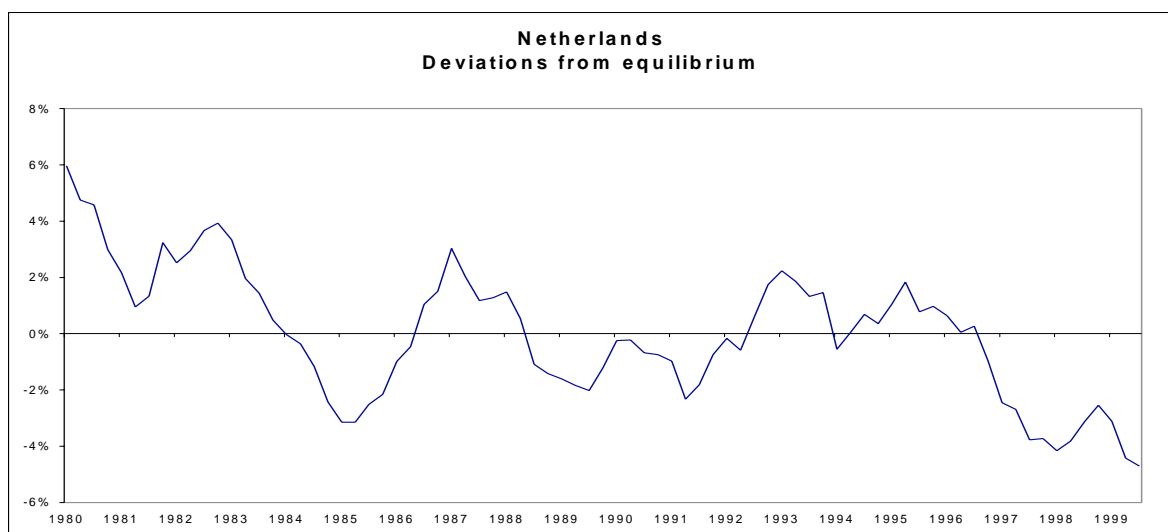
Netherlands
Deviations from equilibrium

46
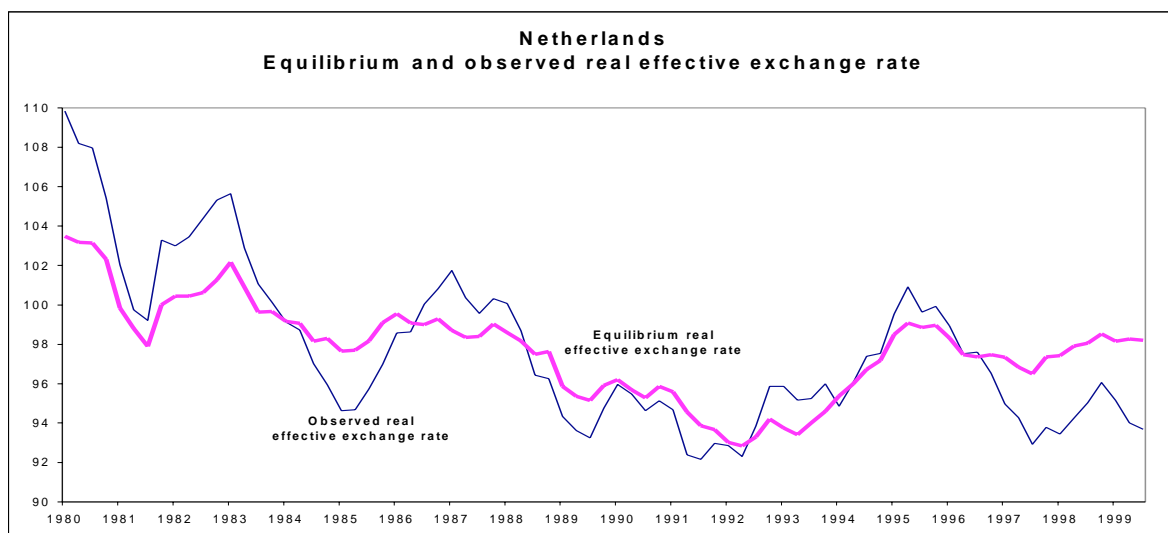
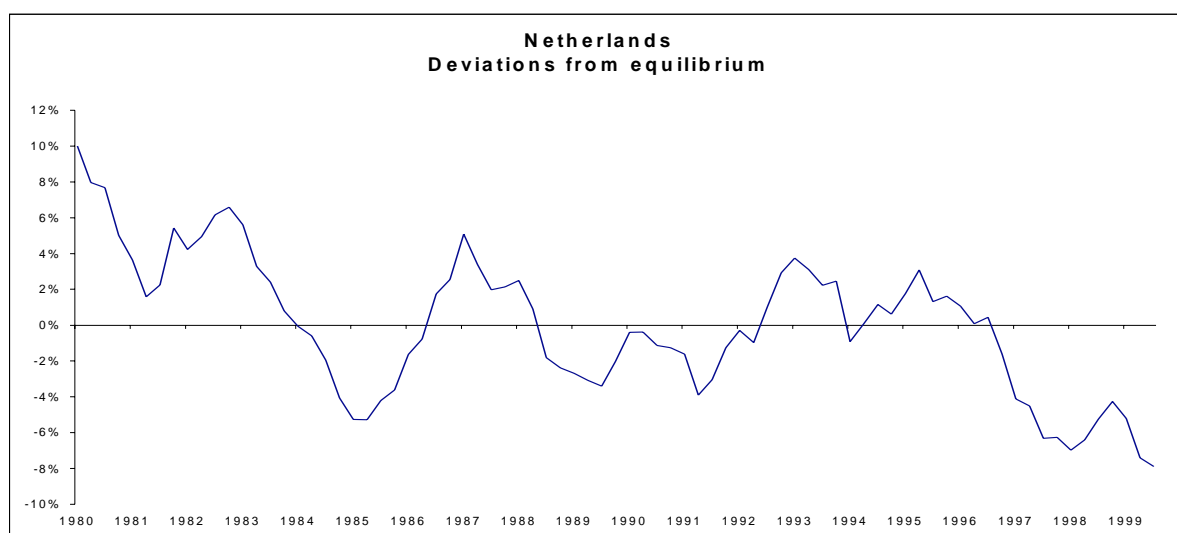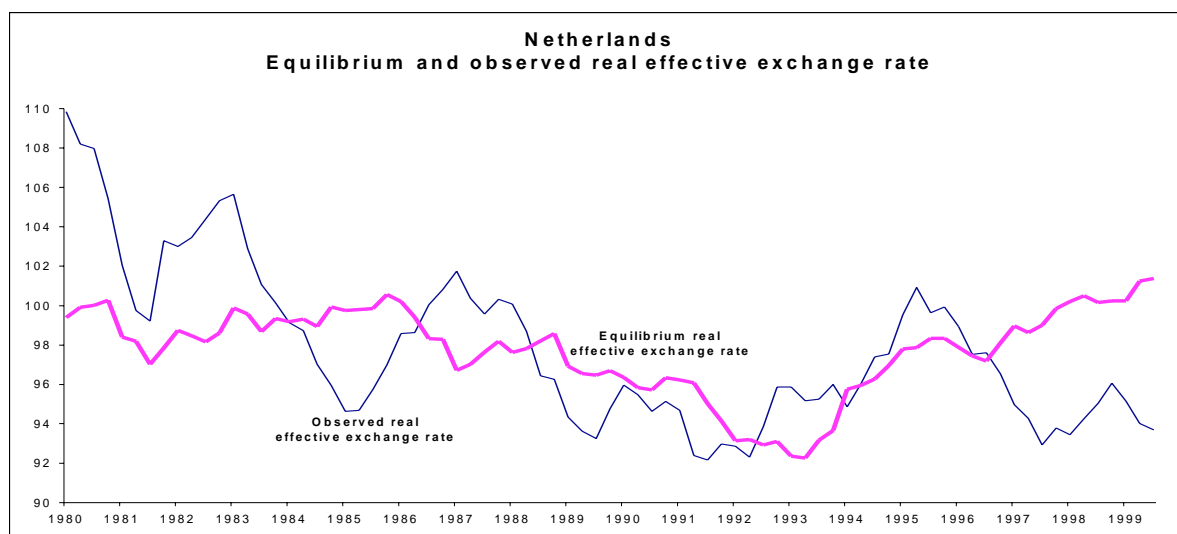*Figure 35 - Estimation results without trend decomposition method*

Netherlands
Equilibrium and observed real effective exchange rate

Netherlands
Deviations from equilibrium

The **Finish** real equilibrium exchange rate appreciated throughout the 1980s due to rising relative tradable vs. nontradable sector productivity and an improving net foreign asset ratio of GDP. The actual real exchange rate however appreciated even more due to a fixed nominal exchange rate regime and a high inflation rate. At the beginning of the 1990s, the Finnish economy was hit by a severe recession, as an asset price bubble in the stock and housing market finally burst and trade with the former Soviet Union collapsed which required a reorientation of trade patterns.[19] The net result of these events were a sharp fall in the net foreign asset ratio of GDP and a falling equilibrium exchange rate which finally set off a sharp devaluation and subsequent undervaluation of the Finnish markka. During the rest of the 1990s, the net foreign asset ratio of GDP rose, as net exports benefited from the weak currency, and the estimated equilibrium exchange rate moved slowly up.

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[19] In our model, the asset price bubble shifts the internal equilibrium schedule upwards , while the breakaway of the Russian export market shifts the external equilibrium schedule downwards.

According to our estimates, the Finnish real exchange rate is still substantially undervalued which appears questionable in the light of the still high foreign debt ratio. Both estimation methodologies generate fairly similar results. At present, Finland's very low net foreign asset ratio of GDP is probably still below its desired long-run level which requires a weak equilibrium exchange rate in the medium-term. The current account surplus has been relatively high in past years despite strong domestic demand growth and available estimates pointing to output being modestly above trend.[20] Thus, the full employment current account appears to be in surplus. As the process of paying off external debt progresses, the actual and equilibrium real exchange rate should appreciate towards their long-run equilibrium.
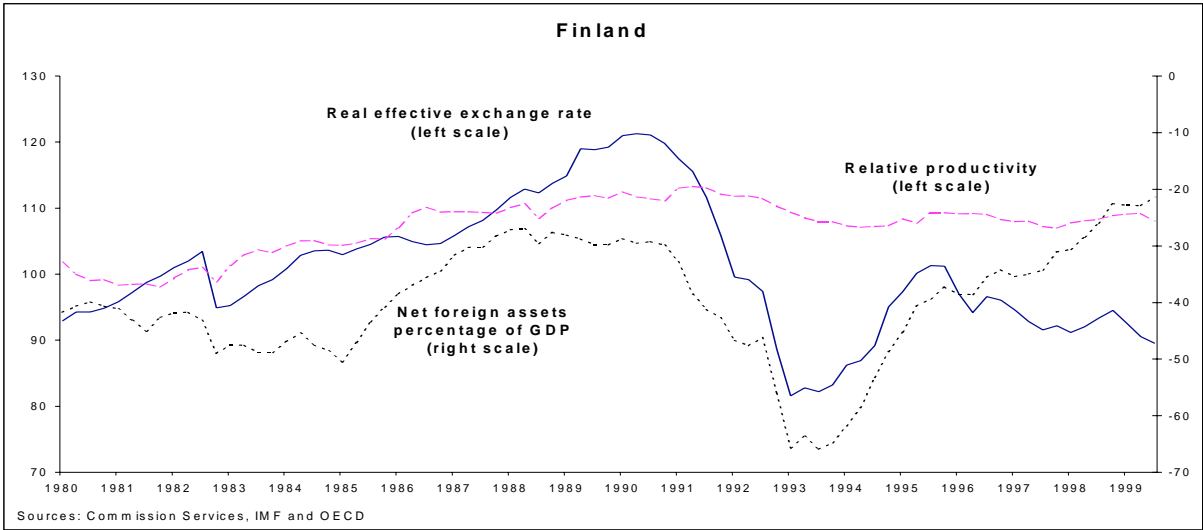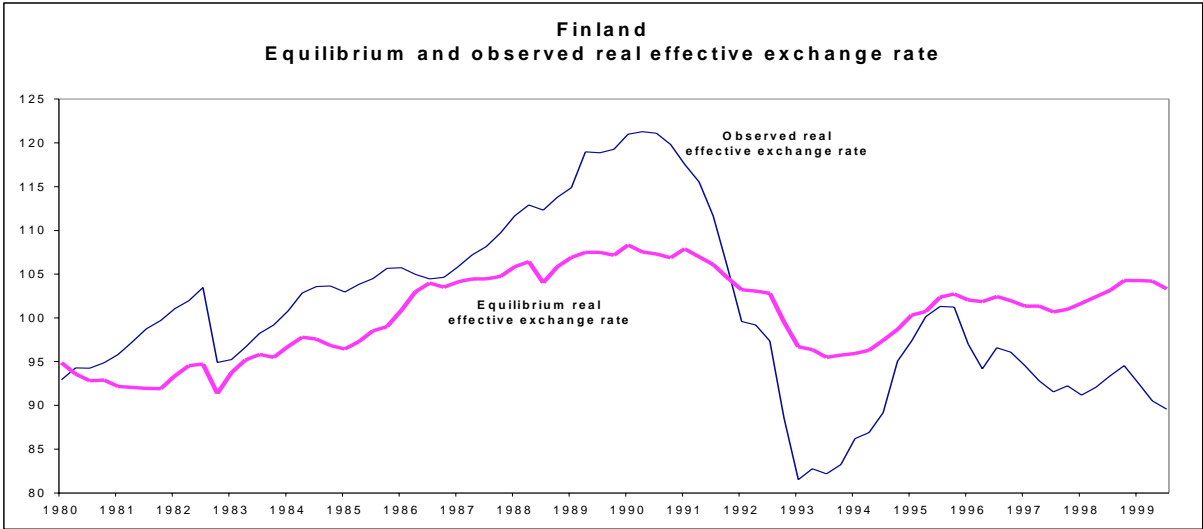
Figure 36 - The data

Figure 37 - Estimation results with trend decomposition method
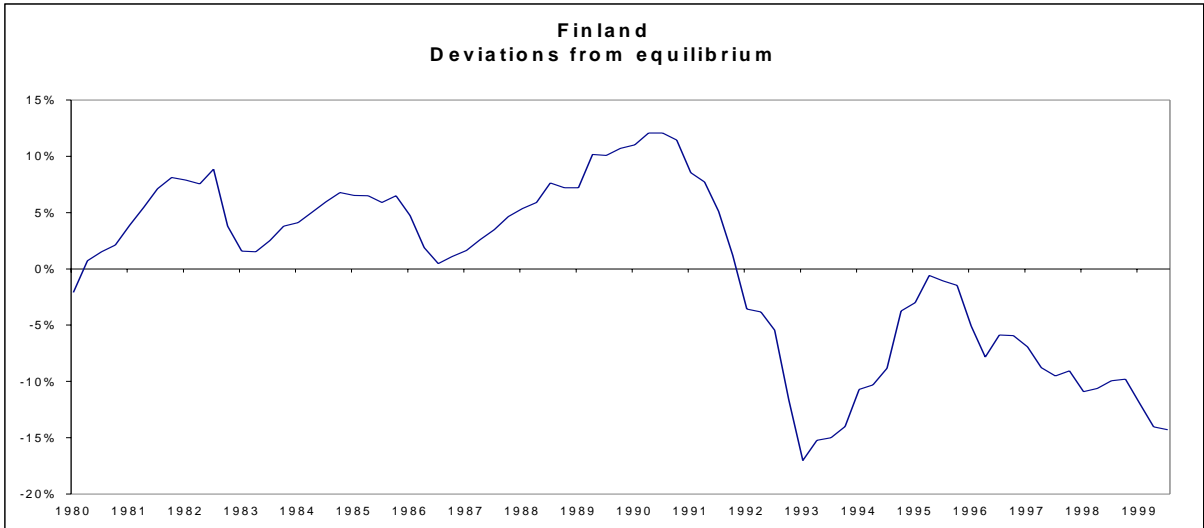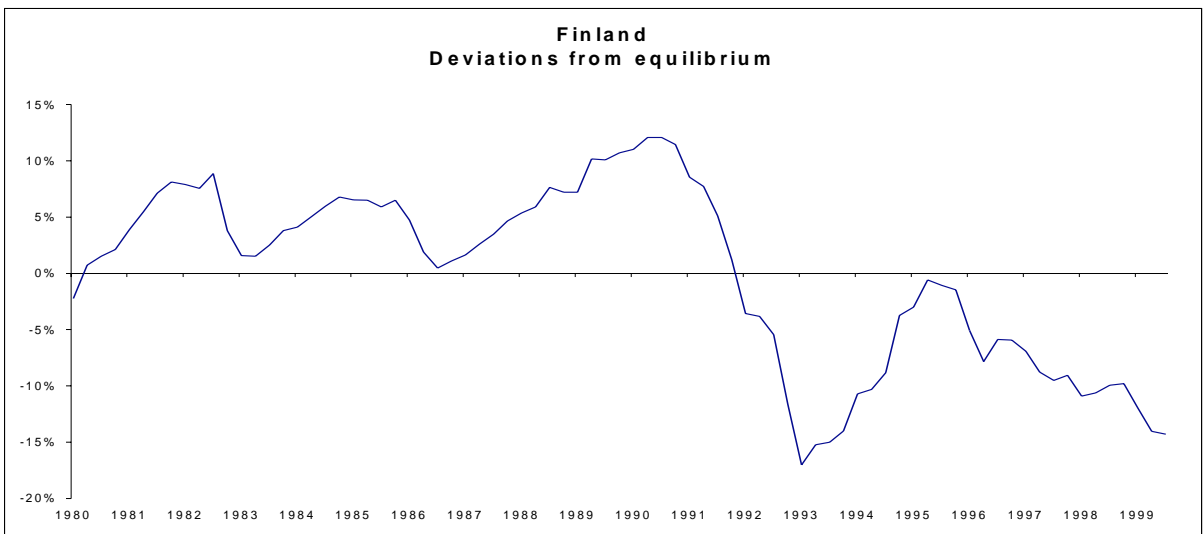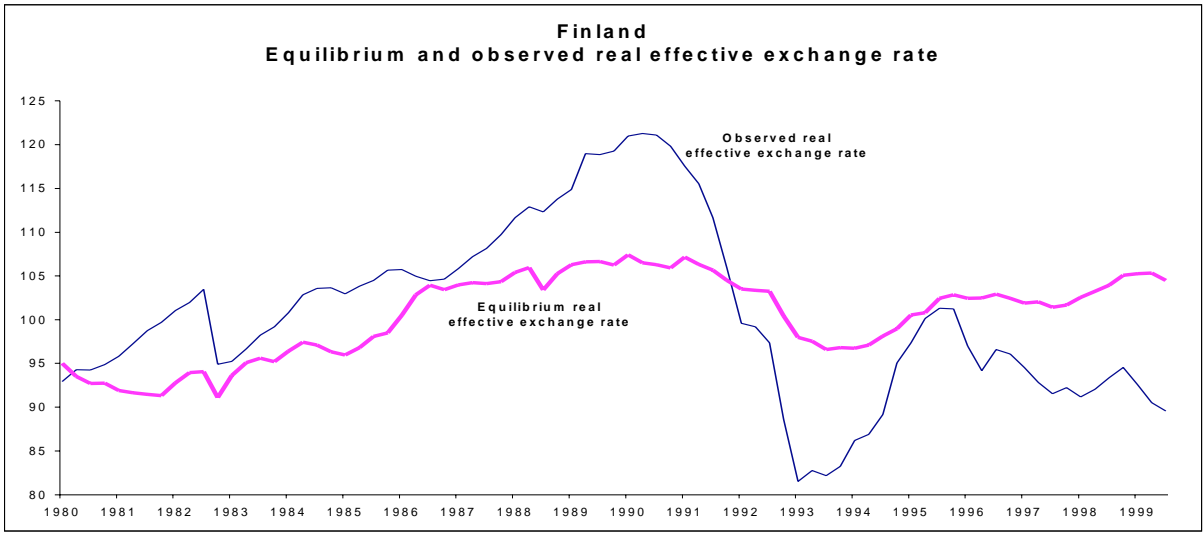

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Figure 38 - Estimation results without trend decomposition method

Portugal's real exchange rate has shown a marked upward trend throughout almost the entire sample period which is in line with the economy being in a catching up process against economically more developed countries. This however appears to be imperfectly reflected by our measure of relative tradable vs. nontradable sector productivity, which has been rather flat or weakly upward trending throughout the 1990s. Net foreign assets have fallen since the mid 1980s, but do not appear to be at an alarmingly low level. Structural reforms have been comprehensive in the past and the labour market is flexible which lowers pressure on future equilibrium exchange rate developments. Growth in recent years has been above euro area average, but there are few indications of actual production exceeding potential and available estimates point to a broadly closed output gap.

The estimated path of the real equilibrium exchange rate has surprisingly fallen despite the successful catching-up of the Portuguese economy (which however does not seem to be properly reflected in our productivity data). However, the current account deficit is large, especially as the economy is judged to operate close to potential. A significant and growing overvaluation of the real exchange rate may therefore be expected which is also indicated by our estimates, even if the estimated magnitude appears to be widely exaggerated. The flexible labour market and probably low NAIRU may however alleviate the need for future adjustment of the real exchange rate. The estimation results for Portugal are very unstable.
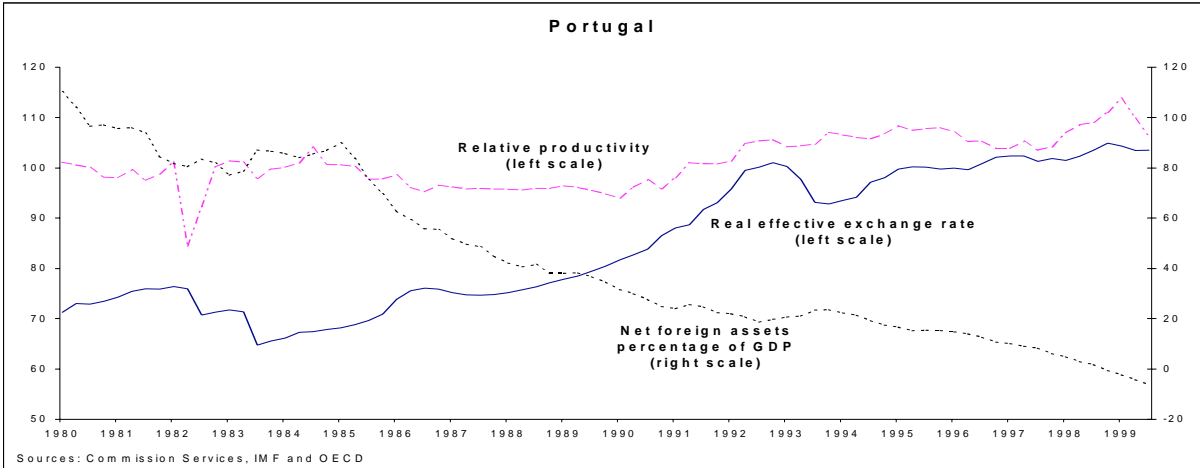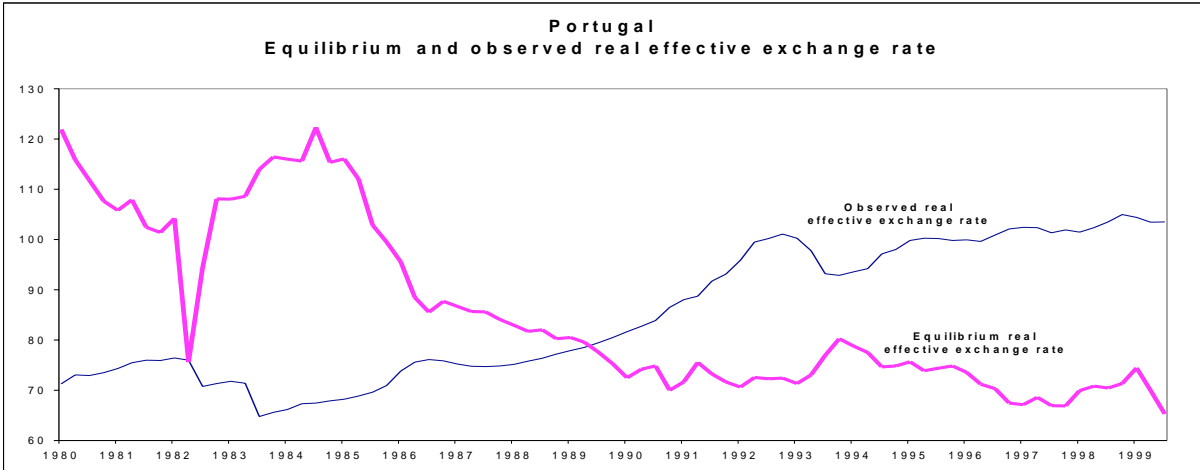
Figure 39 - The data

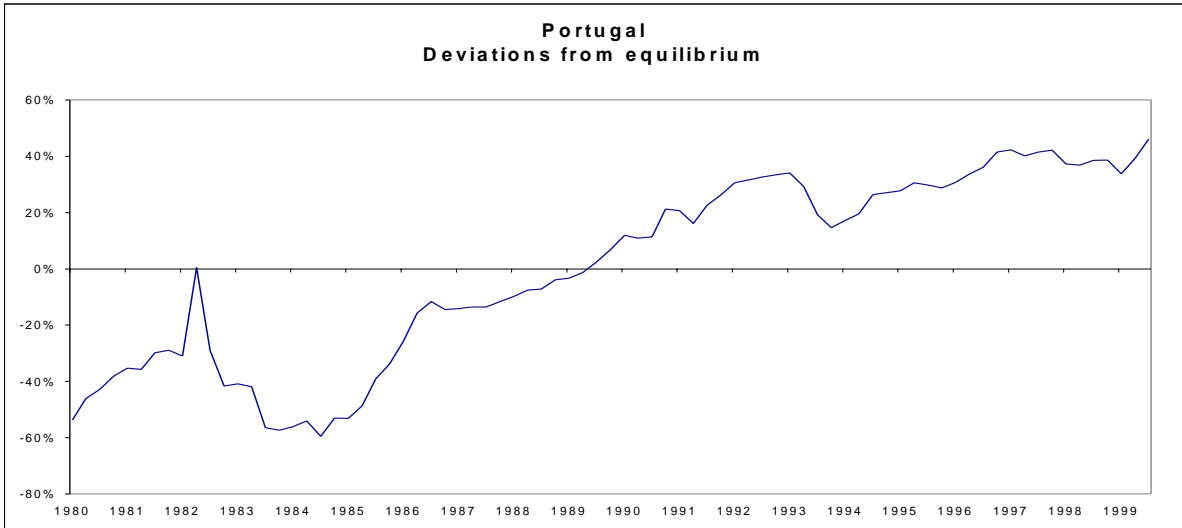*Figure 40 - Estimation results with trend decomposition method*

Figure 41 - Estimation results without trend decomposition method

51
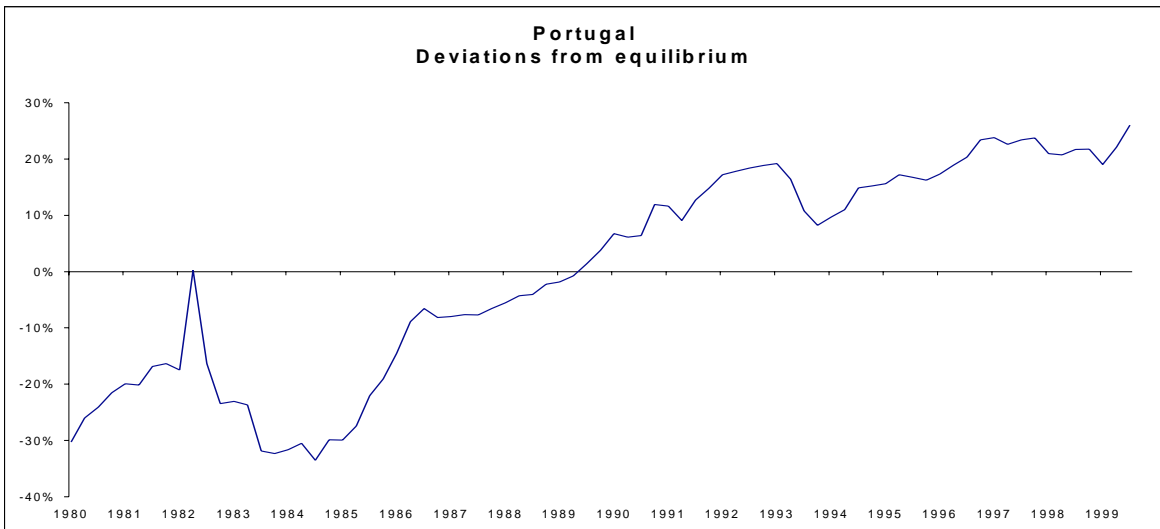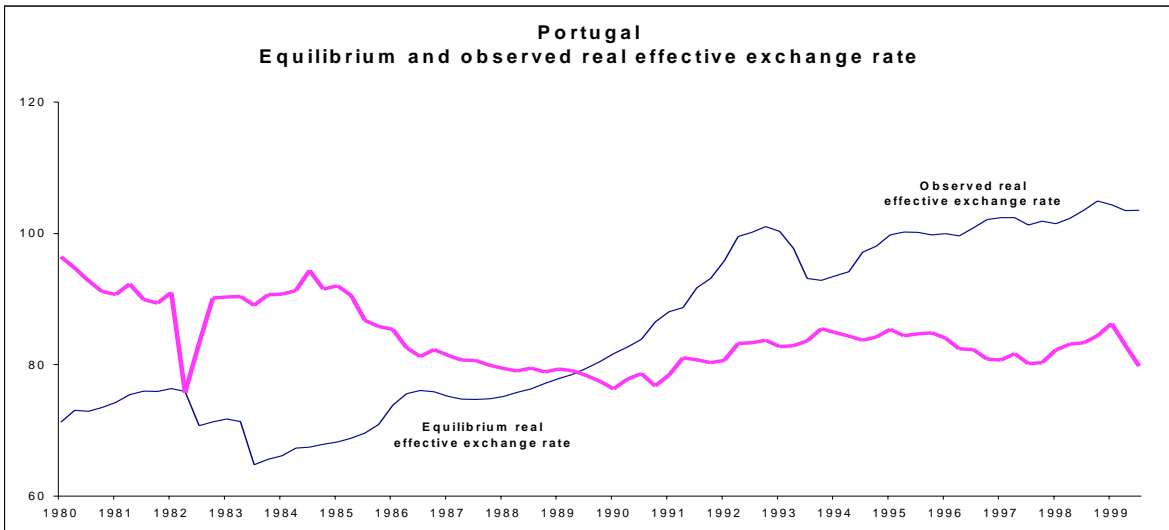
Ireland has experienced a period of real equilibrium exchange rate depreciation between the second half of the1980s and 1990s. This may seem surprising because Ireland is clearly in a rapid catching-up process towards the economically more developed member states and might therefore be expected to have shown a trend appreciation. Part of the explanation is the rapid growth of foreign direct investment which has implied huge productivity increases in parts of the tradable sector. This has created a kind of "dual economy" compared to the "domestic" tradable and non tradable sector complicating the collection of reliable productivity data, which are possibly overstated. Our data for relative tradable vs. nontradable sector productivity are broadly flat for the sample period.

In the middle of the 1980s, a comprehensive program for macroeconomic stabilisation and structural reform was implemented in Ireland. Structural reforms and a huge decline in the NAIRU, from possibly one of the highest to one of the lowest in the euro area, required ceteris paribus a depreciation of the real equilibrium exchange rate. The governments income policy was successful in promising tax cuts in exchange for wage increases below productivity rises. The very high foreign debt ratio in the mid eighties required a period of high competitiveness. However, the persistent fall in the foreign debt ratio argues for a real equilibrium exchange rate appreciation. Despite actual output being probably above potential the current account still exhibits a large surplus.

The estimations, using cointegration methodology alone, indicate an upward sloping equilibrium exchange rate and an undervaluation of about 10 per cent in the third quarter of 1999. Estimation results, achieved by applying the detrending methodology, however exhibit unreasonably small deviations from trend. The estimation results for Ireland are fairly unstable.

Figure 42 - The data

Figure 43 - Estimation results with trend decomposition method

Ireland
Equilibrium and observed real effective exchange rate

Observed real effective exchange rate

Equilibrium real effective exchange rate

Ireland
Deviations from equilibrium
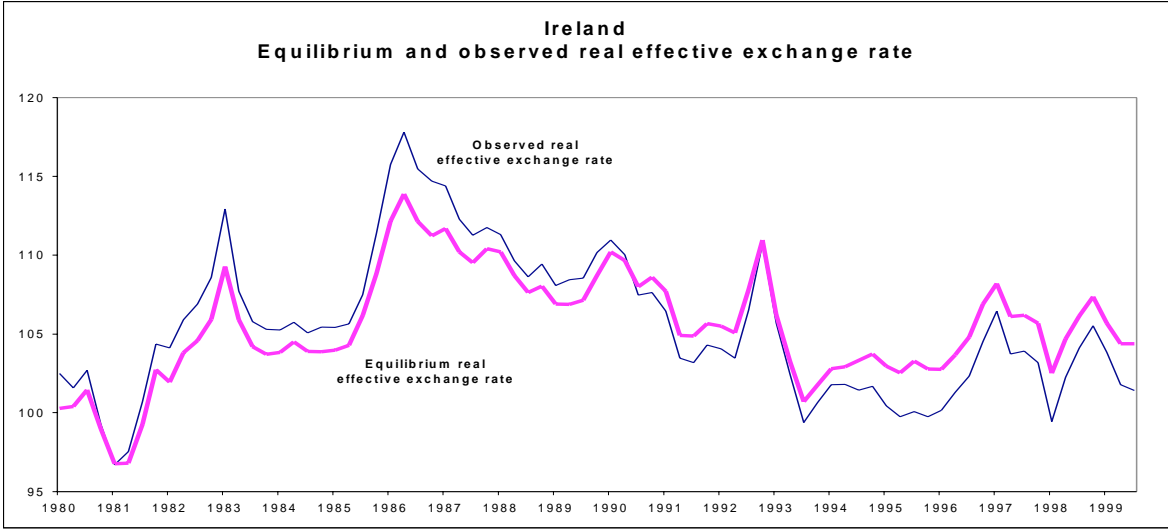
Figure 44 - Estimation results without trend decomposition method

Ireland
Equilibrium and observed real effective exchange rate

Observed real effective exchange rate

Equilibrium real effective exchange rate

Ireland
Deviations from equilibrium

The **Belgian** real equilibrium exchange rate has closely followed trends in relative tradable vs. nontradable sector productivity and the net foreign asset ratio. It appreciated between the mid 1980s and the mid 1990s, before levelling off and falling somewhat in the second half of the 1990s. Estimated deviations from trend are small. Actual GDP is judged to be broadly in line with potential and the current account shows a substantial surplus. The comparatively high and improving net foreign asset ratio of GDP may argue for a medium-term undervaluation of the Belgian franc. The Belgium franc is indicted to have been undervalued by around 2% in the third quarter of 1999.

However, the favourable competitiveness position of the Belgium economy appears, in contrast to the Netherlands, to have been achieved in part through a process whereby labour productivity had to be raised in response to high labour costs and shedding labour. The employment ratio remains low in an international comparison. Stronger employment growth and a lower NAIRU will ceteris paribus require a downward adjustment of the real equilibrium exchange rate.

Figure 45 - The data

Belgium

Relative productivity (left scale)

Real effective exchange rate (left scale)

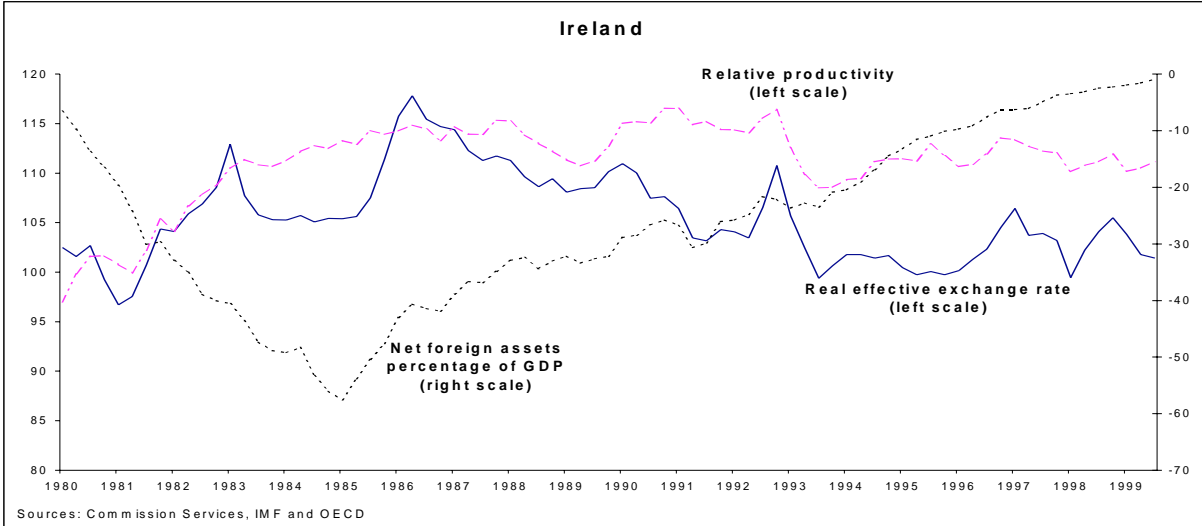Net foreign assets percentage of GDP (right scale)

Sources: Commission Services, IMF and OECD

54

Figure 46 - Estimation results with trend decomposition method

Belgium
Equilibrium and observed real effective exchange rate

Observed real
effective exchange rate

Equilibrium real
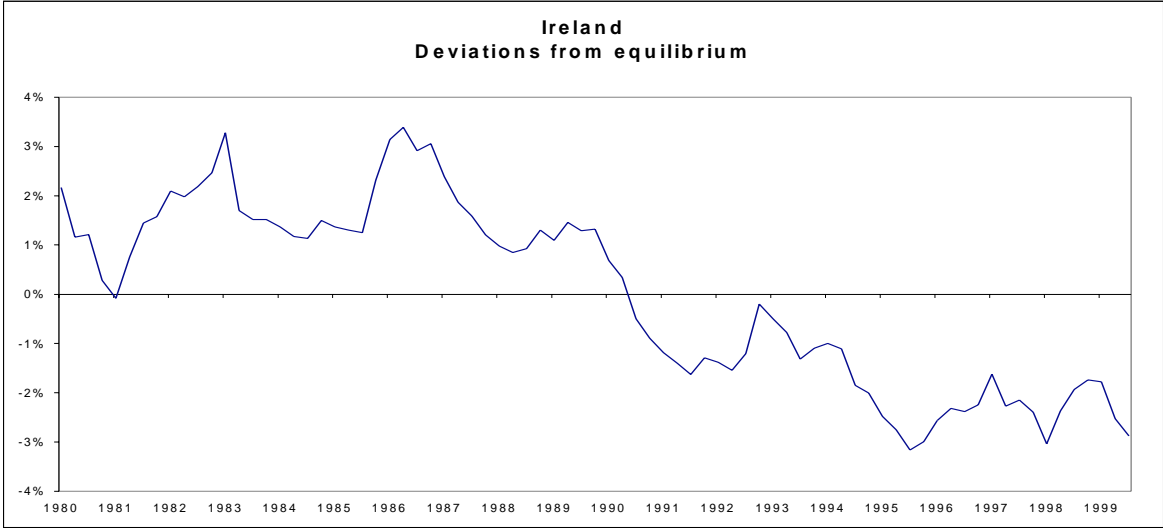effective exchange rate

Belgium
Deviations from equilibrium

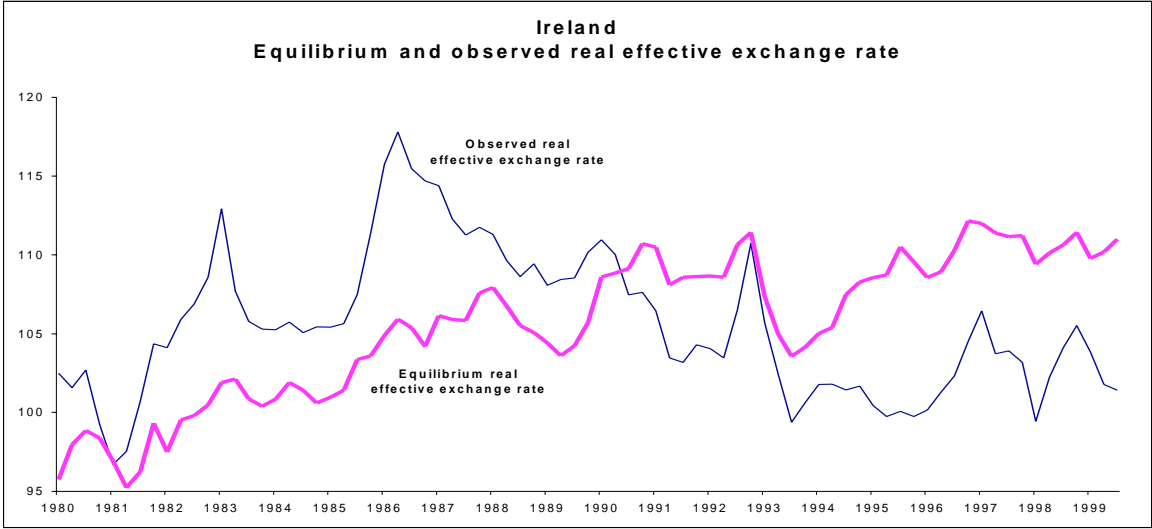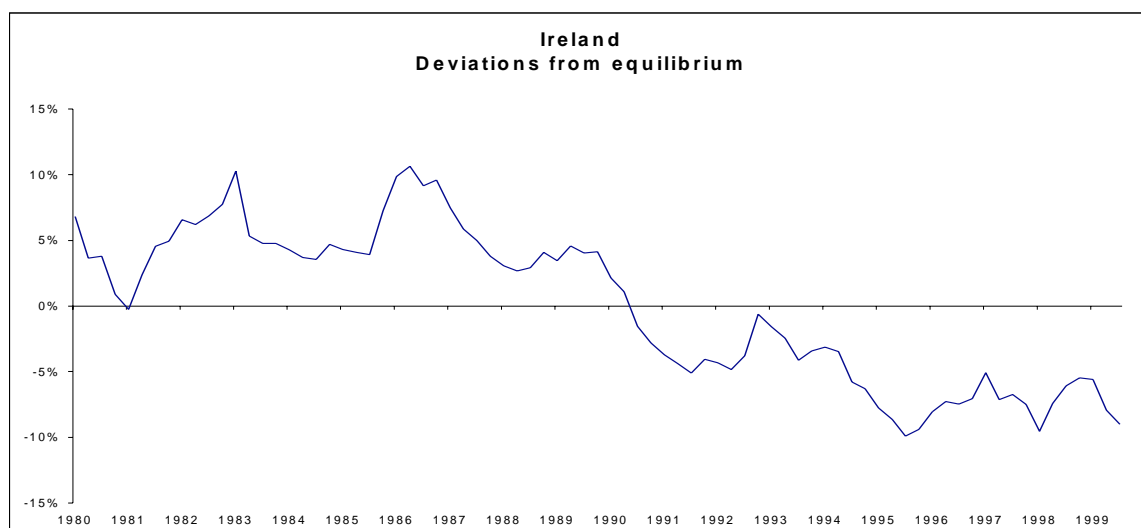*Figure 47 - Estimation results without trend decomposition method*

Belgium
Equilibrium and observed real effective exchange rate

Equilibrium real
effective exchange rate

Observed real
effective exchange rate

Belgium
Deviations from equilibrium

The **UK** has experienced falling relative tradable vs. nontradable sector productivity throughout the sample, probably the result of high employment growth. Actual (and probably even the equilibrium) unemployment has decreased substantially since the first half of the 1980s due to comprehensive labour market reforms and the rate is down to very low levels compared to other EU-countries.[21]

The net foreign asset ratio of GDP has fallen since the second half of the 1980s and levelled off in the past years. The accumulation of foreign debt was provoked by an asset price driven consumption boom in the second half of the 1980s.

The estimated equilibrium exchange rate is driven by relative tradable vs. nontradable sector productivity only and exhibits a falling trend throughout the sample period.[22] Deviations between the actual and estimated equilibrium rate are small, if the trend decomposition method is used, and the pound is indicated to have been overvalued by around 10% in the third quarter of 1999. Estimations relying on cointegration technique alone indicate an overvaluation of the pound in the third quarter of 1999 by about 20%. Taking into account net foreign asset developments which however is not supported statistically would suggest an even larger overvaluation. Estimation results for the UK are very unstable.

Figure 48 - The data

United Kingdom

Real effective exchange rate (left scale)

Relative productivity (left scale)

Net foreign assets percentage of GDP (right scale)

Sources: Commission Services, IMF and OECD

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[21]   As in the case of the Netherlands, falling relative productivity in the tradable vs. nontradable sector should not be seen as the outcome of weak potential growth, but rather high employment growth.

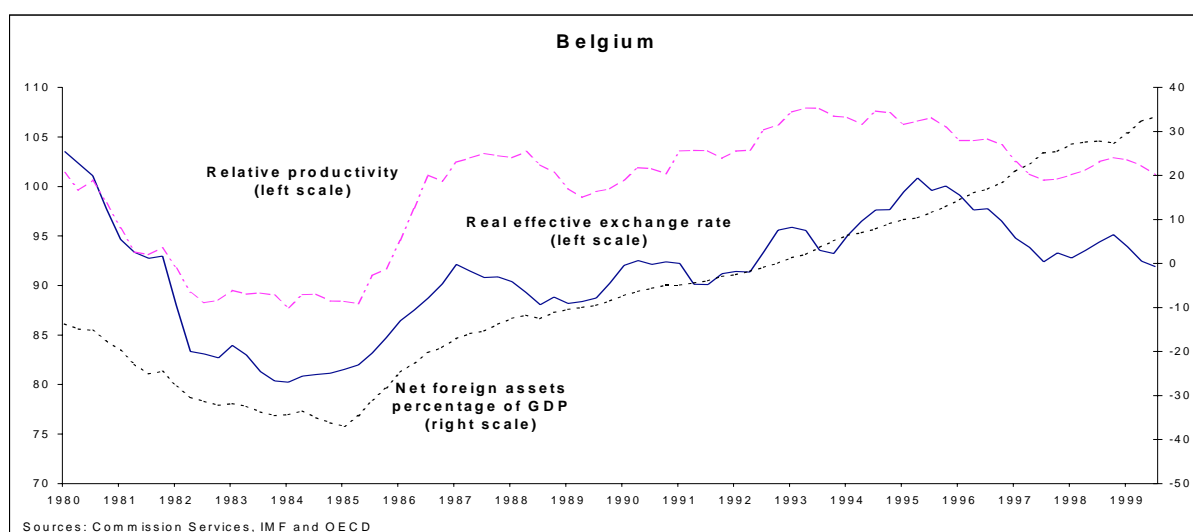[22]   The coefficient for the net foreign asset ratio of GDP has for statistical reasons been restricted to zero.

56

Figure 49 - Estimation results with trend decomposition method

United Kingdom
Equilibrium and observed real effective exchange rate

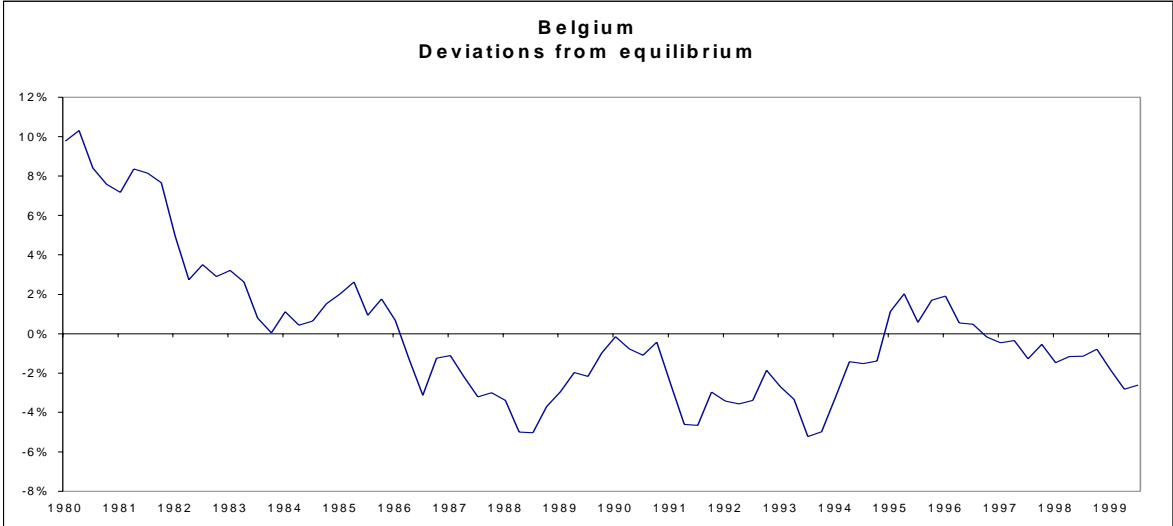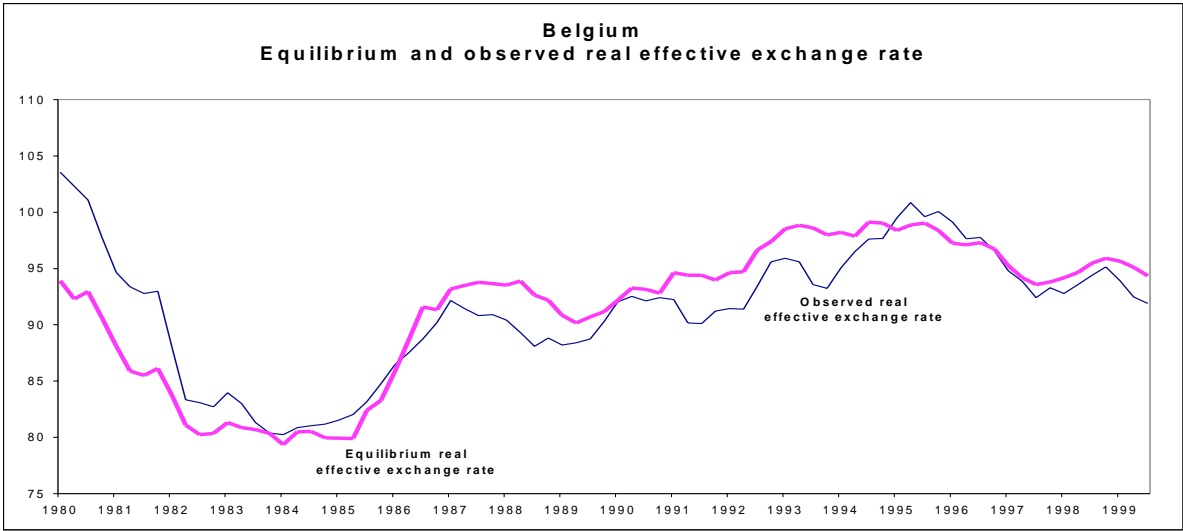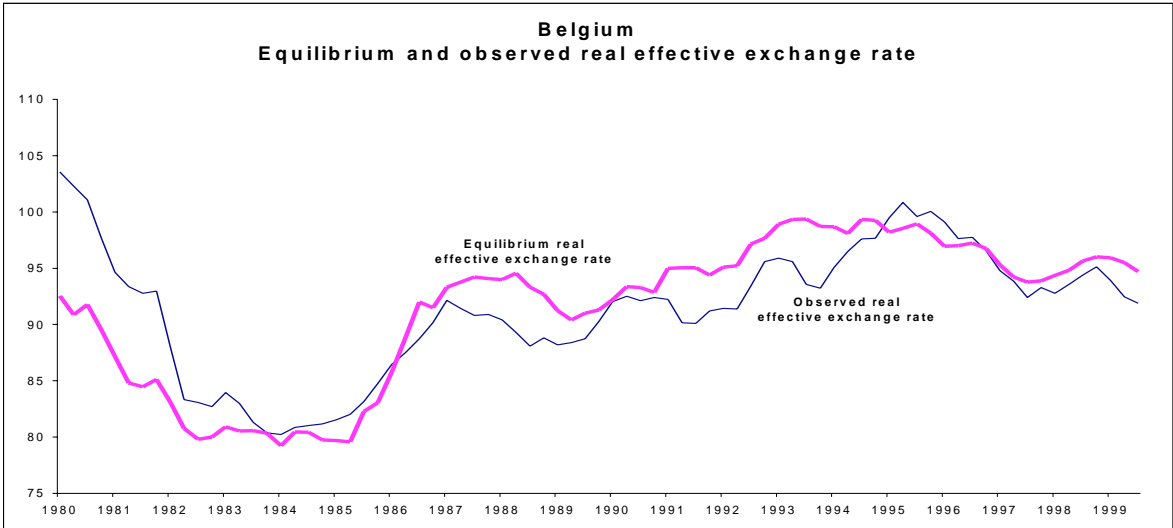
United Kingdom
Deviations from equilibrium
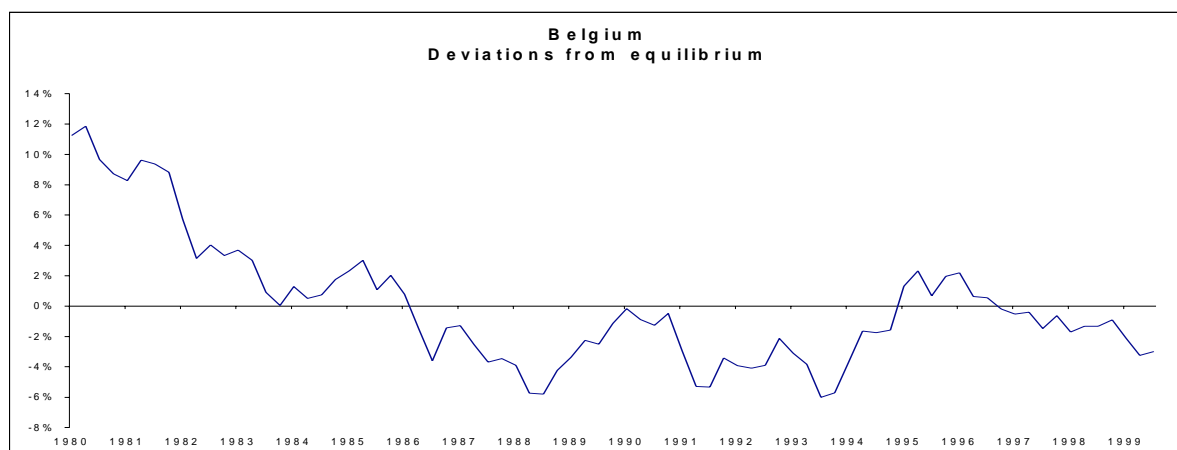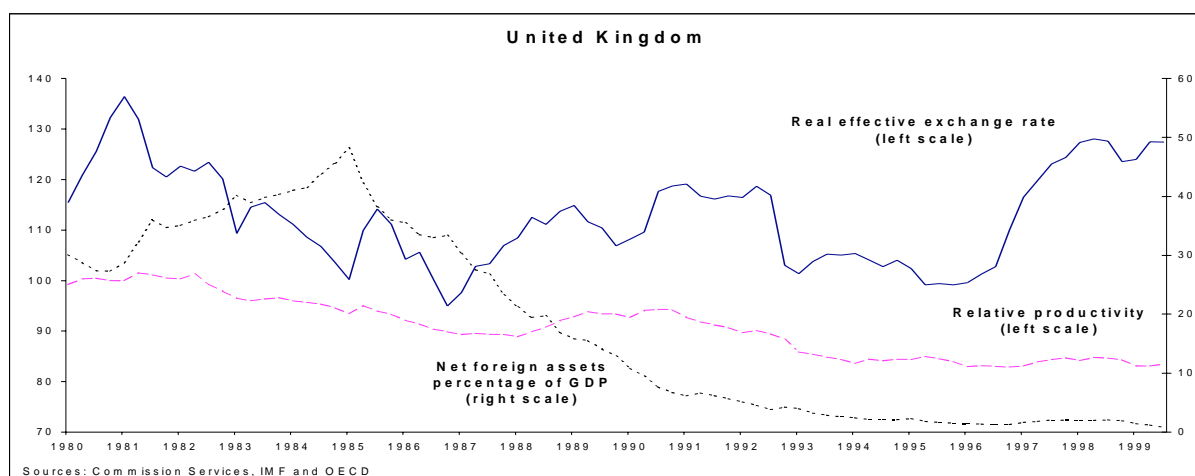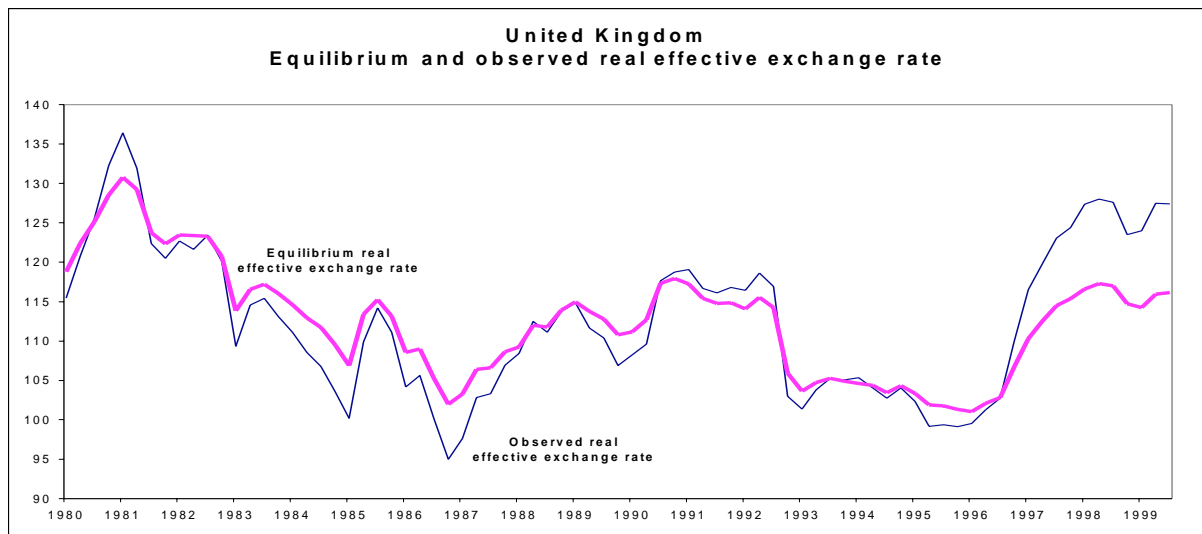
Figure 50 - Estimation results without trend decomposition method

United Kingdom
Equilibrium and observed real effective exchange rate

United Kingdom
Deviations from equilibrium
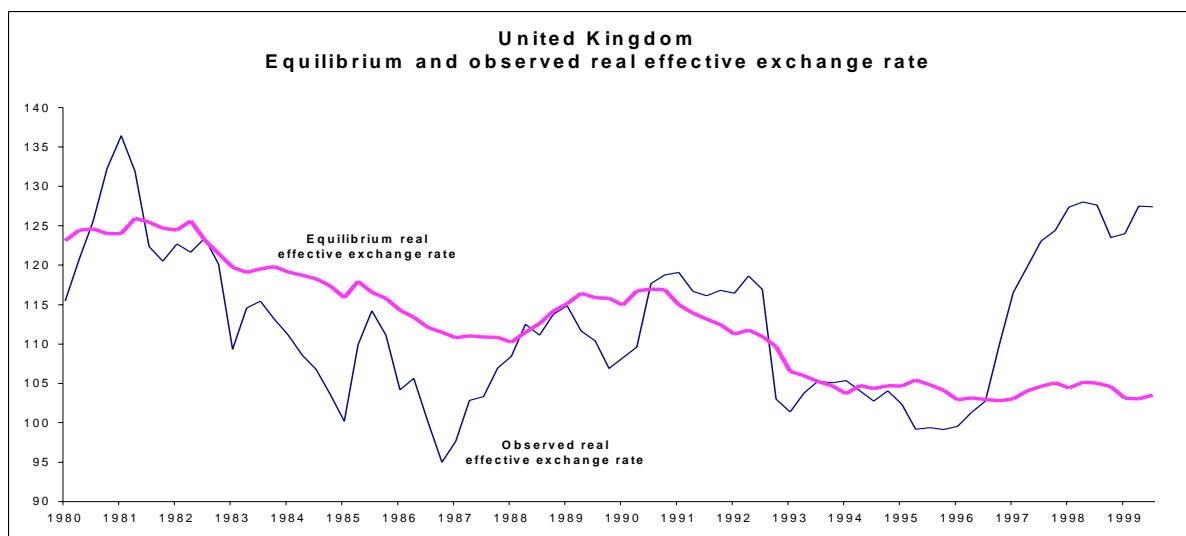
Sweden experienced a long-lasting boom throughout the 1980s which was initiated by two large devaluations and rising net exports at the beginning of the 1980s. After the deregulation of capital markets in the mid eighties, high domestic demand, spurred by high credit growth and rising asset prices, drove production above potential. High inflation in combination with the prevailing fixed exchange rate regime led to a gradual appreciation of the real exchange rate which, according to our estimates became overvalued in the second half of the 1980s. The net foreign asset ratio of GDP rose throughout the second half of the 1980s, but levelled off then and fell sharply at the beginning of the 1990s.

The real exchange rate has been undervalued since the sharp devaluation in 1992 according to our estimates, which may partly be explained by a large output gap. The net foreign asset ratio of GDP has risen substantially in the second half of the 1990s. At present, actual output is estimated to be close to potential and the current account shows a moderate surplus. Our series for relative tradable vs. nontradable productivity shows a fall since the economic recovery started in 1993, which appears doubtful because productivity in manufacturing has risen strongly in Sweden since then.

The Swedish krona was marginally undervalued in the third quarter of 1999 according to our estimates which are very similar for both estimation techniques. The net foreign asset ratio of GDP is still low in a historical and international perspective, which requires a weak krona in the medium term to bring down the foreign debt ratio to a desired lower level. This is also indicated by a full employment current account surplus. As the process of paying off external debt progresses, the actual and real equilibrium exchange rate should further appreciate towards their long-run equilibrium level.

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Figure 51 - The data

Sweden

Sources: Commission Services, IMF and OECD

Figure 52 - Estimation results with trend decomposition method

Sweden
Equilibrium and observed real effective exchange rate
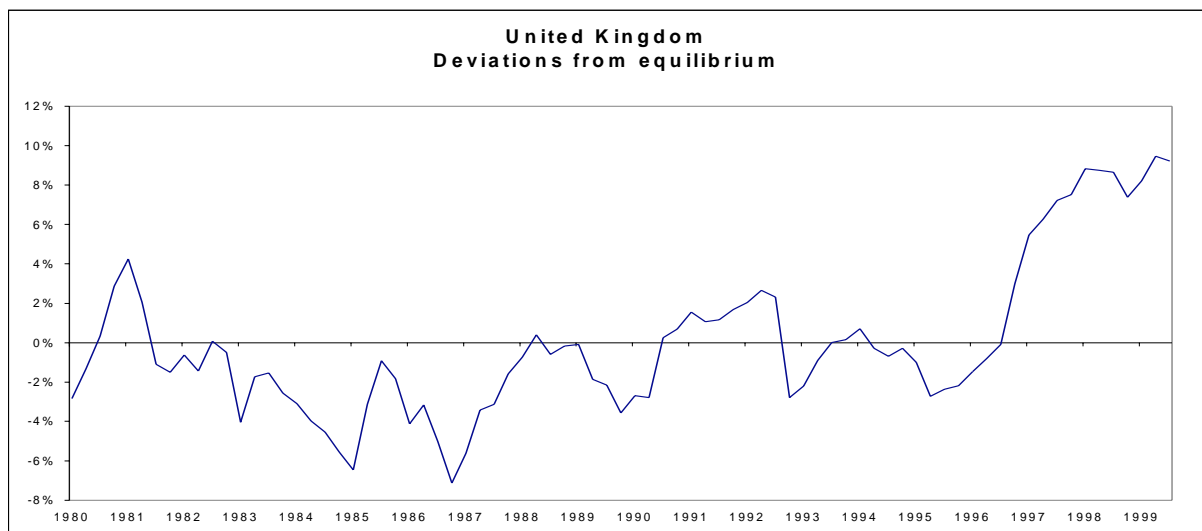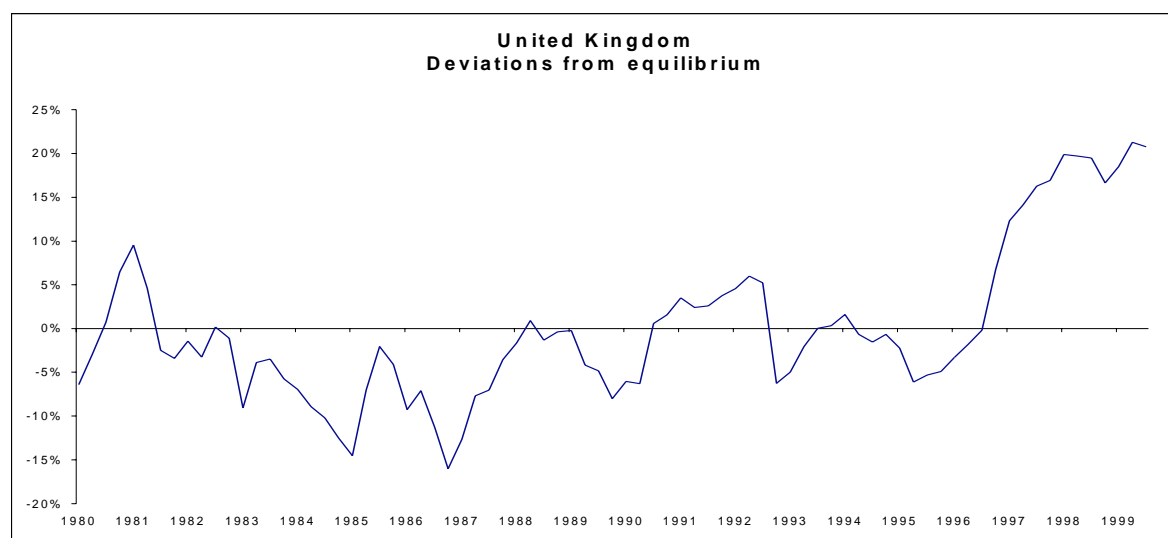

Sweden
Deviations from equilibrium

59
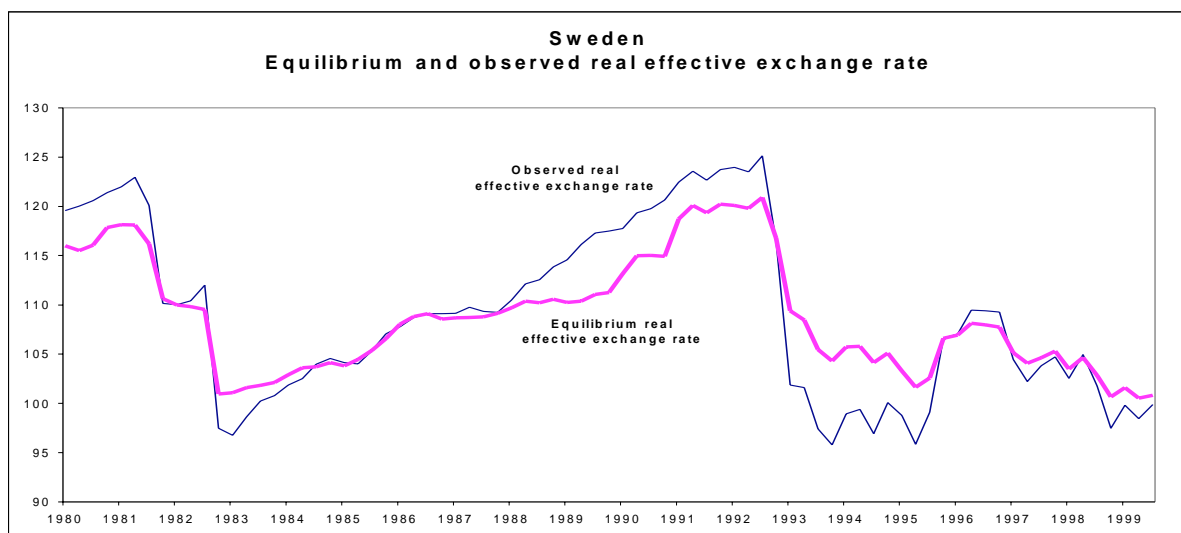
Figure 53 - Estimation results without trend decomposition method

Sweden
Equilibrium and observed real effective exchange rate

(Chart showing Observed real effective exchange rate and Equilibrium real effective exchange rate, 1980–1999, y-axis 90 to 130)

Sweden
Deviations from equilibrium

(Chart showing deviations from equilibrium, 1980–1999, y-axis -15% to 10%)

The **Danish** real effective exchange rate has moved largely in line with trends in the net foreign asset ratio of GDP, which empirically has resulted in small deviations between the actual and trend real exchange rate. This may appear somewhat counterintuitive as the Danish economy has shown macroeconomic imbalances in the past. Economic policy was substantially tightened in the 1980s which resulted in a falling foreign debt ratio and a rising equilibrium exchange rate. Growth has recently slowed in Denmark and is expected to remain below the euro area average in the near term. GDP is estimated to be somewhat above potential, while the current account is broadly in balance. This indicates that the full employment current account is close to zero. For the third quarter of 1999, a small undervaluation of around 2 per cent is estimated according to both methodologies. However, estimated deviations from trend appear unreasonably small, which indicate that deviations should possibly be magnified judgementally.

However, the net foreign asset ratio of GDP is low and possibly below their desired level in Denmark. In this case, a full employment current account surplus would be required and the current real exchange rate could be overvalued.

Figure 54 - The data

Danmark

Sources: Commission Services, IMF and OECD

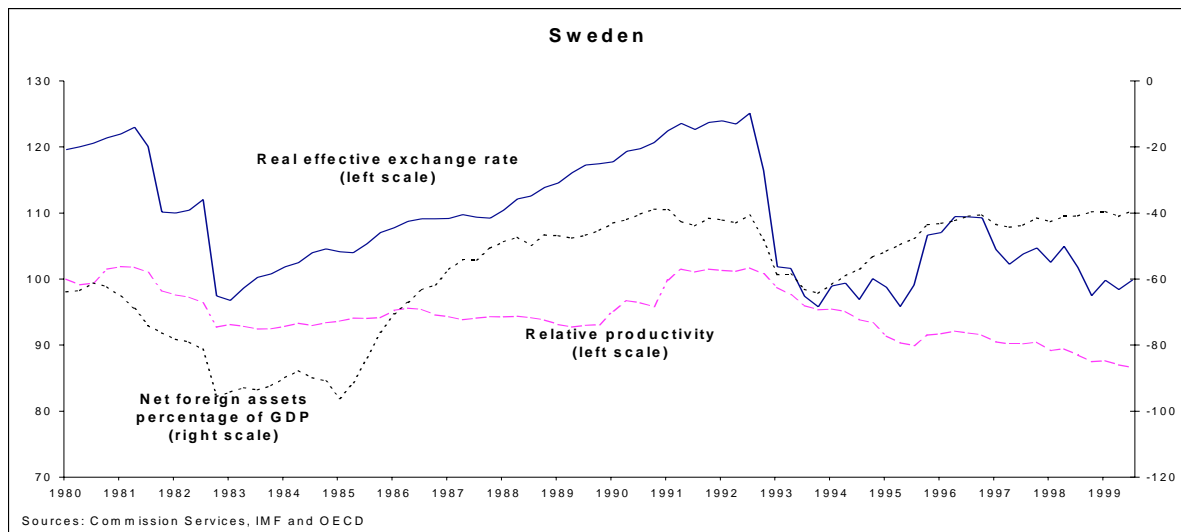*Figure 55 - Estimation results with trend decomposition method*

Denmark
Equilibrium and observed real effective exchange rate
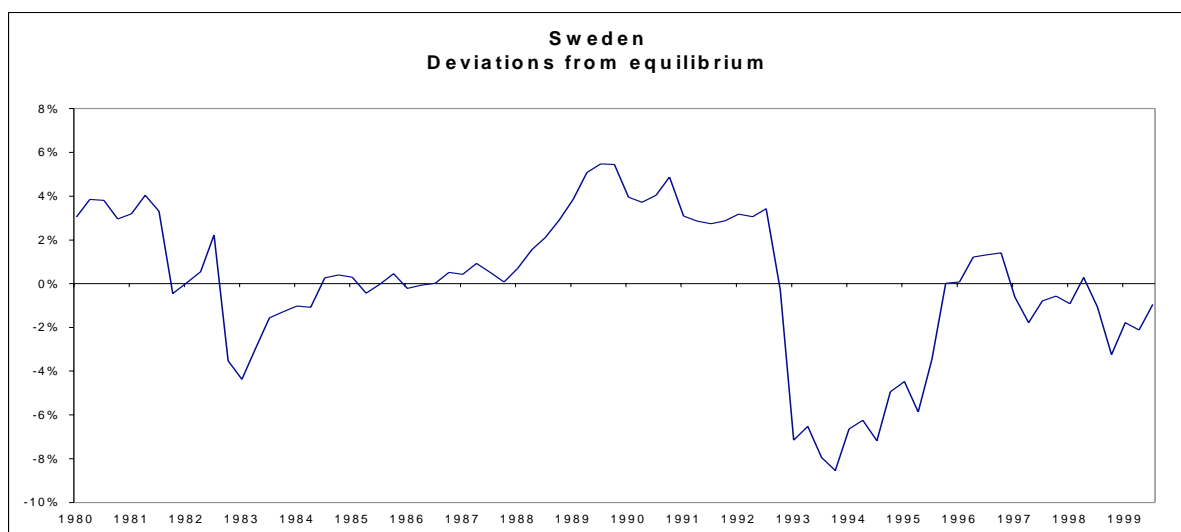

Denmark
Deviations from equilibrium

61
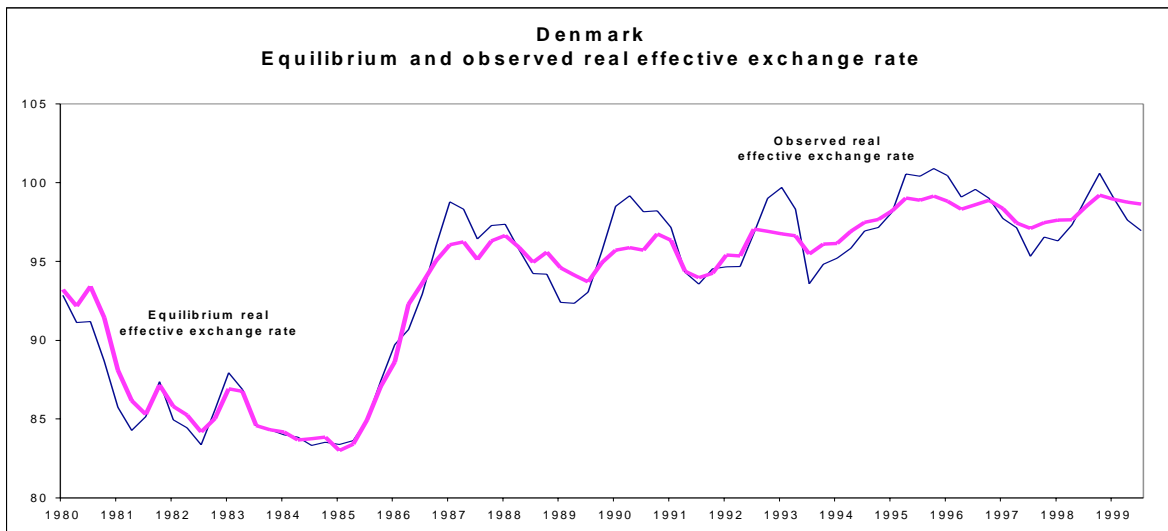
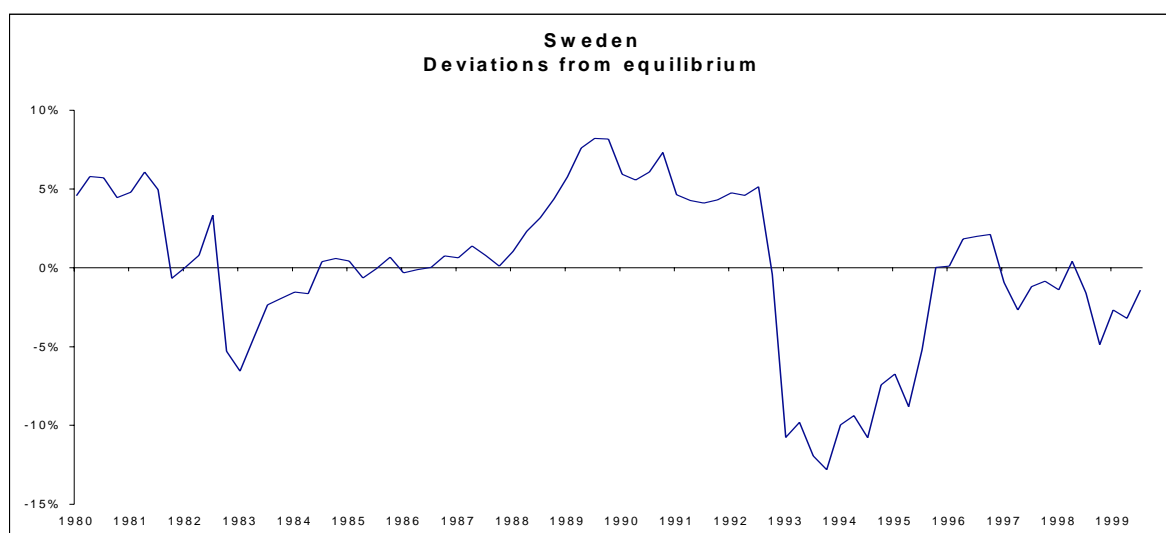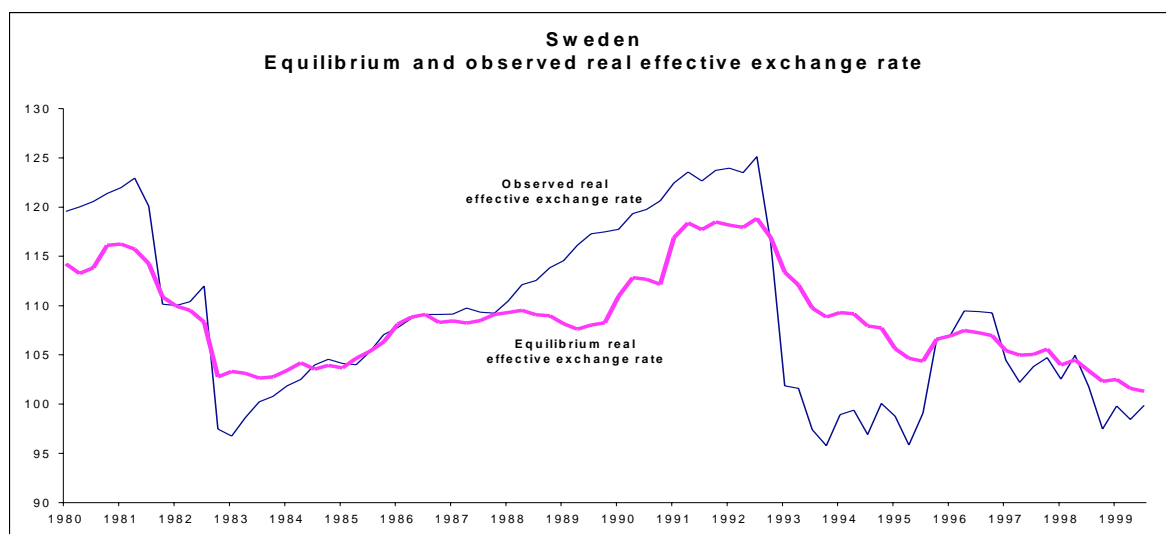*Figure 56 - Estimation results without trend decomposition method*

**Denmark
Equilibrium and observed real effective exchange rate**

**Denmark
Deviations from equilibrium**

The real exchange rate of the **<u>Greek</u>** drachma has steadily appreciated since the mid 1980s due to higher inflation than in its trading partners. Relative tradable vs. nontradable sector productivity has risen modestly throughout the sample period, reflecting the catching up of Greece as an economically less developed country. The net foreign asset ratio of GDP has fallen throughout the sample period and is probably at an internationally very low level.[23] This may partly be explained by favourable investment opportunities in the ongoing process of catching up and hence an adjustment to a lower level of desired net foreign assets. Actual production is judged to be below potential despite high growth rates during the second half of the 1990s and the current account is in deficit. Unemployment is still at historically high rates and has been broadly stable in recent years.

The estimated equilibrium exchange rate has trended downwards during the whole sample period and an overvaluation of nearly 30% is indicated for the third quarter of 1999. The equilibrium exchange rate is largely driven by the falling net foreign asset ratio of GDP. If

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[23] The available data for net foreign assets and the current account is extremely uncertain for Greece.

desired net foreign assets have fallen as well throughout the sample period, the estimated overvaluation is probably overstated. Greece recent economic performance as a catching up country has certainly being less impressive than for other less developed countries in the European Union, but it appears questionable if the estimated negative trend for the equilibrium exchange rate is reasonable. However, the Greek economy is characterised by substantial structural inefficiencies and probably a high NAIRU. Structural reforms and higher long-term employment require ceteris paribus a lower equilibrium exchange rate.

All in all, our estimates indicate that the Greek drachma is overvalued, even if the estimated magnitude is questionable, and a continuation of the current appreciating trend may therefore lead to an unsustainable development of the external position in the medium term. Estimation results for Greece are very unstable.
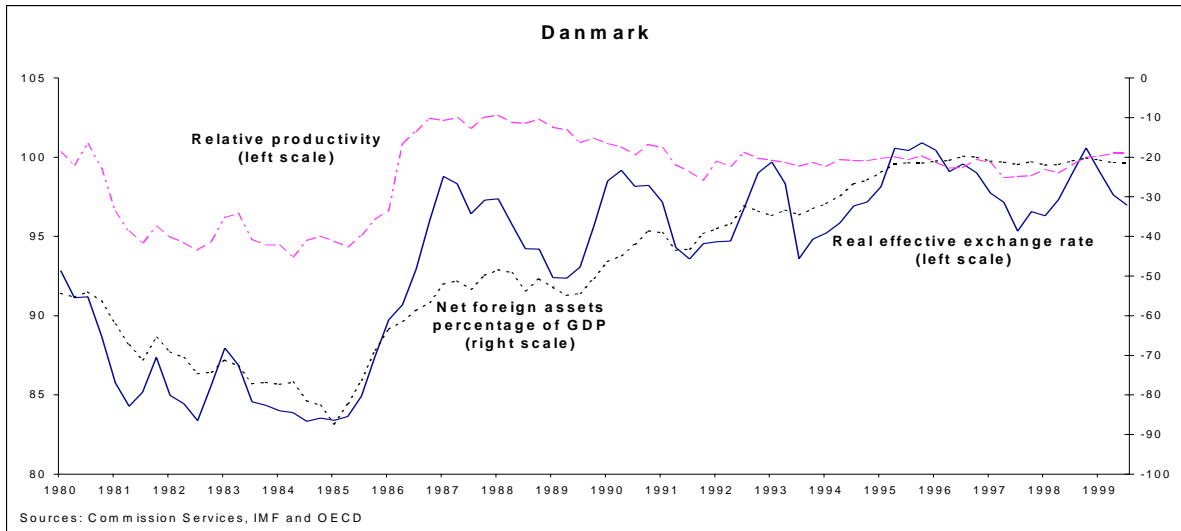
Figure 57: The data

Figure 58 - Estimation result with trend decomposition method
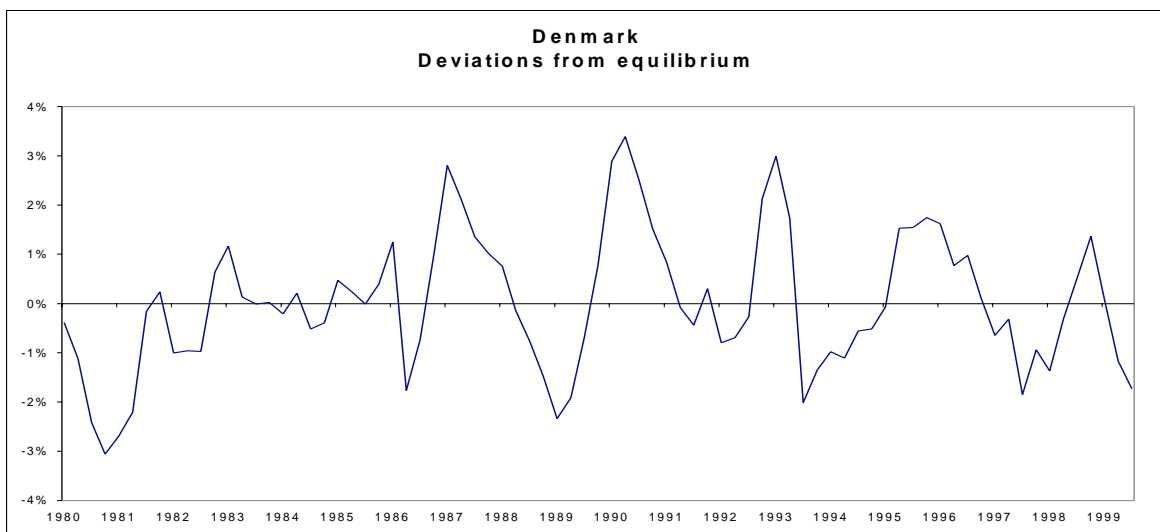

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Greece
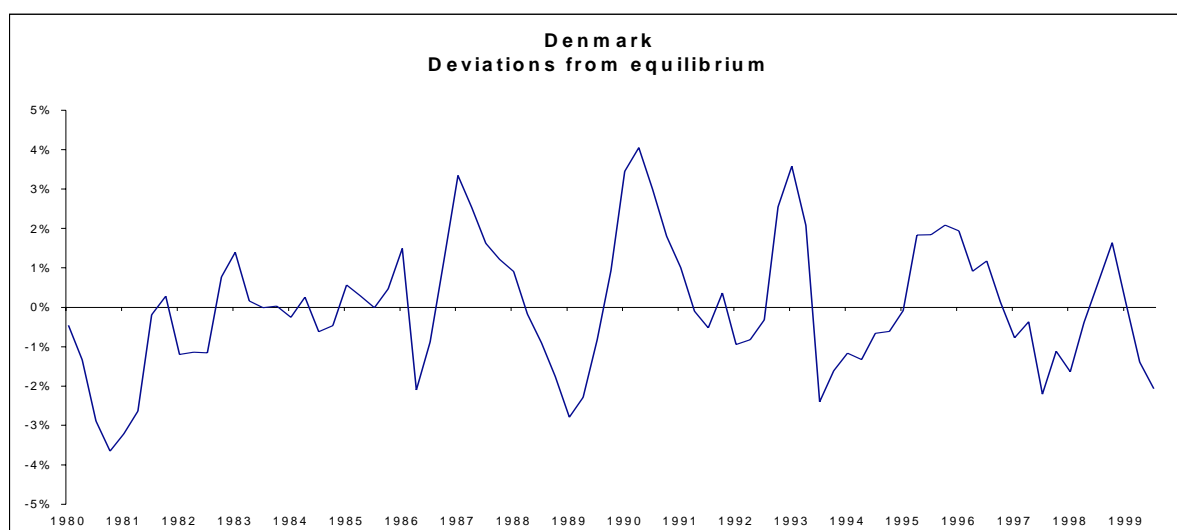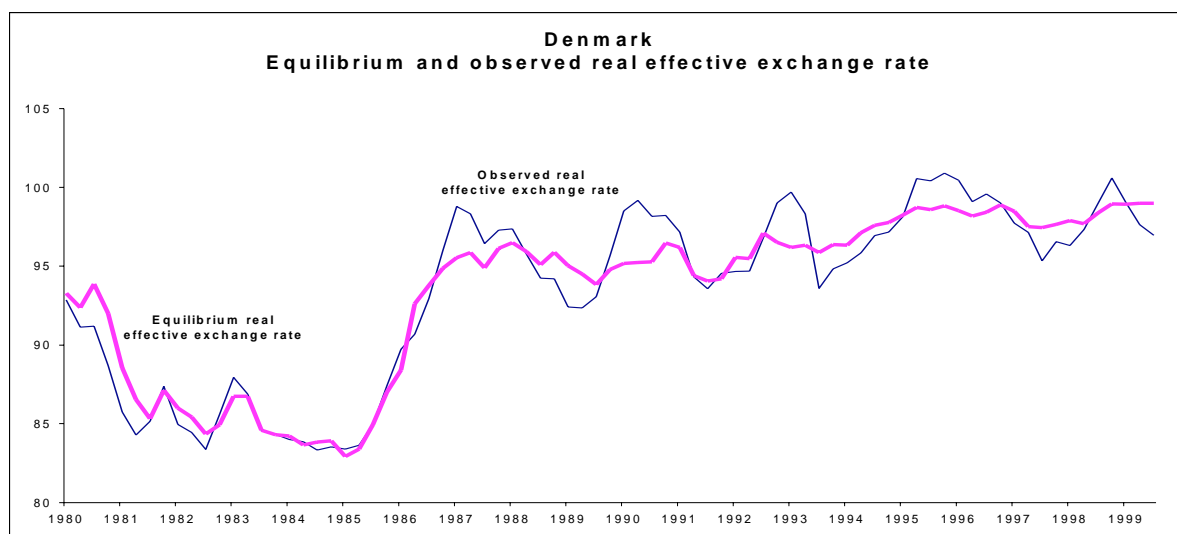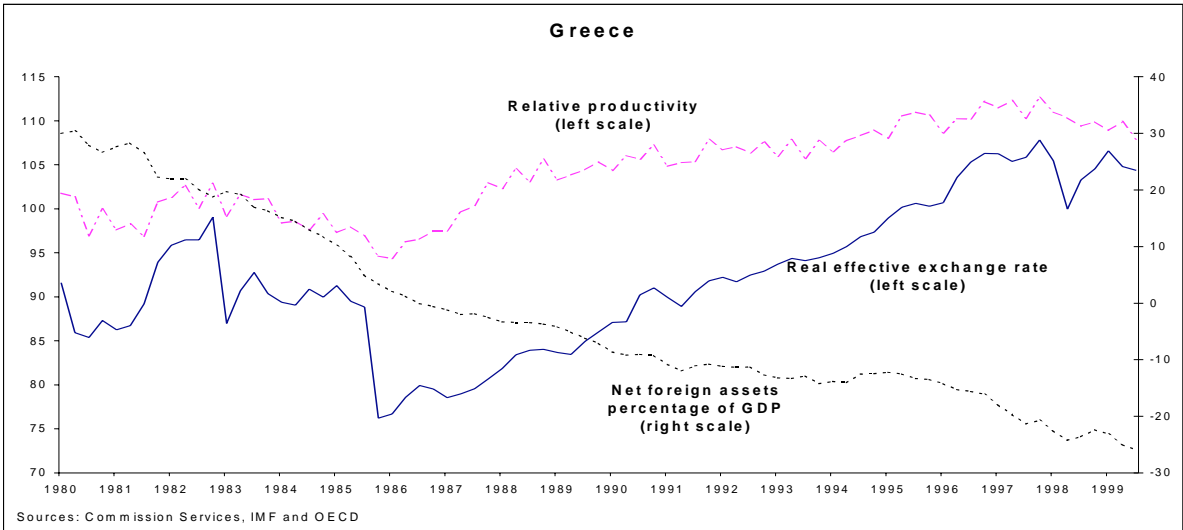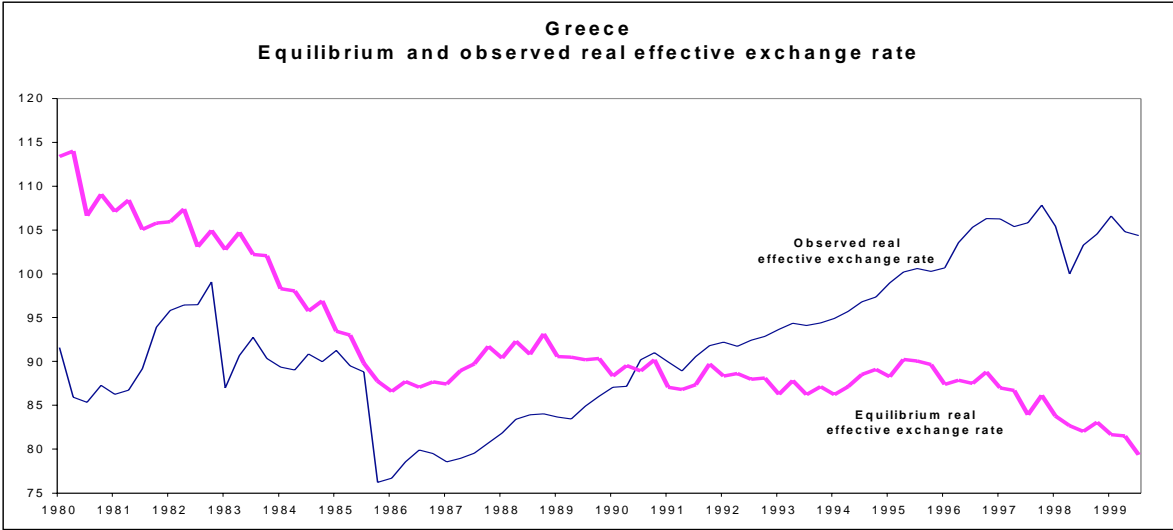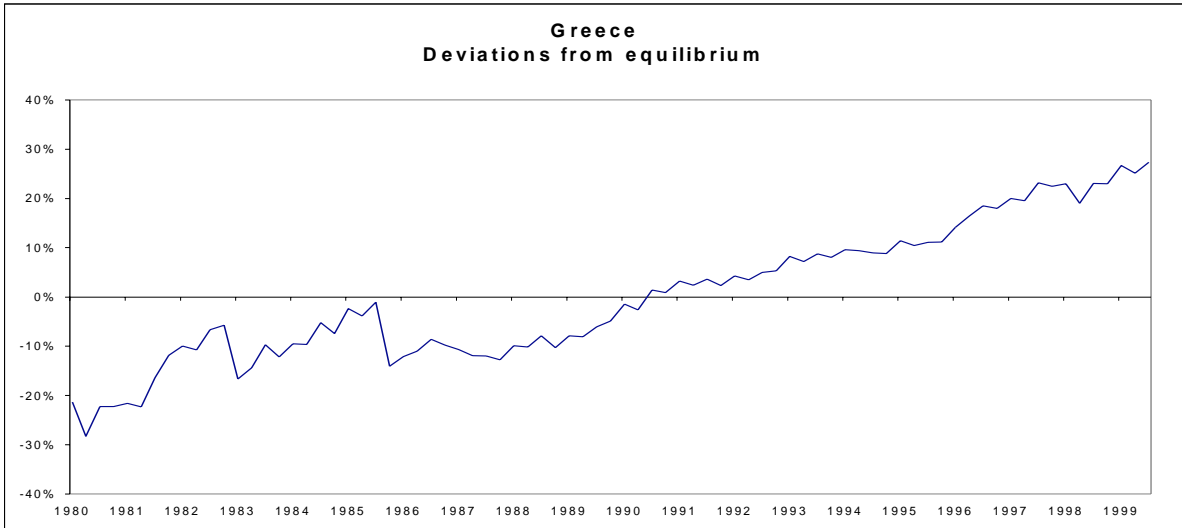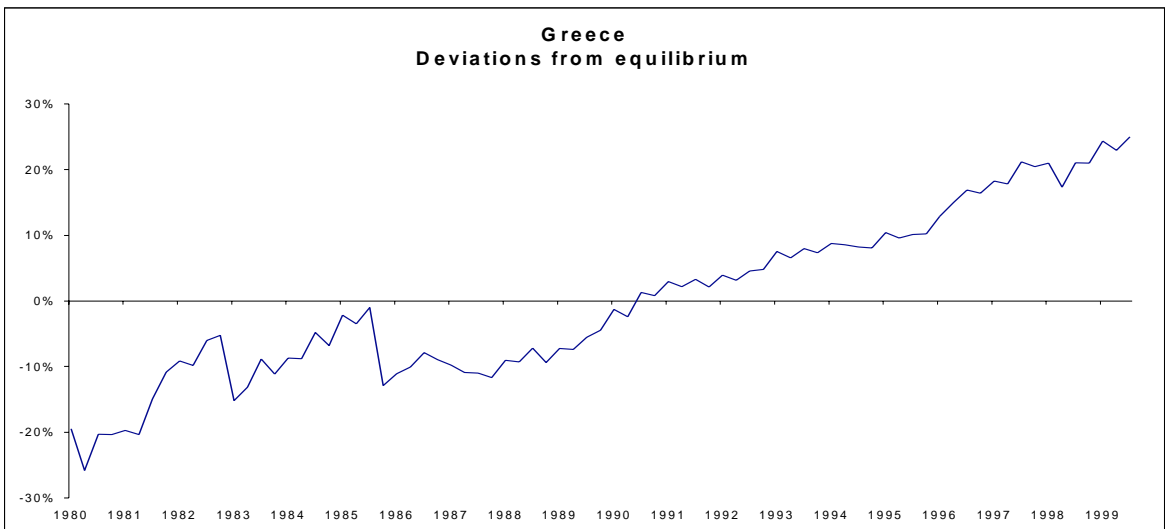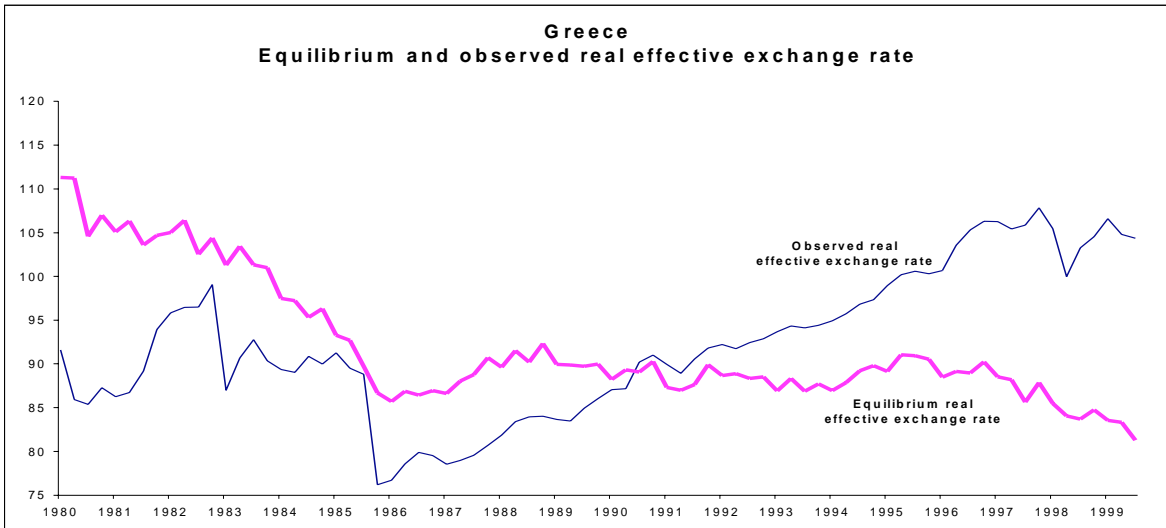**Deviations from equilibrium**

Figure 59 - Estimation result without trend decomposition method

Greece
Equilibrium and observed real effective exchange rate

Greece
Deviations from equilibrium

6. Summary and conclusions

This paper presents and estimates a macroeconomic model for the equilibrium exchange rate based upon internal and external equilibrium. It evaluates the empirical results on a country by country basis. The purpose of the econometric exercise is not to report point estimates for equilibrium exchange rates, but rather to provide some basic econometric evidence as a complement and illustration of the theoretical analysis. The study focuses on medium-term equilibrium exchange rates which means that estimated deviations from trend should not automatically be regarded as "misalignments" but may rather be warranted due to cyclical factors.

The estimates for a larger number of countries suffer from statistical problems, but estimated paths for real effective equilibrium exchange rates are mostly reasonable. The statistical results look broadly favourable for Germany, Finland, Sweden, Denmark and Canada, more neutral for the US, the euro area, Italy, Austria, the Netherlands, Belgium and Greece and less favourable for Japan, France, Spain, Portugal, Ireland and the UK.

In the *US,* the net foreign asset ratio of GDP has practically fallen since the beginning of the eighties due to a combination of high domestic demand pressure and favourable supply side developments which explains the downward trend in the estimated real equilibrium exchange rate, especially in the eighties. This was counteracted by modestly rising relative tradable vs. nontradable sector productivity. The estimated dollar overvaluation in the third quarter of 1999 of around 10% can at least partly be explained by the advanced business cycle position of the US economy. In *Japan*, the real equilibrium exchange rate has appreciated during a long period of time, driven by increasing relative tradable vs. nontradable sector productivity throughout the 1980s and an improving net foreign asset ratio of GDP. The estimates indicate a current undervaluation of the yen by between 10%-20%, which easily can be explained by the probably large output gap. Major question marks are demographic developments and future structural reforms. *Canada's* real exchange rate has closely followed trends in relative tradable vs. nontradable sector productivity and the net foreign asset ratio of GDP. The real exchange rate is estimated to have been modestly below their medium term equilibrium in the third quarter of 1999. However, the foreign debt ratio of GDP is very high and a lower real equilibrium exchange would probably be required to bring it down to internationally more comparable levels.

The estimated equilibrium exchange rate for the *euro* has appreciated throughout the 1990s as the result of a rising net foreign asset ratio of GDP. The estimates indicate an undervaluation of around 15% in the third quarter of 1999. The future path of the real equilibrium exchange rate will depend on supply side trends for the NAIRU and overall productivity growth.

The *German* real effective exchange rate is estimated to have been slightly overvalued in the third quarter of 1999. A downward trend in the net foreign asset ratio of GDP since unification has driven down the equilibrium exchange rate in the 1990s. In contrast, a modest undervaluation is indicated for *France* due to a more favourable development of relative tradable vs. nontradable sector productivity and the net foreign asset ratio of GDP. For *Italy*, a rising net foreign asset ratio of GDP after the breakdown of the Exchange Rate Mechanism (ERM) set off an appreciation of the equilibrium exchange rate and the estimations indicate a substantial undervaluation of the Italian real exchange rate, at least partly explained by a negative output gap. The estimated real equilibrium exchange rate for *Spain* is mainly driven by relative tradable vs. nontradable sector productivity and the real exchange rate is close to equilibrium. The estimated *Dutch* real equilibrium exchange rate has been rather flat throughout the sample period, affected in different directions by falling relative tradable vs. nontradable sector productivity and a rising net foreign asset ratio of GDP. The estimations

point at an undervaluation of the Dutch real exchange rate. A substantial undervaluation is estimated for the *Finnish* real exchange rate, which may be questionable in the light of the still high foreign debt ratio. The real exchange rates for the two catching up economies *Portugal* and *Greece* are estimated to be significantly overvalued, due to a downward trend in the net foreign asset ratio of GDP. However, if the desired net foreign asset ratio of GDP has fallen during the process of catching up, the estimated overvaluation should be overstated. For *Ireland*, a modest, perhaps less than expected, undervaluation, is indicated. The comparatively high and improving net foreign asset ratio of GDP may argue for an undervaluation of the *Belgian* franc, which is also supported by our estimates. However, stronger employment growth and a lower NAIRU will require a downward adjustment of the real equilibrium exchange rate.

The equilibrium exchange rate for the *UK* has fallen during the past two decades, which can be explained by labour market reforms and probably also an increasing foreign debt ratio of GDP. The estimates indicate an overvaluation of between 10% - 20% in the third quarter of 1999. The *Swedish* real exchange rate was marginally undervalued in the third quarter of 1999 according to our estimates. The foreign debt ratio is still high in terms of both an historical and international perspective, which requires a weak krona in the medium term to bring it down to a lower level. The *Danish* real equilibrium exchange rate has appreciated in line with a rising net foreign asset ratio of GDP. The full employment current account appears to be close to zero and a small undervaluation is estimated for the third quarter of 1999. However, the net foreign asset ratio of GDP is low and a weaker equilibrium exchange rate would be required to bring it up to internationally more comparable levels.

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Appendix

<u>*Statistical properties for the preferred models*</u>

The table below summarises the most important statistical properties of the preferred country models.

Column 1:   Country.
Column 2:   Number of lags.
Columns 3-5:   P-value for auto-correlation tests. Null hypotheses of no auto-correlation.
Column 6:   Number of cointegrating vectors according to L-max and Trace test.
Column 7-10:   Unrestricted coefficient estimates (REER=Real effective exchange rate; PROD= Relative productivity; NFA= Net foreign.
                      asset ratio of GDP; C= Constant).
Column 11:   P-values for the factor loadings ("alfa").
Column 12-15:   Restricted coefficient estimates (restricted coefficients in italics).
Column 16:   P-values for the factor loadings ("alfa").
Column 17:   P-value for the restrictions.

	lags	Autocor-relation 1. order (p-value)	1. order (p-value)	4. order (p-value)	No. of coint. vectors	Coefficients Unrestricted REER	PROD	NFA	C	Alfa (t-value)	Restricted REER	PROD	NFA	C	Alfa (t-value)	P-value for restriction
US	4	0.05	0.02	0.07	3	1	-16.13	-3.46	4.93	-1.05	1	*1*	0.69	4.59	-1.67	0.13
JA	4	0.42	0.31	0.12	2	1	4.94	-1.23	3.65	0.03	1	*1*	1.09	3.97	-1.21	0.01
EUR	6	0.01	0.06	0.59	0 or 1	1	4.21	1.21	4.66	-0.28	1	*1*	0.84	4.58	-1.51	0.18
GER	4	0.07	0.23	0.43	2	1	1.63	1.44	4.50	-2.33	1	*1*	1.10	4.48	0.80	-2.64
FR	3	0.21	0.97	0.62	0 or 1	1	-0.36	-0.32	4.52	-4.23	1	*1*	*0*	4.56	-2.35	0.05
ES	4	0.08	0.12	0.38	1	1	-1.15	-2.53	4.28	0.67	1	*1*	*0*	4.50	-0.98	0.01
IT	2	0.11	0.06	0.52	1 or 2	1	-4.80	1.56	5.37	-1.19	1	*1*	1.65	4.77	-2.45	0.09
NL	2	0.69	0.86	0.17	1 or 2	1	1.18	0.26	4.74	-1.00	1	*1*	0.21	4.72	-1.16	0.78
PO	4	0.03	0.02	0.22	1 or 2	1	-0.46	-0.18	5.58	-1.66	1	*1*	*0.20*	5.94	-1.57	0.97
IR	2	0.22	0.85	0.44	1 or 2	1	-3.35	-0.43	4.91	-3.29	1	*1*	*0.20*	4.56	-0.33	0.00
BE	2	0.44	0.40	0.44	2	1	0.78	0.07	4.52	-3.90	1	*1*	0.05	4.53	-3.10	0.31
OS	3	0.08	0.78	0.89	0 or 1	1	0.88	0.07	4.45	-2.81	1	*1*	0.01	4.43	-2.55	0.47
SF	5	0.52	0.75	0.80	0 or 1	1	1.76	0.10	4.52	-1.34	1	*1*	0.17	4.61	-2.12	0.10
DK	2	0.18	0.53	0.51	1	1	1.04	0.18	4.63	-2.80	1	*1*	0.182	4.63	-2.83	0.81
GR	6	0.10	0.10	0.17	2	1	2.07	0.70	4.76	-3.97	1	*1*	0.67	4.93	-3.88	0.81
SW	2	0.52	0.32	0.93	0 or 1	1	0.89	0.09	4.80	-1.19	1	*1*	0.10	4.81	0.77	-1.19
UK	4	0.00	0.21	0.61	0	1	-0.43	0.02	4.69	-3.04	1	*1*	*0*	5.03	-0.22	0.11
CD	4	0.04	0.18	0.96	0 or 1	1	1.34	0.16	4.84	-1.87	1	*1*	0.38	4.89	-2.71	0.21

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