SOURCES OF REAL EXCHANGE RATE FLUCTUATIONS IN THE NORDIC COUNTRIES

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Abstract

In an attempt to move beyond the purchasing power parity hypothesis, this paper studies two issues. First, the causes of movements of real exchange rates are investigated. In contrast to the typical result, supply shocks are found to dominate the long-run variance decompositions for all the countries. This suggests that productivity developments are the most important determinant of long-run movements in real exchange rates. A second topic is the relative importance of stationary and non-stationary components of real exchange rates. Also in contrast to previous findings, transitory shocks are more important than permanent shocks for three of the four countries.

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Introduction

The bulk of the empirical literature on real exchange rates focuses on long run purchasing power parity (PPP), i.e. the hypothesis that real exchange rates fluctuate stationarily around a constant equilibrium. The attention devoted to PPP is primarily motivated not by the presence or absence of unit roots per se but by the information about real exchange rate determination conveyed by the time series properties. To the extent that movements in real exchange rates are caused by monetary shocks, long run monetary neutrality ensures that the deviations from equilibrium are temporary. If all shocks are monetary, real exchange rates are stationary and purchasing power parity holds in the long run. If movements in real exchange rates are instead driven by permanent real shocks, for example shocks to relative productivity, changes in real exchange rates are permanent and equilibrium real exchange rates are unit root processes. As long as permanent shocks are present in the data, the all-or-nothing PPP hypothesis will be rejected in empirical tests. However, it is likely that *some* movements in real exchange rates are transitory, while other movements are permanent. One possibility is the non-stationary components of real exchange rates are small compared to the temporary changes. Most movements in real exchange rates can then be explained by monetary shocks in combination with sticky prices as in the Dornbush (1976) model. Alternatively, the stochastic trend may dominate while the out-of-equilibrium fluctuations are small and short-lived. The behaviour of real exchange rates is then broadly consistent with models according to which changes in real exchange rates are equilibrium movements – for instance Balassa (1964) and Samuelson (1964) or Stockman (1988). The relative importance of permanent and transitory components of real exchange rates is interesting because it contains information about the empirical relevance of models of short run fluctuations around a constant equilibrium versus models where the equilibrium itself varies over time.

An alternative to distinguishing between permanent and temporary shocks is to identify (possibly several types of) structural shocks. Different models of equilibrium real exchange rates stress different structural factors as determinants of long run movements in real exchange rates. According to the Balassa-Samuelson model, real exchange rates are determined by the relative productivity in the tradable and nontradable sectors, i.e. by the supply side of the economy. Real demand shocks in the form of changes in government spending, consumer preferences for tradable versus non-tradable goods or attitude to risk are emphasised by Sachs and Wyplosz (1984), Dornbush and Fisher (1986), Zeira (1991), Chinn and Johnston (1996) and others. In the original Dornbush sticky price model, monetary shocks have temporary but no permanent effects on the real exchange rate. However, most authors in this field allow also monetary shocks to have permanent effects (see for instance Clarida and Gali, 1995, Rogers, 1995, or Weber, 1997). Evidence that a particular type of structural shock accounts for most of the long run movements in real exchange rates can be interpreted as empirical support for a particular (class of) model(s) of real exchange rate determination given that the long run equilibrium changes over time.

In this paper, we want to (i) find out what structural shocks have caused the permanent movements and (ii) asses the relative importance of permanent and temporary shocks to real exchange rates. There are several methods for disentangling the influence of different types of shocks on real exchange rates. Here, movements in the real exchange rates of four Nordic countries are analysed using a common trends model as discussed by King, Plosser, Stock and Watson (1991) and Warne (1993). Within this framework, permanent and transitory shocks as well as the driving stochastic trends can be identified.

Early attempts to decompose real exchange rates movements into permanent and transitory components using a Beveridge-Nelson decomposition include Huizinga (1987), Cumby and Huizinga (1990) and Baxter (1994). According to these papers, most of the variance of changes in real exchange rates is due to permanent shocks. When univariate decompositions are used, the permanent component is around 80 percent. Multivariate decompositions indicate a somewhat smaller share.

Pioneered by Clarida and Gali (1995), a small but growing empirical literature investigates how real exchange rates are affected by structural shocks. They impose long run identifying restrictions a´la Blanchard and Quah (1989) on a VAR model containing the first differences of relative output, relative prices and real exchange rates. Their main result is that real demand shocks account for the bulk of the fluctuations of real exchange rates in the long run as well as in the short run, while the influence of supply shocks is negligible. Forecast error variance decompositions show that demand shocks (including monetary policy shocks) account for about 90 percent of the variance after 8 years in all the four countries studied. For the UK and Canada, the share due to monetary shocks is insignificant, while they account for 30 percent of the long run variance in the case of Japan and 45 percent in the case of Germany. The share of supply shocks is insignificantly different from zero at all horizons for all the countries.

The Clarida and Gali result has already turned into something of a stylised fact. The insignificant influence of supply shocks is surprising given the emphasis placed on productivity variables in the theoretical literature on long run real exchange rate determination. Subsequent research has essentially confirmed the findings of Clarida and Gali. The largest influence of supply shocks is reported by Rogers (1995) and Weber (1997), who conclude that such shocks may account for as much as a third of the long run variance of real exchange rates. These authors allow for several other types of shocks in addition to the supply, demand and monetary shocks identified by Clarida and Gali. Carstensen and Hansen (1997) apply a common trends framework to the German mark – US dollar real exchange rate. They conclude that 85 percent of the long run movements are due to monetary shocks while supply shocks account for 12 percent and demand shocks for 3 percent. In one of the few available studies of small countries, Bjornland (1998) finds that 72 percent of the long run variance of the Norwegian real exchange rate is due to demand shocks and 28 percent is due to supply shocks.

The statistical approach in this paper differs from most similar studies in that it takes relationships between the levels of the variables into consideration. Typically, only changes in the variables are modelled. If there are equilibrium relationships between the levels of the macroeconomic time series, the latter models are misspecified and the information contained in the level data is not utilised. Clarida and Gali report that there is no cointegration among the variables in their data set. Many other authors do not investigate whether the time series are cointegrated (see for instance Weber, 1997, or Rogers, 1995). There are also two studies that employ common trends models (Carstensen and Hansen, 1997 and Bjornland, 1988). Both papers confirm the Clarida and Gali results.

The rest of the paper is organised as follows. In Section 2, the data and the statistical methods are presented. Section 3 contains the empirical results and Section 4 concludes.

2. Data and statistical methods

The data set contains quarterly data from Denmark, Finland, Norway and Sweden between 1960:1 and 1998:2. There are five variables for each country: foreign real GDP (y^*), domestic real GDP (y), foreign prices (p^*), domestic prices (p) and the real exchange rate (q). The real exchange rate is constructed from nominal exchange rates e (units of domestic currency per unit of foreign currency) as $q_t = e_t + p_t^* - p_t$, all in logs. For Norway, the oil price (in Norwegian crowns and divided by CPI) is also included as an exogenous variable. The "foreign country" is Germany. Data on nominal exchange rates, CPI and real GDP series are collected from the OECD database Main Economic Indicators, while the US dollar oil price can be found on the IFS data tape.

We start with the following VAR:

$$\Delta x_t = \mu + \Pi x_{t-1} + \sum_{i=1}^{P} \Gamma_i \Delta x_{t-i} + \varepsilon_t \qquad (1)$$

The number of cointegrating relationships in (1) is determined using the Johansen (1992) procedure. Information criteria can be employed to establish the appropriate number of lags P in the VAR, taking autocorrelation and other signs of misspecification into account. The cointegrated VAR model in (1) can be re-written as a common trends model (see e.g. Hylleberg and Mizon, 1989):

$$x_t = x_0 + A\tau_t + \phi(L)v_t \qquad (2)$$

where

$$\tau_t = \mu + \tau_{t-1} + \varphi_t \qquad (3)$$

$A\tau_t$ constitutes the permanent component x_t^P of x_t and $\phi(L)v_t$ constitutes the transitory component x_t^T. The number of cointegrating vectors r in (1) determines the number of independent stochastic trends k in the common trends model (2) as k=n-r or the number of variables in the system minus the number of cointegrating vectors. τ_t are the k stochastic trends with the drifts μ and the innovations φ_t. The loading matrix A determines how the variables in x_t are affected by the stochastic trends. The permanent shocks in φ_t are allowed to enter into the transitory shocks v_t, whereby shocks to the stochastic trends also affect the "cycles" or short run dynamics of x_t.

Given five variables and at least one cointegrating vector, there are at most four stochastic trends in (1). A natural interpretation would be that there is a domestic and a foreign demand trend, and a domestic and a foreign supply trend. Possibly, foreign and domestic productivity and/or demand are not independent but driven by the same underlying world trend in these small open economies. There may thus be only two or three independent stochastic trends in the form of relative supply and/or relative demand.

In order to individually identify the structural shocks, restrictions are imposed on the long run impact matrix A. $k(k-1)/2$ restrictions are needed for exact identification. We use the following identifying assumptions: (i) only supply shocks have permanent effects on output (ii) domestic shocks do not affect the foreign variables (i.e. the Nordic countries are assumed to be small open economies). Given a single cointegrating vector, these two assumptions yield exact identification in the five-variable system as well as in the reduced four- or three variable systems where output and/or prices enter as relative variables.

In addition to the permanent supply and demand shocks, the common trends model in (2) also contains r transitory shocks. With a single cointegrating vector, there is only one transitory shock. We follow Mellander et al. (1992) and refrain from labelling it – it is simply called transitory.

3. Empirical results

We estimate a common trends model for each of the four Nordic countries. The vector x_t in (1) and (2) contains the real exchange rate q, domestic real GDP y, foreign real GDP y^*, the domestic price level p and the foreign price level p^*. In some cases, the two GDP and/or price level variables are transformed into relative form, i.e. y-y^* or p-p^*. First, the appropriate number of lags to be included in the VAR has to be determined. Including enough lags to remove residual autocorrelation results in four to five lags for all the countries, which is several more than indicated by the information criteria AIC and H-Q. Next, the cointegrating rank r of the systems can be determined given the number of lags. It turns out that there is cointegration among the five original time series for all the countries. Since the number of independent stochastic trends depends on the cointegrating rank, the behaviour of the trends under different assumptions about r is studied as part of the process of determining the appropriate number of cointegrating vectors.

Given a single cointegrating vector, at least one of the trends slopes downward in the five variable systems for all the countries. Since descending productivity or demand trends are difficult to conceive, we consider reducing the dimensions of the systems by using relative output and/or price levels in these cases. Hence, there is a choice between the full five variable system containing

[q, y, y^*, p, p^*], four variable systems where either y and y^* or p and p^* has been replaced by y-y^* or p-p^* and a three variable system where both the output variables and the price variables are transformed into relative form.

Finland and Denmark have a single cointegrating vector in the five-, four- and three-variable systems. In these cases, the condition that the stochastic productivity and demand trends of the individual countries should not be downward sloping indicates that the more restrictive three variable systems are appropriate. (The implied restrictions on the cointegrating vector are not rejected).

At first, the oil dependent economy of Norway appears to experience very different supply shocks than Germany and hence have its own productivity trend. However, once the oil price development is included in the system, the hypothesis that it is relative supply shocks that matter is not rejected. For Norway and Sweden, there are two (three) cointegrating vectors in the full systems. One cointegrating vector relates the long run equilibrium real exchange rate to the other variables. Unless relative output, relative prices or the real exchange rates itself is stationary (hypotheses which are rejected by the data), it is difficult to find an economic interpretation of additional cointegrating relationships. For Norway (Sweden), only four (three) independent upward sloping trends are found and there is a choice between modelling multiple cointegrating vectors in the original full systems and one cointegrating vector in the reduced systems. The results in terms of variance decompositions turn out to be robust with respect to this choice. Given that only one cointegrating vector can be given a meaningful economic interpretation, we have preferred the reduced systems with relative GDP, implying four variables for Sweden and five variables for Norway (including the oil price). An interpretation is that while all four countries are affected by the same world technology trend as Germany, demand shocks like monetary policies are characterised by different stochastic trends in Sweden and Norway. The monetary policies of Denmark and Finland have apparently followed the German monetary policy to a greater extent. The cointegrating rank tests are shown in Table 1. There is a single cointegrating vector for all four countries.

Table 1: Cointegrating rank tests for the chosen models

	trace				l-max			
H_0:	*r=0*	*r=1*	*r=2*	*r=3*	*r=0*	*r=1*	*r=2*	*r=3*
Denmark	36.10*	9.82	1.46		26.28*	8.36	1.46	
Finland	31.44*	12.28	1.73		19.17*	10.55	1.73	
Norway	129.29*	42.28	19.95	5.75	86.45*	22.89	14.19	5.75
Sweden	69.78*	29.58	9.57	2.30	40.20*	20.01	7.27	2.30

* Significantly larger than zero at the five percent level.

The cointegrating vectors imply long run equilibrium relationships between real exchange rates, the price levels and real GDP. Table 2 shows the point estimates of the cointegrating vectors when the coefficients on the real exchange rate q are normalised to one. A possible hypothesis is that the real exchange rate is stationary, implying that the coefficients on the other variables are insignificantly different from zero. This is rejected for all the countries although the test statistic for Finland is close to insignificant with a *p*-value of 0.04.

From a Balassa-Samuelson relationship between the real exchange rate and relative productivity, high domestic (or relative) productivity appreciates the real exchange rate in the long run while high foreign productivity depreciates it. The point estimates of the coefficient on relative productivity are positive and vary between 0.42 for Denmark and 4.405 for Norway. This effect of relative productivity on equilibrium exchange rates is usually found to be slightly smaller than one.[1]

Table 2: Point estimates of the cointegrating vectors

	*y/y**	*p*	*p/p**	*p**	*oilprice*
Denmark	0.420		0.135		
Finland	1.823		-0.349		
Norway	4.405	0.713		-0.439	0.177
Sweden	1.229	0.264		-0.530	

Given the cointegrating vectors and the identifying restrictions, the common trends model in (2) and (3) can be estimated. Due to space limitations, only the most relevant output is discussed here. First, impulse response functions show how the variables react to the different structural shocks. A simple check of the validity of the identifying assumptions is whether these effects have the expected signs.[2] It turns out that both (relative) CPI, GDP and the real exchange rates increase in response to a positive demand shock. However, the effect on output is significant only for Denmark. A positive (relative) supply shock always increases output but the expected fall in prices is (marginally) significant only for Finland. The most consistent finding is that the response of the real exchange rate to supply shocks is always of opposite sign from what is predicted by the Dornbush type of model, i.e. higher productivity always appreciates the real exchange rate significantly. This is in accordance with the results of Clarida and Gali and others, although they find it puzzling. A possible interpretation is that the long run equilibrium relationship between productivity developments and real exchange rates is more consistent with

[1] See for instance Alexius and Nilsson (1997) for a discussion of these empirical results.

[2] The impulse response functions are available from the author on request.

Balassa-Samuelson type of models than by the originally short run IS-LM models used by Clarida and Gali and others.

The common trends model also produces variance decompositions of the real exchange rates at different horizons. The relative importance of the different types of shocks varies over the horizon. Typically, the share of the variance due to transitory shocks is large at first, between 60 and 90 percent of the forecast error variance in the first year. It then declines after two to three years when demand shocks become a more important source of fluctuations (at 8-20 quarters). The share of the forecast error variance due to relative supply shocks is small at first but increases continually as the horizon is extended. For Denmark, transitory shocks remain the primary source of variations even after eight years while relative supply shocks appear less relevant than for the other countries. For Finland, transitory shocks never explain more than 35 percent of the forecast error variance while demand shocks have a comparatively large influence on horizons up to five years.

The long run forecast error variance decompositions (shown in Table 3) reveal what structural shocks have caused the long run movements of the real exchange rates. For Sweden, 85.6 percent of the long run variance of the real exchange rate is due to relative supply shocks, while domestic demand shocks account for 9.7 percent and foreign demand accounts for 4.7 percent. For Denmark, 76 percent is due to relative supply shocks and 24 percent of the variance stems from relative demand shocks and for Finland, the shares are 94 and 6 percent, respectively. The influence of the supply shocks is smallest in Norway, where they only account for 50 percent of the long run variance. Of the remaining variance, 32.2 percent is due to demand shocks and 17.4 percent to oil price shocks. The latter are normally taken to be supply shocks as well.

Table 3: Long run variance decompositions,

Country	*Supply*	*Foreign demand*	*Domestic demand*	*Oil price*
Denmark	0.760	0.240		
	(0.151)	(0.151)		
Finland	0.936	0.064		
	(0.045)	(0.045)		
Norway	0.497	0.007	0.322	0.174
	(0.317)	(0.041)	(0.237)	(0.378)
Sweden	0.856	0.047	0.097	
	(0.098)	(0.072)	(0.070)	

Standard errors within parenthesis

Table 3 shows that supply shocks account for a much larger share of the long run variance of real exchange rates here than what has been documented in previous studies. The smallest share, 67 percent for Norway, is more than twice the size of the largest previous finding (30 percent in Rogers, 1995 and Weber, 1997). Even if the label "supply shocks" can be called into question, the results imply that the same shocks that have permanent effects on (relative) real output also account for most of the long run variance of real exchange rates.

Forecast error variance decompositions is the most natural way to analyse the contributions of different types of shocks to the variance of real exchange rates within a VAR model. An alternative approach that connects to a sizeable empirical literature is to decompose real exchange rates into a permanent component and a transitory component and analyse the variances of the two time series. For instance Huizinga (1987), Clarida and Gali (1995), Baxter (1994), Gonzalo and Granger (1995) and others use various methods to split changes of real exchange rates into a permanent and a transitory part. The variance of the permanent component is invariably found to be much larger than the variance of the transitory component. Since the common trends model also provides Beveridge-Nelson decompositions, such comparisons can be made here as well. Figures 1 a) to d) show actual real exchange rates and their permanent components as defined by the common trends model for the four Nordic countries.

Figure 1a: The Danish real exchange rate and its permanent component

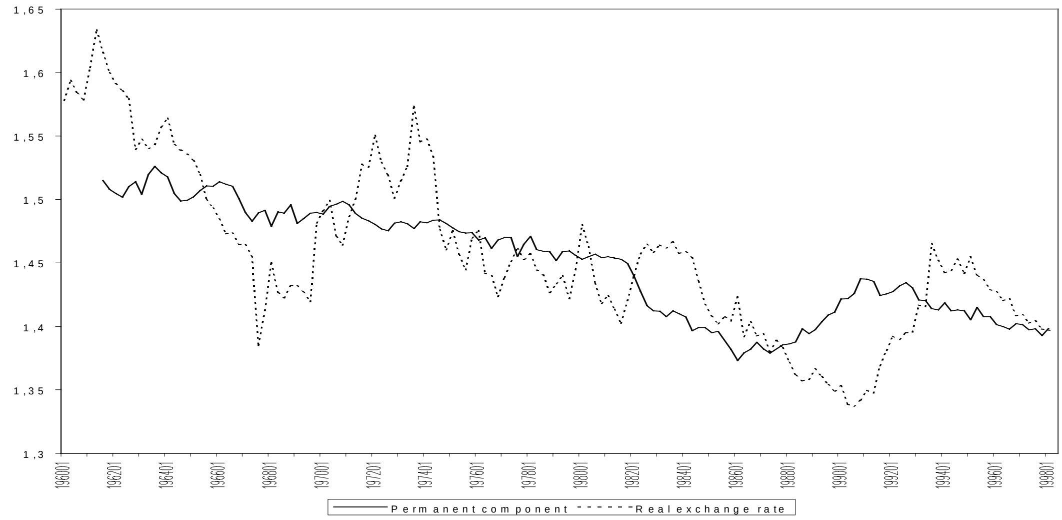


Figure 1b: The Finnish real exchange rate and its permanent component

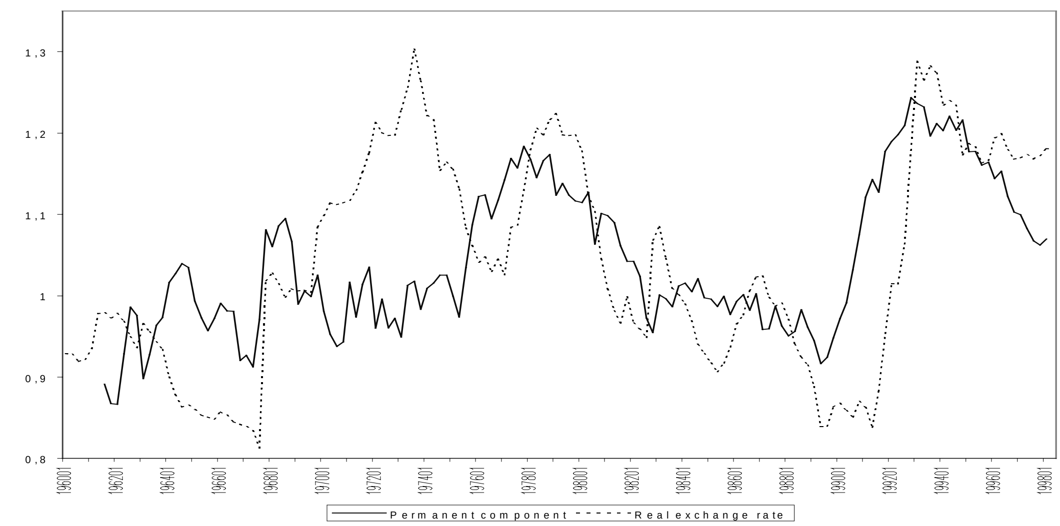
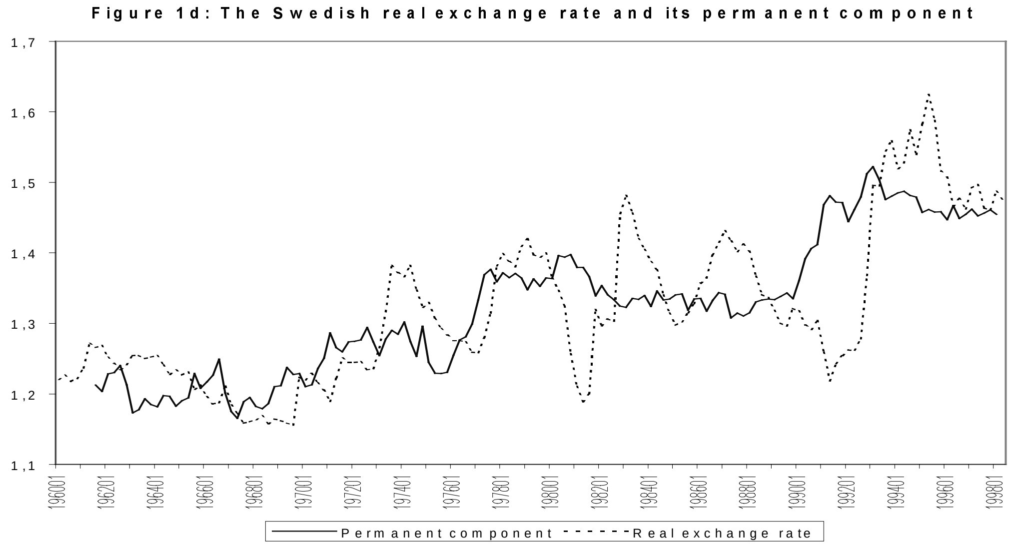


Figure 1c: The Norwegian real exchange rate and its permanent component



The figures for Denmark and Sweden show a distinct permanent stochastic trend and transitory fluctuations around it. Although the transitory out-of-equilibrium fluctuations are quite large, it is the permanent components that account for most of the movements in the real exchange rates. The Finnish case is more difficult to interpret as there is less of a distinct trend in the permanent component. Judging from Figure 1b, PPP could well "almost hold" for Finland. (The formal PPP-tests rejected the hypothesis only marginally). In the case of Norway, the permanent component tracks the actual real exchange rate closely, implying that most movements are movements in the equilibrium real exchange rate while the out-of-equilibrium fluctuations are small.

The variances of changes in the permanent and transitory components for the four real exchange rates as defined by the common trends model are shown in Table 4. The variance of the transitory component is more than ten times as large as the variance of the permanent component in the case of Denmark, five times as large in the case Sweden and twice as large in the case of Finland. Only for Norway is the variance of changes in the permanent component larger than the variance of changes in the transitory component. Previous studies have invariably come to the opposite conclusion, i.e. that the variance of changes in the permanent components is much larger than the variance of changes in the transitory components. Hence, the results for Norway conform to the typical finding. Interpreting the permanent component as the equilibrium real exchange rate, the standard result implies that most changes in real exchange rates are equilibrium movements, while the out-of-equilibrium fluctuations are found to dominate here.

Table 4: Variances of changes in the permanent and transitory components

Country	*Transitory*	*Permanent*	*Permanent/Transitory*
Denmark	0.000393	0.000033	0.08
Finland	0.001845	0.000922	0.50
Norway	0.000385	0.000986	2.55
Sweden	0.001503	0.000312	0.21

* The final column shows the ratio of the variance of the permanent component to the variance of the transitory component.

A possible interpretation of the relative variances of permanent and transitory components is as a measure the extent to which PPP holds. However, the development of the equilibrium real exchange rate over time is a characteristic of the *level* of the real exchange rate, not of its changes. The standard procedure, to analyse the variances of *changes* in the permanent and transitory components as was done above, does not (in my view) actually answer the original question about the relative importance of the stationary and non-stationary components. The reason is that the magnitude of *drift* of the non-stationary component is very important when assessing how much the equilibrium real exchange rate moves over time but it does not affect the variance of changes in the permanent component.

Turning back to the equations of the common trends model for a moment and substituting (3) into (2), A times μ constitute the drift term. It obviously disappears when x_t is differenced. Table 4 compares $\phi(L)\Delta v_t$ to $A\varphi_t$, ignoring the crucial drift $A\mu$. A measure that does provide an answer to the question about the relative importance of stationary and non-stationary components of real exchange rates is, the variation around the mean of the *levels* of the permanent and transitory components.

Table 5: "Variances" of the levels of the permanent and transitory components[3]

Country	*Transitory*	*Permanent*	*Permanent/Transitory**
Denmark	0.001796	0.001832	1.03
Finland	0.013340	0.008011	0.60
Norway	0.001349	0.007178	5.32
Sweden	0.006382	0.00911	1.43

* The final column shows the ratio of the variance of the permanent component to the variance of the transitory component

Table 5 shows the sample "variances" (variations around the mean) of the levels of the two components. It is now clear that the permanent components account for larger shares of the movements in the levels of the real exchange rates than the transitory components in three of the four cases. Only for Finland does the stationary component dominate also this measure of the sample variation of the level real exchange rate. The Danish real exchange rate serve as an illustration of why Table 5 captures an interesting feature of the decomposition that cannot be seen from Table 4 . The variance of changes in the permanent component is small in the case of Denmark, much smaller than the variance of changes in the transitory component. However, the drift is quite large and obviously central to the behaviour of the real exchange rate in

[3] These numbers are simply the variations around the sample means, calculated as $\sum_{i=0}^{T}\left(x_i^P - \bar{x}^P\right)^2 / T$ where $\bar{x}^P$ is the sample mean of the permanent component.

Figure 1a. This bears out in Table 5 but not in Table 4. The results from the standard analysis of the relative variances of changes in the permanent and transitory components nevertheless differ from previous findings since the transitory shocks are found to be more important here.

4. Conclusions

Studying shocks to real exchange rates is interesting for two related reasons. By decomposing real exchange rates into a permanent, non-stationary component and a transitory, stationary component and assessing the relative importance of the two, nuances are added to the all or nothing PPP hypothesis that all movements in real exchange rates are transitory. Some models, for instance the sticky price model of Dornbush (1976), focus on explaining temporary movements in real exchange rates. In contrast, the models of Balassa (1964) and Samuelson (1964) and others imply that changes in real exchange rates are permanent equilibrium movements. Evidence that either type of shock is quantitatively more important can be used to evaluate the empirical relevance of models of temporary out-of-equilibrium movements versus models of time varying equilibrium real exchange rates. Second, the relative influence of supply versus demand factors in the long run movements has direct implications for the relative importance of competing models of equilibrium real exchange rate determination: The relative productivity approach of Balassa-Samuelson versus models emphasising consumer preferences or government consumption. By allowing for a variety of different shocks and disentangling their relative influences, new answers to old questions about real exchange rate determination can be obtained.

While structural VAR models with long run identifying assumptions have been used in macroeconomics since the late 1980:s, their application to real exchange rates is a relatively recent contribution to the literature. The first paper in this field, by Clarida and Gali (1995), found that almost all fluctuations in real exchange rates are due to demand shocks and monetary shocks, while supply shocks do not contribute significantly to the long run variance. Subsequent studies have mainly confirmed the results of Clarida and Gali although the proportion of the long run variance due to supply shocks has been found to be as high as 30 percent.

In this paper, forecast error variance decompositions show that a much larger share of the movements in real exchange rates is due to supply shocks here then what has been found previously. Supply shocks account for 94 percent of the long run variance in Finland, 86 percent in Sweden, 76 percent in Denmark and 50 percent in Norway. Demand and supply shocks are identified in the standard manner following Blanchard and Quah (1989). Irrespectively of what stand one takes concerning the possibilities of identifying different types of structural shocks, it remains interesting that the shocks with permanent effects on (relative) output also account for the bulk of the long run movements in real exchange rates. This result can be interpreted as support for the productivity approach to long run real exchange rate determination, i.e. for the Balassa-Samuelson model.

The statistical approach in this paper differs from most similar studies in that it takes relationships between the levels of the variables into consideration. Given that there is cointegration among the macroeconomic times series, the information contained in the *levels* of variables is better exploited using this statistical model than by modelling only *changes* in the time series as is done in most previous papers. There are two studies that employ common trends models to study shocks to real exchange rates. Bjornland investigates the sources of shocks to the Norwegian economy in a model with the real exchange rate, real GDP, unemployment the oil price and the real wage but find no cointegration among the variables. A possible explanation for this difference between the results is her shorter sample period (1972 to 1994 versus 1960 to 1996 in this paper). Carstensen and Hansen find cointegration between real exchange rates and the other variables. Both these papers confirm the Clarida and Gali results, indicating that the findings of this paper are not only a consequence of the statistical method but probably also of the choice of countries.

A second result is that the transitory components account for a much larger share of the variances of changes in real exchange rates than what previously has been found. For three of the four countries, the variance of changes in the transitory component is larger than the variance of the changes in the permanent component. Other studies have consistently found that the permanent component dominates the variance of changes in real exchange rates. For Finland, the transitory component dominates even the variation around the sample mean of the *level* of the real exchange rate.

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