The Information Content of the Natural Rate of Interest: The Case of Poland

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Abstract

In this paper, I use a structural VAR model and the Kalman filter to estimate the natural rate of interest (NRI) in Poland. I show how the NRI can yield important information for a central banker. First, estimation of the NRI can be helpful for monetary authorities, seeking to stabilize inflation after a long process of disinflation. Second, for a country trying to join a monetary union there exists an additional information content of the estimated NRI. The bigger the difference between the candidates and the Unions natural rates, the more likely the "Portuguese" scenario of a widening current account after adopting the common currency.

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1 Introduction

The concept of the natural rate of interest (NRI) is most often ascribed to the Swedish economist K.Wicksell. However, the first descriptions of the economic processes following a mismatch between the market rate and the "equilibrium rate of interest" can be tracked back as far as to H.Thornton and T.Joplin (Humphrey (1993)). Today, after almost 100 years of *desinteressement*, economists again show much interest in the idea of the natural rate of interest.

This is, however mostly true for academics. Despite recent efforts of some central bankers (K.Neiss and E.Nelson (2001) or T.Laubach and J.C.Williams (2001)) the concept remains almost unused by monetary policy makers. This is probably caused by the relatively high volatility of various estimates of the NRI (Rotemberg and Woodford (1997), Brzoza-Brzezina (2003)), the resulting uncertainty about the current level of the natural rate (BoE (1999)) and probably the lack of a unique NRI definition.

In this paper I show, how, despite the described deficiencies, the NRI concept can yield useful information for a central banker. First, an econometrically tractable definition of the NRI can be helpful for monetary authorities, seeking to stabilize inflation after a long process of disinflation. Second, for a country trying to join a monetary union there exists an additional information content of the estimated NRI. The bigger the difference between the candidates and the Unions natural rates, the more likely the "Portuguese" scenario of a widening current account after adopting the common currency.

Practical experience of Polish monetary policy is used extensively throughout the paper. This is because Poland seems to be a model example of a country, where the NRI concept can be implemented in central banking. After 12 years of almost permanent disinflation, CPI growth was reduced to 1.7% in 2003, implying that monetary policy should now seek to stabilize inflation rather than to lower it further (MPC (2003)). However, lacking the experience of low and stable inflation, not much can be said on historical basis about the level of interest rates that would be compatible with achieving this goal. Hence, there is scope for the introduction of econometric tools that would help estimating the NRI even before disinflation has been finished.

A second field for practical implementation of the NRI concept is related to Poland's expected accession to the Economic and Monetary Union (EMU). As the above signaled estimates point at a relatively high natural rate in Poland as compared to the EMU, one might be tempted to use this result to forecast selected micro- and macroeconomic processes after EMU accession. Although firm quantitative conclusions do not seem possible at present, qualitative assessment can be made.

The paper is structured as follows. In section 2, I briefly describe the historical experience with the natural rate of interest. Then I move towards choosing a NRI definition that would be econometrically tractable and useful for monetary authorities. Section 3 describes the practical implementation of the NRI concept in Poland. Estimates of the natural rate are given on the basis of a structural VAR and the Kalman filter. These help determine the average, neutral level of short term interest rates that should be implemented in order to smoothly finish disinflation. In section 4, a brief discussion of the applicability of the NRI concept for drawing a rough EMU accession scenario is presented. Finally, section 5 concludes.

2 Theoretical considerations

The concept of the equilibrium rate of interest has been known already to classical economists. H.Thornton and T.Joplin described their view about inflationary processes following a mismatch between the equilibrium and market rates of interest. In their opinion such mismatch caused the imbalance of investment and saving, additional credit and money creation and a permanent growth of the price level (Humphrey (1983)). What their models, however lacked, was a stabilization mechanism that would close the interest rate gap and prevent the price level from rising forever.

We owe its introduction to the economist, whose name is in most cases associated with the natural rate of interest, Knut Wicksell (Jonung (1979), p. 461). In essence, Wicksell (1989, 1907) argued that the higher price level would increase cash demand forcing commercial banks to prevent their gold holdings from decreasing. The natural reaction of banks would be to increase interest rates, which brings the system back into equilibrium (Myhrman (1991)). It was also Wicksell who invented the term "natural rate of interest".

Over most part of the 20th century the Wicksellian interest rate theory was not popular among economists. Keynes argued in the Wicksellian spirit in "A Treatise of Money", but rejected the natural rate concept in the "General Theory…" (Keynes (1936), Hicks (1988)). Notable exceptions are E.Lindahl and G.Myrdal from the Stockholm School, who worked on developing Wicksell's ideas in the 1930's (Leijonhufvud (1989)).

It was only in the 1990's that the natural rate of interest returned into mainstream economics. This event is probably related to the growing popularity of direct inflation targeting and other strategies, where the central bank controls the short-term interest rate in order to maximize the probability of achieving an inflation target. Below the main, contemporary examples of NRI related analysis are given.

J.Taylor (1993) noted that the US monetary policy in the 1980's almost perfectly matched a simple rule, relating the short term nominal interest rate to its long run equilibrium value, the gap between inflation and the target and the output gap. Since then, Taylor-type monetary policy reaction functions have been extensively used by academics as well as central bankers (although no central bank committed to follow a rule). These reaction functions contain in most cases an equilibrium level of the short term interest rate (real or nominal) called the "neutral" or "natural" rate of interest. Usually the NRI in reaction functions is time invariant (e.g., ECB (2001); see Plantier and Scrimgeour (2002) for an exception).

K.Neiss and E.Nelson (2001) refrained from the constant natural rate assumption and estimated a time series of the natural rate over 1980-2000 on the basis of a DSGE model, calibrated for the British economy. The natural rate has been defined as the flexible price equilibrium level of the real interest rate. According to their results, the natural rate exhibits a much lower variability than the real, market rate of interest. Consequently, the gap between the rates can be estimated with much certainty on the basis of the real rate and is a good indicator of the monetary policy stance.

Michael Woodford (2003) presented micro-based New Keynesian models and analyzed, among others, the determinants of the natural rate. These include household preferences, productivity growth and demand shocks (for example government expenditures). Woodford postulates that the central bank should closely track the behavior of the natural rate with its short-term rates to stabilize the economy.

T.Laubach and J.C.Willaims (2001) approached the NRI from the time series analysis perspective. Using a Kalman filter they estimated a time series of the natural rate, defined as the short-term real rate that stabilizes inflation. They conclude that the NRI is positively correlated with productivity growth but reflects a relatively high variability. A very similar NRI definition is postulated by A.Blinder (1998).

M.Brzoza-Brzezina (2003) used a structural VAR to estimate the NRI in the US over the period 1960-2000 in accordance with the above definition. Again, the results suggest high variability of the natural rate and strong, positive correlation with the business cycle.

Recently, the natural rate of interest found also some attendance in the context of the Economic and Monetary Union. Crespo-Cuaresma et al. (2003) applied time series techniques to artificial EMU data since 1990 to find a relatively sharp decrease of the NRI during the 1990's. Giammarioli and Valla (2003) followed the approach pioneered by Neiss and Nelson (2000) and used a SDGE model to estimate the NRI in the euro-area. Similarly to Neiss and

Nelson, they suggest using the interest rate gap as an indicator of monetary policy restrictiveness.

As with respect to other unobservable variables that are used by monetary authorities (potential output, NAIRU), it seems absolutely crucial to define precisely what is meant by "natural rate of interest". From the above historical and contemporaneous examples at least five different definitions can be derived. For Wicksell and the classics, the natural rate was equal to the real rate that equated savings and investment. Further, this rate also stabilized the general price level and should be equal to the marginal product of capital. Obviously there is no reason to draw an equality sign between these objects, so that they should be treated as three different NRI definitions (Laidler (1991), p.130). On the other hand, today's definitions differ from those described above. In micro-based models the natural rate is defined as the flexible price equilibrium level of the real rate. According to another popular definition, the natural rate is equal to the real rate that stabilizes inflation.

Defining the NRI is a crucial step in making the concept operational for monetary authorities. In what follows, we make use of the definition, relating the NRI to inflation dynamics[2]:

(1) $$\Delta\pi = \alpha(r^* - r) \qquad \alpha>0,$$

where Δ is the difference operator, π denotes the inflation rate and r^* and r are respectively the natural and real rates of interest. Definition (1) can be regarded especially useful for an inflation targeting central bank. If precisely estimated, such NRI gives a hint, how to set interest rates in order to stabilize, lower or increase inflation. As it has, however been mentioned, this approach to monetary policy suffers in practice from the high variability of the natural rate. In an economy, where the average level of the neutral rate is relatively well known and its current deviation from mean is difficult to estimate, this concept will probably not be of much practical use for monetary authorities. However, in a country like Poland, where, due to a prolonged disinflation even the average NRI is unknown, its estimation can help the central bank finish the disinflation process relatively smoothly.

[2] Definition (2.1) can be also regarded as a reduced form of the transmission model, with the transmission mechanism soaked up in the r^* term. Since data will be scarce, the estimation of a reduced form model seems

Another disadvantage of the "inflationary" definition is its inability to give explanation of determinants of the natural rate. It is a purely statistical concept, econometrically tractable but not grounded in economic theory. Here, the micro-based definition could provide some guidance and must certainly be considered as another important contribution from the NRI literature for central banking. However, detailed analysis of NRI determinants goes beyond the scope of this paper. The reader can refer to Neiss and Nelson (2001), Laubach and Williams (2001), Giamarroli and Valla (2003) and Woodford (2003).

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more appropriate, than of a system of equations with an explicit transmission mechanism. For a broad survey of monetary transmission with hints to the natural rate of interest see L.Mahadeva and P.Sinclair (2002).

3 Estimating the natural rate of interest in Poland

As the aim of the paper is to show that under specific, but relatively common conditions the NRI can yield helpful information for monetary authorities, first these specific conditions have to be described.

Polish market reforms have been launched in 1990 in a near hyperinflationary environment. In 1989 the inflation rate soared to 251%. In January 1990 the Zloty was pegged to the US Dollar, which helped to bring inflation down to 65% in Fall 1991. At that time, to ease the real currency appreciation a rate of crawl has been introduced. The crawling peg system sustained until 1995, when strong capital inflows, bringing about a huge increase in foreign reserves and central bank sterilizing operations, forced the National Bank of Poland (NBP) to start the process of widening the fluctuation bands (table 1). After widening the bands several times the zloty has been floated in April 2000. For further analysis it is, however important to note that the exchange rate has been floating relatively freely already since 1998, when the band was widened to +/- 10% and when foreign exchange interventions have been suspended.

Table 1: Exchange rate regimes in Poland 1990-2003

Period	**FX Regime**	**Band**
I.1990 - V.1991	Peg to USD	
V.1991 - X.1991	Peg to basket of currencies : 45% USD, 35% DEM, 10% GBP, 5% FRF, 5% CHF	
X.1991 - V.1995	Pre-announced crawling peg	
V.1995 - II. 1998	Crawling band	+/-7 %
II.1998 - X.1998	Crawling band FX interventions suspended in 07.1998	+/-10 %
X.1998 - III. 1999	Crawling band. Basket redefined to 45% USD 55 % EUR (01.01.1999)	+/-12,5 %
III.1999 - IV.2000	Crawling band	+/-15 %
Since IV 2000	Floating	

Source: NBP

Due to a long period of crawling devaluation, the disinflation process in Poland took much longer than in other transition economies, where hard pegs have been sustained until inflation reached a single-digit level. When Polish monetary authorities decided to abandon eclectic monetary and exchange rate targeting in 1998 and move to direct inflation targeting (DIT), inflation still exceeded 10% (figure 1). It took another 4 years to bring it down below 2%. In 2003 the Monetary Policy Council (MPC (2003)) publicly announced the end of disinflation and the will to stabilize the y-o-y CPI growth rate at 2.5%.

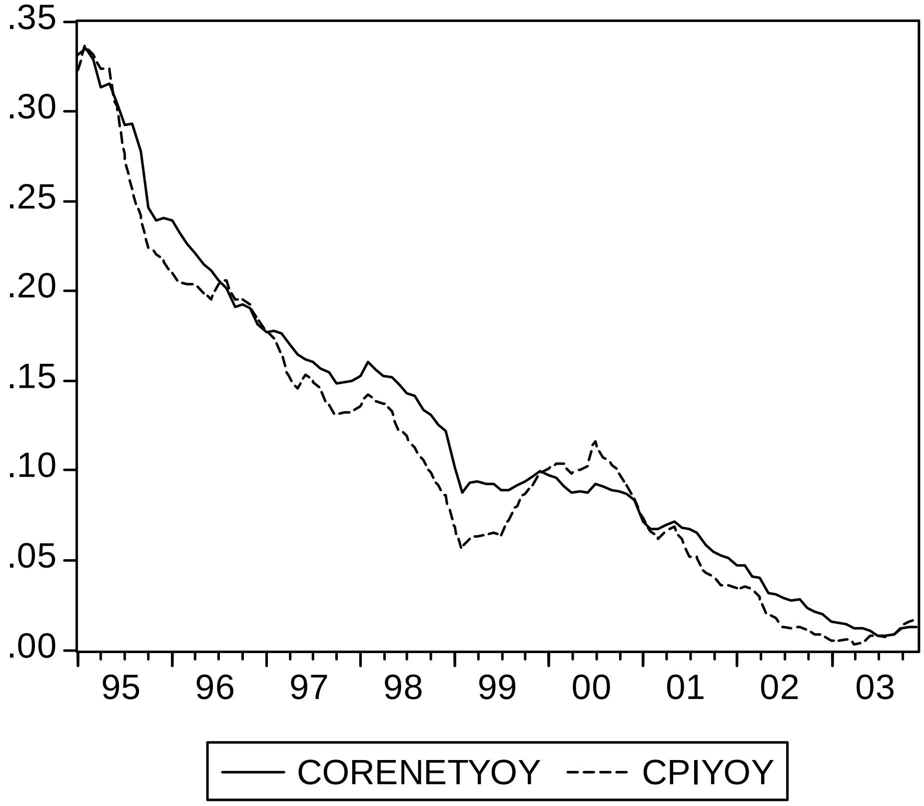
After adopting DIT the National Bank of Poland has been criticized for moving to the strategy without good knowledge of the transmission mechanism (Cristoffersen, Wescott (1999)). In view of the Lucas Critique this point cannot be regarded as serious, as one should expect that a regime switch would change transmission patterns even in a relatively stable economy. Lowering successfully inflation to below 2%, Polish monetary authorities proved that the critique was to some extent unfounded. However, while lowering inflation requires keeping real interest rates high enough for a certain amount of time, terminating the disinflation in a smooth manner might prove more difficult and requires knowing the neutral level to which interest rates should be brought in order to stabilize inflation. It must be kept in mind at this point that the dilemma is by no means similar to the one discussed sometimes at the Federal Reserve Board (1994) “are we at neutral or is it 25 b.p. higher”? After 40 years of centrally planned economy and 12 years of permanent disinflation the question is rather “is neutral at 2% or at 7%”? This shows, how useful it might be to have some estimates of the NRI at the point disinflation has to be finished.

A key issue in the estimation process was the choice of the appropriate data sample. With liberalized capital flows a country which pegs its currency is an “interest rate taker”. Since a stable exchange rate stabilizes also inflation, pegging the currency is equivalent to “borrowing” the natural rate of interest (in the sense of our definition) from abroad. Hence, the estimation of the NRI for a fixed exchange rate period and using it to draw conclusions for a floating economy seems doubtful. Accordingly it becomes crucial to restrict the data sample to a period of relatively floating exchange rate.

The simplest idea would be to start the sample in Q3 2000, after the zloty was floated (table 1). This however, would leave us with slightly more than 3 years of data, obviously to few to do any reasonable econometrics. Another possibility would be to find out, since when approximately the zloty can be considered as floating relatively freely. A glance at figures 5,6 and 7 in appendix 1, depicting the behavior of the exchange rate, interest rate and official reserve assets shows that the intervention process ended somewhere in early 1998. At this date three important facts found place. The zloty exchange rate ceased sticking to the central parity, official reserve assets stopped increasing sharply and the NBP regained the freedom to set real interest rates much above the foreign level. This reasoning is supported by the fact that the last official intervention of the NBP found place in July 1998. Given these information we decided to restrict the data sample to Q1 1998 – Q4 2003.

We use the net inflation index, being CPI less food and fuels. Due to oil price and food supply shocks, headline CPI inflation is more variable than net inflation, a feature that could adversely influence NRI estimates and result in misleading conclusions. As it can be seen from figure 1, net inflation and CPI show similar patterns in Poland the main difference being lower variance of the former.

Figure 1: CPI and net inflation (y-o-y) in Poland 1995-2003



Source: Central Statistical Office and NBP

We use the one-month money market rate WIBOR1M deflated with expected inflation (from household polls) as our measure of the interest rate. WIBOR1M has been relatively closely controlled by the NBP over the estimation period.

In what follows, two alternative estimation techniques have been applied. This is because the time series are relatively short and trusting only one estimation method could be misleading. We start with presenting a specific approach to SVAR decomposition, invented to estimate the natural rate of interest in the US (Brzoza-Brzezina (2003)). In section 3.2 the Kalman filter will be applied.

In both models two dummy variables were added. One reflects the sharp drop in inflation in the aftermath of the Russian crisis (Q1 1999), the second one the quick disinflation in Q1 2001 due to changes in regulated prices.

3.1 The SVAR approach

Structural VAR models have been recently used by many economists to recover the historical time series of unobservable variables. A popular technique is based on the methodology of imposing long-run restrictions proposed by O.J.Blanchard and D.Quah (1989) to estimate potential output[3]. The application of a similar technique to estimating the natural rate of interest will be described below. The major innovation to the Blanchard – Quah method is that we replace the orthogonality assumption with respect to the shocks with a short-run restriction. In our view, such a specification is less restrictive and allows for greater flexibility of the system. With the exception of Brzoza-Brzezina (2003) SVARs have probably not been used for NRI estimation before.

Let us start with the definition of the interest rate gap:

(2) $$GAP \equiv r - r^*,$$

where r^* and r are respectively the natural and real rates of interest. This can be transformed to:

[3] For other good descriptions of the method see W.Enders (1995) or I.Claus (1999).

(3) $r = r^* + GAP$.

Further we assume that both, the natural rate and the interest rate gap follow stationary, autoregressive processes:

(4) $r_t^* = \Phi_1(L) r_{t-1}^* + u_{1,t} = \Xi_1(L) u_{1,t}$

(5) $GAP_t = \Phi_2(L) \cdot GAP_{t-1} + u_{2,t} = \Xi_2(L) u_{2,t}$,

where $\Phi(L)$ and $\Xi(L)$ are polynomials in the lag operator and $\Xi(L) = (I - \Phi(L) \cdot L)^{-1}$. Hence, the real interest rate is affected by two basic (primitive) shocks, $u_{1,t}$ and $u_{2,t}$:

(6) $r = \Xi_1(L) u_{1,t} + \Xi_2(L) u_{2,t}$.

According to the definition of the NRI:

(7) $\Delta\pi = \psi(r - r^*) = \psi \cdot GAP = \psi \cdot \Xi_2(L) u_{2,t}$ $\psi < 0$,

where Δ is the difference operator and π the inflation rate, the $u_{2,t}$ shock also affects inflation. Thus, both the real rate and inflation growth rate can be expressed as a distributed lag of all current and past primitive shocks:

(8) $$\begin{bmatrix} \Delta\pi_t \\ r_r \end{bmatrix} = \begin{bmatrix} S_{11}(L) & S_{12}(L) \\ S_{21}(L) & S_{22}(L) \end{bmatrix} \begin{bmatrix} u_{1,t} \\ u_{2,t} \end{bmatrix},$$

where $S_{i,j}(L)$ is a polynomial in the lag operator, whose coefficients are denoted as $s_{i,j}(l)$.

Unfortunately, the system of equations (8) is in practice not very helpful in recovering the **u** vector. The standard way to proceed is thus the following. First a standard vector autoregression has to be estimated:

$$\Delta\pi_t = \sum_{l=1}^{k_1} a_{1,1}(l)\Delta\pi_{t-l} + \sum_{l=1}^{k_2} a_{1,2}(l) r_{t-l} + \varepsilon_{1,t},$$

(9)

$$r_t = \sum_{l=1}^{k_3} a_{2,1}(l)\Delta\pi_{t-l} + \sum_{l=1}^{k_4} a_{2,2}(l) r_{t-l} + \varepsilon_{2,t},$$

or in matrix notation:

(10) $$\begin{bmatrix} \Delta\pi_t \\ r_r \end{bmatrix} = \begin{bmatrix} A_{11}(L) & A_{12}(L) \\ A_{21}(L) & A_{22}(L) \end{bmatrix} \begin{bmatrix} \Delta\pi_{t-1} \\ r_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix},$$

where $A_{i,j}(L)$ is again a polynomial in the lag operator. This VAR model can be estimated by OLS and, equally as in (8), presented in the vector moving average form:

(11) $$\begin{bmatrix} \Delta\pi_t \\ r_r \end{bmatrix} = \begin{bmatrix} C_{11}(L) & C_{12}(L) \\ C_{21}(L) & C_{22}(L) \end{bmatrix} \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix},$$

where:

(12) $C(L)=(I-A(L)L)^{-1}$.

Unfortunately, the residuals **ε** differ from our innovations **u**. A critical insight is that the VAR residuals are composites of the pure innovations **u** (Enders (1995), p.333):

(13) $$\begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix} = \begin{bmatrix} s_{11}(0) & s_{12}(0) \\ s_{21}(0) & s_{22}(0) \end{bmatrix} \begin{bmatrix} u_{1,t} \\ u_{2,t} \end{bmatrix}.$$

Thus, it would be possible to calculate the primitive shocks from the VAR residuals, if the coefficients $s_{i,j}(0)$ were known. This can be achieved by imposing four identifying restrictions on the system (8).

First, the variance of the primitive shocks is assumed to be 1. This is a standard way of normalizing the shocks, which provides two restrictions. Further, since according to equation

(7), $u_{1,t}$ does not impact upon $\Delta\pi$, we could basically impose the restriction $S_{1,1}(L)=0$ on the S(L) matrix. However, as (7) is supposed to describe long-run relationships, we will only require the NRI shock to have zero influence upon $\Delta\pi$ in the long run, which means that it will not be allowed to permanently affect inflation:

(14) $S_{1,1}(1)=0.$

The last restriction will be based on economic knowledge. As monetary transmission works only with a substantial lag, we can safely restrict the innovation to the interest rate gap $u_{2,t}$ not to have any impact upon inflation in the current month:

(15) $s_{1,2}(0)=0\,.$

At this stage, it is important to note that we did not impose the standard identifying restriction of orthogonality of $u_{1,t}$ and $u_{2,t}$. This means for instance that a shock to the natural rate can only partially affect the real rate. The rest of the impact will be interpreted as a change of the interest rate gap. Taking into account the above-described restrictions, some straightforward calculations, presented in detail in Appendix 2, can be done to recover the remaining elements of the s(0) matrix[4]:

(16) $$s_{1,1}(0)=\pm\sqrt{\operatorname{var}(\varepsilon_{1,t})}\ ,$$

(17) $$s_{2,1}(0)=\mp\left[\frac{C_{1,1}(1)}{C_{1,2}(1)}\right]\cdot\sqrt{\operatorname{var}(\varepsilon_{1,t})}\ ,$$

(18) $$s_{2,2}(0)=\sqrt{-2\frac{s_{2,1}(0)}{s_{1,1}(0)}\cdot\operatorname{cov}(\varepsilon_{1,t},\varepsilon_{2,t})+s_{2,1}^{2}(0)+\operatorname{var}(\varepsilon_{2,t})}\ .$$

[4] It is important to note that in spite of the existence of two solutions for $s_{1,1}(0)$ and $s_{2,1}(0)$ the natural rate of interest in equation (19) is unique.

Thus, as the VCV matrix of **ε** is known, the elements of the S(0) matrix can be easily calculated. As a consequence, we can calculate the natural rate of interest, as solely affected by $u_{1,t}$ disturbances. This means setting all $S_{2,2}(L)=0$ in (8):

(19) $$r_t^* = S_{2,1}(L)u_{1,t} ,$$

where the coefficients $s_{2,1}(l)$ can be calculated from:

(20) S(L)=C(L) S(0),

which results from substituting (8) and (11) into (13).

Since the presented decomposition relies on the assumption of real rate stationarity, time series properties of the real rate have been tested. As it can be seen from table 1 (Appendix 3), the real money market rate is probably a stationary variable. This is as well the case with the change in the inflation rate (Δπ). However, it must be noted that the time series properties neither of real rates nor of inflation are unambiguous[5]. In Poland they depend quite heavily on the estimation sample and thus, have to be treated with caution.

Figure 2 presents the estimated[6] time series of the NRI (NRI_SVAR). The natural rate shows relatively high variability, of comparable magnitude to the variance of the real rate. The estimate finds itself almost permanently below the real rate implying that the interest rate gap was permanently open. This result is coherent with the fact that inflation has been falling almost uninterruptedly over the sample period (figure 1). The average NRI is 4,6%. Two big interest rate gaps can be clearly observed, in 1998-99 and 2001-2002. Both resulted in fast disinflation, as can be observed on figure 1.

Figure 2: Real WIBOR1M and NRI estimate from SVAR

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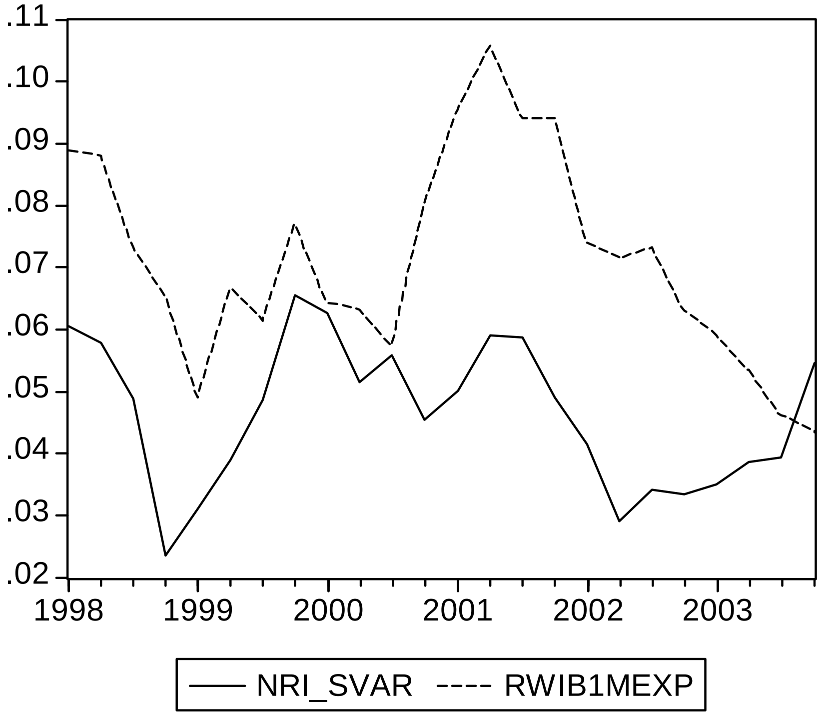
[5] The time series properties of inflation and real interest rates have been debated for years. In a recent publication M.Lanne (2002) argues that inflation is a unit root process, whereas real interest rates are stationary. However, it must be noted that some researchers have come to the conclusion that nominal rates and inflation do not move one for one, which implies a unit root process for the real rate of interest (see J.Bullard 1999).

[6] One subtle estimation problem is that given the identifying assumption (3.13), the interest rate gap has no influence on inflation in the current period. This is certainly true for monthly data, a little bit less so for quarterly. Nevertheless we use quarterly data, because with relatively long transmission lags they allow for



3.2 Using the Kalman filter

The Kalman filter is currently the most popular technique to estimate unobservable economic variables. It has recently been used by T.Laubach and J.C.Williams (2001) to estimate the natural rate of interest in the US. The details, regarding the estimation procedure are relatively complicated and will not be presented in this paper[7]. In brief, the estimated model consists of 2 equations. The first (called observation equation) of the form:

$$(21) \qquad \Delta\pi_t = a_1 \Delta\pi_{t-1} + a_2 (r_{t-1} - r^*_{t-1}) + \varepsilon_{1,t},$$

describes the relationship between observable and unobservable variables. It can be easily seen that (21) is the dynamic, stochastic form of our NRI definition (1).

constructing a better VAR model. Still, it must be noted that the NRI estimates based on monthly data did not differ substantially.

[7] Kalman filtering is described in detail in Hamilton (1994) or Kim and Nelson (1999).

The second model equation (called the state equation), describes our assumption about the process, generating $r*$. We use two alternative approaches, the first, assuming that the NRI is a random walk:

$$(22) \qquad r_t^* = r_{t-1}^* + \varepsilon_{2,t} ,$$

the second imposing stationarity upon $r*$:

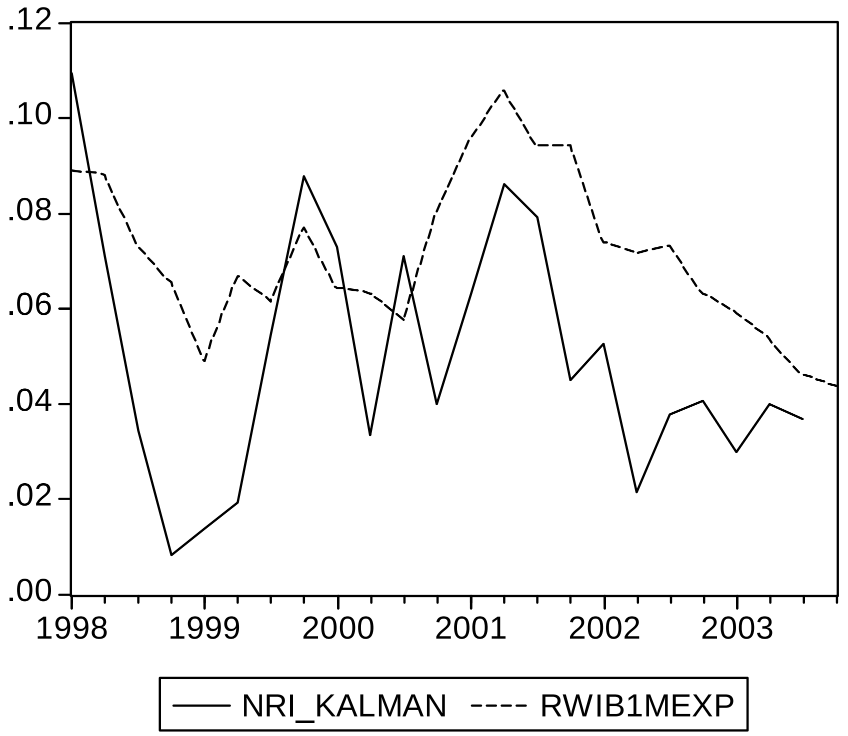
$$(23) \qquad r_t^* = a_3 + a_4 r_{t-1}^* + \varepsilon_{3,t} .$$

This approach is motivated by the international ambiguity regarding the time series properties of the real and natural rate of interest.

One difficult point in using the Kalman filter is related to the residual variance. This can be either assumed or estimated. In practice, in the latter case, long time series are necessary to recover the historical variance. If the data is scarce, the only possibility to proceed is to calibrate the variances. In our case the variance of $\varepsilon_{1,t}$ was set at a very low level, for the NRI definition to be fulfilled relatively strictly. On the other hand, $\varepsilon_{2,t}$ and $\varepsilon_{3,t}$ have been calibrated in such a way that the estimated natural rates show possibly highest correlation to the SVAR estimates. As in the SVAR, two dummies were added to the model.

Unfortunately, it proved impossible to obtain a reasonable model under the NRI stationarity assumption, since the algorithm simply did not converge. It seems understandable that estimating six parameters plus the state variable with such a small data set lacked degrees of freedom. On the other hand, the specification (21) + (22), assuming a unit root process for the NRI and requiring the estimation of only four parameters gave a reasonable model (Appendix 3). Figure 3 presents the result (NRI_KALMAN). The average NRI amounts to 5%.

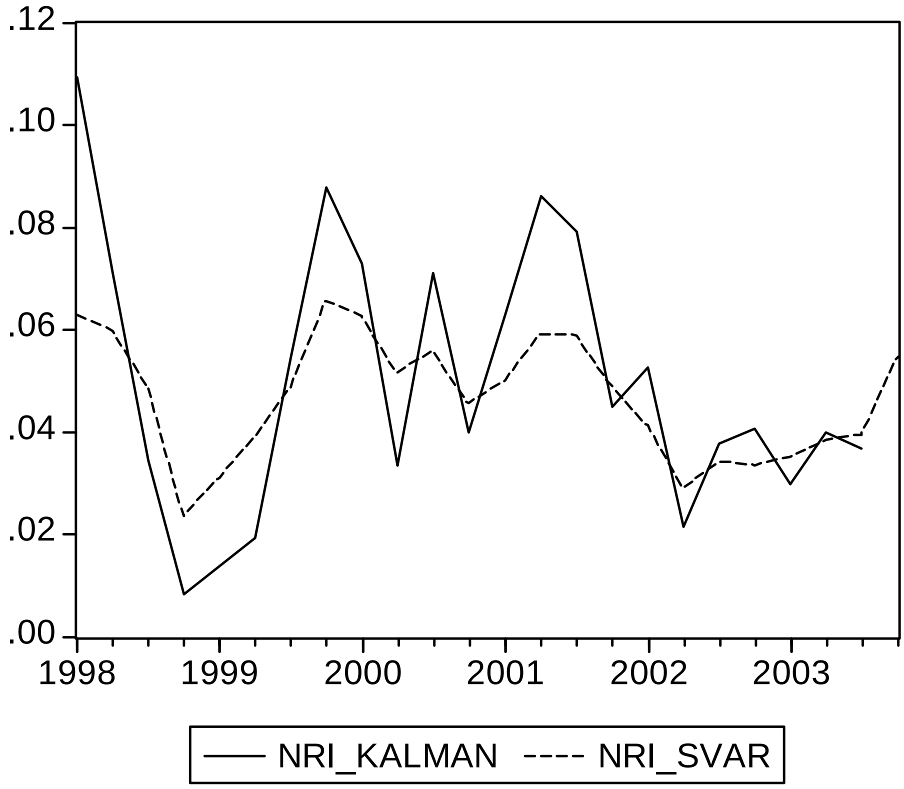
Figure 3: Real WIBOR1M and NRI estimate from Kalman Filter



This result is consistent with the SVAR estimate of the NRI, shows however higher variance. The same two disinflationary gaps can be observed. Figure 4 presents both estimates taken together. They show high colinearity, reflected by a correlation coefficient of 0.88. Given that both the SVAR and the Kalman filter models give only scarce advice on whether the model has been specified appropriately, the fact that NRI estimates obtained with two different tools are so similar is certainly somewhat encouraging.

Summing up, over the last 5 years the natural rate of interest, defined as the real rate that stabilizes inflation averaged in Poland 4.6-5%. Hence, the National Bank of Poland should bring real rates approximately to this level if it wanted to end disinflation. However, it must be born in mind that because of the high variability of the natural rate, one can expect that keeping inflation stable in the future will probably require quite active interest rate policy from Polish monetary authorities. Given the NRI procyclicality result from estimation on longer time series in the US (Brzoza-Brzezina 2003) increasing rates in the boom and lowering them in the downturn is among others a necessary condition for keeping inflation stable.

Figure 4: NRI estimates from SVAR and the Kalman filter



The NRI estimates for Poland are definitely much higher than those obtained for instance for the US or the euro area, which place the NRI in the range 2-3% (Laubach and Williams (2001), Crespo-Cuaresma et al. (2002)). On the other hand they are not uncommon, as similar natural rate levels have been reported from other OECD countries like New Zealand (4-5% according to Archibald and Hunter (2001)) or selected euro area countries before 1999 (Crespo-Cuaresma et al. (2002)). Still, one can wonder, what would be the consequences of Poland's euro area accession in case the observed NRI differential remains present. This is discussed in section 4.

4 The NRI gap and Poland's EMU accession

Given the NRI estimates for Poland, obtained in section 3, one could expect that if the NBP lowered today interest rates to the euro area level (about 1% in real terms), inflation would start increasing due to the permanently open interest rate gap. In fact, interest rates will be lowered to euro area level at the latest once Poland becomes a member of the euro zone. Does this mean that, in view of the natural rate theory, assuming the NRI differential still holds by then, inflation will start increasing forever?

It is straightforward that, assuming that the law of one price (LOOP) holds, once the euro replaces the zloty, prices of tradables will be given from abroad and, given the size of the Polish economy, will be independent of domestic demand. It is, however not so obvious, whether the same will apply for nontradables. To see the answer requires developing a simple 2 country – 2 sector model.

We will start with a flexible exchange rate model, and impose the euro-conversion restriction as the final step. Domestic prices of tradables (P_T) are related to their foreign counterparts (P^*_T) via the exchange rate (E):

(24) $P_T = EP^*_T$,

Hence:

(25) $\Pi_T = \Delta e + \Pi^*_T$,

where Π_T denotes domestic tradables inflation, Π^*_T foreign tradables inflation, e is the log exchange rate and Δ is the difference operator.

Additionally to LOOP, another crucial assumption in the model is the equality of wages between the tradable and nontradable sectors:

(26) $w_{NT} = w_T$,

Assuming, for simplicity[8], a linear production function of the form:

(27) $Y_i=a_i\,L_i.$ $\qquad i=NT,T$

where Y denotes production and L labor supply, we can write down the optimality conditions, relating the marginal product of labor to the real wage:

(28) $W_{NT}/P_{NT}=a_{NT}$

(29) $W_T/P_T=a_T$

Substituting from (24), (28) and (29) into (26), taking logs and differentiating we arrive at:

(30) $\Pi_{NT}=\Delta e+\Pi^*_T+\Delta(log(a_T))-\Delta\,(log(a_{NT})).$

According to equations (25) and (30) higher domestic demand, through its influence on imports and the exchange rate, can lead to higher inflation (both tradable and nontradable) in an open economy with a flexible exchange rate.

The situation will look differently when Poland joins the euro area. This means irrevocable substitution of the Polish currency by the Euro, which for the model implies $\Delta e=0$. Substituting this condition into (25) and (30) simplifies the domestic inflation determinants substantially. Domestic tradable inflation will equal its euro area counterpart:

(31) $\Pi_T=\Pi^*_T$

and domestic nontradable inflation will surpass Π^*_T by the difference in productivity growth rates between sectors:

(32) $\Pi_{NT}=\Pi^*_T+\Delta(log(a_T))-\Delta\,(log(a_{NT})).$

[8] The conclusions would not differ substantially if a constant returns to scale Cobb-Douglas function were applied (Chmielewski 2003).

Hence, independent of what happens to the interest rate gap and domestic demand, after Poland joins the euro area, inflation in Poland will stay under control and will be tightly related to the euro area inflation rate and real factors. Of course, the assumptions of LOOP for tradables and wage equality between sectors need not hold in the short run. Hence, the conclusions will rather apply for the long run whereas in the shorter horizon it cannot be excluded that increased demand will fuel domestic inflation.

Other macroeconomic effects of the potential difference in natural interest rates that should be expected from joining the eurosystem are related to the external balance. As it has previously been noted, the likely to happen increase in domestic demand will end up in higher imports and thus, in a bigger current account deficit[9]. Since after joining the euro area no threat of a traditional currency crisis will be present, a high current account deficit should be on the first sight no worry for macroeconomic stability.

However, monetary authorities must be aware of the microeconomic consequences of increased private sector borrowing both, for investment and consumption. Higher indebtedness can potentially lead to solvency problems, which, if on mass scale, could again become a macroeconomic issue. Although the exact magnitude of this process cannot be predicted at the moment, it is relatively straightforward that bigger problems should be expected in countries, with a substantial natural rate gap vis-à-vis the euro area. Hence, one can conclude that due to the NRI divergence, Polish monetary authorities should be more cautious than for instance the Czech ones, where the NRI is estimated close to euro area levels (CNB (2003)).

At this point the question emerges, how authorities can handle the issue once they loose monetary independence. In our view, there are two options left. From the macroeconomic point of view, fiscal tightening could be used to improve the economic balance. On the microeconomic level, banking supervision can be strengthened. It must be, however admitted that after adopting the euro, the capability of the NBP to curb private borrowing will be substantially limited.

[9] Such scenario materialized for instance in Greece and Portugal after euro adoption Blanchard, Giavazzi (2002).

5 Conclusions

Since the mid 1990's much interest of the academic literature has been devoted to the natural rate of interest (NRI). However, central bankers are relatively reluctant to introduce this concept into their day-to-day decision making process. One possible reason is the high variability of the natural rate as measured for the short term interest rate, being the central bank's instrument.

This paper aimed at showing that the concept of the natural rate of interest can be, under certain conditions, a useful tool for monetary authorities. One crucial thing is formulating the appropriate definition of the NRI. In this paper we used extensively the definition, relating the NRI to the real rate that stabilizes inflation.

We introduced the Kalman filter and a structural VAR model to estimate the time series of the NRI. The estimates, obtained from different econometric tools proved relatively similar and, thus could be used to assess the average level and the variance of the natural rate in Poland. Accordingly, the natural rate averaged 4.6 - 5% over the last 6 years, showing relatively high variability, comparable to the variance of the real rate. For a central bank, like the National Bank of Poland, which, after 12 years of disinflation seeks the neutral interest rate level to stabilize inflation, this is important news. Hence, to stabilize inflation the NBP should bring real interest rates approximately to this level.

The result of a relatively high natural rate as compared to the euro area, puts forward the question, how the economy will behave, after Poland joins the eurozone and low ECB rates will be applied. Provided that the NRI in Poland remains high, this could mean a substantial increase in domestic demand, which under a flexible exchange rate regime would result in inflation going up. On the basis of a simple 2 country – 2 sector model we show that, once the Euro replaces the Zloty, neither the prices of tradables nor nontradables should increase due to higher domestic demand. However, one can expect that increased absorption will increase private sector borrowing and worsen the current account balance. Such scenario might end up in solvency problems. This effect will be probably more pronounced in countries characterized with a relatively big NRI gap against the eurozone. We see this as an interesting field for further research.

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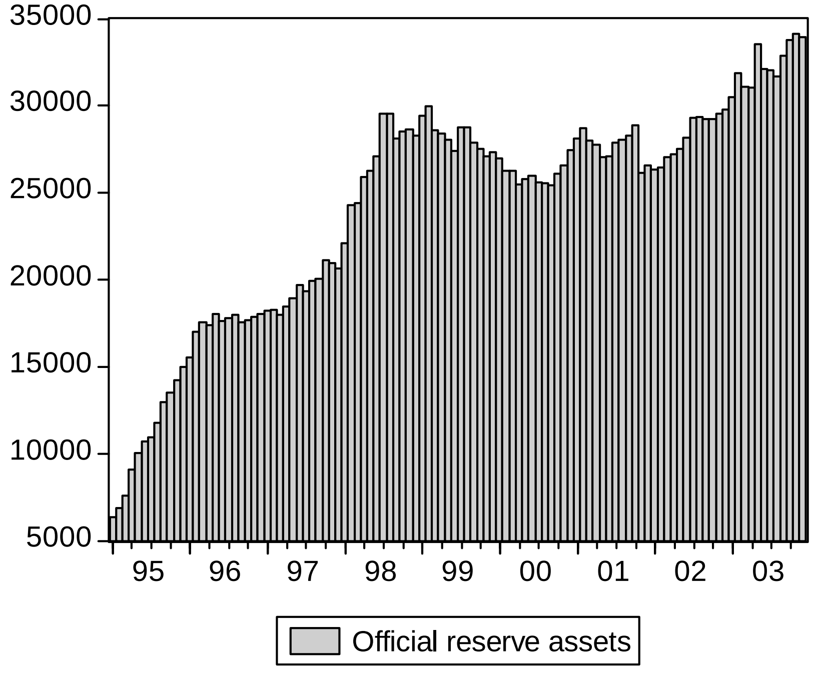
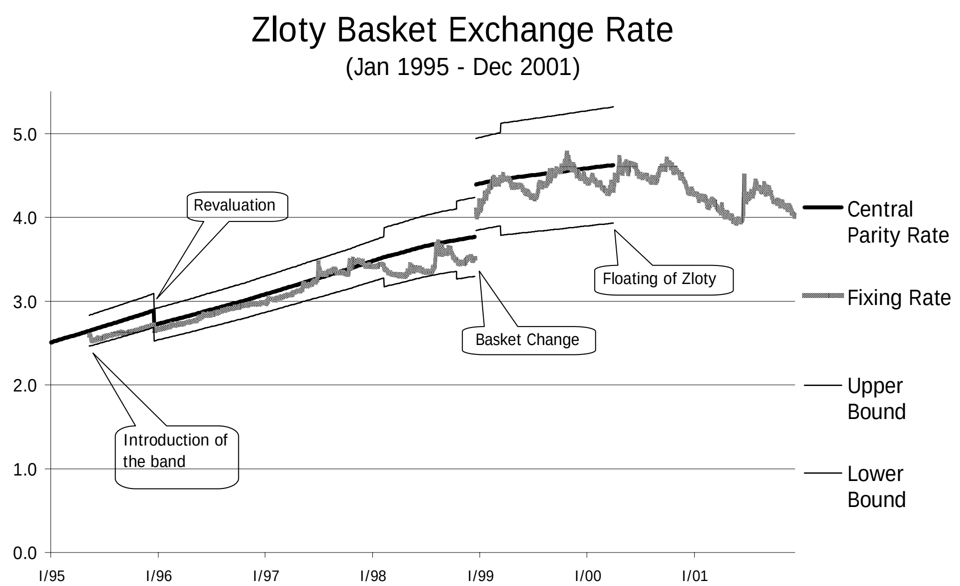
Appendix 1: Figures

Figure 5: *Official reserve assets of the NBP (USD mn)*



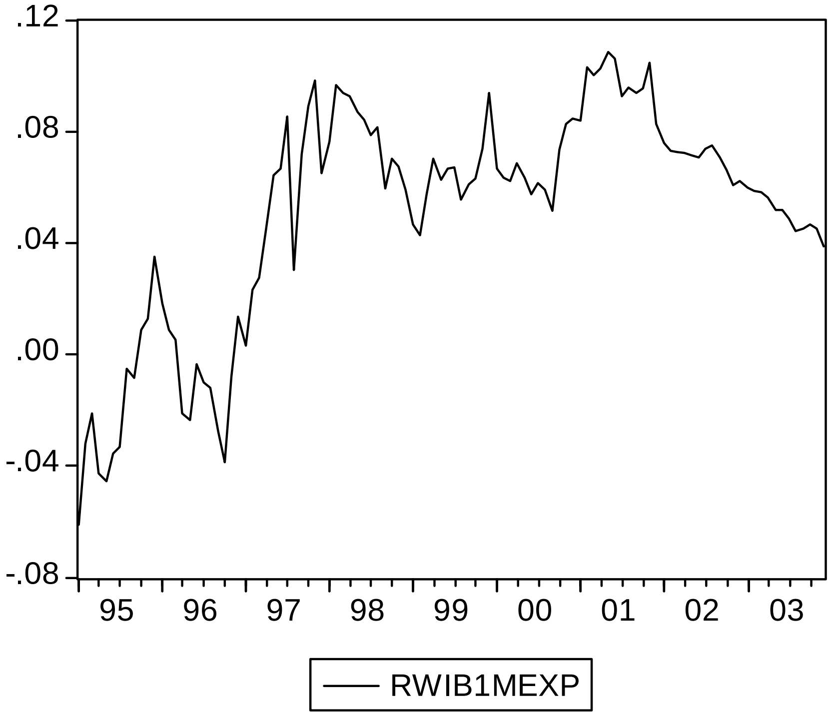
Source: NBP

Figure 6: *Zloty - basket exchange rate*



Source: NBP

Figure 7: *Real WIBOR1M, 1995 - 2003*



Source: NBP

Appendix 2: Calculating the elements of the s(0) matrix

Given the identifying assumptions (14), (15) and the assumption of unit variance of the $u_{1,t}$ and $u_{2,t}$ shocks, the elements of the s(0) matrix can be calculated in the following way.

From (13) and (15) we have:

(A 1) $$\mathrm{Var}(\varepsilon_{1,t}) = s_{1,1}(0)^2 + s_{1,2}(0)^2 + 2\,\mathrm{cov}(u_{1,t}u_{2,t}) \cdot s_{1,1}(0) \cdot s_{1,2}(0) = s_{11}^2(0)\,,$$

(A 2) $$\mathrm{Var}(\varepsilon_{2,t}) = s_{2,1}(0)^2 + s_{2,2}(0)^2 + 2\,\mathrm{cov}(u_{1,t}u_{2,t}) \cdot s_{2,1}(0) \cdot s_{2,2}(0)$$

and

(A 3) $$\mathrm{cov}(\varepsilon_{1,t}\varepsilon_{2,t}) = s_{1,1}(0) \cdot s_{2,1}(0) + s_{1,1}(0) s_{2,2}(0) \cdot \mathrm{cov}(u_{1,t}u_{2,t})$$

From (21):

(A 4) $$s_{1,1}(0) = {}^{+}_{-}\sqrt{\mathrm{Var}(\varepsilon_{1,t})}\,,$$

and from (14) and (20) we can write:

(A 5) $$C_{1,1}(1) \cdot s_{1,1}(0) = -C_{1,2}(1) \cdot s_{2,1}(0)\,.$$

Substituting from (24) into (25) allows us calculate $s_{2,1}(0)$:

(A 6) $$s_{2,1}(0) = {}^{-}_{+}\left[\frac{C_{1,1}(1)}{C_{1,2}(1)}\right] \cdot \sqrt{\mathrm{Var}(\varepsilon_{1,t})}\,.$$

Substituting for $\mathrm{cov}(u_{1,t}u_{2,t})$ from (22) into (23) yields the following expression for $s_{2,2}(0)$:

(A 7) $$s_{2,2}(0) = \sqrt{-2\frac{s_{2,1}(0)}{s_{1,1}(0)} \cdot \mathrm{cov}(\varepsilon_{1,t}, \varepsilon_{2,t}) + s_{2,1}^2(0) + \mathrm{var}(\varepsilon_{2,t})}\,,$$

which can be easily calculated by substituting $s_{1,1}(0)$ and $s_{2,1}(0)$ from previous results.

Appendix 3: Estimation results

Table 1: *ADF tests (with constant)*

Variable	t-statistics	Lags	p-value
CORENETYOY	-0.86	0	0.782
D(CORENETYOY)	-4.08	0	0.005
RWIB1MEXP	-3.54	2	0.015

Table 2: *Parameter estimates form the Kalman filter model*

	Coefficient	Std. Error	z-Statistic	Prob.
a_1	-0.175597	0.088481	-1.984582	0.0472
a_2	-23.45739	2.333264	-10.05346	0.0000
DUM1	-1.410459	0.431018	-3.272392	0.0011
DUM2	-2.203032	1.798627	-1.224841	0.2206

Table 3: *Parameter estimates from the SVAR model (standard errors and t-statistics below)*

	D(INFL)	RINT
D(INFL(-1))	0.015441	-0.002914
	(0.15215)	(0.00272)
	[0.10148]	[-1.07014]
RINT(-1)	-11.69056	0.781380
	(7.60411)	(0.13611)
	[-1.53740]	[5.74082]
C	12.15719	0.231022
	(8.17223)	(0.14628)
	[1.48762]	[1.57933]
DUM1	-2.865304	-0.018458
	(0.59061)	(0.01057)
	[-4.85146]	[-1.74600]
DUM2	-1.252876	0.019161
	(0.58179)	(0.01041)
	[-2.15349]	[1.84000]
R-squared	0.612460	0.696444
Adj. R-squared	0.530873	0.632537
S.E. equation	0.566319	0.010137
F-statistic	7.506806	10.89783