

### Summary

The doctoral dissertation verifies the hypothesis of long-run neutrality (LRN) and long-run superneutrality (LRSN) of money using a new research tool in the form of a cointegrated VAR (CVAR) model for second-order integrated processes - I(2). The LRN and LRSN hypotheses address the effects of changes in the money supply and its rate on the money market itself, the goods and services market, the labour market and the foreign exchange market. They indicate what short- and long-term effect the (mainly) expansionary monetary policy of the central bank has on the economy. The effects of changes in the money supply and its rate are viewed differently by schools of economics.

So far, the LRN and LRSN hypotheses have been verified using mainly the SVAR model.

The analysis of the LRN hypothesis was carried out, on the one hand, by imposing exclusion restrictions on the parameters in the cointegration space and, on the other hand, by applying exclusionary restrictions on the parameters in the weight matrix of common stochastic trends  $I(2) \tilde{B}_{2\perp}$ , in which the import of I(2) shocks is determined. Using polynomial cointegration analysis in the CVAR model for I(2) processes, it is shown that the detailed hypotheses of money neutrality and super-neutrality can be analysed simultaneously. Polynomial cointegration also made it possible to analyse medium-term equilibrium relationships that perpetuate over the long term. Using a matrix of coefficients defining common underlying stochastic trends  $I(1) A_{1\perp}$ , the main sources of cyclical behaviour in the Polish economy were identified.

The study was conducted in two sets of variables.

The dissertation verified the following research hypotheses:

1. A permanent and exogenous change in the money supply leads in the long run to a proportional increase in prices, the nominal exchange rate, the nominal wage and inflation expectations, and has no effect on real output, employment, the real wage and the nominal interest rate - LRN.
2. A permanent and exogenous change in the growth rate of the money supply leads to the same change in the nominal interest rate, inflation expectations and the growth rate of prices, nominal wages, the nominal exchange rate, while not affecting the level of real output and the unemployment rate - LRSN.
3. It is more common to reject the hypothesis of neutrality for money in narrow terms than in broad terms.

Four supporting questions were also answered:

1. Is the velocity of money stable over time ?
2. Is modern money still exogenous money ?
3. Is inflation according to LRN only a monetary phenomenon ?
4. Are lower price and nominal exchange rate elasticities with respect to money to be expected in narrow terms than in broad terms ?

In the case of the LRN hypothesis for money in broad terms, its non-neutrality with respect to nominal variables: prices, wages, the exchange rate and inflation expectations was confirmed. *M2* money was found to be non-neutral to real variables: output and the unemployment rate, and to the nominal interest rate. The analysis of underlying common stochastic trends  $I(1)$  indicated that money was not super-neutral to inflation, the nominal interest rate, real output, the rate of change of nominal wages and the nominal exchange rate. Money was found to be super-neutral to the unemployment rate.

For the analysis of the LRN hypothesis in the cointegration space, the full verifiable version of the hypothesis was confirmed with four underlying cointegrating vectors. According

to the hypothesis of money neutrality, the elasticity of prices and the nominal exchange rate with respect to money  $M2$  turned out to be unitary, and with respect to money  $M0$  the elasticities were much lower, 0.39 and 0.3, respectively. Positive elasticity of nominal wages with respect to money  $M2$  and the neutrality of money with respect to real output were indicated.

Analysis of the LRSN hypothesis in the cointegration space indicated that the reason for rejecting the full LRSN hypothesis is the lack of confirmation of Fisher's rule. The nominal interest rate does not rise in line with the rate of price changes, inflation is neutral to the real interest rate.

It was confirmed that the disparity between the short- and long-term nominal interest rate is an appropriate approximant for the velocity of money circulation. Furthermore, it was pointed out that the velocity of money circulation is characterized by instability over time.

Analysis of the matrix of coefficients of adjustments to equilibrium relations  $A_0$  and  $A_1$  in the CVAR model for  $I(2)$  processes indicated that the money supply adjusts to equilibrium relations. Adjustments of the money supply to equilibrium relations indicate the endogenous nature of money. The endogenous nature of money is also evidenced by the elements of the matrix of weights significantly  $\neq 0$  at the underlying common stochastic trends  $I(2) \tilde{B}_{2\perp}$  related to money supply, which represent to which  $I(2)$  shocks money (prices and nominal wages) is sensitive. Elements of the same matrix confirm that the money supply is generated by a stochastic  $I(2)$  process.

Analysis of the price equation in the cointegrating space confirmed that inflation in Poland is not exclusively monetary in nature. In addition to the increase in the money supply, the price increase is also influenced by the increase in nominal wages, the depreciation of the zloty (which translates into an increase in the cost of imports), an increase in inflation expectations and an increase in production.

