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# The Long-Run Superneutrality of Money Revised: the Extended European Evidence

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**Abstract**: This article investigates the validity of the money superneutrality concept for the large panel of European economies. While focusing exclusively on endogenous growth theories including the Mundell-Tobin effect, we examine the long-run response of real output to a permanent inflation shock in every studied country using a structural vector autoregressive framework. For the majority of countries in our sample, the long-run superneutrality concept is confirmed since the original increase/decrease in output growth fades in time. We also test the additional hypothesis of whether the group of countries with smaller in-sample inflation mean forms the exception to the long-run money superneutrality. As the result, modern economies might be better described from the viewpoint of Sidrauski.

**Key words**: endogenous growth theories, superneutrality, SVAR

**JEL Classification:** C32, E50

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## Introduction

The relationship between inflation and economic growth is strategically important for the understanding of how successful is the economic policy or how well functioning is the institutional environment. The existence of such relationship is crucial for policy-makers, especially for monetary authorities. The causality between inflation and growth is the focal point in the concept of money neutrality and superneutrality.

The concept of long-run money superneutrality states that permanent changes in the growth rate of money supply have no appreciable effect on output, real interest rate, and real exchange rate. In other words, inflation rate and growth rate of nominal variables change in the similar proportion as the growth rate of the money stock. While there is a general agreement that changes in inflation arise solely from an equal change of money supply, there are many supporters of the view that fluctuations in the money supply growth rate maintain an appreciable effect on the determinants of real variables – mak-

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ing money not superneutral in the long run. However, there is no agreement about the size and significance of short-term effects, and even long-run superneutrality is open to debate. Given the disunity in opinions of monetary theorists, it is important to study this relationship in detail using an empirical approach.

In this paper, we aim to revise the concept of the long-run superneutrality of money and investigate the long-run relationship between real GDP and inflation growth rates in European countries. We assume that inflation is a monetary phenomenon (as famously stated by Friedman, 1948), meaning that the permanent component of inflation is associated with permanent changes in the growth rate of money supply. Therefore, the effect of a permanent inflation change to a real output growth can be positive, negative or negligible. If negative, a permanent increase in money supply leads to inflation growth which has a distortive effect on real output. If positive, an inflation growth would lead to a rise in real output. Therefore, we expect the long-run responses to be positive for low level inflation countries and negative for countries with high average inflation rates. Otherwise, if no response is found, we declare the validity of the superneutrality concept.

Earlier studies of money superneutrality use reduced-form regression analysis, which alone is a rather insufficient approach since such models tend to have low explanatory powers and no ability to identify permanent and temporary changes in money supply. As shown by Fisher and Seater (1993) within the autoregressive integrated moving average model framework, meaningful superneutrality tests might only be constructed if variables are non-stationary and, thus, are subject to permanent shocks. This approach has since been considered the standard for the empirical testing of money neutrality with several extensions being proposed recently, usually addressing structural breaks in studied variables (for example, Noriega et al., 2008) or fractional integration (Bae at el., 2005). Our approach is somewhat different from these developments since we consider the decomposition of output into trend and cycle components as proposed by Blanchard and Quah (1988).

Empirical studies are typically either focused on a time series analysis for a single country or small group of countries (usually advanced economies) or uses panel or cross-sectional data to study a larger group of countries without any general consensus on the validity of the superneutrality concept. For example, King and Watson (1992) finds no superneutrality for the post-war US economy using differenced output and twice differenced money in a bivariate VAR model framework. Other studies are focused to provide an international level analysis. Weber (1994) finds no superneutrality for G-7 postwar economies. Bullard and Keating (1995) use structural vector autoregression model to identify the relationship between inflation and real output in the large sample of 58 countries during the post-war period. The evidence in this large scale study mainly supports the superneutrality concept: in sixteen cases, the reaction of output to a permanent inflation shock was zero, in four cases positive and negative only for one country.

We add to the literature by investigating the validity of the money superneutrality concept on the sample of 29 European economies. In our analysis, we are not limiting our analysis to EU member countries; however, they form a majority in our sample. The European Central bank alongside with other central banks significantly increased the money supply after the global financial crisis to rehabilitate the macroeconomic situa-

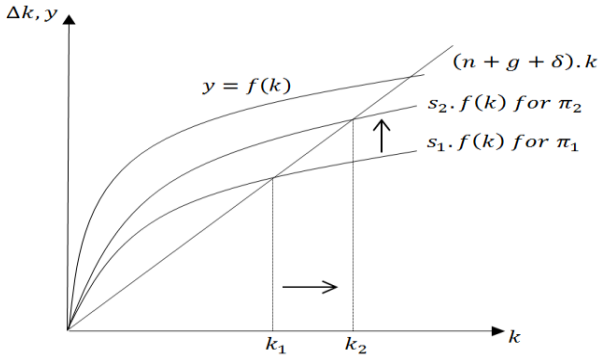
tion and encourage investments and consumer demand. The European sample of countries is also an interesting case study due to the fact that most of its countries have steady, low inflation and the official adherence of its monetary authorities to the classical dichotomy. We find that for eighteen countries the long-run superneutrality concept is confirmed, seven countries have experienced positive output response to a permanent inflation shock, while only one country has experienced negative response. The remaining countries did not experience any permanent inflation shocks.

## Theoretical Background to the Neutrality and Superneutrality Concept

Money neutrality and superneutrality concepts have become deeply rooted in practically all of the significant schools of economics. There is, however, an ever going dispute about the size and significance of the monetary policy effects on the long term output growth. The debate is tightly connected to the development of the quantity theory of money, the natural interest rate concept and the elasticity of money and wages. Empirical studies and views of monetary policy practitioners have still not resolved this theoretical dispute. Since the purpose of this article is not to deliver an excessive historical overview, we provide here a basic summary of related relevant theoretical concepts.

A majority of historically older schools of economics believe that money stock has no potential influence on real macroeconomic variables in the long-run. The short-term effect was declared by the classical school through the interest rates which were supposed to raise investments. This channel was questioned by Keynes (1973) who argued, as formulated by the liquidity trap concept, that the demand for money is infinitely elastic to any changes in interest rates. Apart from classical and neoclassical schools, Keynes also emphasized the significance of money viewed as value holding instrument. Savings are, therefore, causally adapting to the investments thanks to the changes in income and employment. It was the positive deterministic influence of interest rates to investments that has led Keynes to refuse the money neutrality concept in the short-run. In the long-run, Keynesians believed in a stable Phillips curve and a trade-off between inflation and unemployment.

**Figure 1 Mundell-Tobin effect in neoclassical growth model**




*Note: k denotes capital stock, y - production function, s - savings*
*Source: Haslag (1997), own construction*

The Keynesian formulation was questioned by Patinkin (1987) who introduced the real balance effect of changes in the nominal money supply. He argued that if the nominal interest rates drop under their natural level, the money stock increases resulting in a discrepancy between the nominal and real interest rates. These discrepancies have the potential to negatively influence the output (and vice versa). Friedman (1968) and the Monetarist school took a similar approach and explain money neutrality via Friedman's fooling model.

Efforts to confirm or refute the money neutrality or superneutrality concept are usually built on the Mundell-Tobin effect (see Mundell, 1963 and Tobin, 1965). The Mundell-Tobin effect implies that nominal interest rate increases proportionally less than the inflation rate. It is due to the fact that economic agents hold less cash due to increasing alternate money holding costs. Hence, they transfer their wealth to other financial assets causing the interest rate to lower in response. To explain the Mundell-Tobin effect in nominal interest rate logic the initial money stock growth causes the rise in nominal interest rates but lowers the real interest rate. These changes in economic agents' portfolio cause permanently higher capital stock and permanently higher output. This situation is described in Figure 1. The permanent increase in the inflation rate from to is considered, which means that the purchasing power has declined. In the Mundell-Tobin mechanism, economic agents will now substitute capital for money, thus, the line will shift to resulting in higher capital stock ( to ).

*Neutrality and Superneutrality in Endogenous Growth Theories*

There are three main effects explaining the long term relationship between the price level and output in endogenous growth theories (see Kotlán, 2008 for a detailed description): Tobin effect described above, Sidrauski effect and Stockman effect. Sidrauski (1967) postulates that economic agents are more likely set to restore their wealth after permanent inflation shock (the sudden rise in the inflation rate) and there is no new capital accumulation following. On the other hand, Stockman (1981) demonstrates that an inverse Tobin effect may arise when money is needed for buying capital goods. The support for money superneutrality is also evident in the modern macroeconomic literature, where it aims to explain the equity premium puzzle. For example, Faria (2001) introduces the hypothesis of habit formation in consumption into the Sidrauski model and finds that superneutrality is robust even if consumption is taken into account.

Three basic empirical possibilities are usually identified to analyze the neutrality and superneutrality concept in the long term. The most apparent way is to analyze the long term relationship between money stock (preferably M2 aggregate) and real output. The empirical evidence on such relationship is mixed. For example, Ahmed (1993) concludes that money stock definitely has some effect on the output, but it is not the key determinant. A similar conclusion can be drawn from Manchester (1989), who found that it is not the changes in money stock but in money multiplier that causes the changes of output. The other way to approach money neutrality is to test the validity of the Fisher effect, the notion that permanent changes in the inflation rate do not influence the real interest rates. Earlier studies investigating the Fisher effect generally support the proposed relationship (see Fama, 1975 or Nelson and Schwert, 1977). However, several subsequent studies argue that the relationship does not hold for the certain period of time or when the test is performed in different countries other than the United States

(see Kandel, et al., 1996). Mishkin (1992) re-examination of the Fisher effect provides supporting evidence in favor of the relationship, stating that earlier rejections of the hypothesis were mainly due to the presence of a stochastic trend in interest rates and inflation. The third approach is based on the analysis of the long term Phillips curve slope. Empirical studies (Koustas and Serletis, 2003; Bashar, 2011) confirm that the Phillips curve is close to the vertical position, if not fully vertical.

This study uses a different, more straightforward concept based on the neoclassical endogenous growth framework. We test the long term relationship between real GDP and inflation, approximated by GDP deflator. The theoretical basis is the Mundell-Tobin model, since we are restricting the temporary inflation shock from influencing the inflation itself. In other words, if the permanent changes in inflation are caused by permanent changes in the money stock, the temporary inflation shock must have its origin in non-monetary disturbances which are believed to be minor.

## Methodology and Data

Empirical testing of money superneutrality is not an easy task since we have to separate temporary and permanent effects of macroeconomic shocks. Here, we partially build on the methodology proposed by Blanchard and Quah (1988), a statistical model that is able to decompose output movements into permanent and transitory components (trend/cycle decomposition). The basic assumption is that there are two types of disturbances affecting output. The first (temporary) has no long-run effect on output and the second (permanent) has. These two disturbances have to be uncorrelated with all leads and lags.

Let $Y$ and $\pi$ denote the GDP and inflation. Let $\varepsilon^{\pi}$ be the permanent inflation shock which is attributed to permanent changes in money supply growth rate. Temporary shock to inflation $\varepsilon^{y}$ is permitted to have a permanent effect on output (it could only temporary raise the inflation but permanently lower the output). For the sake of clarity, temporary inflation shocks can be considered as demand shocks, while permanent inflation shock can be marked as supply shock in a standard AS-AD model framework.

If we set $X$ to be the vector $(Y, \pi)'$ and $e$ be the vector of disturbances $(\varepsilon^{\pi}, \varepsilon^{y})$ than $X$ follows a stationary process[3] given by:

$$X_t = A(0)e_t + A(1)e_{t-1} + \cdots = \sum_{k=0}^{\infty} A_j e_{t-j}, \quad (1)$$

where the sequence of $A$ matrices has its upper left entry $a_{11}(j), j = 1,2, \ldots$, sums to zero. So if the temporary effect of $e$ on $X$ is given by $A(0)$, subsequent effects are given by $A_j, j \geq 1$ and $X$ is $I(0)$ process, then neither disturbance has a long-run effect on used variables. Our bivariate time series model takes a following form:

$$\Delta\pi_t = \theta_{11}(L)\varepsilon_t^{\pi} + \theta_{12}(L)\varepsilon_t^{y}, \quad (2)$$

[3] The intuition behind inflation being a nonstationary variable follows the theory of optimal collection of seigniorage proposed by Mankiw (1987). He considers inflation to be a kind of tax on holding money balances and states: 'just as the smoothing of consumptions by the consumers makes consumption a random walk, the smoothing of tax rate by the government makes tax rate a random walk' (Mankiw, 1987, pp. 327). While applying the same principle, the theory of optimal seigniorage suggests that inflation should be smoothened which make this series a random walk.

$$\Delta y_t = \theta_{21}(L)\varepsilon_t^{\pi} + \theta_{22}(L)\varepsilon_t^{y}, \tag{3}$$

where $\Delta\pi_t$ is the change in the rate of inflation, $\Delta y_t$ is the growth rate of GDP, $\varepsilon_t^{\pi}$ and $\varepsilon_t^{y}$ are the two disturbances explained above. Each lag operator has the following general form:

$$\theta_{ij}(L) = \sum_{k=0}^{\infty} \theta_{ijk} L^k, \tag{4}$$

for $i = 1,2$ and $j = 1,2$ with each $\theta_{ijk}$ as a scalar parameter. The model is defined by two restrictions. First:

$$\theta_{12}(1) = \sum_{k=0}^{\infty} \theta_{12k} = 0, \tag{5}$$

$\varepsilon^{y}$ shock is not allowed to have a permanent effect on inflation, so the remaining transitory inflation shock will primarily result from nonmonetary disturbances. The second restriction is that the disturbances are uncorrelated.

Considering $\Delta x_t = [\Delta\pi, \Delta y]^T$ and $\varepsilon = [\varepsilon^{\pi}, \varepsilon^{y}]^T$, we than rewrite (2) and (3) into:

$$\Delta x_t = \theta(L)\varepsilon_t, \text{ where } \theta(L) = \begin{bmatrix} \theta_{11}(L) & \theta_{12}(L) \\ \theta_{21}(L) & \theta_{22}(L) \end{bmatrix}, \tag{6}$$

In order to obtain the VAR representation, we must rewrite (6) as:

$$\Delta x_t = \theta(L)\Delta x_{t-1} + e_t, \tag{7}$$

where $\theta(L) = A^{-1}B(L)$ assuming that $A$ is invertible, $B$ is a polynomial in the lag operator and $e_t = A^{-1}\varepsilon_t$. Setting $E(\varepsilon_t\varepsilon_t') = \sum_t$ and $E(e_t e_t') = \sum_e$ we achieve:

$$\sum_e = A^{-1}\sum_{\varepsilon} A^{-1}, \tag{8}$$

For the detailed discussion on identification of $A^{-1}$ through long-run restrictions see Blanchard and Quah (1988).

We proceed as follows: first, we use the Choleski decomposition of (8) to identify the parameters in $A^{-1}$ matrix. We then use the VAR coefficients and $\theta(L) = A^{-1}B(L)$ to identify structural disturbances and finally we insert obtained parameters into (7). The long-run response of output to a permanent one percent increase in inflation is then obtained through a simple representation in the matrix of long-run multipliers (see Fisher and Seater, 1993 for detailed derivation):

$$d = \lim_{k\to\infty} \frac{\partial y_{t+k}}{\partial \varepsilon_t^{\pi}} \Big/ \frac{\partial \pi_{t+k}}{\partial \varepsilon_t^{\pi}} = a_{21}/a_{11}, \tag{9}$$

From (9) we can observe several cases:

- $d \approx 0$ – a case of superneutrality,
- $d > 0$ – positive output response to inflation shock and
- $d < 0$ – negative output response to inflation shock.

To apply proposed SVAR modelling, we require permanent shocks to the inflation rate and output. In other words, if the GDP deflator time series are found to be stationary, we cannot expect them to contain any permanent changes. To check the stochastic nonstationarity of the data the unit root is required. We conducted the standard Augment Dickey-Fuller (1981) unit root test (ADF), which constructs a parametric correction for

higher-order correlation by assuming that the y time series follows an AR(p) process with p lagged difference terms and with or without deterministic trend:

$$y_t = \theta y_{t-1} + \delta x_t' + \varepsilon_t, \quad (10)$$

We use the annual real gross domestic product (2000=100) and gross domestic product deflator for 29 European countries from the World Bank's World Development Indicators. We consider the growth rate of the real GDP and first difference of the GDP deflator. We initially chose European sample of countries and then removed those not offering a long continuous set of observations on the both time series. Since we are interested in the long-run relationship analysis, we set the criterion to be at least twenty-five years.

**Table 1 Unit root test results and sample characteristics**

| Country | Sample | N | ADF $\Delta\pi$ | ADF $\Delta y$ | Lag | Detrended |
|---|---|---|---|---|---|---|
| Albania | 1981-2015 | 34 | -3.211653 | -1.916051 | 0,0 | $\Delta y$ |
| Austria | 1961-2015 | 54 | -2.691513 | -0.918651 | 0,0 | $\Delta y$ |
| Belarus | 1991-2015 | 24 | -9.351681 | No permanent shock to inflation | | |
| Belgium | 1961-2015 | 54 | -3.100605 | -2.210651 | 1,0 | $\Delta y$ |
| Bulgaria | 1981-2015 | 34 | -5.165165 | No permanent shock to inflation | | |
| Cyprus | 1976-2015 | 39 | -1.661584 | -1.981154 | 0,0 | $\Delta y$ |
| Czech Republic | 1989-2015 | 26 | -1.216516 | -2.216354 | 0,0 | $\Delta y$ |
| Denmark | 1961-2015 | 54 | -0.905651 | -1.416106 | 3,0 | $\Delta y$ |
| Finland | 1961-2015 | 54 | -1.985164 | -2.651651 | 3,1 | $\Delta y$ |
| France | 1961-2015 | 54 | -0.651661 | -1.351611 | 1,0 | $\Delta y$ |
| Germany | 1971-2015 | 44 | -1.966165 | -1.298195 | 0,0 | |
| Greece | 1961-2015 | 54 | -1.156154 | -0.70165 | 0,0 | $\Delta y$ |
| Hungary | 1992-2015 | 23 | -4.216511 | No permanent shock to inflation | | |
| Iceland | 1961-2015 | 54 | -0.298165 | -1.316514 | 0,1 | $\Delta y$ |
| Ireland | 1971-2015 | 44 | -1.365561 | -1.065054 | 1,0 | $\Delta y$ |
| Italy | 1961-2015 | 54 | -1.815165 | -2.065161 | 1,1 | $\Delta\pi, \Delta y$ |
| Latvia | 1966-2015 | 49 | -2.516551 | -1.506515 | 0,0 | |
| Lithuania | 1991-2015 | 24 | -1.756561 | -1.816516 | 0,1 | $\Delta y$ |
| Malta | 1971-2015 | 44 | -2.456611 | -0.665161 | 0,0 | |
| Netherlands | 1961-2015 | 54 | -0.741661 | -1.165156 | 0,0 | $\Delta y$ |
| Norway | 1961-2015 | 54 | -3.651654 | -2.065161 | 0,0 | |
| Poland | 1991-2015 | 24 | -1.751614 | -1.651611 | 1,0 | |
| Portugal | 1961-2015 | 54 | -2.65165 | -1.216515 | 0,0 | $\Delta y$ |
| Romania | 1982-2015 | 33 | -1.328321 | -1.651651 | 0,0 | $\Delta y$ |
| Spain | 1961-2015 | 54 | -0.955014 | -1.039561 | 0,0 | |
| Sweden | 1961-2015 | 54 | -0.715486 | -1.465165 | 1,0 | $\Delta y$ |
| Switzerland | 1981-2013 | 32 | -1.258970 | -2.136021 | 0,0 | |
| Turkey | 1961-2013 | 52 | -1.425644 | -1.351642 | 0,0 | $\Delta y$ |
| United Kingdom | 1961-2013 | 52 | -1.449151 | -2.297070 | 1,0 | $\Delta y$ |

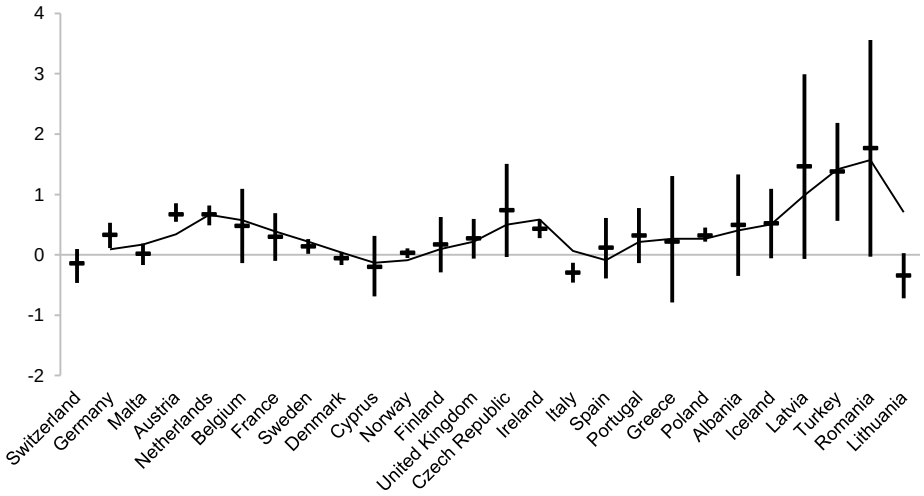
*Note: Non-stationarity is the ADF test null hypothesis.*
*Source: World Development Indicators, own computation.*

## Results and Discussion

Since the proposed model assumes that $\Delta x_t = [\Delta\pi, \Delta y]^T$ follows a $I(1)$ process, we start the empirical investigation with the adjusted Dickey-Fuller tests to check the stationarity of studied time series. As seen from Table 1, there is no strong evidence against nonstationarity of either deflator nor output in most cases. However, results for Belarus, Bulgaria, and Hungary show a strong evidence for their inflation time series to

be stationary and are, therefore, removed from further analysis. The selection of various information criteria also allows us to choose an appropriate lag in our time series. From the inspection of information criteria results, we chose Hannan-Quinn, which under general conditions gives us the appropriate lag for our data analysis. As stated in Lütkepohl (2011), AIC tends to overestimate the order asymptotically with a small probability, while Ivanov and Kilian (2001) show that the Hannan-Quinn Criterion appears to be the most accurate lag selection criterion for annual data. The last column of Table 1 contains information on whether it was necessary to detrend a variable before entering VAR model. Following Bullard and Keating (1995), we run a simple regression with constant, linear time trend and a lag chosen by sequential testing (maximum lag of four). If the t-statistics was significant for the corresponding trend with particular lag, the variable was detrended.

**Figure 2 Long-run response of the output growth to a permanent inflation shock**




*Note: Horizontal lines represent point estimates; vertical lines are 90% confidence bounds. Estimates are shown together with moving average trend line.*
*Source: own computation*

Figure 2 summarizes the estimated long-run relationship between output and inflation together with 90% confidence bounds. We sort the sample so that countries are in the increasing order of in-sample inflation mean. Judging from graphical representation, we can derive that out of 27 countries seven economies (Austria, Germany, Ireland, Netherlands, Poland, Sweden and Turkey) has experienced inflation shock with a positive permanent increase in the level of output (between 0,5 and 1,5%). However, Poland has less than 25 consecutive years of observations, so we should refer to this result with great caution. Italy has experienced a negative permanent shock to output. For the rest of countries, the results are not conclusive since their confidence bounds include zero. Detailed results and point estimates of SVAR mode are reported in Table 2.

**Table 2 SVAR analysis results with 90% confidence interval reported**

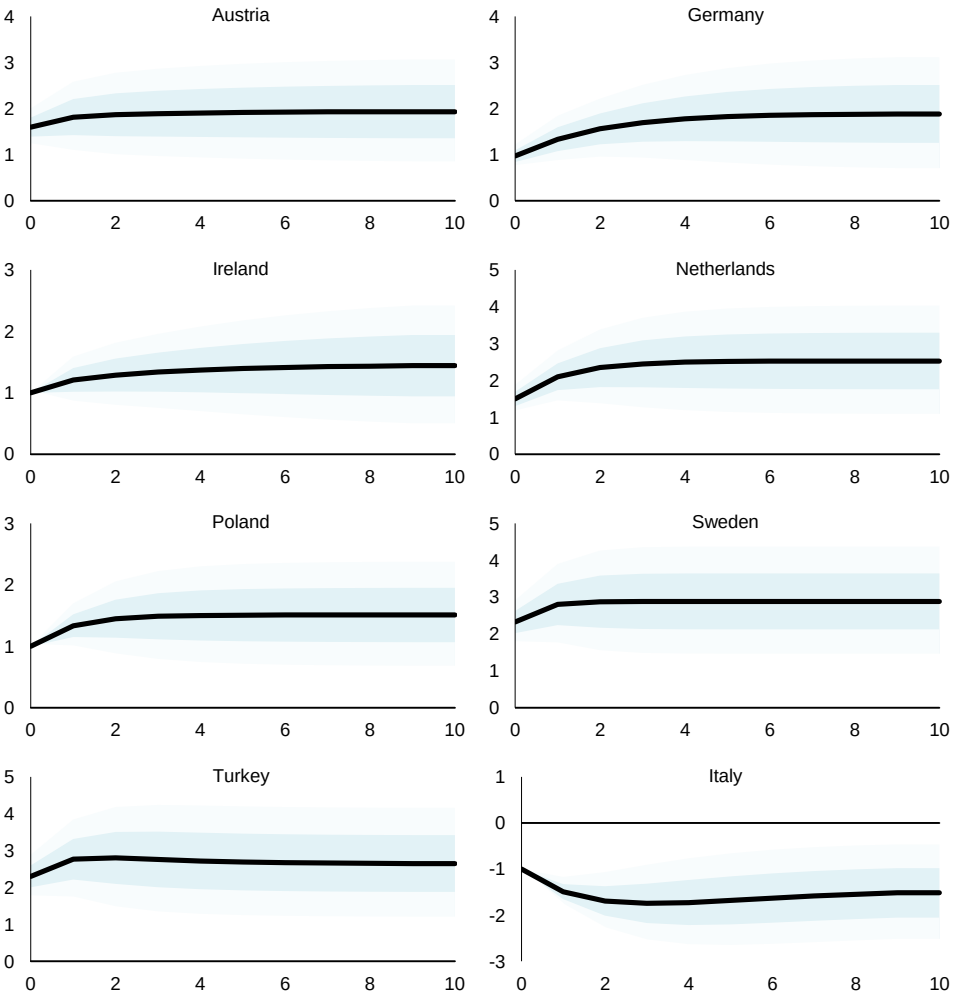
| Country | d21/d11 | low | high | inflation mean | Long-Run Relationship |
|---|---|---|---|---|---|
| Switzerland | -0,146 | -0,465 | 0,099 | 1,82 | - |
| Germany | 0,329 | 0,111 | 0,531 | 2,62 | positive |
| Malta | 0,01651 | -0,17 | 0,184 | 3,2 | - |
| Austria | 0,66511 | 0,546 | 0,854 | 3,35 | positive |
| Netherlands | 0,6651 | 0,489 | 0,816 | 3,61 | positive |
| Belgium | 0,478 | -0,137 | 1,092 | 3,67 | - |
| France | 0,296 | -0,098 | 0,69 | 4,41 | - |
| Sweden | 0,138 | 0,017 | 0,259 | 4,95 | positive |
| Denmark | -0,06 | -0,17 | 0,047 | 5,01 | - |
| Cyprus | -0,203 | -0,69 | 0,312 | 5,04 | - |
| Norway | 0,028 | -0,05 | 0,106 | 5,32 | - |
| Finland | 0,167 | -0,29 | 0,624 | 5,38 | - |
| United Kingdom | 0,267 | -0,062 | 0,597 | 5,74 | - |
| Czech Republic | 0,734 | -0,036 | 1,504 | 6,11 | - |
| Ireland | 0,43 | 0,277 | 0,583 | 6,27 | positive |
| Italy | -0,297 | -0,46 | -0,13 | 6,91 | negative |
| Spain | 0,115 | -0,39 | 0,61 | 7,26 | - |
| Portugal | 0,315 | -0,137 | 0,773 | 8,47 | - |
| Greece | 0,215 | -0,79 | 1,304 | 9,43 | - |
| Poland | 0,3165 | 0,216 | 0,454 | 12,21 | positive |
| Albania | 0,49 | -0,35 | 1,334 | 16,53 | - |
| Iceland | 0,517 | -0,06 | 1,095 | 17,36 | - |
| Latvia | 1,46 | -0,07 | 2,993 | 28,1 | - |
| Turkey | 1,375 | 0,565 | 2,184 | 35,11 | positive |
| Romania | 1,762 | -0,03 | 3,557 | 41,75 | - |
| Lithuania | -0,345 | -0,72 | 0,03 | 72,54 | - |

*Note: d21/d11 refers to equation (9) based on Fisher and Seater (1993) formulation. It represents the point estimates of the long-run relationship between inflation and output.*
*Source: World Development Indicators, own computation.*

To assure robustness of our analysis, we have also run our analyses on shorter time range excluding the crisis and post-crisis period after 2008. The results remained almost unchanged for the majority of our sample with one exception being Switzerland. The estimate for the period till 2011 showed quite opposite result, jumping from negative -0,166 to positive 0,107 with 90% confidence bounds still including zero. New results still conclude superneutrality but the short-run responses were different. To explain this, it should be taken into account that Switzerland is experiencing deflation since the second quarter of 2011. It shows that any further analyses should be corrected for such times using dummies as it might cause distorted estimates.

Since it is evident that the results are randomly distributed, we fail to conclusively proof the hypothesis that the positive long-run relationship between studied variables will exist for the initially low level inflation countries, as Ireland, Poland and Turkey violate this assumption. These countries cannot be described as low-level inflationary countries, so the relationship may be more dependent on country characteristics rather than inflation volatility. Next, we turn our attention to impulse response functions analysis of particular groups of countries.

**Figure 3 Impulse response functions of the first group of countries (shocks are considered to be 1% permanent increase in inflation level)**



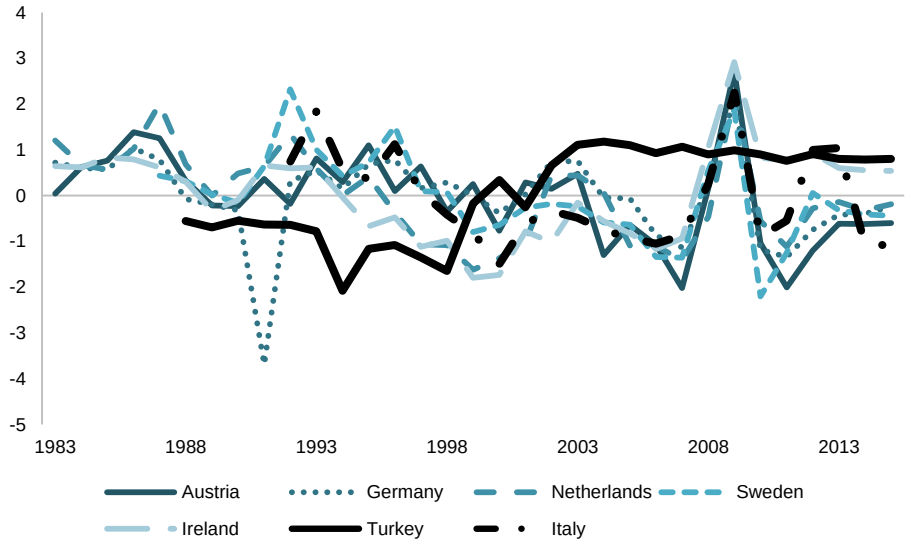

*Note: The solid line represents the point estimates; the areas around the line represent the 95% and 68% confidence bounds. Numbers on the horizontal axis denote years after the shock.*
*Source: own computation*

*Positive Output Response to Inflation Shock*

First, we consider countries with statistically significant output responses to permanent inflationary shock: Austria, Germany, Ireland, Netherlands, Poland, Sweden, Turkey and Italy (impulse response functions are displayed in Figure 3). It is obvious that for the majority of these countries, the unit inflation shock increases real output which permanently remains higher after the shock (except for Italy). This would suggest the non-superneutrality of money for these cases. The positive inflation-output response for

Austria, Germany, Ireland, Netherlands and Sweden can be interpreted as the long-run response to supply shock. In the AS-AD model framework, the long-run aggregate supply curve would shift rightwards causing the prices to fall and output to grow. Hence, in this case the supply shocks are the primary source of variations in output.

**Figure 4 Difference between real interest rate and GDP growth for the Group A countries (in %, normalized)**




*Source: own computation*

In the light of the recent global financial and European debt crisis, we can explain the positive effect of inflation on output through the long-run monetary policy channel and its connection to governments' debt management theory. The logic is simple: if the real interest rate is kept higher than GDP growth, then raising governments' debt will lower seigniorage. In this situation, any restrictive monetary policy action should force the government to lower its debt and leads to lower real interest rate at impact. The restrictave monetary policy is, therefore, transmitted into higher GDP outcome (for details please consult the model of Espinosa-Vega and Russel, 1998) and vice versa. High inflation as a result of inflationary shock will require the central bank to react and to increase interest rates or to cut down money supply which would then require governments to take actions as well. We plot the differences between real interest rates and GDP growth in Figure 4. The differences remain mostly positive and highly correlated in the case of Austria, Germany, Ireland, Netherlands and Sweden. This can be an argument in favor of the above described theory for this group of countries. Turkey might be a special case, as it went through a period of high GDP growth during the 1980s and 1990s due to high foreign investment activity, and we detect a strong correlation between GDP growth and inflation. Turkey then experienced its own local economic crisis

in 2001 and undertook structural reforms where the relationship between studied variables has changed.

There also exist some theoretical and empirical support for the view, studied by some cross-country regressions, that a permanent decrease in inflation will increase the long-run real output (see Barro, 1995 or Motley, 1998), however, we did not find any evidence supporting this theory.

*Negative Output Response to Inflation Shock*

Only one country in our sample has experienced negative inflation shock to output – Italy. The shape of impulse response function corresponds to this claim (see Figure 3). But judging from the differences between real interest rate and GDP growth in Figure 4, we would expect it to be the opposite. This is not the case, if we add yet another variable into question – the level of public debt and its management. Compared to previous results of Austria, Germany, Ireland Netherlands and Sweden, Italy exhibits a much higher level of public debt. Hence, overall inflation influence on real interest rate and output is a combination of distortive and positive effects. Whether positive or negative effects dominate seem to be dependent on long-term inflation level, public debt and its management, and country-specific factors, such as the relationship between wages and unemployment, general economic situation, etc. Mainly before 1999, the relationship between wages and unemployment were particularly strong and it was only after the euro adoption that this relationship began to weaken (see Riggi and Santoro, 2015 or Del Boca et al., 2010 for the analysis of the Italian Phillips curve).

*Neutral Output Response to Inflation Shock*

Most countries do not display the statistically significant long-run output response to a permanent inflation shock. For most, output growth was not responding to the inflation shock. This would suggest that the output and inflation are uncorrelated in the long-run. The impulse response functions for this group of countries results are available in the Appendix.

In most cases, the initial increase in output is fading out after some time, which could be viewed as an empirical support to the money illusion theory or to Sidrauski economic agents' behavior. This situation is observed by the majority in our sample while the only number of periods for the shock to disappear differs. There are a few countries that exhibit negative output response few years after the shock (Denmark, Greece and Lithuania), but again the shocks fades and the response, therefore, cannot be considered as permanent. It is interesting though that both Denmark and Greece are struggling with high public debts much like Italy. The level of public debt seems to be an important determinant of the long-run output-inflation relationship.

## Conclusions

In this paper, we consider long-run money superneutrality concept in modern times for 29 European economies in the neoclassical theoretical framework. The estimates are generated through structural VAR model using identifying restrictions motivated by the methodology combining Blanchard and Quah (1989) and Fisher and Seater (1993) ap-

proaches. The model allows the permanent effects of inflation shock on the output growth to be zero, positive or negative.

We have found that in 26 European countries a permanent shock to inflation occurred. For these countries, we have run a bivariate structural VAR model and found that six countries have experienced a permanent positive shock to output, while only one country has experienced negative shock. Hence, the Mundell-Tobin effect, that a permanent increase in inflation will increase the long-run real output, has some empirical support. However, for the rest of the analyzed countries, the results are not conclusive since confidence bounds of impulse response functions include zero which is taken as an evidence of money superneutrality.

Opposite to findings of Bullard and Keating (1995), we have failed to conclusively proof the hypothesis that positive long-run relationship between studied variables will exist for the initially low level inflation countries. It seems that inflation influence on real interest rate and output is a combination of distortive and positive effects. Whether positive or negative effects dominate seem to be dependent on country-specific factors. Our results also contradict the findings of Rapach (1998) which rejects the superneutrality of money for all 14 industrialized countries in the sample. This also confirms the general notion that inflation volatility has decreased rapidly in the industrialized countries in the last ten years.

While focusing exclusively on the endogenous growth theories, particularly on the Mundell-Tobin effect, we find the evidence supporting superneutrality of money for the majority of countries in our sample. This shows that the inflation and output might be unrelated in the long run and that todays' economy could be better described by the Sidrauski monetary model.

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## Appendix 1 - Output responses to permanent inflation shock