Mise en évidence d’effets de seuil dans la transmission de la politique monétaire sur l’activité réelle

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The existence of threshold effects in the transmission of monetary policy on real activity

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Abstract :

This paper deepens the relationship between real interest rate changes and output. Based on Shen (2000), we outline that there exists an inflation threshold effect mechanism in the monetary policy transmission. More precisely, we show that the sign and the magnitude of the real interest rate multiplier may depend on the current inflation regime. We use Hansen (1996) method to estimate this inflation threshold mechanism. Generally speaking, empirical results for France and Italy suggest that inflation thresholds sometimes are statistically significant and support monetary policy asymmetries found by Cover (1992). Lastly, the knowledge of these threshold values may be crucial for monetary policy implementation in Economic Monetary Union.

JEL classification : C15, C22, E51, E52

Keywords : nuisance parameter, inflation threshold effect, monetary policy, real interest rate shocks.
1 Introduction

The aim of this paper is to deepen the relationship between a monetary policy shock and real economic activity. Both theoretical and empirical works that have focused on this point insist on the fact that interest rate and/or credit supply variations may have short run real effects. Nevertheless, many researchers claim that interest rate is the key variable in the transmission of monetary policy. Indeed, in situations where monetary aggregates are unstable, Bernanke and Blinder (1992), Friedman and Kuttner (1992) show that interest rate plays a crucial role by indicating the monetary policy direction. Besides, Taylor (1993, 1998) considers that the transmission of a monetary shock on real output via interest rate variations is the main component of monetary policy.

In this work and following Romer (2000), we focus on real interest rate rather than nominal interest rate shocks as proxy for monetary policy stance. According to Romer, once we consider an horizon beyond the very short run, a real interest rate rule is more realistic than a nominal rate rule. Indeed, central banks when setting their nominal rate target, always take into account expected inflation. This behaviour leads effectively to decide how to set real interest rate.

The monetary policy conventional impact on real economic activity is the crowding out effect. Each increase in real interest rate depresses output. Few economists tried to know whether monetary policy ends up always with this conventional impact. Empirical studies such as Shen (2000) show that a rise in interest rate can in some cases stimulates economic activity. This result contradicts standard macro-economic analysis and suggests that sometimes monetary policy may have non conventional effects on economic activity. In this context it seems relevant to re-examine the link between monetary policy shock and output. Recent analyses insist on the fact that both negative and positive correlation between an increase in real interest rate and output can occur.

The net effect of real interest rate variations on output remains thus ambiguous. This belief leads us to consider that the monetary shock-activity relationship can depend on the level of another macro-economic variable. In this work, we consider that the current inflation regime (high or low inflation regime) is a variable that conditions the resulting impact of a real interest rate shock on output. Put differently, the sign and the magnitude of the real interest rate multiplier differ according
to the prevailing inflation regime in the economy. This mechanism is called an inflation threshold effect in the transmission of monetary policy. Our empirical work deals with French and Italian data on the last twenty years. To detect an inflation threshold at the origin of a significant shift in real interest rate multiplier, we use Hansen (1996) methodology. This last method enables us to pick up in an endogenous way the inflation threshold levels.

Consequently, this paper deepens the monetary policy transmission in the light of an inflation threshold. In the following section, we propose a theoretical explanation for the occurrence of an inflation threshold effect mechanism. We then introduce our empirical strategy. Econometric results are presented in a last section.

2 Real impact of monetary policy in the presence of an inflation threshold

A recent survey of economic literature leads us to consider that the impact of a monetary shock on real activity can strongly depend on the current inflation regime. Say differently, according to the inflation rate regime that prevails today in the economy (high inflation regime or low inflation regime) a real interest rate shock may have different effects on economic activity. Basically, a rise in real interest rate has a traditional recessive effect on activity. We shall show that this same monetary policy shock can also have either no significant effect or stimulates output.

In what follows, we refer to Shen (2000), Ball and Mankiw (1994) models to explain the occurrence of an inflation threshold in monetary policy transmission. These models are based on a “L-shaped” aggregate supply curve. Since the time horizon of the analysis is short-run, we assume that the bended aggregate supply curve does not move after a monetary policy shock. Thus, a real interest rate shock triggers a shift in aggregate demand and the resulting effect on activity depends on the “L-shaped” aggregate supply curve slope. To illustrate the inflation threshold mechanism we use Shen’s scheme that draws up the output responses after an aggregate demand shock according to the level of inflation rate.

(Insert figure 1)
Inflation expectations of the private sector are assumed to differ in each inflation rate regime (low inflation, high inflation and hyper-inflation regimes). In the low inflation regime ($\Pi < \Pi_1$), workers under anticipate inflation. In the high inflation regime ($\Pi_1 < \Pi < \Pi_2$), private sector anticipates correctly the price variations. And finally, in the hyper-inflation regime ($\Pi > \Pi_2$) people over anticipate inflation. These assumptions are crucial to explain the differences in monetary policy impacts within each regime.

During low inflation regime, a decrease in real interest rate shifts to the right the aggregate demand curve ($AD \rightarrow AD_0$). This entails a rise in nominal wages and prices. Workers perceive the increase in nominal wages as an increase in their real wages and thus supply more labour (the substitution effect dominates) and real output rises. On the contrary, a rise in real interest rate crowds out output. As shown by the figure, the aggregate supply curve is positively sloped in this regime and the real interest multiplier is negative.

In the high inflation rate regime and with output close to its natural rate, an expansionary monetary policy as usual shifts up aggregate demand ($AD_1 \rightarrow AD_2$) provoking increases in nominal wages and prices. However in this context, private employees do not make expectations errors and consider that real wages have not changed. Both labour supply and output remain at the same level. The monetary impulse results only in price increases.

The difference in the value of real interest rate multipliers in the two regimes analysed above comes from the fact that we implicitly assume here that the aggregate supply curve is “L-shaped”. The presence of such a curve is justified by considering that prices are sticky downward and flexible upward. Ball and Mankiw (1994) assuming small menu cost and a positive trend inflation end up to this result. Firms’ price setting behaviour are responsible for this price asymmetry. Thus in their analysis, with high inflation, a rise in aggregate demand is likely to induce larger price adjustments because this positive shock creates a large gap between desired and actual prices. Consequently, it has a smaller absolute impact on output because prices adjust more quickly. By contrast, a fall in aggregate demand depresses output substantially. Indeed, in this case, firms need not pay the menu cost for having lower relative price because inflation does much of the work. Consequently, referring
to this model may help to explain the occurrence of an inflation threshold in low and high inflation regimes.

Let’s consider now the hyperinflation regime. We explicitly assume here that private sector over anticipates inflation. Indeed in this situation, inflation is already quite high and the announcement or the implementation of an expansionary monetary policy accelerates inflation expectations. Thus, employees consider that their real wages decrease and supply less labour. Aggregate supply moves up to the left \((\text{AS}_2 \rightarrow \text{AS}_3)\). Because of the lax monetary policy, aggregate demand increases \((\text{AD}_2 \rightarrow \text{AD}_3)\). However, the AD increase is less important in absolute value than the reduction of the supply. In this area, the monetary policy expansion leads to an output reduction. The real interest rate multiplier is positive. We call this mechanism, the “Shen effect”.

This scheme puts the stress on two things. First, real interest rate variation decided by a central bank can have different impacts on economic activity. Second, these different impacts strongly depend on the prevailing inflation rate regime. To sum up, in low inflation regime, we come up with the standard real interest rate crowding out effect. In high inflation regime, there’s no significant effect. In hyperinflation regime, the real interest rate multiplier becomes positive. We face here an inflation threshold effect mechanism in the transmission of monetary policy. This last mechanism is illustrated by the other scheme below.

(Insert figure 2)

This theoretical graph puts the stress on the fact that the real interest rate multiplier strongly depends on the prevailing interest rate regime. We explicitly assume here that when inflation is below the first threshold \((\Pi < \Pi_1)\), the crowding out effect dominates. When current inflation is between the two thresholds \((\Pi_1 < \Pi < \Pi_2)\), monetary policy has no significant impact on output. And finally, in hyperinflation regime \((\Pi > \Pi_2)\), the “Shen effect” prevails, the real interest rate multiplier becomes positive.

Knowing this, it seems relevant now in an empirical perspective to test whether or not the inflation threshold effects are significant. In our empirical work, because of technical tractability, we test the existence of only one threshold. Put differently, we determine only two inflation regimes.
Nevertheless, according first to the level of inflation thresholds estimated and second to the
significance and the signs of real interest rate multipliers in each regime, we will be able to deduce the
inflation regimes detected by the econometric model.

The countries under investigation are France and Italy. These two democracies belong to
Economic Monetary Union (EMU) but they have encountered during the last twenty years various
inflation rate regimes. Thus, the comparison of the estimated thresholds in these countries seems
appealing.

In the third section, we first introduce more formally the concept of threshold effect. By the
way, we introduce our empirical strategy.

3 Empirical strategy

When we speak about threshold effects, we explicitly assume that the value of the monetary
policy multiplier is conditioned by the level of other macro-economic variables. Put differently, these
variables present a threshold level below and above which the real interest multiplier differs
substantially. To define this concept more formally, we introduce first the following relationship
which describes the setting of variable Y.

\[ Y_t = f ( Y_{t-1}, \ldots, Y_{t-p}, \text{shock}_t, X_{t-1}, \ldots, X_{t-s}) \quad t = 1, \ldots, T \] (1)

\( Y_t \) means the value of Y at time t. In this work, Y stands for real output. \( X_t \) is a sample of
exogenous variables and the positive parameters p and s define the dynamic of linear equation (1).
\text{shock}_t \) is a proxy variable for the real interest shock at time t. The shock definition will be specified in
the following sections. Using this relationship, it is now possible to illustrate the monetary policy
threshold effect mechanism allowing the multiplier (that is to say, the partial derivative \( \frac{\partial Y_t}{\partial \text{shock}_t} \)) to
depend on the level of inflation rate:
The system (2) indicates that the effect of monetary shock on economic activity represented by the multipliers $m_1$ and $m_2$ depends on the level ($\bar{Z}$) of another variable $Z$ at time $t-d$. $Z$ is called a threshold variable and, in that precise case, is a proxy for the inflation regime. Depending on the country under investigation, $Z$ can belong or not belong to the set of exogenous variables $X_t$.

Generally speaking, the detection of a threshold mechanism in the relationship between monetary policy and economic activity raises many difficulties. Indeed, we have to carry on statistic tests in which the interest parameter is observable only in the alternative hypothesis. We face actually the nuisance parameter problem. Our empirical strategy is decomposed in three main steps.

3.1 First step : estimation of the "initial regression"

First we estimate using OLS, the linear regression below:

$$Y_t = \alpha_0 + \alpha_1 \text{shock}_t + \sum_{i=1}^{p} \alpha_{2i} Y_{t-i} + \sum_{j=1}^{k} \sum_{i=0}^{s} \alpha_{3ij} X_{t-i} + U_t \quad t = 1, \ldots, T \quad (3)$$

Where $X_t = (X_{1t}, \ldots, X_{kt})$ is a vector of exogenous; $\text{shock}_t$ and $Y_t$ are representative variables respectively for monetary policy and real output; $U_t$ is the usual random error term. Equation (3) is called an "initial regression". Lags ($p$, $s$) as well as the number of exogenous variables are selected starting from a general specification allowing four lags for all variables and using a backward recursive method. Besides, to check the right specification we apply usual diagnostic tests (non-autocorrelation, homoscedasticity and structural stability of parameters). We carry on hypothesis tests to detect the presence of a threshold effect on this specific regression.
3.2 Second step: threshold detection

We try to identify the occurrence of an inflation threshold effect using Hansen (1996). It leads to test whether there exists a threshold level \( \bar{\sigma} \) for the threshold variable \( (Z_{t-d}) \) above which the real interest rate shock has a significant impact on real GDP. Let’s consider the model below.

\[
Y_t = \alpha_0 + \alpha_1 \text{shock}^t + \alpha_2 S (Z_{t-d} \geq \bar{\sigma}) r^t + \sum_{i=1}^{p} \alpha_{i} Y_{t-i} + \sum_{j=0}^{k} \sum_{i=0}^{l} \alpha_{ij} X_{j,t-i} + U_t
\]

\[t = 1, \ldots, T\] (4)

Equation (4) contains the same variables as the initial regression (3) at the exception of \( S (Z_{t-d} \geq \bar{\sigma}) \). This last is a dummy variable that takes value 1 when the threshold variable \( (Z_{t-d}) \) is above \( \bar{\sigma} \) and value 0 otherwise. The introduction of this dummy variable enables us to truncate the monetary shock series \( \text{shock}^t \) and to compare multipliers when the threshold variable is above its threshold level \( \bar{\sigma} \) (parameter \( \alpha_2 \)) and when we take all the observations of the monetary shock series into account (parameter \( \alpha_1 \)). More specifically, we will be able to assess the real interest rate impact on output in different inflation contexts. Thus, we have to carry on the following test:

\[
\begin{align*}
H_0 & : \alpha_2 = 0 \\
H_1 & : \alpha_2 \neq 0
\end{align*}
\]

This test is non-standard because under \( H_0 \), the threshold \( \bar{\sigma} \) at the origin of the additive non-linearity is not identified and it is impossible to use a standard test procedure. \( \bar{\sigma} \) is a nuisance parameter. If the threshold value is set in a purely exogenous way, that is to say independently of the sample observation, the test procedure becomes standard. With the help of a dummy variable, observations of monetary shocks for which \( Z_{t-d} \geq \bar{\sigma} \) are introduced as an additional explanatory variable and the parameter significance associated to this truncated variable is tested with a traditional Student, Lagrange multiplier or Wald statistic. In this way of proceeding, economic theory is a guide to set the threshold value.
McCallum (1991) proposes to select the threshold level that maximises the likelihood function. However, Galbraith (1996) using a Monte Carlo simulation shows that this approach often leads to a high size for the test. In his work, the simulated Student statistic distribution is very different from the conventional nominal one.

Hansen procedure consists in setting $\bar{s}$ at a level that maximises the Wald statistic associated to parameter $\alpha_2$ in model (4). Consequently we carry on, using OLS, regression (4) for each level of the threshold variable in the interval $I = [Q_{10%}(Z_{t-d}), Q_{90%}(Z_{t-d})]$ where $Q_{10%}$ et $Q_{90%}$ stand for 10% and 90% quartiles of $Z_{t-d}$. $H_0$ is tested using the Wald maximal statistic. This last is called "Supwald":

$$\text{Supwald} = \sup_{s} (\text{Wald}(\bar{s}))$$

This test statistic does not follow a standard asymptotic distribution and in fact can not be compared to a $\chi^2(1)$. Theorem 1 in Hansen (1996) gives the true asymptotic distribution for this statistic. This author then proposes a simulation based on the drawing of gaussian samples to approximate corresponding p-values. Appendix 1 gives the details of Hansen simulation.

When the random drawing is sufficiently high, this test has a good power. By another way it is possible to use this procedure to approximate p-values corresponding to the maximal Lagrange multiplier statistic. In this paper we report only Wald statistics.

For each threshold variable, we choose a sufficiently small segment to divide interval $I = [Q_{10%}(Z_{t-d}), Q_{90%}(Z_{t-d})]$ in at least 500 equal parts. We test therefore additive non linearity on more than 500 thresholds levels. Only specifications for threshold variables that lead to reject $H_0$ are presented in tables 1, 2, 3 and 4. An important thing to note is that both maximal Lagrange multiplier and Wald statistics select exactly the same threshold level. When proceeding to the simulation, we draw 200 gaussian samples to approximate the p-values. Finally, we compute 90% confidence intervals for the estimated threshold value ($\bar{s}$). One more time, the estimator $\bar{s}$ does not follow a standard asymptotic distribution. However, critical values are simulated and available in Hansen (2000).
3.3 Third step: the "ex-post regression"

When $H_0$ is rejected and when the threshold level is identified, it is now possible to assess both
the sign and the value of the impact multiplier in each regime ($Z_{t-d} \geq \overline{Z}$ and $Z_{t-d} < \overline{Z}$) executing the
following OLS regression.

$$Y_t = \alpha_0 + \alpha_1 S(Z_{t-d} \geq \overline{Z}) \text{shock}^I + \alpha_2 [1 - S(Z_{t-d} \geq \overline{Z})] \text{shock}^I + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{j=1}^{k} \sum_{i=0}^{s} \alpha_{3ij} X_{j,t-i} + U_t \quad t = 1,\ldots,T \quad (5)$$

The dummy variable $S(Z_{t-d} \geq \overline{Z})$ is set now in a purely exogenous way (that is to say, in
accordance to the estimated $\overline{Z}$) and can truncate adequately the monetary shock series. This way of
proceeding allows to estimate and assess monetary impacts on economic activity in the two regimes
delimited by the threshold variable $Z_{t-d}$. Since the threshold variable in this exercise is a proxy for
inflation rate regimes, these selected regimes will signify alternatively low inflation, high inflation or
hyperinflation regimes.

4 Econometric results

We have collected gross domestic product, government consumption, implicit price deflator
and nominal interest rate series for France and Italy. These quarterly time series run from 1980:1 to
1998:4. They come from OECD, IMF and INSEE databases. GDP and government consumption
observations are collected in constant prices. Moreover, real interest rate is computed by removing
annual inflation rate from the nominal interest rate. Series then are one order differentiated to get
stationarity. Indeed, this condition is required to implement Hansen tests.

To detect an inflation threshold effect mechanism we have considered two different
specifications for the real interest rate shock:
1/ First specification: \[ r_t = \frac{1}{4} (r_{t-1} + r_{t-2} + r_{t-3} + r_{t-4}) \]

This monetary shock corresponds to the gap in level between the contemporaneous real interest rate and its one period lagged annual moving average.

2/ Second specification: \[ \Delta r_t = \frac{1}{4} (\Delta r_{t-1} + \Delta r_{t-2} + \Delta r_{t-3} + \Delta r_{t-4}) \]

Similarly, it is the same specification except that all variables are in variations.

Since we have explicitly introduced a difference between the current series and its lagged average, we think that these two monetary shocks definitions are proxy variables for an unexpected monetary policy shock. Besides, we have introduced the inflation rate as exogenous variable in each initial regression. This enables us to capture the supply side of the model and to prevent any aggregate supply curve shifts.

We first focus on monetary shock in level. Results are reported in tables 1 and 2.

(Insert tables 1 and 2)

In spite of the presence of four-order serially correlated residuals in Italy at a 10 \% significance level, the diagnostic tests for non-autocorrelation (Godfrey’s test), homoscedasticity (Breusch-Pagan’s test), structural and predictive failure (Chow’s tests) reveal that initial regressions in both cases are correctly specified.

By another way, we note that the estimated parameters associated to the monetary shocks are statistically significant and negative. This indicates that the eviction or crowding out effect dominates when taking into account all the series.

Based on these initial linear regressions, we then apply Hansen tests to detect the existence of an inflation threshold effect. Results are presented in table 2.

The second line returns the inflation threshold variable specification used in the test. It is defined in variations as the gap between the current inflation rate and the last two quarters moving averages. This threshold variable describes an accelerating inflation regime. The sup-Wald statistic and the estimated threshold level are reported in the following lines. Both simulated p-values associated to the threshold (\( \bar{\lambda} \)) indicate that we can reject the linearity hypothesis at 5 \% significance.
level \((p = 0.025)\) for France and 11% significance level for Italy. The monetary shock series are then truncated according to the estimated threshold level \((\bar{s})\). In both countries, the real interest rate multipliers estimated for each regime and their corresponding t-stat are given in the last two lines of table 2.

Econometric results show clearly the crowding effect mentioned in the theoretical part. Indeed we can notice for both countries that the interest rate multiplier is statistically negative when the threshold variable \(Z_{t-d}\) is below the estimated threshold level \((\bar{s})\). In other words, an increase of the interest rate in this regime has a recessive effect in both countries. On the other hand, when \(Z_{t-d}\) is above \(\bar{s}\), the interest rate multiplier becomes statistically insignificant. This suggests that neo-classical effect dominates in this regime.

These results seem quite appealing because they show that the threshold effect mechanism does exist and works in a similar way in both countries. Besides, we note that the threshold variable specification is exactly the same \((\Delta \Pi_t - (\Delta \Pi_{t-3} + \Delta \Pi_{t-4})/2)\). This fact enables us to compare directly the estimated thresholds \((\bar{s})\). In this perspective, the threshold levels are \(-0.8896\) and \(0.0068\) for France and Italy respectively. This indicates that when inflation rate accelerates, crowding out effect disappears more rapidly in France.

Lastly, when the inflation threshold variable is below \(\bar{s}\), the crowding out effect is more pronounced in Italy than in France.

We now focus on monetary shock in variations. Results are reported in tables 3 and 4.

(Insert tables 3 and 4)

Despite the presence of heteroscedasticity in Italy, the other diagnostic tests indicate that initial regressions in both cases are well specified.

By another way, we note that the estimated parameters associated to the monetary shocks are not statistically significant. This can be explained by the existence of two opposite effects (eviction effect and Shen effect for example) which tend statistically to offset themselves.

Based on these initial linear regressions, we then apply Hansen tests to detect the existence of an inflation threshold effect. Results are presented in table 4.
The second line returns the inflation threshold variable specification used in the test. It is defined in variations in both cases. Nonetheless there is a little difference between the definitions used in France and Italy. Indeed, in case of France it is an annual lagged moving average of the inflation rate in variations whereas it is the difference between the current and four lagged inflation rates in variation in Italy. These threshold variables describe one more time an accelerating inflation situation. According to the simulated p-values, we can reject the model’s linearity only in France. In spite of the high p-value for Italy, we have computed the real interest rate multipliers in each regime.

Econometric results show clearly for France the main two effects mentioned before: the crowding effect \( \frac{\Delta Y_t}{\Delta r_t} < 0 \) and the Shen effect \( \frac{\Delta Y_t}{\Delta r_t} > 0 \). Indeed we can notice that the interest rate multiplier is statistically negative when the threshold variable \( Z_{t-d} \) is below the estimated threshold level \( \bar{\tau} \) and positive when \( Z_{t-d} \) is above \( \bar{\tau} \). This last result means that an increase of the interest rate in this regime pushes up the output instead of lowering it. For Italy, the results seem less clear. The multiplier is insignificant below the estimated threshold level and it appears also positive when the multiplier is above \( \bar{\tau} \). Nevertheless this result in Italy has to be interpreted with cautious according to the high p-value obtained for \( \bar{\tau} \). One more time, even if the comparison between the threshold variable definitions is not straightforward, we can say that the Shen’s effect emerges later in France and it is less pronounced. Put differently, real interest rate multiplier becomes positive in France when inflation quickens. The rate of acceleration is above Italian one.

As an illustration of our econometric results, we draw up two schemes representing the real interest rate multipliers with respect to the inflation regime in France and in Italy. However, since the high p-value obtained for Italy does not allow us to reject the model’s linearity with the second specification, we have not represented the estimated multipliers in the respective scheme (figure 3 part two).

(Insert figure 3)

It seems interesting to rely these two schemes above first to the evolution of inflation rate in France and Italy and the theory introduced in section 2. Indeed, according to the figure 4, Italian inflation rate is all the time above French one. This suggests that Italian authorities care less about
inflation than in France. Thus Italian private sector may under expect inflation more often. In this country monetary policy may have a keynesian effect in most cases. This can explain the fact that we end up with a higher estimated threshold level in Italy (figure 3 first part above).

(Insert figure 4)

In the same way, it is not surprising to detect a Shen effect with the second shock specification in France. It is reasonable to say that French monetary authorities during the last twenty years have cared more about inflation. Thus, as soon as inflation rate acceleration exceeds a certain threshold French private sector may in that precise case over anticipate inflation. This behaviour leads to a positive interest rate multiplier as explained by the theory mentioned in section 2 (Shen effect).

By another way, as far as the first monetary shock specification is concerned (real interest rate in levels), we have detected periods for which the inflation threshold variable is above 0.0068 in Italy and below -0.8896 in France.

For the Italian case, “accelerating regimes” correspond to the following dates : 1981:2-1982:1, 1982:4-1983:2, 1985, 1987, 1989:2-1990:2, 1993, 1995, 1997. When relying to the chart 4, we can notice that the periods mentioned above square actually to successive and pronounced increases in inflation rate levels. According to our estimations, monetary policy does not have a real impact on output in that precise periods. In other words, people anticipate perfectly the evolution of nominal wages and prices at that periods of times.

This remark puts the stress on the fact that the information on the levels of inflation rates does not seem quite relevant when assessing real monetary shocks impacts on output. Effectively, even in high inflation periods (the decade 80), the real interest rate multiplier is alternatively negative and non significant. According to the theory mentioned on the second section, only the neo classical effect should prevail in high inflation regimes. Thus, the information concerning the inflation’s acceleration seems on the contrary much more relevant. Indeed, monetary policy has no real impact on economic activity during important accelerating inflation times. In that precise periods, people care more about
prices variations and the real value of their wages. Thus, after an expansionary monetary shock, people may expect perfectly the prices evolution leading to insignificant monetary policy impact.

Similarly in France, the graphical inspection of the inflation threshold variable enables us to detect periods of times for which the threshold variable is below \(-0.8896\): 1984, 1986:3-1987:1, 1990:2-1992:2, 1994. On these precise periods, the crowding out effect prevails. Say differently, people under expect systematically inflation. In spite of the regular decrease of inflation rate largely due to a competitive deflation policy, economic agents have not always exactly anticipated inflation. Effectively, the crowding out effect emerges only when there exists successive and substantial decreases in inflation rates. One more time and symmetrically, it is the inflation deceleration that constitutes the key information in the setting of individuals expectations.

Besides, we can rely these econometric results to monetary policy asymmetric effects estimated by Cover(1992) and justified theoretically by Ball and Mankiw (1994). Indeed, Cover shows that a restrictive monetary policy has more pronounced real impacts in absolute value than an expansionary monetary policy. As far as our work is concerned, we first note that in Italy, accelerating inflation regimes \((\Delta \Pi_t - (\Delta \Pi_{t-3} + \Delta \Pi_{t-4})/2 > 0.0068)\) are characterised in a large majority by negative real interest rate shocks (expansionary monetary policy). In this regime, our results indicate that monetary policy has no significant effect on output.

Secondly, identified regimes in France for which the crowding out effect dominates \((\Delta \Pi_t - (\Delta \Pi_{t-3} + \Delta \Pi_{t-4})/2 < -0.8896)\) correspond largely to positive real interest rate shocks (restrictive monetary policy). Thus, our results seem also to demonstrate that a restrictive monetary shock has a real recessive impact on output, whereas an expansionary one does not have any significant effect on activity. These observations corroborate Cover’s conclusions on the monetary policy asymmetric effect.

Lastly, let’s see what can happen now in the case of single monetary policy. We assume that this threshold effect mechanism remains the same in Economic Monetary Union (EMU). Knowing this, we can show that a change in interest rate decided by the European Central Bank may lead to substantial different effects in France and Italy. Effectively, in the case of the shock specification in
level, the two estimated thresholds (-0.8896 = \( \Pi_F \) for France and 0.0068 = \( \Pi_I \) for Italy) enable us to distinguish three inflation regimes.

As long as the inflation regime is below \( \Pi_F \) in both countries, the monetary policy multiplier sign is similar. Crowding out effect prevails. On the contrary, if the inflation regime is located between \( \Pi_F \) and \( \Pi_I \), monetary policy has no more effect in France and has still an eviction effect in Italy. This case is appealing because it stresses the fact that single monetary policy can have asymmetric real effects within EMU members. Thus the knowledge of this threshold seems crucial for the implementation of the European monetary policy. Finally, when inflation regime exceeds \( \Pi_I \) in both countries, monetary policy has no more real effect everywhere.

5 Conclusion

The aim of this paper was to revisit the monetary transmission mechanism. In this perspective we have put the stress on inflation threshold effect. To detect such an inflation threshold at the origin of a significance change in real interest multiplier we have applied Hansen (1996) tests.

Results show that inflation threshold effects mechanism in some cases does exist in France and Italy on the last two decades. Estimated real interest rate multipliers in each regime enables us to retrieve the three theoretical monetary policy effects: keynesian effect \( \frac{\partial Y_t}{\partial r_t} < 0 \), neo-classical effect \( \frac{\partial Y_t}{\partial r_t} = 0 \) and Shen’s effect \( \frac{\partial Y_t}{\partial r_t} > 0 \).

We note then that the information on the past and current state of accelerating inflation regimes is crucial when assessing the monetary policy effects on output. Thus, the individuals expectations setting strongly depend on the past and current inflation acceleration regimes. Besides, our econometric results corroborate Cover’s finding that only restrictive monetary shocks have negative real impact on output.
Lastly, according to the inflation regime in which French and Italian economies are located, a single monetary policy can have asymmetric real impacts. In this prospect, knowing these threshold levels may be a key information for ECB to conduct single monetary policy.

To pursue this work, it would be interesting to introduce in the econometric model two different threshold variables. For example let’s consider the following series as potential candidates for threshold variables: interest and inflation rates. Testing the presence of thresholds in that case and using these two threshold variables sequentially, would allow us to analyse monetary policy impacts for example in regime of both high inflation and interest rates. Here when combining the two threshold variables, four different zones rather than only two regimes can emerge.

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Consider the model (4) in the text:

\[ Y_t = \alpha_0 + \alpha_1 \text{shock}_t + \alpha_2 S( Z_{t-d} \geq \bar{\tau} ) \text{shock}_t + \sum_{i=1}^{p} \alpha_{i1} Y_{t-i} + \sum_{j=1}^{k} \sum_{i=0}^{s} \alpha_{3ij} X_{j,t-i} + U_t \quad t = 1, \ldots, T \]

\[ Y_t, \text{shock}_t \] and \( X_t = (X_{1t}, \ldots, X_{kt}) \) respectively stand for real output, the monetary shock and a sample of exogenous variables. \( S( Z_{t-d} \geq \bar{\tau} ) \) is a dummy variable that takes the value 1 when the threshold variable \( Z_{t-d} \) is above \( \bar{\tau} \) and 0 otherwise. We have to carry on the following test:

\[
\begin{align*}
H_0 : \alpha_2 &= 0 \\
H_1 : \alpha_2 &\neq 0
\end{align*}
\]

This test is non-standard because under \( H_0 \), the nuisance parameter \( \bar{\tau} \) is not identified. Hansen proposes to test this hypothesis by selecting \( \bar{\tau} \) in the interval \( I = [Q_{10}\%(Z(t-d)), Q_{90}\%(Z(t-d))] \) that maximises the Wald statistic. We call "Supwald" this precise statistic.

\[
\text{Supwald} = \max_{\bar{\tau}} \text{Wald}(\bar{\tau})
\]

This statistic does not follow a standard asymptotic distribution. The exact distribution is given by theorem 1 in Hansen (1996). To approximate p-values associated with "Supwald", Hansen computes the following simulation.

We first generate \( J \) random samples of size \( T \) composed by normal variables. Thus for \( j = 1, \ldots, J \) we have the random samples \{\( V_{ij}, \ldots, V_{Tj} \)\}~N(0,1)

We compute then the following quantity:

\[
S_j^j(\bar{\tau}) = \frac{1}{\sqrt{T}} \sum_{i=1}^{T} \hat{S}_i(\bar{\tau}) * V_{ij} \quad j = 1, \ldots, J
\]
Where \( s_t(\bar{s}) = X_t(s)\hat{u}(\bar{s}) \). \( X_t(\bar{s}) \) and \( \hat{u}(\bar{s}) \) stand for the exogenous variables and residuals vector in model (4) under \( H_1 \) (unconstrained model). We can note that these two elements depend on the threshold value \( \bar{s} \); \( \bar{s} \) belongs to interval \( I \). \( s_t(\bar{s}) \) is the regression score.

In a third step we compute the Wald statistic ratio. It comes :

\[
T_T^j(\bar{s}) = S_T^j(\bar{s})' M_T(\bar{s},\bar{s})^{-1} R (R' V_T^* R)^{-1} R' M_T(\bar{s},\bar{s})^{-1} S_T^j(\bar{s}) \quad j = 1,\ldots,J
\]

with \( M_T(\bar{s},\bar{s}) = \frac{1}{T} \sum_{t=1}^{T} X_t(\bar{s}) X_t(\bar{s})' \)

and \( V_T^* = M_T(\bar{s},\bar{s})^{-1} \left( \frac{1}{T} \sum_{t=1}^{T} \hat{s}_t(\bar{s})' \hat{s}_t(\bar{s}) \right) M_T(\bar{s},\bar{s})^{-1} \).

\( V_T^* \) is a consistent estimator for variance-covariance matrix corrected to take into account heteroscedasticity and \( R \) stands for the constraints matrix.

We assess finally the maximal Wald statistic for each simulated samples : \( g_T^j \).

\[
g_T^j = \text{SUP} \quad T_T^j(\bar{s}) \quad j = 1,\ldots,J
\]

\( \bar{s} \in I \)

\( g_T^j \) represents the maximal Wald statistic we get in the \( j \)-th simulated sample. Now, the estimated p-value corresponds to the percentage maximal Wald statistics that exceed our Supwald.

\[
\hat{p} = \frac{1}{J} \sum_{j=1}^{J} \{ g_T^j \geq \text{sup wald} \}
\]

When \( J \) is sufficiently high, this test is quite powerful. It is possible also to use this simulation to approximate p-values for the maximal Lagrange Multiplier statistic.
References


Hansen B.E., 1996. Inference when a nuisance parameter is not identified under the null hypothesis, Econometrica, vol. 64 (2), 413-430.


Shen effect: $\frac{\partial Y}{\partial r} > 0$

Neoclassical effect: $\frac{\partial Y}{\partial r} = 0$

Keynesian effect: $\frac{\partial Y}{\partial r} < 0$

Figure 1: “L-shaped” aggregate supply curve
Figure 2: real interest rate multiplier and inflation regimes
Table 1: Initial regressions according to definition of the interest rate shock

\[ \text{Shock} = r_t - \frac{1}{4} (r_{t-1} + r_{t-2} + r_{t-3} + r_{t-4}). \]

Endogenous variable = \( \Delta Y_t \)

Results written in brackets are the t-statistics for estimated parameters and the p-values for realised tests.

<table>
<thead>
<tr>
<th></th>
<th>FRANCE</th>
<th>ITALY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shock(_t)</td>
<td>-0.0012</td>
<td>-0.0904</td>
</tr>
<tr>
<td></td>
<td>(-1.95)</td>
<td>(-2.21)</td>
</tr>
<tr>
<td>( \Delta Y_{t-1} )</td>
<td>0.2949</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.69)</td>
<td></td>
</tr>
<tr>
<td>( \Delta Y_{t-2} )</td>
<td>0.3173</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.87)</td>
<td></td>
</tr>
<tr>
<td>( \Delta Y_{t-4} )</td>
<td></td>
<td>0.2598</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.72)</td>
</tr>
<tr>
<td>( \Delta G_t )</td>
<td>0.1694</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.27)</td>
<td></td>
</tr>
<tr>
<td>( \Delta G_{t-3} )</td>
<td></td>
<td>0.4821</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.14)</td>
</tr>
<tr>
<td>( \Delta \Pi_t )</td>
<td>-0.0054</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-3.66)</td>
<td></td>
</tr>
<tr>
<td>( \Delta \Pi_{t-3} )</td>
<td></td>
<td>-0.3427</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-3.60)</td>
</tr>
<tr>
<td>R(^2)</td>
<td>0.047</td>
<td>0.082</td>
</tr>
<tr>
<td>SSR</td>
<td>0.0018</td>
<td>0.0026</td>
</tr>
<tr>
<td>( \delta^2 )</td>
<td>0.0057</td>
<td>0.0061</td>
</tr>
</tbody>
</table>

Non autocorrelation (Godfrey)
\[ \chi^2(4) = 2.2212 \text{ (0.69)} \quad \chi^2(4) = 8.1200 \text{ (0.08)} \]

Homoscedasticity (Breusch-Pagan)
\[ \chi^2(10) = 15.0640 \text{ (0.12)} \quad \chi^2(8) = 7.9498 \text{ (0.43)} \]

Structural stability (Chow)
\[ F(5,53) = 0.7468 \text{ (0.59)} \quad F(4,67) = 0.3067 \text{ (0.87)} \]
\[ F(32,26) = 0.7476 \text{ (0.78)} \quad F(36,35) = 1.4400 \text{ (0.13)} \]
Table 2: Hansen test and multipliers issued from the ex post regressions

<table>
<thead>
<tr>
<th>Monetary shock definition</th>
<th>FRANCE</th>
<th>ITALY</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r_t - \frac{1}{4} (r_{t-1} + r_{t-2} + r_{t-3} + r_{t-4})$</td>
<td>$r_t - \frac{1}{4} (r_{t-1} + r_{t-2} + r_{t-3} + r_{t-4})$</td>
<td></td>
</tr>
</tbody>
</table>

| Specification of the threshold variable $Z_{t-d}$ | $\Delta \Pi_t - (\Delta \Pi_{t-3} + \Delta \Pi_{t-4})/2$ | $\Delta \Pi_t - (\Delta \Pi_{t-3} + \Delta \Pi_{t-4})/2$ |

| Maximal statistic Sup-Wald | 8.94 | 6.42 |

| Threshold level $\tilde{\tau}$ (simulated p-value) | -0.8896 (0.025) | 0.0068 (0.115) |

| Confidence Interval | [-0.8896; -0.5866] | [-0.0066; 0.0109] |

<table>
<thead>
<tr>
<th>Multipliers (t-stat)</th>
<th>$Z_{t-d} &lt; \tilde{\tau}$</th>
<th>$Z_{t-d} &gt; \tilde{\tau}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>FRANCE</td>
<td>-0.006 (-3.51)</td>
<td>-0.0008 (-1.42)</td>
</tr>
<tr>
<td>ITALY</td>
<td>-0.15 (-3.30)</td>
<td>0.07 (0.12)</td>
</tr>
</tbody>
</table>
Table 3: Initial regressions according to definition of the interest rate shock

\[
\text{Shock} = \Delta r_t - \frac{1}{4} (\Delta r_{t-1} + \Delta r_{t-2} + \Delta r_{t-3} + \Delta r_{t-4}).
\]

Endogenous variable = \(\Delta Y_t\)

<table>
<thead>
<tr>
<th></th>
<th>FRANCE</th>
<th>ITALY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shock_t</td>
<td>-0.0008 (0.9452)</td>
<td>0.0716 (1.09)</td>
</tr>
<tr>
<td>(\Delta Y_{t-1})</td>
<td>0.2659 (2.2645)</td>
<td>0.0716 (1.09)</td>
</tr>
<tr>
<td>(\Delta Y_{t-2})</td>
<td>0.2551 (2.1426)</td>
<td>0.0716 (1.09)</td>
</tr>
<tr>
<td>(\Delta Y_{t-3})</td>
<td>0.2191 (1.8048)</td>
<td>0.0716 (1.09)</td>
</tr>
<tr>
<td>(\Delta Y_{t-4})</td>
<td>0.2849 (2.90)</td>
<td>0.0716 (1.09)</td>
</tr>
<tr>
<td>(\Delta G_{t-3})</td>
<td>0.5533 (3.35)</td>
<td>0.0716 (1.09)</td>
</tr>
<tr>
<td>(\Delta \Pi_t)</td>
<td>-0.0049 (-2.7109)</td>
<td>0.3028 (2.23)</td>
</tr>
<tr>
<td>(\Delta \Pi_{t-3})</td>
<td>-0.3513 (-3.42)</td>
<td>0.3028 (2.23)</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.06</td>
<td>0.07</td>
</tr>
<tr>
<td>SSR</td>
<td>0.0019</td>
<td>0.0026</td>
</tr>
<tr>
<td>(\hat{\sigma}^2)</td>
<td>0.0058</td>
<td>0.0061</td>
</tr>
<tr>
<td>Non autocorrelation (Godfrey)</td>
<td>(\chi^2(4) = 3.3805 (0.49))</td>
<td>(\chi^2(4) = 4.31 (0.36))</td>
</tr>
<tr>
<td>Homoscedasticity (Breusch-Pagan)</td>
<td>(\chi^2(10) = 12.6951 (0.24))</td>
<td>(\chi^2(10) = 24.93 (0.005))</td>
</tr>
<tr>
<td>Structural stability (Chow)</td>
<td>(F(5,53) = 0.6859 (0.63))</td>
<td>(F(5,65) = 0.42 (0.83))</td>
</tr>
<tr>
<td></td>
<td>(F(32,26) = 0.9531 (0.55))</td>
<td>(F(36,34) = 1.54 (10.4))</td>
</tr>
</tbody>
</table>
Table 4: Hansen test and multipliers issued from the ex post regressions

<table>
<thead>
<tr>
<th></th>
<th>FRANCE</th>
<th>ITALY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monetary shock definition</td>
<td>$\Delta r_t - \frac{1}{4} (\Delta r_{t-1} + \Delta r_{t-2} + \Delta r_{t-3} + \Delta r_{t-4})$</td>
<td>$\Delta r_t - \frac{1}{4} (\Delta r_{t-1} + \Delta r_{t-2} + \Delta r_{t-3} + \Delta r_{t-4})$</td>
</tr>
<tr>
<td>Specification of the threshold variable $Z_{t-d}$</td>
<td>$\frac{1}{4} (\Delta \Pi_{t-1} + \Delta \Pi_{t-2} + \Delta \Pi_{t-3} + \Delta \Pi_{t-4})$</td>
<td>$\Delta \Pi_t - \Delta \Pi_{t-4}$</td>
</tr>
<tr>
<td>Maximal statistic Sup-Wald</td>
<td>7.18</td>
<td>5.90</td>
</tr>
<tr>
<td>Threshold level $\bar{s}$</td>
<td>0.03469 (0.07)</td>
<td>-0.00406 (0.16)</td>
</tr>
<tr>
<td>(simulated p-value)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confidence Interval</td>
<td>[-0.0032;0.068]</td>
<td>[-0.0071;-0.0003]</td>
</tr>
<tr>
<td>Multipliers (t-stat)</td>
<td>$Z_{t-d} &lt; \bar{s}$</td>
<td>$Z_{t-d} &gt; \bar{s}$</td>
</tr>
<tr>
<td></td>
<td>-0.0017 (0.05)</td>
<td>0.0034 (0.08)</td>
</tr>
<tr>
<td></td>
<td>-0.1134 (-1.14)</td>
<td>0.1794 (2.31)</td>
</tr>
</tbody>
</table>
Figure 3: real interest rate multipliers and inflation regimes

Part one: Shock = $r_t = \frac{1}{4} (r_{t-1} + r_{t-2} + r_{t-3} + r_{t-4})$

Inflation threshold = $\Delta \Pi_t - (\Delta \Pi_{t-3} + \Delta \Pi_{t-4})/2$

Part two: Shock = $\Delta r_t = \frac{1}{4} (\Delta r_{t-1} + \Delta r_{t-2} + \Delta r_{t-3} + \Delta r_{t-4})$

Inflation threshold = $\frac{1}{4} (\Delta \Pi_{t-1} + \Delta \Pi_{t-2} + \Delta \Pi_{t-3} + \Delta \Pi_{t-4})$ for France
Figure 4 : Evolution of the inflation rate in France and Italy since 1980.