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Monetary Policy Shocks in Open Economies and the Inflation Unemployment Trade-Off: The Case of the Euro Area

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Abstract: In this paper, we show that in order to obtain a sound identification of Euro Area monetary policy shocks, one needs to deal with the interaction of the European Central Bank and the US Federal Reserve. In other words, a proper identification of monetary policy shocks for an open economy like the Euro Area requires consideration of the US policy rate. Indeed, when we exclude the Federal Funds Rate from an estimated VAR model including a set of Euro Area variables, i.e., Eonia, inflation and unemployment, we detect a wrong sign in the response of inflation to contractionary monetary policy shocks. Moreover, even adding the world price of oil does not help to overcome the problem. Instead, for a sample covering the period 1999–2019, when the Federal Funds Rate and the Euro–Dollar exchange rate are added to the VAR model inflation shows statistically non-significant effects for two years and thereafter decreases. Under this specification of the model, a clear and significant unemployment inflation trade-off emerges. These conclusions are confirmed by using industrial production instead of the unemployment rate in the VAR model.

Keywords: monetary policy shocks; structural VARs; euro area; inflation; unemployment

JEL Classification: C32; E24; E31; E32

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1. Introduction

The purpose of this paper is twofold. First, we want to explore the role played by the interaction between the European Central Bank (ECB) and the US Federal Reserve in shaping monetary policy in the Euro Area and hence in recovering monetary policy shocks. Second, we want to characterize the dynamic influence exerted by monetary policy shocks on inflation and unemployment in the Economics and Monetary Union (EMU).

In the presence of an increase in inflation, following a contractionary monetary policy shock identified in the context of Vector Autoregressions, one faces a price (and an inflation) puzzle (cf. Sims (1986)). This result represents a puzzle since economic models, on the contrary, predict a contraction in inflation in response to a monetary policy tightening.

Starting with Sims (1992), who suggested including in the VAR model an index representative of commodity prices (see, e.g., Kim and Roubini (2000); Hanson (2004); Sims and Zha (2006)), a variety of solutions has been proposed to overcome this weakness affecting VAR models. For example, Uhlig's methodological proposal Uhlig (2005) to adopt a sign-restriction approach to identification was closely related to the price puzzle since, in the view of the author, imposing a negative sign to the response of inflation to a monetary tightening can be seen as an agnostic approach to VAR identification that allows the ability of monetary policy shock to influence real variables at business cycle frequencies to be studied.

Further contributions aiming to overcome the price puzzle have come from, among others, Giordani (2004); Francis and Owyang (2005); and Estrella (2014).

In this paper, we undertake an empirical investigation concerning the Euro Area and show that controlling for the world price of oil is not enough to obtain a correct sign in the response of inflation to monetary policy shocks.[1] Instead, we show that a crucial role is

played by the interaction between the ECB and the US Federal Reserve. Indeed, when we include the Federal Funds Rate and the Euro–Dollar exchange rate in the estimated VAR model, we find evidence of an inverse relation characterizing inflation and unemployment in response to monetary policy shocks at business cycle frequencies.

Svensson (2003) suggested that the specification of the monetary policy rule for an open economy requires the inclusion of the foreign interest rate and the exchange rate. Indeed, the empirical evidence provided in the present paper seems to support Svensson's suggestion.

It is worth stressing that the importance of considering the role of US short-term interest rates, in empirical investigations concerning monetary policy in industrialized small open economies, had been emphasized by Kim and Roubini (2000). Nevertheless, our study shows that there is a significant influence from US monetary policy even in the case of a large open economy like the Euro Area.

Therefore, in this research, our preferred monetary policy rule is specified in relative terms, i.e., by considering the differential between Eonia and Federal Funds Rate. The economic rationale behind this specification is the following: in the presence of a given increase (decrease) of the policy rate in the Euro Area, the degree of restriction (expansion) implied by this policy rests heavily on the related movements of the Federal Funds Rate. In a pinch, an increase of Eonia may represent an expansionary, rather than a contractionary, monetary policy in the presence of a stronger, simultaneous increase of the US policy rate.

Thus, and paradoxically, it is possible that a contractionary monetary policy shock in the Euro Area, recovered in a closed economy framework, may be associated with an increase in inflation and a decrease in the unemployment rate.

The simple message is that there is a notable interaction between the Euro Area and the US economy that makes it impossible to treat the Euro Area as if it were a closed economy. As a consequence, this interaction needs to be taken into account in the identification of exogenous movements of monetary policy in the currency area.

Indeed, the Federal Funds Rate seems to be useful in forecasting the Euro-area short-term interest rate, hence, in order to shed some light on the results obtained in the structural analysis, we also conduct Granger Causality tests. Not surprisingly, the conclusion is that the Federal Funds Rate causes, in the Granger sense, Eonia. Moreover, and maybe more surprisingly, over the period 1999–2019, i.e., during the first twenty years of the Euro, we detect unidirectional Granger causation running from the Federal Funds Rate to EONIA.

It is worth stressing that although we concentrate attention on the dynamic effects exerted by Euro Area monetary policy shocks on Euro Area macro-variables, a related strand of the literature has recently investigated the spillover effects of monetary policy across borders (see, among others, Cekin et al. (2019) and Fratzscher et al. (2016)).

As far as the unemployment–inflation trade-off is concerned, recent results show that the Phillips curve still represents a good description of the relation between these two variables in the Euro Area (see, e.g., Ball and Mazumder (2021)). At country level, Ribba (2020) finds evidence of a significant trade-off in most Euro Area economies. Another recent study concerning Euro Area countries is provided by Abbritti and Weber (2018) who, by using a panel VAR model, uncover the role played by labor market institutions in the propagation of exogenous shocks and in the reaction of inflation and unemployment to such shocks[2].

Bobeica and Sokol (2019) have instead found that over the period 2008–2018, i.e., the decade starting with the Great Recession, a Phillips curve could offer a good characterization of the behavior of inflation, at least for some sub periods.

As for the US economy, Blanchard (2016) and Gali and Gambetti (2018) find evidence of the unemployment–inflation trade-off and stress that a specification of the inflation rate in levels, rather than in first difference as predicted by the accelerationist model of the Phillips curve, seems to be more appropriate for investigations concerning more recent decades[3].

Ball and Mazumder (2019) introduce the hypothesis of anchored inflation expectations as characterizing the behavior of economic agents in the US economy in the last twenty

years. Even their results on the inverse relation between inflation and unemployment point to a specification in levels of the variables.

The rest of the paper is organized as follows. In Section 2, a trivariate VAR model is estimated for the Euro Area, and the responses of inflation and unemployment to an unexpected increase in Eonia are presented. A wrong sign in the responses of both variables emerges. In Section 3, we estimate a VAR model including the world price of oil. The results presented in this section confirm the wrong sign exhibited by inflation and unemployment in response to a monetary policy shock. In Section 4, we show that adding the US Federal Funds Rate and the nominal exchange rate helps to recover a Euro Area monetary policy shock that produces the dynamic effects on inflation and unemployment predicted by a large class of economic models, i.e., movements in opposite directions of the two variables at business cycle frequencies. In Section 5, we provide an interpretation of the interaction between ECB and Federal Reserve in terms of Granger causation. We find that the Federal Funds Rate contains useful information for the prediction of EONIA. Section 6 provides a robustness exercise conducted by replacing the unemployment rate with industrial production in the estimated VAR model. We find that the main conclusions are confirmed. Section 7 concludes.

2. Identifying Monetary Policy Shocks by Treating the Euro Area as a Closed Economy

Let us start with the estimation of a trivariate VAR model, including the following Euro Area variables, inflation rate, unemployment rate and the Euro OverNight Index Average (EONIA). The reduced-form, VAR model is given by:

$$X_t = \mu + A(L)X_{t-1} + e_t \tag{1}$$

For a VAR of order p, $A(L) = \sum_{i=1}^{p} A_i L^{i-1}$. L is the lag operator, such that: $L^i X_t = X_{t-i}$. μ is a vector of constant terms and e_t is the 3×1 vector of error terms, such that $E(e_t) = 0$ and $E(e_t e_t') = \Sigma_e$.

X_t is a 3×1 vector of macroeconomic variables, given by:

$$X_t' = (\pi_t \; u_t \; i_t)$$

where π_t is the inflation rate, defined as the year-on-year rate of change of the Consumer Price Index, built upon the Harmonized Index of Consumer Price, HICP, including all items; u_t is the unemployment rate.[4] We use a sample data at a monthly frequency over the period 1999:1–2019:12.

Following the seminal contributions by Bernanke and Mihov (1998) and Taylor (1999), the stance of monetary policy is measured by the short-term interest rates.

This closed-economy specification of the VAR model has been used, among others, by Stock and Watson (2001) in an empirical investigation concerning the US economy in the postwar period.

The reduced-form moving average representation of system (1) is given by:

$$X_t = \rho + C(L)e_t \tag{2}$$

where $C(0) = I$.

We recover the monetary policy shocks by imposing a recursive structure. This approach to identification of monetary policy disturbances has been popularized by Christiano et al. (1999) and is based on the idea that monetary policy exerts delayed effects on both inflation and unemployment.

The structural VAR model has the following representation:

$$X_t = \rho + B(L)\eta_t \tag{3}$$

where $B(L) = C(L)P$ and $\eta_t = P^{-1}e_t$. The 3×1 vector η_t contains orthonormal disturbances, i.e., $E(\eta_t \eta_t') = I$ and P is such that $PP' = \Sigma_e$. Given the symmetry of the covariance matrix of error terms, Σ_e, six restrictions are imposed on the nine elements of P. Therefore, three more restrictions are needed in order to obtain exact identification of the VAR model. By choosing a recursive structure, we impose that the third shock (i.e., the monetary policy shock) has zero effects in the contemporaneous period on both inflation and unemployment and, moreover, that the second shock has a zero effect on inflation on impact. Let us also note that P is the so-called Cholesky factor, i.e., is the unique lower triangular matrix such that PP' gives a factorization of the covariance matrix of error terms.

It is worth stressing that inflation and unemployment are taken in levels. There are both economic and econometric reasons underlying this choice. Indeed, as reported in the introduction, Blanchard (2016) concludes that a traditional specification of the inflation and unemployment relation with both variables in levels seems to fit well with the recent historical period. On the other hand, even in light of the uncertainty concerning the ability to discriminate trend-stationary processes exhibiting persistence from unit root processes, particularly when small samples are used, as in the present investigation, we prefer to specify the VAR in levels.

We must add that a specification of the VAR model in levels is consistent with the presence of long-run equilibrium relations, i.e., cointegration, among variables, since a Vector Error Correcion Model can always be thought of as a particular reparameterization of the VAR specified in levels. Two classic references on these subjects are Christiano and Eichenbaum (1990), Sims et al. (1990).

Figure 1 reports the dynamic responses of inflation and unemployment to a contractionary monetary policy shock.[5] A wrong sign in the responses of both variables emerges: following the monetary tightening, inflation increases and unemployment decreases for some periods. More precisely, the inflation rate has a statistically significant increase in response to the contractionary monetary policy shock which lasts for around two years. Instead, the unemployment rate shows a significant contraction for around 20 months.

Undoubtedly, a puzzling outcome pointing to an uncorrect specification of the VAR model.

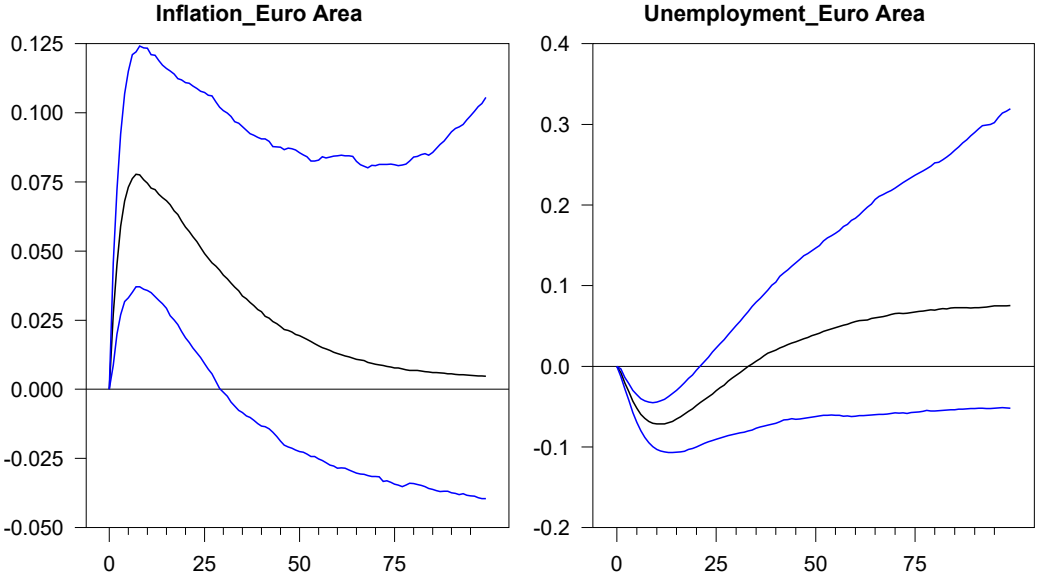

Figure 1. Responses of Euro Area inflation and unemployment to a contractionary monetary policy shock. Monetary policy shock identified as exogenous innovation to European Overnight Average Interest Rate (EONIA). Error bands set at the 10th and the 90th percentiles. Trivariate VAR model including inflation, unemployment and EONIA.

3. Including in the VAR Model the Price of Oil

Starting with Sims (1992), researchers have sometimes included alternative measures of commodity prices in structural VAR models. The underlying idea is that these indicators are indeed monitored by central banks and hence their inclusion may lead to a better specification of the monetary policy equation. Therefore, in this section we estimate a VAR model that, besides the three variables considered in the previous section, also includes the price of oil.

Euro Area countries are largely commodity importers and, in particular, oil importers. Moreover, since we are studying the Euro Area and aim to recover the exogenous component of monetary policy for the currency area, we take the annual rate of change of Brent oil price, expressed in euros.

Let us recall that recent research has confirmed the importance of oil price shocks in shaping the evolution of Euro Area and European macroeconomic variables at business cycle frequencies (see, e.g., Raduzzi and Ribba (2020) and Cavallo and Ribba (2018)). Nevertheless, in the present research we aim to investigate the dynamic effects of monetary policy shocks on nominal and real variables and the proper identification strategy to recover such shocks in the context of the VAR methodology. Thus, inserting the price of oil in the VAR model is instrumental to these objectives rather than to the investigation of the macroeconomic outcomes of oil shocks.

We recover the monetary policy shock in the same way as in Section 2, i.e., by using the Cholesky decomposition and with the price of oil ordered first in the causal ordering.

As shown in Figure 2, the inclusion of the price of oil in the information set of the central bank does not enable the problem to be overcome, since an inflation puzzle is still present. Hence, it seems that adding this variable is not enough to recover monetary policy shocks in the Euro Area.

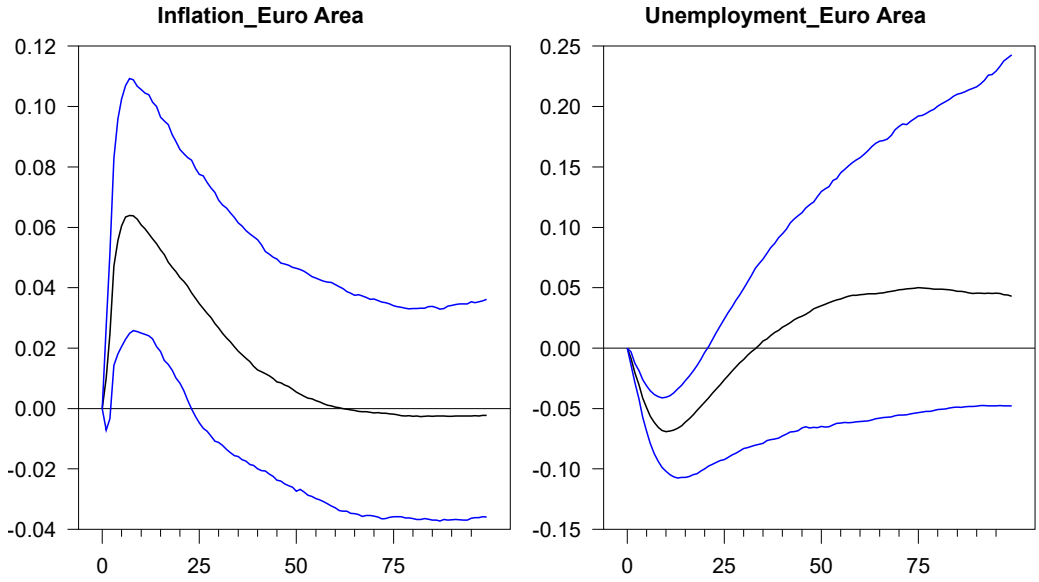

Figure 2. Responses of Euro Area inflation and unemployment to a contractionary monetary policy shock. Monetary policy shock identified as exogenous innovation to European Overnight Average Interest Rate (EONIA). Error bands set at the 10th and the 90th percentiles. VAR model including Brent price of oil, inflation, unemployment and EONIA.

It is also worth noting that, on the whole, the results are not significantly different from those obtained by adopting a trivariate VAR specification, as in Section 2: in the short run, a monetary tightening causes not only an increase in the inflation rate, but also a contraction in the unemployment rate. The conclusion is that under this specification of the VAR model and the identification strategy adopted, a contractionary monetary policy shock provokes an expansion in the economic system for around two years. Clearly, these

results are at odds with the prediction of macroeconomic models of the business cycle and, no less important, are at odds with business cycle facts.

We can conclude that despite the relatively important role still played by oil shocks in driving fluctuations in inflation and unemployment, including the price of oil in the VAR model is not enough, however, to recover the Euro Area monetary policy shock.

4. Monetary Policy Shocks Recovered by Treating the Euro Area as a Large Open Economy

In this section, we build a VAR model augmented by US variables. More precisely, we include the Federal Funds Rate and the Euro–Dollar exchange rate.

A VAR model including five variables is estimated:

$$A(L)X_t = \mu + e_t \tag{4}$$

The 5×1 vector X_t is given by:

$$X_t' = (oil_t \ \pi_t \ u_t \ \epsilon_t \ i_t - i_t^*)$$

The VAR model includes the price of oil, i.e., the annual rate of change of Brent price in euros, the Euro Area inflation rate, π_t, and the unemployment rate, u_t. Moreover, the crucial difference with respect to the specification adopted in the previous sections is that we now include the Euro–Dollar exchange rate, ϵ_t, defined as US dollars per currency units, and the differential between the Eonia and the Federal Funds Rate, $i_t - i_t^*$.

Therefore, we treat the Euro Area as an open economy and the specification of the reaction function of the ECB is consistent with this characterization of the economic system, i.e., in this case we specify an open-economy monetary policy rule.

We have already stressed that Svensson (2003) emphasized the role of the foreign interest rate and the exchange rate in monetary policy rules for open economies.

Since in this research we use the same identification scheme for all the estimated VARs, i.e., a recursive structure with the selected indicator of monetary policy ordered last in the causal ordering, possible differences in the results obtained should be ascribed to the selection of variables included in the VAR model.

As shown in Figure 3, monetary policy tightening, identified as an unexpected increase in the differential between the EONIA and the Federal Funds Rate, provokes a decrease in the inflation rate and an increase in the unemployment rate[6]. Although for eighteen months the reaction of inflation is statistically non-significant, at horizons from two years to five years, inflation shows an unambiguous contraction. Instead, as far as the unemployment rate is concerned, in response to the contractionary monetary policy shock, there is a persistent increase in unemployment that lasts (is statistically significant) for around six years.

Under this specification of the VAR model, we find evidence of the prediction of the traditional Phillips curve, i.e., of a movement in opposite directions, at least in the short and medium run, of inflation and unemployment caused by changes in interest rates induced by monetary policy decisions. The conclusion is that the inflation puzzle detected in previous sections may be ascribed to having neglected the US short-term interest rate and the Euro–Dollar exchange rate.

Recent literature has highlighted the problems related to using interest rates as indicators of the monetary policy stance in periods characterized by the emergence of the zero lower bound (see, e.g., Marfatia (2021) and Wu and Xia (2018)). Undoubtedly, this problem might also be relevant for our investigation and in particular for the period after 2008, i.e., the second part of our sample period that starts in 1999. However, it is also important to point out that an interesting feature of the open-economy monetary policy rule used in this section is that it allows possible problems related to the zero lower bound to be overcome, or at least significantly mitigated, since in this case monetary policy choices are expressed

in relative terms. The important implication is that negative values of the variable, i.e., the differential between domestic and foreign short-term interest rates, are allowed.

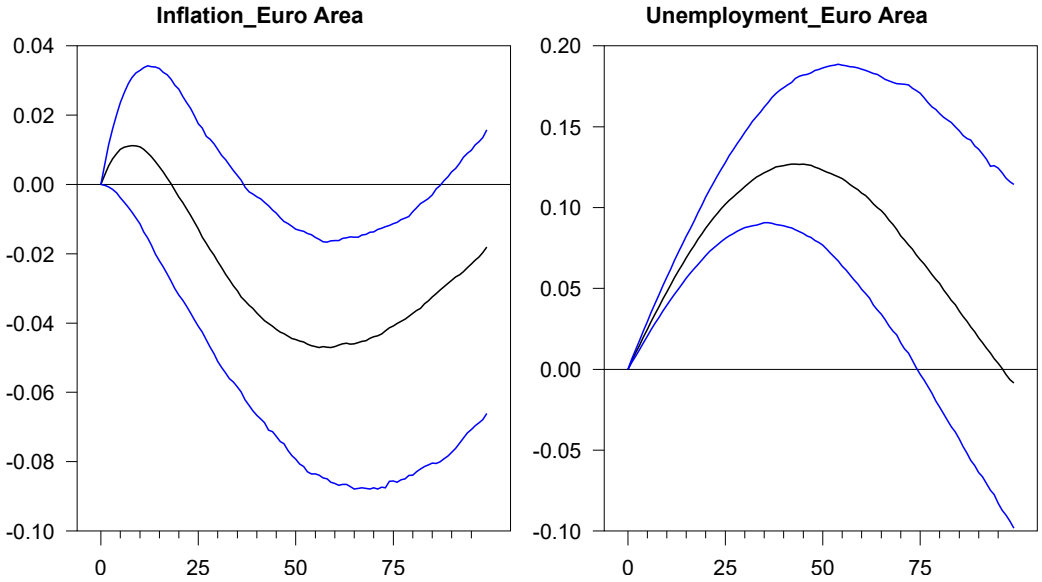

Figure 3. Responses of Euro Area inflation and unemployment to a contractionary monetary policy shock. Monetary policy shock identified as exogenous innovation to the differential between the European Overnight Average Interest Rate (EONIA) and the Federal Funds Rate. Error bands set at the 10th and the 90th percentiles.

5. A Further Look at the Relation between EONIA and Federal Funds Rate in Terms of Granger Causality

In this paper, we have argued that in the light of the open economy feature of the Euro Area and of the strong economic relations with the US economy, one should not neglect US variables when recovering the exogenous component of Euro-area monetary policy. To put it another way, monetary policy in the Euro Area is significantly influenced by US monetary policy.

From an economic point of view, this of course closely relates to the pre-eminent role played by the USA in the world economy. Instead, looking at monetary policy and translating this pre-eminent role into the language of time series analysis, the Federal Funds Rate may contain useful information for prediction of EONIA, i.e., the first variable causes in the Granger sense the second variable.

Indeed, a simple inspection of Figure 4 reveals a strong co-movement characterizing the two variables over the period 1999:1–2019:12. In particular, in the first sixteen years of euro the Federal Funds Rate seems to have behaved as a leading indicator of EONIA since turning points in the conduct of monetary policy in the US economy anticipate subsequent changes in the Eurozone by twelve to eighteen months. For example, considering the years 2007–2008, the Federal Reserve began to reduce the short-term interest rate during Summer 2007, after a peak around 6 percent reached in July, and this reduction in the Federal Funds Rate continued for the next eighteen months, with a strong acceleration during Summer 2008, i.e., when the Great Recession materialized in the US economy. In December 2008 the Federal Funds Rate had reached a plateau near zero. If we now look at the ECB, the peak of EONIA was reached at August 2008 and a value near zero for the Euro Area short-term interest rate was only reached during Summer 2009.

Of course, in relation to the evolution of interest rates between August 2007 and August 2008, the lagging response of monetary policy in the Euro Area may have been partially due to a different phase of the Euro Area business cycle faced by the ECB.

Further, we must add that a decoupling between the two policy rates seems to have materialized only in more recent years.

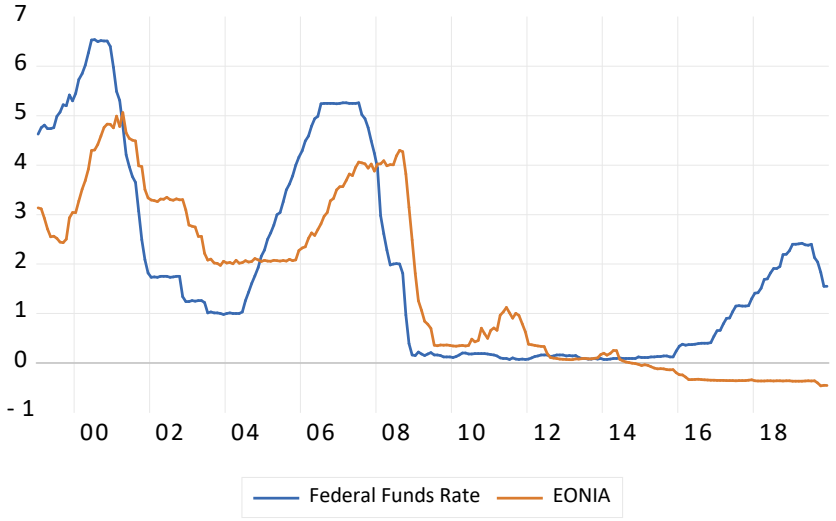

Figure 4. Evolution of Federal Funds Rate and EONIA over the sample period 1999:1–2019:12.

Studying the question of fiscal foresight, Leeper et al. (2013) maintain that the econometrician will not identify the structural shocks if the information set used for identification is smaller with respect to agents. In our case study, the information set used by ECB is larger, i.e., it includes US variables, with respect to the one used by econometricians estimating VAR models for the Euro Area in a closed economy framework.

In this area of studies, Forni and Gambetti (2014) argued that VAR models may suffer from "information deficiency", meaning that if some state variables help to predict the vector of variables included in the VAR estimation, the traditional VAR approach will not allow the structural shocks to be recovered. Therefore, they suggest undertaking Granger causality tests in order to explore if selected state variables turn out to be useful in predicting the endogenous variables.[7]

In Table 1, Granger causality tests are reported. Over the sample period considered, i.e., 1999:1–2019:9, the Federal Funds Rate Granger causes EONIA. Moreover, there is evidence of unidirectional Granger causality since the null hypothesis that EONIA does not Granger cause the Federal Funds Rate is not rejected by data. Thus, the conclusion is that the Federal Funds Rate does contain relevant information for prediction of the Euro Area policy rate.

Table 1. Granger Causality Tests.

Null Hypothesis	Obs	F-Statistics	Prob.
EONIA does not Granger cause Federal Funds Rate	244	1.363	0.214
Federal Funds Rate does not Granger cause EONIA	244	8.150	1×10^{-9}

Notes: Sample 1999:1–2019:12; Lags 8.

6. A Robustness Analysis: Using Industrial Production in Place of the Unemployment Rate

We have so far investigated the joint dynamics of inflation and unemployment in the Euro Area in response to monetary policy shocks. In this section, we aim to explore the dynamic effects exerted by monetary policy changes on inflation and industrial production. In this way, we undertake a robustness exercise, by inserting in the VAR model an indicator of aggregate output instead of the unemployment rate, at the same time keeping a sample of monthly observations.

Substantially, we make the same experiment conducted in the previous sections: we first estimate a VAR model in which EONIA is taken as the monetary policy instrument, then we augment the VAR model by adding the Federal Funds Rate and the Euro–Dollar exchange rate. Results are shown, respectively, in Figures 5 and 6. Indeed, Figure 5

shows that in response to a monetary tightening, there is an increase in both inflation and industrial production. The rise in inflation is statistically-significant for around four years, while the rise in industrial production lasts for around two years. Hence, a specification of the VAR model treating the Euro Area as a closed economy confirms the wrong signs of both inflation and aggregate output in response to monetary policy shocks.

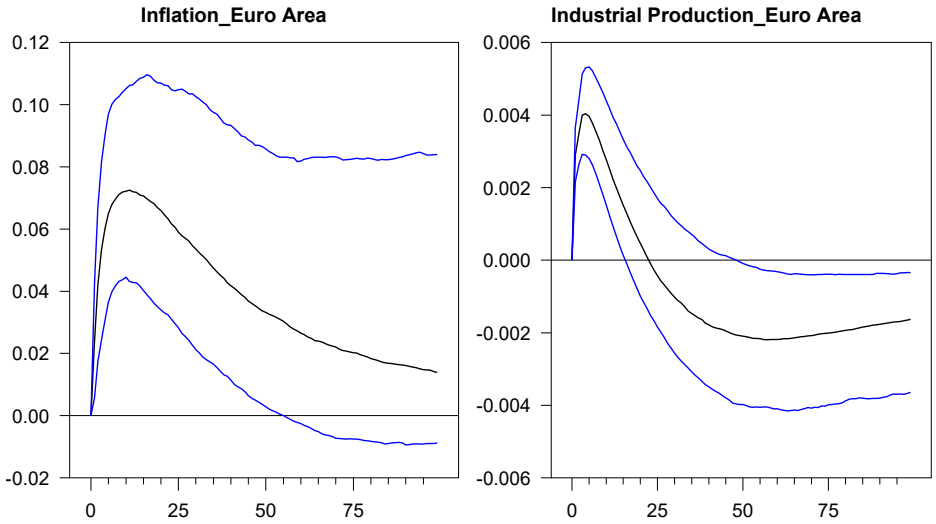

Figure 5. Responses of Euro Area inflation and industrial production to a contractionary monetary policy shock. Monetary policy shock identified as exogenous innovation to European Overnight Average Interest Rate (EONIA). Error bands set at the 10th and the 90th percentiles.

In Figure 6, the dynamic responses of the two variables in response to a monetary policy shock, interpreted as an unexpected increase in the differential between EONIA and the Federal Funds Rate, are shown. In this case, a contractionary monetary policy shock causes a contraction of both inflation and output. It is worth noting that the picture is now quite different with respect to the closed economy specification of the model, since there is a significant decrease of the two variables, which lasts around four years.

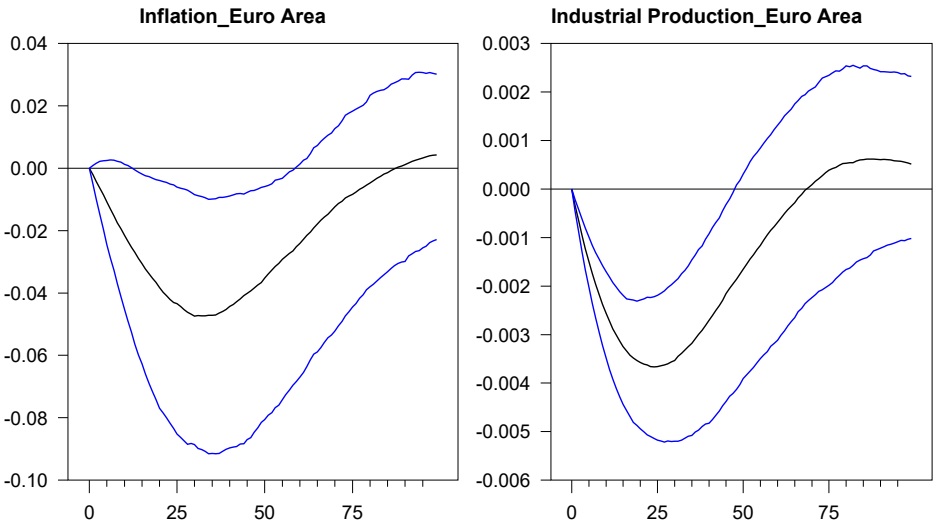

Figure 6. Responses of Euro Area inflation and industrial production to a contractionary monetary policy shock. Monetary policy shock identified as exogenous innovation to the differential between the European Overnight Average Interest Rate (EONIA) and the Federal Funds Rate. Error bands set at the 10th and the 90th percentiles.

Therefore, on the whole, it seems confirmed that an open economy specification of the Euro Area monetary policy rule allows a sounder identification of the monetary policy shock.

7. Conclusions

In this paper, we have shown that in order to recover monetary policy shocks in the Euro Area, by using traditional VAR models, it is of paramount importance to include in the specified VAR US variables and, more precisely, the Federal Funds Rate and the Euro–Dollar exchange rate. This leads to a characterization of the reaction function of the ECB as an open economy monetary policy rule expressed in relative terms, as the differential between EONIA and Federal Funds Rate.

We have also drawn attention to a notable feature of this characterization of monetary policy in the Euro Area: the so-called zero lower bound problem, that may occur when interest rates are used as indicators of monetary policy choices, is significantly mitigated since negative values of the differential are also possible.

Instead, a closed economy specification of the behavior of the central bank produces puzzling responses of inflation and unemployment to Euro Area monetary policy shocks. In the tradition of Sims (1992) and other scholars, we have also inserted the price of oil in the set of VAR variables, but wrong signs in the responses of inflation and unemployment to contractionary monetary policy shocks still persist.

We have also provided an interpretation of the main result obtained in the present research, concerning the importance of the US short-term policy rate for Euro Area monetary policy, in terms of the useful information contained in the Federal Funds Rate in predicting the evolution of EONIA. Therefore, if the researcher did not include the Federal Funds Rate in the estimated VAR model the information set would be smaller with respect to the one used by the central bank and, as a consequence, the monetary policy shock would not be recovered (see, e.g., Leeper et al. (2013); Forni and Gambetti (2014)).

As for the inflation–unemployment relation in the Euro Area, we find that an open economy structural VAR model representation enables one to discover the trade-off between inflation and unemployment in response to unexpected changes in monetary policy choices over a sample period ranging from 1999 to 2019. Thus, another quite important conclusion is that the Phillips curve has far from disappeared in the Euro Area and that an inflation–unemployment trade-off becomes apparent when structural disturbances are correctly recovered.

Let us also stress that we have detected persistent effects exerted on the unemployment rate by monetary policy shocks, while the effects on inflation, though delayed, are statistically-significant and show the expected sign. The slow effects on inflation exerted by changes in Euro Area monetary policy testify to the difficulties faced by ECB in bringing inflation back to the desired target in the last decade.

Nevertheless, on the whole, these results confirm the ability of central banks to influence the unemployment rate through changes in interest rates capable of causing changes in aggregate demand.

These conclusions are confirmed if we replace the unemployment rate with industrial production in the estimated VAR model.

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Data Availability Statement: Data retrieved from the Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org (accessed on 27 October 2021).

Conflicts of Interest: The author declares no conflict of interest.

Notes

[1] Raduzzi and Ribba (2020) have recently investigated the effects of oil price shocks on prices and output in the Euro Area. The main finding is that movements in oil prices are still an important driver of fluctuations in prices in Euro Area countries. Results concerning the role of oil price for other European economies are provided by Cavallo and Ribba (2018).

[2] Some recent studies deal with the broad theme of sustainability, which indeed may comprise a sustainability assessment even on monetary policy and the associated dynamics of inflation and unemployment (see, e.g., Popescu (2020).

[3] Gali and Gambetti (2018), among others, use a structural vector autoregressive model with time-varying coefficients. The authors maintain that this empirical model provides a flexible specification that allows for structural changes in the relation between inflation and unemployment. Of course, the possibility of structural changes might be extended to the interaction between the US and the Euro Area monetary policy, that is indeed one theme of the present investigation. Nonetheless, in this paper we use the traditional VAR approach since our aim is to confront our results, obtained by introducing an open economy monetary policy rule specification, with that strand of the literature that has found evidence of the price puzzle in the context of VAR models with fixed coefficients. It is also worth noting that our sample period is relatively small. Following the same logic of consistent comparison with the relevant literature, we adopt an identification strategy based on recursive structures, and hence do not consider alternative approaches based, for example, on imposing sign restrictions.

[4] All series used in this study are taken from FRED at the St. Louis FED Web site. The selection of the number of lags for the estimated VARs is based on Akaike, Schwartz and Hannan-Quinn criteria. When the information does not converge to a common selection of the number of lags, we have chosen the most parsimonious parameterization for the VAR model.

[5] Confidence bands are obtained by adopting the Bayesian approach proposed by Sims and Zha (1999).

[6] An interesting question, stressed by an anonymous referee and related to this characterization of the monetary policy, is that an expansionary monetary policy in the US economy, for a given policy rate in the Euro Area, would imply a monetary tightening in the Euro Area. However, although counterintuitive, this is consistent with the predicted effects exerted on the domestic economy (at least in the short run) by a foreign expansionary monetary policy, since if, as expected, this policy causes a depreciation of the Euro–Dollar exchange rate in the short run, it may consequently produce a contraction of net exports, and hence a decrease in aggregate demand of the Euro-area economies. In other words, this expansionary monetary policy in the foreign economy is capable of producing the same dynamic effects on inflation and unemployment of a domestic monetary policy tightening.

[7] Thus, some puzzles affecting VAR models could be ascribed to information issues. Forni and Gambetti (2021) use a structural dynamic factor model to study the dynamic effects of policy and business cycle shocks in the US economy. Dynamic factor models exhibit some powerful feature, since although such models allow the inclusion of a large number of macroeconomic variables, the structural analysis is based only on a small number of structural shocks. This represents a clear potential advantage with respect to traditional VAR models. However, the underlying idea that policy makers really have 100 and more variables in their information set is questionable: it is likely that these variables, as in the Orwellian farm, are not all *in pari materia*.

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