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# Is the unemployment inflation trade-off still alive in the Euro Area and its member countries? It seems so

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*Abstract.* The unemployment inflation trade-off can be interpreted as a proposition concerning the response of these two variables to aggregate demand shocks. In this paper we study the possible presence of the trade-off in the Euro Area and in a wide group of Euro-area countries in the last 20 years, i.e. since the start of EMU. We use the structural VAR methodology that allows the separation between supply and demand shocks. Our main finding is that the existence of a trade-off is largely confirmed both at the Euro Area and at the national level. Nevertheless, the size of the trade-off, measured at different horizons, shows some heterogeneity among countries. No less important, when we augment the VAR model by introducing monetary policy in the context of an open economy, we find that monetary policy shocks push inflation and unemployment in opposite directions in the Currency Area. Another interesting result concerns the evidence of a relatively flat relation between unemployment and inflation, conditionally to monetary policy shocks.

*JEL Classification:* C32, E24, E31, E32;

*Keywords:* Unemployment; Inflation; Structural VARs; Euro Area

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## 1. Introduction

In this paper we want to investigate the existence of a negative relation, i.e. a possible trade-off, between unemployment and inflation in the Euro Area and (some of) its member countries in the last 20 years. Moreover, we also aim to provide some measures of the size of the trade-off.

Since the work by Samuelson and Solow (1960) on the US Phillips curve, as they labelled the inverse relation between inflation and unemployment discovered by Phillips for the UK (1958), the trade-off between these two variables, at least the short-run trade-off, has been a building block of traditional and less traditional macroeconomic models. The importance of the Phillips curve in the macroeconomic research over the last 60 years is likely to be related to its ability to characterize in a one single and simple relation the interaction between the nominal and the real side of the economic system. Nevertheless, there is no shortage of periodical announcements of the disappearance of this relation.

In a research concerning the US economy, Blanchard (2016) finds that the Phillips relation still holds in the United States. Another interesting result of this study regards the conclusion that in recent decades the relation between unemployment and inflation could be better described in terms of the old Phillips curve prevailing in the 60s, i.e. an inverse relation between the two variables specified in levels, rather than in terms of the accelerationist model dominating the subsequent periods, in which following the lead of Friedman (1968) the unemployment rate was related to the changes in inflation.

Blanchard's finding on the reduced importance of the accelerationist model in more recent decades has been recently confirmed by Gali and Gambetti (2018). In their study the authors provide estimates of a wage Phillips curve for the US economy.

In another recent study on the US Phillips curve, Ball and Mazumder (2019a) explore the role of anchored inflation expectations in explaining the relation between inflation and unemployment in the more recent decades. Even their results are consistent with Blanchard's conclusion that a relation between the two variables in levels seems to better characterize the Phillips curve in the last twenty years.

As emphasized by modern research on this subject (see, among others, Mankiw, 2001 and Ribba, 2007), the trade-off is essentially a proposition concerning the response of inflation and unemployment to shocks on the demand side of the economy, as those associated with waves of pessimism/optimism affecting economic agents, with changes in government spending or with unexpected changes in monetary policy choices undertaken by central banks. Instead, in the presence of shocks affecting the supply side, as oil shocks or technology shocks, the two variables will move in the same direction (see e.g. Ball and Mankiw, 2002). Indeed, as far as oil shocks are concerned, a very recent research by Raduzzi and Ribba (2019) has shown that oil price movements have played a notable role in driving fluctuations of prices and output both at the Euro-area aggregate level and in the small Euro-area economies over the Economic and Monetary Union (EMU) period.

Thus, and in general, there is no reason to expect that in every historical phase and in every country inflation and unemployment will exhibit a negative relationship, since the detection of a positive or a negative pattern will rest on the specific nature of dominant exogenous shocks hitting the economic system.

In this paper we use the structural VAR methodology to study the trade-off, since it

appears to be a particularly suitable approach for the topic under investigation, in the light of its potential ability to separate demand shocks from supply shocks. We consider the Euro Area and the group of Euro-area countries that have been part of the Economic and Monetary Union since 1999. Moreover, we also include in our investigation Greece, that joined the Euro Area in 2002. Thus, we select those countries that exhibit an historical path of adoption of the common currency of around twenty years and hence we exclude those countries which joined Euro Area more recently and for which, as a consequence, we do not dispose of enough data in order to draw sound conclusions.

A bivariate structural VAR including inflation and unemployment was estimated by King and Watson (1994) to study the trade-off in the postwar period in the United States. Benati (2015), by using the structural VAR methodology, explores the long-run trade-off between unemployment and the inflation rate in the US and other industrialized economies in the postwar period. However, as far as the Euro Area is concerned, he considers the sample period 1970 - 1998, i.e. the period preceding the start of the currency union.

Battharai (2016) uses panel VAR techniques and presents some interesting results for 35 OECD countries. In particular, he finds that in the majority of the countries included in the investigation, and more precisely 28 out of 35, the Phillips relation is empirically significant. However, although Euro-area countries are also considered in the investigation, the sample data covers the period 1990 - 2014, and hence a period over which two different monetary policy and exchange rate regimes have characterized these countries, with national central banks operating in Euro-area countries until 1999.

In fact, although some recent studies have explored the existence of the Phillips curve at the aggregate Euro-area level (see e.g. Ball and Mazumder 2019b and Moretti et al. 2019), to the best of our knowledge, a systematic investigation of the unemployment-inflation trade-off over the EMU period, both for the Euro-area economy and for member countries is still lacking. In our opinion, twenty years of EMU, with a single currency for Member States and the related conduct of monetary policy at the Euro-area supranational level, may now represent a sufficiently long period to undertake an empirical investigation on a topic as important as the unemployment-inflation trade-off.

Maybe the most surprising result of our study is that all Euro-area countries considered in this investigation show similar responses of inflation and unemployment to aggregate demand shocks: in almost all cases we detect the existence of an inverse and persistent relation between these two variables. A partial exception being represented by Germany where although the trade-off holds, it exhibits low persistence. Only for Austria do we find that although the median response of inflation moves in opposite direction to unemployment, given the estimated confidence bands, the trade-off is statistically non-significant at all horizons. Instead in all the other countries included in this study we find that the trade-off is economically and statistically significant at different horizons.

However, when we measure the size of the trade-off in the various countries, we detect the presence of a good deal of heterogeneity.

Moreover, when we augment the VAR model to take into account the role of monetary policy in the context of an open economy, we find that as predicted by a large class of models a monetary policy tightening causes a decrease in the inflation rate and an increase in the unemployment rate at the aggregate Euro-area level. The estimated trade-off turns out to

be statistically significant at some horizons but the implied Phillips relation, conditionally to monetary policy shocks, is relatively flat. Clearly, this implies relatively higher costs associated with disinflationary policies, where necessary, but on the other hand it may make more difficult the task of a central bank trying to recover higher levels of inflation through expansionary monetary policies, i.e. the ECB's current goal.

In a very recent column, Hasenzagl et al. (2019) maintain that although the recent policy debate in the Euro Area has mainly focused on the possible flattening of the Phillips curve, an alternative interpretation of the recent puzzle concerning the difficulties faced by the ECB in raising inflation might instead rest on the evolution of the trend components of aggregate output and inflation, since both of them seem to be characterized by a decline in recent years.

A VAR model including inflation, unemployment and the short-term interest rate has been estimated for the US economy by Stock and Watson (2001). Instead, in Ribba (2006), although the same set of variables as in Stock and Watson is considered, a cointegrated structural VAR for the US economy is estimated and identified.

In the present paper, when measuring the dynamic effects of monetary policy shocks, besides these three variables we also include in our VAR model the foreign interest rate, i.e. in this case the federal funds rate, and the exchange rate. Thus, we take into account the significant economic interaction of the Euro Area with the US economy. Svensson (2003), among others, has stressed the importance of including foreign interest rates and exchange rates in the monetary policy rule for open economies.

The rest of the paper is organized as follows. Section 2 presents the econometric model, based on structural VARs, and the identification strategy of demand shocks. In section 3 the response of inflation and unemployment to aggregate demand shocks is presented, for the Euro Area and for each of the twelve countries included in the investigation. In section 4 we provide an estimation of the strength of the trade-off between unemployment and inflation at various horizons. Section 5 extends the VAR model in order to include the monetary policy. In this section we identify a Euro-area monetary policy shock and then show the response of Euro-area inflation and unemployment to exogenous changes in monetary policy choices. Section 6 concludes and some implications for the conduct of monetary policy are discussed.

## 2. Identifying supply and demand shocks in a bivariate VAR

We estimate a set of bivariate VAR models including the inflation rate and the unemployment rate. To this end, let us consider the following reduced-form, VAR model:

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

For a VAR of order  $p$ ,  $A(L) = \sum_{i=1}^p A_i L^{i-1}$ .  $L$  is the lag operator, such that:  $L^i X_t = X_{t-i}$ .  $\mu$  is a vector of constant terms and  $e_t$  is the  $2 \times 1$  vector of error terms, such that  $E(e_t) = 0$  and  $E(e_t e_t') = \Sigma_e$ .

$X_t$  is a  $2 \times 1$  vector of macroeconomic variables, given by:

$$X_t' = (\pi_t \quad u_t)$$

where  $\pi_t$  is the inflation rate, defined as the year-on-year rate of change of the Consumer Price Index;  $u_t$  is the unemployment rate.<sup>1</sup> We use a sample data at monthly frequency over the period 1999:1 - 2019:6.

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 aggregate supply shocks and the aggregate demand shocks by imposing a contemporaneous causal structure. Thus 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  $2 \times 1$  vector  $\eta_t$  contains orthonormal disturbances, i.e.  $E(\eta_t\eta_t') = I$  and  $P$  is such that  $PP' = \Sigma_e$ . This relation, by virtue of the symmetry of the covariance matrix of error terms,  $\Sigma_e$ , implies three restrictions on the four elements of  $P$ . Exact identification of the model is obtained by imposing the following fourth restriction: the second shock does not exert a contemporary effect on inflation, i.e. the contemporaneous effects of  $\eta_2$  on  $\pi_t$  is restricted to zero. Thus,  $P$  is the unique lower triangular matrix (Cholesky factor) such that  $PP'$  gives a factorization of the covariance matrix of error terms.

The economic rationale of this set of restrictions relies on the interpretation of the first structural equation of the VAR model as a Phillips type relation. This relation summarizes the labour market dynamics and hence this allows the unexpected component in the structural VAR equation to be labelled as an aggregate supply shocks. As for the structural VAR equation of unemployment, as we will show in the next section, its unexpected component can be interpreted as an exogenous aggregate demand shock.

Let us note that inflation and unemployment rate enter the VAR in levels. Ribba (2007) investigates possible long-run effects on unemployment associated with disinflationary policies conducted in Italy over the period 1979 - 1995. To accomplish the task he uses cointegration techniques and hence a Vector Error Correction Model is specified. Nevertheless, given the well known uncertainty characterizing the ability to separate macroeconomic

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<sup>1</sup>All series are taken from Eurostat. The inflation rate is built upon the Harmonized Index of Consumer Price, HICP. The selection of the number of lags for the estimated VARs is based on combined information obtained by Akaike, Schwartz and Hannan-Quinn criteria. In the presence of conflicting indications obtained from the information criteria, we have generally preferred the indication pointing to the most parsimonious parameterization for the VAR model.

series exhibiting a unit root from macroeconomic series exhibiting persistence but trend stationary, in this study we choose to specify the VAR in levels. This is, of course, also a consequence of the (relatively) short sample available.

However, it is worth stressing that in the presence of a long-run equilibrium relation between inflation and unemployment, a bivariate VAR model specified in levels would not be affected by incorrect specification. On the other hand, structural bivariate VAR models including inflation and unemployment in first difference would suffer from misspecification if the two variables are cointegrated.<sup>2</sup>

### 3. Responses of inflation and unemployment to demand shocks

In this section we report the dynamic responses of inflation and unemployment to aggregate demand shocks in the Euro Area and in a large number of Euro-area countries.<sup>3</sup>

As for Euro-area responses, we also show how the two variables react to an aggregate supply shock. The inclusion of supply shocks, at least at the Euro-area level, may be useful in order to assess the soundness of the identification strategy adopted in this paper. Indeed, as shown in figure 1, inflation and unemployment move in the same direction in response to a negative supply shock. The increase in the inflation rate is statistically significant for around two years. Instead, the unemployment rate begins to rise after around one year and after then the increase persists for around seven years, since after 80 months following the shock the response of unemployment becomes statistically non-significant.

A negative demand shock, i.e. a contraction of aggregate demand that causes an increase in the rate of unemployment, provokes a decrease in the inflation rate. Thus, there is clear evidence of the trade-off in the Euro Area in response to aggregate demand shocks. The response of inflation to the shock is not significant for around one year, but thereafter and for around five years inflation decreases. The dynamic effects exerted by the demand shock on unemployment are also quite persistent considering that it requires five years for these effects to vanish.

Turning to the national level, in figure 2 the dynamic responses of inflation and unemployment to aggregate demand shocks are reported for the four largest Euro-area economies. In France, Italy and Spain we detect a negative relation between the two variables and, moreover, we find that the demand shocks exert persistent and significant effects on both inflation and unemployment. The picture for Germany is instead partially different: a persistent effect is detected only for the unemployment rate, while the negative response of inflation is statistically significant only for around one year.

However, it is important to point out that despite the similarity in the persistence profiles of the macroeconomic responses found for these countries, in the next section we will show that the estimated trade-off at different horizons in these economies exhibits a certain heterogeneity.

The results for the other smaller eight economies included in this investigation are shown in figure 3. The Southern Euro-area countries, Greece and Portugal, exhibit both an inverse relation and persistent patterns in response to the demand shock. These features are

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<sup>2</sup>A classical reference on this topic is Sims et al. (1990).

<sup>3</sup>Confidence bands are obtained by adopting the Bayesian approach proposed by Sims and Zha (1999).

also detected for Ireland, Luxembourg, Netherlands and, to a lesser extent, for Finland. Instead, as far as Austria and Belgium are concerned, the response of inflation exhibits or low persistence, in the case of Belgium, or non-statistically significance in the case of Austria.

Let us note that we have imposed a recursive structure in order to recover the two structural disturbances and hence one might legitimate wonder if the results are highly sensitive to the imposed recursive ordering with inflation ordered first. Although we do not report the results in order to save space and to avoid an inflation of figures, we have in fact estimated and identified the set of bivariate VAR models by also considering an alternative ordering, with unemployment ordered first. The conclusion regarding the presence of a trade-off between unemployment and inflation in the majority of Euro-area countries is confirmed. In other words, the results are robust to the consideration of alternative orderings of the variables.

*Insert Figure 1 about here*

*Insert Figure 2 about here*

*Insert Figure 3 about here*

#### 4. Measuring the trade-off between inflation and unemployment

In this section we take a step further in the analysis by providing an estimation of the size of the unemployment-inflation trade-off for the Euro Area and for the member countries. It is worth stressing that possible similar dynamic responses of unemployment and inflation characterizing the various countries may hide quite different sizes of the detected inverse relation between the two variables. Table 1 reports some estimations of the trade-off between inflation and unemployment in response to aggregate demand shocks at different horizons.

We measure the trade-off associated with an aggregate demand shock as the ratio of changes in inflation at different horizons and changes in unemployment in the current period:

$$Tradeoff = \frac{\Delta\pi_{t+j}}{\Delta u_t}$$

More precisely, we calculate the reaction of inflation at various horizons in response to a negative demand shock that causes a one percent increase in unemployment in the current period. Moreover, it is worth noting that, given the identifying restrictions imposed on the set of estimated VAR models, inflation does not react to the demand shock in the contemporaneous period.

Looking at table 1, we observe that although Germany does not exhibit great persistence in the response of variables to demand shocks, the effects exerted at horizons of six and twelve months, i.e. horizons with statistically significant responses of inflation, are relatively sizeable: a negative demand shock that causes an increase of 1 percent in the unemployment rate in the current period, provokes a decrease in the rate of inflation of 0.94 percent after six months and a decrease of 0.68 percent one year after the shock.

Similar results are observed in Finland, where the response of inflation, given the estimated confidence bands, becomes statistically non-significant after two years but, nonetheless, the size of the trade-off from 6 to 24 months is remarkable, in particular over the first year following the shock.

In the second largest Euro-area economy, i.e. France, we find one of the most sizeable reactions of inflation to the demand shock at shorter horizons, i.e. within the first year after the shock. In particular the peak is reached after six months with a contraction in the inflation rate of 1.41 percent. However, sizeable though decreasing responses of inflation persist in the subsequent three years.

A remarkable size of the trade-off is also detected for the Netherlands. In fact, the trade-off in this country is both large and persistent. In particular, it reaches a maximum of 1.43 after two years.

Italy, conversely, exhibits significant responses of variables over more than six years but, nevertheless, the trade-off has a maximum size of 0.28, reached 36 months following the demand shock.

As for the other Mediterranean countries, in Portugal the maximum size of the trade-off is close to the value shown for Italy. Moreover, even for this country persistent effects associated with the demand shocks are detected. Instead, for Greece and Spain our results show a stronger reaction of the inflation rate to changes in unemployment: a one percent increase in the rate of unemployment provokes a 0.48 decrease in inflation in the contemporaneous period with a maximum effect of 0.85 after two years in Spain, while in Greece although the contemporaneous response of inflation is mute, after twelve months following the adverse demand shock, there is a 0.31 per cent decrease in the inflation rate and a maximum negative effect that is reached after three years at a value of 0.63 percent.

*Insert Table 1 about here*

## 5. Monetary policy and the unemployment-inflation trade-off in the Euro Area

Monetary policy shocks, by inducing changes in interest rates, cause movements on the aggregate demand side of the economy and hence are another potential source of the unemployment-inflation trade-off.

In this section we build a VAR model augmented by monetary policy variables and the exchange rate. We aim to identify a monetary policy shock at the Euro-area level and then to characterize the dynamic responses of unemployment and inflation.

More precisely, we estimate a VAR model including four variables.

$$A(L)X_t = \mu + e_t \tag{3}$$

The  $4 \times 1$  vector  $X_t$  is given by:

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

Thus, besides the Euro-area inflation rate,  $\pi_t$ , and unemployment rate,  $u_t$ , included in the bivariate VARs of previous sections, the VAR model now includes the differential between the Eonia and the federal funds rate,  $i_t - i_t^*$ , and the nominal exchange rate,  $\epsilon_t$ , defined as US dollars per currency units.<sup>4</sup>

It is worth recalling that a VAR model including inflation, unemployment and the federal funds rate, with all the variables in levels, has been estimated for the US economy in the postwar period by Stock and Watson (2001).

Nevertheless, we believe it is important for a proper characterization of the monetary policy conducted by the European Central Bank to use the differential between the Euro area and US short-term interest rate. Indeed, this implies the specification of a reaction function of the ECB in terms of an open-economy monetary policy rule. The stance of monetary policy is measured by the short-term interest rates (see e.g. Bernanke and Mihov, 1998 and Taylor, 1999).

The importance of including both the foreign interest rate and the exchange rate in the specification of monetary policy rules for open economies has been emphasized, among others, by Svensson (2003). It is also important to stress that this specification of the monetary rule does not seem to suffer from zero lower bound restrictions, since monetary policy choices are expressed in relative terms and hence negative values of the differential are allowed.

We identify the monetary policy shock by imposing a recursive contemporaneous structure. Thus, given the general relation between the vector of error terms,  $e_t$ , and the vector of exogenous shocks,  $\epsilon_t$ :  $e_t = F\epsilon_t$ , it follows that  $FF' = \Sigma_e$ . Where in this case  $F$  is selected as the unique lower triangular matrix such that  $FF' = \Sigma_e$ .

This identification strategy for investigations concerning the dynamic effects of monetary policy shocks on real and nominal macroeconomic variables has been popularized by Christiano et al. (1999). The economic interpretation of the imposed restrictions is, essentially, that unexpected changes in short-term interest rates have delayed effects on both inflation and unemployment.

Another relevant application of this identification strategy of structural shocks in large open economies is provided by Eichenbaum and Evans (1995).

Figure 4 shows that in response to a monetary policy tightening, i.e. in response to an increase in the differential between the EONIA and the Federal Funds Rate, there is a movement in opposite directions of Euro-area unemployment and inflation. More precisely, for around two years the reaction of inflation turns out to be statistically non-significant but thereafter there is a significant decrease in the rate of inflation which lasts for around three years. Instead, the unemployment rate begins to increase in response to the monetary policy shock after six months and this effect persists for five years.

We can also quantify the dynamic effects exerted by the monetary policy shock: a 1 percent increase in the differential between the two monetary policy rates, i.e. a monetary tightening in the Euro Area, causes a maximum increase in unemployment of 1,3 percent after 36 months and a maximum decrease in inflation of 0.53 percent at the same horizon.

Thus, and summing up, the unemployment-inflation trade-off, conditionally to aggregate

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<sup>4</sup>Monthly series of federal funds rate and exchange rate are taken from FRED at the St. Louis FED Web site.

demand shocks, is both an aggregate Euro-area phenomenon and a national one. At least in the majority of Euro-area countries. Moreover, as far as the trade-off induced by monetary policy shocks is concerned, we find significant evidence of its existence at the aggregate Euro-area level.

*Insert Figure 4 about here*

## 6. Conclusion and some implications for monetary policy

This study has shown that the unemployment-inflation trade-off is still alive in the Euro Area. Moreover, we have detected the presence of a significant trade-off also at the national level, by investigating the relation between inflation and unemployment in those countries that have adopted the single currency since 1999, and in Greece, that instead entered the Eurozone in 2002.

In all the twelve countries considered in the present investigation we have found evidence of an inverse relation between unemployment and inflation in response to aggregate demand shocks. Nevertheless, we have also detected a certain degree of heterogeneity concerning the size of the trade-off in the national economies. For example, in the case of France, a negative demand shock that causes an increase of 1 percent in unemployment in the current period is associated with a maximum decrease in inflation of 1.4 percent. On the other hand, in Italy, an increase in the rate of unemployment of equal size, i.e. 1 percent in the current period, produces a maximum decrease in the inflation rate of around 0.3 percent after three years. Considering that all these economies share a common currency, a common central bank and the same exchange rate regime, a possible explanation for the differences might lie in the institutional features of the national labour and goods markets. For example, it is a common view that labour markets in Mediterranean countries are characterized by a higher degree of rigidity. And in fact, our estimations show that in these countries potential disinflationary processes could be more costly. Of course, in the light of the current low values of inflation in Euro-area countries, this does not seem to be an imminent problem for the policy agenda.

As far as the response of unemployment and inflation to monetary policy shocks is concerned, we find that an inverse relation holds in the Euro Area over the EMU period: an increase in short-term interest rates, more precisely a relative increase with respect to US short-term interest rates, pushes inflation and unemployment in opposite directions. In particular, three years after a 100 basis points increase in the differential between the Euro-area and the US short-term interest rate, the unemployment rate increases of 1.3 percent and the inflation rate decreases of 0.5 percent.

It is worth stressing that these values imply a relatively flat Phillips relation at the Euro-area level, conditionally to monetary policy shocks. If we are sufficiently confident that the linear multivariate model used in this investigation provides a satisfying characterization of the dynamic interaction between unemployment and inflation, then the conclusion should be that in order to obtain an increase in the inflation rate of 1 percent, the ECB would need to generate a strong expansion of the economy so as to obtain a reduction of the unemployment

rate by nearly 2.5 percent. Indeed, these results are consistent with the difficulties faced by the ECB in recent years in its effort to prevent risk of deflation and aim towards the target of two percent. So far, as is well known, this has turned out to be an almost Sisyphean task. The present study provides another possible interpretation of these difficulties as due to the flattening of the Phillips curve in the Euro Area.

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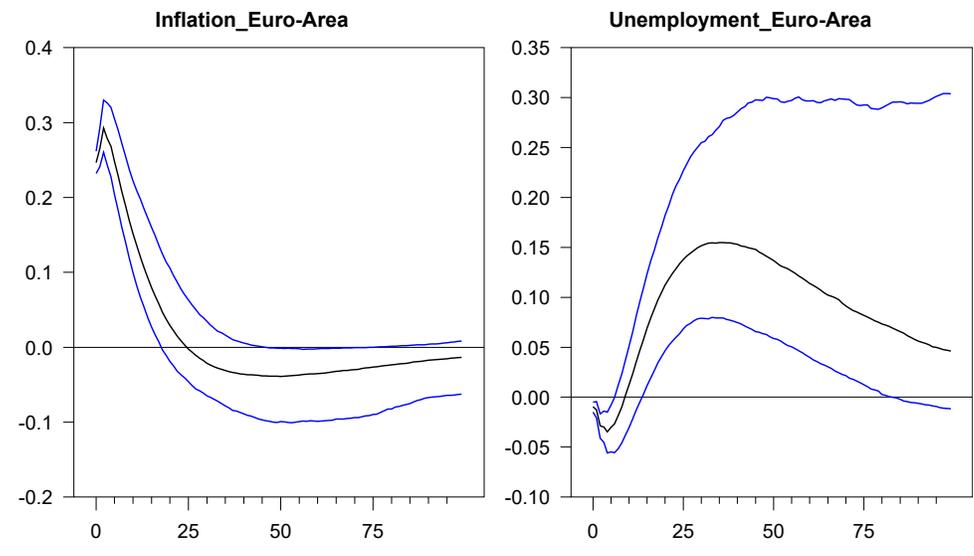
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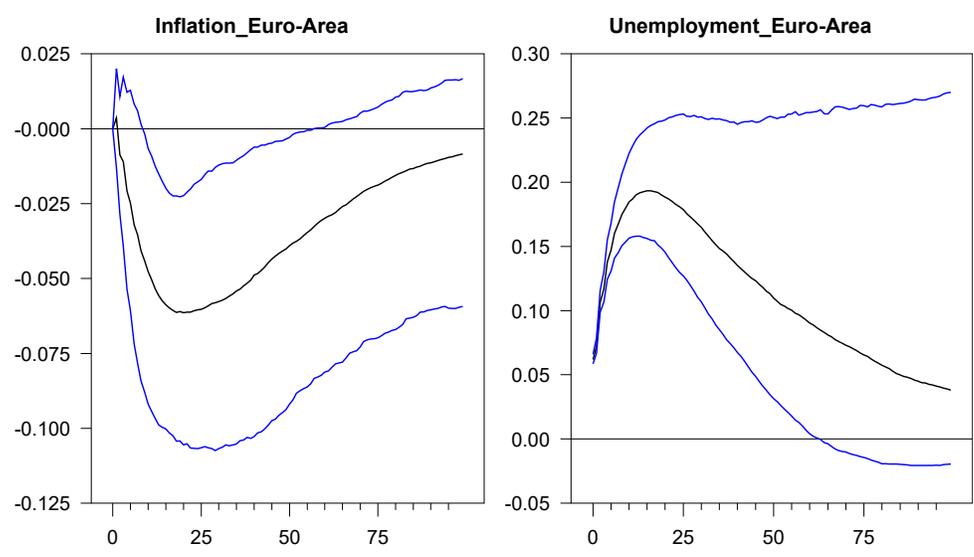
Table 1. Measuring the trade-off between unemployment and inflation at different horizons.

Horizon	EA	AU	BE	FI	FR	GE	GR	IR	IT	LU	NE	PO	SP
6	-0.42	NS	-0.6	-1.30	-1.41	-0.94	NS	-0.93	-0.1	-0.1	-0.94	NS	-0.46
12	-0.83	NS	-0.4	-1.17	-1.04	-0.68	-0.31	-1.14	-0.17	-0.17	-1.31	-0.23	-0.69
24	-1.02	NS	NS	-0.76	-0.59	NS	-0.54	-0.97	-0.20	-0.20	-1.43	-0.35	-0.85
36	-0.82	NS	NS	NS	-0.48	NS	-0.63	-0.78	-0.28	-0.28	-1.25	-0.37	-0.77
48	-0.67	NS	NS	NS	-0.31	NS	-0.61	-0.69	-0.25	-0.25	-0.98	-0.37	-0.69

Note: For each country, changes in the inflation rate at different horizons are computed in response to an aggregate demand shock that raises the unemployment rate of 1 percent in the current period. "NS" indicates a statistically non-significant trade-off.



Responses to Supply Shock



Responses to Demand Shock

Figure 1. Responses of Euro-area inflation and unemployment to aggregate supply and demand shocks. Error bands set at the 10th and the 90th percentiles.

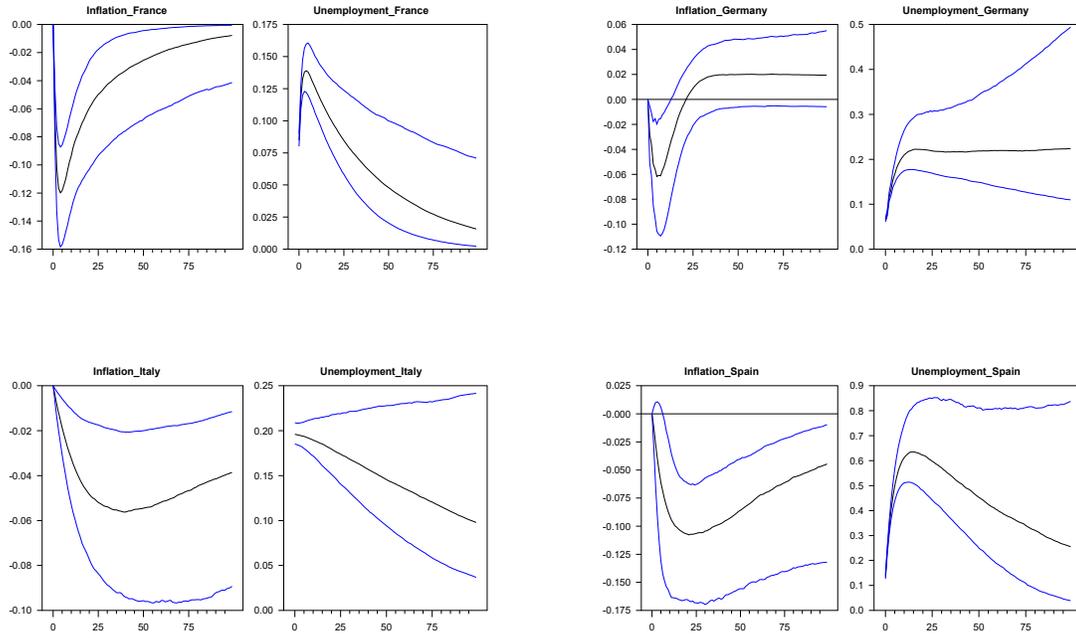


Figure 2. Impulse responses to an aggregate demand shock. Responses of inflation and unemployment for the four largest Euro-area economies. Error bands set at the 10th and the 90th percentiles.

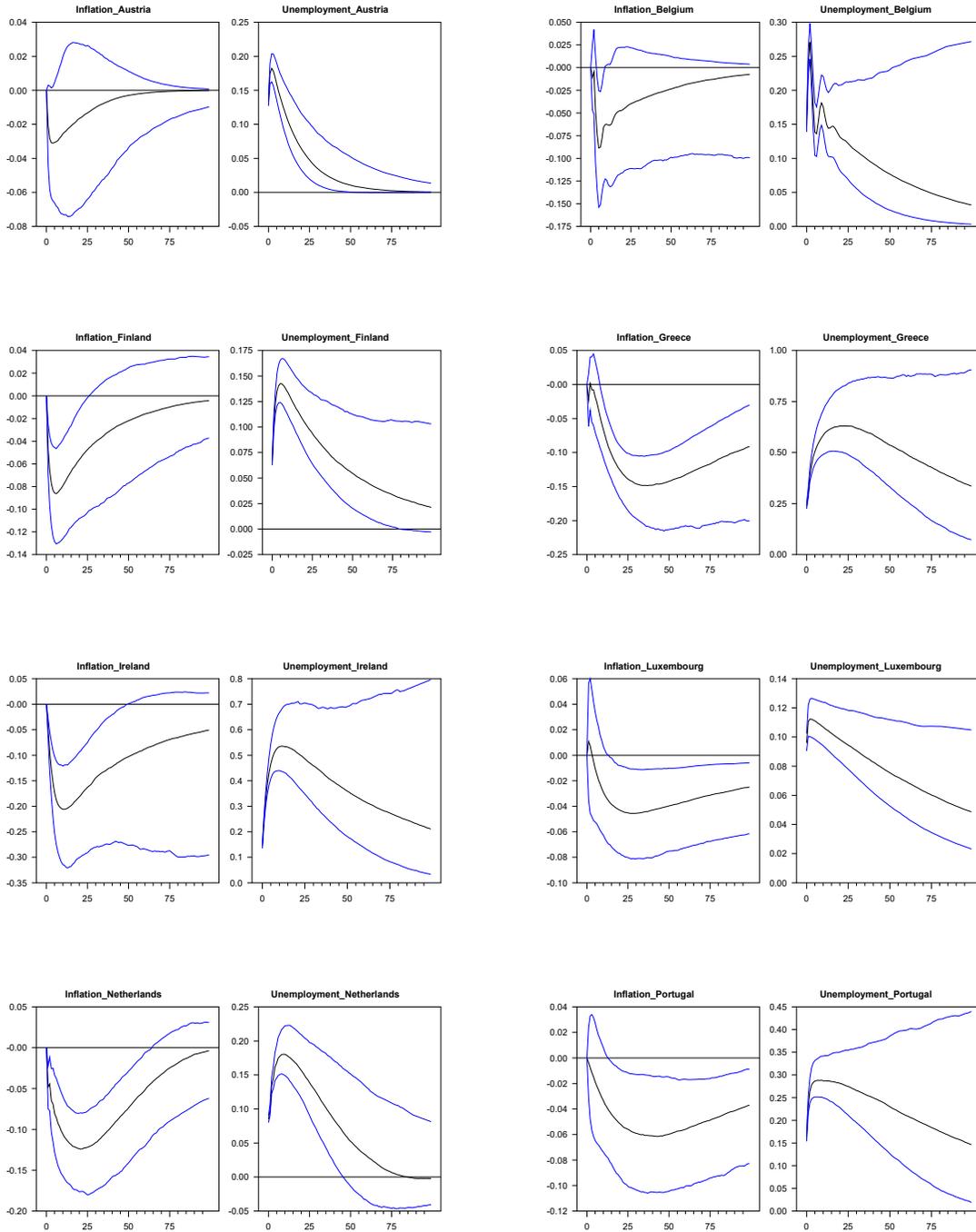
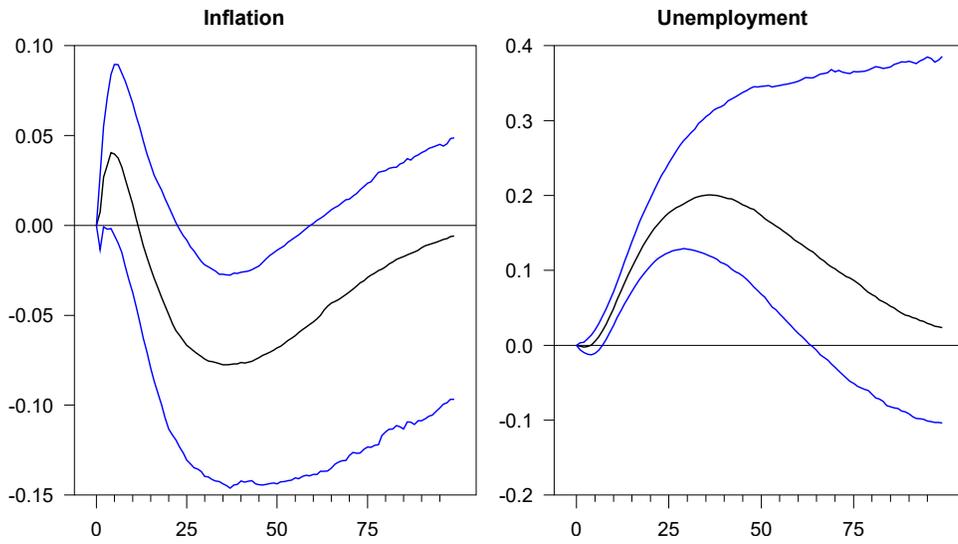


Figure 3. Impulse responses to an aggregate demand shock. Responses of inflation and unemployment for the other national economies included in the investigation. Error bands set at the 10th and the 90th percentiles.



*Figure 4.* Responses of Euro-area inflation and unemployment to monetary policy shocks. Error bands set at the 10th and the 90th percentiles.

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