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#### IMPRESSUM

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# THE ASYMMETRIC EFFECTS OF MONETARY POLICY IN THE EURO AREA

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## Abstract

We study sign asymmetry in the effect of conventional monetary policy on key real macroeconomic variables in the euro area, using monthly data ranging from 2002 until 2022. We make use of local projections with state-dependence coming from the sign of the monetary policy shock, employing shocks identified using high-frequency identification. Our baseline findings suggest that there are asymmetries in the response of real variables to contractionary and expansionary monetary policy shocks. Furthermore, we investigate the potential sources of asymmetry by clustering countries that present similarities in proxies of labour, financial and housing markets, respectively. We find results that are consistent with theoretical predictions that downward nominal wage rigidities, sectoral composition of the economy, firm sizes as well as the housing market and housing debt conditions all contribute to the sign asymmetries we uncover in our baseline results.

**Keywords:** Monetary Economics, Central Banking, High-frequency Identification, Asymmetries

**JEL Codes:** E52 Monetary Policy, E58 Central Bank and Their Policies

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# 1 Introduction

The presence and magnitude of asymmetries in the effects of monetary policy is a classic question within macroeconomics. Literature on asymmetric effects or other types of nonlinearities in the effects of monetary policy is extensive and it can be partitioned into business cycle, size and sign asymmetries. We focus on sign asymmetry and examine whether monetary policy easing and tightening have differential effects on prices and real activity. Many findings have generally supported the presence of sign asymmetry in monetary policy responses, particularly that monetary tightening has larger effects on real economic variables than easing. Evidence of sign asymmetry in the US is quite broad (De Long et al., 1988; Cover, 1992; Karras, 2013; Tenreyro & Thwaites, 2016). Focusing on the most recent literature, using US data ranging from 1961 to the 2007-08 financial crisis, Debortoli et al. (2020) similarly find that expansionary monetary policy shocks have small effects on real variables and large effects on prices and vice-versa for contractionary shocks. Evidence of this asymmetry in monetary policy transmission in the euro area is meanwhile relatively limited, particularly for recent time periods, and mixed. Murgia (2020) finds sizable asymmetries when looking at impacts on industrial production (IP) and inflation over the 2000-2016 timeframe following the narrative approach of Romer and Romer (2004). On the other hand, Laine and Pihlajamaa (2023) find no evidence of sign asymmetries on inflation in the euro area overall during the zero-lower bound period using Altavilla et al. (2019) shock identification.

The objective of this paper is to investigate sign asymmetry in the effect of conventional monetary policy on real macroeconomic variables. The sample consists of 19 euro area countries, and we use monthly data ranging from 2002 until 2022. We make use of the local projections approach of Jordà (2005) with state-dependence coming from the sign of the monetary policy shock, employing shocks identified using high-frequency identification (Altavilla et al., 2019).

As evidenced above, the literature on sign asymmetry in the euro area has been relatively scant, particularly in recent years. The novelty of our analysis lies in using data from a longer time period and for a more comprehensive set of outcome variables. Further contribution is achieved by clustering euro area countries based on institutional and economic characteristics which could explain the channels through which sign asymmetry of monetary policy shocks arises (Corsetti et al., 2022). Given the vast diversity in institutional characteristics and economic features in the euro area, this group of countries is ideal to empirically study how characteristics affect sign asymmetry in monetary transmission. Furthermore, the financial and debt crisis in the EA has led to further changes in channels

over the time period under analysis, further motivating a country clustering approach to corroborate the baseline results.

The asymmetric responses of real variables to monetary policy shocks could potentially be explained through theoretical channels such as the labour and financial markets. More specifically, downward wage rigidity, as well as the financial sensitivity of households and of firms, can explain the presence of sign asymmetry of monetary policy shocks (Debortoli et al., 2020; Ciccarelli et al., 2013). Following a contractionary monetary policy shock, downward wage rigidities prevent nominal wages from falling, leading to involuntary unemployment (Debortoli et al., 2020; Barnichon et al., 2017). In turn, policy tightening has a larger effect on real activity variables relative to policy easing. To assess the financial sensitivity of firms, the literature makes reference to the size of firms and sectoral composition. In particular, small firms tend to be more credit constrained and are more dependent on bank financing from smaller banks, which in turn are more financially constrained (Ciccarelli et al., 2013). Banks which are more financially constrained are more likely to raise interest rates following an increase in policy rates (Kishan & Opiela, 2006). Thus, a stronger asymmetry in countries with larger shares of SMEs is expected.

Our baseline findings suggest that contractionary monetary policy shocks have a more immediate and stronger effect on real variables than expansionary shocks. The results are robust to the various robustness checks carried out, including varying leads and lags of independent variables in the regression and removing different countries from our sample. Furthermore, the country grouping extension shows that there are stronger sign asymmetries in monetary policy transmission for countries with a higher degree of downward wage rigidity. Additionally, the asymmetric effects on unemployment and industrial production (IP) are less pronounced in countries with smaller shares of small-medium sized enterprises (SMEs). Lastly, countries with higher shares of home ownership and variable rate mortgages exhibit larger declines in consumption following increases in policy rates, and smaller increases after policy easing. This group of countries also exhibited a stronger increase in unemployment as a result of contractionary shocks.

The rest of the paper is structured as follows. Section 2 outlines the methodology used for the baseline results and the country cluster extension, together with the data sources used. Section 3 presents the baseline results and robustness checks, while Section 4 presents the results relating to channels through which asymmetric effects of monetary policy arise. Section 5 concludes.

## 2 Methodology and Data

### 2.1 Econometric specification

We separately estimate the impact of expansionary and contractionary monetary policy shocks in the euro area by employing Jordà (2005) local projections augmented with nonlinearities (e.g. Shirota, 2022; Laine & Pihlajamaa, 2023; Hülsewig & Rottmann, 2023). The panel structure of our data consists of monthly data ranging from 2002M1 to 2022M10, introducing each of the euro area member countries into the sample as from the year they joined the euro area. The full sample comprises 4,054 observations and, over the sample period, we identify 145 expansionary monetary policy shocks and 73 contractionary shocks. A time-series plot of the monetary policy surprises, classified as expansionary or contractionary, is reported in Figure 1.

Local projections have been applied to a wide range of topics in the literature aside from monetary policy, including fiscal multipliers (e.g. Ghassibe & Zanetti, 2022; Ramey & Zubairy, 2018), financial stability (e.g. Jung, 2023) and the link between credit cycles and recession dynamics (e.g. Jordà et al., 2015). Apart from their relative simplicity, advantages of local projections include their robustness to misspecification of the data generating process - in contrast to more typical methods of estimating impulse response functions such as vector autoregressions (VARs) - as well as their ability to easily accommodate nonlinear effects (Jordà, 2005; Miranda-Agrippino & Ricco, 2021; Ramey, 2016).<sup>1</sup> Its robustness to potential misspecification of the data generating process (DGP) makes this methodology favourable for forecasting at longer horizons (Montiel Olea & Plagborg-Møller, 2021; Ramey, 2016).

Our specification takes the following form. For each forecast horizon  $h$ , we estimate the following regression:

$$y_{i,t+h} - y_{i,t-1} = \alpha_i + \delta_t \left( \phi_h^+ \epsilon_t + \mathbf{x}'_{i,t} \boldsymbol{\beta}_{0,h}^+ + \sum_{j=1}^{12} \mathbf{x}'_{i,t-j} \boldsymbol{\beta}_{j,h}^+ \right) + (1 - \delta_t) \left( \phi_h^- \epsilon_t + \mathbf{x}'_{i,t} \boldsymbol{\beta}_{0,h}^- + \sum_{j=1}^{12} \mathbf{x}'_{i,t-j} \boldsymbol{\beta}_{j,h}^- \right) + u_{i,t+h} \quad (1)$$

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<sup>1</sup>Plagborg-Møller and Wolf (2021) show that in population and with unrestricted lag structures, local projections and VARs estimate the same impulse responses even under nonlinear data generating processes. Moreover, with finite lag lengths  $p$ , their impulse responses will tend to be very similar at forecast horizons  $h < p$  under appropriate specification.

where  $y_{i,t}$  is the dependent variable for country  $i$  at time  $t$ ,  $h$  is the forecast horizon,  $\alpha_i$  is a country fixed effect,  $\delta_t$  is a state dummy variable which takes a value of 1 when the monetary policy shock is positive and 0 when it is negative,  $\epsilon_t$  is the value of the monetary policy shock at time  $t$ ,  $\mathbf{x}'_{i,t}$  and  $\mathbf{x}'_{i,t-j}$  are contemporaneous and lagged independent variables, for which we estimate coefficients  $\beta_{0,h}$  and  $\beta_{j,h}$  in each state, and  $u_{i,t+h}$  is the error term of the horizon- $h$  regression.

We obtain state-dependent impulse response functions by estimating the above regression for each successive forecast horizon, obtaining the cumulative impact of a shock at time  $t$  on the dependent variable  $h$  months ahead, namely  $y_{i,t+h} - y_{i,t-1}$ , and plotting the series of  $h$  coefficients for each of the two states,  $\phi_h^+$  and  $\phi_h^-$ . In this case, since we are considering the euro area, the shock values  $\epsilon_t$  are common for all countries in the sample. We formalise our analysis of asymmetric reactions to monetary policy shocks by carrying out, in each horizon regression, a t-test for the equality of magnitudes of the coefficients pertaining to the impulse response in each state ( $\phi_h^+$  and  $\phi_h^-$ ).

We set the maximum forecast horizon to 24 months in all our estimations. Also, following Jordà (2005) we employ Newey-West variance-covariance matrices in all regressions to account for heteroskedasticity and serial correlation of the error terms. Appendix I reports complementary inference based on Driscoll-Kraay variance-covariance matrices and when grouping by country and time. Finally, we set the lag length for independent variables to 12 months. In subsection 3.2 we present the results of our robustness tests on the lag length of independent variables among others. For our estimations, we use the `lpirfs` package in R (Adämmer, 2019).

## 2.2 Dependent and independent variables

We estimate the above equations for two dependent variables: unemployment and industrial production (IP). The seasonally-adjusted IP index is employed as a measure of real output (Eurostat, 2023e) and the unemployment rate is estimated to capture the impact of monetary policy shocks on the labour market (Eurostat, 2023f). The data for the IP index and the unemployment rate are seasonally-adjusted and the indices are indexed at 100 in 2015.

In line with Ramey (2016), when regressing each of these two dependent variables, we include the contemporaneous values of the other variable as regressor, up to 12 lags of the two, as well as contemporaneous and lagged values of the logarithm of the HICP index (ECB, 2023b), which we use to gauge consumer prices. Also, following Ramey (2016),  $\mathbf{x}'_{i,t}$

also includes a constant term and deterministic time trends up to the third order. The HICP index and IP are included in log levels, whilst the unemployment rate is included in levels. Apart from lags of the dependent variables, which has been shown to lead to more efficient estimates (Li et al., 2022), we include up to 12 lags of the shock to account for the possibility of any serial correlation in the shock series (Ramey, 2016).

We also include some additional control variables in the regression, such as money market interest rates which is the averaged EONIA (Euro OverNight Index Average) rates over each month (Eurostat, 2023d) and the OECD euro area stock price index (OECD, 2023). We include such variables in order to clear any possible residual endogeneity of the shock (Ramey, 2016).

### **2.3 Monetary policy shock identification**

We employ monetary policy shocks identified by Altavilla et al. (2019), who construct a database for the Euro Area using high-frequency identification methods. High-frequency identification is one of several methods commonly used in the literature for isolating monetary policy shocks (Ramey, 2016; Stock & Watson, 2018). The method hinges on quantifying movements in interest rates and asset prices in narrow time windows around central bank policy decision announcements, thus identifying unanticipated policy actions by the monetary authorities. The narrow time window ensures that isolated unexpected variation is plausibly exogenous to economic conditions and causality flows from monetary policy to the measured interest rate and financial market changes (Altavilla et al., 2019; Gertler & Karadi, 2015; Bauer & Swanson, 2023). The identified shocks can thus be used to extract causal impacts of monetary policy on financial and real economic variables.

Building on some of the earlier work such as Kuttner (2001) and Gurkaynak et al. (2004) for the US, Altavilla et al. (2019) extract factors from intraday changes in yields of risk-free rates of different maturities (primarily Overnight Index Swap (OIS) rates), ranging from one month to ten years, within each of the two time windows that characterise the announcements of ECB policy decisions. ECB policy decisions are communicated in two steps: via a press release, where no rationale for the decision is disclosed, followed by a press conference window, where further information is provided regarding the decision. Using factor analysis, the authors extract conventional and unconventional monetary policy communication shocks from both windows. The authors identify four factors and normalise them to have unit effects on specific sections of the yield curve.

In our analysis, we focus on the effects of the “Target” factor, which measures variation

in the short-term rates, thus proxying conventional monetary policy. Specifically, a unit change in the Target factor has a unit effect (100 basis points) on the 1-month OIS rate. Because this factor moves short-term rates, thus reflecting unexpected changes in the current policy stance, it provides the most appropriate proxy for conventional monetary policy shocks. In fact, Altavilla et al. (2019) also identify latent factors at longer maturities, but the latter reflect a combination of policy expectations, forward guidance, and information effects, which goes beyond the scope of our analysis. The value of the series is set to zero in months where no policy decisions take place.

## 2.4 Robustness checks and potential limitations

We run several additional regressions to verify the robustness of our baseline results. First, we rerun our baseline results excluding lagged shocks to get an indication of whether serial correlation in the shock series could be affecting our results. Meanwhile, Alloza et al. (2020) suggest including leads of the shock to eliminate serial correlation. Therefore, we run robustness checks including 4, 8, and 12 leads of the shock in our regression.

Results in local projections frameworks may be sensitive to the lag length chosen for independent variables (Bauer & Swanson, 2023). We also re-run our regressions including 6 and 9 lags of our independent variables. There are different approaches in the literature on whether or not to include certain regressors contemporaneously.<sup>2</sup> We run a robustness check consisting of not including remaining dependent variables as contemporaneous regressors. Lastly, we run our baseline specification excluding sequentially the five largest euro area countries by ECB capital key - Germany, France, Italy, Spain and the Netherlands - to assess any sensitivity of our results to the data from any specific country.

Recent literature has occasionally cast doubts on the properties of shocks identified around central bank policy announcements. One particular strand argues that rather than just monetary policy shocks, the identified shocks also encompass “central bank information shocks” – new information about the central bank’s assessment of the economic conditions and outlook (Jarociński & Karadi, 2020; Miranda-Agrippino & Ricco, 2021; Bauer & Swanson, 2023).<sup>3</sup> Jarociński and Karadi (2020) find that shock series from which the impact

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<sup>2</sup>In general, including such variables is consistent with the recursiveness assumption common in VAR identification, which assumes that variables such as output and unemployment do not respond to monetary policy shocks within the same period (Ramey, 2016). Still, other authors such as Laine and Pihlajamaa (2023) exclude this assumption.

<sup>3</sup>For instance, a policy tightening expected to have downward effects on prices and activity may be conflated with ‘news’ of central bank expectations of upward price and output pressures, which may dampen or even reverse the expected effects of monetary policy, leading to often-observed

of information effects are not purged may bias estimates; Miranda-Agrippino and Ricco (2021) show similar findings after cleaning their initial series of high-frequency shocks from any correlation with the Fed’s Greenbook forecasts for major macroeconomic indicators. Similarly, Bauer and Swanson (2023) show that Miranda-Agrippino and Ricco (2021)’s results can be obtained using publicly available surveys of professional forecasters available prior to the central bank announcement. They obtain orthogonalised shocks by regressing their series on a selection of six variables, and consistently find larger and more significant effects of the orthogonalized shock on macroeconomic variables than with the unadjusted shocks.

In light of these considerations, we assess the robustness of our baseline results by re-estimating the analysis using the shock series proposed by Jarociński and Karadi (2020), which explicitly disentangles monetary policy shocks from central bank information effects. The results, discussed in Section 3.2, indicate that our main findings remain largely unchanged under this alternative identification strategy.

## 2.5 Country groupings: Sources of asymmetry

We investigate further to understand the channels behind the observed asymmetries in monetary policy transmission within the euro area. To do this, we first define characteristics which have been previously identified to have a strong positive correlation with the strength of monetary policy impacts within a similar geographic and time period (e.g. Burriel & Galesi, 2018; Corsetti et al., 2022). The potential channels we consider include elements from the labour market and the financial and housing market to capture the sensitivity of households or firms to changes in financing conditions. For each potential channel we examine, the sample of 19 euro-area countries are then grouped depending on whether they were above or below the euro-area median value of the variable relating to each specific channel, with median values calculated over the 2002-2022 timeframe for most variables.

The variables used to measure the financial sensitivity of firms are the share of value-added generated from small-medium sized enterprises (SMEs) or from industry (Eurostat, 2023c, 2023a), while those measuring the financial sensitivity of households are the homeownership rate (Eurostat, 2023b) and the share of adjustable rate mortgages (ECB, 2023a). For the labour market, we proxy downward wage rigidity using the percentage of firms that cut nominal wages over the 2010-2013 period using the most recent Eurosystem Wage Dynamics Network (WDN) survey (Izquierdo et al., 2017). This measure reflects institutional features price and output ‘puzzles’ in empirical studies.

of wage-setting, which tend to evolve slowly over time, making the assumption of broadly stable wage rigidity across periods a reasonable approximation for our analysis. In Table 1 we present summary statistics on institutional and economic characteristics of the euro area, which proxy potential sources of asymmetry. Furthermore, as observed in the country maps in Appendix G, the groupings differ across the channels, although some overlaps are still present in using a 19 country sample.

### 3 Baseline results

#### 3.1 Asymmetric effects of monetary policy at EA level

The left column of Figure 2 shows the estimated impulses from the local projections estimation performed for the euro area between January 2002 and October 2022. As already stated in the Methodology section, we focus on the effect of a 100 basis point increase (contractionary shock) or decrease (expansionary shock) in the Overnight Index Swap rate with 1 month maturity, identified through the Target factor in Altavilla et al. (2019), on two real macroeconomic variables, namely the unemployment rate and the logarithm of industrial production (IP).

The first row of Figure 2 shows the response of the unemployment rate. In the right column of Figure 2, we report the respective p-values from a t-test comparing the magnitude of the coefficients of the two states for each time horizon. We observe that the effect of an expansionary Target shock on unemployment is initially lower in magnitude and grows more slowly than the response generated by a contractionary shock. In particular, a contractionary shock generates a peak cumulative increase in the unemployment rate of 0.05 percentage points, occurring around the 14th month, while an expansionary shock leads to a gradual cumulative decrease that reaches a magnitude of around 0.1 percentage points on the 22nd month. Overall, we find evidence of asymmetry across states between the 3rd and the 7th month. These impulse response functions (IRFs) suggest the presence of unobserved factors driving asymmetries, such as nominal downward wage rigidities, since downward wage stickiness plays a role in the contractionary setting, rather than in the expansionary one. We discuss the channel of downward wage rigidity in the next section.

The second row of Figure 2 reports the response of the logarithm of IP and the respective p-values. Our results show that IP drops immediately after the contractionary shock. We estimate that a contractionary Target shock generates a drop of 0.9% in IP at its peak, namely in the second month after the shock. We see that the p-values show evidence

of sign asymmetry during the first months after the shock, exactly when IP experiences the strongest shrinkage due to the contractionary shock. When excluding the COVID-19 observations from the sample, the impulse responses of IP present a slightly different dynamic: instead of the sudden decrease on the second horizon, IP decreases over horizons, reaching a trough of  $-0.4\%$  on the 15th horizon.

Our findings for IP (output) being more responsive to contractionary shocks are in line with a number of the results in the literature. For instance, Karras (1996) finds that only increases in interest rates have a statistically significant effect on output. Additionally, Zeev et al. (2019), though using US data, finds that contractionary shocks have a  $0.4\%$ - $0.5\%$  greater reduction in IP than the corresponding expansionary shocks, in line with our findings in Figure 2. Comparing the magnitude of responses across output and inflation, our results are in line with Murgia (2020), where IP responds to a 100 bps contractionary shock by over  $0.5\%$ . The impulse responses for output are also consistent with the results of earlier research on the transmission of monetary policy in the euro area, namely that a monetary policy shock has a faster and more short-lived effect on euro area real output, in contrast to a more gradual effect on inflation (Angeloni et al., 2003).

Beyond the non-linear responses reported in Figure 2, we also present the linear impulse responses to the monetary policy shock series in Figure A1 of Appendix A. The linear responses display patterns consistent with those obtained in the non-linear framework, although with smaller magnitudes, and remain statistically significant over several horizons. We also report results obtained using a standardized version of the shock series in Figure B1 of Appendix B. Standardizing the shocks mechanically increases the magnitude of the coefficients (approximately doubling them), while leaving the dynamics of the responses unchanged. Finally, we report the results of a linear LP-IV estimation in Appendix C.

## 3.2 Robustness checks

**Specification robustness.** We run several robustness checks in line with the discussion in the Methodology section. Specifically, removing lagged shocks has only slight effects on results for industrial production, but more prolonged asymmetry is observed in the effects on the unemployment rate after removing lagged shocks (Figure H5 in Appendix D). Secondly, our baseline results are not sensitive to changes in the lag to 6 and 9 months. Our baseline results are not sensitive to removing contemporaneous regressors from the specification (Figure D5). Including leads of the shock also leaves our results largely unchanged (Figure D3). Lastly, removing one by one from our sample the five largest countries in the euro area by ECB capital key also leaves our results virtually

unchanged (see Figure D4). Due to space constraints, we only include one result for each kind of robustness check, but all results are available upon request.

**Information effects and alternative shock series.** As discussed in the Methodology, shocks identified around policy announcements may conflate unexpected changes in the policy stance with information revealed by the central bank about economic conditions (Jarociński & Karadi, 2020; Miranda-Agrippino & Ricco, 2021). To address this concern, we re-estimate our analysis using the monetary policy shocks constructed by Jarociński and Karadi (2020) for the euro area<sup>4</sup>, which explicitly disentangle monetary policy shocks from central bank information shocks.

The results under the Jarocinski and Karadi (2020)’s monetary policy shock series are reported in Appendix E, where, for each variable, we compare impulse responses obtained using the baseline shocks of Altavilla et al. (2019) (as in Figure 2) with those obtained using the monetary policy shock series of Jarociński and Karadi (2020). Figure E1 reports the IRFs and corresponding p-value profiles for the unemployment rate and industrial production, constructed using Newey–West variance–covariance matrices. The responses of both variables to contractionary monetary policy shocks are remarkably similar in terms of magnitude and dynamics when using either the Jarociński and Karadi (2020) monetary policy shocks or the Altavilla et al. (2019) target shock. Also, the p-value profiles based on the Jarociński and Karadi (2020) series provide even stronger evidence of sign asymmetry for both the unemployment rate and industrial production. Similarly, the responses to expansionary monetary policy shocks are largely unchanged across the two identification strategies.

Figures E2 and E3 report the same results, constructed using Driscoll-Kraay standard errors and when clustering by country and time. Remarkably, the IRFs produced with the Jarociński and Karadi (2020) monetary policy shock series are strongly statistically significant and more persistent over time compared with the series of Altavilla et al. (2019), both under Newey–West and Driscoll–Kraay variance–covariance matrices. Ultimately, this robustness test shows that our baseline results are robust to alternative monetary policy shock identification.

**COVID-19 period.** To account for differences potentially driven by COVID-19 observations we re-estimate our model using a sample that ends in December 2019, rather than

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<sup>4</sup>We use the *MP\_median* shock series, obtained with the median rotation that implements the sign restrictions. See Jarociński, M. and Karadi, P. (2020), *Deconstructing Monetary Policy Surprises: The Role of Information Shocks*, *American Economic Journal: Macroeconomics*.

our baseline sample, which extends to October 2022. Figure F1 in Appendix F shows the results. Overall, excluding the COVID-19 observations does not materially affect the dynamics of the impulse responses. Nevertheless, while industrial production continues to exhibit strong asymmetries under both samples, the unemployment rate displays dynamics similar to those identified in does not exhibit asymmetries in the absolute values of the coefficients.

## 4 Sources of asymmetric responses to monetary policy in the euro area

As outlined in the Methodology, we group countries conditional on a set of economic and institutional characteristics to test whether these underlying country-specific attributes can explain the sign asymmetry in the transmission of monetary policy. Specifically, for each potential channel we examine, the sample of 19 euro-area countries are then grouped depending on whether they were above or below the euro-area median value of the variable related to each specific channel, as specified in the Methodology. We explore further disaggregations by using k-means clustering to split countries into four non-homogeneous groups, and plot the results from this in Appendix I. We focus on the housing market, sectoral composition of the economy, and on labour market rigidities, specifically downward nominal wage rigidities (Burriel & Galesi, 2018; Ciccarelli et al., 2013; Corsetti et al., 2022). As before, we run our analysis on IP and unemployment rate. Furthermore, we include private consumption as a third dependent variable as it can give further insights on real activity.

While the response of commercial banks to changes in policy rates is crucial in determining the potential impact of monetary policy on the economy, this section focuses solely on the characteristics of non-financial borrowers, namely households and firms. This is because banks' response depends on their liquidity (Kashyap & Stein, 1995; Burriel & Galesi, 2018) and this is in turn correlated with bank size (De Santis & Surico, 2013; Jiménez et al., 2012). In turn, as firms tend to borrow from banks of similar size (Ehrmann & Fratzscher, 2009; Ciccarelli et al., 2013), by looking in detail at firm size we also expect to capture the overall banking conditions of the countries. Furthermore, the sectoral composition and the sensitivity of households to policy rate changes, as measured by the homeownership rate and the variable rate mortgage share, can shed further light on the asymmetries of monetary policy. In the current section, we discuss the results of the sign restricted effects of monetary policy, while the IRFs without sign restrictions for the key dependent variables

are provided in Appendix H.

## 4.1 Housing market

The housing market and household debt conditions have attracted significant attention due to their potential role in the transmission of monetary policy (Amzallag et al., 2019; Baum et al., 2013; Dias & Duarte, 2022). We focus on two variables that capture the financial sensitivity of households to policy rate changes: the home ownership rate and the share of variable rate mortgages. These two variables should capture both the role of the stock and flow of debt on the transmission mechanism. Within this section, we evaluate the effects of unexpected changes in the policy rate on an additional real activity measure, private consumption (ECB, 2026). We use the logarithm of consumption, interpolated from quarterly to monthly frequency (Chow & Lin, 1971). Fluctuations in mortgage payments and debt refinancing would impact consumer demand by affecting disposable income and influencing expectations about future income and wealth. Economies with a higher share of home ownership and variable rate mortgages would be more affected by changes in target rates set by the ECB (Corsetti et al., 2022). Furthermore, high household debt levels may impede the benefits of interest rate cuts in stimulating consumption due to debt overhang (Dynan et al., 2012).

Figure 3 illustrates that, while the effects of monetary policy shocks on consumption paths are broadly similar across the two country groupings based on homeownership rates, there are notable differences in the magnitude of the coefficients when considering the share of variable-rate mortgage loans. Specifically, countries with a higher share of households holding variable-rate mortgages experience larger declines in consumption following contractionary shocks, as well as significant increases in consumption after expansionary shocks. The response to contractionary shocks is immediate, whereas the effects of expansionary shocks materialize only from around the tenth month onward.

These findings are consistent with the theoretical prediction that economies with a higher prevalence of variable-rate mortgages are more sensitive to monetary policy shocks. Moreover, consumption appears to contract more rapidly following policy tightening, while the stimulative effects of monetary easing take longer to materialize. In contrast, the relationship between homeownership rates and the transmission of monetary policy remains less clear and warrants further investigation, particularly in light of cross-country differences in rental market structures. In conclusion, while we observe that monetary policy shocks have asymmetric effects on consumption overall, we find that household leverage plays a significant role in the transmission of monetary policies to real variables.

Furthermore, in line with the empirical findings of Corsetti et al. (2022), we find that above median countries have stronger increases in unemployment as a result of contractionary shocks (Figure 4). The rationale comes from the larger decline of house prices as a response to the monetary policy shocks, which is commonly associated with a weakening of labour markets due to lower mobility of homeowner workers (Charles et al., 2013).

The greater response in unemployment points towards the idea that factors other than housing market conditions and household liquidity are playing a role in the heterogeneity of monetary policy transmission. Corroborating further on these results, recent literature has noted that both homeowners and the bottom/middle quintile of the income distribution are more sensitive to changes in policy rates. Indeed, Wong et al. (2019) and Baum et al. (2013) use a Heterogeneous Agent New Keynesian model to show that contractionary monetary policy has the highest impact on liquidity and borrowing constrained households, which are also those associated with a greater exposure to unemployment (Beraja et al., 2019). In turn, this point towards heterogeneous effects of the monetary policy transmission through the housing markets across the income distribution, where low and middle income households bear the greatest losses.

## 4.2 Sectoral composition and firm size

Within this section, we consider how the share of value-added generated from SMEs and, separately, from industry contributes to the observed asymmetry in monetary policy transmission. Extensive evidence suggests that both small banks and small firms, which tend to be more reliant on small banks, tend to face greater liquidity constraints (Ehrmann & Fratzscher, 2009; Altavilla et al., 2018; Ciccarelli et al., 2013). As a result, banks facing greater liquidity constraints have a greater need to raise interest rates in response to policy rate increases (Kishan & Opiela, 2006; Van Den Heuvel, 2002). In turn, as SMEs are generally perceived riskier by banks due to the less diversified business model (Crouzet & Mehrotra, 2020), a bank shift in risk propensity may lead to corporate borrowing rates increasing even more than the magnitude of the monetary policy shock (Jeenas, 2019). Finally, SMEs also encounter the most significant decline in market capitalization as a consequence of contractionary monetary policy (Arco-Castro et al., 2020), exacerbating their liquidity conditions and ability to borrow.

In particular, countries with a larger share of value-added originating from SMEs demonstrate a pronounced imbalance in responses of unemployment rates following monetary policy shocks (Figure 5). Expansionary monetary policy appears to only stimulate employment growth in countries where the average firm size is larger. This discrepancy also

manifests as a swifter and sharper rise in unemployment following contractionary shocks for countries where SMEs are more predominant, lasting for 15 months. These observations align with the findings presented by Buera et al. (2015), which explore how credit crunches result in a greater reduction in net employment growth for smaller firms. A similar pattern holds for IP, which experiences a more substantial contraction within this particular subset of countries. Although the response in IP begins promptly after the shock, it is less persistent compared to the impact on unemployment.

Moreover, the greater financial constraint may imply that SMEs have larger incentives to increase prices, however we do not see any significant difference in price response, and this may be attributed to the fact that demand reacts more strongly for small firms (Ehrmann & Fratzscher, 2009). It is suggested that countries where a greater share of value added comes from large enterprises may have an increased capacity to exploit their market power. This can result in these countries being more capable of raising prices compared to countries where small and medium-sized enterprises (SMEs) have a larger share of value added. The size distribution of firms within a country appears to have significant implications for the effects of monetary policy. The damage produced by unexpected hikes, particularly on the labour market, amplifies with respect to the stimulus from cuts in economies where firms' financial stability is more delicate.

Turning now to the role played by sectoral compositions in the transmission of monetary policy, Carlino and DeFina (1999) argue that economies with a larger industrial sector exhibit stronger effects on the real economy following adjustments in the policy rate. The main reasons for this is that industries are more frequent product turnover in manufacturing which means greater price flexibility (Bils & Klenow, 2004; Klenow & Kryvtsov, 2008; Nakamura & Steinsson, 2008).

Furthermore, we find that (expansionary) monetary policy is only able to stimulate employment in economies with a lower presence of the industry sector (Figure 6), while high industry economies face strongest increases in unemployment following a contractionary shock. This potentially speaks to the capital intensity of the industrial sector, making them more willing to reduce employment during credit constrained periods and more likely to allocate spending on capital and equipment following an interest rate cut. In turn, expansionary shocks lead to significant increases in industrial production only in high industry countries, whereas in countries where this sector is smaller, responses to contractionary shocks are larger in magnitude. Therefore, our findings corroborate the idea that sectoral composition has an effect on the transmission of monetary policy shocks, which supports investment and reduces the cost of capital, exerts a more substantial stimulus to economic growth in countries with a lower degree of service intensity.

### 4.3 Downward wage rigidity

Nominal wages can be revised upwards following policy easing. However, downward wage rigidities prevent nominal wages from falling, leading to excess supply at the prevailing wage rate (Debortoli et al., 2020; Barnichon et al., 2017). Due to this, contractionary monetary policy shocks are often found to have a larger effect on real activity variables, namely unemployment, in comparison to expansionary monetary policy shocks.

Figure 7 shows the differences in countries response by the degree of wage rigidity. Interestingly, much of the difference between above and below median countries is seen with respect to interest rate cuts. In fact, countries with higher share of rigid contracts show more benefits from interest rate cuts on unemployment. This corroborates what we observe in the linear local projections in Appendix H, where monetary policy has a stronger effect in countries with high wage rigidity. However, in Appendix I, we plot the response in unemployment between countries in the 'Upper' group and 'Bottom' group of wage rigidity, as split using k-means. At the extremes, the response in unemployment following a contractionary shock in high wage rigidity countries is more than twice as high that for those in the Bottom group at its peak. Hence, this may imply that differences in transmission of monetary policy w.r.t wage rigidity is non linear, such that the negative impact of wage rigidity on unemployment is mainly observed within countries with extremely sticky wage setting structure.

### 4.4 Final remarks

The country mappings (Appendix G) help to visualise which countries might be more exposed to eventual monetary policy shocks. For example, Italy, Greece, and the northeastern countries show both high dependence on small-medium enterprises and a high degree of downward wage rigidities. This implies that they may face the largest contractions in employment and IP in response to an unexpected rate hike. In addition, Portugal, with a high share of household exposure in the housing market as well as a high degree of wage rigidity, may point towards serious general equilibrium effects of rate hikes, particularly for individuals in the lowest part of the income distribution. In this sense, performing a country by country analysis could further implement the research by looking at how country economic structure and institutional settings interact in generating a response to a monetary policy shock.

## 5 Conclusion

We have quantified the asymmetric effects of monetary policy in the euro area on two main macroeconomic variables - unemployment and IP - and analysed the channels that may be driving such asymmetric effects in the currency bloc. Our results suggest that output and unemployment react more strongly and immediately to contractionary shocks relative to expansionary ones. The results are consistent with expectations formed from the literature and robust to a number of checks. Extending our analysis to sources which could explain these asymmetric effects, we find results consistent with theoretical predictions that downward nominal wage rigidities, sectoral composition of the economy, firm sizes as well as the housing market and housing debt conditions all contribute to the sign asymmetries we uncover in our baseline results. In so doing, we have provided a more robust and comprehensive treatment of sign asymmetries in the effects of monetary policy in the euro area than previously present in the literature.

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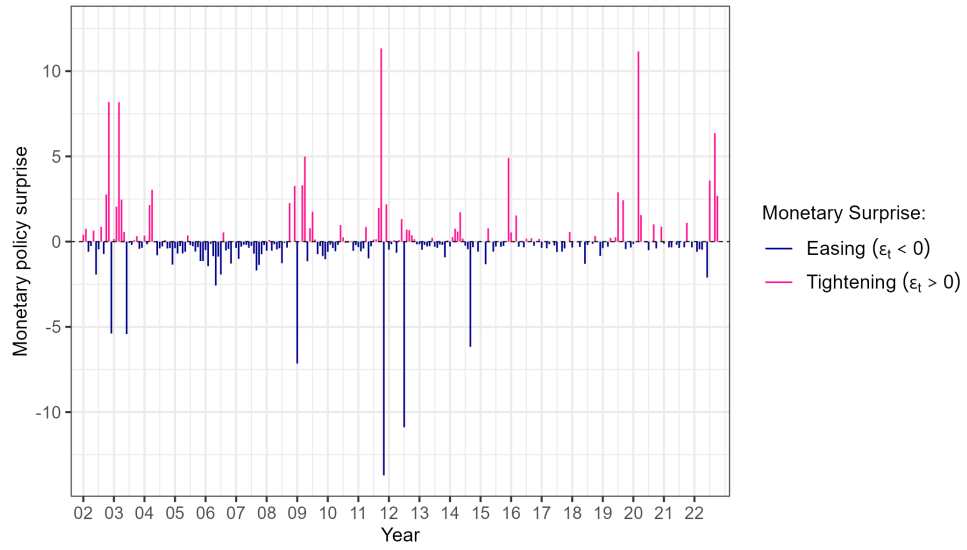
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## 6 Tables

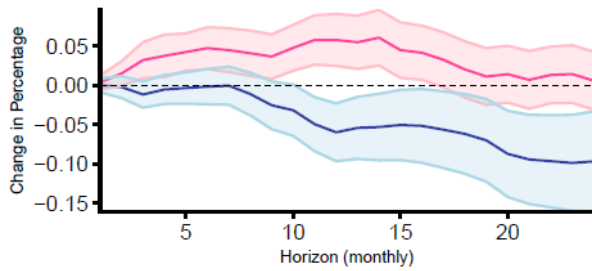
|   | <b>Median</b> | <b>Mean</b> | <b>Std. Dev.</b> | <b>Min</b> | <b>Max</b> |
|---|---------------|-------------|------------------|------------|------------|
| <b>Firms that cut nominal wages (%)</b> | 7.5           | 12.1        | 14.5             | 0.8        | 54.6       |
| <b>Home ownership rate (%)</b>          | 72.9          | 73.6        | 9.8              | 51.7       | 90.3       |
| <b>Variable rate loans (%)</b>          | 72.9          | 62.6        | 33.6             | 5.2        | 96.8       |
| <b>Value-added from SMEs (%)</b>        | 63.8          | 63.1        | 9.4              | 37.1       | 76.8       |
| <b>Value-added from industry (%)</b>    | 15.5          | 16.5        | 5.2              | 6.3        | 23.5       |

**Table 1:** Summary statistics: country channels

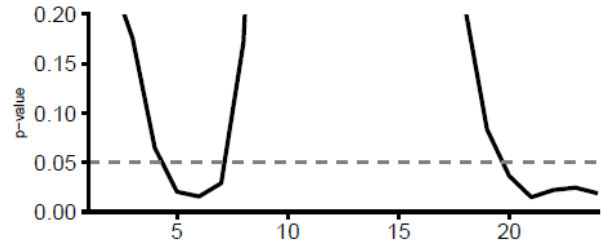
## 7 Figures



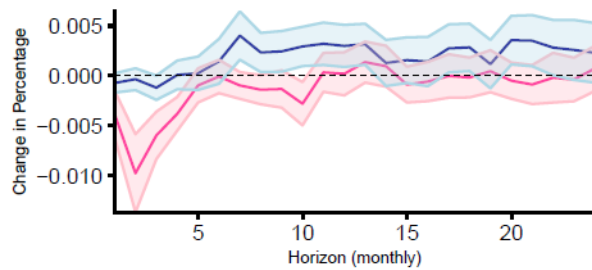
**Figure 1:** Time series of identified monetary policy shocks.



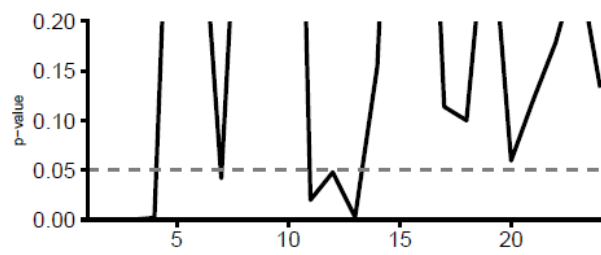
(a) Impact of 100bp target shock on unemployment rate



(b) p-value: target shock on unemployment rate



(c) Impact of 100bp target shock on IP



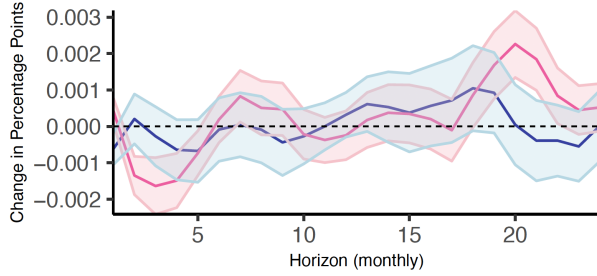
(d) p-value: target shock on IP

**Figure 2:** Baseline results for 100bp target shock

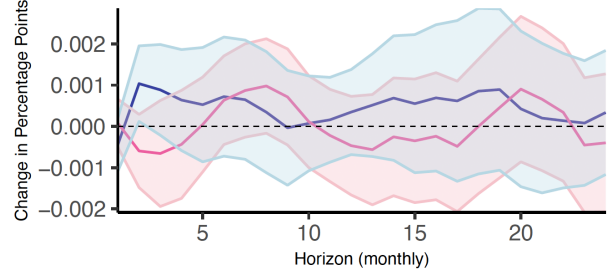
Notes: Pink IRF and confidence bands are for contractionary shocks and blue IRF and confidence bands are for expansionary shocks. Confidence bands are for 95% confidence intervals. In all regressions we use Newey-West variance-covariance matrices. The p-value is from a t-test that allows a comparison between the magnitudes of the coefficients computed in the two states (expansionary and contractionary shocks) for each forecast horizon.

## 7.1 Country Groupings

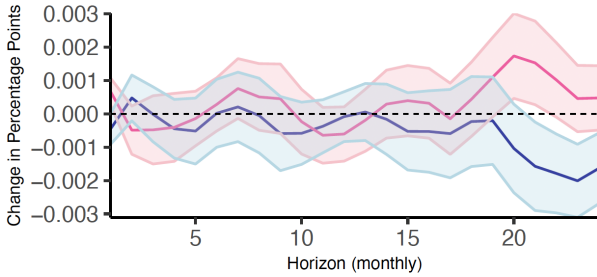
### 7.1.1 Housing Market



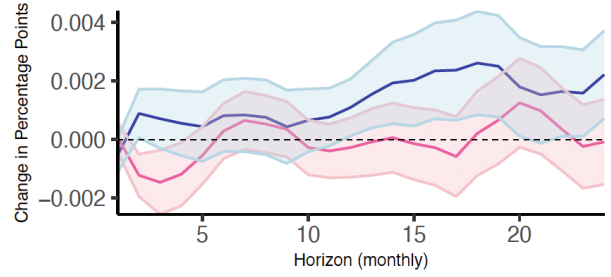
(a) Below median home ownership rate - Impact of 100bp target shock on consumption



(b) Above median home ownership rate - Impact of 100bp target shock on consumption



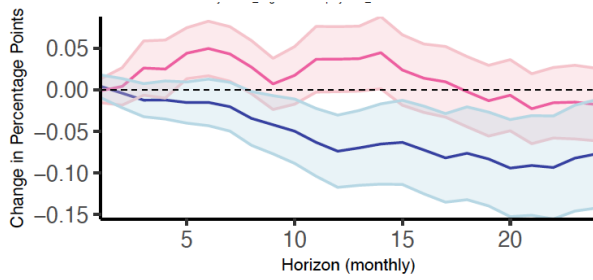
(c) Below median variable rate loan share - Impact of 100bp target shock on consumption



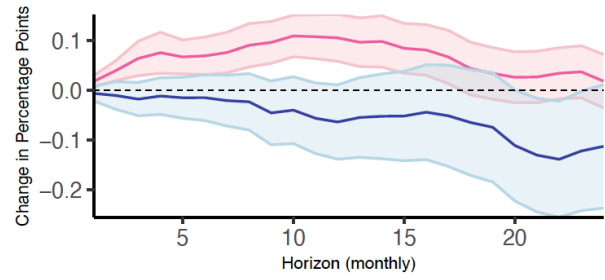
(d) Above median variable rate loan share - Impact of 100bp target shock on consumption

**Figure 3:** Home ownership and variable rate loan country grouping results following 100bp target shock

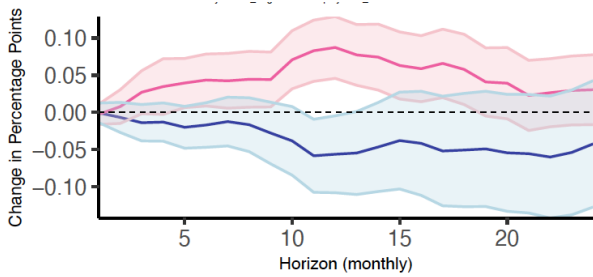
Notes: Pink IRF and confidence bands are for contractionary shocks and blue IRF and confidence bands are for expansionary shocks. Confidence bands are for 95% confidence intervals. In all regressions we use Newey-West variance-covariance matrices.



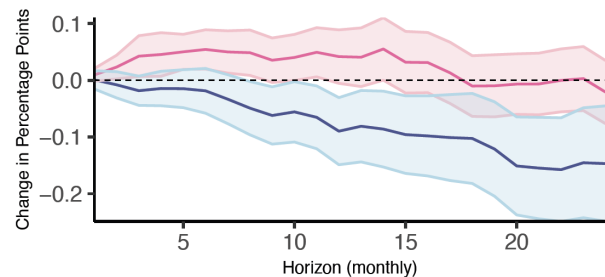
(a) Below median home ownership rate - Impact of 100bp target shock on unemployment



(b) Above median home ownership rate - Impact of 100bp target shock on unemployment



(c) Below median variable rate loan share - Impact of 100bp target shock on unemployment

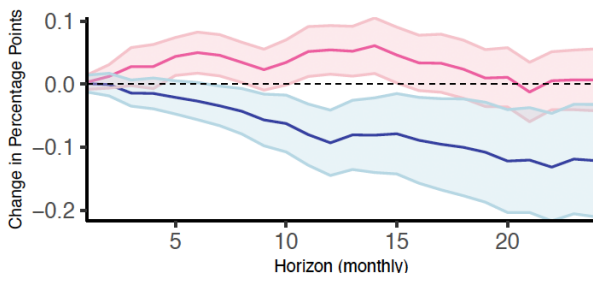


(d) Above median variable rate loan share - Impact of 100bp target shock on unemployment

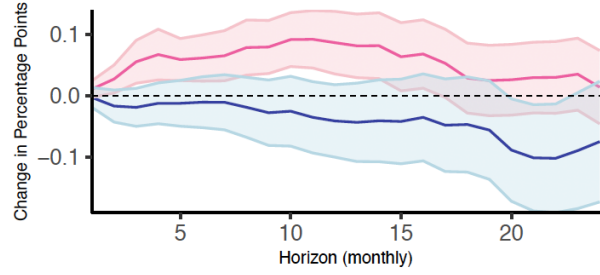
**Figure 4:** Home ownership and variable rate loan country grouping results following 100bp target shock

Notes: Pink IRF and confidence bands are for contractionary shocks and blue IRF and confidence bands are for expansionary shocks. Confidence bands are for 95% confidence intervals. In all regressions we use Newey-West variance-covariance matrices.

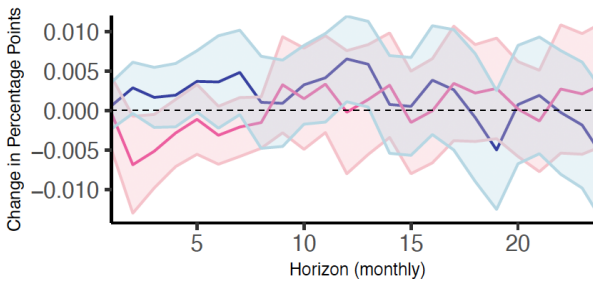
### 7.1.2 Firm Size and Sectoral Composition



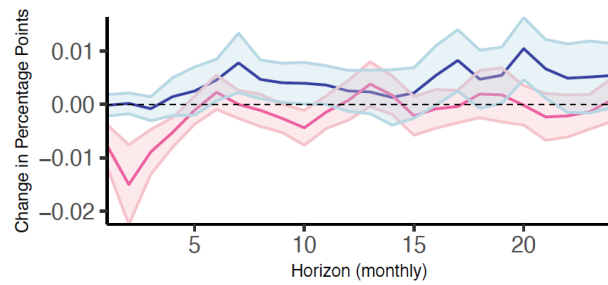
(a) Below median % of value-added from SMEs - Impact of 100bp target shock on unemployment



(b) Above median % of value-added from SMEs - Impact of 100bp target shock on unemployment



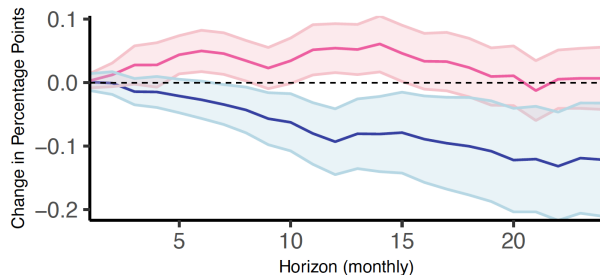
(c) Below median % of value-added from SMEs - Impact of 100bp target shock on IP



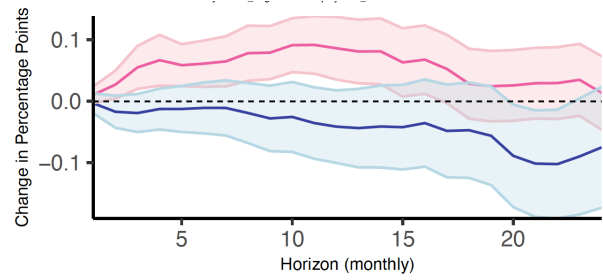
(d) Above median % of value-added from SMEs - Impact of 100bp target shock on IP

**Figure 5:** SMEs country groupings results following 100bp target shock

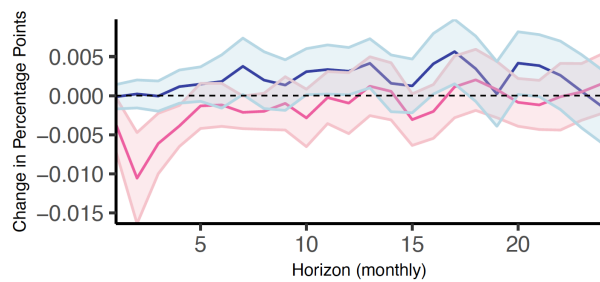
Notes: Pink IRF and confidence bands are for contractionary shocks and blue IRF and confidence bands are for expansionary shocks. Confidence bands are for 95% confidence intervals. In all regressions we use Newey-West variance-covariance matrices.



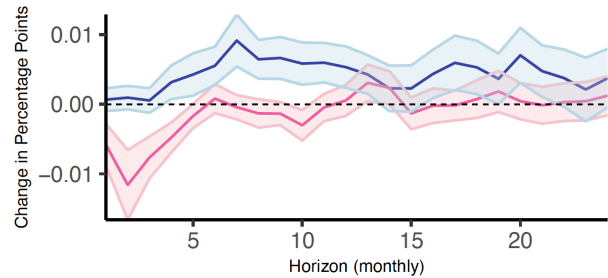
(a) Below median % of value-added from industry - Impact of 100bp target shock on unemployment



(b) Above median % of value-added from industry - Impact of 100bp target shock on unemployment



(c) Below median % of value-added from industry - Impact of 100bp target shock on IP

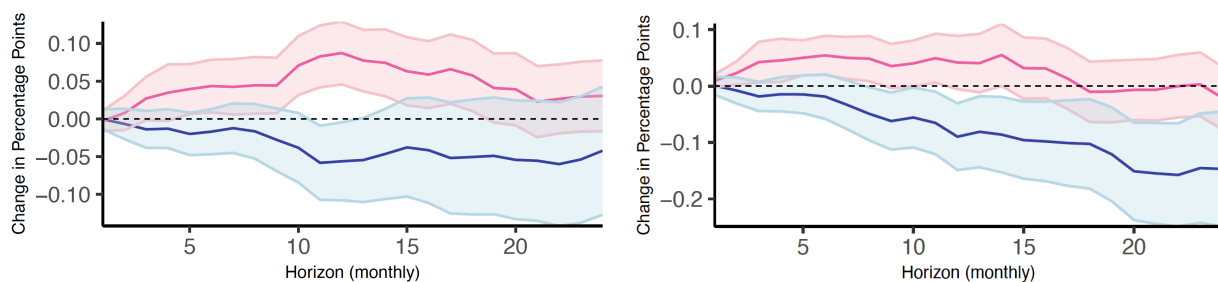


(d) Above median % of value-added from industry - Impact of 100bp target shock on IP

**Figure 6:** Sectoral composition country groupings results following 100bp target shock

Notes: Pink IRF and confidence bands are for contractionary shocks and blue IRF and confidence bands are for expansionary shocks. Confidence bands are for 95% confidence intervals. In all regressions we use Newey-West variance-covariance matrices.

### 7.1.3 Wage Rigidity

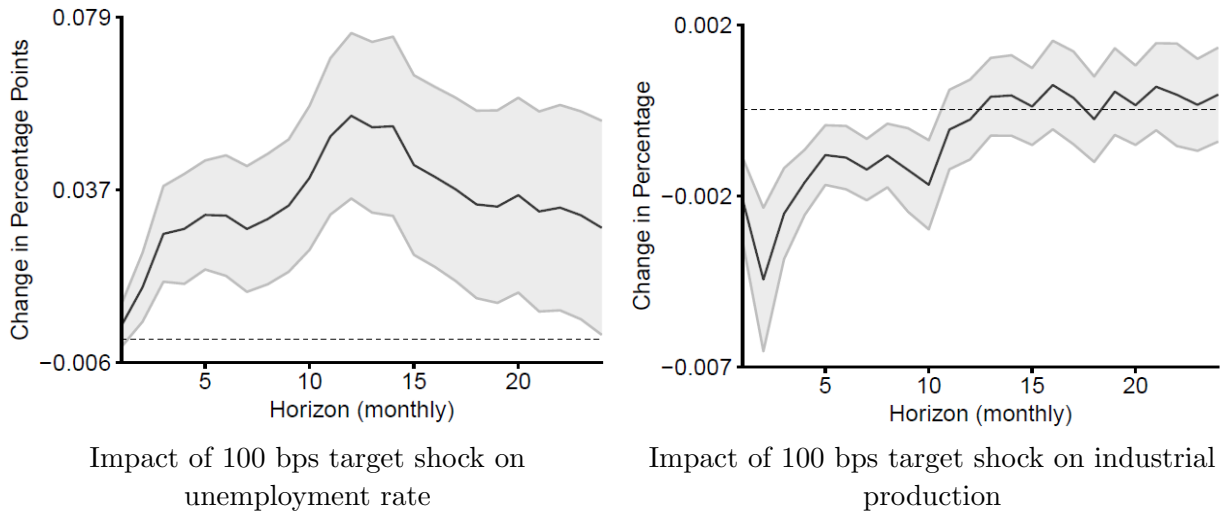


(a) Lower degree of downward wage rigidity - Impact of 100bp target shock on unemployment      (b) Higher degree of downward wage rigidity - Impact of 100bp target shock on unemployment

**Figure 7:** Downward wage rigidity country groupings results following 100bp target shock

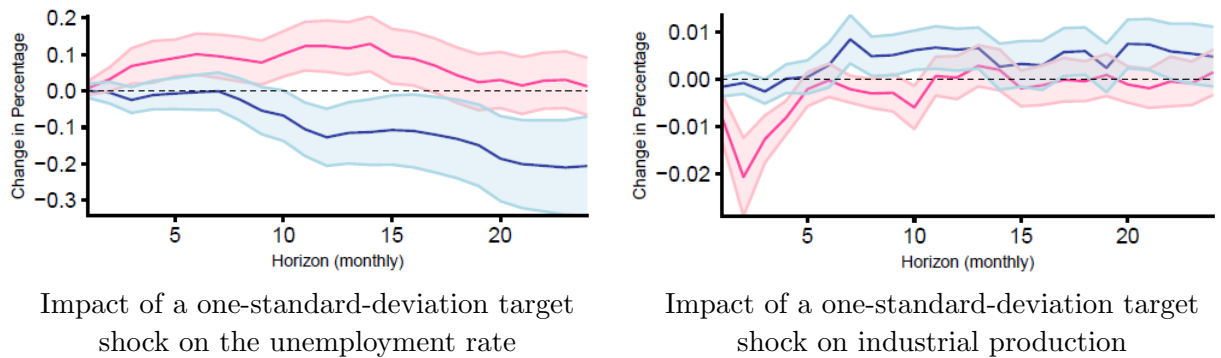
Notes: **Pink** IRF and confidence bands are for **contractionary shocks** and **blue** IRF and confidence bands are for **expansionary shocks**. Confidence bands are for 95% confidence intervals. In all regressions we use Newey-West variance-covariance matrices.

## A Linear impulse responses to the target shock



**Figure A1:** Linear impulse responses to the target shock. Shaded areas denote 95% confidence intervals. In all regressions, standard errors are computed using Newey–West variance–covariance matrices.

## B Baseline results for a one-standard-deviation target shock



**Figure B1:** Linear impulse responses to the standardized target shock. **Pink** IRF and confidence bands are for **contractionary shocks** and **blue** IRF and confidence bands are for **expansionary shocks**. Shaded areas denote 95% confidence intervals. In all regressions, standard errors are computed using Newey–West variance–covariance matrices.

## C Appendix: Linear LP-IV specification

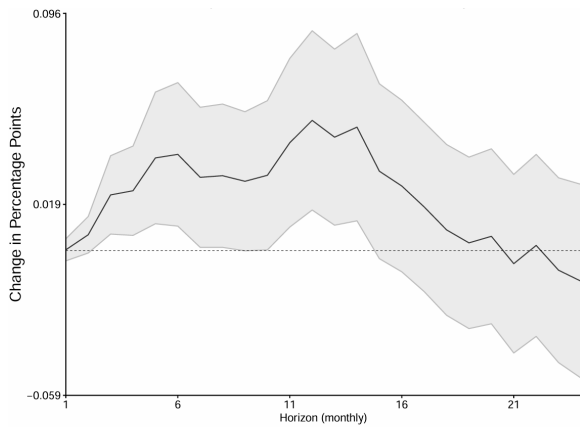
We estimate the linear responses of IP and the unemployment rate to the target factor using the local projections instrumental variable (LP-IV) method, where the instrument is the target shock of Altavilla et al. (2019). Figures C1 plots the sequence of coefficients  $\{\phi_h\}_{h=0}^H$  for unemployment rate and IP obtained from the following estimated equations:

$$y_{i,t+h} - y_{i,t-1} = \alpha_{i,h} + \phi_h i_t + \mathbf{x}'_{i,t} \boldsymbol{\beta}_{0,h} + \sum_{j=1}^{12} \mathbf{x}'_{i,t-j} \boldsymbol{\beta}_{j,h} + u_{i,t+h}, \quad (2)$$

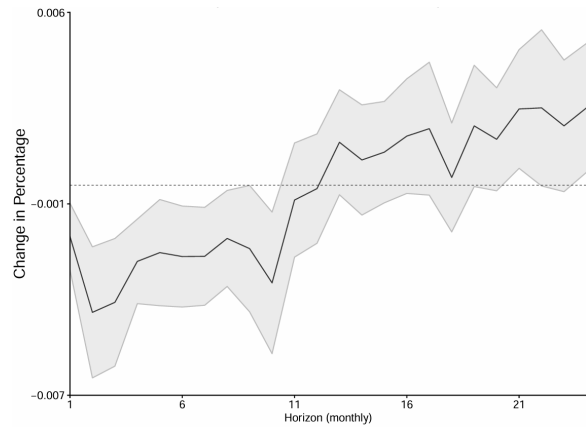
where  $i_t$  is the ECB main refinancing operations rate (ECB, 2024), instrumented by  $\epsilon_t$ , namely the target shock (Altavilla et al., 2019). The corresponding first-stage regression at horizon  $h$  is given by:

$$i_t = c_{i,h} + \gamma_h \epsilon_t + \mathbf{x}'_{i,t} \boldsymbol{\pi}_{0,h} + \sum_{j=1}^{12} \mathbf{x}'_{i,t-j} \boldsymbol{\pi}_{j,h} + v_{i,t}. \quad (3)$$

where  $y_{i,t}$  is the dependent variable for country  $i$  at time  $t$  (either unemployment rate or the logarithm of IP),  $h$  is the forecast horizon, while  $\mathbf{x}'_{i,t}$  and  $\mathbf{x}'_{i,t-j}$  are contemporaneous and lagged independent variables that we use in our baseline estimation. As in the baseline estimation, we employ Newey-West variance-covariance matrices in all regressions to account for heteroskedasticity and serial correlation of the error terms. Finally, we set the lag length for independent variables to 12 months and also set the maximum forecast horizon to 24 months. Figure C1 presents the results for our variables of interest.



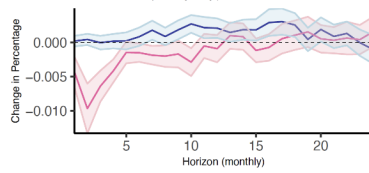
Impact of fitted policy rate shock on unemployment rate



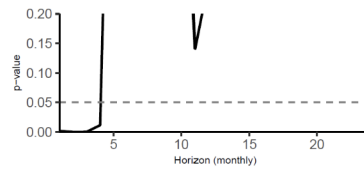
Impact of fitted policy rate shock on IP

**Figure C1:** Panel LP-IV IRFs (from left to right) of the unemployment rate and IP to the fitted policy shock. The fitted values are obtained using the target shock as an instrument. Shaded areas denote 95% confidence intervals. In all regressions, standard errors are computed using Newey–West variance–covariance matrices.

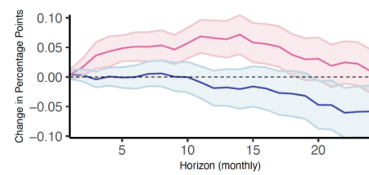
## D Appendix: Robustness checks



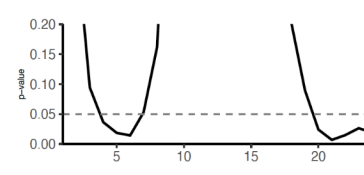
(a) impact of 100bp target shock on IP



(b) p-value: target shock on IP

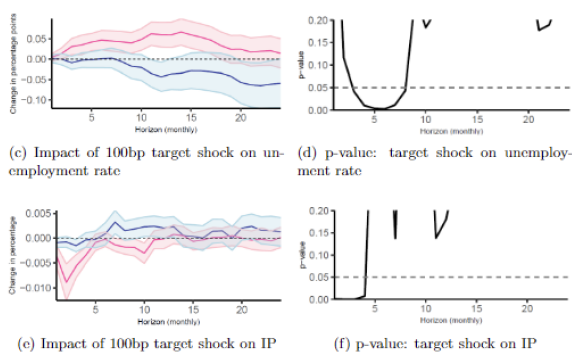


(c) impact of 100bp target shock on unemployment

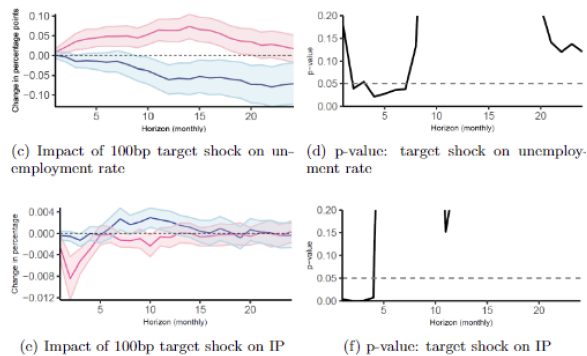


(d) p-value: target shock on unemployment

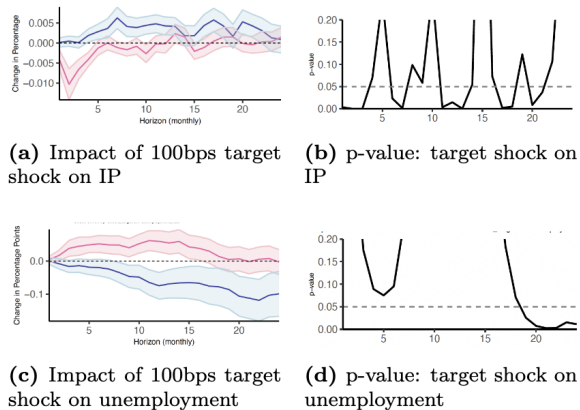
**Figure D1:** Robustness check: No lagged shock



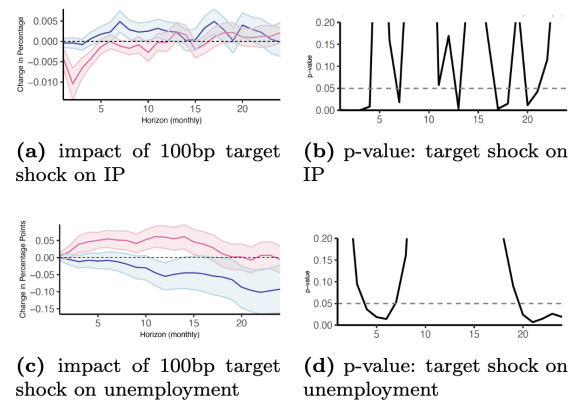
**Figure D2:** Robustness check: 9 lags of regressors



**Figure D3:** Robustness check: 12 leads of shock



**Figure D4:** Robustness check: excluding Germany

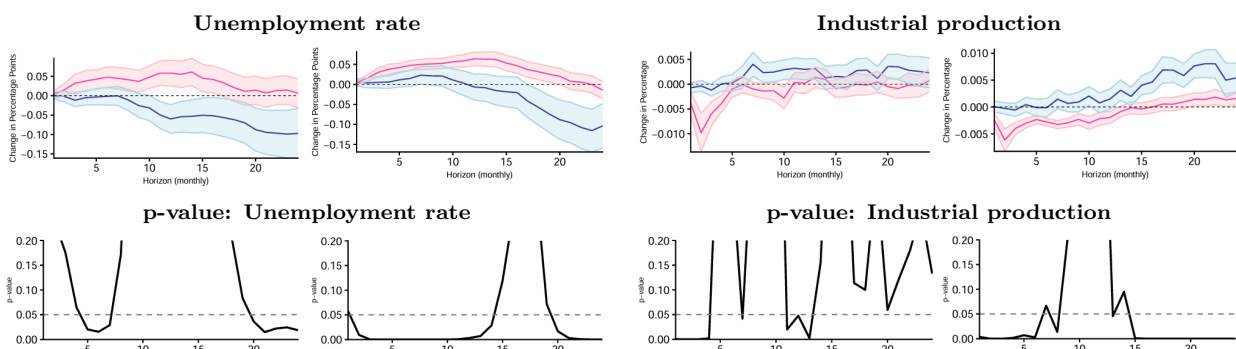


**Figure D5:** Robustness check: no contemporaneous regressors

# E Appendix: Impulse Responses to Alternative Monetary Policy Shock Measures

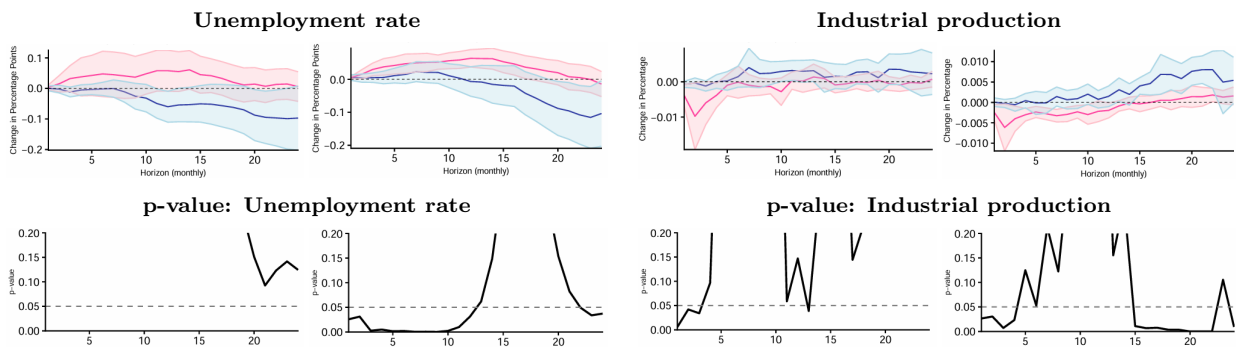
We compare the responses implied by the target shock of Altavilla et al. (2019) and the monetary policy shock of Jarociński and Karadi (2020)<sup>5</sup>, along with the corresponding p-value profiles, under Newey–West standard errors, Driscoll–Kraay standard errors and when clustering by group and time.

## Newey–West Standard Errors



**Figure E1:** Baseline results under Newey–West standard errors. For each variable, the **left** plot uses the target shock of Altavilla et al. (2019) and the **right** plot uses the monetary policy shock (*MP\_median*) of Jarociński and Karadi (2020).

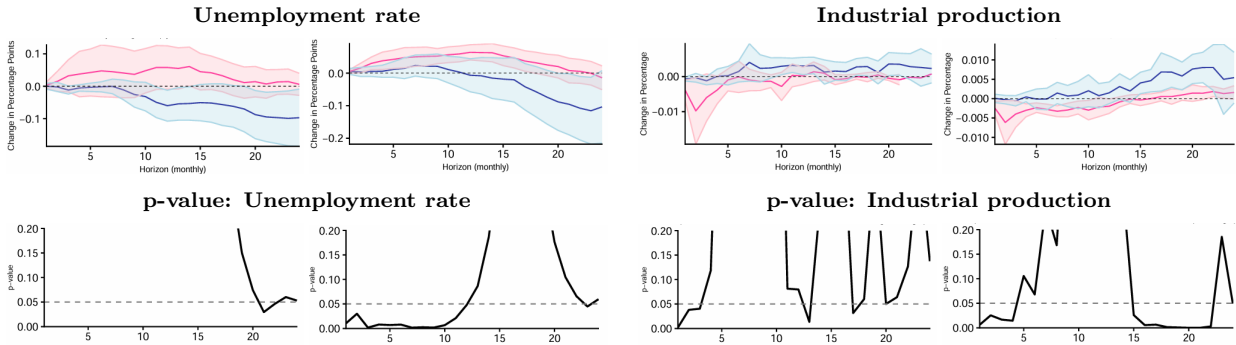
## Driscoll–Kraay Standard Errors



**Figure E2:** Baseline results under Newey–West standard errors. For each variable, the **left** plot uses the target shock of Altavilla et al. (2019) and the **right** plot uses the monetary policy shock (*MP\_median*) of Jarociński and Karadi (2020).

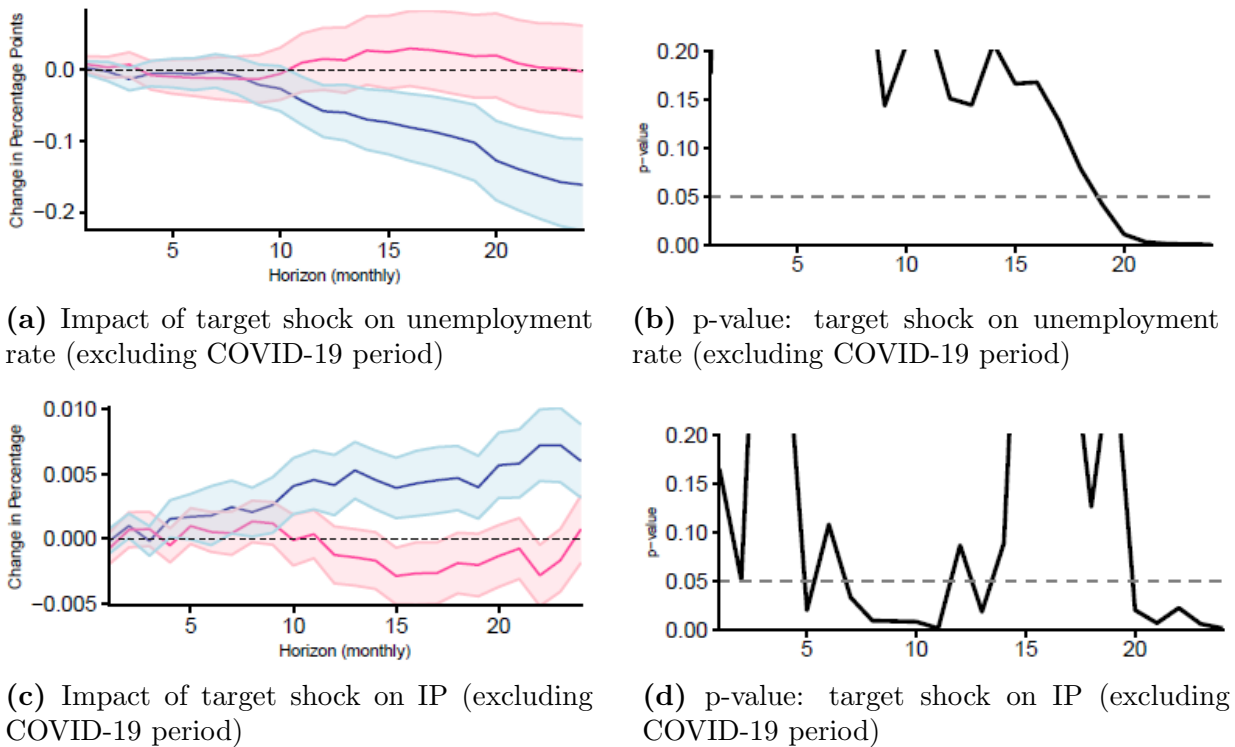
<sup>5</sup>We use the *MP\_median* shock series

## Clustering by Country and Time



**Figure E3:** Baseline results under Newey–West standard errors. For each variable, the **left** plot uses the target shock of Altavilla et al. (2019) and the **right** plot uses the monetary policy shock ( $MP\_median$ ) of Jarociński and Karadi (2020).

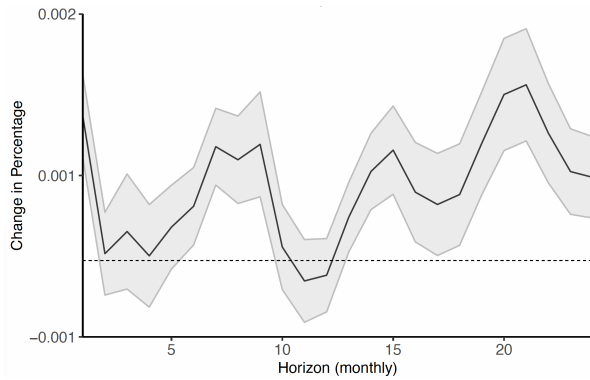
## F Appendix: Excluding COVID-19 observations



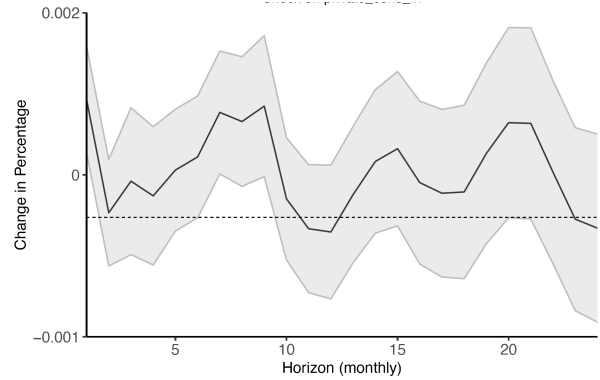
**Figure F1:** Baseline results of the impact of the target shock excluding COVID period

Notes: **Pink** IRF and confidence bands are for **contractionary shocks** and **blue** IRF and confidence bands are for **expansionary shocks**. Confidence bands are 95% confidence intervals. Standard errors are computed using Newey–West variance–covariance matrices. The p-value is from a t-test comparing the state-dependent coefficients (expansionary vs. contractionary) at each forecast horizon.

## G Appendix: Country groupings, linear IRFs

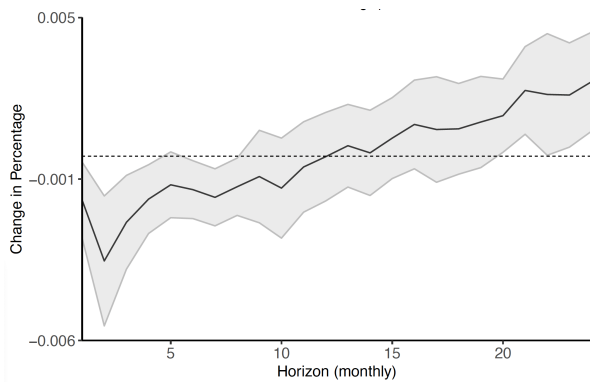


Below Median home ownership rate: Impact of 100bp target shock on consumption

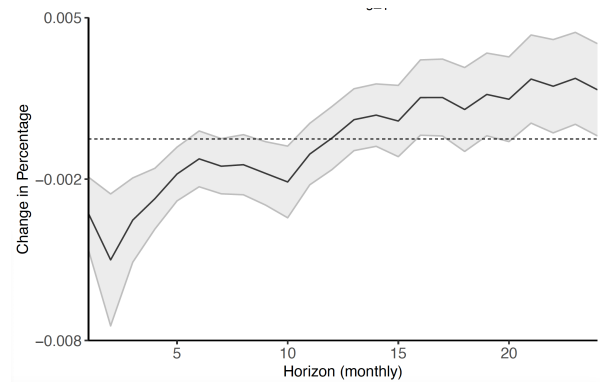


Above Median home ownership rate: Impact of 100bp target shock on consumption

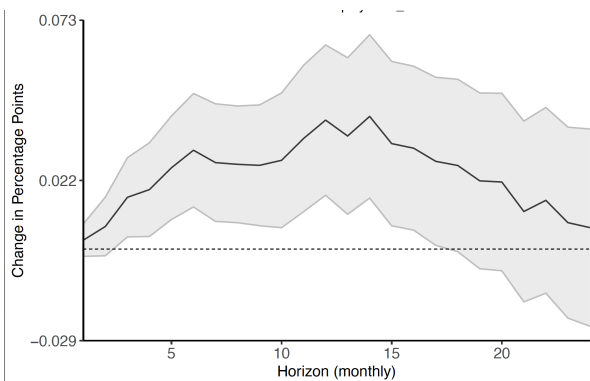
**Figure G1:** Linear IRFs – Home ownership rate grouping



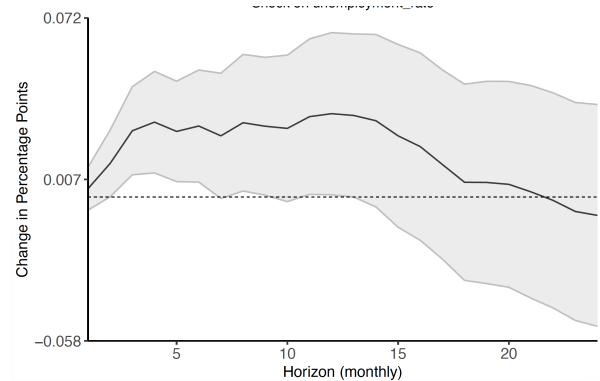
Below Median SME share: Impact of 100bp target shock on industrial production



Above Median SME share: Impact of 100bp target shock on industrial production

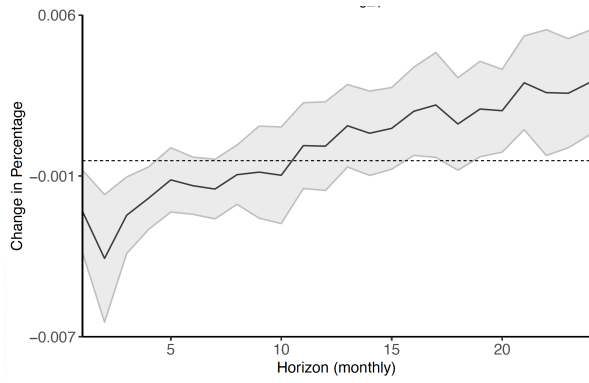


Below Median SME share: Impact of 100bp target shock on unemployment

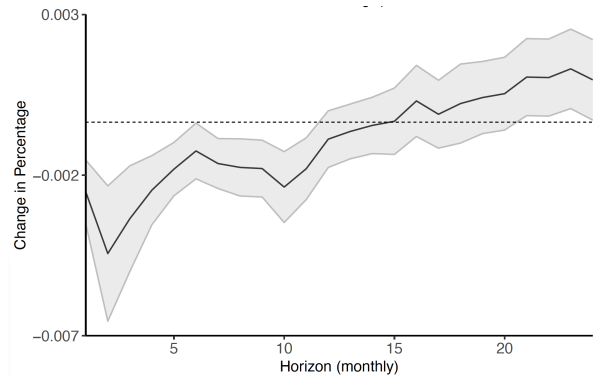


Above Median SME share: Impact of 100bp target shock on unemployment

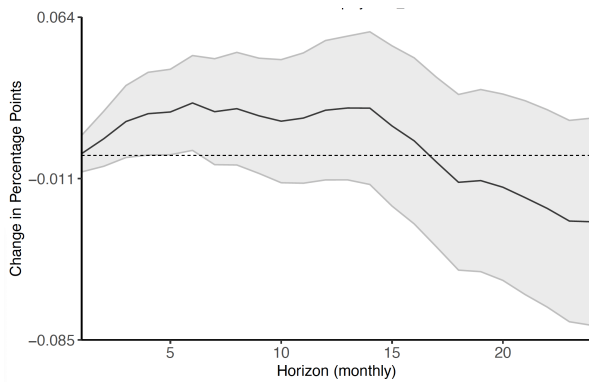
**Figure G2:** Linear IRFs – SME share grouping



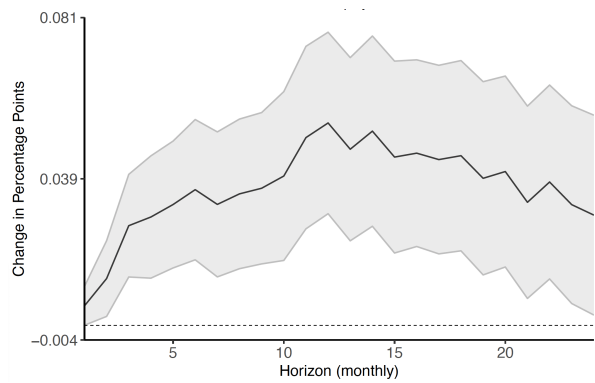
Below Median industry share: Impact of 100bp target shock on industrial production



Above Median industry share: Impact of 100bp target shock on industrial production

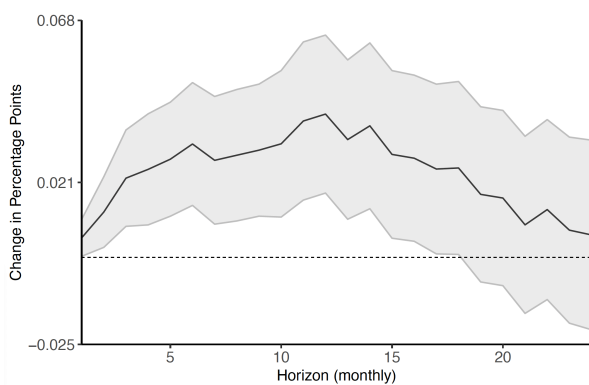


Below Median industry share: Impact of 100bp target shock on unemployment

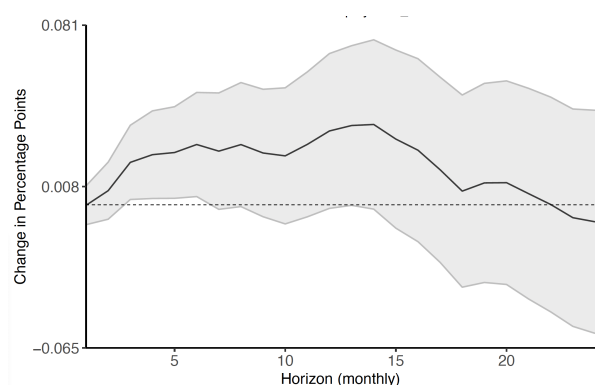


Above Median industry share: Impact of 100bp target shock on unemployment

**Figure G3:** Linear IRFs – Industry share grouping



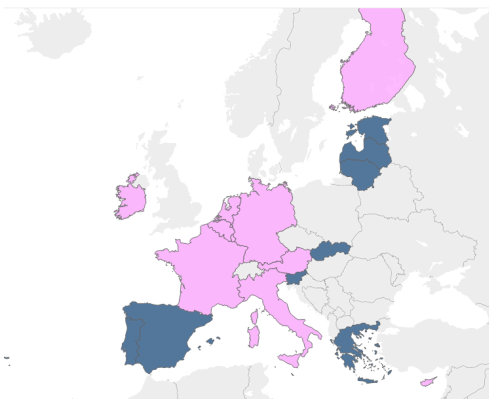
Below Median downward wage rigidity: Impact of 100bp target shock on unemployment



Above Median downward wage rigidity: Impact of 100bp target shock on unemployment

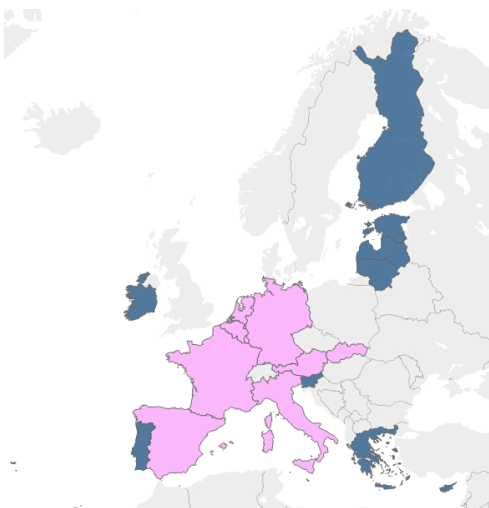
**Figure G4:** Linear IRFs – Downward wage rigidity grouping

## H Appendix: Country grouping maps



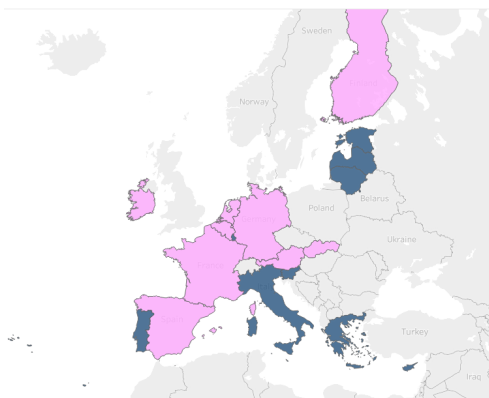
**Figure H1:** Home ownership rate

Notes: Pink represents below median countries and blue represents above median countries.



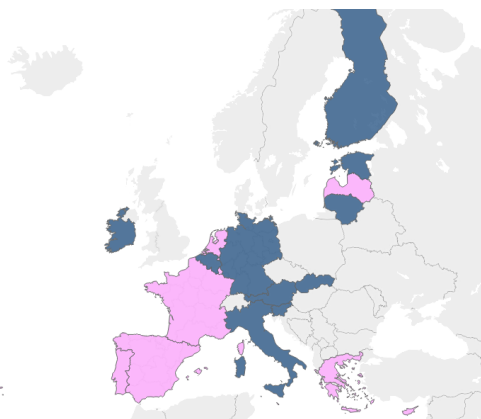
**Figure H2:** Variable rate mortgage

Notes: Pink represents below median countries and blue represents above median countries.



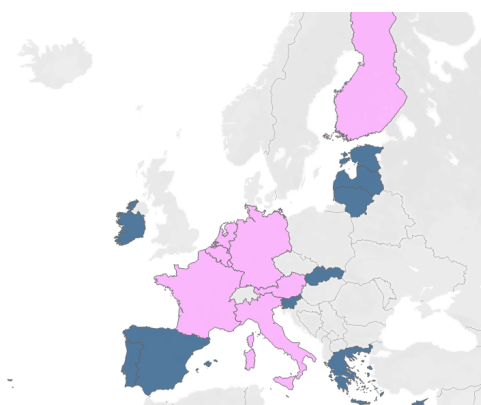
**Figure H3:** Share of value-added from SMEs

Notes: Pink represents below median countries and blue represents above median countries.



**Figure H4:** Share of value-added from industry

Notes: Pink represents below median countries and blue represents above median countries.



**Figure H5:** Wage rigidity

Notes: Pink represents below median countries and blue represents above median countries.

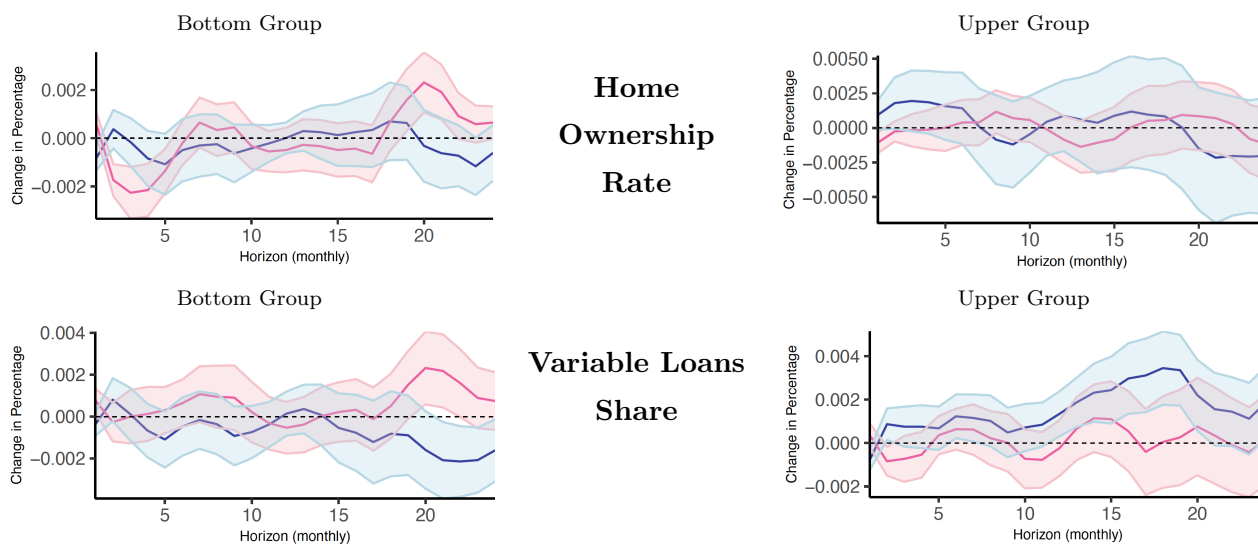
## I Appendix: Country groupings, K-means clustering

In an alternative to the median country split, we apply k-means clustering and group the countries accordingly. We choose this approach over a simple quartile split as it allows to capture non-linearities in the data and avoids imposing arbitrary thresholds. For each characteristic, countries are split into four groups (“Bottom”, “Bottom-mid”, “Upper-mid”, “Upper”). The breakdown of the country groups using k-means is shown in Table I1 below. Note that the wage-rigidity measure based on the WDN survey is not available for Finland and therefore the country is excluded from this grouping

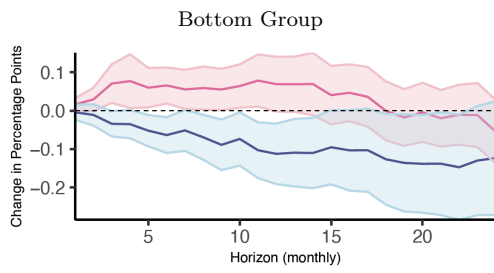
| country     | Home ownership | GDP from SME's | GDP from Industry | Wage Rigidity | Adjustable Mortgage Loans rate |
|-------------|----------------|----------------|-------------------|---------------|--------------------------------|
| Austria     | Bottom         | Bottom         | Upper             | Bottom        | Bottom-Mid                     |
| Belgium     | Bottom-Mid     | Upper-mid      | Upper-mid         | Bottom        | Bottom                         |
| Cyprus      | Bottom-Mid     | Upper          | Bottom            | Upper-mid     | Upper-mid                      |
| Estonia     | Upper          | Upper          | Upper             | Bottom-Mid    | Bottom                         |
| Finland     | Bottom-Mid     | Bottom-Mid     | Upper-mid         |               | Upper                          |
| France      | Bottom         | Upper-mid      | Bottom-Mid        | Bottom        | Upper                          |
| Germany     | Bottom         | Bottom         | Upper             | Upper-mid     | Bottom                         |
| Greece      | Upper-mid      | Bottom         | Bottom            | Upper         | Upper-mid                      |
| Ireland     | Bottom         | Bottom         | Bottom-Mid        | Upper         | Bottom-Mid                     |
| Italy       | Bottom-Mid     | Upper          | Bottom            | Upper         | Bottom-Mid                     |
| Latvia      | Upper          | Bottom-Mid     | Upper-mid         | Upper-mid     | Upper                          |
| Lithuania   | Upper          | Bottom         | Bottom-Mid        | Upper-mid     | Upper-mid                      |
| Luxembourg  | Bottom-Mid     | Bottom-Mid     | Bottom            | Bottom        | Upper                          |
| Malta       | Upper          | Upper          | Bottom            | Bottom        | Upper-mid                      |
| Netherlands | Bottom         | Bottom-Mid     | Bottom-Mid        | Bottom-Mid    | Bottom                         |
| Portugal    | Upper-mid      | Upper-mid      | Upper-mid         | Upper         | Upper                          |
| Slovakia    | Upper          | Upper-mid      | Upper             | Bottom-Mid    | Bottom-Mid                     |
| Slovenia    | Upper-mid      | Bottom-Mid     | Upper             | Upper         | Bottom                         |
| Spain       | Upper-mid      | Upper          | Bottom-Mid        | Bottom-Mid    | Bottom-Mid                     |

**Table II:** Country Groupings using k-means, across characteristics

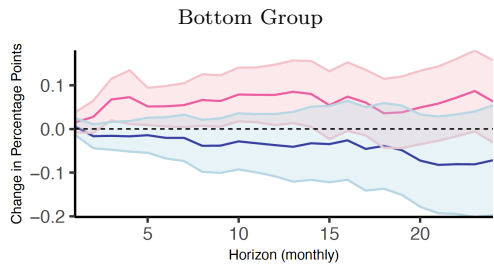
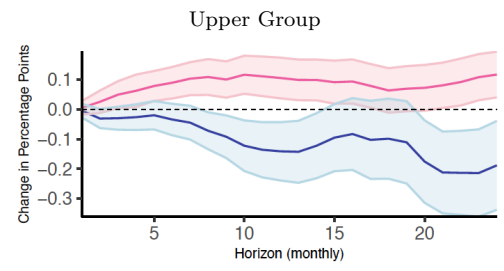
## Consumption



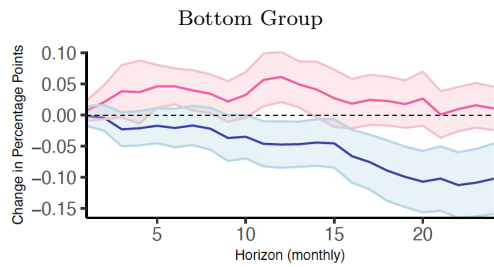
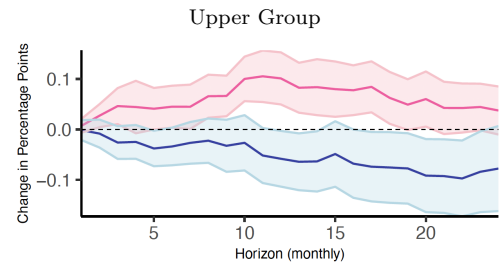
## Unemployment



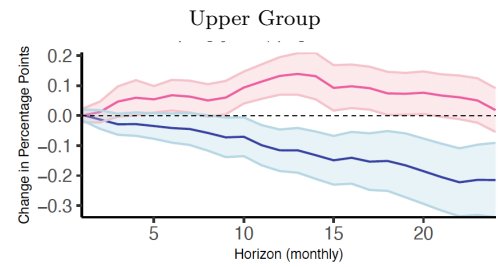
**Value added  
by SMEs**



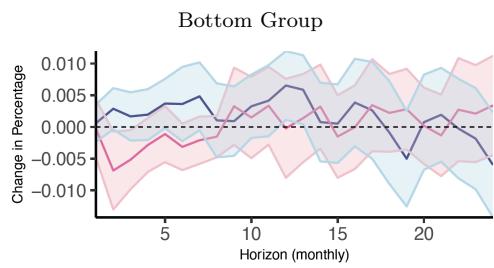
**Value added  
by Industry**



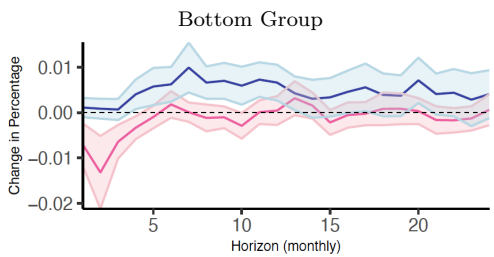
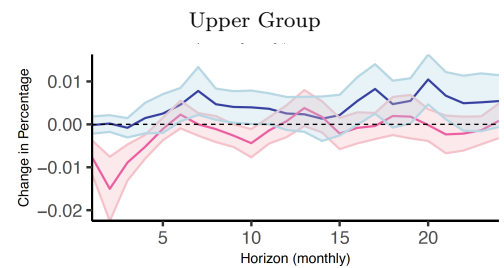
**Wage Rigidity**



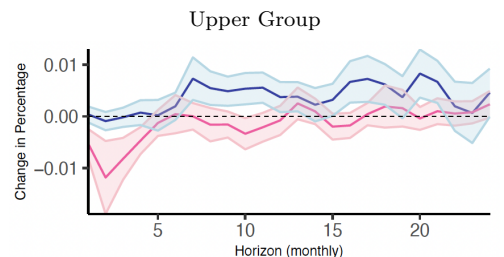
## Industrial Production



**Value added  
by SMEs**

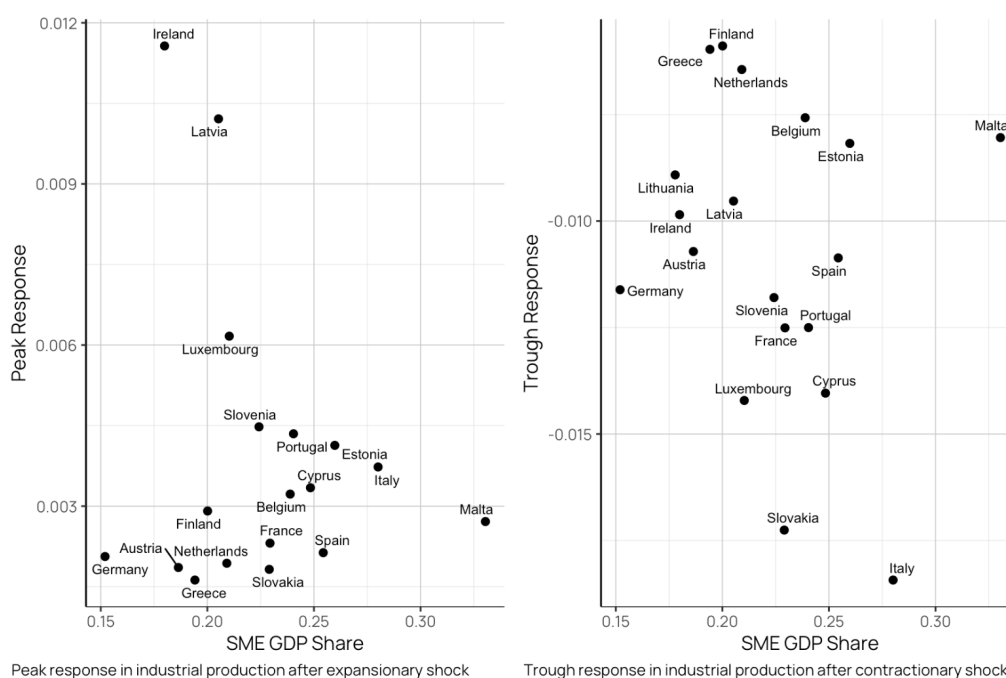


**Value added  
by Industry**

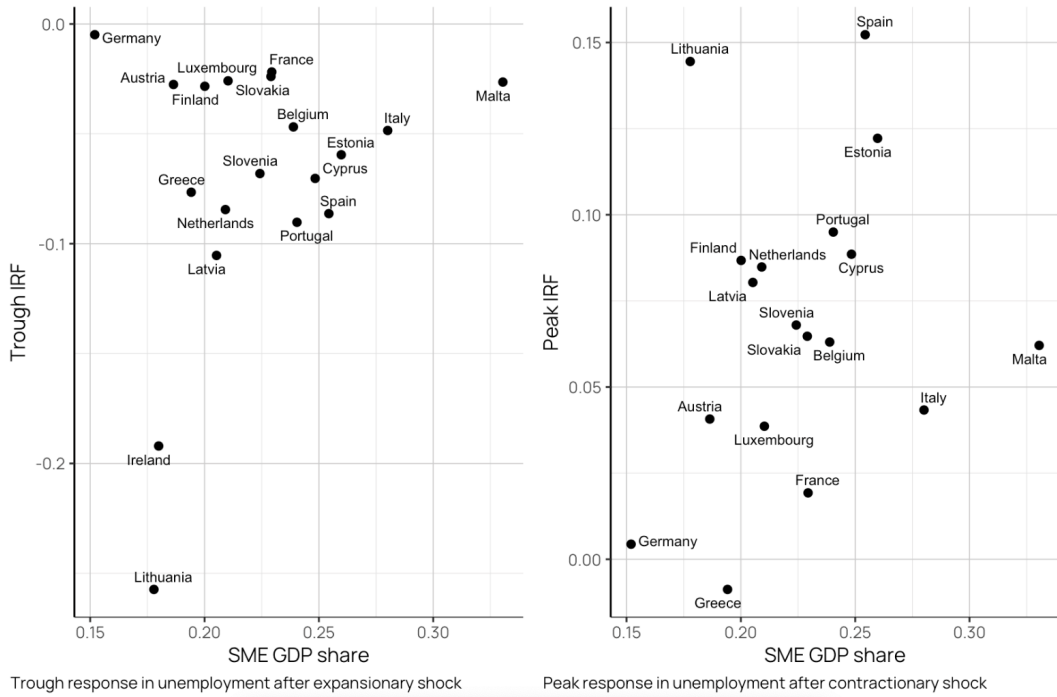


## J Appendix: Country groupings, Peak Trough Classification

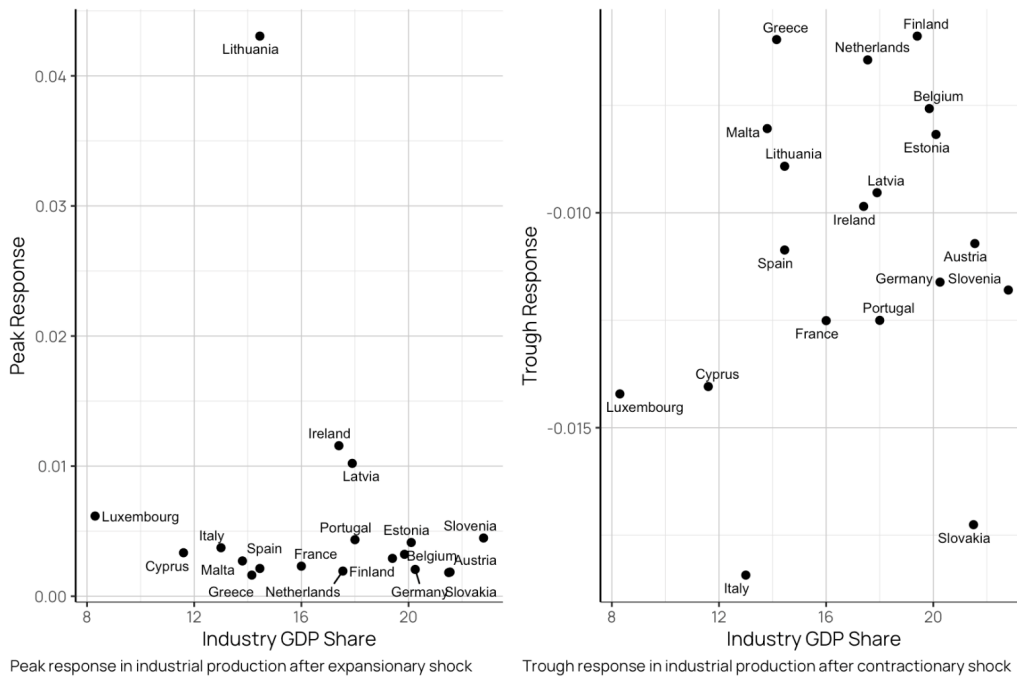
We extracted the peak and troughs of countries IRF's and mapped it against the values of country characteristics. For industrial production and consumption, the strongest response is measured at the peak following an expansionary shock and at the trough following a contractionary shock. Conversely, since unemployment is expected to decline after a reduction in interest rates, we extract the trough (i.e. the largest decline) of the IRF following an expansionary shock, while the peak corresponds to the largest increase in unemployment following a contractionary shock.

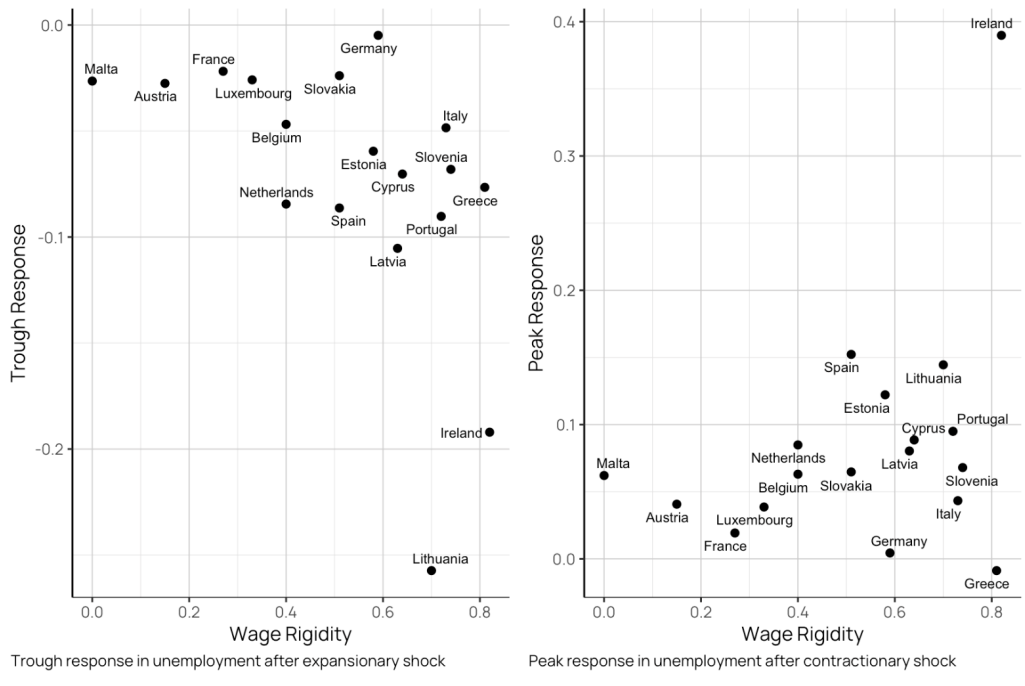


**Figure J1:** IP response peak/trough by share of value added from SMEs

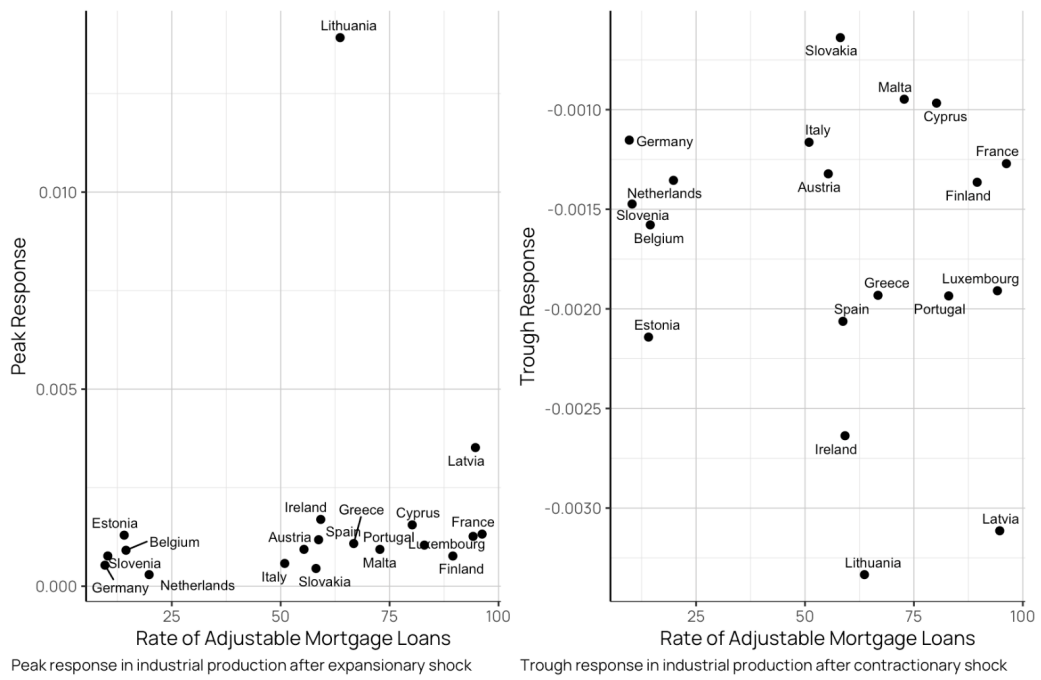


**Figure J2:** Unemployment response peak/trough by share of value added from SMEs

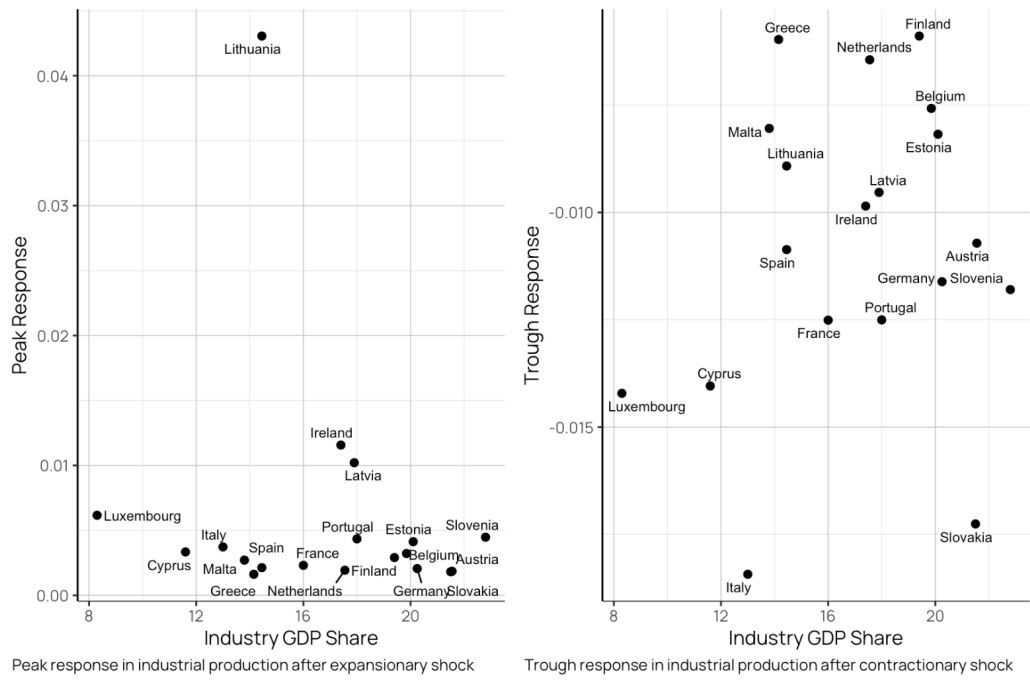




**Figure J4:** Unemployment response peak/trough by Wage rigidity



**Figure J5:** Consumption response peak/trough by Variable loans share



**Figure J6:** IP response peak/trough by share of value added from SMEs

## **Declarations**

### **Funding Statement**

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

### **Ethics Declaration**

Not applicable.

### **Author Contributions**

All authors contributed equally to the conception, design, analysis, and writing of this manuscript. The final stage of the revision was primarily carried out by Arianna Antezza (corresponding author) and Gianmarco Meta.

### **Data Availability**

The data supporting the findings of this study are provided in the supplementary material.

### **Competing Interests**

The authors declare no competing interests.