

Second-Round Effects of Oil Price Shocks – Implications for Europe’s Inflation Outlook

Chikako Baba and Jaewoo Lee

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**Second-Round Effects of Oil Price Shocks
Implications for Europe's Inflation Outlook**
Prepared by Chikako Baba and Jaewoo Lee*

Authorized for distribution by Jaewoo Lee
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ABSTRACT: The pass-through effects of oil price shocks on wage and consumer price inflation vary with the states or structural characteristics of an economy. The effects have declined over time in Europe and been higher in emerging European economies than in advanced economies. The pass-through to wages is found to have been higher when the prevailing level of inflation was higher or when the degrees of unionization and centralized bargaining were higher, while lower under a higher credibility of monetary policy. The effects of oil price shocks on core inflation and inflation expectations are consistent with their effects on wages.

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WORKING PAPERS

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1. Introduction

At the tail end of the Covid-19 pandemic and aggravated by the war in Ukraine, high inflation has come to the fore of macroeconomic policy discussion. Inflation rates have hit multi-decade highs in many countries, reaching 8.6 percent in the U.S. in May 2022 (the highest in 40 years) and 8.1 percent in the euro area (the highest since the creation of euro) to take a few examples. High inflation had arrived in other advanced and major emerging market economies even earlier.

Two main drivers of the current surge in inflation have been commodity prices and supply bottlenecks. Energy prices account for the lion's share of inflation in most advanced European economies, while they account for a smaller share of inflation in several emerging European economies where the recovery from the pandemic has progressed faster (IMF, 2022b). Supply bottlenecks, which new waves of the Covid-19 viruses have deepened and prolonged, show little sign of abating quickly (Celasun et al, 2022). The war in Ukraine pushed up commodity prices further and worsened supply bottlenecks, which were aggravated by Covid-related lockdowns in China (IMF, 2022a and 2022b).

Given the prominence of supply shocks, the second-round effects of exogenous price shocks have become one of key considerations for monetary policy. To take a classic example of oil price shocks pushing up inflation, a country's monetary policy cannot alter global oil prices but can influence the extent to which oil price changes are passed on to wages and non-oil consumer prices, namely the second-round effects. If oil price shocks push up wages to the point of fueling generalized price increases, central banks will be confronted by heightened risks for a wage-price spiral and unmooring inflation expectations. The larger the second-round effects, the more vigilant or hawkish would central banks need to be against inflation pressure.

To better understand the second-round effects, we investigate the impact of oil price shocks on wages and inflation. We focus on wages as a critical channel for second-round effects and on oil prices as the primary example of exogenous price shocks (including shocks to the terms of trade). While there are slightly different views on the scope of second-round effects, the response of wages to shocks is viewed to be their primary channel.¹ However, little empirical research has been conducted to directly analyze the effects of oil price shocks on wages and factors affecting their strength. This paper aims at filling the gap.

The main part of this paper is to estimate the pass-through from oil prices to wages using two data sets: quarterly data for 24 European OECD countries since the 1960s and quarterly data for 39 European countries since 2000. This produces direct information on the response of wages, different from most papers that focus on inflation or estimate a Phillips curve. By using international oil prices whose movements are exogenous to individual economies², this approach increases the odds of accurately estimating the strength of pass-through. We also explore how the pass-through varies with the states or structural characteristics of an economy. Some novel results are uncovered, providing empirical evidence on several channels that have been discussed theoretically more often than empirically.

¹ One major difference lies with "indirect" effects on the prices of non-oil goods and services due to higher energy input costs. ECB (2004) distinguishes such indirect effects from second-round effects on wage and price-setting behavior, while Bernanke (2006) includes them in the second-round effects, by which he refers to all non-direct effects on prices (including indirect effects due to higher input costs).

² For example, Blanchard and Gali (2007) or Killian and Zhou (2022) note that an individual open economy does not affect global oil prices. Section 5.3 presents results that support this approach.

We find that the pass-through from oil prices to wages is state-dependent, consistent with or strengthening the existing theoretical and empirical findings. The pass-through is higher when overall inflation is higher, and cyclical conditions are also found to affect the pass-through, albeit with weak statistical significance. In a broad stroke, the pass-through has declined over time in Europe. Turning to more structural characteristics, the pass-through is higher under lower credibility of monetary policy, while being higher in emerging European economies. The link between the pass-through and labor market characteristics defies a simple characterization, although the pass-through is often found to be higher when a high centralization of collective bargaining is combined with a high degree of unionization.

The paper then turns to several complementary questions. First, how much do wages respond to the headline inflation changes that have been triggered by oil price changes? We find that the headline inflation induced by oil price shocks pushes up wages about one-to-one in the near term, while the strength of this pass-through is also state-dependent. This indicates that our primary results on the pass-through to wages carry over to this measure of second-round effects. Next, how do oil price shocks affect core inflation and inflation expectations, which are two variables that enter a standard Phillips curve? Both core and expected inflation respond more slowly to oil price shocks than wages do. At the same time, the strength of their responses also depends on structural characteristics and economic states as does the strength of the pass-through of oil shocks to wages. Lastly, how does the pass-through vary with the source of shocks to oil prices, namely global demand or supply shocks to the oil market? We find that oil price changes have similar effects on wages whether the changes were induced by global demand or supply shocks to the oil market, consistent with the widely shared premise that global oil price changes are exogenous shocks for individual economies.

The rest of the paper is organized as follows. Section 2 discusses the related literature, albeit not cast directly in terms of the pass-through. Section 3 describes key trends in the data used, with further details contained in Annex I. Section 4 presents the results on the pass-through of oil price shocks to wages, followed by Section 5 that discusses several extensions. Section 6 briefly discusses policy implications of our results and Section 7 concludes.

2. Related literature

This paper relates to the literature on changing macroeconomic effects of oil shocks, including on the non-linear Phillips curve. With no pretense of providing a comprehensive literature review, we discuss several papers that have examined, directly or indirectly, the pass-through of oil prices to consumer prices and sometimes to wages, as well as those that have explored the sensitivity of the (implied) pass-through to states or characteristics of an economy.

Blanchard and Gali (2007) investigated the apparent changes in the macroeconomic effects of oil shocks since the 1970s. In a VAR analysis of six advanced economies, they find that oil shocks had much larger effects on activity and inflation before mid-1980s.³ They then construct a model to show that three channels could have played a role in this change over time. Real wage rigidities may have declined over time, with labor market

³ Using a broader sample of countries including emerging markets, De Gregorio et al. (2007) documented evidence of a declining pass-through from international oil prices to the general price level. Using the post-1980 data for five advanced economies, LeBlanc and Chinn (2004) found moderate inflationary effects of oil prices.

flexibility increasing. Stronger anti-inflation commitment by central banks may have improved the policy tradeoff between inflation and activity. The share of oil in the economy may have declined sufficiently over the sample period.

Estimating the impact of global oil prices on domestic inflation using annual data for 72 economies, Choi et. al (2017) find that a 10 percent increase in global oil inflation increases domestic inflation by about 0.4 percentage point on impact, with the effects vanishing after two years. Conflitti and Luciani (2017) study the pass-through of oil prices to core inflation for the US and euro area. They find that an unexpected 10 percent increase in the real oil price raises core inflation by less than 0.1 percentage point, but with the effect remaining statistically significant for more than 4 years in the US. The effects are similarly small and persistent in the euro area.

Several papers imply that the pass-through can vary with the level of inflation or cyclical state of the economy. Forbes and Gagnon (2021) find support for a non-linear Phillips curve, which steepens when output is above potential and the inflation rate exceeds a threshold level. This could lead to a higher pass-through to inflation when the cyclical condition is tight and inflation itself is high. Borio et al. (2021) document a drop in the pass-through of salient relative price increases to core inflation in a low inflation regime. In a macroeconomic model with a non-linear Phillips curve based on quasi-kinked demand, Harding et. al (2022) show that higher inflation steepens the Phillips curve and intensifies the responses of inflation to demand-type and cost-push shocks, implying a larger pass-through of commodity price shocks to inflation. BIS (2022) argues that a high inflation environment can strengthen the alertness of agents to price changes and increase the pass-through of price shocks, as larger and more wide-spread price changes can lead agents to shed “rational inattention” that would prevail when price changes and inflation are smaller. Related, Sims (2010) discussed rational inattention in the context of monetary policy and Chau (2020) developed a model of a flatter Phillips curve due to behavioral inattention.

Central banks’ credibility, or anti-inflation credentials, have been viewed to ease the policy tradeoff between growth and inflation, thereby promoting price stability and anchoring inflation expectations better (Mishkin 2007). Bems et al (2018) provided recent evidence in support of this credibility benefit. Also, a large body of empirical literature suggested that credibility of central bank is associated with greater central bank independence (Cukierman, 2008). Under a central bank with greater credibility, inflation will be less sensitive to shocks and oil price shocks will also have weaker second-round effects on wages and inflation.

The implication of labor market characteristics on wage setting has been discussed in the context of wage Phillips curve. Blanchard and Katz (1999) highlighted the potential role of unionization and bargaining in bringing about different features of the wage-unemployment relationship between the US and Europe. Several papers have regarded the decline in unionization or centralized bargaining as a contributing factor to the observed flattening in the wage Phillips curve in Europe (Gali (2011) and Nickel and others (2020)).

Gelos and Ustyugova (2017) empirically examined the pass-through of oil prices to inflation by estimating an augmented Phillips curve. They in particular examined the effect of structural characteristics and policy frameworks on the inflationary effects of commodity—oil and food—price shocks. Country-by-country estimation implies that a 10 percentage-point oil price shock raises domestic inflation by less than 0.1 percentage point in most countries. In a panel estimation with interaction terms, they find the implied pass-through of oil prices to headline inflation to have been associated with higher pre-existing inflation but not with labor market flexibility.

3. Data and stylized facts

We construct two complementary datasets for the analysis. The first one (to be called “*broad*” dataset) covers 39 countries in Europe comprising 23 advanced and 16 emerging economies,⁴ starting in 2000 on the quarterly basis. The second dataset (“*long*” dataset) covers 24 mostly advanced economies, starting in the 1960s on the quarterly basis. Except for the country and time coverage, the main difference between the two datasets lies in the definition of wage series. In the broad dataset, wages cover as broad industries as possible, usually for the whole economy or all industries excluding construction. Wages in the long dataset cover the manufacturing sector only. While the country and industry coverages are limited, the long dataset allows us to analyze experiences around the oil shock and high inflation episodes in the 1970s.

Several oil price shocks are covered in both datasets (see Annex I for further information on data sources). Figure 1 plots the annual oil price inflation denominated in the US dollar.⁵ The shaded areas indicate periods when oil price inflation exceeded 35 percent (one standard deviation). The highest price shock of 184 percent was observed during the oil shock in 1974, followed by 130 percent in 1980. Oil price inflation was relatively moderate in the 1980s and 1990s, until it rose again to 120 percent in 2000. In the post-2000 period, oil prices became more volatile, against the background of growing demand and stagnant supply (Hamilton, 2013), bringing about large spikes exceeding 50 percent in 2003, 2004, 2007-08, 2010, and 2021.

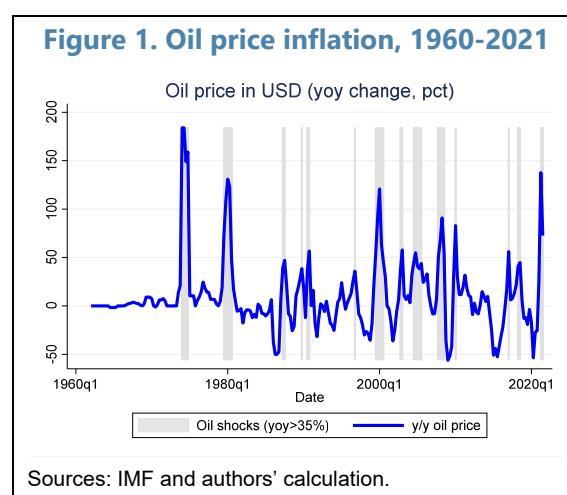
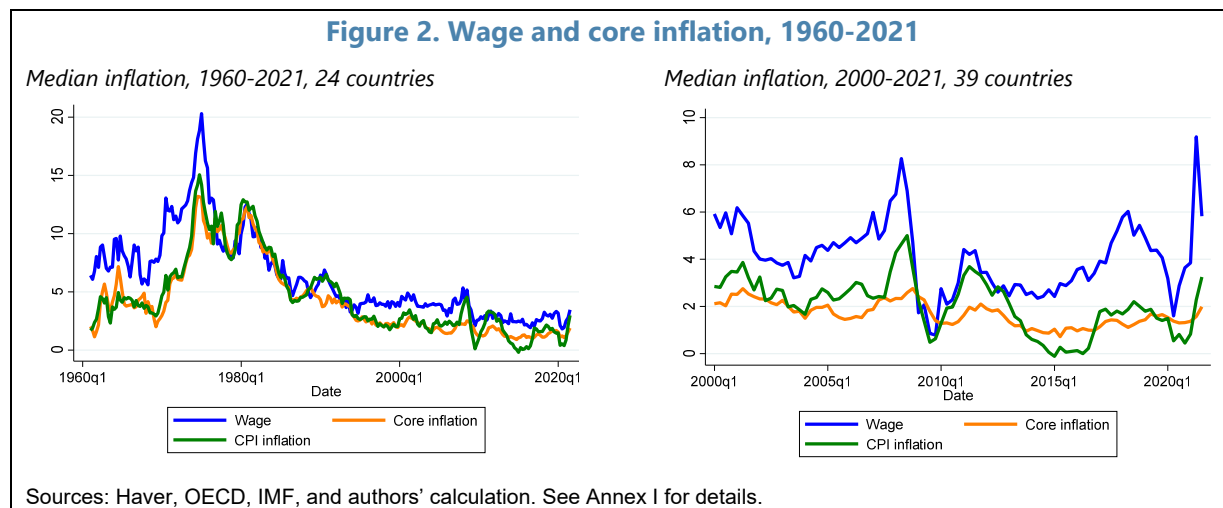


Figure 2 displays high wage and core inflation of the 1970s and 1980s, which gradually moderated in the 2000s and onward. Median wage and core inflation peaked at 19 percent and 13 percent, respectively, in 1975, following the oil shock in 1974. Once inflation rates moderated to around 5 percent in 2000, they remained modest despite recurrent high oil price episodes in the 2000s. Median inflation is more volatile in the broad dataset, because it includes more emerging economies that tend to have higher and more volatile inflation rates.

⁴ Advanced European countries comprise Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Israel, Italy, Latvia, Lithuania, Netherlands, Norway, Portugal, Slovak Republic, Slovenia, Spain, Sweden, and United Kingdom. Emerging European countries comprise Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Hungary, Kosovo, Moldova, Montenegro, North Macedonia, Poland, Romania, Russia, Serbia, Türkiye, and Ukraine. Data start from a later period for some countries. See Annex II.

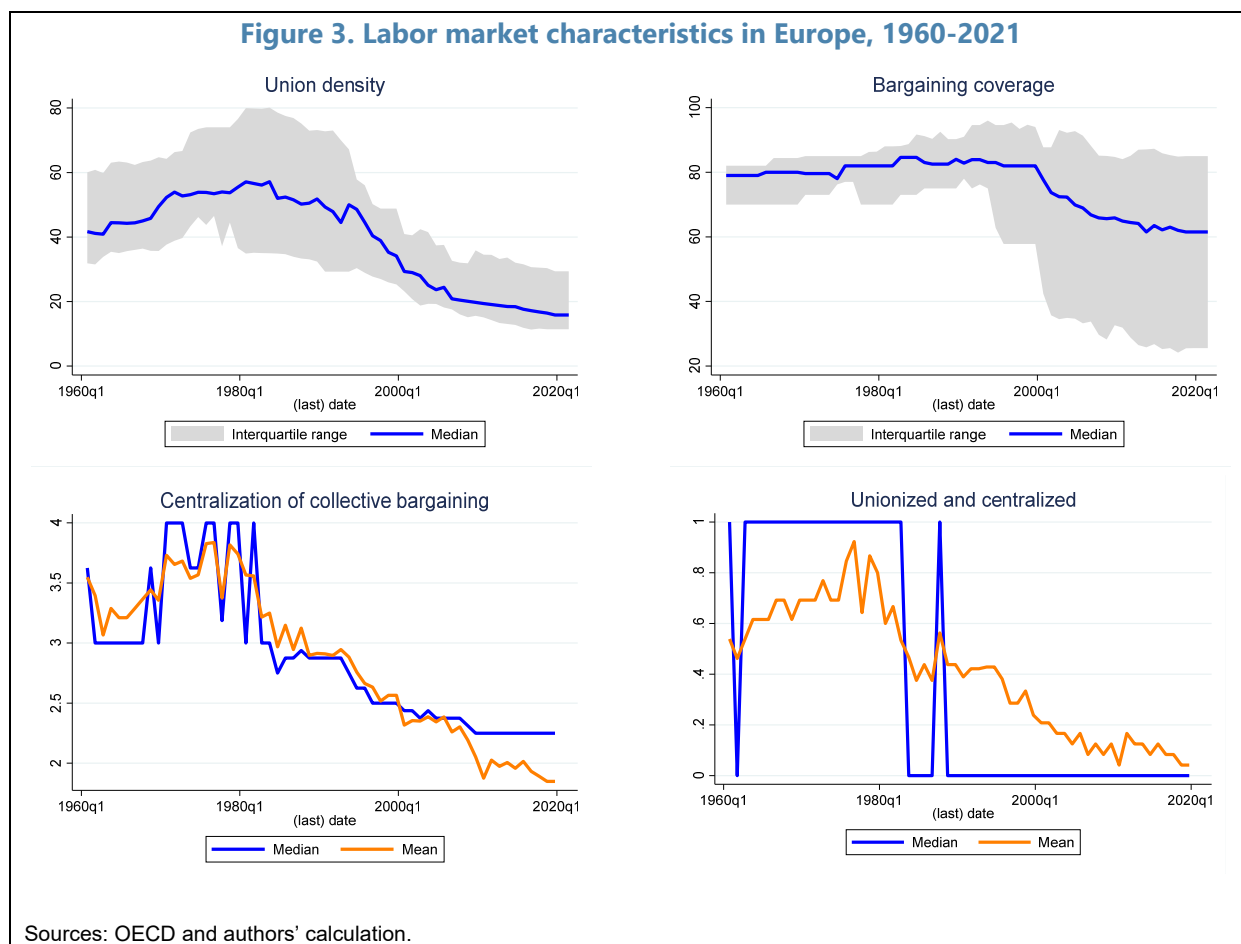
⁵ Simple average of three spot crude oil prices. See Annex I.



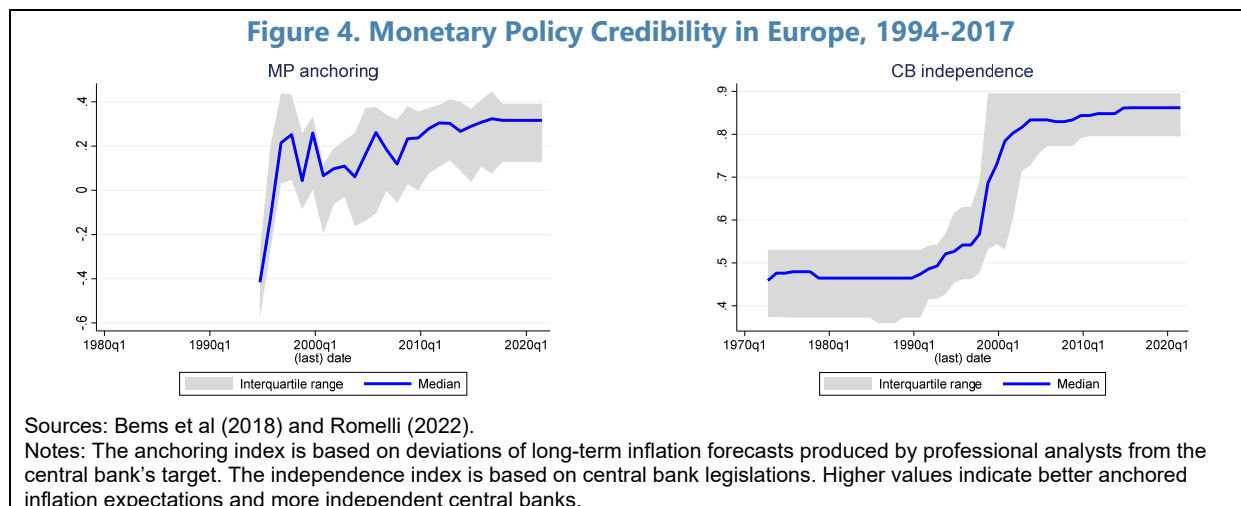
During the same period, labor markets in Europe underwent substantial changes toward greater flexibility, possibly affecting firms' wage setting behaviors along the way. Figure 3 shows evolutions in selected labor market characteristics in European OECD countries from 1960 to 2021. All measures related to wage setting flexibility, including the degree of unionization, coverage of collective bargaining, and centralization of collective bargaining, show that they have been liberalized since the 1980s, reversing previous trends toward less liberal frameworks in the 1960s and 70s.⁶ In seven emerging European economies for which data are available, the median union density dropped sharply in the 1990s from nearly 100 percent to around 25 percent in 2000 and have remained lower than the advanced-Europe median by about 5 percentage points thereafter. Similar liberalizing trends are observed in a combined binary indicator that we constructed to capture highly unionized *and* centralized bargaining regimes, which takes the value of 1 if the degrees of unionization and centralization are both above their median values.

While country coverage is limited, most indicators suggest emerging European economies (EEs) have weaker organization of labor compared to advanced European economies (AEs), in line with Duval and Loungani (2019). However, the macroeconomic effects of labor market characteristics are not conclusive empirically or theoretically, with detailed features likely affecting the outcomes (see Blanchard et al (2013)). It is also worth noting that, while labor market characteristics are viewed to affect employment and wage outcomes at firm and economy level, their effects on the response of wages to exogenous price shocks have not been directly estimated.

⁶ The collective bargaining coverage rate measures the share of workers covered by collective agreements, while the centralization represents the role of peak associations in collective bargaining. For example, when more workers are covered by agreements negotiated at industry level than by agreements negotiated at firm level, the system is more centralized.



Institutional arrangements for monetary policy have been strengthened especially in the 2000s, likely weakening the pass-through of exogenous oil shocks to wages through better anchoring of expected inflation. Since the adoption of euro in 1999, the European Central Bank effectively anchored inflation expectations in its member countries with a clear target on medium-term inflation. Countries outside the euro area also adopted inflation targeting frameworks, starting with the United Kingdom in 1992, and more widely among emerging European countries in the late 1990s and 2000s. An index of inflation expectations' anchoring based on the deviation of long-term inflation forecasts from central bank targets demonstrates marked improvements in the 2000s, along with greater central bank independence, indicating the strengthening of monetary policy credibility (Figure 4).



4. Results

4.1. Baseline impulse responses

We document the strength and dynamics of pass-through from oil prices to wages by estimating impulse response functions. They are estimated with the panel data using the local projection method proposed by Jordà (2005), which allows more flexibility in the shape of impulse response functions and is less sensitive to misspecification in practice, while being econometrically equivalent to a VAR (Plagborg-Møller et al 2021). We estimate cumulative changes in wages following oil price shocks, which are viewed to be exogenous to individual economies in our sample, consistent with the literature (e.g. Kilian and Zhou, 2022). The argument is that the demand for oil by small-open economies does not affect the global oil price.

For each horizon $h=1, \dots, H$, the following wage equation is estimated on quarterly data:

$$\Delta_h w_{t+h-1,j} = \alpha_j(h) + \sum_{i=1} \beta_i(h) \Delta w_{t-i,j} + \sum_{i=1} \gamma_i(h) \Delta p_{t-i,j} + \sum_{i=1} \delta_i(h) \Delta y_{t-i,j} + \varepsilon_{t,j,h}$$

where $\Delta_h w_{t+h-1,j} = \ln W_{t+h-1,j} - \ln W_{t-1,j}$ refers to the cumulative growth in wages in h quarters from time $t-1$ in country j , $\Delta w_{t-i,j}$ is quarterly wage growth with a lag of i -quarter, $\Delta p_{t-i,j}$ is i -quarter lagged quarterly oil price change denominated in the US dollar, y refers to a set of control variables, and α_j represents country fixed effects. The sample period for both datasets ends in 2019Q4, before the start of the pandemic, to stay clear of extraordinary effects of the pandemic.

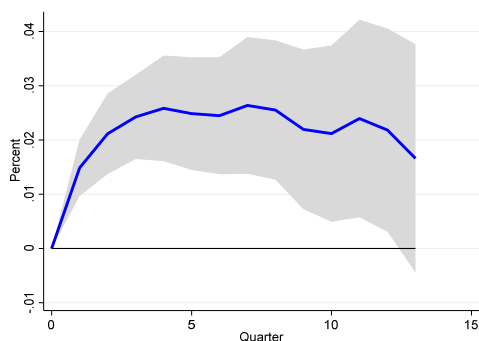
In the benchmark specification, we include 4 lags of quarterly growth in wages and oil prices and control for cyclical positions of the economy and the non-oil terms of trade shocks by including quarterly changes in unemployment rates and nominal effective exchange rates (NEER), both up to 4 quarter lags. For the long dataset, we include quarterly log differences in industrial production and nominal exchange rates against the US dollar, due to the data availability before the 1980s. We also experimented with additional control variables, including GDP growth rates and interest rates, but did not include them in the benchmark regressions as they were not statistically significant and often reduced the number of usable observations. The results presented below are robust to the choice of lag lengths.

One algebraic digression is in order, as we begin to discuss the estimated pass-through. The estimate of pass-through (or impulse responses) in the rest of the paper is the response of cumulative wage growth to a shock to quarterly oil price inflation by 1 percentage point. The resulting increase in cumulative wage growth, however, is equivalent to the percent increase in wage level relative to the pre-shock wage level as the base. We thus discuss the pass-through in terms of percent increase in wages in the rest of the paper.

The regressions confirm statistically significant pass-through from oil price shocks to wages. Table 1 reports the regression results for $h=1, 3, \dots, 12$ quarters using the broad dataset. The variable of our main interest is the coefficient on the one-lagged oil price shock of 1 percentage point, which is illustrated in Figure 5 with the 90 percent confidence band. Wages rise by about 0.015 percent in 1 quarter after an oil price shock (increase by 1 percentage point), and the cumulative response stabilizes around 0.025 percent by 1 year after the shock.⁷ The control variables enter with expected signs, confirming that wages rise with lower unemployment rates and fall with the exchange rate appreciation. The autoregressive terms for wages are statistically significant in the first three lags consistently, while the lagged oil price shocks do not enter with the expected sign and lose statistical significance beyond one lag.

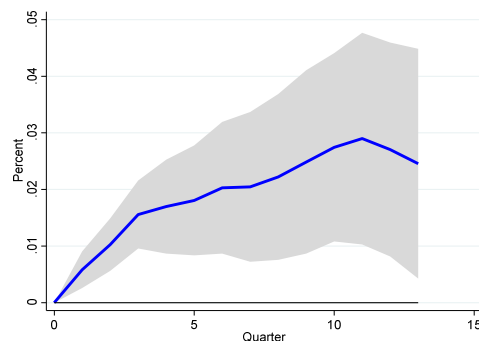
In the long dataset covering 1960-2019, the pass-through elasticities are slightly higher (Figure 6). Wages increase by 0.006 percent in one quarter and by 0.03 percent in about 3 years after the shock. The pass-through elasticities estimated from the long and broad datasets are of the same *order of magnitude* as the pass-through estimates to consumer price inflation obtained in Choi et al. (2017) or Conflitti and Luciani (2017). But a finer comparison cannot be made because of the difference in the sample as well as the variable of interest (wages versus consumer prices). A comparison of the effects on wages and consumer prices in our data is discussed in a later section.

Figure 5. Cumulative impulse responses following oil price shocks, 2000-2019



Notes: Estimated with unbalanced panel data for 2000Q1-2019Q4 for 39 countries in Europe using the local projection method. The regressions includes 4 lags for the autoregressive terms, lagged oil price shocks, changes in unemployment rates and changes in NEER. The shaded area represents the 90 percent confidence band.

Figure 6. Cumulative impulse responses following oil price shocks, 1960-2019



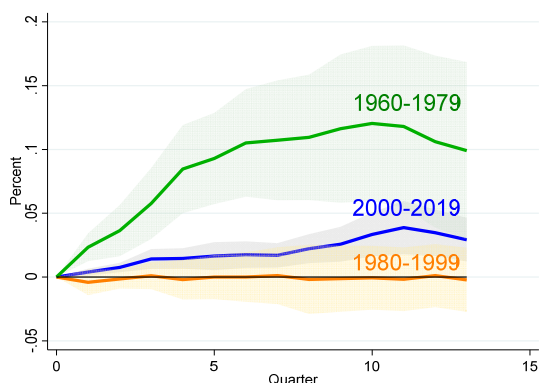
Notes: Estimated with unbalanced panel data for 1960Q1-2019Q4 for 24 countries in Europe using the local projection method. The regressions includes 4 lags for the autoregressive terms, lagged oil price shocks, industrial production growth and exchange rate growth. The shaded area represents the 90 percent confidence band.

⁷ This implies that the median quarterly wage growth no longer responds to oil price shocks, or slightly declines, after 4 quarters. In the rest of the paper, we truncate the impulse response charts at 2 or 3 years after the shock, because interpretation of point estimates becomes difficult over longer horizons with expanding confidence bands.

The stronger responses in wages in the long dataset seem to reflect the experiences around the oil shocks in the 1970s. Figure 7 plots the impulse responses in subsample periods with the long dataset. The pass-through coefficients are higher in the subsample covering the 1960s and 1970s, with the response in wages exceeding 0.1 percent in 1½ year after the shock. In contrast, the estimates for the subsequent periods are smaller with almost zero pass-through for 1980-1999 and around 0.02 percent for 2000-2019. The decline in the pass-through to wages is in line with the existing evidence that finds lower economic effects of oil shocks on the other macro variables, notably GDP growth and inflation, since the mid-1980s (for example, Blanchard and Gali (2007), Baumeister et al (2009)).

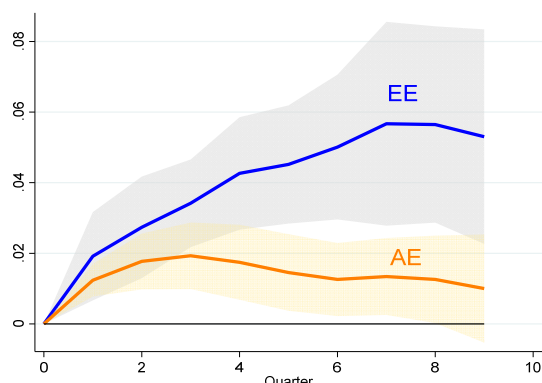
The responses are also different between advanced European economies (AEs) and emerging European economies (EEs). Table 3 reports the estimation results for the AEs and EEs separately using the broad dataset. As also displayed in Figure 8, the elasticity of wages to oil price shock peaks around 0.02 percent for AEs in 3 quarters, while the corresponding elasticity nears 0.05 percent for EEs in 1½ years after the shock. As for the performance of control variables, unemployment rates are statistically significant only in the AE sample, while NEER is statistically significant in both sets of countries with larger effects for EEs.

Figure 7. Cumulative impulse responses following oil price shocks, by subsample period, 1960-2019



Notes: Estimated with unbalanced panel data for 1960Q1-2019Q4 for 24 countries in Europe using the local projection method. The regressions includes 4 lags for the autoregressive terms, lagged oil price shocks, industrial production growth and exchange rate growth. The shaded area represents the 90 percent confidence band.

Figure 8. Cumulative impulse responses following oil price shocks, advanced and emerging economies, 2000-2019



Notes: Estimated with unbalanced panel data for 2000Q1-2019Q4 for 23 advanced and 16 emerging economies in Europe using the local projection method. The regressions includes 4 lags for the autoregressive terms, lagged oil price shocks, changes in unemployment rates and changes in NEER. The shaded area represents the 90 percent confidence band.

4.2. Pass-through and structural factors

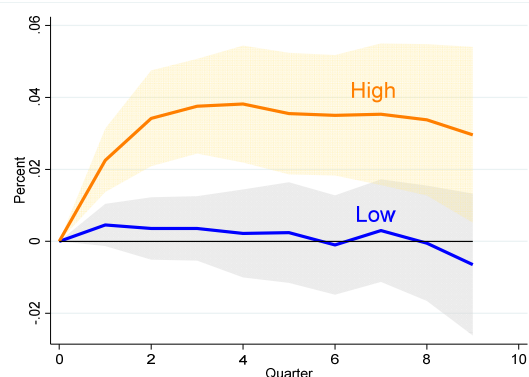
To examine factors that affect the strength of pass-through, we extend the wage equation with a few structural variables $z_{t,j}$ and their interaction terms with oil price shocks $\Delta p_{t,j}z_{t,j}$:

$$\Delta_h w_{t+h-1,j} = \alpha_j(h) + \sum_{i=1} \beta_i(h) \Delta w_{t-i,j} + \sum_{i=1} \gamma_i(h) \Delta p_{t-i,j} + \sum_{i=1} \theta_i(h) \Delta p_{t-i,j} z_{t-i,j} + \vartheta(h) z_{t-1,j} + \sum_{i=1} \delta_i(h) y_{t-i,j} + \varepsilon_{t,j,h}$$

for horizon $h = 1, \dots, H$, country j and time t . As in the benchmark regressions, all regressors (except structural characteristics) include their lagged terms up to 4 quarters. The structural characteristics variables that are available in annual frequency are interpolated to quarterly series by using the last observations. In addition, they are converted to binary data series with 1 indicating values greater than the medians for a given series, and 0 otherwise.⁸ The equation is estimated separately for each structural variable to ensure sufficient country coverage for each specification.

We start with the weights of energy in the consumption basket. The pass-through of oil price shocks is expected to be greater in countries where oil represents a larger share in the consumption basket and thus has larger direct impacts on inflation. We use country-specific annual CPI weights of fuel and energy to gauge the share of oil in the consumption basket. The CPI weights data that are available for 34 countries are relatively narrowly distributed across countries with the interquartile range of 8.7 and 13 percent. As reported in Table 4, the regression analysis using the broad dataset finds that the interaction term of energy weights with oil price shock is positively (and statistically significantly) related to wage growth.⁹ An analogous exercise using the binary energy weights shows that regimes with high energy weights have stronger oil price pass-through to wages compared to low energy weight regimes (Figure 9). Given that EEs on average have a higher share of energy in their consumption basket (12.7 percent) compared to AEs (10 percent), this contributes to the difference in the strength of pass-through between AEs and EEs in Figure 8.¹⁰

Figure 9. Cumulative impulse response of wages following oil price shocks, by energy weights in consumption basket, 2000-2019



Notes: Estimated with unbalanced panel data for 2000Q1-2019Q4 for 23 advanced and 11 emerging economies in Europe using the local projection method. The regressions include 4 lags for the autoregressive terms, lagged CPI inflation, changes in unemployment rates and changes in NEER. The shaded area represents the 90 percent confidence band.

We then explore the effects of institutional frameworks for wage bargaining. Because most structural variables follow a declining trend from the 1980s (Figure 3), we focus on three variables that remain statistically significant as a stand-alone control variable in the wage equation (separate from interaction terms). These variables are the union density, the coverage rate of collective bargaining, and a combined indicator for highly unionized and centralized wage bargaining.¹¹ With all structural characteristics converted to binary variables, the pass-through estimates are reported for “high” and “low” values of structural characteristics separately, along with the 90 percent confidence bands (using standard errors calculated by the delta method).

⁸ The median values are the followings: (1) *long dataset*: 35 percent for the union density, 80 percent for the collective bargaining coverage, 2.5 for the bargaining centralization, 0.2 for the monetary policy anchoring index, and 7 for the central bank transparency index. (2) *broad dataset*: 10.7 percent for the energy weights, 28 percent for the union density, 78 percent for the collective bargaining coverage, 2.4 for the bargaining centralization, 0.22 for the monetary policy anchoring index, and 7.5 for the central bank transparency index.

⁹ We omit the results using the long dataset, because the energy weight data are available only from 1999 and defeat the purpose of using the long dataset.

¹⁰ Another contributing factor to the difference between AEs and EEs would be the monetary policy credibility, which was on average higher in AEs than in EEs during the sample period. The results are presented in Figure 11.

¹¹ The degree of centralization of bargaining is only weakly significant unless it is combined with the union density. The binary values for the combined variable are constructed so that “high” indicates the degrees of unionization and centralization are both above their median, and “low” indicates all other combinations. Although the coefficient on the bargaining coverage is often statistically significant, the coefficient usually has a negative sign.

The estimates obtained from the long dataset show that two labor market characteristics are positively correlated with levels of (cumulative) wage inflation and the pass-through of oil price shocks to wages. The left column of Figure 10 summarizes the effects of labor market characteristics using the long dataset for 1960-2019. It shows that the pass-through is stronger in countries (and periods) with higher unionization and with both highly unionized and centralized wage bargaining, with statistically significant relationship for interaction terms at 5 percent level. We do not find evidence that the coverage of collective bargaining affects the pass-through strength with statistical significance, however. Turning to direct effects of structural characteristics, wage inflation is higher in countries with higher unionization and centralized bargaining, in addition to higher pass-through effects. In all specifications, control variables (industrial production and exchange rates) enter with expected signs.

However, these relationships between labor market characteristics and the pass-through strength do not hold in the more recent data. With the broad dataset covering 2000-2019, as reported in the right column of Figure 10, the degree of unionization does not significantly affect the pass-through strength, and the contrast between high unionization cum centralized bargaining and the rest becomes less stark. Nor does the coverage of collective bargaining have statistically significant effects on the pass-through strength. Similarly, in the long dataset, the association between the wage bargaining characteristics and the strength of pass-through is not statistically significant if we repeat the same exercise with the post-2000 subsample.¹² In the longer sample, these variables might also act as proxies for other variables that drove inflation, particularly during 1970-2000.

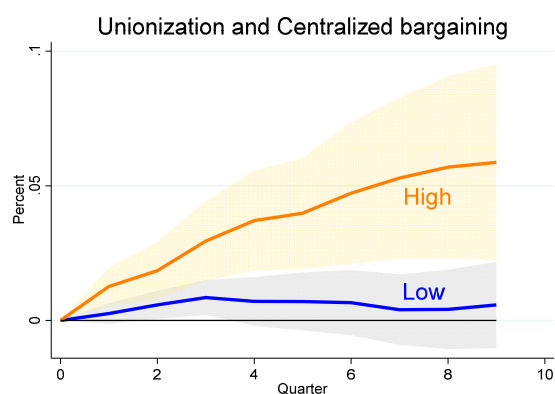
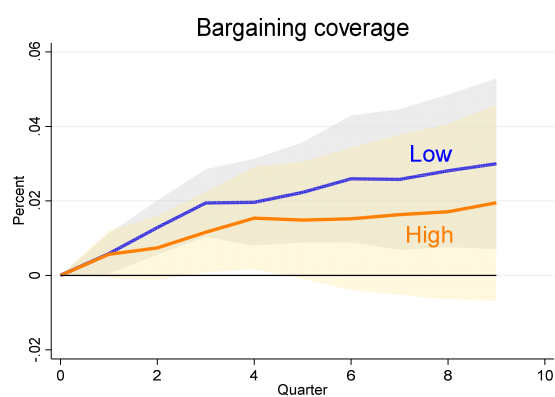
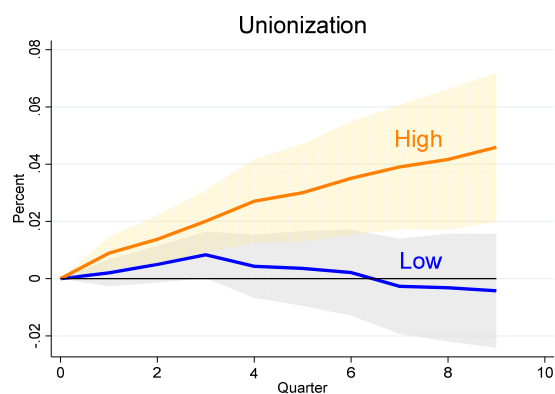
Our results on the roles of labor market institutions appear consistent with the unresolved state of the literature (Addison (2016) and Visser (2016)). While the “corporatism” view of Bruno and Sachs (1985) and the “hump-shape thesis” of Calmfors and Drifill (1988) imply that a higher coverage of collective wage bargaining could moderate wage demands in response to external price shocks, the empirical verdict remains open and the literature has instead highlighted the complicated and varied nature of bargaining systems and their macroeconomic effects. Nor have our estimated results on the coverage rate been statistically significant. The results associated with high unionization cum centralized bargaining lose statistical significance with the post-2000 data, consistent with studies that do not always find a statistically significant role of labor market variables (e.g. Gelos and Ustyugova, 2017).

The contrast between the long dataset and broad dataset could reflect much smaller variation in the data for labor market characteristics since 2000, which in turn is the outcome of a regime change in the labor market with the 1980s as the watershed. Such a regime change is viewed as an exogenous development in this paper, although one cannot rule out the possibility that the regime change itself was associated with the developments in inflation and policy responses. In the latter case, this would underscore the importance of the overall inflation environment and monetary policy credibility, which we discuss next.

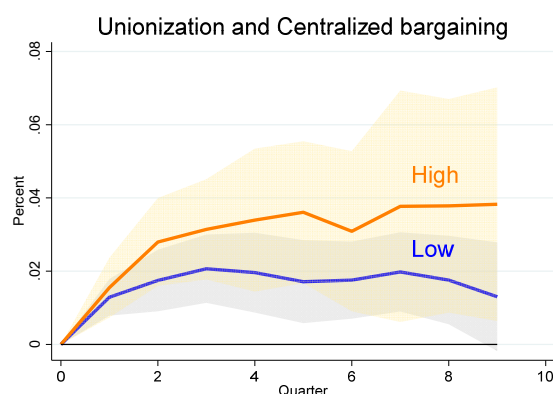
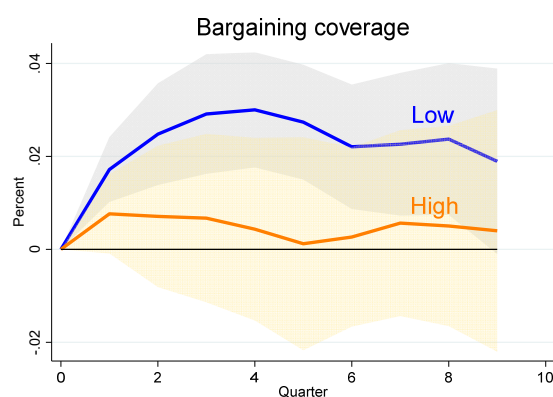
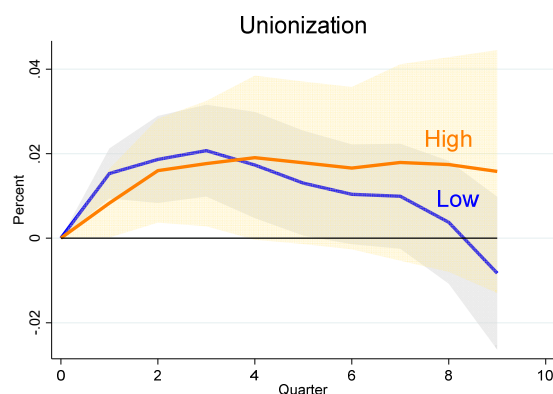
¹² Charts are available upon requests.

Figure 10. Cumulative impulse response of wages following oil price shocks, by labor market characteristics

1960-2019

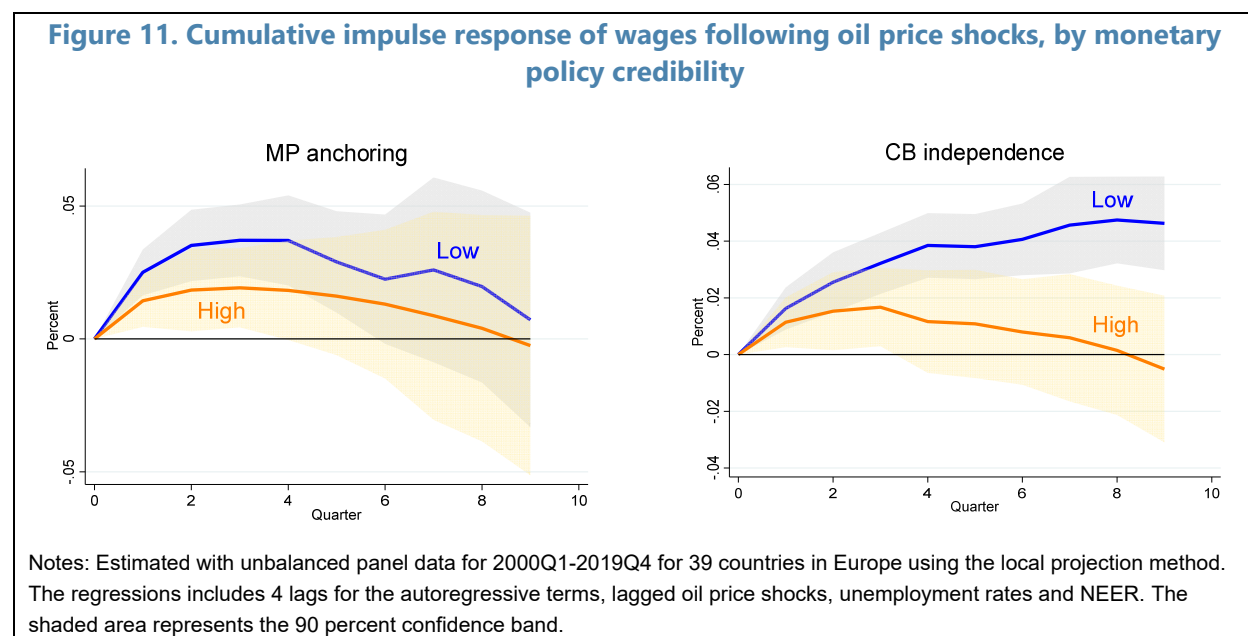


2000-2019



Notes: Left panel charts show IRFs estimated with unbalanced panel data for 1960Q1-2019Q4 for 24 countries in Europe using the local projection method. The regressions includes 4 lags for the autoregressive terms, lagged oil price shocks, industrial production growth and exchange rate growth. Right panel charts show IRFs estimated with unbalanced panel data for 2000Q1-2019Q4 for 39 countries in Europe. The regressions includes 4 lags for the autoregressive terms, lagged oil price shocks, changes in unemployment rates and changes in NEER. The shaded area represents the 90 percent confidence band.

The equivalent specification is used to uncover the roles played by monetary policy credibility. Figure 11 displays the impulse responses for wages utilizing interaction terms with measures of monetary policy credibility, estimated for the broad dataset.¹³ The pass-through to wages is weaker if inflation expectations are better anchored and central banks are more independent. The wage pass-through is weaker under high values of the anchoring index, with statistically significant differences lasting for a year after the shock, whereas the interaction terms with the central bank independence are statistically significant three quarters after the shock and thereafter. These results are consistent with the literature on the benefit of monetary policy credibility discussed earlier.



4.3. Pass-through and economic states

We then look into differences in the wage pass-through based on the states of economy when the oil price shock hits. We start with the effects of the level of inflation at the time of oil price shock. There are a few reasons to expect stronger pass-through in economies with high pre-existing inflation, including higher wage negotiation incentives, higher likelihood for firms to change prices and hence pass on the costs of pay rises, and a perception of weak monetary policy reactions. These overlap the literature on non-linear Phillips curve, including theories of rational or behavioral inattention discussed earlier. Similar to our approach for structural variables in the previous section, we created a dummy variable indicating that the level of headline inflation exceeded a threshold at the time of oil price shock. We experiment with thresholds of 2, 4, and 6 percent.

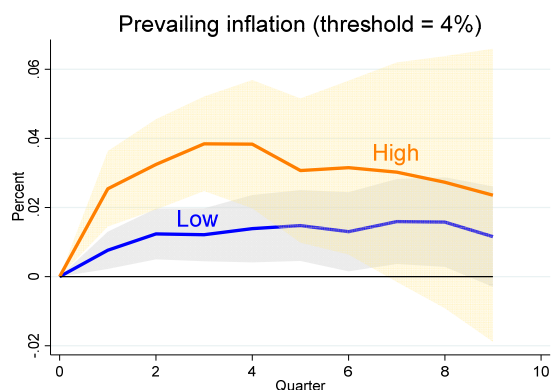
The estimation confirms lower pass-through to wages in economies with low pre-existing inflation. Figure 12 contrasts the impulse response functions for the high and low inflation states, estimated for the broad dataset with the threshold for high inflation set at 4 percent. Wages react more strongly to oil shocks if inflation was already high, with the pass-through elasticity of 0.04 in about a year after the shock, while the corresponding elasticity is 0.01 for low inflation states. When we apply the threshold of 6 percent, the (statistically significant)

¹³ The results with the long dataset are similar and omitted.

difference in the elasticity expands to 0.07 in high inflation states compared to 0.02 for low inflation states. On the other hand, no statistically significant differences are found if the threshold is set at 2 percent.

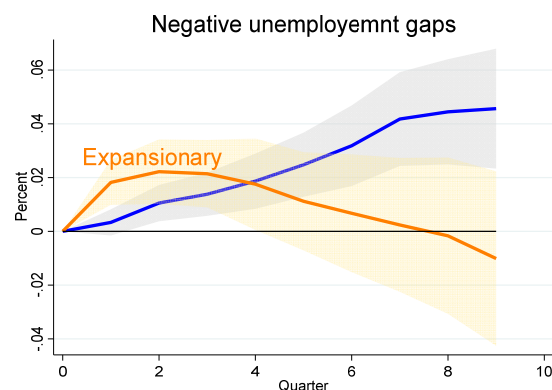
We next examine how the strength of the pass-through depends on the phases of business cycles. Wages could respond more strongly to oil price shocks when labor market slack is low. This relationship is partially confirmed in the data. Figure 13 contrasts the impulse response functions for oil shocks that hit during expansionary phases and others, estimated with a binary indicator for expansionary phases based on the deviations of unemployment rates from HP trends. For about a year after the oil price shock, wages respond more strongly if the economy was in an expansionary phase at the time of the shock. The relationship does not last long, probably because economic expansion at the time of the initial shock is likely to be followed by contraction, especially when it is combined with a rise in oil prices. As presented later in the shock decomposition of global oil prices (in Section 5.3), oil price shocks are often driven by a strong aggregate demand in the world economy. When both the local and global economies are in an expansionary phase, the local economy would quite likely turn to a less expansionary or contractionary phase in 1-2 years, including due to monetary tightening to bring down inflation.

Figure 12. Cumulative impulse responses following oil price shocks, by pre-shock inflation level, 2000-2019



Notes: Estimated with unbalanced panel data for 2000Q1-2019Q4 for 39 countries in Europe using the local projection method. The regressions includes 4 lags for the autoregressive terms, lagged oil price shocks, changes in unemployment rates and changes in NEER. The shaded area represents the 90 percent confidence band.

Figure 13. Cumulative impulse responses following oil price shocks, by cyclical phase, 2000-2019



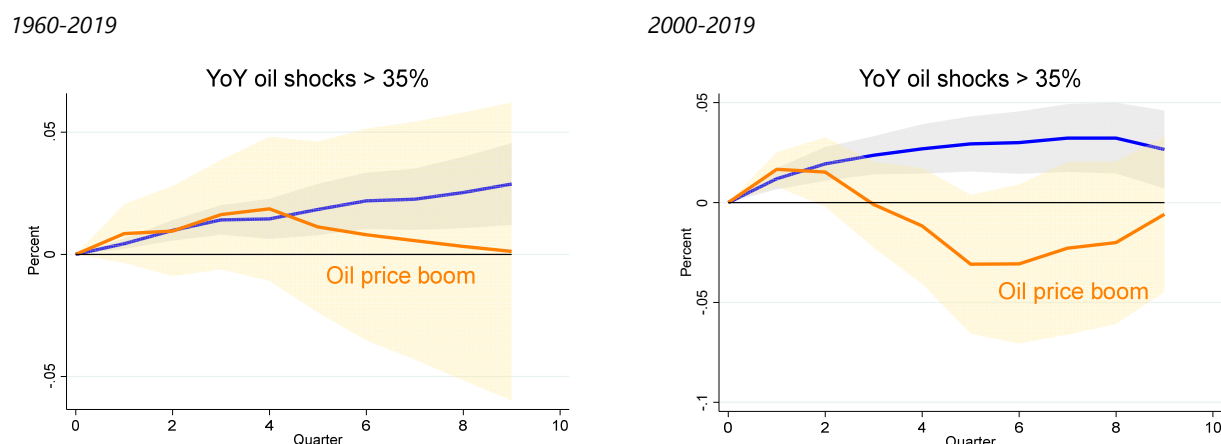
Notes: Estimated with unbalanced panel data for 2000Q1-2019Q4 for 39 countries in Europe using the local projection method. The regressions includes 4 lags for the autoregressive terms, lagged oil price shocks, changes in unemployment rates and changes in NEER. The shaded area represents the 90 percent confidence band.

We then explore whether wage reactions would be different under large shocks to oil prices. Given the volatile nature of oil prices, a simple comparison of wage reactions relative to the size of quarterly shocks may not provide a meaningful picture. An oil price shock followed by an offsetting shock, namely short-lived increases in oil prices, could affect wages less strongly than sustained oil price shocks. We thus analyze wage reactions when the annual oil price inflation exceeded a threshold, which is set at 35 percent (equal to one standard deviation and corresponding to the shaded areas in Figure 1).¹⁴ Figure 14 summarizes the impulse response

¹⁴ The findings are consistent if we use alternative definitions, including the net oil price increase used by Hamilton (2003) (the amount by which oil prices exceed their peak value over the previous 12 months), or higher thresholds for large shocks.

functions derived from the two datasets. With the long dataset (left panel), we do not find significant differences in the reactions. The estimates from the broad dataset (right panel) show that shocks during large oil price booms have significantly weaker pass-through to wages, contrary to our expectation. These results could reflect the complex structure of retail energy markets that dampens the effect of large swings in oil prices or reflect other economic and policy reactions triggered by large shocks to oil prices (e.g. tax cuts).

Figure 14. Cumulative impulse responses of wages following oil price shocks during oil price booms



Notes: Estimated with unbalanced panel data for 1960Q1-2019Q4 for 24 countries (left) or 2000Q1-2019Q4 for 39 countries (right) in Europe using the local projection method. The regressions includes 4 lags for the autoregressive terms, lagged oil price shocks, changes in unemployment rates and changes in NEER. The shaded area represents the 90 percent confidence band.

5. Extensions

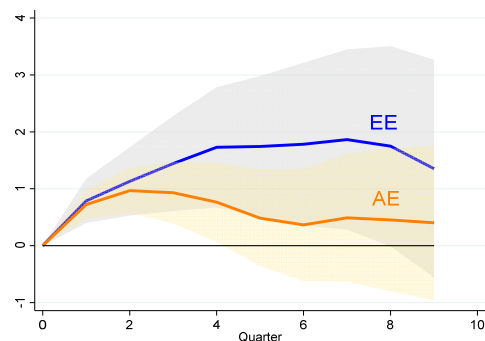
5.1. Transmission via CPI inflation

Another way to measure the second-round effects of oil price shocks is via the response of wages to the increase in (headline) inflation that has been induced by oil price shocks. This response can be estimated by the same specification, replacing the oil price change with CPI inflation as a regressor and using oil price changes as an instrument for CPI inflation in the estimation. Specifically, we use oil price shocks with lags up to 4 quarters as instruments and work with the broad dataset.

The baseline specification shows that an oil-induced rise in CPI inflation leads to a rise in wages of about the same magnitude in two quarters following the rise in inflation (Figure 15). The impacts thereafter ease to about a half in AEs, while wage increases in EEs are twice as large as the rise in CPI inflation in the second year. These results are consistent with larger second round effects on wages in EEs, which were estimated in the previous section.

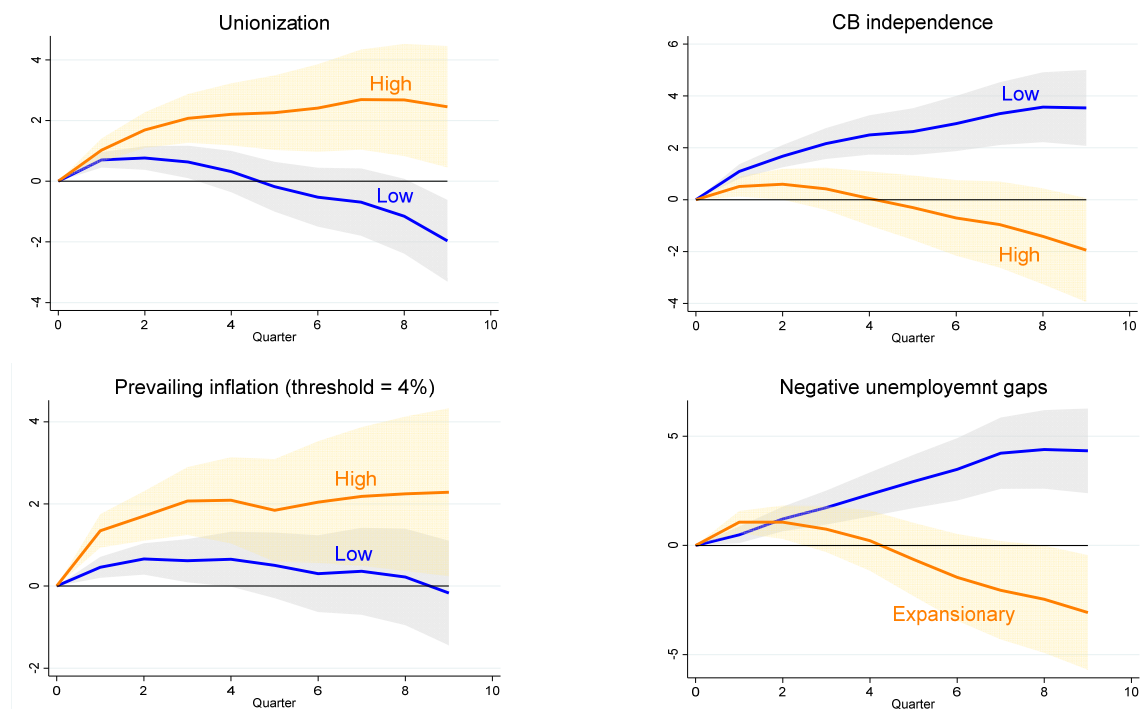
Similarly, findings on the relationship with structural factors and economic states are in line with those documented in the previous sections for the direct effects of oil price shocks on wages. Figure 16 shows the impulse responses estimated with interactions for four structural or economic state variables. The pass-through from oil-induced inflation to wages is higher if the economy is highly unionized, has less anchored inflation expectations, and has high pre-existing inflation. The relationship with business cycles is also similar to that of wages, which was discussed with Figure 13.

Figure 15. Cumulative impulse responses of wages to oil-induced CPI inflation, 2000-2019



Notes: Estimated with unbalanced panel data for 2000Q1-2019Q4 for 23 advanced and 16 emerging economies in Europe using the local projection method. The regressions includes 4 lags for the autoregressive terms, lagged CPI inflation, changes in unemployment rates and changes in NEER. The shaded area represents the 90 percent confidence band.

Figure 16. Cumulative impulse responses of wages following oil price induced inflation, by structural factor, 2000-2019



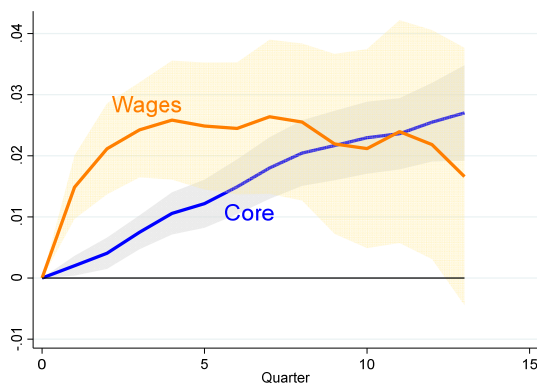
Notes: Estimated with unbalanced panel data for 2000Q1-2019Q4 for 39 countries in Europe using the local projection method. The regressions includes 4 lags for the autoregressive terms, lagged oil price shocks, changes in unemployment rates and changes in NEER. The shaded area represents the 90 percent confidence band.

5.2. Pass-through to core and expected inflation

The pass-through of oil price shocks to expected inflation and core inflation provides another measure of second-round effects, which could have direct implications for monetary policy responses. We use the same econometric model as before but with cumulative changes in core inflation as the dependent variable instead of cumulative wage changes. For expected inflation we do the same but note that the data is available only in terms of annual growth rates. The dependent variable is thus changes in annual expected inflation rates relative to the pre-shock values and should approach zero when the impact from oil price shocks on expected inflation fades. The broad dataset is used for estimation.

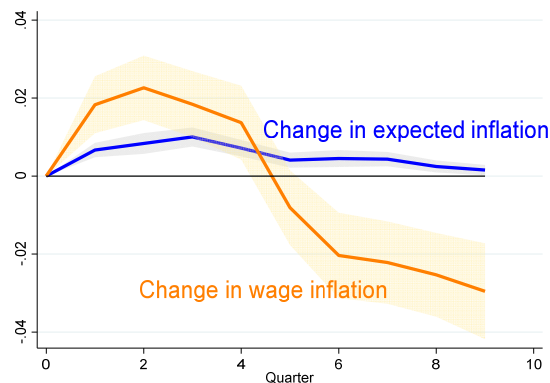
Both core and expected inflation respond more slowly to oil price shocks than wages do. Figures 17 and 18 show the impulse responses for core and expected inflation, respectively, along with the corresponding estimates for wages.¹⁵ In the first quarter after an oil price shock, the pass-through elasticity for core inflation is 0.002, which is much smaller than the estimate of 0.015 for wages. However, it gradually rises to 0.03 in three years after the initial shock. The confidence band is narrower than the one for wages, reflecting smaller dispersion of core inflation across countries and time. Likewise, expected inflation reacts more gradually than wages, where the peak elasticity observed in 3 quarters after the shock is 0.01, which is about a half of the pass-through elasticity to wages. In response to oil price shocks, expected inflation is affected for about two years. The control variables have expected signs in both specifications, but statistical significance of the coefficients on changes in unemployment rates is low for core inflation.

Figure 17. Cumulative impulse responses of core inflation to oil price shocks, 2000-2019



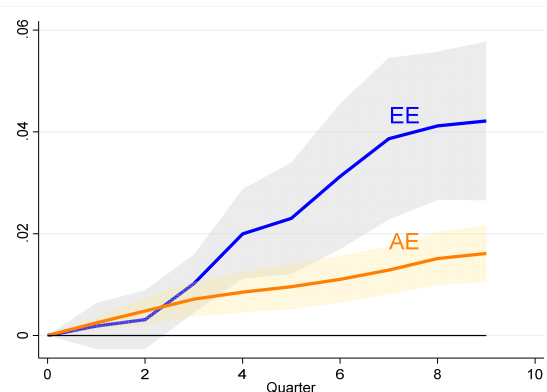
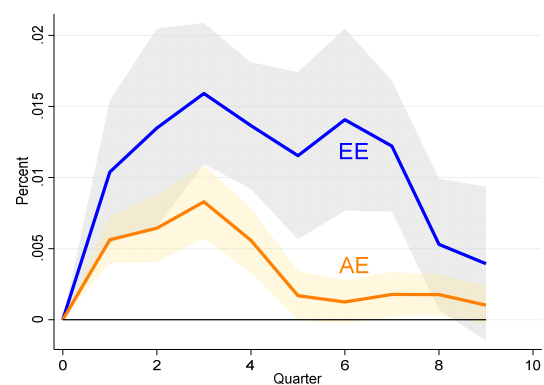
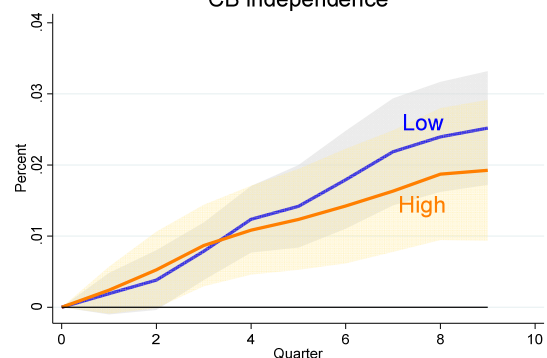
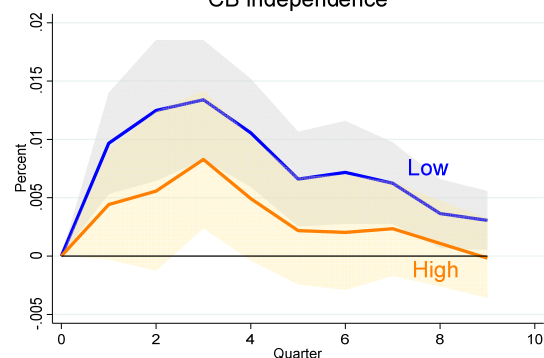
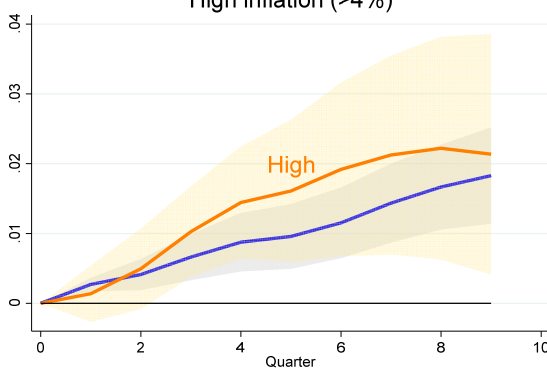
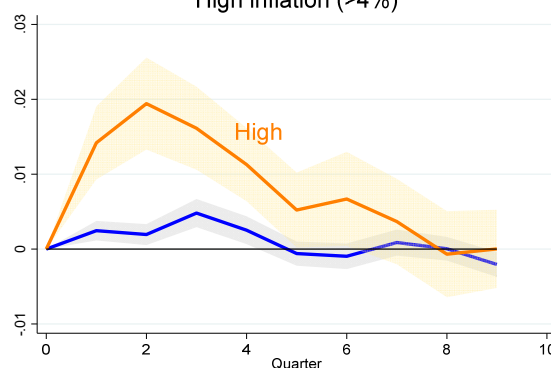
Notes: Estimated with unbalanced panel data for 2000Q1-2019Q4 for 34 countries in Europe using the local projection method. The regressions includes 4 lags for the autoregressive terms, lagged oil price shocks, changes in unemployment rates and changes in NEER. The shaded area represents the 90 percent confidence band.

Figure 18. Impulse responses of expected inflation to oil price shocks, 2000-2019



Notes: Estimated with unbalanced panel data for 2000Q1-2019Q4 for 36 countries in Europe using the local projection method. The regressions includes 4 lags for the autoregressive terms, lagged oil price shocks, changes in unemployment rates and changes in NEER. The shaded area represents the 90 percent confidence band.

¹⁵ To ensure the comparability, the impulse responses for wages in Figure 19 are estimated with changes in annual wage inflation rates, not quarterly changes in wages as presented in the previous sections.

Figure 19. Cumulative impulse response of core and expected inflation to oil price shocks**Core inflation****Expected inflation rates****CB independence****CB independence****High inflation (>4%)****High inflation (>4%)**

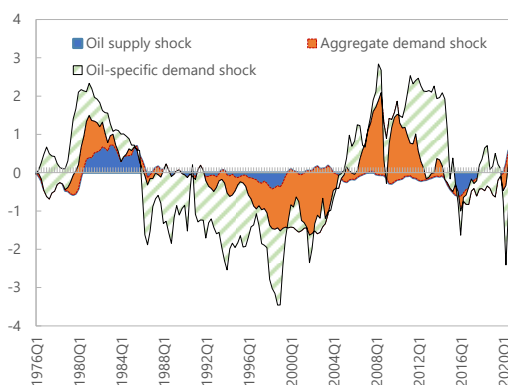
Notes: Left panel charts show IRFs for core inflation estimated with unbalanced panel data for 2000Q1-2019Q4 for 24 advanced and 10 emerging countries in Europe using the local projection method. Right panel charts show IRFs for expected inflation rates estimated with unbalanced panel data for 2000Q1-2019Q4 for 24 advanced and 12 emerging economies in Europe. The regressions includes 4 lags for the autoregressive terms, lagged oil price shocks, changes in unemployment rates and changes in NEER. The shaded area represents the 90 percent confidence band.

The strength of the pass-through to core and expected inflation also depends on structural characteristics and economic states, although we omit the analysis with the labor market characteristics, because they are less directly related to the determination of core and expected inflation.¹⁶ As shown in Figure 19, both core and expected inflation reacts more strongly in EEs than in AEs, with greater dispersion among EEs. Two factors that are correlated with the strength of pass-through are monetary policy credibility and pre-existing high inflation. The middle panels of Figure 19 show that more independent central banks are associated with smaller pass-through of oil price shocks to both core inflation and expected inflation.¹⁷ The bottom panels of Figure 19 show that the pass-through strength depends on the level of pre-existing inflation, while statistical significance is not established for the interacting terms for core inflation with the threshold of 4 percent. With the threshold of 6 percent, the interacting terms show statistically significant differences for expected and core inflation a year after the shock.

5.3. Sources of shocks

Following Kilian (2009), we decompose the oil price shocks into three, on the basis of a structural VAR model using monthly data for global crude oil production, an index of real economic activity, and the real oil price.¹⁸ The three shocks are defined as follows: *oil supply shocks* refer to unpredictable innovations to global oil production; *aggregate demand shocks* refer to innovations to global real economic activity that cannot be explained based on crude oil supply shocks; and *oil-specific demand shocks* refer to innovations to the real price of oil that cannot be explained based on oil supply shocks or aggregate demand shocks, which could include precautionary demand for oil. The sample period covers January 1973 through December 2021.

Figure 20. Cumulative effect of shocks on real oil price, 1976-2021



Notes: Estimated with monthly data from January 1973 through December 2021, then aggregated to quarterly series.

The estimated shocks and their decomposed effects on the real oil price highlight the increased importance of aggregate demand shocks in the 2000s (Figure 20). The fluctuations in aggregate demand shocks increased in the 2000s and have been the main driver of real oil prices between 2005 and 2012. The oil supply shocks played a smaller role in driving the real oil price, confirming the trends described in Kilian (2009), while the oil-specific demand shocks had large impacts on the real oil price in the 2010s.

¹⁶ The analysis (not included in the paper) in fact confirms that most wage bargaining variables do not have statistically significant relations. This is consistent with the presence of multiple factors that influence the mark-up of prices over wage costs (Boranova and others, 2019).

¹⁷ The analysis with the monetary policy anchoring index is omitted because the index is based on deviations in inflation expectations themselves, making the regression tautological.

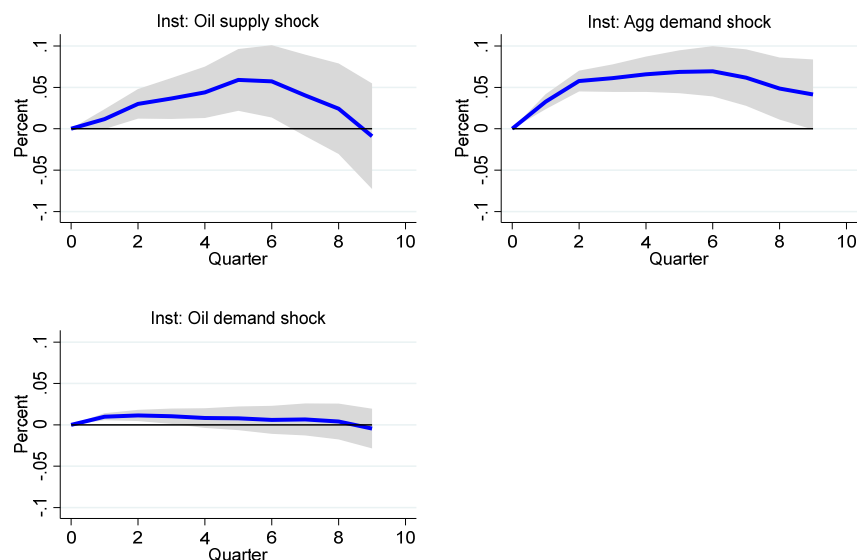
¹⁸ Data on the world crude oil production and crude oil price (US refiner acquisition cost) are obtained from the US Energy Information Administration. The oil price is deflated by the US CPI. The index of global real economic activity, available from the Federal Reserve Bank of Dallas, is an updated version of the index proposed in Kilian (2009). It is derived from a panel of dollar-denominated global bulk dry cargo shipping rates. The global transport rates may not be a good measure of world economic activity during the time of global supply disruptions, but our sample period for local projection regressions was until 2019Q4.

We use these decomposed oil shocks as instrumental variables to explore the dependence of the oil price pass-through on global demand or supply shocks. The equation for estimation is identical to the benchmark specification, except that the quarterly oil price growth $\Delta p_{t-i,j}$ is now treated as an endogenous variable, instrumented by the shocks to the real oil price (with lags up to 4 quarters) in the two-stage least squares (2SLS) estimation. The coefficients on the lagged shocks in the first stage regression suggest that all three shocks affect oil price growth in the expected direction on impact, with positive impacts of demand shocks and negative impacts of supply shocks.

Figure 21 displays the paths for pass-through with the confidence band of 90 percent. All three types of shocks trigger a rise in wages, but the pass-through is more immediate and stronger if the price rise is induced by aggregate demand shocks, with the impact rising to 0.06 in 2 quarters after the shock. An oil specific demand shock likewise has a positive and statistically significant impact on wages, but the elasticity rises only to 0.01 in 2 quarters after the shock. Reactions of wages to supply-driven oil price increases are more gradual, peaking at 0.06 in about 1½ years after the shock.

The similarity in the pass-through coefficients between global demand and supply shocks underlying the oil price movements lends support to treating global oil price changes as exogenous for our analysis. As discussed earlier, this is consistent with the fact that most countries in our sample are oil-importing small-open economies.

Figure 21. Cumulative impulse response of wages to oil price shocks, 2000-2019



Notes: Estimated with unbalanced panel data for 2000Q1-2019Q4 for 39 countries in Europe using the local projection method. Each chart displays reactions to one percent shock to oil prices, induced by shocks to oil supply, aggregate demand, and oil-specific demand, respectively. The regressions include one-quarter lagged oil price growth as an endogenous variable, up to 4 lags for the autoregressive terms, lagged oil price growth, unemployment rates and NEER. Supply and demand shocks (lagged up to 4 quarters) are used as instruments in each regression. The shaded area represents the 90 percent confidence band.

6. Taking stock

The results so far appear to indicate a limited risk of a wage-price spiral and regime shift in inflation expectations in response to supply shocks. For the past several decades, including the decades that preceded the wide adoption of inflation targeting in AEs, we found no evidence of oil price shocks leading to a sustained wage-price spiral that would have pushed up the inflation rate for a sustained period (nor permanently). The pass-through from oil price shocks to wages and core inflation peaked in 1-2 years and largely dissipated in 3-4 years. Again, these results are obtained not only in the broad dataset (which falls in the post-Volker era), but also in the long dataset that includes periods when the pass-through and thus the risk of a wage-price spiral would have been higher under less inflation-vigilant monetary policy regimes and a labor market with higher unionization and more centralized wage bargaining. This fact suggests that the bar for a wage-price spiral being unleashed by oil price shocks (or supply shocks) would be quite high under the current policy framework and labor market institutions. This reading of evidence is reinforced by the 2-3 year horizon of the positive pass-through of oil price shocks to inflation expectations, although these were based on the post-2000 data.

Of course, caveats are in order. Our results have been obtained on the basis of underlying policy and institutional frameworks in operation, especially in the post-2000 period. The results themselves do not constitute prescriptive evidence for the “optimal” policy responses, which await future analysis. Nor can the cross-country estimation capture particular episodes in some countries during certain times that might indicate an elevated risk of a wage-price spiral or unmooring inflation expectations in the current juncture. Lastly, our own results point to the risk that the high headline inflation itself could aggravate supply-driven inflationary pressure, punctuated by the unusually large increase in gas prices in Europe, thereby intensifying the second-round effects and pushing up expected inflation. A similar argument has been made by BIS (2022).

7. Conclusion

This paper estimates the pass-through effects of oil price shocks onto wages, consumer price inflation, and inflation expectations. It shows that pass-through depends on the level of inflation and the cyclical state of activity as well as structural characteristics of an economy. The pass-through appears higher when overall inflation is higher at the time of the shocks, and higher in emerging than advanced European economies. It appears lower when central banks anchor inflation expectations well or are more independent. The link between the pass-through and labor market characteristics is not clear, except that a higher level of centralized bargaining cum unionization seems associated with a higher pass-through. The effects of oil price shocks on core inflation and inflation expectations are consistent with their effects on wages. In response to oil price shocks, headline inflation and wages are found to move by about the same magnitude.

This paper provided some novel evidence on the role played by structural characteristics and states of economy on the strength of the pass-through to wages and inflation (and thus of the second-round effects), where the empirical investigation has been relatively thin. Future research, however, could broaden the analysis in several directions. A broader country coverage could provide greater variation in data, albeit at the cost of a larger heterogeneity which might complicate econometric investigation. More analysis of why pass-through varies with the level of inflation and the implications for monetary policy and the choice of inflation targets would be very useful. Different econometric or quantitative methodologies could sharpen some of the results.

Table 1. Pass-through of oil price shocks to wages, Broad dataset, 2000-2019

	h = 1		h = 3		h = 6		h = 9		h = 12	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Wage growth										
(t-1)	0.123	(0.043) ***	0.616	(0.095) ***	0.968	(0.146) ***	1.127	(0.179) ***	1.150	(0.215) ***
(t-2)	0.260	(0.030) ***	0.538	(0.062) ***	0.834	(0.106) ***	0.934	(0.160) ***	0.997	(0.220) ***
(t-3)	0.165	(0.033) ***	0.275	(0.060) ***	0.353	(0.128) ***	0.470	(0.172) ***	0.576	(0.228) **
(t-4)	0.019	(0.029)	0.094	(0.076)	0.137	(0.138)	0.164	(0.153)	0.290	(0.176)
Oil price growth										
(t-1)	0.015	(0.003) ***	0.024	(0.005) ***	0.024	(0.007) ***	0.022	(0.009) **	0.022	(0.011) *
(t-2)	0.001	(0.002)	-0.005	(0.004)	-0.014	(0.008) *	-0.019	(0.009) **	-0.025	(0.010) **
(t-3)	0.000	(0.002)	-0.007	(0.003) **	-0.013	(0.006) **	-0.014	(0.007) *	-0.020	(0.009) **
(t-4)	-0.002	(0.002)	-0.008	(0.005)	-0.016	(0.007) **	-0.021	(0.009) **	-0.038	(0.012) ***
Unemployment rates (change)										
(t-1)	-0.250	(0.103) **	-0.851	(0.233) ***	-1.306	(0.551) **	-1.790	(0.814) **	-2.002	(0.964) **
(t-2)	-0.121	(0.068) *	-0.394	(0.165) **	-0.726	(0.326) **	-0.935	(0.506) *	-0.927	(0.609)
(t-3)	-0.164	(0.063) **	-0.135	(0.134)	-0.152	(0.255)	-0.228	(0.308)	-0.257	(0.387)
(t-4)	0.079	(0.106)	0.220	(0.183)	0.205	(0.267)	0.272	(0.311)	0.437	(0.426)
Nominal effective exchange rates (change)										
(t-1)	-0.009	(0.015)	-0.115	(0.037) ***	-0.226	(0.078) ***	-0.311	(0.112) ***	-0.437	(0.158) ***
(t-2)	-0.044	(0.014) ***	-0.131	(0.032) ***	-0.167	(0.051) ***	-0.281	(0.087) ***	-0.343	(0.120) ***
(t-3)	-0.040	(0.018) **	-0.097	(0.034) ***	-0.114	(0.062) *	-0.189	(0.084) **	-0.207	(0.103) *
(t-4)	-0.030	(0.012) **	-0.044	(0.025) *	-0.115	(0.066) *	-0.175	(0.088) *	-0.183	(0.114)
N	2636		2558		2,441		2326		2215	
Countries	39		39		39		37		36	
R2	0.5003		0.6126		0.567		0.5294		0.5089	

Notes: ***, **, and * denote statistical significance at 99, 95 and 90 percent confidence levels. The wage equation is estimated with quarterly unbalanced panel data, covering 39 countries in Europe from 2000Q1 through 2019Q4, while the exact time coverage differs by country.

Table 2. Pass-through of oil price shocks to wages, Long dataset, 1960-2019

	h = 1		h = 3		h = 6		h = 9		h = 12	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Wage growth										
(t-1)	0.133	(0.031) ***	0.594	(0.060) ***	1.309	(0.088) ***	1.880	(0.118) ***	2.387	(0.197) ***
(t-2)	0.274	(0.029) ***	0.719	(0.045) ***	1.412	(0.123) ***	1.929	(0.160) ***	2.365	(0.233) ***
(t-3)	0.264	(0.030) ***	0.667	(0.059) ***	1.108	(0.108) ***	1.550	(0.147) ***	1.999	(0.189) ***
(t-4)	0.134	(0.020) ***	0.432	(0.039) ***	0.767	(0.089) ***	1.095	(0.116) ***	1.440	(0.136) ***
Oil price growth										
(t-1)	0.006	(0.002) ***	0.016	(0.004) ***	0.020	(0.007) ***	0.025	(0.010) **	0.027	(0.011) **
(t-2)	0.002	(0.001)	0.004	(0.003)	-0.002	(0.005)	-0.001	(0.008)	-0.011	(0.010)
(t-3)	0.002	(0.002)	-0.003	(0.003)	-0.010	(0.005) *	-0.012	(0.007) *	-0.028	(0.008) ***
(t-4)	-0.001	(0.001)	-0.007	(0.003) **	-0.012	(0.005) **	-0.021	(0.008) ***	-0.042	(0.011) ***
IP growth										
(t-1)	0.021	(0.012) *	0.062	(0.023) **	0.174	(0.043) ***	0.294	(0.062) ***	0.393	(0.077) ***
(t-2)	0.024	(0.009) **	0.075	(0.022) ***	0.176	(0.038) ***	0.275	(0.054) ***	0.373	(0.072) ***
(t-3)	-0.001	(0.013)	0.055	(0.018) ***	0.137	(0.029) ***	0.209	(0.044) ***	0.291	(0.061) ***
(t-4)	0.031	(0.013) **	0.073	(0.019) ***	0.137	(0.031) ***	0.191	(0.045) ***	0.262	(0.056) ***
Exchange rate change										
(t-1)	0.013	(0.006) **	0.040	(0.013) ***	0.057	(0.024) **	0.101	(0.043) **	0.148	(0.074) *
(t-2)	0.006	(0.004)	0.018	(0.009) *	0.027	(0.019)	0.071	(0.043)	0.080	(0.057)
(t-3)	0.014	(0.007) *	0.010	(0.009)	0.022	(0.022)	0.048	(0.043)	0.036	(0.052)
(t-4)	-0.004	(0.004)	-0.005	(0.012)	0.025	(0.030)	0.032	(0.052)	0.031	(0.068)
N	3734		3686		3,614		3542		3470	
Countries	24		24		24		24		24	
R2	0.6329		0.7912		0.811		0.7987		0.7822	

Notes: ***, **, and * denote statistical significance at 99, 95 and 90 percent confidence levels. The equation is estimated with quarterly unbalanced panel data, covering 24 countries in Europe from 1960Q1 through 2019Q4, while the exact time coverage differs by country.

Table 3. Pass-through of oil price shocks to wages for advanced economies and emerging economies

	Advanced economies						Emerging economies					
	h = 1		h = 3		h = 6		h = 1		h = 3		h = 6	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Autoregressive terms												
(t-1)	0.092	(0.081)	0.526	(0.193) **	0.725	(0.266) **	0.127	(0.053) **	0.595	(0.062) ***	0.931	(0.096) ***
(t-2)	0.173	(0.052) ***	0.349	(0.090) ***	0.400	(0.137) ***	0.299	(0.028) ***	0.586	(0.066) ***	0.917	(0.113) ***
(t-3)	0.141	(0.043) ***	0.099	(0.104)	-0.145	(0.211)	0.144	(0.045) ***	0.319	(0.044) ***	0.553	(0.093) ***
(t-4)	-0.031	(0.044)	-0.074	(0.136)	-0.302	(0.230)	0.037	(0.035)	0.156	(0.084) *	0.315	(0.180)
Oil price growth												
(t-1)	0.012	(0.003) ***	0.019	(0.006) ***	0.013	(0.006) *	0.019	(0.008) **	0.034	(0.008) ***	0.050	(0.012) ***
(t-2)	0.001	(0.002)	-0.009	(0.004) **	-0.017	(0.006) ***	0.001	(0.004)	0.005	(0.009)	0.003	(0.016)
(t-3)	-0.002	(0.002)	-0.011	(0.003) ***	-0.019	(0.005) ***	0.002	(0.005)	0.004	(0.005)	0.004	(0.009)
(t-4)	-0.004	(0.003)	-0.012	(0.004) **	-0.017	(0.007) **	0.004	(0.005)	0.003	(0.013)	-0.004	(0.017)
Unemployment rates (change)												
(t-1)	-0.485	(0.118) ***	-1.359	(0.274) ***	-2.561	(0.566) ***	-0.050	(0.124)	-0.390	(0.256)	-0.167	(0.740)
(t-2)	-0.306	(0.114)	-0.895	(0.225)	-1.681	(0.419)	0.027	(0.062)	0.006	(0.173)	-0.081	(0.486)
(t-3)	-0.022	(0.079)	-0.353	(0.216)	-0.734	(0.344)	-0.299	(0.064)	-0.058	(0.266)	-0.134	(0.585)
(t-4)	-0.156	(0.106)	-0.086	(0.197)	-0.449	(0.262)	0.235	(0.184)	0.320	(0.356)	0.168	(0.537)
Nominal effective exchange rates (change)												
(t-1)	-0.033	(0.028)	-0.116	(0.047) **	-0.222	(0.092) **	0.003	(0.016)	-0.108	(0.045) **	-0.213	(0.100) **
(t-2)	-0.010	(0.019)	-0.100	(0.051) *	-0.133	(0.067) *	-0.054	(0.019) **	-0.136	(0.039) ***	-0.157	(0.069) **
(t-3)	-0.045	(0.021) **	-0.098	(0.039) **	-0.120	(0.062) *	-0.035	(0.019) *	-0.092	(0.040) **	-0.106	(0.083)
(t-4)	-0.015	(0.021)	-0.001	(0.030)	-0.047	(0.073)	-0.033	(0.017) *	-0.045	(0.033)	-0.103	(0.086)
N	1785		1739		1,670		851		819		771	
Countries	23		23		23		16		16		16	
R2	0.3126		0.4021		0.2967		0.5414		0.6429		0.6215	

Notes: ***, **, and * denote statistical significance at 99, 95 and 90 percent confidence levels. The wage equation is estimated with quarterly unbalanced panel data, covering 23 advanced and 16 emerging countries in Europe from 2000Q1 through 2019Q4, while the exact time coverage differs by country.

Table 4. Pass-through of oil price shocks in 6 quarters, by energy weights in consumption basket

	<i>Energy weights</i>		<i>Energy weights (binary)</i>	
	h=6		h = 6	
	Coef	SE	Coef	SE
Wage growth (autoregressive terms)				
(t-1)	0.812	(0.161) ***	0.800	(0.175) ***
(t-2)	0.576	(0.088) ***	0.551	(0.098) ***
(t-3)	0.097	(0.157)	0.066	(0.166)
(t-4)	-0.043	(0.180)	-0.079	(0.173)
Oil price growth				
(t-1)	-0.037	(0.018) **	-0.001	(0.008)
(t-2)	0.016	(0.028)	-0.009	(0.010)
(t-3)	0.012	(0.025)	-0.010	(0.009)
(t-4)	0.018	(0.026)	-0.011	(0.010)
Structural factor				
Energy weights	-0.290	(0.167) *		
Energy weights (binary)			-0.263	(0.179)
Oil price growth x structural factor				
(t-1)	0.005	(0.002) ***	0.036	(0.010) ***
(t-2)	-0.003	(0.003)	-0.009	(0.016)
(t-3)	-0.003	(0.002)	-0.008	(0.014)
(t-4)	-0.003	(0.002)	-0.012	(0.013)
Unemployment rates (change)				
(t-1)	-1.747	(0.557) ***	-1.813	(0.574) ***
(t-2)	-1.131	(0.303) ***	-1.186	(0.312) ***
(t-3)	-0.369	(0.194) *	-0.379	(0.207) *
(t-4)	-0.119	(0.202)	-0.121	(0.208)
Nominal effective exchange rates (change)				
(t-1)	-0.183	(0.077) **	-0.187	(0.079) **
(t-2)	-0.165	(0.062) **	-0.159	(0.065) **
(t-3)	-0.083	(0.058)	-0.074	(0.062)
(t-4)	-0.102	(0.046) **	-0.082	(0.045) *
N	2340		2231	
Countries	34		34	
R2	0.3116		0.3139	

Notes: Results for h=6. ***, **, and * denote statistical significance at 99, 95 and 90 percent confidence levels. The wage equation is estimated with quarterly unbalanced panel data from 1979Q1 through 2019Q4 covering 23 advanced and 11 emerging countries in Europe, while the exact time coverage differs by country.

Table 5. Pass-through of oil price shocks in 6 quarters, by labor market structural factors

	1960-2019 (long dataset)						2000-2019 (broad dataset)					
	Union density		Bargaining coverage		Unionized & centralized		Union density		Bargaining coverage		Unionized & centralized	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Wage growth (autoregressive terms)												
(t-1)	1.141	(0.090) ***	1.222	(0.094) ***	1.163	(0.085) ***	0.813	(0.189) ***	0.703	(0.270) **	0.831	(0.192) ***
(t-2)	1.220	(0.107) ***	1.296	(0.088) ***	1.250	(0.090) ***	0.592	(0.112) ***	0.419	(0.137) ***	0.609	(0.118) ***
(t-3)	0.914	(0.102) ***	0.990	(0.091) ***	0.954	(0.090) ***	0.078	(0.196)	-0.208	(0.210)	0.126	(0.228)
(t-4)	0.596	(0.104) ***	0.665	(0.112) ***	0.633	(0.101) ***	-0.042	(0.206)	-0.308	(0.233)	0.015	(0.224)
Oil price growth												
(t-1)	0.002	(0.009)	0.026	(0.010) **	0.007	(0.007)	0.010	(0.007)	0.022	(0.008) **	0.018	(0.006) ***
(t-2)	-0.019	(0.007) **	-0.003	(0.008)	-0.013	(0.005) **	-0.028	(0.009) ***	-0.019	(0.010) *	-0.014	(0.006) **
(t-3)	-0.024	(0.007) ***	-0.013	(0.007) *	-0.018	(0.006) ***	-0.029	(0.009) ***	-0.021	(0.008) **	-0.013	(0.006) **
(t-4)	-0.028	(0.006) ***	-0.016	(0.008) *	-0.018	(0.005) ***	-0.037	(0.008) ***	-0.026	(0.011) **	-0.016	(0.007) **
Structural factor (binary)												
Union density	0.091	(0.046) *					0.304	(0.073) ***				
Collective bargaining			0.014	(0.030)					-0.002	(0.035)		
Bargaining centralization												
Unionized and centralized bargaining					1.518	(0.511) ***					-0.272	(1.026)
Oil price growth x structural factor (binary)												
(t-1)	0.033	(0.012) **	-0.011	(0.012)	0.041	(0.016) **	0.006	(0.011)	-0.019	(0.012)	0.013	(0.013)
(t-2)	0.030	(0.009) ***	0.000	(0.009)	0.025	(0.009) ***	0.020	(0.012)	0.004	(0.013)	0.008	(0.017)
(t-3)	0.030	(0.009) ***	0.010	(0.007)	0.029	(0.010) ***	0.018	(0.014)	0.012	(0.011)	0.008	(0.012)
(t-4)	0.029	(0.010) ***	0.009	(0.009)	0.013	(0.010)	0.036	(0.014) **	0.023	(0.012) *	0.012	(0.018)
Industrial production or Unemployment rate (change)												
(t-1)	0.193	(0.043) ***	0.200	(0.042) ***	0.196	(0.042) ***	-2.513	(0.456) ***	-2.437	(0.516) ***	-2.374	(0.457) ***
(t-2)	0.205	(0.040) ***	0.197	(0.037) ***	0.198	(0.039) ***	-1.369	(0.314) ***	-1.632	(0.359) ***	-1.211	(0.331) ***
(t-3)	0.172	(0.028) ***	0.151	(0.026) ***	0.161	(0.028) ***	-0.488	(0.223) **	-0.750	(0.323) **	-0.303	(0.255)
(t-4)	0.160	(0.032) ***	0.147	(0.032) ***	0.155	(0.033) ***	-0.206	(0.271)	-0.363	(0.243)	-0.075	(0.279)
Exchange rates (change)												
(t-1)	0.018	(0.019)	0.031	(0.017) *	0.022	(0.019)	-0.150	(0.084) *	-0.199	(0.072) **	-0.246	(0.074) ***
(t-2)	-0.029	(0.013) **	-0.029	(0.012) **	-0.028	(0.013) **	-0.092	(0.044) **	-0.100	(0.052) *	-0.136	(0.046) ***
(t-3)	0.005	(0.018)	0.003	(0.019)	0.007	(0.018)	-0.032	(0.060)	-0.065	(0.047)	-0.111	(0.053) **
(t-4)	-0.027	(0.029)	-0.031	(0.029)	-0.032	(0.030)	-0.083	(0.089)	-0.033	(0.047)	-0.188	(0.096) *
N	3615		3558		3615		2126		1745		2056	
Countries	24		24		24		30		25		29	
R2	0.6828		0.7349		0.7083		0.1017		0.3021		0.4408	

Notes: Results for h=6. ***, **, and * denote statistical significance at 99, 95 and 90 percent confidence levels. The wage equation is estimated with quarterly unbalanced panel data from 1979Q1 through 2019Q4, while the exact time coverage differs by country. The country coverage depends on the availability of structural factors.

Table 6. Pass-through of oil price shocks in 6 quarters, by monetary policy factors

	1960-2019 (long dataset)				2000-2019 (broad dataset)			
	Monetary policy anchor		CB independence		Monetary policy anchor		CB independence	
	Coef	SE	Coef	SE	Coef	SE	Coef	SE
Wage growth (autoregressive terms)								
(t-1)	0.962	(0.173) ***	1.085	(0.090) ***	0.932	(0.192) ***	0.878	(0.160) ***
(t-2)	0.990	(0.183) ***	1.189	(0.084) ***	0.603	(0.102) ***	0.678	(0.106) ***
(t-3)	0.513	(0.238) **	0.863	(0.091) ***	-0.043	(0.200)	0.228	(0.173)
(t-4)	0.104	(0.244)	0.516	(0.109) ***	-0.038	(0.237)	0.102	(0.183)
Oil price growth								
(t-1)	0.007	(0.009)	0.031	(0.009) ***	0.022	(0.015)	0.041	(0.008) ***
(t-2)	-0.017	(0.011)	0.013	(0.005) **	-0.035	(0.023)	-0.005	(0.013)
(t-3)	-0.018	(0.010) *	0.006	(0.006)	-0.025	(0.017)	-0.003	(0.008)
(t-4)	-0.048	(0.018) **	0.002	(0.007)	-0.033	(0.020)	-0.009	(0.014)
Structural factor (binary)								
Monetary policy anchoring	-0.175	(0.953)			-5.135	(1.287) ***		
Central bank independence			-5.340	(0.751) ***			-13.680	(4.837) ***
Oil price growth x structural factor (binary)								
(t-1)	0.021	(0.009) **	-0.023	(0.014)	-0.009	(0.017)	-0.033	(0.012) ***
(t-2)	0.026	(0.013) *	-0.031	(0.008) ***	0.008	(0.025)	-0.020	(0.016)
(t-3)	0.032	(0.013) **	-0.023	(0.010) **	-0.001	(0.019)	-0.024	(0.012) **
(t-4)	0.052	(0.021) **	-0.025	(0.010) **	0.009	(0.025)	-0.023	(0.015)
Unemployment rate (change)								
(t-1)	0.104	(0.057) *	0.176	(0.044) ***	-2.148	(0.528) ***	-1.810	(0.431) ***
(t-2)	0.070	(0.056)	0.164	(0.038) ***	-0.647	(0.275) **	-1.118	(0.275) ***
(t-3)	0.027	(0.035)	0.133	(0.028) ***	-0.026	(0.219)	-0.494	(0.219) **
(t-4)	0.095	(0.041) **	0.129	(0.035) ***	0.733	(0.311) **	-0.070	(0.253)
NEER (change)								
(t-1)	0.087	(0.044) *	0.016	(0.023)	-0.189	(0.091) *	-0.256	(0.084) ***
(t-2)	-0.035	(0.044)	-0.028	(0.016) *	-0.080	(0.066)	-0.157	(0.051) ***
(t-3)	0.012	(0.031)	0.009	(0.018)	-0.019	(0.076)	-0.084	(0.064)
(t-4)	-0.057	(0.036)	-0.034	(0.029)	-0.052	(0.087)	-0.095	(0.075)
N	1255		3164		1333		2290	
Countries	17		23		22		36	
R2	0.6219		0.6729		0.5701		0.5051	

Notes: Results for h=6. ***, **, and * denote statistical significance at 99, 95 and 90 percent confidence levels. The wage equation is estimated with quarterly unbalanced panel data from 1979Q1 through 2019Q4, while the exact time coverage differs by country. The country coverage depends on the availability of structural factors. All structural factors are converted to a binary indicator with 1 indicating a value greater than the median.

Table 7. Pass-through of oil price shocks in 6 quarters, by underlying shock

	Oil supply shock		Agg demand shock		Oil demand shock	
	Coef	SE	Coef	SE	Coef	SE
First stage regressions						
Wage growth						
(t-1)	0.948	(0.211) ***	0.676	(0.199) ***	0.690	(0.140) ***
(t-2)	0.653	(0.205) ***	0.543	(0.193) ***	0.376	(0.135) ***
(t-3)	0.047	(0.206)	-0.194	(0.193)	0.131	(0.136)
(t-4)	-0.706	(0.199) ***	-0.502	(0.187) ***	-0.289	(0.131) **
Lagged oil price growth						
(t-2)	0.111	(0.022) ***	0.187	(0.021) ***	-0.046	(0.019) **
(t-3)	-0.188	(0.022) ***	-0.159	(0.021) ***	0.172	(0.019) ***
(t-4)	-0.052	(0.022) **	-0.059	(0.020) ***	0.090	(0.016) ***
Unemployment rates (change)						
(t-1)	-1.416	(0.610) **	-1.334	(0.571) **	-0.790	(0.401) **
(t-2)	0.322	(0.618)	0.228	(0.578)	-0.328	(0.405)
(t-3)	2.019	(0.617) ***	1.866	(0.579) ***	0.954	(0.406) **
(t-4)	1.710	(0.610) ***	1.302	(0.573) **	1.530	(0.401) ***
Nominal effective exchange rates (change)						
(t-1)	0.854	(0.134) ***	0.713	(0.126) ***	0.384	(0.088) ***
(t-2)	0.067	(0.138)	-0.039	(0.130)	0.227	(0.091) **
(t-3)	0.050	(0.138)	0.173	(0.130)	0.126	(0.091)
(t-4)	0.411	(0.135) ***	0.124	(0.127)	0.080	(0.089)
Shocks						
(t-1)	-0.134	(0.011) ***	0.041	(0.004) ***	0.159	(0.004) ***
(t-2)	0.028	(0.011) **	0.073	(0.005) ***	0.123	(0.005) ***
(t-3)	0.019	(0.011) *	-0.046	(0.005) ***	-0.043	(0.005) ***
(t-4)	-0.047	(0.011) ***	0.046	(0.005) ***	-0.127	(0.005) ***
Second stage regressions						
Oil price growth						
(t-1)	0.057	(0.027) **	0.070	(0.018) ***	0.006	(0.010)
Wage growth						
(t-1)	0.939	(0.081) ***	0.928	(0.079) ***	0.985	(0.078) ***
(t-2)	0.820	(0.075) ***	0.815	(0.075) ***	0.842	(0.074) ***
(t-3)	0.355	(0.075) ***	0.356	(0.075) ***	0.352	(0.074) ***
(t-4)	0.159	(0.075) **	0.166	(0.074) **	0.125	(0.073) *
Lagged oil price growth						
(t-2)	-0.020	(0.009) **	-0.022	(0.009) **	-0.011	(0.008)
(t-3)	-0.007	(0.009)	-0.005	(0.009)	-0.017	(0.008) **
(t-4)	-0.015	(0.008) *	-0.015	(0.008) *	-0.016	(0.008) **
Unemployment rates (change)						
(t-1)	-1.263	(0.232) ***	-1.246	(0.232) ***	-1.331	(0.229) ***
(t-2)	-0.737	(0.233) ***	-0.741	(0.233) ***	-0.720	(0.232) ***
(t-3)	-0.200	(0.236)	-0.218	(0.235)	-0.126	(0.233)
(t-4)	0.138	(0.234)	0.114	(0.232)	0.242	(0.228)
Nominal effective exchange rates (change)						
(t-1)	-0.254	(0.057) ***	-0.265	(0.055) ***	-0.210	(0.053) ***
(t-2)	-0.172	(0.054) ***	-0.175	(0.054) ***	-0.163	(0.053) ***
(t-3)	-0.114	(0.053) **	-0.114	(0.053) **	-0.114	(0.052) **
(t-4)	-0.122	(0.051) **	-0.125	(0.051) **	-0.110	(0.051) **
N	2441		2441		2441	
Countries	39		39		39	
R2	0.559		0.554		0.567	

Notes: Results for h=6. ***, **, and * denote statistical significance at 99, 95 and 90 percent confidence levels. The wage equation is estimated with quarterly unbalanced panel data from 1979Q1 through 2019Q4, while the exact time coverage differs by country. The country coverage depends on the availability of structural factors. All structural factors are converted to a binary indicator with 1 indicating a value greater than the median.

Annex I. Data Description

Indicator	Definition	Sources
	Definition and coverage may vary across countries. Wages and salaries, or gross earnings are used, except the followings: hourly earnings for Denmark and Sweden, earnings excluding bonus for Finland, compensation of employees for Norway, and net earnings for Croatia. As for the industry coverage, wages for Austria, Belgium, Cyprus, Czech Republic, Germany, Greece, Ireland, Italy, Lithuania, Portugal, Slovakia and Türkiye cover industry excluding construction. Wages for Norway and Sweden cover industries only. Wages for Denmark cover private sector only. Wages for Kosovo cover public sector only. For the remaining countries, wages cover the whole economy. Seasonally adjusted by the authors.	
Wage (broad data)		Haver Analytics
Wage (long data)	Hourly earnings in manufacturing.	OECD
Core inflation		Haver Analytics; OECD
Headline inflation		Haver Analytics; OECD
Oil price (in USD)	Crude Oil (petroleum), USD, simple average of three spot prices; Dated Brent, West Texas Intermediate, and the Dubai Fateh	IMF RES Commodity Database
NEER	Nominal effective exchange rate	IMF IFS; IMF INS
Unemployment rates	For Albania, Bulgaria and Romania, registered unemployment rates are used. Seasonally adjusted by the authors.	Haver Analytics; OECD
Energy weights	The energy weights are defined as the sum of CPI weights given to “energy” under housing and “fuels” under transport.	Haver Analytics
Union density	The trade union density is defined as the number of net union members (i.e excluding those who are not in the labour force, unemployed and self-employed) as a proportion of the number of employees. Missing observations are interpolated with the last available observations.	OECD

Indicator	Definition	Sources
Collective bargaining coverage	The adjusted collective bargaining coverage rate is defined as the number of employees covered by a collective agreement in force as a proportion of the number of eligible employees equipped (i.e., the total number of employees minus the number of employees legally excluded from the right to bargain). Missing observations are interpolated with the last available observations.	OECD
Centralization of Collective bargaining	A composite index which first measures the dominant level of collective bargaining and then considers the presence of additional enterprise bargaining. In a fully decentralized system, all negotiations take place in the enterprise. In a fully centralized system, all wages are negotiated at the central (cross-industry) level without further amendments. Most wage bargaining systems are located somewhere in between.	OECD
MP anchoring	This is an index of inflation expectations' anchoring for 45 countries in the period starting in 1989. The index is calculated based on four metrics: deviation of long-term mean inflation forecasts from target, variability of mean long-term inflation forecasts, dispersion of long-term inflation forecasts, and sensitivity of long-term inflation forecasts to inflation surprises.	Bems, Mr Rudolfs, et al. <i>Expectations' Anchoring and Inflation Persistence</i> . International Monetary Fund, 2018.
CB independence	Index ranging between 0 (no independence) and 1 (full independence). The index is calculated based on 42 criteria of institutional design as provided in central bank legislation. Available for 155 countries for 1972-2017.	Romelli. 2022

Annex II. Data Coverage

Advanced economies	(Broad)	(Long)	Emerging economies	(Broad)	(Long)
	from	from		from	from
Austria	2000q1	1961q1	Albania	2012q1	
Belgium	2000q1	1961q1	Belarus	2017q1	
Cyprus	2000q1		Bosnia and Herzegovina	2017q1	
Czech Republic	2000q1	1994q1	Bulgaria	2000q1	
Denmark	2000q1	1974q1	Croatia	2000q1	
Estonia	2000q1	2001q1	Hungary	2004q1	1996q1
Finland	2000q1	1961q1	Kosovo	2016q1	
France	2000q1	1961q1	North Macedonia	2000q1	
Germany	2000q1	1961q1	Moldova	2004q1	
Greece	2000q1		Montenegro, Rep. of	2008q1	
Ireland	2000q1	1975q3	Poland	2000q1	1996q1
Israel	2000q1	1996q1	Romania	2000q1	
Italy	2000q1	1961q1	Russia	2000q1	
Latvia	2000q1	2001q1	Serbia	2000q1	
Lithuania	2000q1	2001q2	Türkiye	2009q1	1989q1
Netherlands	2000q1	1971q1	Ukraine	2004q4	
Norway	2000q1	1961q1			
Portugal	2000q1	2001q1			
Slovak Republic	2000q1	1993q1			
Slovenia	2000q1	1999q1			
Spain	2000q1	1982q1			
Sweden	2000q1	1972q1			
United Kingdom	2000q1	1968q1			

References

- Addison, John T. 2016. Collective bargaining systems and macroeconomic and microeconomic flexibility: the quest for appropriate institutional forms in advanced economies, [Vol 5:19], IZA Journal of Labor Policy.
- BIS, 2022, "Inflation: a look under the hood," Annual Report June 2022, Bank for International Settlements.
- Baumeister, Christiane, Gert Peersman and Ine Van Robays, The Economic Consequences of Oil Shocks: Differences across Countries and Time
- Bems, Rudolfs, Francesca Caselli, Francesco Grigoli, Bertrand Gruss and Weicheng Lian, 2018, Expectations' Anchoring and Inflation Persistence, IMF WP/18/280.
- Bernanke, Benjamin, 2006, Energy and the Economy, FRB Chairman Speech Before the Economic Club of Chicago, <https://www.federalreserve.gov/newsevents/speech/bernanke20060615a.htm>
- Blanchard, Olivier, Florence Jaumotte, and Prakash Loungani. 2014. "Labor market policies and IMF advice in advanced economies during the Great Recession." IZA Journal of Labor Policy 3: 2.
- Blanchard Olivier and Jordi Gali, 2007, The Macroeconomic Effects of Oil Shocks: Why Are The 2000s So Different From the 1970s? NBER WP 13368.
- Blanchard, Olivier and Lawrence Katz, 1999, Wage Dynamics: Reconciling Theory and Evidence, American Economic Review 89(2): 69-74.
- Boranova, Vizhdan, Raju Huidrom, Sylwia Nowak, Petia Topalova, Volodymyr Tulin, and Richard Varghese, 2019, Wage Growth and Inflation in Europe: A Puzzles? IMF Working paper 19/280.
- Borio, Claudio, Piti Disyatat, Dora Xia, and Egon Zakrajšek, 2021, Second-round effects feature less prominently in inflation dynamics, BIS Quarterly Review, pp. 23-24.
- Bruno, Michael and Jeffrey Sachs, 1985, Economics of Worldwide Stagflation, Harvard University.
- Calmfors Lars and John Driffill, 1988, Bargaining structure, corporatism, and macroeconomic performance, Economic Policy 3(6):13-62.
- Celasun, Oya, Niels-Jakob Hansen, Aiko Mineshima, Mariano Spector, and Jing Zhou, 2022, Supply Bottlenecks: Where, Why, How Much, and What Next, IMF Working paper 2022/031.
- Chau, Vu, 2020, Behavioral-Attention Phillips Curve: Theory and Evidence from Inflation Surveys, manuscript, Harvard University.
- Choi, Sangyup, Davide Furceri, Prakash Loungani, Saurabh Mishra, Marcos Poplawski-Ribeiro, 2017, Oil Prices and Inflation Dynamics: Evidence from Advanced and Developing Economies, IMF WP/17/196.
- Conflitti, Cristina and Matteo Luciani, 2017, Oil price pass-through into core inflation, Finance and Economics Discussion Series 2017-085. Washington: Board of Governors of the Federal Reserve System, <https://doi.org/10.17016/FEDS.2017.085>.
- Cukierman, Alex, 2008, Central bank independence and monetary policymaking institutions — Past, present and future, European Journal of Political Economy, 24 (4): 722-736.
- DeGregorio, Jose, Oscar Landerretche, and Christopher Neilson, 2007, Another Pass-Through Bites the Dust? Oil Prices and Inflation, Economia Journal, 7(2):155-208.

- Duval, Romain, and Prakash Loungani, 2019. "Designing Labor Market Institutions in Emerging and Developing Economies: Evidence and Policy Options," IMF Staff Discussion Notes No. 2019/004.
- ECB, 2004, Box 3: Recent Oil Price Developments and Their Impact on Euro Area Prices, ECB Monthly Bulletin July 2004.
- Gali, Jordi, 2011, The Return of the Wage Phillips Curve, *Journal of the European Economic Association*, 9(3): 436-61.
- Gelos, Gaston, and Yulia Ustyugova, 2017. Inflation responses to commodity price shock – How and why do countries differ? 72:28-47, *Journal of International Money and Finance*.
- Hamilton, James, 2013. Historical Oil Shocks, in *Routledge Handbook of Major Events in Economic History*, pp. 239-265, edited by Randall E. Parker and Robert Whaples, New York: Routledge Taylor and Francis Group.
- Harding, Martin, Jesper Linde, and Mathias Trabandt, 2022, Understanding Post-Covid Inflation Dynamics, Manuscript.
- IMF, 2022a, World Economic Outlook April 2022.
- IMF, 2022b, Regional Economic Outlook for Europe, April 2022
- Jorda, Oscar, 2005, "Estimation and Inference of Impulse Responses by Local Projections." *American Economic Review* 95(1): 161-182.
- Killian, Lutz, 2009, "Not All Oil Price Shocks Are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market." *American Economic Review*, 99 (3): 1053-69.
- Killian, Lutz, and Xiaoqing Zhou, 2022. "The Propagation of Regional Shocks in Housing Markets: Evidence from Oil Price Shocks in Canada," *Journal of Money, Credit and Banking*, Vol.54, No.4, 953-987.
- Kristin Forbes, Joseph Gagnon, and Christopher G. Collins, 2021, Low Inflation Bends the Phillips Curve around the World, NBER WP 29323.
- LeBlanc, Michael and Menzie D. Chinn, 2004, Do High Oil Prices Presage Inflation? *Business Economics*, 39(2): 38-48.
- Mishkin, Frederic S., 2007, Inflation Dynamics, *International Finance* 10(3): 317-334.
- Nickel, Christiane, Elena Bobeica, Gerrit Koester, Eliza Lis, and Mario Porqueddu, 2020, Understanding low wage growth in the euro area and European countries, ECB Occasional Paper Series No 232.
- Plagborg-Møller, Mikkel and Christian Wolf, 2021, Local Projections and VARs Estimate the Same Impulse Responses, *Econometrica*, 89(2):955-80.
- Romeli, Davide, 2022, The political economy of reforms in Central Bank design: evidence from a new dataset, *Economic Policy*.
- Sims, Christopher, 2010, Rational inattention and monetary economics, *Handbook of Monetary Economics*, 3:155-81.
- Visser, Jelle, 2016, What happened to collective bargaining during the great recession? *IZA Journal of Labor Policy* 5:9



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