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Increases in energy prices could have a stronger effect on consumer prices than decreases

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Going forward, Europe risks more volatile energy prices due to geoeconomic fragmentation, climate change and the transition to renewable energy sources. This economic memo explores the pass-through from changes in energy prices to consumer prices in Denmark and the euro area. The results indicate that increases in the price of natural gas or crude oil have a greater effect on consumer prices than decreases. Awareness of this asymmetry is important for central banks in safeguarding price stability.



Positive energy price shocks affect consumer prices more than negative shocks

Empirical results from Denmark and the euro area suggest that increases in energy prices have a greater and more persistent effect on consumer prices than decreases. This asymmetry may stem from downward rigidities in prices and, more importantly, wages. As a result, rising energy prices increase the aggregate price level, while falling energy prices do not lead to a similar reduction.



More volatility in energy prices could lead to higher overall inflation

The asymmetry between the effects of positive and negative energy price shocks implies that periods of more volatile energy prices (i.e., more frequent increases and decreases in energy prices) result in a higher inflation rate in the absence of counteracting policy measures. This is the case even if average energy prices remain stable.



Energy price volatility may necessitate a tighter monetary policy

If future energy prices become more volatile because of geoeconomic fragmentation, climate change and the transition to renewable energy sources, this could necessitate a tighter monetary policy to prevent permanently higher inflation, given the asymmetric impact of positive vs. negative energy price shocks.

Why is this important?

Central banks are charged with ensuring price stability amid the risk of rising energy price volatility. Therefore, it is important for central banks to understand the propagation of shocks to energy prices onto consumer prices. If energy price volatility puts upward pressure on inflation in the future, this will require central banks to tighten monetary policy in order to preserve price stability.

Main chart: Energy price shocks affect consumer prices asymmetrically, with stronger pass-through of positive shocks



Note: The chart shows impulse responses in per cent to positive and negative gas price shocks on the Danish HICP. The negative shock is inverted for comparability reasons. Standard errors are calculated using Newey-West standard errors. Gas price shocks are estimated using an ARIMA model.

Source: Own calculations.

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Increasing physical and transition risks from climate change are also likely to amplify short-term fluctuations in inflation

Gita Gopinath,
 First Deputy Managing Director,
 International Monetary Fund



Keywords

Climate Inflation and price development

01 Changes in energy prices affect inflation

In the coming years, geoeconomic fragmentation, climate change and the transition to renewable energy sources, among others, may expose Europe to larger and more frequent supply and demand shocks in energy markets. This could result in more volatile energy prices going forward.¹

Energy price volatility potentially affects consumer prices through three channels.² First, shocks to energy prices have a direct effect on consumer prices through household purchases of energy for e.g., heating and transportation. Second, as firms rely on energy as an input in their production, higher energy prices can indirectly increase prices of other goods and services and thereby affect consumer prices more broadly. Third, energy price shocks may also lead to wage pressures if workers demand higher wages to offset the erosion of purchasing power. This wage adjustment could further contribute to inflationary pressures, also known as second-round effects.

CHART 1

Both energy prices and overall inflation in Denmark rose considerably around 2022...

Danish inflation



Note: The chart shows contributions to inflation in Denmark according to the EU Harmonised Index of Consumer Prices. Food covers food, alcohol and tobacco.

Source: Macrobond and own calculations.

CHART 2

... and the same happened in the euro area





Note: The chart shows contributions to inflation in the euro area according to the EU Harmonised Index of Consumer Prices. Food covers food, alcohol and tobacco.

Source: Macrobond and own calculations.

¹ See e.g., Gopinath (2023), European Commission (2024), Tertre (2023), Reichlin and Zettelmeyer (2024) and Branner and Ingholt (2023) who argue that Western economies face higher volatility in energy prices, compared to the period before the COVID-19 pandemic.

² See e.g., Abdallah and Kpodar (2023).

This memo analyses the transmission of energy price shocks to consumer prices, focusing on the asymmetric effects of positive and negative shocks

The pass-through of energy shocks onto consumer prices has received increased attention following the substantial rise in energy prices around 2022, see Chart 1 and Chart 2.³ In this memo, I use local projections to estimate the transmission of energy price shocks to consumer prices in Denmark and the euro area.⁴

The potential transmission of energy price shocks via the second and third channel outlined above suggests that these shocks may not only affect headline consumer prices through the energy component of the consumer price index, but also pass through to core consumer prices. To investigate this, I estimate the average effect of an energy price shock on both headline and core consumer prices. Considering recent evidence suggesting that the inflationary impact of energy shocks may be asymmetric,⁵ I employ non-linear models to explore potential asymmetries in the response to positive versus negative shocks.

I focus on shocks to the wholesale price of natural gas and crude oil, as these are two of the most important drivers of energy prices. Besides the direct contribution to the consumer price index, both gas and oil prices are important for the price of other energy products. Oil prices affect petrol costs, which is a major component in consumer expenses.⁶ Gas prices regularly determine the electricity price, since gas sets the marginal price of electricity generation whenever output from other sources (e.g., solar and wind) falls short of meeting demand.⁷

The results show a substantial asymmetry in the transmission of positive vs. negative energy price shocks onto consumer prices. This may plausibly be due to downward nominal rigidities in price and wage setting, so that prices and wages increase following positive cost shocks but do not fall following negative shocks.

⁴ See Jordá (2005).

and De Santis and Tornese (2023).

³ See e.g., Neri et al. (2023), Kuik et al. (2022) and Kilian and Zhou (2022).

⁵ See e.g., Burriel et al. (2024), Borrallo et al. (2024), Adolfsen et al. (2024), Abdallah and Kpodar (2023)

⁶ See Baumeister and Kilian (2017).

⁷ See Zakeri et al. (2023).

02 Estimating the effect of energy price shocks using local projections

A challenge when estimating a statistical model that describes the connection between energy prices and inflation is that energy prices do not operate in a vacuum but are influenced by other economic conditions. If the economy is doing well, there will typically be high demand for energy, which will push up energy prices. At the same time, there might also be higher demand for other goods, low unemployment and an upward pressure on wages, which also affect inflation. In that case, a simple correlation between energy prices and inflation will contain an upward bias in the effect of energy prices on inflation.

To address this challenge, I use a two-step empirical approach commonly used in the literature.⁸ In the first step, I identify unexpected changes (shocks) in the price of gas and oil. In the second step, I use these shocks to estimate the transmission to Danish and euro area consumer prices, using local projections (LP).⁹ In the LP framework, the impulse responses are estimated by running a series of regressions, where the outcome variable at different time horizons is regressed on the identified shock. I thereby obtain the response of consumer prices to a one-time shock to the price of gas or oil. The LP framework also allows me to explore the possible heterogeneity of negative and positive price shocks using state-dependent LP.¹⁰ For a more detailed explanation of the method, see box 1.

I use the wholesale price of natural gas and crude oil, measured by the ICE Dutch TTF Daily gas futures and the US Brent European closing spot price, respectively. The oil price data span from January 2001 to May 2024, while the gas price data cover the period from June 2015 to May 2024. Notably, the gas price series begins in 2015, as this marks the point when Dutch TTF became the largest trading hub for natural gas in Europe.¹¹ The price of gas and oil both show sizable fluctuations around 2022, see Chart 3.

⁸ See, e.g., Montiel Olea (2021).

⁹ See Jordá (2005).

¹⁰ See Cloyne et al. (2023).

¹¹ European natural gas pricing has undergone radical changes in recent decades. After several years of being linked to the price of oil, gas pricing started to be replaced by hub-based pricing after the financial crisis in 2008. Around 2015, the Dutch TTF became the largest trading hub for natural gas in Europe and it now serves as a primary option for the hedging and trading activities of European gas entities, see Obadi and Korcek (2020).

CHART 3

The price of natural gas and crude oil experienced greater fluctuations around 2022



Note: The price of natural gas is measured by the ICE Dutch TTF Daily gas futures, closing 1st position. The price of crude oil is measured by the US Brent European closing spot price. Source: Macrobond.

Identifying shocks to gas and oil prices using time series models

An increasingly popular approach in the literature involves first estimating time series models for the independent variable and then using the resulting error terms as exogenous shocks.¹² This approach has been used to estimate the impact of monetary policy shocks, temperature shocks as well as gas and oil market shocks on the economy.¹³ In this memo, I estimate univariate time series models to identify shocks to the natural gas and crude oil wholesale prices.¹⁴ I define the error terms from the estimated models as the price shocks, i.e., the part of a gas or oil price change that is not expected based on previous price fluctuations.

The estimated shocks are shown in Chart 4 and Chart 5. Both series are characterised by both positive and negative shocks and they do not show signs of autocorrelation.¹⁵ The volatility of the oil price shocks is constant throughout the sample period, meaning that the shocks overall occur with the same frequency and magnitude over time.¹⁶ For the gas price shocks, the volatility is greater after 2019 compared to the period before, see Chart 4, implying that the LP estimates may relate particularly to the period from 2019 onward. I discuss this further in Chapter 4.

¹² See Ramsey (2016).

¹³ See, e.g., Miranda-Agrippino and Ricco (2021), Bilal and Känzig (2024), Gervais (2019) and Adolfsen et al. (2024).

¹⁴ I do not distinguish between supply and demand shocks, as my focus is on the overall effect of price shocks, unlike Adolfsen et al. (2024) and Kilian and Murphy (2014). ¹⁵ I use the Ljung-Box test to evaluate the autocorrelation of the estimated residuals at different lags. The

total number of lags is set to 24. ¹⁶ I use the Breusch-Pagan test to test for heteroscedastic variance in the estimated residuals.

CHART 4

Shocks to gas prices appear larger and more frequent after 2019

Estimated shocks to the price of natural gas



Note: The chart shows estimated residuals of an AR(1) model for natural gas prices. Natural gas prices are measured by the ICE Dutch TTF futures and enter the model in log first-differences.

Source: Macrobond and own calculations.

CHART 5

Shocks to oil prices occur with the same frequency and magnitude

Estimated shocks to the price of crude oil



Note: The chart shows estimated residuals of an MA(1) model for crude oil prices. Crude oil prices are measured by the Brent European spot price and enter the model in log first-differences.

Source: Macrobond and own calculations.

BOX 1

Using local projections to analyse the effect of energy price shocks on consumer prices

To investigate how energy price shocks affect consumer prices, I estimate local projection models through a two-step procedure. In the first step, unexpected gas and oil wholesale price shocks are identified using an autoregressive integrated moving average (ARIMA) model for the gas and oil price, respectively. Specifically, I use the Bayesian Information Criterion (BIC) to select the best fitted ARIMA model, which is an AR(1) model for the gas price and an MA(1) model for the oil price. The BIC evaluates how well the model fits the data while penalising the addition of more parameters to avoid overfitting. The model with the lowest BIC is preferred, as it indicates the best trade-off between accurately capturing the data and keeping the model simple.

I then take the estimated residuals from the ARIMA models and use these as the exogenous shocks to the gas and oil price. By using this approach, I define unexpected price shocks as the part of the gas or oil price that previous price movements cannot predict. Using simple univariate ARIMA models to identify exogenous shocks offers the benefit of ease in interpretation and reduced risk of overfitting due to fewer parameters. However, one drawback is that these models may miss complex patterns or interactions present in the data, which more sophisticated models might capture.

In the second step, the time series of unexpected energy price shocks are used in a local projections model.¹ Local projections are useful for this task because they do not rely on specific assumptions about the direction or size of the response to the shock in question. Additionally, they do not impose linearity assumptions on the relationship between the shock and outcome variables. Therefore, local projections are particularly suited to explore possible heterogenous effects of positive price shocks compared to negative price shocks. I estimate separate models using the error terms for gas and oil, respectively.

The price of gas and oil enters the model in log first-differences. The dependent variables include the log of Danish and euro area headline HICP and core HICP. To account for any endogeneity not captured by the ARIMA models, I include Danish and euro area industrial production expressed in log as control variables. In the local projections for the gas market, I also include the price of oil as a control variable, as the gas price is often linked to the oil price.² Furthermore, I include three lags of the dependent variable. All variables used in the models are listed below.

	Enters the model in	Unit	Start date	End date	Source
Danish and euro area Harmonised Index of Consumer Prices (HICP)	Log	Index, 2015=100	JAN 2001	MAY 2024	Eurostat
Danish and euro area HICP excl. Energy, Food, Alcohol & Tobacco	Log	Index, 2015=100	JAN 2001	MAY 2024	Eurostat
Natural Gas, Future, ICE Dutch TTF Daily Gas, 1 st Position, Close	Log first- differences	EUR	JUN 2015	MAY 2024	ICE
United States, Crude Oil, Brent Europe Spot Price FOB	Log first- differences	USD	JAN 2001	MAY 2024	EIA
Euro area industrial production, SA	Log	Index, 2021=100	JAN 2001	MAY 2024	Eurostat
Denmark industrial production	Log	Index, 2021=100	JAN 2001	MAY 2024	Statistics Denmark

¹ See Jordá (2005).

² See Kuik et al. (2022).

03 Energy price shocks affect consumer prices similarly in Denmark and the euro area

Chart 6 and Chart 7 show the response of headline and core HICP consumer prices to a doubling of the wholesale natural gas price in Denmark and the euro area.¹⁷ The impulse responses show the accumulated effect on consumer price levels of a one-time shock to the gas price. Overall, the response is similar between Denmark and the euro area.

CHART 6

Gas price shocks affect both headline and core consumer prices in Denmark...

Impulse responses for Denmark



Iote: The chart shows impulse responses in per cent of a doubling of the gas wholesale price on Danish HICP and core HICP (solid lines). Standard errors are calculated using Newey-West standard errors and the 90-per cent confidence intervals are shown (filled area). Gas price shocks are estimated using an ARIMA model.

CHART 7

... and the response of euro area consumer prices is weaker, but overall similar to the response of Danish consumer prices

Impulse responses for the euro area



Note: The chart shows impulse responses in per cent of a doubling of the gas wholesale price on euro area HICP and core HICP (solid lines). Standard errors are calculated using Newey–West standard errors and the 90-per cent confidence intervals are shown (filled area). Gas price shocks are estimated using an ARIMA model. Source: Own calculations.

Source: Own calculations.

The effect on headline consumer prices is muted in the first five months, after which it increases by around 3 per cent after one year. Due to the gas market's reliance on long-term contracts, retail prices adjust more slowly to wholesale prices. As a result, the first channel in which wholesale gas prices directly affect consumer prices occurs with a delay.¹⁸ Core consumer prices – which exclude firms' and households' direct energy expenditure – begin to rise around one year after the shock. This indicates that gas price shocks pass through to core consumer prices via the second and third channel, namely the indirect effect on production costs and possible second-round effects on wages.

¹⁷ Core HICP denotes consumer prices excluding energy, food, alcohol and tobacco.

¹⁸ See Adolfsen et al. (2024).

The impulse responses resemble the responses to gas price shocks that are found elsewhere in the literature. For instance, the shape of the responses closely resembles the demand and supply shocks in Adolfsen et al. (2024) despite methodological differences, pointing to robustness of the results.

A slightly stronger response of Danish consumer prices could be caused by differences in compensation schemes and the role of fixed price contracts

Although the response to energy price shocks is generally similar in Denmark and the euro area, Danish consumer prices have a slightly stronger response, especially after around one year.

The stronger response in Denmark vis-à-vis the euro area could be due to differences in energy compensation schemes following the 2022-2023 energy price increases. Compensation schemes (e.g., tax reductions on energy products) can dampen price increases, which potentially delays the immediate impact of gas price shocks. Unlike many other euro area countries, Denmark did not implement comprehensive compensation schemes, which could explain why gas price shocks have a greater effect in Denmark.¹⁹

Another reason for the stronger response in Denmark could be a higher share of fixed price electricity contracts in the euro area compared to Denmark, where most electricity prices are adjusted either monthly or quarterly.²⁰ This suggests that the pass-through from energy prices to consumer prices is more rapid in Denmark.

A shock to the oil price has a smaller impact on consumer prices compared to a gas price shock

Turning to an oil price shock, Chart 8 and 7 show the response of headline and core HICP consumer prices in Denmark and the euro area to a shock that doubles the oil wholesale price. As with the gas price shock, both regions are similarly affected by the shock. However, the responses to oil price shocks differ from the response to gas price shocks in two ways, consistent with the results obtained by Alessandri and Gazzani (2023).

First, oil price shocks have an immediate effect on consumer prices, unlike gas price shocks. Gas and oil markets differ notably in their structure and usage, which could explain the faster pass-through.²¹ Gas markets rely on long-term contracts with slower price adjustments, while oil markets use spot contracts with faster price transmission to, e.g., petrol prices. The direct effect on consumer prices is thereby faster for oil price shocks compared to gas price shocks.

Second, gas price shocks result in larger increases in both headline and core consumer prices compared to oil price shocks. The greater impact of gas price shocks on consumer prices may be attributed to greater indirect effects, as gas often determines the marginal price of electricity, which is largely used by households and for production. Another reason for the difference in the impact of gas and oil price shocks could be the timeframes of the data: oil price data go back to 2001, while gas price data are only available from 2015 onward. The

¹⁹ Between the beginning of September 2021 and June 2023, compensation schemes have totalled € 651 in the EU. Across several euro area countries, the relief packages have generally taken the form of uniform subsidies to households and businesses, reductions in value-added tax (VAT) and energy taxes, or direct price ceilings on gas and electricity, see Sgaravatti et al. (2023).
²⁰ See Danmarks Nationalbank (2023).

²¹ The gas market relies on long-term contracts usually indexed to past prices, with retail prices adjusting more slowly to wholesale prices, whereas the oil market primarily uses spot contracts, leading to a faster transmission to petrol prices. In terms of usage, about 65 per cent of oil consumption in the EU is for transportation, while 15 per cent is used as a non-energy input in industry. Conversely, natural gas affects 65 per cent of industrial energy consumption, either directly or through its crucial impact on electricity prices, see Alessandri and Gazzani (2023).

2022 surge in gas prices may therefore be a reason behind the greater response to gas price shocks compared to oil price shocks.

CHART 8

There is an immediate response of headline consumer prices to an oil price shock...

Impulse responses for Denmark



Note: The chart shows impulse responses in per cent of a doubling of the oil wholesale price on Danish HICP and core HICP (solid lines). Standard errors are calculated using Newey-West standard errors and the 90-per cent confidence intervals are shown (filled area). Oil price shocks are estimated using an ARIMA model. Source: Own calculations. CHART 9

... and the response is similar in the euro area

Impulse responses for the euro area



Note: The chart shows impulse responses in per cent of a doubling of the oil wholesale price on euro area HICP and core HICP (solid lines). Standard errors are calculated using Newey-West standard errors and the 90-per cent confidence intervals are shown (filled area). Oil price shocks are estimated using an ARIMA model. Source: Own calculations.

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04 Positive shocks to energy prices have a greater effect than negative shocks

Chart 10 and Chart 11 show the impulse response of Danish and euro area consumer prices to a positive and negative gas price shock. For comparability reasons, the negative price shock is inverted. In both regions, positive gas price shocks have a greater effect on consumer prices, compared to negative shocks. In Denmark, a positive gas price shock increases consumer prices by 6 per cent after one year. In contrast, negative shocks have almost no effect.

CHART 10

Positive gas price shocks have a greater effect on Danish consumer prices compared to negative shocks...



Note: The chart shows impulse responses in per cent of positive and negative gas price shocks on Danish HICP (solid lines). The negative shock is inverted for comparability reasons. Standard errors are calculated using Newey-West standard errors and the 90-per cent confidence intervals are shown (filled area). Gas price shocks are estimated using an ARIMA model.

Source: Own calculations.

The impact of positive oil price shocks is greater than negative shocks – especially when inflation is high

The impulse responses of consumer prices to positive and negative oil price shocks are shown in Chart 12 and Chart 13. For Danish consumer prices, positive shocks have a slightly greater effect on consumer prices compared to negative shocks. By contrast, in the euro area, the difference between positive and negative shocks only emerges after 20 months.

CHART 11

... and the same holds true for the euro area

Impulse responses for the euro area



Note: The chart shows impulse responses in per cent of positive and negative gas price shocks on euro area HICP (solid lines). The negative shock is inverted for comparability reasons. Standard errors are calculated using Newey–West standard errors and the 90-per cent confidence intervals are shown (filled area). Oil price shocks are estimated using an ARIMA model. Source: Own calculations.

CHART 12

A positive oil price shock has a slightly greater effect on consumer prices in Denmark...

Impulse responses for Denmark



Note: The chart shows impulse responses in per cent of positive and negative oil price shocks on Danish HICP (solid lines). The negative shock is inverted for comparability reasons. Standard errors are calculated using Newey-West standard errors and the 90-per cent confidence intervals are shown (filled area). Oil price shocks are estimated using an ARIMA model.

CHART 13

... whereas there is little asymmetry between shocks in the euro area

Impulse responses for the euro area



Note: The chart shows impulse responses in per cent of positive and negative oil price shocks on euro area HICP (solid lines). The negative shock is inverted for comparability reasons. Standard errors are calculated using Newey-West standard errors and the 90-per cent confidence intervals are shown (filled area). Oil price shocks are estimated using an ARIMA model. Source: Own calculations.

Source: Own calculations.

Other studies find that the level of inflation in an economy affects how oil price shocks are transmitted to consumer prices.²² Following Adolfsen et al. (2024), I therefore estimate impulse responses for different levels of inflation, using a 2 per cent inflation level as the threshold for high inflation.²³

Chart 14 and Chart 15 show that, when inflation is above 2 per cent, the asymmetry between positive and negative shocks becomes more pronounced. A negative oil price shock has minimal effect on consumer prices, whereas a positive shock increases consumer prices substantially. By contrast, when inflation is below 2 per cent, the asymmetry between positive and negative oil price shocks is negligible.

²² See Garzon and Hierro (2021).

²³ I also estimate impulse responses of positive and negative gas price shocks when inflation is above and below 2 per cent. Consistent with the findings of Adolfsen et al. (2024), the impulse responses do not depend on the inflation level.

CHART 14

The asymmetry in the response of consumer prices to an oil price shock is greater, when inflation is above 2 per cent...

Impulse responses for Denmark in a high-inflation environment



Note: The chart shows impulse responses in per cent of positive and negative oil price shocks on Danish HICP (solid lines) when Danish inflation is above 2 per cent. The negative shock is inverted for comparability reasons. Standard errors are calculated using Newey–West standard errors and the 90-per cent confidence intervals are shown (filled area). Oil price shocks are estimated using an ARIMA model.

Source: Own calculations.

CHART 15

... and this result also holds true for the euro area

Impulse responses for the euro area in a high-inflation environment



Note: The chart shows impulse responses in per cent of positive and negative oil price shocks on euro area HICP (solid lines), when euro area inflation is above 2 per cent. The negative shock is inverted for comparability reasons. Standard errors are calculated using Newey-West standard errors and the 90-per cent confidence intervals are shown (filled area). Oil price shocks are estimated using an ARIMA model.

Source: Own calculations.

The results demonstrate robust evidence of asymmetry in energy price shocks, consistent with findings in the literature

A potential caveat to the results presented above is the relatively short time span of the gas price data, which are only available from 2015 onwards. As discussed in Chapter 2, the gas price shocks exhibit greater volatility after 2019, which could potentially drive the results. Nevertheless, the results are robust to using gas price data that date further back. The results are also robust to including a dummy variable for 2022, which was marked by significant volatility in gas prices, see Chart 3 and Chart 4.²⁴

Additionally, the response to oil price shocks exhibits an asymmetry like that from gas shocks, further supporting the argument that the transmission of energy price shocks to consumer prices depends on the direction of the shock. The asymmetries between positive and negative oil price shocks are particularly present when inflation is above 2 per cent.

Finally, the results align with other studies, which identify asymmetric effects of positive and negative gas and oil price shocks.²⁵ This provides further validation of the robustness of the present findings.

The asymmetric impact of positive and negative shocks may be due to downward nominal rigidities

The results above show that increases in energy prices translate into increases in consumer price levels, while decreases in energy prices do not translate into decreases in price levels to the same extent. The estimated asymmetries likely

 ²⁴ I extend the gas price data back to 2013 using the ICE Dutch TTF natural gas base load or back to 2010 using the Dutch TTF natural gas index. This does not change the overall results.
 ²⁵ See Burriel et al. (2024), Abdallah and Kpodar (2023), Borrallo et al. (2024) and Garzon and Hierro (2021).

stem from downward nominal rigidities in the transmission of wholesale energy prices through the three channels outlined in Chapter 1: retail energy prices, general consumer prices and wages.

First, downward nominal rigidities could be present in the pass-through from wholesale to retail energy prices, especially for the price of gas. Retail gas prices in most of the EU are regularly determined by long-term contracts between the gas distributors and consumers. Thus, when wholesale gas prices increase, the distributor can raise retail prices accordingly but might not lower them to the same extent when wholesale prices fall.²⁶ Adolfsen et al. (2024) corroborate this hypothesis, finding that profit margins increase when there is a positive shock to gas prices. This might reflect the fact that firms increase prices disproportionately to the increase in input costs due to the costs associated with changing prices frequently.

Second, downward price rigidity could be present in the pass-through from retail energy prices faced by firms to consumer prices broadly. When energy prices rise, they indirectly increase other consumer prices due to higher production costs for firms that rely on energy in their production. Considering that it is costly for firms to adjust prices, firms are more likely to adjust prices in response to rising costs than to declining ones.²⁷ This implies that positive energy price shocks could have a stronger transmission to consumer prices, as compared to negative shocks. Downward price rigidity in consumer and retail energy prices might be more pronounced in high-inflation environments, explaining the pronounced asymmetries for oil price shocks when inflation is high.²⁸

Third, downward nominal rigidity could be present in wage setting behaviour. Even if energy price shocks transmit to both retail energy prices and consumer prices, and these are characterised by downward nominal rigidity, the effect on inflation may still be transitory. However, if wages begin to rise in response to a positive energy price shock the inflationary effects can be amplified. Additionally, if wages are characterised by downward nominal rigidity, this implies that nominal wages do not adjust downward when underlying price pressures adjust down and wages are above their market-clearing level.²⁹ The backdrop for this would be a reluctance among workers to accept wage reductions.

Asymmetries imply that Europe could face a period of higher inflation amid energy price volatility, requiring central banks to act

The asymmetry in the pass-through of positive and negative energy price shocks to consumer prices implies that higher energy prices increase the aggregate price level, while the reverse does not happen when energy prices fall. A likely implication of this asymmetry is that periods of more volatile energy prices result in a higher inflation rate. This occurs because more frequent energy price shocks cause continuous upward pressure on consumer prices and nominal wages, without corresponding downward pressure. In this case, central banks would need to act by raising monetary policy interest rates to reduce demand in the economy, thereby lowering inflation.

This phenomenon is called 'menu costs', see Ball and Mankiw (1994).

²⁶ Adolfsen et al. (2024) find that profit margins increase when there is a shock to gas supply or demand. This might reflect the fact that firms increase prices disproportionately to the increase in input costs due to the menu costs associated with changing prices frequently.

²⁸ Downward price rigidity in consumer and retail energy prices tends to be more pronounced in periods of high inflation, as firms are more likely to update their prices in high-inflation environments, see Garzon and Hierro (2021). Furthermore, when inflation is high, firms anticipate higher future inflation and more persistent energy price shocks, prompting them to pass on these higher costs to prices more extensively, see Taylor (2000). ²⁹ See Elsby and Solon (2019) for a literature review on downward nominal wage rigidities.

Bibliography

Abdallah, C., & Kpodar, K. (2023). How large and persistent is the response of inflation to changes in retail energy prices? *Journal of International Money and Finance*, 132, 102806.

Adolfsen, J. F., Minesso, M. F., Mork, J. E., & Robays, I. V. (2024). Gas price shocks and euro area inflation, *ECB Working Paper Series*.

Alessandri, P., & Gazzani, A. (2023). Natural gas and the macroeconomy: not all energy shocks are alike. *Bank of Italy Temi di Discussione (Working Paper)*, No. 1428.

Alonso, I., Kataryniuk, I., & Martínez-Martín, J. (2021), The impact of supply and demand shocks on recent economic developments and prices. *Economic Bulletin*, 4(2021), 28-30.

Baumeister, C., Kilian, L., & Lee, T. K. (2017). Inside the crystal ball: new approaches to predicting the gasoline price at the pump. *Journal of Applied Econometrics*, 32(2), 275-295.

Bilal, A., & Känzig, D. R. (2024). The Macroeconomic Impact of Climate Change: Global vs. Local Temperature (No. w32450). *National Bureau of Economic Research*.

Bonam, D., & Hobijn, B. (2024). Downward Price Rigidities and Inflationary Relative Demand Shocks. *Federal Reserve Bank of Chicago, Working Paper*, No. WP 2024, November.

Borrallo, F., Cuadro-Sáez, L., Gras-Miralles, Á., & Perez, J. J. (2024). The transmission of shocks to food and energy commodity prices to food inflation in the euro area. *Applied Economics Letters*, 1-6.

Branner, Victoria Havsteen and Ingholt, Marcus Mølbak (2023), Denmark risks a period of energy price fluctuations, impacting inflation and monetary policy. *Danmarks Nationalbank*, November.

Burriel, P., Odendahl, F., & Párraga Rodríguez, S. (2024). Asymmetries in the transmission of energy price increases and decreases to underlying inflation in the euro area and Spain. *Economic Bulletin/Banco de España*, 2024/Q1, June.

Cloyne, J., Jordà, Ò., & Taylor, A. M. (2023). State-dependent local projections: Understanding impulse response heterogeneity (No. w30971). *National Bureau* of Economic Research.

Danmarks Nationalbank (2023), Persistently high inflationary pressures call for tight economic policy, *Danmarks Nationalbank Analysis (Outlook for the Danish economy)*, no. 4, March.

Danmarks Nationalbank (2023), Presset I Økonomien bør dæmpes, Danmarks Nationalbank Analysis (Outlook for the Danish economy), no. 11, September.

De Santis, R. A., & Tornese, T. (2023). Energy supply shocks' nonlinearities on output and prices, *ECB Working Paper Series*.

Dhyne, E., Konieczny, J., Rumler, F., & Sevestre, P. (2009). Price rigidity in the euro area - An assessment (no. 380). *Directorate General Economic and Financial Affairs (DG ECFIN), European Commission*.

Elsby, M. W., & Solon, G. (2019). How prevalent is downward rigidity in nominal wages? International evidence from payroll records and pay slips. Journal of *Economic Perspectives*, 33(3), 185-201.

European Commission (2024). The future of European competitiveness Part A | A competitiveness strategy for Europe. *European Commission*, September.

Garzon, A. J., & Hierro, L. A. (2021). Asymmetries in the transmission of oil price shocks to inflation in the eurozone. *Economic Modelling*, 105, 105665.

Gervais, O. (2019). How oil supply shocks affect the global economy: Evidence from local projections (no. 2019-6). *Bank of Canada Staff Discussion Paper*.

Gopinath, G. (2023). Three Uncomfortable Truths for Monetary Policy. In Remarks by the IMF First Deputy Managing Director for the European Central Bank Forum on Central Banking, June.

Jordà, Ò. (2005). Estimation and inference of impulse responses by local projections. *American Economic Review*, 95(1), 161-182.

Kilian, L., & Murphy, D. P. (2014). The role of inventories and speculative trading in the global market for crude oil. *Journal of Applied Econometrics*, 29(3), 454-478.

Kilian, L., & Zhou, X. (2022). The impact of rising oil prices on US inflation and inflation expectations in 2020–23. *Energy Economics*, 113, 106228.

Kuik, F., Adolfsen, J. F., Meyler, A., & Lis, E. (2022). Energy price developments in and out of the COVID-19 pandemic-from commodity prices to consumer prices. *Economic Bulletin Articles*, 4.

Miranda-Agrippino, S., & Ricco, G. (2021). The transmission of monetary policy shocks. *American Economic Journal: Macroeconomics*, 13(3), 74-107.

Montiel Olea, J. L., & Plagborg-Møller, M. (2021). Local projection inference is simpler and more robust than you think. *Econometrica*, 89(4), 1789-1823.

Neri, S., Busetti, F., Conflitti, C., Corsello, F., Delle Monache, D., & Tagliabracci, A. (2023). Energy price shocks and inflation in the euro area. *Bank of Italy Occasional Paper*, (792).

Obadi, S. M., & Korcek, M. (2020). Driving fundamentals of natural gas price in Europe. *International Journal of Energy Economics and Policy*, 10(6), 318-324.

Ramey, V. A. (2016). Macroeconomic shocks and their propagation. *Handbook of Macroeconomics*, 2, 71-162.

Reichlin, L., & Zettelmeyer, J. (2024). The European Central Bank must adapt to an environment of inflation volatility, *Bruegel*, June.

Sgaravatti, G., S. Tagliapietra, C. Trasi and G. Zachmann (2023) 'National policies to shield consumers from rising energy prices', Bruegel Datasets, first published 4 November 2021, available at <u>https://www.bruegel.org/dataset/national-policies-shield-consumers-rising-energy-prices</u>

Taylor, J. B. (2000). Low inflation, pass-through, and the pricing power of firms. *European Economic Review*, 44(7), 1389-1408.

Tertre, Miguel Gil (2023), Structural changes in energy markets and price implications: Effects of the recent energy crisis and perspectives of the green transition, *ECB Forum on Central Banking 2023, European Central Bank*, June.

Zakeri, B., Staffell, I., Dodds, P. E., Grubb, M., Ekins, P., Jääskeläinen, J., & Gissey, G. C. (2023). The role of natural gas in setting electricity prices in Europe. *Energy Reports*, 10, 2778-2792.

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