

Carbon Pricing and Inflation Expectations

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Abstract

Putting a price on carbon emissions helps mitigate climate change but may also raise overall price inflation. Using high-frequency event studies based on regulatory news in the European carbon market, we show that carbon price surprises generate significant increases not only in energy futures prices, but also in inflation swap prices and breakeven inflation rates. These measures of market-based inflation expectations respond positively at both short and long horizons, with significant effects up to ten years out. Such long-lived inflationary consequences of climate policy are relevant for central banks. However, despite the sustained increases in market-based inflation expectations, forward-looking nominal interest rates show no meaningful response to the carbon policy shocks, suggesting that investors do not anticipate that the European Central Bank will lean against the inflationary effects of higher carbon prices.

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1 Introduction

Carbon pricing—through emissions trading systems or carbon taxes—is an effective policy tool to accelerate the green transition, as it forces emitters to internalize the social cost of greenhouse gas emissions and promotes the most efficient emission reductions. Yet carbon pricing may also generate broader macroeconomic spillovers, including upward pressure on inflation (e.g., [Mann, 2023](#)). Whether such inflationary effects remain contained depends critically on expectations. If households and financial markets anticipate persistent inflation from climate policy actions, these expectations may become self-fulfilling and complicate central banks’ efforts to maintain price stability. This paper asks: Do unanticipated carbon price shocks affect short- and long-term inflation expectations? And how do financial markets expect monetary policy to respond?

We examine these questions in the context of the European Emissions Trading System (ETS), one of the largest carbon markets in the world. A central econometric challenge in estimating the effects of carbon pricing on inflation expectations is the endogeneity of ETS carbon prices. The demand and price for ETS carbon emission allowances respond to current macroeconomic conditions, energy demand, and expectations about future economic activity—the same factors that drive overall inflation expectations. Naive regressions of inflation expectations on carbon prices would therefore conflate the causal effect of carbon policy with reverse causality and omitted variable bias.

To address this identification problem, we conduct a high-frequency event study that isolates plausibly exogenous variation in carbon prices. As described in [Section 2](#), “carbon policy surprises” are identified by measuring changes in carbon futures prices within narrow daily windows around ETS regulatory announcements that affect the future supply of emission allowances. The key identifying assumption is that within these tight event windows, carbon price movements are dominated by the regulatory news rather than by other macroeconomic shocks, which are predetermined with respect to the announcement. We apply the high-frequency identification of [Känzig \(2023\)](#)—originally developed for macroeconomic VARs—in a novel event-study framework that exploits the term structure of inflation-linked financial instruments. In addition, we use this methodology to analyse the concomitant response of nominal interest rates and anticipated monetary policy. By estimating the responses across the term structure and exploiting the fast price discovery in financial markets, our design avoids the need to extrapolate dynamic responses over long horizons from low-frequency time series regressions, and instead delivers a direct market-based assessment of the expected persistence of inflationary effects and the monetary policy response. As a practical contribution, we also extend the [Känzig \(2023\)](#) event set through 2024, which incorporates important policy variation, including the start of Phase 4 of the EU ETS and the recent period of very elevated carbon prices, thereby increasing statistical power.

We begin by studying the response of energy futures—including carbon, electricity, gas, and oil futures—as a first step to understanding the transmission of carbon pricing to the aggregate price level and inflation. The results in [Section 3](#) document a strong impact of carbon prices on energy markets. We estimate significant pass-through to European electricity prices, on the order of 20–40%, as well as material spillovers to gas and oil prices. These results provide evidence of the importance of carbon prices for European energy markets.

We then examine a range of market-based measures of euro-area inflation expectations in [Section 4](#). Our data include breakeven inflation rates based on nominal and inflation-indexed French government bonds, inflation swap rates based on both the French Consumer Price Index (CPI) and the euro-area Harmonised Index of Consumer Prices (HICP), as well as inflation swap and breakeven inflation rates for the United Kingdom. We find significantly positive effects of carbon policy surprises on all these measures of inflation

expectations. The increase is evident across the entire term structure, with statistically significant responses extending from short horizons to ten-year maturities. The magnitude and shape of the responses are consistent across markets and instruments and robust to alternative samples, the exclusion of potentially confounding events, and alternative surprise measures. The high persistence of carbon price level effects on expected inflation is puzzling but similar to the long-run effects of oil price shocks on market-based inflation expectations. Overall, these results indicate that financial markets expect carbon price increases to exert enduring inflationary pressures.

The persistent response of inflation expectations raises the question of how monetary policy is expected to react. In Section 5, we study the event-study responses of the euro-area nominal term structure of interest rates—with maturities extending to ten years—to carbon policy surprises. We find no appreciable response of nominal interest rates, despite the sustained increases in market-based inflation expectations. This suggests that investors do not anticipate that the European Central Bank (ECB) will lean against the inflationary effects of carbon price increases. The absence of an interest rate response is puzzling through the lens of optimal monetary policy, which would prescribe a proactive policy response to persistent inflation pressures caused by supply shocks. Indeed, the ECB has adopted this view in its analysis of the relevance of carbon taxes and climate policies to the conduct of monetary policy. Notably, in a policy speech, [Schnabel \(2022\)](#) warned that the inflationary consequences of carbon pricing may not always be purely transitory and stressed that monetary policy should not automatically “look through” such shocks if they risk propagating into medium-term inflation dynamics and inflation expectations—precisely the risk indicated by our inflation responses. Yet, we do not observe such a response anticipated in financial markets.

Related literature. The theoretical support for “greenflation”—the inflationary pressure stemming from the green transition—is ambiguous (e.g., [Ferrari and Nispi Landi, 2025](#); [Del Negro et al., 2023](#)). On the supply side, higher fossil fuel prices raise production costs that propagate through wholesale and retail prices. However, these inflationary pressures may be offset by weaker household demand if agents expect persistently higher carbon tax burdens. Longer-term forces likely also matter: costly and sluggish structural adjustment, including labour and capital reallocation during decarbonization, could temporarily push inflation higher. Conversely, inflation could subside if the green transition spurs innovation and productivity. In addition, climate change itself can increase inflationary risks, for example, from the supply disruptions or adaptation expenses owing to more extreme weather events, so avoiding climate damages through a green transition could help ease inflation. The net effect of carbon pricing on inflation is therefore an empirical question.

Empirically, studies of carbon pricing and realized inflation report mixed findings. [Breitenfellner et al. \(2022\)](#), [Känzig \(2023\)](#), [Känzig and Konradt \(2024\)](#), [Semik \(2025\)](#), and [Ortubai et al. \(2025\)](#) generally find positive but short-lived inflationary effects, whereas [Konradt and Weder di Mauro \(2023\)](#), [De Silva and Tenreiro \(2021\)](#), [McKibbin et al. \(2022\)](#), [Konradt et al. \(2024\)](#), and [Moessner \(2025\)](#) find little if any impact on headline inflation. [Degasperi et al. \(2025\)](#) distinguish between current “stance” and “path” factors with opposing effects. Some of this disparity in results may reflect sample differences—for example, variation in how climate policy recycles carbon tax revenues. However, a common feature of these macro studies is that they rely on vector autoregression (VAR) methods at a monthly or quarterly frequency, which require extrapolating dynamic responses and imposing assumptions about persistence. In contrast, our high-frequency event-study approach directly recovers the market-implied response of inflation expectations across maturities, providing a forward-looking assessment of the expected persistence of greenflation under minimal structural assumptions.

Our paper also complements survey-based evidence on inflation expectations. [Frank \(2025\)](#), [Hensel](#)

et al. (2024), and Mangiante (2026) show that household and firm inflation expectations increase following ETS shocks, with effects lasting several years.¹ Using financial market data, we obtain more precise estimates across horizons and jointly study the response of inflation expectations and nominal interest rates.

Compared with earlier studies based on realized inflation and survey expectations, we find similar magnitudes for peak effects. The key difference lies in persistence. While VAR-based estimates of realized inflation typically imply effects that dissipate within one to two years, and survey evidence suggests elevated expectations over a horizon of roughly two to three years, our results indicate that financial markets price a materially more persistent impact. In this sense, our findings complement the existing evidence on short-run effects while providing new forward-looking evidence that investors anticipate a sustained inflationary component associated with carbon price shocks.

In sum, our paper makes both methodological and empirical contributions to climate economics. On the methodological side, we implement high-frequency financial market event studies using a novel set of plausibly exogenous ETS policy shocks. Our paper is the first to apply this ETS shock methodology to bond and derivative markets, estimating the term structure response of inflation and monetary policy expectations.² On the empirical side, we provide new evidence of pass-through and spillover effects to energy markets, and of the wider impacts on expected inflation and interest rates.

2 Carbon policy surprises

We measure carbon policy surprises using data from the EU Emission Trading System. The EU ETS currently covers around 40% of Europe’s greenhouse gas (GHG) emissions, primarily from factories and power plants. To enforce a cap on emissions, the ETS distributes European Union Allowances (EUA), which grant the owner the right to emit one metric ton of CO₂-equivalent GHG. The number of new EUAs issued each year decreases over time, and companies that are covered by the ETS must surrender enough of these carbon permits each April to cover their emissions during the previous year. These permits are traded by the emitting companies as well as by financial arbitrageurs in spot, futures, and options markets.

In assessing the inflationary consequences of climate policies, it is important to note that the quantity-based nature of a cap and trade system makes the carbon market prices sensitive to changes in the demand for emission allowances. Therefore, carbon prices will naturally be correlated with overall economic activity and the associated price pressures, so simply regressing measures of inflation or inflation expectations on changes in carbon prices will generally not identify the causal effect of carbon policy on inflation. The identification problem resembles that in monetary economics, where correlations between inflation and interest rates do not provide any indication of the macroeconomic effects of monetary policy.

To address this problem, we adopt a high-frequency identification approach similar to the event studies commonly used in empirical monetary economics (Kuttner, 2001; Gürkaynak et al., 2005; Bauer and Swanson, 2023). The validity of our event-study estimates rests on two key assumptions. First, the regulatory announcements must generate sufficient variation in carbon prices—a relevance condition that we verify by documenting large and statistically significant price movements on event days. Second, other shocks affecting inflation expectations must be orthogonal to the regulatory news within the event window—an exogeneity condition that is plausible given the predetermined nature of macroeconomic conditions at the daily

¹ Other related work examines the effects of changes in energy prices more generally on inflation expectations using household surveys. For example, Patzelt and Reis (2024) documents the inflationary fallout from the rise in European energy prices over the 2021–2023 period.

² While a few other papers have also studied financial market reactions to carbon price shocks, they have focused on equity markets (Hengge et al., 2023; Di Giovanni et al., 2025) or market-based r-star (Jezequel-Royer and Leveuge, 2025).

frequency and that we probe through robustness checks excluding events coinciding with major macroeconomic news.

Our high-frequency identification extends [Känzig \(2023\)](#), who measures EU ETS policy surprises by isolating the variation in carbon prices associated with regulatory news about the supply or allocation of emission allowances. Such news events are arguably exogenous with respect to the demand shocks affecting inflation. Indeed, [Känzig \(2023\)](#) finds little predictability for these carbon policy surprises from macro news, alleviating concerns that macroeconomic conditions provide information that can predict carbon prices around these regulatory events.

Following [Känzig \(2023\)](#), we construct carbon policy surprises, cps_t , from changes in EUA futures prices on the day of a regulatory event relative to the last trading day before the event:

$$cps_t = 100 \cdot \frac{f_t^{carbon} - f_{t-1}^{carbon}}{p_{t-1}^{elec}}, \quad (1)$$

where t is a day corresponding to a regulatory event and f_t^{carbon} is the settlement (end-of-day) price of the front-quarter EUA futures contract on day t . The level of carbon prices has varied substantially over our sample (see [Figure B.1](#) in [Appendix B](#)). Therefore, we scale the surprises as in [Känzig \(2023\)](#) by the prevailing wholesale electricity price on the day prior to the event, p_{t-1}^{elec} . This normalization helps account for the wide variation in nominal prices since the introduction of the ETS and expresses the surprises in economically meaningful terms.³ We multiply the scaled surprise by 100 to measure cps_t in percent. In short, cps_t is the percent change in the ETS carbon price relative to the wholesale electricity price, caused by the news from the carbon policy regulatory event on day t .

The key advantage of cps_t is that it captures plausibly exogenous supply-side variation in carbon prices. By measuring price changes over narrow daily event windows, we isolate regulatory news from demand-side factors. Reverse causality can plausibly be ruled out as economic conditions are predetermined within these windows.⁴ A potential concern about this exogeneity assumption is that other important economic news could be released on the ETS event days and affect both carbon prices and inflation expectations. To address it, we identify event dates with confounding news, such as major energy-related and geopolitical news or ECB policy actions, and check the robustness of our results in alternative estimation samples that exclude these dates.

Our sample of regulatory events starts in 2008 and ends in 2024. For the period from 2008 to 2019, we use the events described in [Känzig \(2023\)](#) (see [Table A.1](#) therein). We supplement these dates with a new set of 45 EU ETS regulatory events from January 2020 to December 2024 to capture more recent policy shocks, as described in [Appendix A](#). This yields a total of 152 regulatory events from 2008 to 2024. Our baseline sample for all subsequent analysis starts in 2013, when the ETS started its “Phase 3” which marked a major shift towards a single, EU-wide emissions cap with harmonized allocation rules, broader coverage, and auctioning as the default method for allocating allowances.⁵ This baseline sample from 2013 to 2024 includes 117 events. For additional robustness analysis, we will also consider a longer sample starting in 2008 with the launch of “Phase 2” of the ETS, which contains 152 surprises.

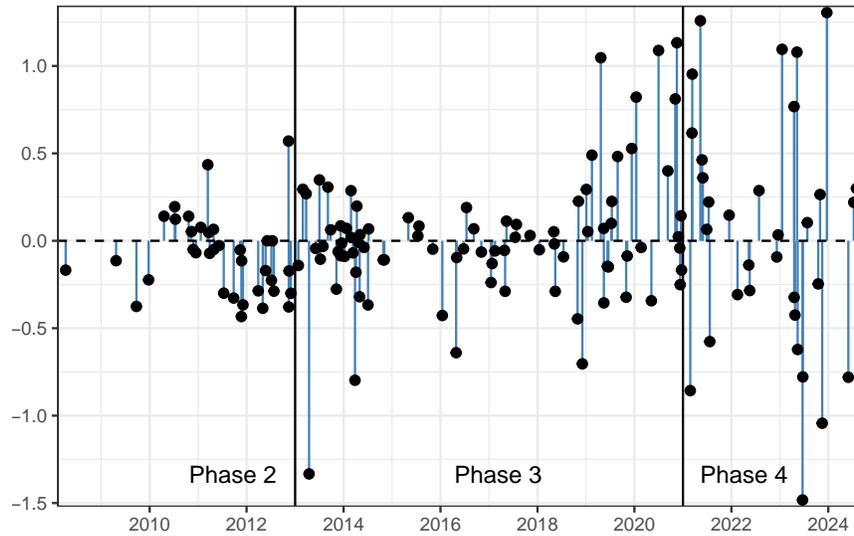
[Figure 1](#) shows the series of carbon policy surprises. The regulatory news in the carbon market frequently

³ To translate the electricity price, which is measured in euros per megawatt hour, into the same units as the carbon price, which is in euros per ton of CO₂, the electricity price is divided by 0.38 tCO₂/mwh. This conversion factor used by [Känzig \(2023\)](#) is the carbon intensity of electricity generation before the introduction of the EU ETS in 2004.

⁴ This identifying assumption closely corresponds to the assumption underlying much recent work in empirical monetary economics, namely that high-frequency monetary policy surprises are predetermined with respect to economic and financial conditions when the Fed announces monetary policy decisions ([Bauer and Swanson, 2023](#)).

⁵ For more information on the ETS and the different phases, see https://climate.ec.europa.eu/eu-action/carbon-markets/about-eu-ets_en.

Figure 1: Carbon policy surprises



Notes: Time series of carbon policy surprises, cps_t , following Känzig (2023). Units are price changes relative to prevailing wholesale electricity price, in percent. Phase 3 of the EU ETS starts in January 2013 and Phase 4 starts in January 2021. Sample: 152 ETS regulatory events from 2008 to 2024.

led to material price changes. Over the full sample, the standard deviation of cps_t is 0.43%. The volatility was significantly lower over Phase 2 of the ETS, with a standard deviation of 0.23% over that period, compared to 0.47% over our baseline sample period from 2013 to 2024.

The series for cps_t clearly exhibits some heteroskedasticity, with especially large surprises over the last few years of our sample. To understand this pattern better, it is helpful to note that the EUA carbon price rose significantly and became much more volatile since 2018 (as evident in Appendix Figure B.1). The wholesale electricity price exhibited some occasional volatility, especially in 2022 due to the Russian invasion of Ukraine, but did not show a similar trend increase as the carbon price, since electricity prices are held down by renewables and policy subsidies (see Appendix Figure B.2). Thus the larger absolute carbon price changes since 2019 do not get scaled by a consistently higher price level. If we use an alternative scaling and divide by the previous day's carbon price—resulting in a simple relative price change—then the resulting series has less heteroskedasticity (shown in Appendix Figure B.3). However, this alternative scaling has the two major disadvantages that, first, it leads to significant outliers during times of very low levels of the carbon price, and second, it is less economically interpretable than a change expressed relative to the price of electricity. For these reasons, we follow Känzig (2023) and use the preferable cps_t measure.

Figure 1 shows that the most impactful events resulted in carbon price changes of 1% and more. Under full pass-through, the observed changes in carbon prices would imply that certain carbon policy events could lead to changes in wholesale electricity prices of this magnitude, while for more limited pass-through the effect would scale accordingly. The degree of pass-through and spillover effects to electricity and energy prices is an important open issue that will be the focus of the next section.

To gain some intuition about carbon policy surprises, we now describe some key events that led to material changes in ETS allowance prices. On 16 April 2013, the European Parliament voted against the Commission's back-loading proposal. The vote undermined the expectations of near-term supply restraint and led to a sharp fall in EUA prices, with a carbon policy surprise of -1.3% . On 12 May 2021, the annual publication of the surplus of allowances in circulation triggered a substantial increase in withdrawals under the ETS Market Stability Reserve, reducing auction volumes by more than 378 million allowances between Septem-

ber 2021 and August 2022. This shift in the supply expectations triggered a significant EUA repricing with an increase of 1.3%. On 21 June 2023, the revised 2023 auction calendar was published, which explicitly incorporates additional auction volumes linked to the Recovery and Resilience Facility of REPowerEU. The news about increased near-term supply led to a sharp decrease in the EUA price, with a cps_t of -1.5%, the largest drop in our sample. Finally, on 21 December 2023, the publication of the 2024 EU ETS auction calendars clarified the near-term flow of supplied allowances under the revised auctioning rules, which led to an increase in the carbon price by 1.3%, the largest increase in our sample. These examples of carbon policy news illustrate the nature of the event-study identification in this paper.

3 Response of energy futures

With our first set of event studies, we estimate the response of energy futures to carbon price shocks. These responses capture the price effects for the goods directly affected by changes in ETS carbon prices, and thus constitute a key signal of the transmission channel from carbon prices to aggregate inflation.

For the analysis in this section, we rescale the carbon policy surprise as

$$\widehat{cps}_t = s \cdot cps_t$$

with a scaling factor s corresponding to the coefficient in a regression of the percent change in the carbon price, $\Delta f_t^{carbon} / f_{t-1}^{carbon}$, on the normalized change, $\Delta f_t^{carbon} / p_{t-1}^{elec}$. With this scaling factor, the response of the return on the first EUA futures contract to \widehat{cps}_t is exactly unity.⁶ The coefficients in the event studies in this section therefore have an intuitive interpretation: They capture the degree of pass-through from a change in the carbon price (measured using the front-quarter futures contract) to carbon and energy futures prices, with a coefficient of unity corresponding to full pass-through.

To investigate the pass-through of carbon policy surprises to the term structure of futures prices, we use event-study regressions

$$r_t^{(n)} = \alpha^{(n)} + \widehat{\beta}^{(n)} \widehat{cps}_t + \varepsilon_t^{(n)}, \quad (2)$$

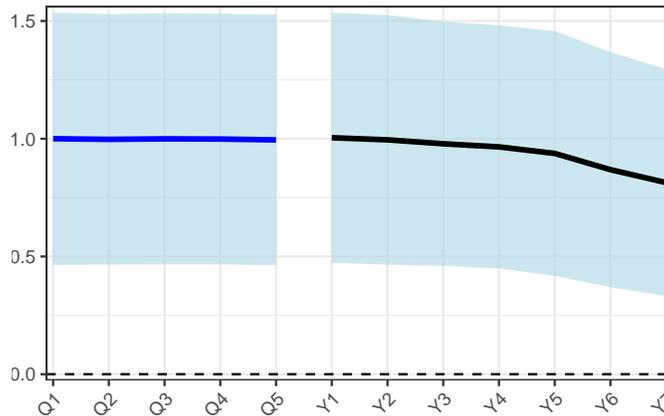
where $r_t^{(n)}$ is the one-day log return, in percent, for a carbon or energy futures contract with maturity n , \widehat{cps}_t is the rescaled carbon policy surprise, and t indexes ETS regulatory event days. Here as in all event studies in the rest of the paper, we ensure that the asset return (or interest rate change) used as the dependent variable covers a time window that includes the ETS events. Our interest lies in the magnitude, significance, and maturity pattern of the pass-through coefficient $\widehat{\beta}^{(n)}$.

The logical first step in this analysis is to investigate the response of the term structure of carbon futures prices to the carbon policy surprise, which is constructed using the front-quarter contract. The main question is whether the EUA term structure responds with level shifts to regulatory news, or whether longer-dated contracts show only limited pass-through and respond less than one-for-one.

Figure 2 shows the estimated price responses of five quarterly and seven annual EUA futures contracts. The response coefficient for the front-quarter contract is equal to one due to the scaling of the surprise variable, and the uncertainty around this estimate is due to variation of the carbon price relative to the wholesale electricity price. Our interest now mainly lies in the horizon pattern of response coefficients. All quarterly contracts respond essentially one-for-one to the carbon policy surprise. Annual contracts show similar responses, with the coefficient dropping below 0.9 only beyond the five-year contract. The results indicate that the near-term carbon policy surprise causes a level shift in the term structure of carbon prices.

⁶ In the baseline sample, $s = 7.06$. This scaling factor captures the central tendency of $p_t^{elec} / f_t^{carbon} \times 1/0.38$ where 0.38 is the carbon intensity of electricity generation described in footnote 3.

Figure 2: Response of carbon futures



Notes: Estimated price response (in percent) of emission allowance (EUA) futures contracts from event-study regressions on carbon policy surprises. Horizontal scale is quarterly and annual. Blue shaded areas indicate 95% confidence intervals based on White standard errors. Sample: 117 EU ETS regulatory events from 2013 to 2024.

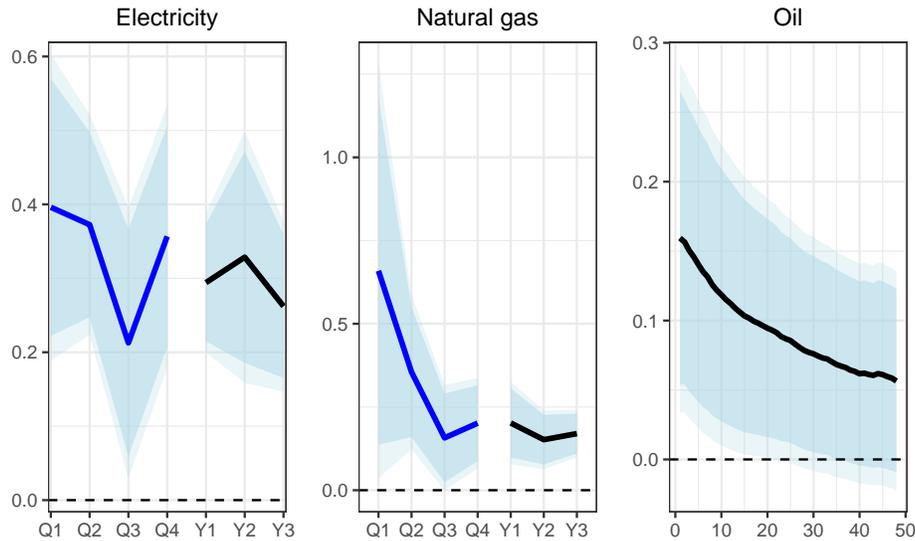
The institutional features of the ETS market are important for understanding the response pattern of carbon futures prices. Emission allowances (EUAs) have a date of issuance but no set date of use. Therefore, a company can meet its emission requirements with current-year, unused “banked” past-year, or “borrowed” future-year EUAs (bought on the futures market). In theory, the complete fungibility of all these vintages of EUAs, along with the essentially free storage of EUAs, implies that the key difference between a spot and a futures EUA is the opportunity cost of money paid for the former (as the futures EUA will not be paid for until settlement). Therefore, the term structure of carbon prices is mainly affected by the term structure of interest rates, and factors that affect the slope of the yield curve will also affect the slope of carbon prices. In practice, empirical research has documented that carbon futures prices are also affected by a broader range of financial factors (Bredin and Parsons, 2016; Palao and Pardo, 2021), and most recently, Azzone et al. (2025) identify the credit spread of the biggest polluting companies in the EU as an important empirical driver of the arbitrage in this market. In contrast, changes in carbon policy are viewed as less relevant to determining the shape of the carbon futures term structure, as such changes generally affect the level of all carbon futures prices. For example, projected changes in the ETS emissions cap would affect equally the prices of all current and future EUAs. It is less obvious how carbon policy surprises might shift the slope of the yield curve (Bredin and Parsons, 2016).

Our results shown in Figure 2 are consistent with this level effect of carbon policy surprises on the entire term structure of EUA prices. These estimates suggest that the carbon policy surprises do not have a substantial imprint on nominal interest rates, an issue we directly address in Section 5, or on the other financial factors studied in Bredin and Parsons (2016) and related work.

Next, we turn to energy futures to understand the pass-through of carbon policy changes to electricity prices, as well as spillover effects to natural gas and oil markets. For each of these energy sources, we consider a term structure of futures contracts and estimate the price response using event-study regressions as in equation (2). For electricity and gas futures, we use one-day returns, while for oil futures we use two-day returns due to the trading hours of U.S. futures markets. Figure 3 shows the estimated term structures of response coefficients for these three different futures markets (at quarterly and annual horizons for electricity and natural gas and at a monthly one for oil).⁷

⁷ To account for potentially confounding news jointly affecting all commodity markets, we also consider a sample that excludes two major energy-related event days (April 23, 2019 with an oil price shock and December 21, 2023 with shipping-related/geopolitical news) as well as the ECB announcement days, similar to the sample used in Appendix Figure B.6. The estimated effects, which we

Figure 3: Response of energy futures



Notes: Estimated price response (in percent) of energy futures contracts from event-study regressions on carbon policy surprises. Horizontal scales are quarterly and annual for electricity and natural gas and monthly for oil. Dark (light) shaded areas indicate 90% (95%) confidence intervals based on White standard errors. Sample: 117 EU ETS regulatory events from 2013 to 2024.

For electricity, we use German power futures, which are traded on the European Energy Exchange (EEX) and serve as the most liquid and widely used benchmark for wholesale electricity prices in Europe. The response coefficients in the left panel of Figure 3 show that the elasticity of electricity futures prices to carbon futures prices around ETS events is 0.2–0.4, indicating a pass-through of carbon prices to wholesale electricity prices of 20–40%. The positive coefficient estimates are statistically significant, and the magnitudes broadly similar, across all quarterly and annual futures contracts. The estimated pattern across contracts—essentially a level shift in response to carbon policy surprises—echoes the response pattern for carbon futures. The prior literature on the EU ETS—despite different samples and methods—also points to a sizable pass-through of carbon prices to wholesale electricity prices on impact (e.g., [Fabra and Reguant, 2014](#)).

The middle panel of Figure 3 plots estimated natural gas price responses to the carbon shocks. We use Natural Gas TTF futures, which are contracts referencing gas delivery rights at the Dutch Title Transfer Facility (TTF), Europe’s primary natural gas hub, traded on both EEX and Intercontinental Exchange (ICE) Endex. The estimated elasticities are mostly around 0.2, with somewhat larger but less precisely estimated coefficients for current- and next-quarter contracts. These estimates suggest significant spillover effects from carbon price changes to the natural gas market. Such spillover effects likely reflect the additional demand for natural gas from “fuel-switching” as higher carbon prices give a competitive advantage to electricity generation from gas over coal-based power as the carbon intensity of natural gas is less than half that of coal. As a result, demand for natural gas rises, and gas producers with market power can capture some of the surplus by raising gas prices.

Finally, we estimate the responses of Brent crude oil futures, which are also traded on ICE Futures Europe and are among the most important benchmarks for global energy markets. We report, in the right panel of Figure 3, the response of monthly contracts out to a horizon of 48 months. The coefficient pattern is slightly different from that for electricity and gas futures: For oil futures, the effects of carbon price

omit for brevity, remain essentially unchanged.

surprises are somewhat lower and declining with maturity, with elasticities of 0.17 at the short end to 0.05 for longer maturities of 3–4 years. Nevertheless, these effects remain statistically significant even at long horizons. These estimates suggest sizable spillover effects on oil markets, which are consistent with the institutional setting: The EU ETS covers emissions associated with the exploration and drilling, production and processing (including gas flaring), transportation, and refining of oil, so fluctuations in carbon prices can affect crude oil prices. Still, the integrated global nature of the oil market, in contrast to the European electricity and natural gas futures, may mute the oil price sensitivity to EU carbon policy.

It is instructive to compare our event-study estimates of the effects on oil futures prices to VAR estimates of Känzig (2023) and Ortubai et al. (2025). After rescaling our estimates to make them comparable to the shock size in the VAR studies, the carbon policy surprise raises oil prices around 4% at short horizons and 1% at longer horizons.⁸ Känzig (2023) estimates an impact effect on oil around 7%, while the magnitude of the oil price effects in Ortubai et al. (2025) is around 5%. The effects we estimate on short-maturity futures are similar in magnitude, but more precisely estimated given the greater statistical power from our financial market event-studies.

Overall, we find statistically significant and economically meaningful effects of carbon policy surprises on energy markets. While the pass-through and spillover effects are somewhat stronger for European energy markets than for global oil markets, our estimation reveals pronounced effects on the level of energy futures prices in all markets that we consider.

4 Response of market-based inflation expectations

To understand the broader consequences of the estimated energy price responses to ETS carbon price shocks, we now consider the potential transmission of these shocks to the expected path of overall prices. Our analysis relies on a range of market-based measures of inflation expectations for the euro area and event-study regressions around EU ETS regulatory events.

We use two measures of inflation expectations from financial markets: Breakeven inflation (BEI) rates, which are the difference between nominal and inflation-linked government bond yields, and inflation swap rates, which are the average expected inflation rates measured directly from prices of inflation swap contracts. There are deep and liquid markets with good data for these measures in three major European economic areas: the euro area, France, and the U.K. As part of Brexit, British businesses remained under EU law—including the EU ETS—through the end of 2020, so we curtail the sample for our U.K. analysis.

For France and the euro area, we calculate BEI rates using the fitted nominal and real yield curves for French sovereign bonds (Obligations Assimilables du Trésor, OAT) and their inflation-indexed counterparts (OATi) from Grishchenko et al. (2025). The available yield data ends in mid-February 2023, and our estimation sample therefore ends with the ETS event on 18 January 2023, for a total of 102 events.⁹ The French inflation-indexed OATi bonds are among the most liquid indexed securities globally and have become a *de facto* benchmark to construct eurozone inflation expectations. BEI rates for euro area HICP inflation and for French CPI inflation are formed by subtracting yields of OATi bonds indexed either to euro area HICP inflation or French CPI from nominal yields. Similarly, U.K. BEI rates are constructed as the differences between yields on conventional gilts (U.K. sovereign bonds) and so-called inflation linkers.¹⁰ These breakeven

⁸ The VAR studies normalize the carbon price shock to have a one percentage point impact effect on energy inflation. To similarly rescale our estimated effects, we use the same method described below in Section 4 (see footnote 12). We regress energy price inflation on carbon policy surprises to obtain a scaling coefficient, which for $\widehat{c\psi}_i$ is 0.043.

⁹ We are grateful to the authors for sharing their data.

¹⁰ The data from the Bank of England (<https://www.bankofengland.co.uk/statistics/yield-curves>) are constructed using a curve-fitting technique to estimate smooth yield curves.

rates provide market-based expectations of future inflation based on the U.K. Retail Price Index (RPI).

One limitation to BEI rates is that they reflect not just expected inflation but also inflation risk and liquidity premiums (the compensation for uncertainty about inflation and potential supply-demand distortions). Swap contracts provide a complementary alternative. While swap rates also reflect inflation risk premia, they are less affected by liquidity differences between nominal and inflation-indexed bond markets, and they do not require yield curve estimation from observed coupon bond prices.¹¹ We obtain data from Bloomberg on euro area inflation swaps, which reference the HICP index, French inflation swaps, which reference the French CPI, and U.K. swaps, which reference the Retail Price Index (RPI). Using both BEI and inflation swap measures of expected inflation helps ensure the robustness of our results to technical bond market or other factors. Our estimation uses the same sample for BEI rates and inflation swap rates.

We use BEI rates and inflation swaps with maturities of two to ten years. BEI rates with short maturities are unreliable because inflation-linked bonds are generally issued with long maturities and the available short-dated bonds therefore tend to be old, illiquid, and more affected by idiosyncratic pricing and indexation-lag effects (Gürkaynak et al., 2010). All our baseline results use changes in yields or swap rates, meaning that they capture the effects on expected average inflation over the next n years, but we also show results for forward rates in Appendix B.

We estimate the response of market-based inflation expectations to carbon price changes using event-study regressions

$$\Delta\pi_t^{(n)} = \alpha^{(n)} + \beta^{(n)} cps_t + \varepsilon_t^{(n)}, \quad (3)$$

for days t with EU ETS regulatory events, where $\Delta\pi_t^{(n)}$ is the one-day change in a BEI or inflation swap rate of maturity n years. The carbon policy surprise, cps_t , is the series shown in Figure 1. The rate change is measured in percentage points, and as noted above, cps_t is the percent change in the ETS carbon price relative to the wholesale electricity price. The slope coefficients $\beta^{(n)}$ estimate the impact of exogenous carbon price changes on euro area expected inflation over the subsequent n years. Again, our baseline sample for these event-study regressions is from 2013 to 2024, but for the U.K. we end the sample in 2020, when its participation in the EU ETS ended.

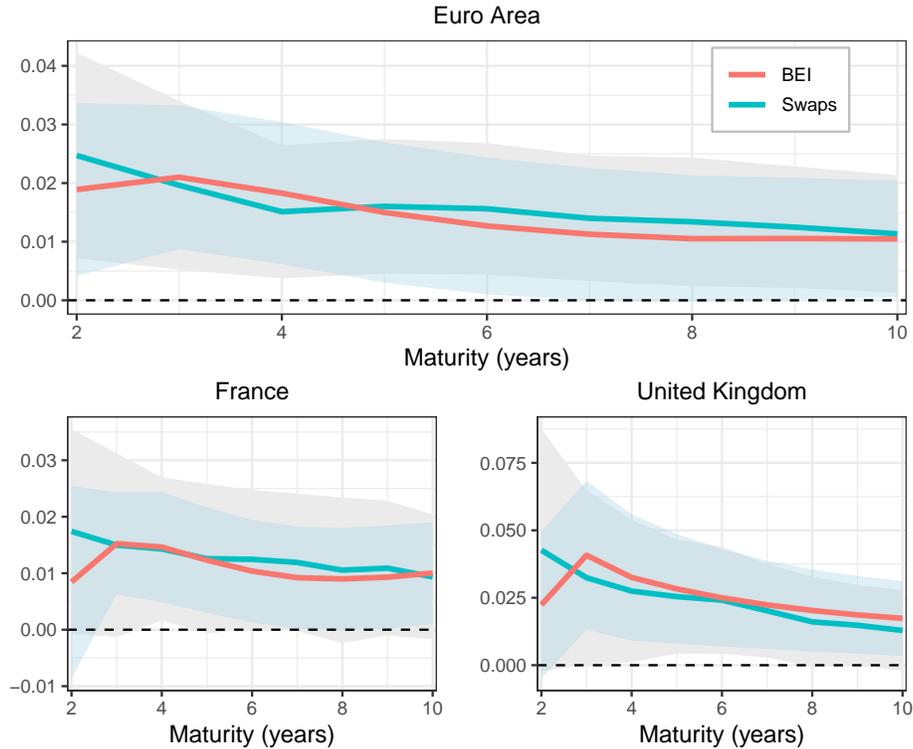
Figure 4 plots the estimated coefficients $\beta^{(n)}$ across horizons. Each panel shows estimated responses for BEI and inflation swap rates for one of three economic jurisdictions. Across all of the various specifications, there is a fairly remarkable consistency in the magnitude, significance, and persistence of the response coefficients: Positive (negative) carbon policy shocks lead to statistically significant and persistent increases (decreases) in inflation expectations.

The magnitude of the response is moderate but economically meaningful: A 1% increase in the EUA carbon price relative to the wholesale electricity price causes market-based inflation expectations to shift up by 1–3 basis points, with a peak effect in the euro area of 2.5 basis points. To put this magnitude in perspective, note that the volatility of cps_t is about 0.5, as reported above in Section 2. For daily changes in breakeven inflation rates and inflation swap rates, the volatility tends to be around 2–3 basis points. Thus, for a one-standard-deviation carbon policy surprise, the magnitude of the effect on market-based inflation expectations is about 0.5 to 1.5 basis points, depending on horizon, and this effect corresponds to roughly 1/3 to 1/2 of one standard deviation of daily changes in BEI rates.

The magnitude of our estimates is broadly consistent with the peak headline inflation effects in euro-area VARs that are also identified with high-frequency carbon policy innovations. Notably, Känzig (2023), Ortubai et al. (2025), and Frank (2025) find that a carbon policy shock boosts headline inflation by about 15

¹¹ While counterparty and credit risk may play a role in inflation swap markets, a large portion of the transactions is centrally cleared, which significantly reduces these risks. For more details on the inflation swap market and its usefulness for constructing market-based inflation expectations, see Bahaj et al. (2023).

Figure 4: Response of inflation compensation to carbon policy surprises



Notes: Estimated response of euro area, French, and UK inflation compensation (in percentage points), based on inflation swaps and BEI rates, from event-study regressions of changes in swap/BEI rates on carbon policy surprises. Shaded areas indicate 95% confidence intervals based on White standard errors. Sample for euro area and France: 102 EU ETS regulatory events from Jan-2013 to Jan-2023. Sample for UK: 85 regulatory events from 2013 to 2020.

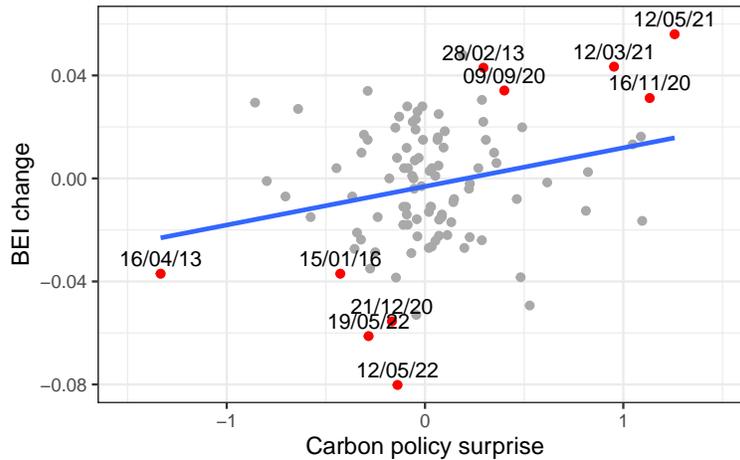
to 20 basis points on impact. Rescaling our estimates to make them comparable to these studies, the peak effect on euro area inflation expectations is about 9 basis points.¹² Importantly, however, the VAR-based inflation responses are transitory, with peak effects occurring on impact. These transitory effects partly reflect the structure and specification of these VAR models, which use log price levels and extrapolate from the first few autocovariances, with limited power to identify long-run inflation dynamics. In contrast, our estimates based on market-implied inflation compensation indicate a much more persistent upward shift in expected inflation, suggesting that carbon policy surprises affect the longer-term inflation outlook more strongly than implied by standard VAR evidence.

The pronounced persistence in the expected inflation impact is indeed the most surprising feature of the term structure responses in Figure 4. Because the response of yields and swap rates at long horizons reflects the response of *average* expected inflation over these horizons, it is helpful to also look separately at forward rates. Appendix Figure B.4 confirms that various long-horizon forward inflation compensation rates also exhibit a significant positive response to carbon policy surprises, even though the responses are estimated less precisely, especially for the more noisy forward inflation swap rates. Overall, the response of market-based inflation expectations to carbon policy surprises exhibits significant persistence across horizons.

The results of our forward-looking analysis may not be directly comparable to the actual inflation re-

¹² To match the VAR shocks, which are normalized to raise energy inflation by one percentage point, we regress HICP energy inflation on the carbon policy surprise (as well as on lagged inflation and seasonal dummies). We then rescale our euro-area 2.5 basis point peak effect by dividing it by the carbon policy surprise coefficient of 0.27.

Figure 5: Euro area inflation compensation and carbon policy surprises



Notes: Regression of changes in five-year euro area inflation compensation, measured by changes in breakeven inflation rates in percentage points, on carbon policy surprises. Regression line shows least squares fit. Ten most influential observations, measured by DFBETA, are highlighted in red. Sample: 102 EU ETS regulatory events from Jan-2013 to Jan-2023.

sponse results estimated with historical data over the past couple of decades. For much of the early history of the ETS, carbon prices were very low, even minuscule. Future climate policy is likely to be much more ambitious compared to what has been observed so far with substantially higher carbon prices. In this case, using the past responses of actual inflation may not be a good guide for assessing the response of inflation expectations. From this perspective, our forward-looking analysis may be a better indicator of the likely inflation effects of carbon policies.

To gain further insights into the estimated inflationary effects of carbon policy surprises, Figure 5 shows the empirical relationship in the underlying data. It plots the changes in five-year breakeven inflation rates for the euro area against carbon policy surprises, with some of the most influential observations highlighted in red.

To better understand this relationship, it is useful to consider examples of key regulatory events and their associated market reactions. For example, on 16 April 2013 (the leftmost dot in Figure 5), the European Parliament rejected the Commission’s back-loading proposal, which sought to temporarily withdraw allowances to address the persistent surplus that had accumulated since the global financial crisis. As discussed above, the negative vote was a clear signal of limited political support for tightening the cap on allowances, and it triggered one of the largest carbon price drops in EU ETS history and a decline in BEI rates. Another prominent episode was the start of Phase 4 on 16 November 2020, which formalized a stricter cap and auctioning framework for 2021 onward, implying a lower future supply path for carbon allowances. Markets reacted strongly to the tighter supply path with immediate increases in carbon prices and BEI rates.

Taken together, these episodes demonstrate that some of the largest realizations in our surprise series are tied to clear regulatory decisions that materially move carbon prices. Given the pass-through of energy costs into production and consumer prices, such carbon price adjustments naturally feed into inflation expectations, consistent with the estimated responses of BEI and inflation swap rates.

To assess the robustness of our results to sample choices and the presence of confounding events, we estimate the event-study regressions over alternative samples of ETS regulatory event days. Specifically, we consider estimation samples that start with Phase 2 of the ETS and that exclude a subset of event days with potentially significant confounding news including ECB monetary policy decisions. We also consider an es-

timation using an alternative measure of the carbon policy surprise, which uses the relative carbon price change (i.e., the daily return on EUA futures) instead of the change normalized by the wholesale electricity price. These additional results are shown in Appendix B. Overall, this evidence is consistent with our baseline estimates of the effects on market-based inflation expectations, even though some of these alternative samples yield more noisy estimates with less pronounced and sometimes only marginally significant effects. We conclude from this additional analysis that our results are broadly robust to alternative sample and measurement choices.

The persistent movements in expected inflation in response to carbon policy surprises are unexpected. Carbon policy surprises primarily induce *level* shifts in energy prices and would therefore be expected to have more transitory effects on inflation. Yet we find sustained responses in inflation expectations. This pattern parallels evidence from the oil price literature showing that energy price shocks are associated with persistent movements in market-based inflation expectations despite largely transitory effects on realized inflation (Venditti and Veronese, 2020; Hammoudeh and Reboredo, 2018). We confirm this finding, showing that OPEC surprises from Känzig (2021) generate persistent increases in the term structure of breakeven inflation rates (see Appendix B). One possible explanation is that energy price shocks affect inflation risk premia, as investors demand compensation for greater uncertainty about future inflation. Alternatively, these responses may reflect behavioral updating, whereby agents extrapolate from salient energy price movements when forming expectations.

5 Nominal rates and monetary policy expectations

The inflationary consequences of ETS carbon policy shocks raise the question of how European monetary authorities will respond to those shocks. For example, facing a persistent rise in inflation expectations resulting from a jump in carbon prices, the ECB may be anticipated to tighten monetary policy—raising interest rates over time to lean against the overall price pressures. The standard theory of optimal monetary policy prescribes that central banks should adjust policy interest rates to only partially offset the inflationary effects of supply shocks. The optimal degree of this partial accommodation depends crucially on the persistence of the shock. Transitory supply shocks should induce a relatively muted interest rate response as central banks “look through” temporary price volatility. By contrast, a stronger and more timely policy response is appropriate for more persistent inflationary supply shocks in order to prevent the de-anchoring of inflation expectations and to mitigate second-round effects that could compromise long-term price stability (e.g., Svensson, 1999; Aoki, 2001). In line with this general guidance, the ECB has recently emphasized the importance of the inflationary pressures arising from carbon taxes and climate policies for monetary policy (e.g., Eurosystem, 2021; Schnabel, 2022; Coenen et al., 2024). Indeed, Eurosystem staff macroeconomic projections have included explicit paths for ETS carbon prices as baseline inputs to ECB inflation projections (ECB, 2025).

To assess whether market participants anticipate the forceful ECB monetary policy reaction that appears consistent with their expectations of persistent inflationary effects from the carbon policy shocks, we examine event-study responses of the nominal term structure of interest rates to carbon policy surprises. These responses will reflect expected shifts in the ECB’s policy path to carbon surprises (up to changes in term premia) and elucidate the anticipated monetary policy implications of carbon pricing in the euro area. To ensure the robustness of our results to any market-specific institutional idiosyncrasies, we employ four different measures of risk-free European interest rates as proxies of expected future policy rates: (1) European overnight-indexed swap (OIS) rates, which reference a benchmark short-term interest rate; (2) euro-area benchmark government bond yields from LSEG; (3) ECB estimates of AAA-rated euro-area zero-coupon

Table 1: Response of different risk-free interest rates to carbon policy surprises

	German yields	OIS rates	Euro area benchmark	Euro area AAA zero-coupon
<i>(A) 5-year yields</i>				
CPS	0.004 (0.011)	-0.001 (0.008)	0.001 (0.009)	0.002 (0.009)
Intercept	-0.008* (0.004)	-0.001 (0.004)	-0.003 (0.004)	-0.006* (0.004)
R ²	0.002	0.0001	0.0001	0.0005
<i>(B) 10-year yields</i>				
CPS	0.004 (0.012)	0.0002 (0.008)	0.003 (0.009)	0.004 (0.010)
Intercept	-0.007 (0.005)	-0.002 (0.004)	-0.003 (0.004)	-0.007* (0.004)
R ²	0.001	0.00000	0.001	0.002
N	117	114	117	114

Notes: Event-study regressions of changes in risk-free European interest rates on carbon policy surprise (CPS). German yields are from Bundesbank zero-coupon yield curve. Euro-area benchmark yields are from LSEG. Euro area zero-coupon yields are from the ECB. Dependent variable: one-day rate changes for OIS and euro-area rates; two-day changes for German yields. Sample period: 2013–2024. Significance: *p<0.1; **p<0.05; ***p<0.01

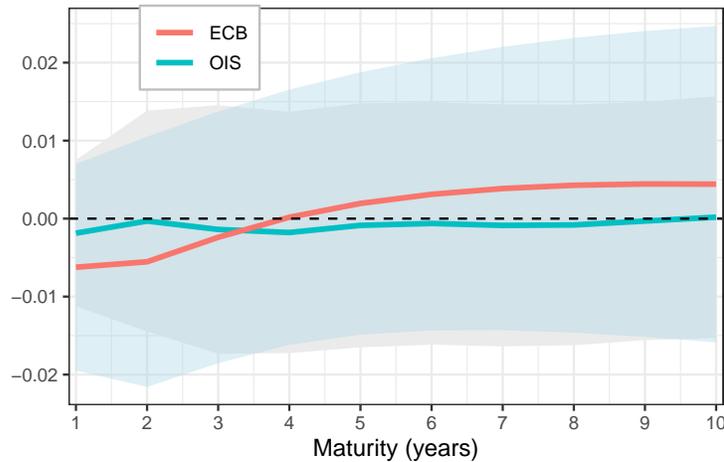
yields; and (4) German zero-coupon yields from the Bundesbank.¹³ Except for the German yield curve from the Bundesbank, all interest rates reflect end-of-day pricing, so we use one-day changes for the day of the carbon policy event. For German yields, we use two-day changes from the day after the carbon policy event relative to the day before the event.

Table 1 shows the estimated responses of five-year yields (top panel) and ten-year yields (bottom panel) to carbon policy surprises. Each column provides the responses for a different measure of risk-free nominal euro-area interest rates. Figure 6 plots the response across the term structure for OIS rates and ECB zero-coupon yields. In stark contrast to our results for inflation, there are no significant responses of nominal rates to carbon policy surprises for any measure or at any horizon. All the estimated response coefficients in Table 1 and Figure 6 are near zero and statistically insignificant. While the point estimates are generally positive, they never exceed 0.011 or approach even marginal statistical significance.

One interpretation of these estimates is that investors do not expect an appreciable response of the ECB’s monetary policy to carbon policy surprises. The absence of an expected policy response appears puzzling in light of the evidence for persistent effects on inflation expectations documented in Section 4. Given the persistent nature of this inflationary supply shock, the conventional policy prescription would be to tighten monetary policy to counter this inflation pressure. Of course, these estimates are average responses over the entire 2013–2024 sample, while the ECB only forcefully highlighted greenflation as a potential policy concern toward the end of that sample. However, adding a sample split to allow the estimated response to

¹³ Euro area OIS rates are widely used as market-based expectations of the euro area’s benchmark short-term interest rate (e.g., Hubert and Labondance, 2018). Due to regulatory changes in the common benchmark rate, we use OIS contracts referencing the EONIA (Euro Overnight Index Average) rate up to 2019 and contracts referencing €STR (Euro Short-Term Rate) from 2020 onward. The LSEG “Reuters Reference” benchmark rates are par yields based on the most liquid sovereign bonds denominated in euros. In practice, German Bunds usually serve as the reference securities for these benchmarks, though bonds from other countries can become the relevant benchmark at certain times. The ECB estimates zero-coupon yield curves using a parametric Nelson-Siegel-Svensson framework; see https://www.ecb.europa.eu/stats/financial_markets_and_interest_rates/euro_area_yield_curves/html/index.en.html. The Bundesbank also estimates zero-coupon yields using the Nelson-Siegel-Svensson approach. The reference prices for the listed Federal securities (Bonds, Bobls, etc.) are fixed “around noon” on the Frankfurt Stock Exchange. For details, see <https://www.bundesbank.de/en/statistics/money-and-capital-markets/interest-rates-and-yields/term-structure-of-interest-rates/term-structure-of-interest-rates-793592>.

Figure 6: Response of term structure of interest rates to carbon policy surprises



Notes: Estimated response of OIS and ECB zero-coupon nominal interest rates from event-study regressions of rate changes on carbon policy surprises. Shaded areas indicate 95% confidence intervals based on White standard errors. Sample: 117 EU ETS regulatory events from 2013 to 2024.

shift after 2020 does not change the results.¹⁴

While statistical noise and large confidence intervals could obscure the presence of an expected monetary policy response in our full-sample estimates, a simple back-of-the-envelope calculation suggests that despite the statistical uncertainty, there is indeed a puzzle. A standard Taylor-rule response of 1.5 to inflation would imply, based on our estimated effects of about 2 basis points on inflation expectations, that the expected policy path should shift up by about 3 basis points. Our confidence intervals exclude such magnitudes, given how precisely the minimal effect of carbon shocks on the nominal rate term structure is estimated, rejecting such a standard monetary policy response.

Given the ECB’s inflation mandate, it is puzzling for monetary policy to be expected to “look through” the persistent inflationary effects of carbon policy surprises. However, there are possible avenues to justify the absence of a nominal rate response. For example, the carbon policy surprises could have effects on expected real activity and employment, which monetary policy might respond to. Indeed, [Känzig \(2023\)](#) finds negative effects of carbon policy shocks on output and employment. This may reflect the fact that carbon price shocks lead to a persistent inflation risk premium shock that tightens overall financial conditions. While this could also lead to higher nominal rates, it is possible that monetary policy is expected to neutralize tighter conditions somewhat and mitigate the rise in yields. Still, without a clear reconciliation, the absence of any effects on nominal rates despite the effects on inflation compensation remains an open issue.

6 Conclusion

As carbon pricing continues to play a key role in global climate strategy, understanding its broader inflationary footprint is important for ensuring a smooth green transition. Our analysis of the high-frequency response of financial markets to carbon policy shocks complements earlier studies that used monthly inflation data or survey readings. Although the previous literature generally found relatively small or short-lived effects, our results suggest that inflation expectations respond more persistently across short- and long-term

¹⁴ These additional results are omitted for brevity.

horizons. Even a decade ahead, market participants do not view carbon policy shocks as temporary surprises, but as more persistent shifts in the inflationary environment.

Despite the persistent rise in inflation expectations following a carbon policy shock, we find no appreciable response in forward-looking nominal interest rates. This divergence implies that investors do not currently anticipate that the ECB will lean against the inflationary pressures generated by the green transition. If greenflation is indeed incorporated into longer-run inflation expectations, the task of maintaining price stability becomes much more complex for central banks. Therefore, our results underscore the need for central banks to account for the expectations channel when assessing the macroeconomic trade-offs of climate policies.

Appendices

A Extended chronology of ETS regulatory events

Table A.1 presents 45 recent ETS regulatory events that we use to extend the [Känzig \(2023\)](#) chronology. The event dates and descriptions are compiled from the [European Commission’s Climate Action news portal](#), supplemented by coverage from [EU Law Live](#) and the Commission’s official [Carbon Market Reports](#).

Table A.1: EU ETS Regulatory Events, 2020–2024

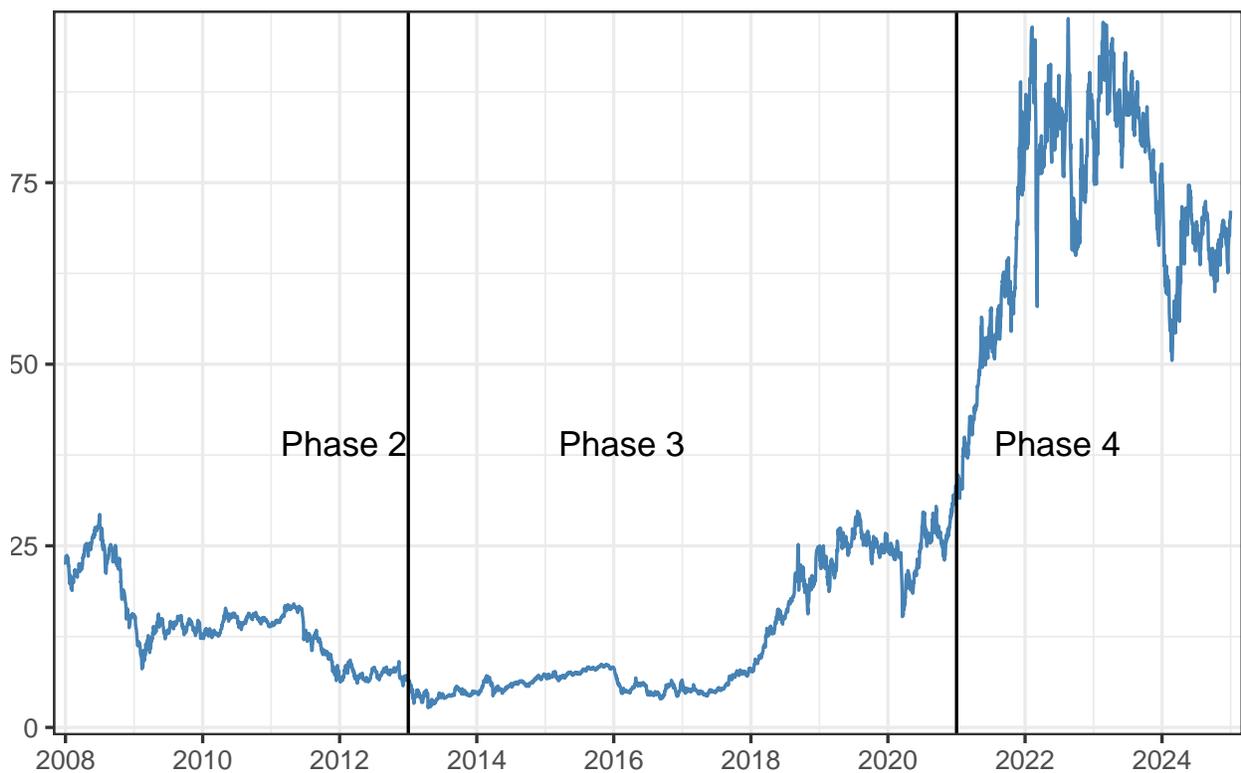
No.	Date	Event	Category
1	15/01/2020	Status update on New Entrants’ Reserve	Free allowance
2	21/02/2020	UK auction calendar published	Auction
3	08/05/2020	Update on exchange and international credit use	International credits
4	18/05/2020	Revised 2020 UK aviation auction calendar	Auction
5	01/07/2020	Revised 2020 auction calendars	Auction
6	09/09/2020	2020 aviation auction calendars revised (Swiss linking)	Auction
7	04/11/2020	EEX appointed EU ETS common auction platform	Auction
8	16/11/2020	Adoption of Phase 4 cap and auction start	Cap
9	27/11/2020	Timing of 2021 free allowance distribution	Free allowance
10	08/12/2020	Draft regulation on 2021–2025 benchmark values	Free allowance
11	11/12/2020	Further details on Phase 4 start	Cap
12	17/12/2020	Member States’ auction shares for 2021–2030	Cap
13	21/12/2020	2021 auction calendars published	Auction
14	25/02/2021	Decision on transitional free allocation	Free allowance
15	10/03/2021	European Parliament vote on CBAM	International credits
16	12/03/2021	Adoption of benchmark free allocation regulation (2021–2025)	Free allowance
17	12/05/2021	MSR reduces auction volume (Sep 2021–Aug 2022)	Auction
18	25/05/2021	Update on exchange and international credit use	International credits
19	31/05/2021	Cross-sectoral correction factor for 2021–2025	Free allowance
20	29/06/2021	National allocation tables (2021–2025)	Free allowance
21	14/07/2021	European Green Deal package delivered	Cap
22	22/07/2021	Revised 2021–2022 auction calendars	Auction
23	15/12/2021	Additional 2022 auction calendars	Auction
24	16/02/2022	Revised 2022 general auction calendar	Auction
25	12/05/2022	MSR reduces auction volume (Sep 2022–Aug 2023)	Auction
26	19/05/2022	Further revision of 2022 auction calendar	Auction
27	28/07/2022	Revised 2022–2023 auction calendars	Auction
28	09/12/2022	New aviation ETS rules agreed	Free allowance
29	19/12/2022	Agreement to strengthen ETS; Social Climate Fund created	Cap
30	18/01/2023	ETS reform concerning aviation	International credits
31	18/04/2023	Parliament approval of Fit for 55	Cap
32	19/04/2023	Reform strengthening the MSR	Auction
33	25/04/2023	Council approval of Fit for 55	Cap
34	10/05/2023	Reform increasing ETS ambition (Fit for 55)	Cap
35	15/05/2023	MSR reduces auction volume	Auction
36	21/06/2023	Revised 2023 auction calendar	Auction
37	23/06/2023	Corrected auction calendar	Auction
38	27/07/2023	Decision on 2024 Union-wide allowance quantity	Cap
39	17/10/2023	New ETS Auctioning Regulation (Fit for 55)	Auction
40	31/10/2023	2024 allowances for aircraft operators decided	Cap
41	16/11/2023	Provisional 2024 auction volume notice	Auction
42	21/12/2023	2024 auction calendars published	Auction
43	31/05/2024	MSR reduces auction volume	Auction

No.	Date	Event	Category
44	11/07/2024	Update on cancelled allowances for Effort Sharing compliance	Auction
45	31/07/2024	Revised 2024–2025 auction calendars	Auction

B Additional exhibits

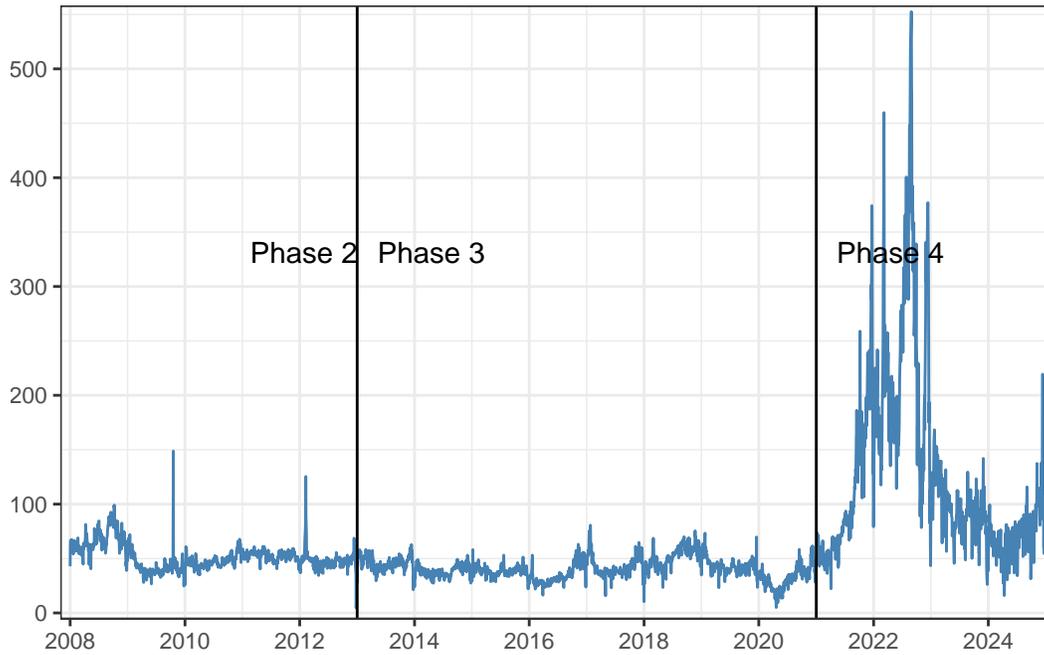
This appendix provides additional figures showing robustness checks and alternative specifications for the main results presented in the paper.

Figure B.1: EUA carbon price



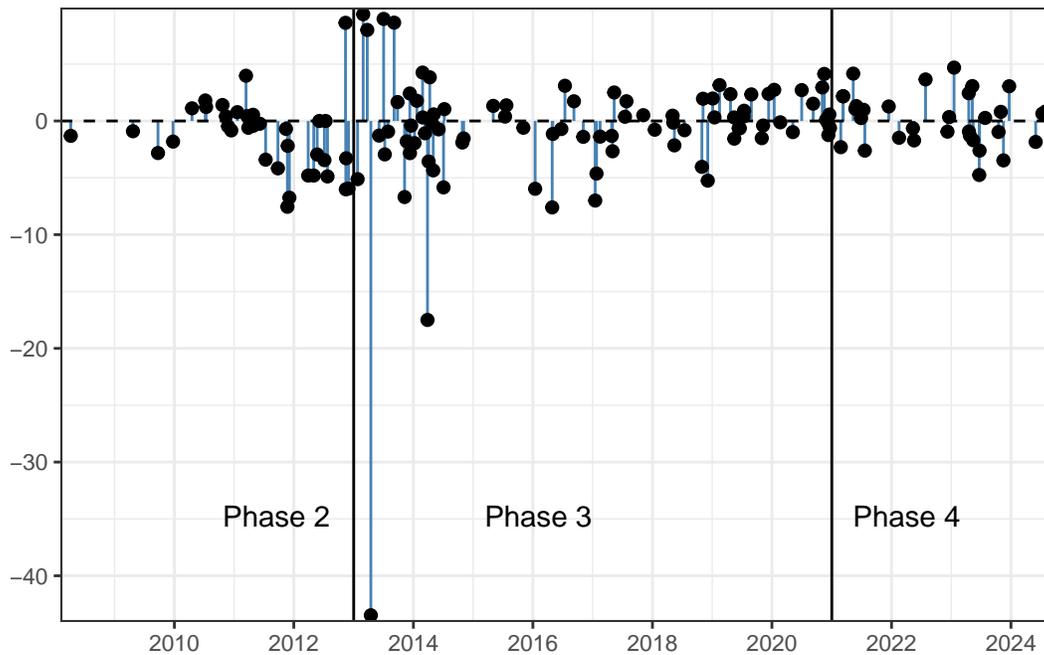
Notes: Time series of carbon price in current euros. Phase 3 of the EU ETS starts in January 2013. Sample period: 2008 to 2024.

Figure B.2: Wholesale electricity price



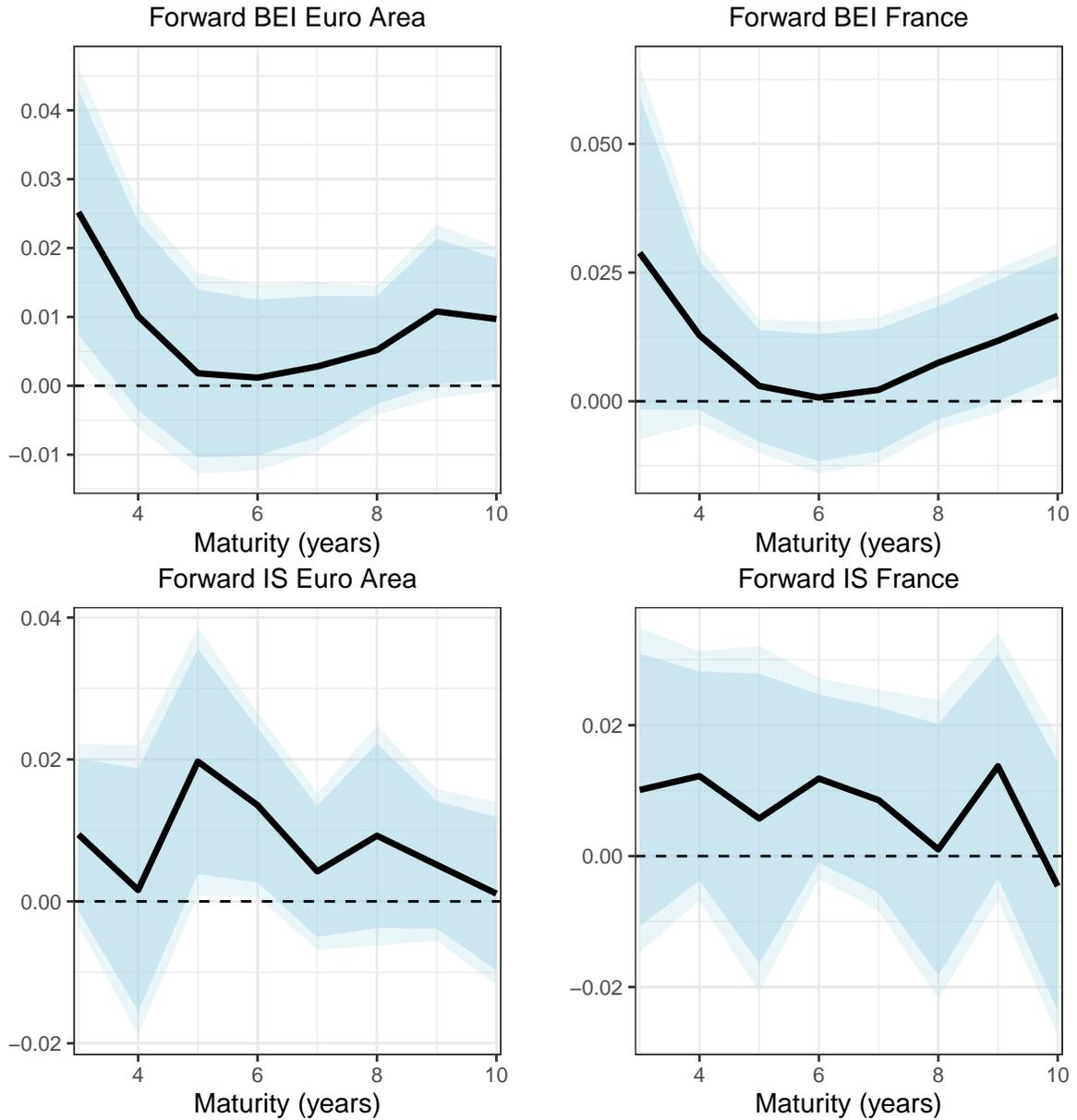
Notes: Time series of wholesale electricity price in current euros. Phase 3 starts in January 2013. Sample period: 2008 to 2024.

Figure B.3: Carbon policy surprises, alternative scaling



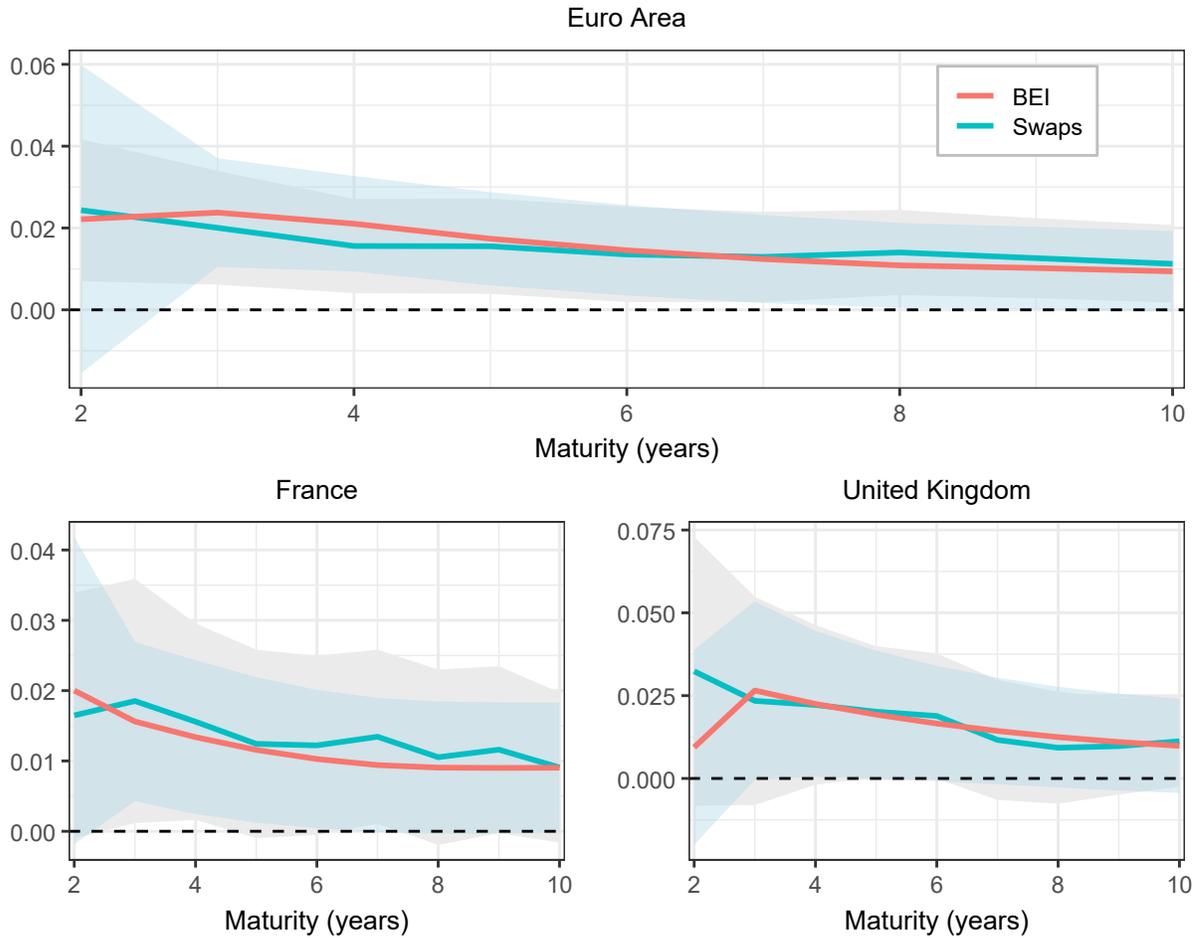
Notes: Time series of carbon policy surprises using an alternative scaling: Percent change relative to previous day settlement price, $100 \cdot \frac{f_t^{\text{carbon}} - f_{t-1}^{\text{carbon}}}{f_{t-1}^{\text{carbon}}}$. Phase 3 of the EU ETS starts in January 2013. Sample: 152 ETS regulatory events from 2008 to 2024.

Figure B.4: Response of forward inflation compensation to carbon policy surprises



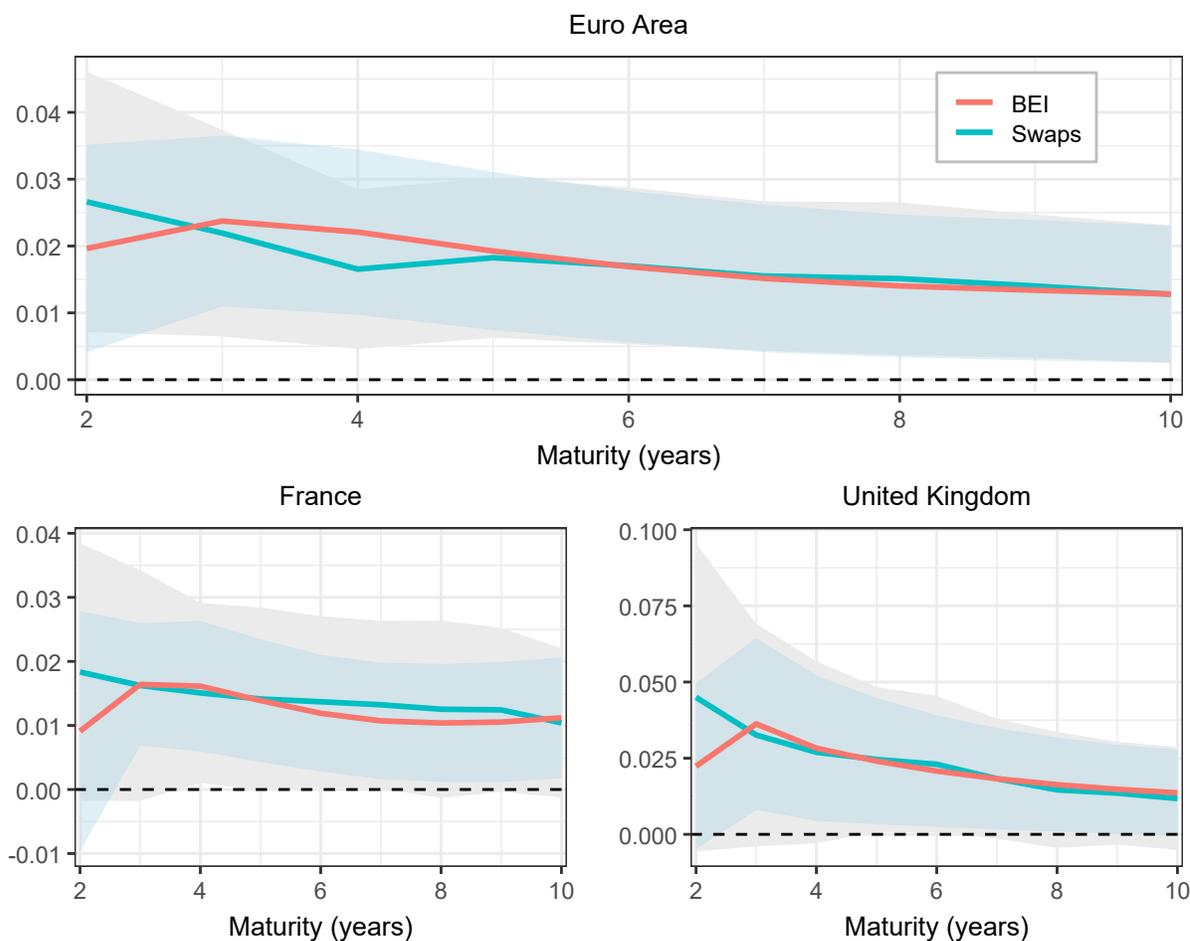
Notes: Estimated response of forward inflation compensation for euro area and France (in percentage points), based on inflation swaps (IS) and breakeven inflation (BEI), from event-study regressions of changes in swap/BEI forward rates on carbon policy surprises. Dark shaded areas indicate 90% confidence intervals, and light shaded areas indicate 95% confidence, based on White standard errors. Sample: 102 regulatory events during Phase 3 of EU ETS, from Jan-2013 to Jan-2023.

Figure B.5: Response to CPS: sample starts with ETS Phase 2



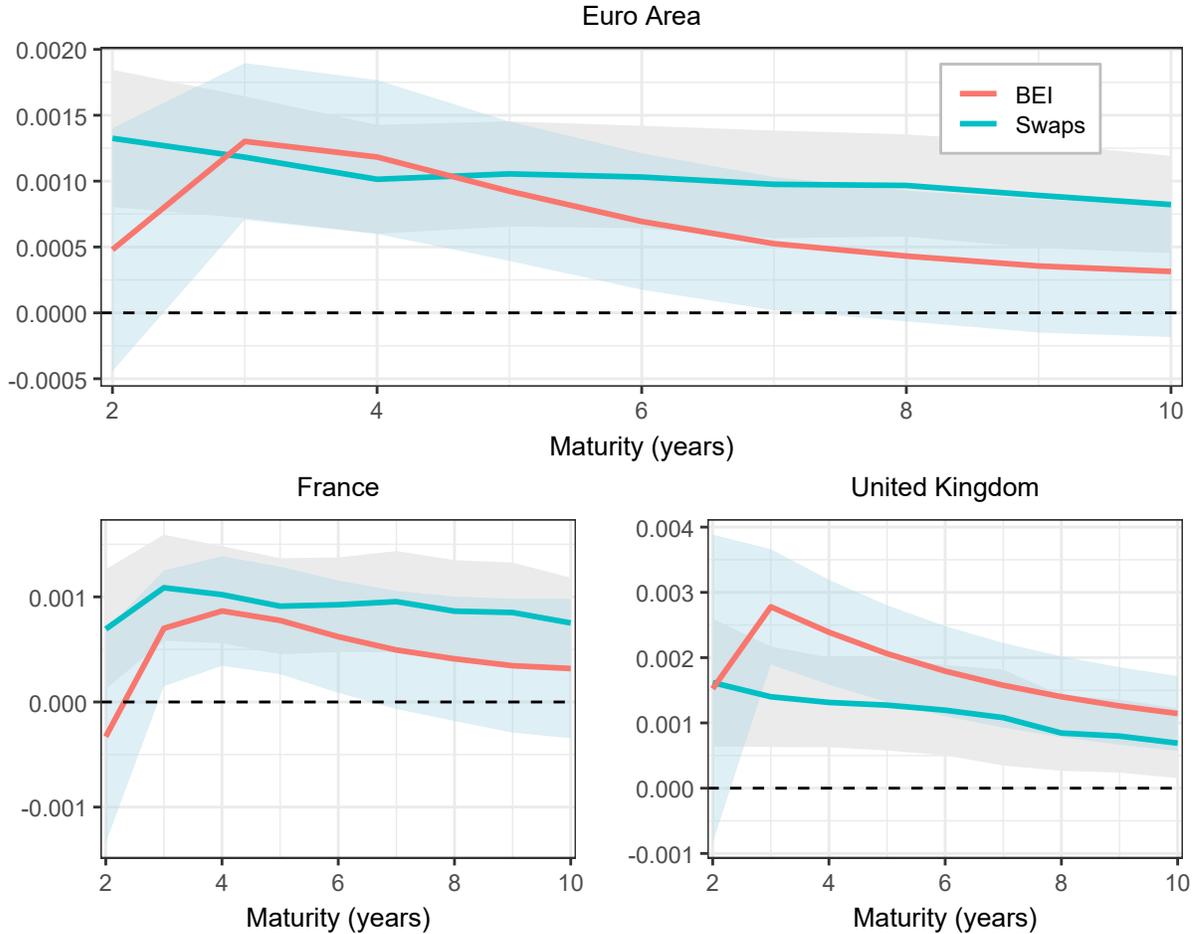
Notes: Estimated response of euro area, French, and UK inflation compensation (in percentage points), based on inflation swaps and breakeven inflation (BEI), from event-study regressions of changes in swap/BEI rates on carbon policy surprises. Shaded areas indicate 95% confidence intervals based on White standard errors. Sample for euro area and France: 137 regulatory events during Phase 2 and 3 of EU ETS, from Apr-2008 to Jan-2023. Sample for UK: 121 regulatory events from 2008 to 2020.

Figure B.6: Response to CPS: exclude confounding events



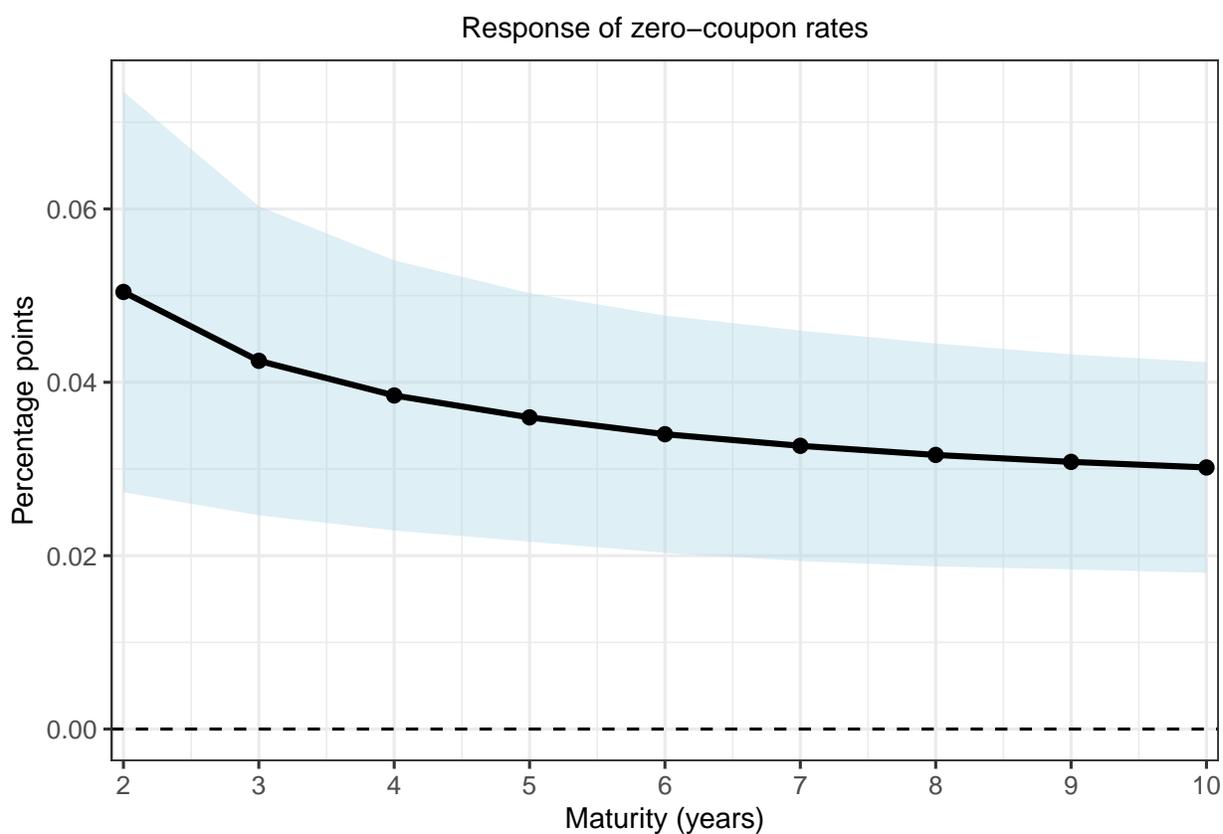
Notes: Estimated response of euro area, French, and UK inflation compensation (in percentage points), based on inflation swaps and breakeven inflation (BEI), from event-study regressions of changes in swap/BEI rates on carbon policy surprises. Shaded areas indicate 95% confidence intervals based on White standard errors. The sample excludes days with ECB announcements, and April 23, 2019 (when U.S. sanctions on Iran caused an oil price shock). Euro area and France: 96 regulatory events during Phase 3 of EU ETS, from Jan-2013 to Jan-2023. For UK: 81 regulatory events from 2013 to 2020.

Figure B.7: Response to CPS: alternative surprise normalization



Notes: Estimated response of euro area, French, and UK inflation compensation (in percentage points), based on inflation swaps and breakeven inflation (BEI), from event-study regressions of changes in swap/BEI rates on carbon policy surprises. Alternative measure of carbon policy surprise is the relative carbon price change—the daily return on EUA futures—instead of the change normalized by the wholesale electricity price used in the baseline estimation. Shaded areas indicate 95% confidence intervals based on White standard errors. Sample for euro area and France: 102 regulatory events during Phase 3 of EU ETS, from Jan-2013 to Jan-2023. Sample for UK: 87 regulatory events from 2013 to 2020.

Figure B.8: Response of breakeven inflation to oil shocks



Notes: Estimated response of euro area breakeven inflation rates (in percentage points) from event-study regressions of rate changes on the oil supply shocks from OPEC announcements. Changes in breakeven inflation rates are over two days, from the day before to the day after the announcement. Oil supply shocks are updated series from [Känzig \(2021\)](#), standardized to have a unit standard deviation in the estimation sample. Shaded areas indicate 95% confidence intervals based on White standard errors. Sample: 65 OPEC announcements from 2004 to 2022.

References

- Aoki, Kosuke (2001) “Optimal monetary policy responses to relative-price changes,” *Journal of monetary economics*, 48 (1), 55–80.
- Azzone, Michele, Roberto Baviera, and Pietro Manzone (2025) “The puzzle of Carbon Allowance spread,” *Energy Economics*, 146, 108459.
- Bahaj, Saleem, Robert Czech, Lei Ding, and Ricardo Reis (2023) “The Market for Inflation Risk,” Discussion Paper20157, CEPR.
- Bauer, Michael D. and Eric T. Swanson (2023) “A Reassessment of Monetary Policy Surprises and High-Frequency Identification,” *NBER Macroeconomics Annual*, 37 (1), 87–155.
- Bredin, Don and John Parsons (2016) “Why is Spot Carbon so Cheap and Future Carbon so Dear? The Term Structure of Carbon Prices,” *The Energy Journal*, 37 (3), 83–108, [10.5547/01956574.37.3.dbre](https://doi.org/10.5547/01956574.37.3.dbre).
- Breitenfellner, Andreas, Friedrich Fritzer, Doris Prammer, Fabio Rumler, and Mirjam Salish (2022) “What is the impact of carbon pricing on inflation in Austria?” *Monetary Policy & the Economy*, Q3 (22), 23–41.
- Coenen, Günter, Matija Lozej, and Romanos Priftis (2024) “Macroeconomic effects of carbon transition policies: An assessment based on the ECB’s New Area-Wide Model with a disaggregated energy sector,” *European Economic Review*, 167, 104798.
- De Silva, Tiloka and Silvana Tenreyro (2021) “Presidential Address 2021 Climate-Change Pledges, Actions, and Outcomes,” *Journal of the European Economic Association*, 19 (6), 2958–2991, [10.1093/jeea/jvab046](https://doi.org/10.1093/jeea/jvab046).
- Degasperi, Riccardo, Filippo Natoli, Valerio Nispi Landi, and Kevin Pallara (2025) “Forward Guidance in Climate Policy,” Working Paper, July.
- Del Negro, Marco, Julian di Giovanni, and Keshav Dogra (2023) “Is the Green Transition Inflationary?,” Staff Report1053, Federal Reserve Bank of New York, [10.2139/ssrn.4359216](https://doi.org/10.2139/ssrn.4359216).
- Di Giovanni, Julian, Galina Hale, Neel Lahiri, and Anirban Sanyal (2025) “Global Spillovers of Climate Policy Shocks,” Working Paperw33647, National Bureau of Economic Research.
- ECB (2025) “Eurosystem staff macroeconomic projections for the euro area, December 2025,” https://www.ecb.europa.eu/press/projections/html/ecb.projections202512_eurosystemstaff~12ead61977.en.html?
- Eurosystem (2021) “Climate change and monetary policy in the euro area,” Occasional Paper Series271, European Central Bank.
- Fabra, Natalia and Mar Reguant (2014) “Pass-through of emissions costs in electricity markets,” *American Economic Review*, 104 (9), 2872–99.
- Ferrari, Alessandro and Valerio Nispi Landi (2025) “Will the Green Transition Be Inflationary? Expectations Matter,” *IMF Economic Review*, 73 (4), 1195–1258, [10.1057/s41308-024-00256-9](https://doi.org/10.1057/s41308-024-00256-9).
- Frank, Pascal (2025) “Carbon Pricing and Heterogeneity in Household Inflation Expectations: Evidence from the Euro Area,” SSRN Working Paper.

- Grishchenko, Olesya, Franck Moraux, and Olga Pakulyak (2025) “How Stable are Inflation Expectations in the Euro Area? Evidence from the Euro-Area Financial Markets,” Finance and Economics Discussion Series 2025-041, Federal Reserve Board.
- Gürkaynak, Refet S., Brian Sack, and Jonathan H. Wright (2010) “The TIPS Yield Curve and Inflation Compensation,” *American Economic Journal: Macroeconomics*, 2 (1), 70–92.
- Gürkaynak, Refet S., Brian Sack, and Eric T. Swanson (2005) “Do Actions Speak Louder Than Words? The Response of Asset Prices to Monetary Policy Actions and Statements,” *International Journal of Central Banking*, 1 (1).
- Hammoudeh, Shawkat and Juan C. Reboredo (2018) “Oil price dynamics and market-based inflation expectations,” *Energy Economics*, 75, 484–491.
- Hengge, Martina, Ugo Panizza, and Richard Varghese (2023) “Carbon Policy and Stock Returns: Signals from Financial Markets,” Working Paper 2023/013, International Monetary Fund.
- Hensel, Jannik, Giacomo Mangiante, and Luca Moretti (2024) “Carbon pricing and inflation expectations: Evidence from France,” *Journal of Monetary Economics*, 147, 103593.
- Hubert, Paul and Fabien Labondance (2018) “The Effect of ECB Forward Guidance on the Term Structure of Interest Rates,” *International Journal of Central Banking*, 14 (5), 193–222.
- Jezequel-Royer, Marie and Gregory Leveuge (2025) “Going Green: Will the R-Star Shine Brighter?”, SSRN Working Paper.
- Känzig, Diego R (2023) “The unequal economic consequences of carbon pricing,” Working Paper 31221, National Bureau of Economic Research.
- Konradt, Maximilian and Beatrice Weder di Mauro (2023) “Carbon Taxation and Greenflation: Evidence from Europe and Canada,” *Journal of the European Economic Association*, 21 (6), 2518–2546, [10.1093/jeea/jvad020](https://doi.org/10.1093/jeea/jvad020).
- Konradt, Maximilian, Thomas McGregor, and Frederik Toscani (2024) “Carbon Prices and Inflation in the Euro Area,” Working Paper 2024/031, International Monetary Fund, [10.5089/9798400267277.001](https://doi.org/10.5089/9798400267277.001).
- Kuttner, Kenneth N. (2001) “Monetary Policy Surprises and Interest Rates: Evidence from the Fed Funds Futures Market,” *Journal of Monetary Economics*, 47 (3), 523–544.
- Känzig, Diego and Maximilian Konradt (2024) “Climate Policy and the Economy: Evidence from Europe’s Carbon Pricing Initiatives,” *IMF Economic Review*, 72, 1081 – 1125, [10.1057/s41308-024-00256-9](https://doi.org/10.1057/s41308-024-00256-9).
- Känzig, Diego R. (2021) “The Macroeconomic Effects of Oil Supply News: Evidence from OPEC Announcements,” *American Economic Review*, 111 (4), 1092–1125, [10.1257/aer.20190964](https://doi.org/10.1257/aer.20190964).
- Mangiante, Giacomo (2026) “Carbon Pricing and Firms’ Expectations: Evidence from Italy,” *IMF Economic Review*, [10.1057/s41308-026-00301-9](https://doi.org/10.1057/s41308-026-00301-9).
- Mann, Catherine L. (2023) “Climate policy and monetary policy: interactions and implications,” <https://www.bankofengland.co.uk/speech/2023/november/catherine-l-mann-university-of-oxford-environmental-economics-seminar>, Oxford Environmental Economics Seminar.

- McKibbin, Warwick, Maximilian Konradt, and Beatrice Weder di Mauro (2022) *Climate Policies and Monetary Policies in the Euro Area*, Vol. 1, 200–238: European Central Bank, ECB Forum on Central Banking : 28-29 September 2021 : Conference Proceedings online; ECB Forum on Central Banking ; Conference date: 28-09-2021 Through 29-09-2021.
- Moessner, Richhild (2025) “Effects of carbon pricing on inflation,” *Climate Policy*, 25 (9), 1–14, [10.1080/14693062.2025.2467961](https://doi.org/10.1080/14693062.2025.2467961).
- Ortubai, Joxe, Rodrigo Piacentini, Agustín Serrador, and Juan F. Rubio-Ramírez (2025) “Unraveling the impact of a carbon price shock on macroeconomic variables: a narrative sign restrictions approach,” Working Paper25/04, BBVA Research.
- Palao, Fernando and Ángel Pardo (2021) “The inconvenience yield of carbon futures,” *Energy Economics*, 101, 105461, <https://doi.org/10.1016/j.eneco.2021.105461>.
- Patzelt, Paula and Ricardo Reis (2024) “Estimating the rise in expected inflation from higher energy prices,” Discussion Paper18907, CEPR.
- Schnabel, Isabel (2022) “A New Strategy for a Changing World,” Speech at the ECB and Its Watchers Conference, January, <https://www.ecb.europa.eu/press/key/date/2022/html/ecb.sp220108~0425a24eb7.en.html>, Remarks on inflation dynamics, energy prices, and implications for monetary policy.
- Semik, Sofia (2025) “Carbon Pricing and Monetary Policy in an Estimated Macro-Climate Model,” https://www.ecb.europa.eu/press/conferences/shared/pdf/20251006_monpolconf/Semik_paper.pdf.
- Svensson, Lars EO (1999) “Inflation targeting: some extensions,” *Scandinavian journal of Economics*, 101 (3), 337–361.
- Venditti, Fabrizio and Giovanni Veronese (2020) “Global financial markets and oil price shocks in real time,” Working Paper Series2472, European Central Bank.



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