INTERNATIONAL MONETARY FUND

Do Renewables Shield Inflation from Fossil Fuel-Price Fluctuations?

Laurent Millischer, Chenxu Fu, Ulrich Volz, John Beirne

WP/24/111

2024
MAY

WORKING PAPER

IMF Working Paper
Institute for Capacity Development

Do Renewables Shield Inflation from Fossil Fuel-Price Fluctuations?

Prepared by Laurent Millischer, Chenxu Fu, Ulrich Volz, John Beirne*

Authorized for distribution by Mercedes Garcia-Escribano
May 2024

ABSTRACT: This study investigates the relationship between the adoption of renewable energy and the sensitivity of inflation to changes in fossil energy prices across 69 countries over a 50-year period from 1973 to 2022. In the wake of recently increased oil and gas prices leading to a surge in inflation, the notion of a "divine coincidence" suggests that higher levels of renewable energy adoption, in addition to fighting climate change, could mitigate fossil fuel price-induced inflation volatility. Confirming the *divine coincidence hypothesis* could be an argument in favor of greening monetary policy. However, our empirical results are inconsistent with the hypothesis as we find no evidence that increased renewable energy adoption reduces the impact of fossil fuel price changes on energy inflation rates. This counter-intuitive result may be attributed to idiosyncratic national energy policies, potential threshold effects, or trade linkage spillovers. As the world continues transitioning towards a low-carbon economy, understanding the implications of this shift on inflation dynamics is crucial.

RECOMMENDED CITATION: Millischer, L., Fu, C., Volz, U., and Beirne, J. (2024). Do Renewables Shield Inflation from Fossil Fuel-Price Fluctuations? *IMF Working Paper WP/24/111*.

JEL Classification Numbers:	E31, E58, Q42, Q43, Q54
Keywords:	Inflation; Renewable Energy; Energy Prices; Oil Price; Monetary Policy
Author's email addresses:	lmillischer@imf.org

* The authors would like to thank Matthew Agarwala, Dimitri Zenghelis and other participants at a seminar at the University of Cambridge, Jesús Crespo and Oscar Fernandez, Tolga Tiryaki and participants at the ICD seminar, and participants at the research seminar of the Austrian National Bank for very helpful questions and suggestions Parts of the paper were written while Ulrich Volz visited the Asian Development Bank Institute (ADBI) in Tokyo.

WORKING PAPERS

Do Renewables Shield Inflation from Fossil Fuel-Price Fluctuations?

Prepared by Laurent Millischer, Chenxu Fu, Ulrich Volz, and John Beirne

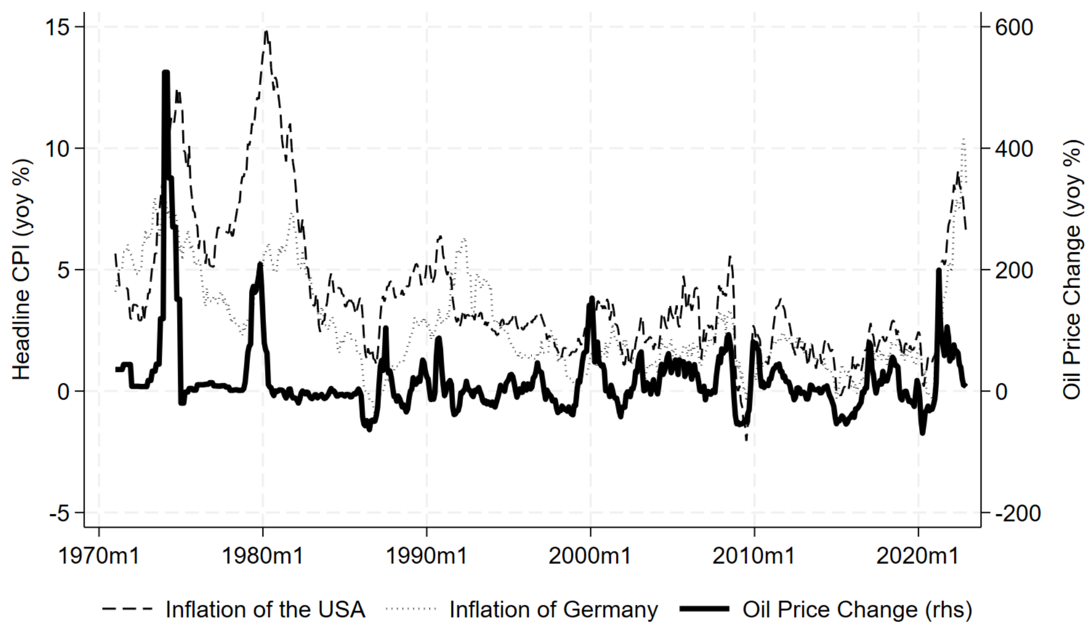
Contents

1 Introduction

After a prolonged period of low inflation across most of the world, inflation surged in 2021 and 2022. While there are various drivers of inflation including supply chain disruptions related to the COVID-19 pandemic and fiscal stimulus programs (Bernanke & Blanchard, 2023), the increase in oil and gas prices were a dominant factor. Schnabel (2022) notes that in February 2022 "energy accounted for more than 50% of headline inflation in the euro area, mainly reflecting the sharp increases in oil and gas prices".

This is not the first time that oil price increases cause spikes in inflation. As can be seen in Figure 1, all three episodes of high inflation (1973, 1979 and 2021) in the United States and Germany follow jumps in the oil price. Fluctuations in fossil fuel prices are a challenge for price stability.

Figure 1: Monthly series of year-on-year headline inflation (USA and Germany) and oil-price changes. Periods of high inflation (1973, 1979 and 2021) follow jumps in the oil price.



There is a rich literature examining the impact of oil price fluctuations on inflation. Their pass-through to consumer and producer price inflation (Chen, 2009; Clark & Terry, 2010; Gao et al., 2014; Castro & Jiménez-Rodríguez, 2017; Conflitti & Luciani, 2019; Wen et al., 2021; Baba & Lee, 2022) as well as inflation expectations (Wong, 2015, C. C. Binder, 2018, Kilian & Zhou, 2022, C. Binder & Makridis, 2022) is well documented. The effect of an oil price change depends on whether that change is driven by negative supply or positive demand shocks (Kilian, 2008; Kilian, 2009; Peersman & Van Robays, 2012; Baumeister & Peersman, 2013). Recently, Ha, Kose, Ohnsorge, & Yilmazkuday (2023) show that oil price shocks tend to contribute significantly more to inflation variation in advanced economies, countries with stronger global trade and financial linkages, commodity and net energy importers, countries without inflation-targeting and with pegged exchange rate regimes.

Fossil fuel have not only contributed to macroeconomic volatility. The burning of fossil fuels is also the major driver of climate change (Ritchie et al., 2023a). The Intergovernmental Panel on Climate Change (IPCC) – the United Nations body for assessing the science related to climate change – clearly states that humanity urgently needs to phase out fossil fuel use to limit global warming to levels that are compatible with human development (IPCC, 2022).

In light of the well-established sensitivity of inflation to changes in oil and gas prices (what Schnabel, 2022 calls "fossilflation"), it is reasonable to hypothesize that reducing the share of fossil fuels in an country's energy mix – by increasing the share of renewable and possibly nuclear energy – could mitigate the impact of oil and gas price changes on inflation. Indeed, the marginal costs of renewable electricity production are close to 0 (Hogan, 2022) and therefore not correlated with international fossil energy prices. Were this hypothesis confirmed, a higher share of renewable energy would act as a "shield" against inflation volatility induced by oil price shocks, particularly in cases of sudden surges in fossil fuel prices such as those observed in 1973, 1979, or 2021.

Indeed, policy makers and think-tanks have been arguing that the transition away from fossil fuels could support price stability while also fighting climate change (e.g. Heemskerk et al., 2022, Melodia & Karlsson, 2022, and Pous et al., 2022). Panetta (2022) calls that possible outcome a "divine coincidence".

While the *divine coincidence hypothesis* is widely discussed, we are not aware of published empirical research studying how renewable energy affects the sensitivity of inflation to changes in fossil fuel prices. Deka & Dube (2021) and Deka et al. (2022) study the interactions of renewable energy use, inflation and the exchange rate in Mexico and Brazil but do not discuss international fossil energy prices. Ha, Kose, Ohnsorge, & Yilmazkuday (2023) do note include renewables in their study and Akan (2023) investigates how renewables affect the impact of inflation on emissions rather than the impact of fossil fuel prices on inflation.

Our study aims to fill that gap. Using a panel data set spanning 50 years (from 1973 to 2022, including all three price spikes: 1973, 1979, 2021/2) and covering 75 countries, we regress energy inflation rates – the rate of change of the energy consumer price index – on a set of macroeconomic variables as well as on changes in international fossil energy prices. By interacting the change in fossil prices with the share of renewable energy, we can estimate whether an increase of fossil prices is associated with a lower increase in energy inflation in countries with a higher share of renewable energy.

We do not find this to be true as the empirical results are inconsistent with the *divine coincidence hypothesis*. That finding is robust to sub-periods, country sub-samples and alternative metrics of inflation, fossil prices and renewable energy.

This result seems counter-intuitive at first. Surely when countries' reliance on fossil fuels decreases, so should the sensitivity of their inflation on fossil fuel prices. Three reasons could explain why the regression results are inconsistent with the dampening effect of renewable energy on the fossil fuel price-inflation relationship in this study. First, for lack of a structured dataset, we do not account for countries' energy policies beyond fossil-fuel subsidies, in particular price controls. Second, there might be threshold effects, in particular for electricity prices, where in a number of countries the marginal producer (often a coal or gas-fired power plant) sets the wholesale price for the entire market. Third, trade linkage spillovers could imply that the *divine coincidence hypothesis* does not hold at the country level.

While the world progresses in the transition to a low-carbon economy and weans itself off fossil fuels, more work is required to understand the impact the transition will have on inflation. Should the *divine coincidence hypothesis* be confirmed in the future and renewable energy expansion have a positive effect both on climate change mitigation and on price stability, this would have a bearing on the conduct of monetary policy and the greening of the monetary policy toolkit.

The remainder of the paper is structured as follows. Section 2 presents a simple model of energy prices and inflation. Section 3 describes the data sources, aggregation process and the sample. Section 4 present the empirical strategy and results. Finally, Section 5 discusses the results and concludes.

2 A simple model of energy prices and inflation

Inflation, the yearly rate of change of the consumer price index (or a sub-index thereof), is computed as follows:[1]

$$\pi = \sum_i w_i \frac{p_i^t - p_i^{t-1}}{p_i^{t-1}} = \sum_i w_i \pi_i \tag{1}$$

where π is the consumer price index inflation, w_i is the weight of item i in the underlying consumption basket, p_i^t (p_i^{t-1}) is the price of item i in year t ($t-1$) and $\pi_i = (p_i^t - p_i^{t-1})/p_i^{t-1}$ is the price increase of item i over the span of a year.

In order to compare the impact of a fossil energy price change on energy inflation of two countries labeled RE (with a high share of Renewable energy) and F (for fossil, i.e. having low share of renewable energy), one can write the difference in inflation impacts as:

$$\Delta\pi^{RE} - \Delta\pi^{F} = \sum_i (w_i^{RE} \Delta\pi_i^{RE} - w_i^{F} \Delta\pi_i^{F}) \tag{2}$$

where $\Delta\pi$ is the change in energy inflation induced by the change in international fossil energy prices. Equation (2) can be re-written as:

$$\Delta\pi^{RE} - \Delta\pi^{F} = \sum_i (\underbrace{w_i^{RE} \left[\Delta\pi_i^{RE} - \Delta\pi_i^{F}\right]}_{\text{[P] price effect}} + \underbrace{\left[w_i^{RE} - w_i^{F}\right] \Delta\pi_i^{F}}_{\text{[W] weight effect}}) \tag{3}$$

Equation (3) shows that a lower inflation impact in the high-renewables country RE could stem from two effects, a price and a weight effect.

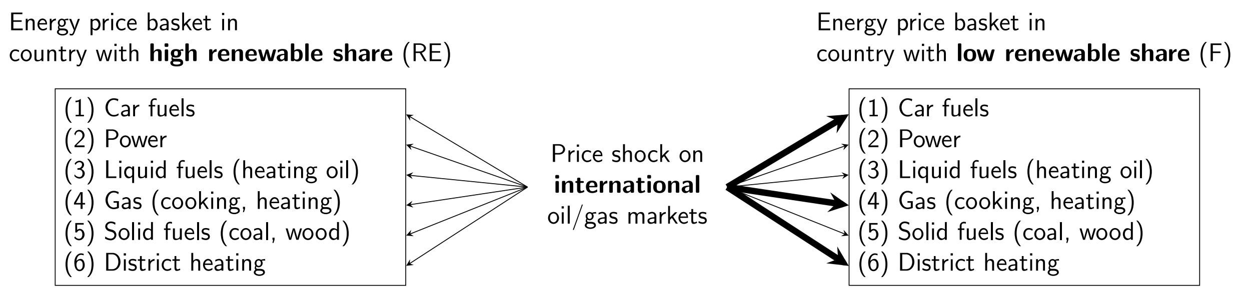
Price channel

Assuming all items have equal weight in the consumption baskets of the two countries, term [W] in equation (3) would be equal to zero (as $w_i^{RE} = w_i^F$) and $\Delta\pi^{RE}$ would be lower than $\Delta\pi^F$ if and only if the price impact on the dominant items in the consumption basket were lower in RE (in mathematical terms: $\sum_i w_i \left[\Delta\pi_i^{RE} - \Delta\pi_i^{F}\right] < 0$).

Figure 2 illustrates this possible effect. When considering the impact of a fossil fuel price change on different items of the energy consumption basket, one could expect the impact on some items to be lower in countries with a high share of renewable energies. For instance, in a country with a high share of biofuels and biogas, the impact car fuel and gas prices, items (1) and (4) on the figure, could be expected to be lower than in a country in which most of the car fuels and gas come from fossil sources. Similarly, if district heating, item (6), is powered by geothermal sources rather than fossil gas, the impact of a fossil fuel price increase would expected to be lower.

[1] In most countries, when looking at December to December inflation rates, the weights of individual items in the consumption basked are not updated and equation (1) holds.

Figure 2: Illustration of the **hypothetical price channel**. In both countries RE and F the weights of items in the energy consumption basket are assumed to be identical. However, an increase in international fossil energy prices would impact the price of car fuels, gas and district heating more in the country with a low renewable energy share. This results in an overall higher impact on country F.

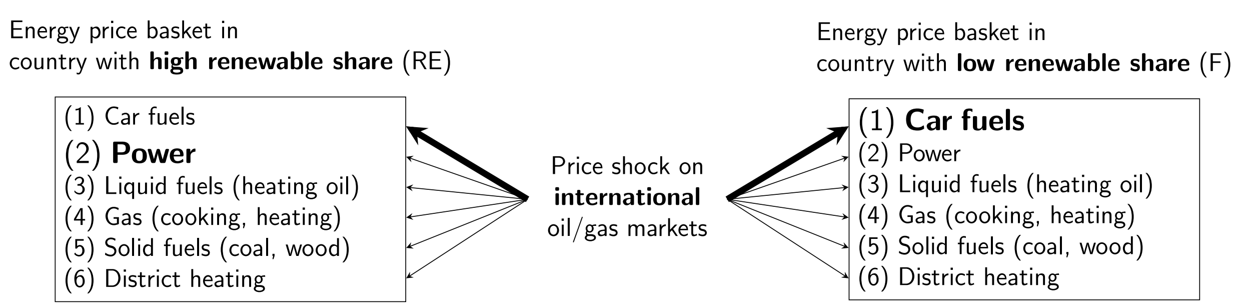


Weight channel

On the other hand, assuming all items saw identical inflation impacts in both countries, term [P] in equation (3) would be equal to zero (as $\Delta\pi_i^{RE} = \Delta\pi_i^F$) and $\Delta\pi^{RE}$ would be lower than $\Delta\pi^F$ if the highest-inflation items had lower weights in the consumption basket of country R (in mathematical terms: $\sum_i \left[w_i^{RE} - w_i^F\right] \Delta\pi_i < 0$).

This effect can be illustrated with Figure 3. Assuming the impact of international fossil energy prices on car fuels to be much higher than on other items in the energy consumption basket, then a country with a dominant electric vehicle fleet and a decarbonized power sector would experience a lower energy inflation in the face of a price change on international energy markets than a country whose vehicles overwhelmingly run on fossil fuels. This would not be driven by a lower inflation of any of the items but by a higher weight of the most affect item (1) in the energy consumption basket.

Figure 3: Illustration of the **hypothetical weight channel**. An increase in international fossil energy prices is assumed to have the same effect on each item in the energy consumption basked in both countries: a high impact on car fuels and a lower impact on all other items. However, the weight of car fuels is assumed to be much higher in the country F, whereas the weight of power is much higher in country RE. This results in an overall higher impact on country F.



Influencing factors

A number of factors are likely to influence the relative importance of these two channels. A country's trade openness, its net energy imports, energy market design, energy subsidies and price controls, and its economic weight will impact the price channel, i.e. the degree to which individual items in the energy consumption basket are impacted by changes in international fossil energy prices. The sources of renewable energy (whether electricity, bio-fuels or biomass used in heating) will both affect the weight of individual items and the degree to which their retail prices fluctuate with international markets.

The remainder of the paper will focus on empirically investigating the *divine coincidence hypothesis*, that is testing whether a higher shares of renewables in the energy mix of a country is associated with a smaller co-movement of international oil and gas prices and domestic energy inflation.

3 Data

This section describes the data set used in the empirical study. Section 3.1 presents the data sources, Section 3.2 discusses how we compute the change of fossil-fuel prices for each country and Section 3.3 presents stylized facts.

3.1 Data Sources

Inflation Our inflation measures are drawn from Ha, Kose, & Ohnsorge (2023) that comprehensively documents various types of inflation measures for 37 advanced economies (AEs) and 159 emerging markets and developing economies (EMDEs) for 1970-2022. The databse contains the standard consumper price index (CPI) inflation along with the the energy CPI (ECPI) and producer price index (PPI) inflation. In this analysis we will focus on ECPI and analyse how it is affected by changes in international fossil energy prices.[2] Ha, Kose, & Ohnsorge (2023) follow the OECD definition of energy CPI inflation and draw data from multiple sources.[3]

Renewable Energy Renewable energy share is the main variable of our interest as it could potentially shield a country's inflation from international energy price fluctuations. Ritchie et al. (2023b) combines data from major energy-related databases such as British Petroleum (BP), International Energy Agency (IEA) and others. Renewable energy (defined as solar, wind and hydroelectic energy) is measured either as a share in a country's total primary energy consumption or as a share in a country's electricity production. Furthermore, we also use the share of nuclear energy from this database to test if the *divine coincidence hypothesis* might hold when considering low-carbon energy sources (the sum of renewables and nuclear).

Energy Price International energy prices are sourced from the World Bank Commodity Price Database (the "Pink Sheet").[4] This database contains USD-denominated price index of crude oil, several natual

[2] Annual energy inflation rate is used wherever available. If not, it is complemented by the annual energy inflation rate computed from quarterly inflation.

[3] OECD.Stat, UNdata, Consumer Price Index, Eurostat, and FRED. Country-specific sources provide additional data for up to 52 countries.

[4] https://www.worldbank.org/en/research/commodity-markets

gas hubs and coal. Exchange rates from the Bank of International Settlement (BIS)[5] are applied to convert the international fossil energy prices into local currency for each country.

Energy Imports Another critical component in our analysis is whether a country is a net importer or exporter of energy from the international market. To calculate the share of the renewable and fossil as of total energy import, data is drawn from the World Energy Balance by the IEA. Additionally, net energy import as percentage of energy use is taken from the World Bank to categorize each country into either a high energy importer, low importer or exporter.[6]

Fossil Fuel Subsidies Fuel subsidy data is taken from the Fossil Fuel Subsidy Tracker that is jointly published by the OECD and International Institute for Sustainable Development (IISD). This data is widely available for 185 countries from 2010 to 2021. It gathered data from three sources, namely, the OECD Inventory of Support Measures for Fossil Fuels, the IEA Energy subsidies and the IMF Fossil Fuel Subsidies databases. Specifically, this data source picks up IMF "explicit" consumption subsidy estimates only. Eventually, total subsidy as a percentage of GDP is computed for each country and used as a proxy for price rigidity policy in the analysis later.

3.2 Change in International Fossil Energy Prices

As discussed in Section 1, international fossil energy price changes are strongly correlated with domestic (energy) inflation. Nonetheless, international fossil energy price "seen" by country differs from the international market due to factors such as exchange rate, energy imports, or domestic energy mix. We therefore construct a price index for countries in our sample that captures above factors as detailed in equation (4). Specifically, we compute this country-specific international fossil energy price index by weighting the oil and gas prices according to their relative share in that country's consumption and – for gas prices – by considering the geographically closest available gas exchange price. That index is then converted to local currency. For countries without the energy mix data, the international average share is used.

$$F_{i,t}^{LC} = \left[s_{i,t}^{oil} O_t^{USD} + (1 - s_{i,t}^{oil}) G_{i,t}^{USD} \right] ER_{i,t}^{USD-LC} \quad (4)$$

where $F_{i,t}^{LC}$ is the local-currency fossil energy price index for country i in year t, s^{oil} and $(1-s^{oil})$ are the relative shares of oil and gas in the oil-and-gas consumption of that country, O_t^{USD} is the USD oil price index in year t and $G_{i,t}^{USD}$ the USD gas price index in year t, where i indexes the geographically closest gas hub for country i.[7] Finally, $ER_{i,t}^{USD-LC}$ is the USD exchange rate index of country i's currency in year t.

As shown in Figure 4, the country-specific fossil energy price changes broadly follow the dynamics of the international fossil energy price, although there is a larger distributions across countries due to weighting and exchange rate fluctuations.[8]

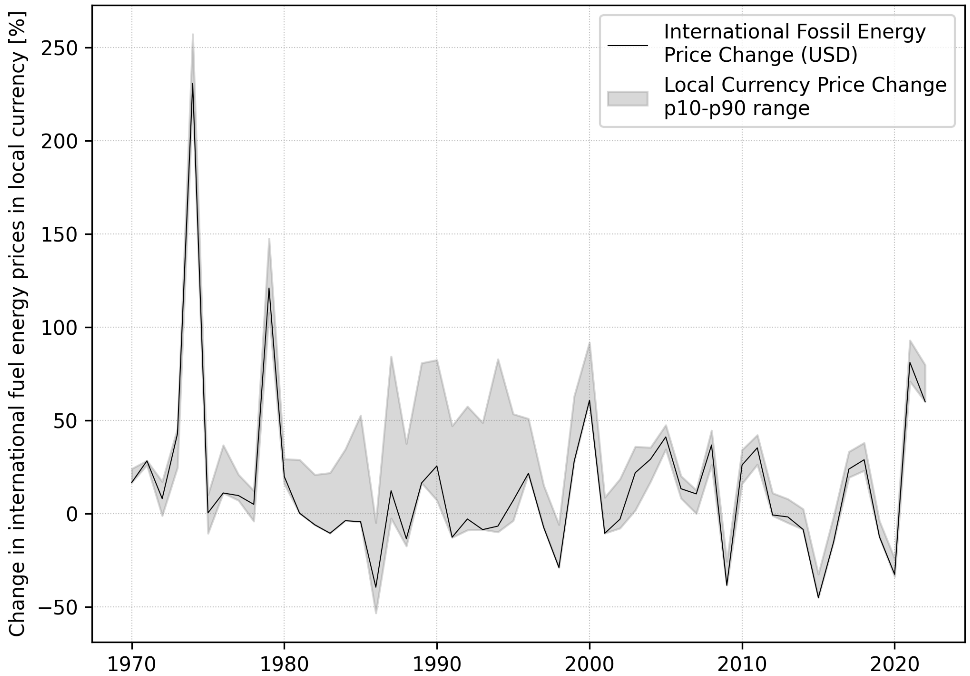
[5] https://www.bis.org/statistics/full_xru_csv.zip

[6] Net energy import data was discontinued in 2015, so we carry forward the latest observation.

[7] Three gas hub prices, from the Henry Hub in the US, the Dutch TTF in the EU and the Tokyo hub are available. We made this adjustment to specifically account for the divergence in gas prices in 2021/22.

[8] The country-specific fossil energy price change is the year-on-year percent change of the local-currency fossil energy index defined in equation (4).

Figure 4: Country-specific and international year-on-year fossil energy price change.



3.3 Stylized Facts

Table 1 summarizes the data statistics of main variables used in the analysis across countries and time horizon. Three variables (inflation, fossil energy price changes, energy imports) exhibit very broad distributions with big upward or downward outlier observations, reflecting periods of hyperinflation and/or dramatic currency devaluation. These extreme values will have to be appropriately taken care of in the empirical analysis. The variables RE and LC in consumption respectively denote “renewable energy” and “low-carbon” (i.e. the sum of renewables and nuclear) in total domestic energy consumption.

Table 2 shows the correlations among the main variables. Beyond the unsurprising high correlation of headline and energy inflation on one hand and RE and LC shares in energy consumption, it should be noted that fossil subsidies tend to be higher for countries with a low share of renewables and low-carbon energy (-27% and -30% correlation respectively) and higher for countries that have lower energy imports (-25% correlation).

Table 1: Summary statistics of the variables used in the regression (all units are [%]).

	mean	sd	min	p25	p50	p75	max	n
Headline inflation	44.8	837.7	-72.7	2.3	5.6	11.8	65,374.1	9,220
Energy inflation	38.6	1,209.4	-98.7	1.3	4.6	11.3	94,802.4	6,744
Energy price change	161.0	8,324.0	-99.9	-3.3	7.0	28.1	747,182.0	10,466
RE in consumption	11.0	12.8	0.0	2.1	6.1	15.9	74.3	3,382
RE in electricity	30.7	32.3	0.0	2.1	17.5	54.5	100.0	5,480
LC in consumption	15.0	14.9	0.0	3.6	10.8	21.3	74.3	3,382
Net energy import	-75.2	559.6	-17,632.8	-23.3	23.0	60.6	100.0	5,997
Output gap	0.3	37.8	-1,270.0	-4.1	-0.1	3.8	2,208.5	9,711
Fossil subsidy	1.4	2.9	0.0	0.0	0.3	1.3	31.7	2,109

Table 2: Cross-correlation table of the variables used in the regression.

	1	2	3	4	5	6	7	8	9
1 Headline inflation	1.00								
2 Energy inflation	0.96	1.00							
3 Energy price change	0.79	0.89	1.00						
4 RE in consumption	0.03	0.02	0.02	1.00					
5 RE in electricity	0.02	0.01	0.01	0.93	1.00				
6 LC in consumption	0.01	0.01	0.01	0.87	0.72	1.00			
7 Net energy import	0.01	0.01	-0.04	-0.06	-0.04	0.01	1.00		
8 Output gap	-0.03	-0.02	-0.01	-0.05	-0.06	-0.05	-0.04	1.00	
9 Fossil subsidy	0.02	0.03	0.02	-0.27	-0.14	-0.30	-0.25	0.03	1.00

Before diving into the impact of renewable energy and energy imports, we first confirm that fossil fuels make up almost all the energy import for countries. In our sample, Figure 5 shows that all countries import at least 97% fossil of total energy import in 1980 whereas renewable energy accounted for almost none. Although fossil import share decreased over four decades, it still accounts for over 92% of total energy imports in 75% of countries in 2020. In comparison, renewable energy imports are below 2% in most countries despite an increase in the past decades.

Figure 5: Shares of fossil (top) and renewable energy (bottom) in total energy imports.

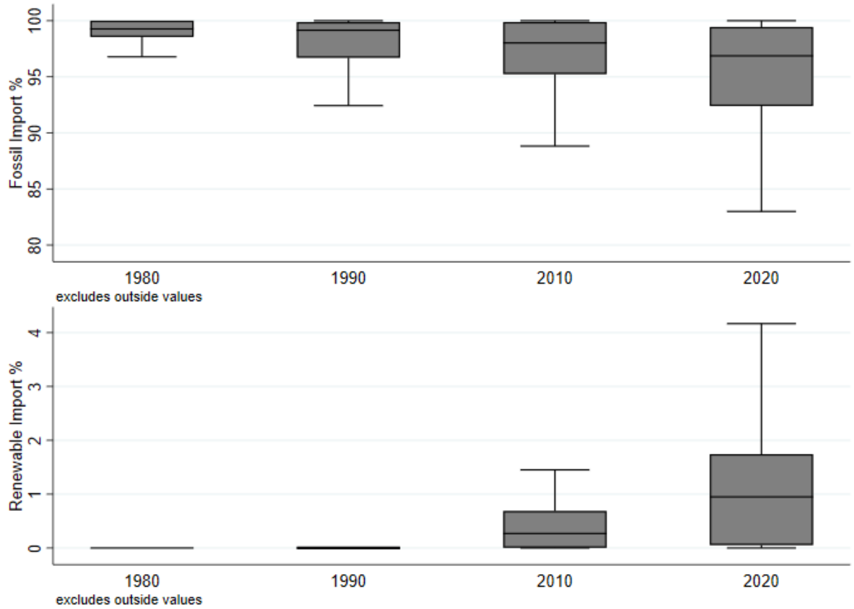


Figure 6 shows the energy inflation across countries since 1970. There are two clear hikes during the oil crises in the 1970s and most recently, the energy price shock after 2021.

Figure 6: Distribution of countries' year-on-year energy inflation over time.

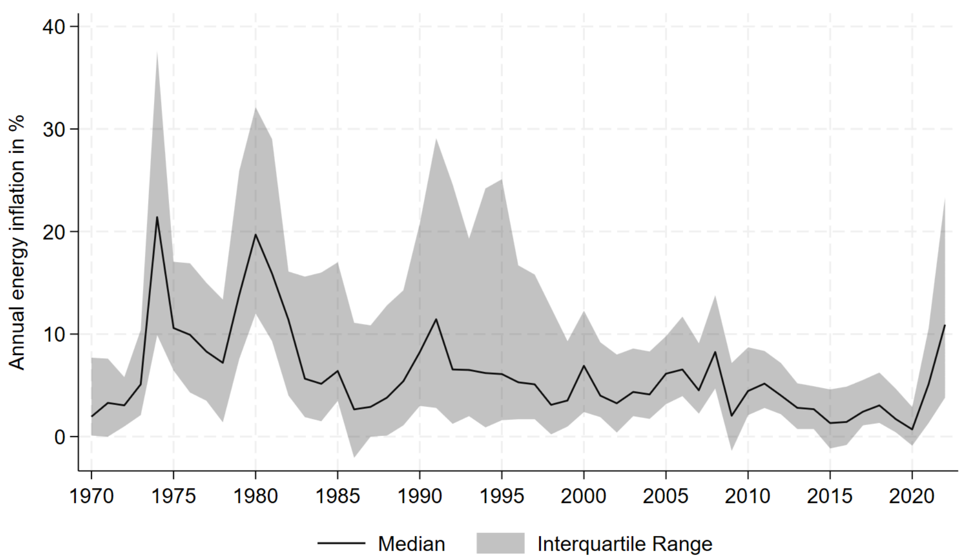
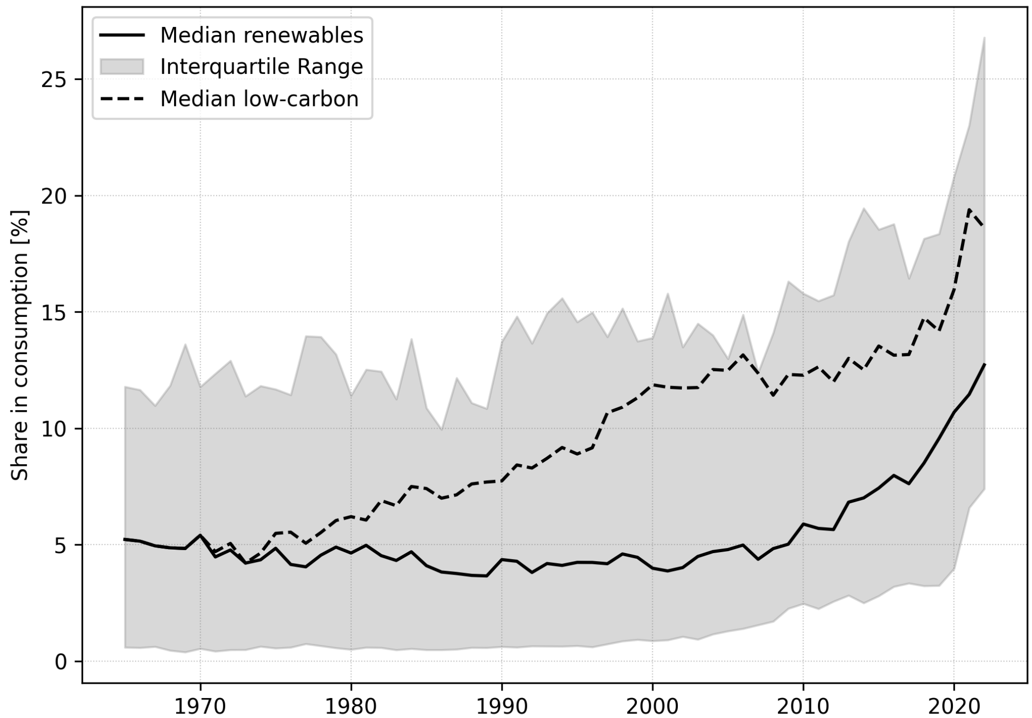


Figure 7 presents the distribution of the share of renewable energy in countries' energy consumption over time. While the median level hovered just below 5% from 1970 to 2005,it has started gradually increasing since then to above 10%.

Finally, as a counter-example, Figure 8 shows the co-movement of energy inflation and change in fossil energy prices of Denmark, a country in which the share of renewables rose steadily from close to

Figure 7: Distribution of the share of renewables in countries' energy consumption over time.



0% in 1990 to over 40% in 2022. When looking at the scatter plot of the two variables (Figure 9), it appears that recent increases in fossil energy prices (when the share of renewables was higher) are not associated with lower energy inflation than past increases. This is an indication that a higher share of renewables in the case of Denmark might not shield energy inflation from changes in international fossil energy prices.

Figure 8: Energy inflation, change in fossil energy prices and the share of renewables in Denmark.

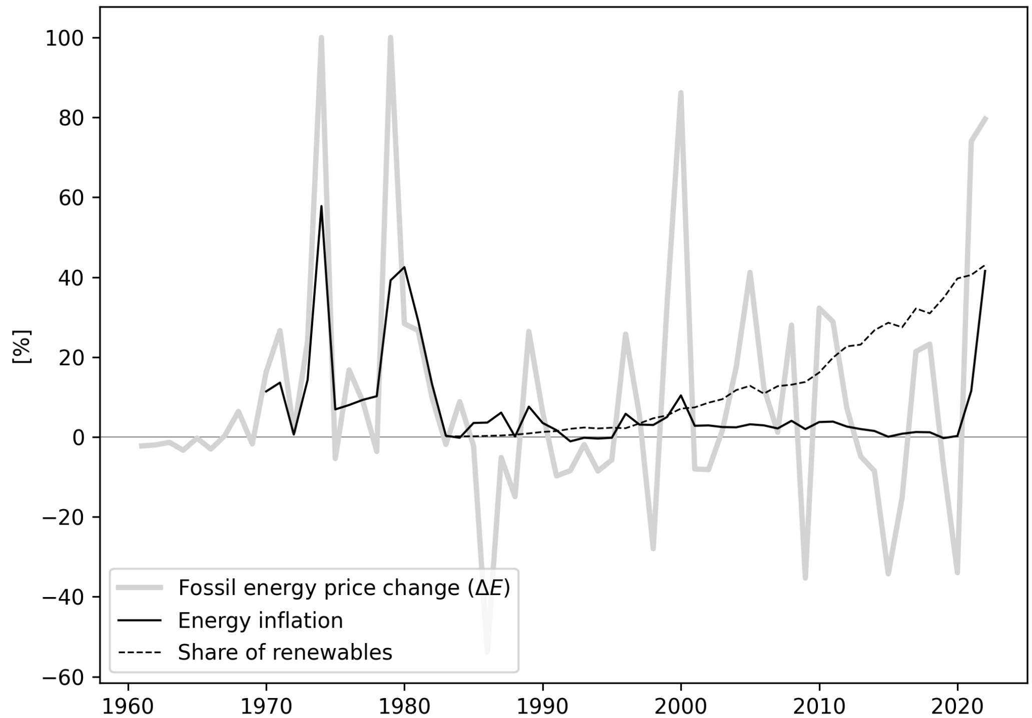
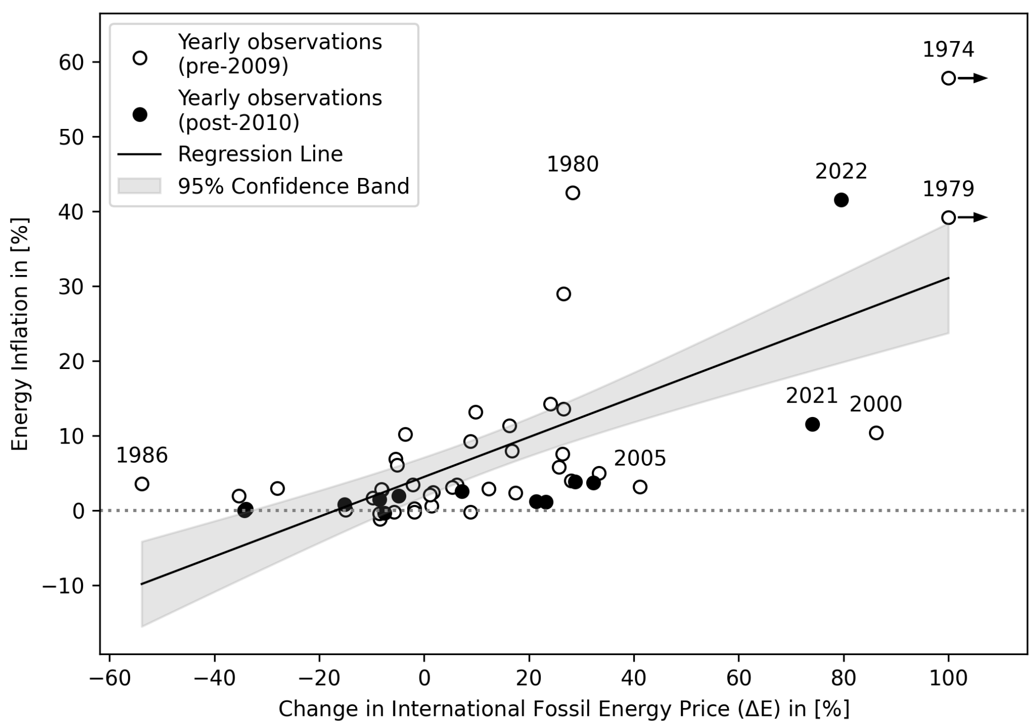


Figure 9: Linear regression of energy inflation on the change in fossil energy prices for Denmark.



4 Empirical Results

4.1 Specification

In order to capture the co-movements of international energy prices and energy inflation and see whether these are modulated by a country's fraction of renewable energy, we estimate the following OLS panel regression with year-on-year data, following a standard New Keynesian Phillips Curve approach (Galí & Monacelli, 2005) including energy prices (similar to Blanchard & Galí, 2007):

$$\pi^e_{i,t} = \beta^E \Delta E_{i,t} + \beta^X X_{i,t} + \beta^{E \cdot X} \Delta E_{i,t} \cdot X_{i,t} + \beta^g g_{i,t} + \beta^{\mathbb{E}\pi} \mathbb{E}\pi_{i,t} + C_i + \epsilon_{i,t} \tag{5}$$

where $\pi^e_{i,t}$ is the energy inflation[9] of country i in year t, $\Delta E_{i,t}$ is the percentage change in international fossil energy prices expressed in local currency for country i in year t,[10] $X_{i,t}$ is the modulating variable, e.g. the share of renewables in country i's energy consumption in year t. Concerning macroeconomic controls, $g_{i,t}$ is the output gap[11], $\mathbb{E}\pi_{i,t}$ the expected inflation[12] of country i in year t, C_i are country fixed effects, and $\epsilon_{i,t}$ is the error term. In order to avoid the regression results to be driven by those observations corresponding to hyper-inflation or extreme devaluation (see Table 1 showing the extreme outliers), both $\pi^e_{i,t}$ and $\Delta E_{i,t}$ have been winsorized at 100%, corresponding to the 95th percentile. The main results are robust to winsorizing at 150% as well as dropping outlier observations.

4.2 Results

Table 3 presents the regression results. Column (1) shows the results of the simplest regression obtained when leaving out the modulating variable in equation (5). The parameter in front of $\Delta E_{i,t}$ is highly significant and positive: an increase in local-currency fossil energy prices of 1% is associated with an increase of energy inflation of 0.114% in the same year. The parameters of the macro controls (output gap and expected inflation) are significant and exhibit the economically intuitive signs. Indeed, a high output gap is associated with higher energy inflation as are higher inflation expectations.

Column (2) presents the results of the regression when using the share of renewable energy (RE) in total energy consumption as the modulating variable $X_{i,t}$. The parameter in front of $\Delta E_{i,t}$ is still highly significant and positive,[13] but the parameters in front of the renewable share (X) and the interaction term of $\Delta E_{i,t}$ and the renewable share are not statistically significantly different from 0. A higher share of renewables in total energy consumption of a country is therefore not associated with a lower energy inflation increase in the face of an increase in international energy prices. This result is inconsistent with the *divine coincidence hypothesis*.

Column (3) in Table 3 presents the results of the regression using the fraction of low-carbon energy (LC) in the total energy consumption as the modulating variable $X_{i,t}$ and the results echo those of

[9] The growth rate of the consumption basket of energy products as described in Section 3.

[10] $\Delta E_{i,t}$ is the yearly percentage change of the local-currency fossil-fuel price index which is described in Section 3.2.

[11] Computed as the percentage gap of real GDP to its Hodrick-Prescott filtered trend. Controlling for the output gap allows for a better identification in the case that both countries' energy inflation and international fossil fuel prices are driven by a global deman shock.

[12] The expected inflation is proxied by the average headline inflation of years $t-1$, $t-2$ and $t-3$.

[13] An increase in local-currency fossil energy prices of 1% is associated with an increase of energy inflation of 0.121% in the same year.

Table 3: Results of the regression defined in equation (5)

	(1)	(2) RE	(3) LC	(4) IMP	(5) SUB
ΔE (β^E)	0.114***	0.121***	0.117***	0.118***	0.123***
	(0.009)	(0.018)	(0.019)	(0.010)	(0.012)
X (β^X)		0.109	-0.019	0.006	0.132
		(0.068)	(0.056)	(0.022)	(0.118)
$\Delta E \times$ X ($\beta^{E \cdot X}$)		0.001	0.001	0.000*	-0.014***
		(0.001)	(0.001)	(0.000)	(0.003)
Output gap (β^g)	0.088*	0.133	0.125	0.088	0.084
	(0.035)	(0.067)	(0.067)	(0.046)	(0.047)
Inflation expectation ($\beta^{\mathbb{E}\pi}$)	0.608***	0.689***	0.684***	0.598***	0.461*
	(0.052)	(0.058)	(0.058)	(0.054)	(0.217)
Country FE	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty
R^2	0.49	0.62	0.62	0.51	0.45
Country-Year	5,911	2,472	2,472	4,705	1,424
Countries	170	69	69	128	151
Countries: AE	35	31	31	34	32
Countries: EM	86	35	35	67	75
Countries: LIC	49	3	3	27	44
Start	1973	1973	1973	1973	2010
End	2022	2022	2022	2022	2022

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

column (2). Low-carbon energy is defined here as the sum of renewable and nuclear energy. We run this regression to test a different version of the *divine coincidence hypothesis*. Indeed it could be envisaged that countries can decouple their energy inflation from fluctuations of international fossil energy prices by increasing the share of non-fossil or low-carbon energy sources (including renewables and nuclear). Empirically however, a higher consumption of low-carbon energy is not associated with a higher or lower energy inflation in the face of an increase in international energy prices – the relevant parameter ($\beta^{E \cdot X}$) is found not to be significantly different from 0.

Column (4) shows the regression results obtained when using net energy imports[14] as the modulating variable $X_{i,t}$. The relevant parameter ($\beta^{E \cdot X} = 0.000$) exhibits weak statistical significance but no

[14]Net energy imports (defined as imports minus exports as a fraction of total domestic energy consumption) can be negative when a country exports more energy than it imports. As some countries export a multiple of

economic significance. The level of energy imports does not meaningfully modulate the co-movement of energy prices and energy inflation.

Finally, column (5) in Table 3 presents the result of the regression when using the fossil fuel subsidies as a share of GDP as the modulating variable. The parameter in front of ΔE is significant as for the other variables. However, for the first time, so too is the interaction term $\Delta E \cdot X$. Unsurprisingly, higher fossil fuel subsidies are associated with a lower impact on energy inflation of an increase in international fossil energy prices.

Introducing lags

When international fossil energy prices rise, the price of retail energy products[15] does not rise immediately. Indeed, both wholesale and retail contracts often lock in prices over some period and readjust at set dates. The impact of an increase in international prices therefore takes time to "feed through" to energy inflation. In order to account for this mechanism, we have introduced lags of the energy-price change in the regression as shown in equation (6).

$$\pi^e_{i,t} = \beta^X X_{i,t} + \sum_{k=0}^{k=N} \left[\beta^E_k \Delta E_{i,t-k} + \beta^{E \cdot X}_k \Delta E_{i,t-k} \cdot X_{i,t} \right] + ... \tag{6}$$

where $\Delta E_{i,t-k}$ is the kth lagged change in international energy prices, which is also interacted with the modulating variable $X_{i,t}$ (e.g. the share of renewables or low-carbon sources in final energy consumption). The same macro controls as in equation (5) were used.

Table 4 presents the results. Column (1) shows the results of the simple regression without modulating variable. The parameter in front of ΔE and the two lags $L.\Delta E$ and $L2.\Delta E$ are highly significant and positive: an increase in local-currency fossil energy prices of 1% is associated with an increase of energy inflation of 0.109% in the same year, 0.073% in the next year and 0.026% in the year after that. The third lag is no longer significant and was hence not included in the regression. The parameters of the macro controls (output gap and expected inflation) are significant and exhibit the economically intuitive signs.

their domestic consumption, we winsorized the variable at -100%. The result still holds when dropping the high values instead of winsorizing.

[15] The energy consumption basket typically includes transportation fuels, electricity, gas (for cooking and heating), solid fuels (such as wood and coal), liquid fuels (heating oil) and heat (such as district heating).

Table 4: Result of the regression including lags defined in equation (6)

	(1)	(2) RE	(3) LC	(4) IMP	(5) SUB
ΔE (β^E)	0.109***	0.112***	0.110***	0.113***	0.105***
	(0.009)	(0.015)	(0.016)	(0.010)	(0.010)
L.ΔE (β_1^E)	0.073***	0.089***	0.092***	0.074***	0.079***
	(0.006)	(0.013)	(0.014)	(0.007)	(0.012)
L2.ΔE (β_2^E)	0.026***	0.053***	0.058***	0.028***	-0.001
	(0.005)	(0.013)	(0.013)	(0.007)	(0.006)
X (β^X)		0.152*	0.058	-0.003	0.027
		(0.069)	(0.059)	(0.023)	(0.169)
$\Delta E \times$ X ($\beta^{E \cdot X}$)		0.001	0.001	0.000*	-0.011***
		(0.001)	(0.001)	(0.000)	(0.003)
L.$\Delta E \times$ X ($\beta_1^{E \cdot X}$)		-0.000	-0.000	0.000	-0.007**
		(0.001)	(0.000)	(0.000)	(0.002)
L2.$\Delta E \times$ X ($\beta_2^{E \cdot X}$)		-0.002**	-0.002***	-0.000	0.001
		(0.001)	(0.001)	(0.000)	(0.002)
Output gap (β^g)	0.072*	0.110	0.102	0.064	0.058
	(0.036)	(0.073)	(0.072)	(0.047)	(0.044)
Inflation expectation ($\beta^{\mathbb{E}\pi}$)	0.541***	0.608***	0.602***	0.531***	0.443*
	(0.054)	(0.058)	(0.058)	(0.055)	(0.200)
Country FE	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty
R^2	0.51	0.63	0.63	0.53	0.49
Country-Year	5,894	2,460	2,460	4,688	1,424
Countries	170	69	69	128	151
Countries: AE	35	31	31	34	32
Countries: EM	86	35	35	67	75
Countries: LIC	49	3	3	27	44
Start	1973	1973	1973	1973	2010
End	2022	2022	2022	2022	2022

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Column (2) presents the results when introducing the share of renewables (RE) in total energy consumption as the modulating variable. The parameter β^X is weakly significant and positive showing that in this regression setting countries with higher shares of renewables tend to have higher energy inflation. This could be linked to a number of factors however – in this paper we do not aim to explain levels of energy inflation (for which the number of controls would have to be much higher) but rather the co-movement of energy inflation and fossil energy prices. The first two interaction terms, which capture this co-movement,[16] are not significant, meaning that a higher share of renewables in the energy mix is not associated with a lower fossil energy-induced increase in energy inflation. This is true in the year of the fossil energy price increase as well as in the subsequent year. The two-lag interaction term $\Delta E \cdot X$ is statistically significant but exhibits weak economic significance. Indeed, while a 1% increase in international fossil energy prices in a given year would be associated with a cumulative increase of retail energy prices of 0.254% over a three year horizon,[17] a country with, all else equal, a 10% higher share in renewables – a feat which takes most countries decades to implement – would see its retail energy prices increase by 0.234% over the same three-year period,[18] hardly a significant difference, economically.

Column (3) shows the regression outcome when using the share of low-carbon energy in total energy consumption as modulating variable. The results are very close to those of the renewable energy consumption[19] with the contemporaneous and one-lag interaction terms not significant. The two-year lag interaction term is statistically but not economically significant. In column (4) we show the results when using net imports as the modulating variable. Only the contemporaneous interaction term is weakly statistically significant but with no economic significance ($\beta^{\Delta E \cdot X} = 0.000$). In column (5), similarly to the regression with no lags, fossil fuel subsidies are found to be associated with a lower co-movement of international fossil energy prices and domestic energy inflation, both in the year of the fossil energy price increase and in the subsequent year.

To summarize, even when considering lags of fossil energy prices in order to account for the slow feed-through from international wholesale to domestic retail prices, our empirically results are inconsistent with the *divine coincidence hypothesis*. Higher shares of renewables or low-carbon energy sources are not associated with a lower fossil-fuel induced inflation volatility.

Two modulating variables

Finally, we wanted to study whether the *divine coincidence hypothesis* could be empirically identified when controlling for other effects. Indeed, it could be possible that a higher consumption of renewable energy was associated with a weaker co-movement of energy inflation and international energy prices *at any given level of net energy imports*, for instance. We therefore introduce two modulating variables as described in equation (7) below.[20]

$$\pi^e_{i,t} = \beta^E \Delta E_{i,t} + \beta^X X_{i,t} + \beta^{E \cdot X} \Delta E_{i,t} \cdot X_{i,t} + \beta^Y Y_{i,t} + \beta^{E \cdot Y} \Delta E_{i,t} \cdot Y_{i,t} + ... \tag{7}$$

where X and Y are the two modulating variables. These could be the share of renewables and net energy imports respectively, but we do study a number of combinations.

[16] $\Delta E \cdot X$, $L.\Delta E \cdot X$

[17] This is approximated by the sum of parameters for ΔE, $L.\Delta E$ and $L2.\Delta E$: $0.112 + 0.089 + 0.053 = 0.254$

[18] That is because the parameter for $L2.\Delta E \cdot LC$ is -0.002

[19] This is not surprising as the two variables are strongly correlated.

[20] The same macro controls as in equation (5) were used.

Table 5 presents the results of this regression, with the first modulating variable X being the share of renewables (RE) in columns (1) to (3) and the share of low-carbon energy in columns (4) to (6). Three different variables have been chosen for the second modulating variable Y: net imports (IMP) to distinguish fossil-fuel producing countries from importers, fossil fuel subsidies (SUB) to test whether the *divine coincidence hypothesis* holds, e.g. between countries that do not subsidies fossil fuels, and GDP per capita (GDP) to account for the fact that the co-movement of energy inflation and international fossil energy might depend on the level of economic development. We focus on the sign, amplitude and significance of the parameters in front of the terms $\Delta E \cdot X$, $L.\Delta E \cdot X$ and $L2.\Delta E \cdot X$: should they be negative and statistically and economically significant this would corroborate the *divine coincidence hypothesis*.

Table 5: Result of the regression with lags and two modulating variables defined in equation (7)

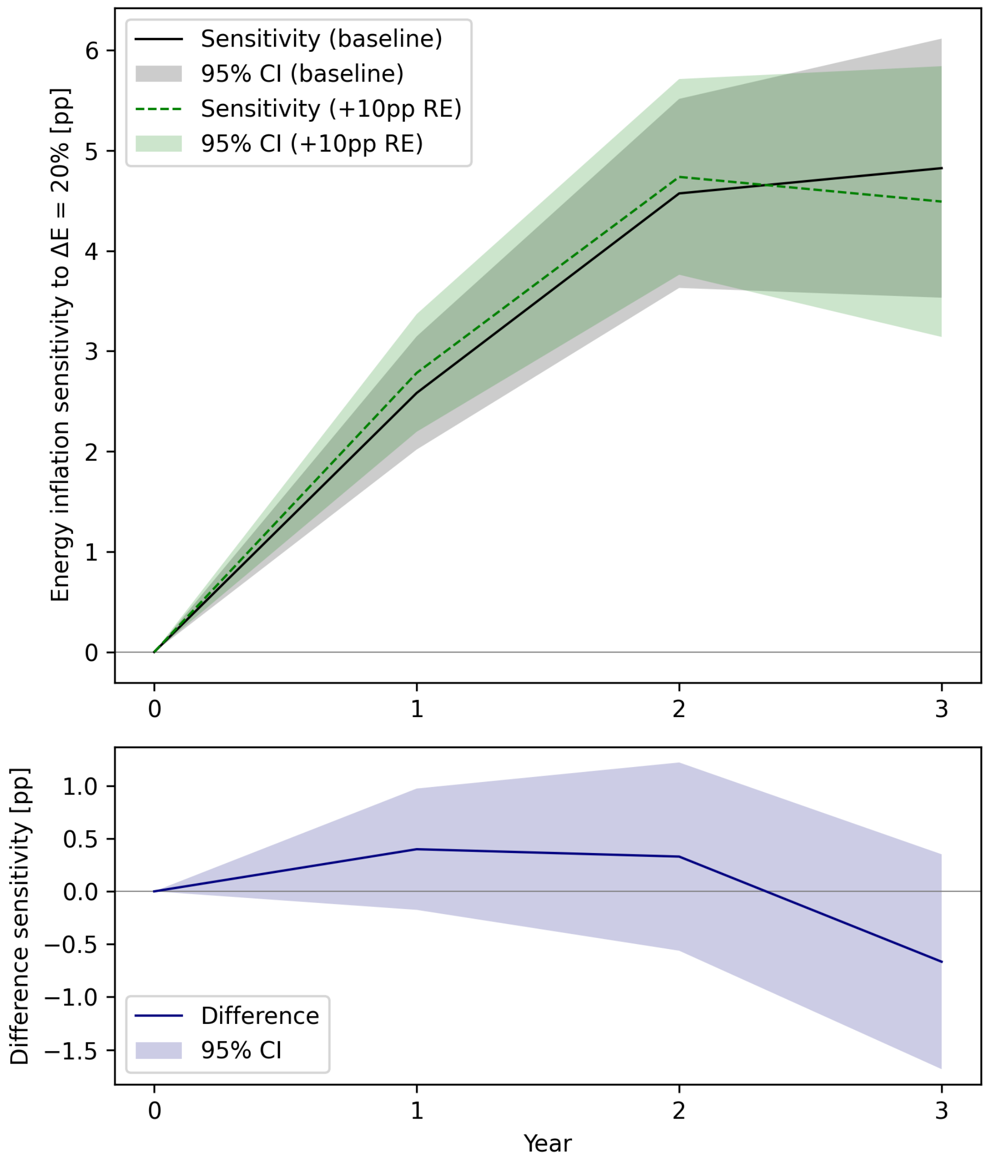
	(1) RE IMP	(2) RE SUB	(3) RE GDP	(4) LC IMP	(5) LC SUB	(6) LC GDP
ΔE (β^E)	0.110***	0.092***	0.165	0.109***	0.093***	0.177*
	(0.016)	(0.017)	(0.087)	(0.016)	(0.020)	(0.088)
L.ΔE (β_1^E)	0.085***	0.078**	0.095	0.090***	0.090***	0.093
	(0.013)	(0.025)	(0.059)	(0.014)	(0.026)	(0.060)
L2.ΔE (β_2^E)	0.058***	0.007	0.205**	0.059***	0.014	0.205**
	(0.014)	(0.012)	(0.066)	(0.014)	(0.013)	(0.067)
X (β^X)	0.141*	0.497***	0.194**	0.054	0.470***	0.079
	(0.070)	(0.116)	(0.067)	(0.062)	(0.120)	(0.064)
$\Delta E \times$ X ($\beta^{E \cdot X}$)	0.001	0.002**	0.002	0.001	0.002*	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
L.$\Delta E \times$ X ($\beta_1^{E \cdot X}$)	-0.000	0.001	-0.000	-0.000	0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
L2.$\Delta E \times$ X ($\beta_2^{E \cdot X}$)	-0.002**	-0.001	-0.002*	-0.002***	-0.001*	-0.001*
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
Y (β^Y)	-0.008	0.019	-0.871	-0.007	0.114	-0.686
	(0.024)	(0.363)	(0.696)	(0.024)	(0.402)	(0.701)
$\Delta E \times$ Y ($\beta_0^{E \cdot Y}$)	0.000	-0.008**	-0.008	0.000	-0.009*	-0.010
	(0.000)	(0.003)	(0.010)	(0.000)	(0.003)	(0.010)
L.$\Delta E \times$ Y ($\beta_1^{E \cdot Y}$)	0.000	-0.006	-0.002	0.000	-0.007	-0.001
	(0.000)	(0.003)	(0.006)	(0.000)	(0.004)	(0.007)
L2.$\Delta E \times$ Y ($\beta_2^{E \cdot Y}$)	-0.000	0.001	-0.019**	-0.000	0.000	-0.019*
	(0.000)	(0.003)	(0.007)	(0.000)	(0.003)	(0.007)
Output gap (β^g)	0.101	0.074	0.139	0.095	0.109	0.131
	(0.075)	(0.064)	(0.081)	(0.074)	(0.073)	(0.081)
Inflation expectation ($\beta^{\mathbb{E}\pi}$)	0.608***	0.367**	0.577***	0.602***	0.379**	0.575***
	(0.058)	(0.127)	(0.070)	(0.058)	(0.126)	(0.070)
Country FE	Y	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty	cty
R^2	0.64	0.59	0.63	0.64	0.59	0.62
Country-Year	2,460	749	2,443	2,460	749	2,443
Countries	69	65	69	69	65	69
Countries: AE	31	30	31	31	30	31
Countries: EM	35	32	35	35	32	35
Countries: LIC	3	3	3	3	3	3
Start	1973	2010	1973	1973	2010	1973
End	2022	2022	2022	2022	2022	2022

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

However, none of those terms are both statistically and economically significant. Taking column (1) in Table 5 as an example, one sees that a higher consumption of renewable energy is not associated with a weaker co-movement of energy inflation and international energy prices when controlling for energy imports. The second lag term $L2.\Delta E \cdot X$ is statistically significant but, as for the results in Table 4, an increase in the share of renewables would not affect the co-movement of domestic energy inflation and international energy prices in an economically significant way.

Figure 10: Sensitivity of the energy inflation to a change in international fossil energy prices (ΔE) of 20% in year 1, for a hypothetical country with net energy imports of 70% and a renewable share of 10% (baseline) and 20%. The sensitivity does not depend on the share of renewables.



The results can be illustrated as on Figure 10 above, using the regression of Column (1) of Table 5. Facing an increase of international fossil energy prices of 20% in year 1, a hypothetical country with net energy imports of 70% and a share of renewables of 10% of final energy consumption would see its energy inflation rise by 2.6% at the end of the first year, 4.6% at the end of the second and 4.8% at the end of the third year, all else equal.[21] That same country with a share of renewables of 20% instead of 10% (a change that took Denmark nine years to achieve, see Figure 8) would not see its energy inflation sensitivity to ΔE change in a statistically significant way.[22]

4.3 Additional Robustness

The fact that empirical results are inconsistent with the *divine coincidence hypothesis* is robust to a broad range of different data inputs, sub-samples and econometric assumptions.[23]

The results are robust when clustering standard errors at the year instead of the country level (Table 8) as well as to dropping outliers instead of winsorizing (Table 9) or winsorizing at 150% (Table 10). The results are also robust to considering a different definition of fossil energy price changes instead of the baseline definition described in Section 3.2 (Table 11, Table 12 and Table 13). They are further robust to considering the shares of renewables and nuclear in electricity production rather than in total energy consumption (Table 14) as well as considering different sub-periods (Table 15 and Table 16) and sub-regions (Table 17 and Table 18). Finally, the results are also robust to using the producer price index (PPI) inflation as the dependent variable, which is less affected by changes in consumption taxes, retail energy subsidies and price controls (Table 19).

[21]Actual *levels* of energy inflation will also be affected by macroeconomic factors.

[22]Given the interaction parameter $\beta^{E \cdot X}$ is not significant, no level of renewables would lead to a statistically significant divergence of energy inflation paths.

[23]The alternative regression tables are shown in the Appendix.

5 Discussion

5.1 A Counter-intuitive Result

Policy makers and experts have been arguing that the transition away from fossil fuels could support price stability while also fighting climate change. Panetta (2022) calls that possible outcome a "divine coincidence". While the *divine coincidence hypothesis* is widely discussed, we are not aware of published empirical research studying how renewable energy affects the sensitivity of inflation to changes in fossil energy prices.

Our empirical results are inconsistent with the *divine coincidence hypothesis*. That result is robust to sub-periods, country sub-samples and alternative metrics of inflation, fossil prices and renewable energy. This result seems counter-intuitive at first. Indeed, one would expect to see a positive relationship between a country's consumption of a commodity and that commodity's impact on the country's inflation. Three reasons could explain why the empirical results are inconsistent with a dampening effect of renewable energy on the fossil energy price-inflation relationship in this study: national energy policies, threshold effects induced by marginal pricing and trade-linkage spillovers.

National energy policies

One possibility could be for the *divine coincidence* effect to be drowned in countries' varying energy policies, which did not fully include in the regression for data-availability reasons. While we did include the level of fossil fuel subsidies in the regression – and found it to shield domestic energy inflation from fossil energy price fluctuations – we lack a structured data set on the broad range of other energy policies that can affect the transmission of international fossil energy prices to retail energy prices. These policies include: market structure and liberalization, long-term price agreements on imports, or price controls with no budgetary impact.

As an illustration, in June 2022, the Spanish and Portuguese governments implemented a mechanism that came to be know as the "Iberian exception" (Corbeau et al., 2023). The objective of that policy was to decouple domestic electricity prices from international gas prices, which were skyrocketing in the wake of Russia's invasion of Ukraine. This was achieved by a price cap on gas used in electricity generation, which was funded by a general levy on utilities and therefore had only a small impact on fiscal expenses. This is just one example of an energy policy affecting the relationship between international fossil energy prices and retail energy prices but would not be fully captured by official statistics on fossil fuel subsidies. Not accounting for these policies in the regression could lead to the *divine coincidence* signal to be drowned in noise.

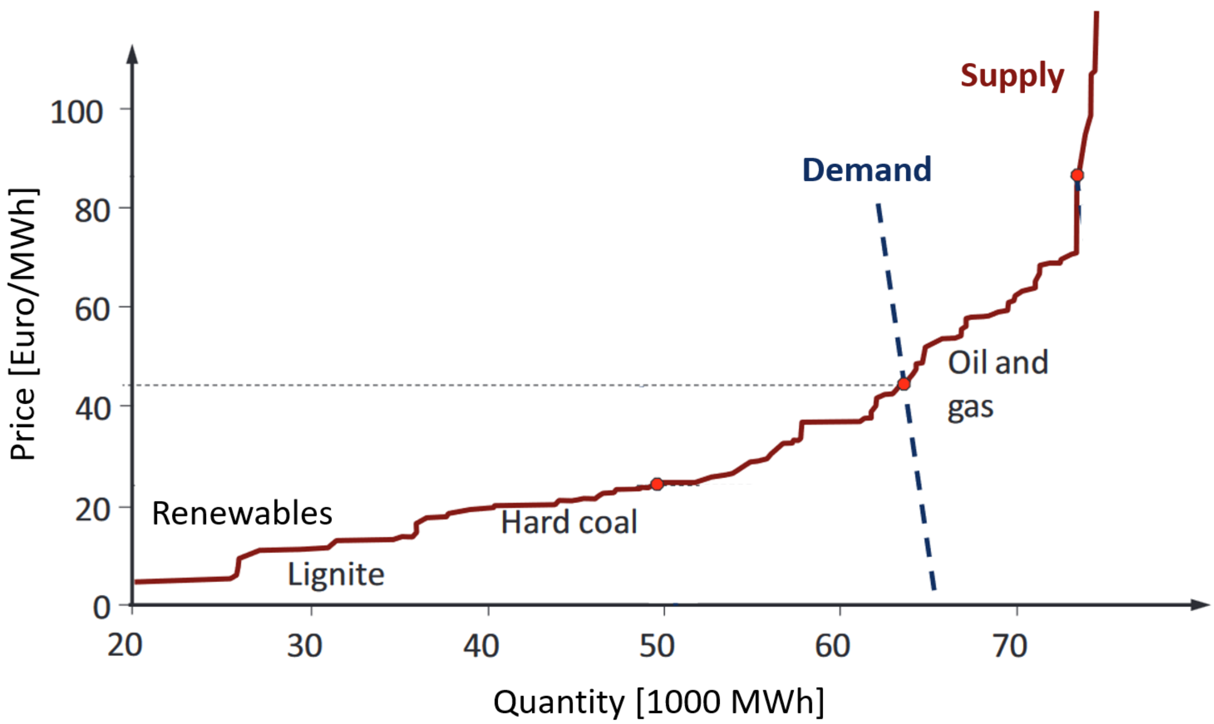
Marginal pricing

A second reason for the empirical results being inconsistent with the *divine coincidence hypothesis* could be the existence of threshold effects in the moderating effect renewable energy has on the co-movement of inflation and fossil-fuel prices.

Indeed, a number of final energy goods that make up the energy consumption basket are commodities, the properties of which do not depend on whether they were produced with fossil or renewable primary energy sources. This is the case for electricity, where a kilowatt-hour (kWh) from a wind turbine is indistinguishable from a kWh produced in a coal-fired power plant. It is largely true also of biomethane or biodiesel.

In the absence of transportation costs, commodity markets tend to converge to a single price (Ielpo, 2018). This is the case in domestic wholesale power markets. Indeed, if the domestic wholesale power market is liberalized, the marginal producer sets the price received by all power plants, even if they have far lower marginal production costs as is the case for renewables.[24] If, as illustrated on Figure 11, that marginal producer is a gas-fired power plant, the entire domestic wholesale power price is linked to the international gas price and fluctuations of that will feed through to domestic energy inflation.

Figure 11: Schematic illustration of the supply-demand equilibrium on wholesale electricity markets. If the dotted demand curve intersects the supply curve where a gas-fired power plant is the marginal producer, gas prices fully drive the domestic wholesale power price on which retail prices are indexed. Figure adapted from Erdmann (2017)



In that situation, renewable energy producers to the very left of the supply curve on Figure 11 would be paid a much higher price than their marginal production costs, earning a windfall profit. Consequently however, the *divine coincidence hypothesis* – a gradual decoupling of fossil energy prices and energy inflation when the share of renewables increases – does not hold. Indeed, as long as the marginal producer is a gas fired power plant, it does not matter whether 5% or 75% of electricity production comes from renewables, power prices and gas prices move in sync.

[24] In case the market is not liberalized and prices are set centrally, by, say, a national electricity monopoly, they might consider average rather than marginal pricing. For lack of a structured dataset, we cannot control for energy market design.

This market structure implies a threshold effect for decoupling energy inflation from international fossil energy prices. Once the share of renewables in electricity production increases towards 100%, the number of hours where renewables are the marginal producer and gas-fired power plants are "pushed out" will increase. Only above that threshold would the *divine coincidence hypothesis* materialize.

To test this threshold effect, a regression focusing specifically on electricity prices was run. Eurostat publishes granular inflation for individual items in the consumer price index for 36 EU member states and accession candidates. It is therefore possible to estimate the relationship shown in equation (6) but using *electricity price inflation* as the dependent variable ($\pi_{i,t}^{elec}$ in equation 8 below) and the share of renewables in *electricity production* as the modulating variable ($X_{i,t}^{elec}$ in the equation below).

$$\pi_{i,t}^{elec} = \beta^X X_{i,t}^{elec} + \sum_{k=0}^{k=2} \left[\beta_k^E \Delta E_{i,t-k} + \beta_k^{E \cdot X} \Delta E_{i,t-k} \cdot X_{i,t}^{elec} \right] + ... \tag{8}$$

More precisely, we estimated the relationship using the continuous modulating variable (the share of renewables in electricity production) as well as dummy variables, indicating whether that share was above certain thresholds (50%, 60%, etc. up to 85%[25]).

Table 6 presents the results. Column (1) shows the results of the continuous regression which are similar to previous results: the interaction terms are not economically or statistically significant. This means that any marginal increase in the fraction of renewables in electricity production is not associated with a weaker co-movement of electricity prices and international fossil-fuel prices.

However, Column (6) holds an interesting result. The contemporaneous and one-lag ΔE terms and the one-lag interaction term are both statistically and economically significant. This indicates that the electricity prices do rise in the year that international fossil energy prices rise, but for countries with very high shares of renewables in electricity production ($\geq$85%) the electricity prices no longer rise in the second year while they do so for other countries.

This preliminary result might be interpreted as indication of the *divine coincidence hypothesis* in its threshold formulation. The shielding effect is relatively weak, materializing with a one-year delay only and is limited to one of the six items in the basket of the energy consumer price index. A direct shielding effect on ECPI inflation let alone on headline inflation is not supported by these results. Furthermore this result is obtained only on a sub-sample of European countries. Further research on this threshold effect is needed.

[25] Too few countries had shares above 90%, this threshold was hence left out.

Table 6: Regression result using electricity price inflation and the share of renewables in electricity generation as modulating variable. Column (1) presents the result of the continuous regression as in equation (6) while in Columns (2) to (6) the modulating variable X is a dummy indicating whether the share of renewables in electricity generation is above 50%, 60%, etc.

	(1)	(2)	(3)	(4)	(5)	(6)
	RE	RE>50	RE>60	RE>70	RE>80	RE>85
ΔE (β^E)	0.109**	0.139***	0.128***	0.123***	0.123***	0.125***
	(0.039)	(0.029)	(0.028)	(0.026)	(0.025)	(0.024)
L.ΔE (β_1^E)	0.085**	0.103***	0.101***	0.099***	0.102***	0.106***
	(0.028)	(0.025)	(0.023)	(0.022)	(0.021)	(0.020)
L2.ΔE (β_2^E)	0.042*	0.026	0.019	0.016	0.017	0.015
	(0.019)	(0.017)	(0.017)	(0.016)	(0.016)	(0.016)
X (β^X)	0.143*	2.055	1.897	3.159**	6.658	-7.708
	(0.057)	(1.417)	(1.174)	(1.014)	(7.545)	(4.584)
ΔE × X ($\beta^{E \cdot X}$)	0.000	-0.048	-0.013	0.023	0.036	0.029
	(0.001)	(0.045)	(0.050)	(0.075)	(0.091)	(0.102)
L.ΔE × X ($\beta_1^{E \cdot X}$)	0.000	-0.024	-0.019	-0.029	-0.079	-0.133*
	(0.001)	(0.043)	(0.052)	(0.071)	(0.072)	(0.051)
L2.ΔE × X ($\beta_2^{E \cdot X}$)	-0.001	-0.049	-0.020	-0.000	-0.029	-0.013
	(0.000)	(0.025)	(0.020)	(0.022)	(0.022)	(0.016)
Output gap (β^g)	0.014	-0.030	-0.027	-0.025	-0.028	-0.034
	(0.076)	(0.076)	(0.076)	(0.077)	(0.077)	(0.076)
Inflation expectation ($\beta^{\mathbb{E}\pi}$)	0.395***	0.354***	0.364***	0.370***	0.367***	0.364***
	(0.087)	(0.089)	(0.092)	(0.093)	(0.094)	(0.094)
Country FE	Y (β^Y)	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty	cty
R^2	0.35	0.33	0.33	0.33	0.33	0.33
Country-Year	843	843	843	843	843	843
High RE obs.		205	144	92	65	60
High RE cty.		14	13	9	6	4
Countries	35	35	35	35	35	35
Countries: AE	26	26	26	26	26	26
Countries: EM	9	9	9	9	9	9
Countries: LIC	0	0	0	0	0	0
Start	1996	1996	1996	1996	1996	1996
End	2022	2022	2022	2022	2022	2022

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Trade linkages and spillovers

A third possibility could be that the *divine coincidence hypothesis* simply does not hold at the country level, because of trade linkages and spillovers. A country covering all of its domestic energy consumption with renewable energy would see the international demand for its (renewable) electricity (Gugler et al., 2018), heating biomass and biofuels increase significantly in the face of an oil price shock as its fossil energy-dependent trading partners look for cheaper sources of energy. This would lead domestic energy prices to increase, which would eventually feed through to other prices and increase inflation. In this case, the *divine coincidence hypothesis* would hold at global level only, but not at the level of individual countries.

5.2 Conclusions

In conclusion, while the results of this analysis are inconsistent with the *divine coincidence hypothesis*, they should not be interpreted as critique of renewable energy development, the benefits of which are well-established (Birol, 2022) and go far beyond a hypothetical decoupling of inflation from oil and gas prices. Renewables help reduce greenhouse gas emissions and thereby mitigate climate change and have further benefits (Black, Parry, et al., 2023) such as reducing local air pollution. Furthermore, this analysis should certainly not be read as advocating for subsidising fossil fuels, which distort prices, fail to address externalities and accelerate climate change (Black, Liu, & Ian Parry, 2023).

As the global economy shifts towards a low-carbon model and reduces reliance on fossil fuels, it becomes increasingly important to explore how this transition influences inflation. Specifically, future research should account for national energy policies, threshold effects and trade linkages. Confirming the *divine coincidence hypothesis* – that renewable energy expansion benefits both climate change mitigation and price stability – could have a bearing on the conduct of monetary policy and the greening of the monetary policy toolkit (NGFS, 2021).

References

Akan, T. (2023). Can renewable energy mitigate the impacts of inflation and policy interest on climate change? *Renewable Energy*, *214*, 255-289. doi: 10.1016/j.renene.2023.05.023

Baba, C., & Lee, J. (2022). Second-round effects of oil price shocks – Implications for Europe's inflation outlook. *IMF Working Papers*.

Baumeister, C., & Peersman, G. (2013). Time-Varying Effects of Oil Supply Shocks on the US Economy. *American Economic Journal: Macroeconomics*, *5*(4), 1-28. doi: 10.1257/mac.5.4.1

Bernanke, B., & Blanchard, O. (2023). What Caused the U.S. Pandemic-Era Inflation? *Hutchins Center Working Papers*.

Binder, C., & Makridis, C. (2022). Stuck in the Seventies: Gas Prices and Consumer Sentiment. *The Review of Economics and Statistics*, *104*(2), 293-305. doi: 10.1162/rest_a_00944

Binder, C. C. (2018). Inflation expectations and the price at the pump. *Journal of Macroeconomics*, *58*, 1-18. doi: 10.1016/j.jmacro.2018.08.006

Birol, F. (2022). A call to clean energy. *Finance & Development*.

Black, S., Liu, A., & Ian Parry, N. V. (2023). IMF Fossil Fuel Subsidies Data: 2023 Update. *IMF Working Papers*.

Black, S., Parry, I., Mylonas, V., Vernon, N., & Zhunussova, K. (2023). The IMF-World Bank Climate Policy Assessment Tool (CPAT): A Model to Help Countries Mitigate Climate Change. *IMF Working Papers*.

Blanchard, O., & Galí, J. (2007). Real Wage Rigidities and the New Keynesian Model. *Journal of Money, Credit and Banking*, *39*(s1), 35-65. doi: 10.1111/j.1538-4616.2007.00015.x

Castro, C., & Jiménez-Rodríguez, R. (2017). Oil price pass-through along the price chain in the euro area. *Energy Economics*, *64*, 24-30. doi: 10.1016/j.eneco.2017.03.012

Chen, S.-S. (2009). Revisiting the inflationary effects of oil prices. *The Energy Journal*, *30*(4), 141–154. doi: 10.5547/ISSN0195-6574-EJ-Vol30-No4-5

Clark, T. E., & Terry, S. J. (2010). Time variation in the inflation passthrough of energy prices. *Journal of Money, Credit and Banking*, *42*. doi: 10.1111/j.1538-4616.2010.00347.x

Conflitti, C., & Luciani, M. (2019). Oil price pass-through into core inflation. *Energy Journal*, *40*. doi: 10.5547/01956574.40.6.ccon

Corbeau, A.-S., Farfan, J. C., & Orozco, S. (2023). The Iberian Exception and Its Impact. *Center of Global Energy Policy at Columbia University*.

Deka, A., Cavusoglu, B., & Dube, S. (2022). Does renewable energy use enhance exchange rate appreciation and stable rate of inflation? *Environmental Science and Pollution Research*, *29*. doi: 10.1007/s11356-021-16758-2

Deka, A., & Dube, S. (2021). Analyzing the causal relationship between exchange rate, renewable energy and inflation of mexico (1990–2019) with ardl bounds test approach. *Renewable Energy Focus*, *37*, 78-83. doi: 10.1016/j.ref.2021.04.001

Erdmann, G. (2017). Power system and market integration of renewable electricity. *EPJ Web of Conferences*, *148*. doi: 10.1051/epjconf/201714800005

Galí, J., & Monacelli, T. (2005, 07). Monetary Policy and Exchange Rate Volatility in a Small Open Economy. *The Review of Economic Studies*, *72*(3), 707-734. doi: 10.1111/j.1467-937X.2005.00349.x

Gao, L., Kim, H., & Saba, R. (2014). How do oil price shocks affect consumer prices? *Energy Economics*, *45*. doi: 10.1016/j.eneco.2014.08.001

Gugler, K., Haxhimusa, A., & Liebensteiner, M. (2018). Integration of European Electricity Markets: Evidence from Spot Prices. *The Energy Journal*, *39*, 41-66. doi: 10.5547/01956574.39.SI2.kgug

Ha, J., Kose, M. A., & Ohnsorge, F. (2023). One-stop source: A global database of inflation. *Journal of International Money and Finance*, *137*, 102896. doi: 10.1016/j.jimonfin.2023.102896

Ha, J., Kose, M. A., Ohnsorge, F., & Yilmazkuday, H. (2023). Understanding the global drivers of inflation : How important are oil prices? *World Bank Policy Research Working Paper*.

Heemskerk, I., Nerlich, C., & Parker, M. (2022). Turning down the heat: How the green transition supports price stability. *The ECB Blog, 9 November*.

Hogan, W. W. (2022). Electricity Market Design and Zero-Marginal Cost Generation. *Current Sustainable/Renewable Energy Reports*, *9*, 15–26. Retrieved from https://doi.org/10.1007/s40518-021-00200-9 doi: 10.1007/s40518-021-00200-9

Ielpo, F. (2018). The Economics of Commodities and Commodity Markets. In *Commodities: Markets, Performance, and Strategies.* Oxford University Press. doi: 10.1093/oso/9780190656010.003.0002

IPCC. (2022). *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (Tech. Rep.). Intergovernmental Panel on Climate Change.

Kilian, L. (2008). The economic effects of energy price shocks. *Journal of Economic Literature*, *46*(4), 871-909. doi: 10.1257/jel.46.4.871

Kilian, L. (2009). Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *American Economic Review*, *99*(3), 1053-69. doi: 10.1257/aer.99.3.1053

Kilian, L., & Zhou, X. (2022). Oil prices, gasoline prices, and inflation expectations. *Journal of Applied Econometrics*, *37*(5), 867-881. doi: 10.1002/jae.2911

Melodia, L., & Karlsson, K. (2022). Energy price stability: The peril of fossil fuels and the promise of renewables. *Roosevelt Institute Policy Issue Brief*.

NGFS. (2021). Adapting central bank operations to a hotter world: Reviewing some options. *NGFS Report*.

Panetta, F. (2022). Greener and cheaper: Could the transition away from fossil fuels generate a divine coincidence? *Speech at the Italian Banking Association Rome, 16 November*.

Peersman, G., & Van Robays, I. (2012). Cross-country differences in the effects of oil shocks. *Energy Economics*, *34*(5), 1532-1547. doi: 10.1016/j.eneco.2011.11.010

Pous, P. D., Patuleia, A., Brown, S., & Rosslowe, C. (2022, October). More renewables, less inflation. restoring eu economic stabiltiy through investment in renewables. *E3G EMBER Briefing Paper*.

Ritchie, H., Roser, M., & Rosado, P. (2023a). CO2 and Greenhouse Gas Emissions. *Our World in Data*. Retrieved from ourworldindata.org/co2-and-greenhouse-gas-emissions

Ritchie, H., Roser, M., & Rosado, P. (2023b). Energy. *Our World in Data*. Retrieved from ourworldindata.org/energy

Schnabel, I. (2022). A new age of energy inflation: Climateflation, fossilflation and greenflation. *Speech at a panel on "Monetary Policy and Climate Change" at The ECB and its Watchers XXII Conference, Frankfurt am Main, 17 March*.

Wen, F., Zhang, K., & Gong, X. (2021). The effects of oil price shocks on inflation in the G7 countries. *The North American Journal of Economics and Finance*, *57*, 101391. doi: 10.1016/j.najef.2021.101391

Wong, B. (2015). Do inflation expectations propagate the inflationary impact of real oil price shocks?: Evidence from the michigan survey. *Journal of Money, Credit and Banking*, *47*(8), 1673-1689. doi: 10.1111/jmcb.12288

A Appendix - List of countries in the regression

Table 7: Country list

Country	IFS code	ISO3C	Class	Country	IFS code	ISO3C	Class
Algeria	612	DZA	EM	Luxembourg	137	LUX	AE
Argentina	213	ARG	EM	Macedonia	962	MKD	EM
Australia	193	AUS	AE	Malaysia	548	MYS	EM
Austria	122	AUT	AE	Mexico	273	MEX	EM
Azerbaijan	912	AZE	EM	Morocco	686	MAR	EM
Bangladesh	513	BGD	LIC	Netherlands	138	NLD	AE
Belarus	913	BLR	EM	New Zealand	196	NZL	AE
Belgium	124	BEL	AE	Norway	142	NOR	AE
Brazil	223	BRA	EM	Oman	449	OMN	EM
Bulgaria	918	BGR	EM	Pakistan	564	PAK	EM
Canada	156	CAN	AE	Peru	293	PER	EM
Chile	228	CHL	EM	Philippines	566	PHL	EM
China	924	CHN	EM	Poland	964	POL	EM
Colombia	233	COL	EM	Portugal	182	PRT	AE
Croatia	960	HRV	EM	Romania	968	ROU	EM
Czech Republic	935	CZE	AE	Russia	922	RUS	EM
Denmark	128	DNK	AE	Saudi Arabia	456	SAU	EM
Egypt	469	EGY	EM	Singapore	576	SGP	AE
Estonia	939	EST	AE	Slovak Republic	936	SVK	AE
Finland	172	FIN	AE	Slovenia	961	SVN	AE
France	132	FRA	AE	South Africa	199	ZAF	EM
Germany	134	DEU	AE	South Korea	542	KOR	AE
Greece	174	GRC	AE	Spain	184	ESP	AE
Hungary	944	HUN	EM	Sweden	144	SWE	AE
India	534	IND	EM	Switzerland	146	CHE	AE
Indonesia	536	IDN	EM	Thailand	578	THA	EM
Iran	429	IRN	EM	Trinidad and Tobago	369	TTO	EM
Iraq	433	IRQ	EM	Turkey	186	TUR	EM
Ireland	178	IRL	AE	Ukraine	926	UKR	EM
Israel	436	ISR	AE	United Kingdom	112	GBR	AE
Italy	136	ITA	AE	United States	111	USA	AE
Japan	158	JPN	AE	Uzbekistan	927	UZB	LIC
Kazakhstan	916	KAZ	EM	Venezuela	299	VEN	EM
Latvia	941	LVA	AE	Vietnam	582	VNM	LIC
Lithuania	946	LTU	AE				

B Appendix - Additional robustness checks

Table 8: Regression results clustering standard errors at the year instead of the country level. The results are unchanged.

	(1)	(2) RE	(3) LC	(4) IMP	(5) SUB
ΔE	0.109***	0.112***	0.110***	0.112***	0.105**
	(0.012)	(0.015)	(0.017)	(0.012)	(0.029)
L.ΔE	0.074***	0.089***	0.092***	0.076***	0.079
	(0.012)	(0.018)	(0.018)	(0.011)	(0.046)
L2.ΔE	0.026*	0.053**	0.058**	0.028*	-0.001
	(0.012)	(0.016)	(0.017)	(0.013)	(0.028)
X		0.152	0.058	-0.004	0.027
		(0.129)	(0.079)	(0.015)	(0.266)
$\Delta E \times$ X		0.001	0.001	0.000*	-0.011*
		(0.001)	(0.001)	(0.000)	(0.004)
L.$\Delta E \times$ X		-0.000	-0.000	0.000	-0.007
		(0.001)	(0.001)	(0.000)	(0.005)
L2.$\Delta E \times$ X		-0.002*	-0.002**	-0.000	0.001
		(0.001)	(0.001)	(0.000)	(0.003)
Output gap (g)	0.069*	0.110*	0.102	0.060	0.058
	(0.029)	(0.053)	(0.053)	(0.034)	(0.063)
Inflation expectation ($\mathbb{E}\pi$)	0.539***	0.608***	0.602***	0.528***	0.443*
	(0.040)	(0.043)	(0.043)	(0.041)	(0.160)
Country FE	Y	Y	Y	Y	Y
Cluster	year	year	year	year	year
R^2	0.50	0.63	0.63	0.52	0.49
Country-Year	5,895	2,460	2,460	4,689	1,424
Countries	170	69	69	128	151
Countries: AE	35	31	31	34	32
Countries: EM	86	35	35	67	75
Countries: LIC	49	3	3	27	44
Start	1973	1973	1973	1973	2010
End	2022	2022	2022	2022	2022

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 9: Regression results when dropping outliers instead of winsorizing. The interaction terms exhibit statistical significance but no economic significance (except for fossil subsidies).

	(1)	(2) RE	(3) LC	(4) IMP	(5) SUB
ΔE	0.097***	0.080***	0.080***	0.096***	0.106***
	(0.007)	(0.011)	(0.012)	(0.007)	(0.010)
L.ΔE	0.064***	0.064***	0.066***	0.060***	0.069***
	(0.006)	(0.011)	(0.013)	(0.007)	(0.012)
L2.ΔE	0.029***	0.034***	0.036***	0.029***	-0.006
	(0.004)	(0.007)	(0.008)	(0.005)	(0.006)
X		0.137*	0.026	0.001	-0.088
		(0.061)	(0.060)	(0.017)	(0.204)
$\Delta E \times$ X		0.001*	0.001*	0.000**	-0.008**
		(0.001)	(0.000)	(0.000)	(0.003)
L.$\Delta E \times$ X		0.000	0.000	0.000**	-0.007*
		(0.001)	(0.000)	(0.000)	(0.003)
L2.$\Delta E \times$ X		-0.001*	-0.001**	-0.000	0.002
		(0.000)	(0.000)	(0.000)	(0.002)
Output gap (g)	0.056	0.089	0.082	0.045	0.007
	(0.030)	(0.053)	(0.053)	(0.037)	(0.058)
Inflation expectation ($\mathbb{E}\pi$)	0.347***	0.435***	0.427***	0.315***	0.391***
	(0.069)	(0.085)	(0.084)	(0.070)	(0.116)
Country FE	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty
R^2	0.36	0.44	0.44	0.37	0.49
Country-Year	5,473	2,322	2,322	4,382	1,386
Countries	169	68	68	127	147
Countries: AE	35	31	31	34	32
Countries: EM	86	35	35	67	74
Countries: LIC	48	2	2	26	41
Start	1973	1973	1973	1973	2010
End	2022	2022	2022	2022	2022

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 10: Regression results when winsorizing at 150% instead of 100%. The results are unchanged.

	(1)	(2) RE	(3) LC	(4) IMP	(5) SUB
ΔE	0.118***	0.136***	0.130***	0.123***	0.109***
	(0.011)	(0.024)	(0.022)	(0.013)	(0.012)
L.ΔE	0.077***	0.105***	0.108***	0.080***	0.083***
	(0.008)	(0.018)	(0.020)	(0.010)	(0.014)
L2.ΔE	0.020**	0.052**	0.061**	0.022*	0.007
	(0.007)	(0.017)	(0.018)	(0.009)	(0.009)
X		0.183*	0.121	-0.002	0.019
		(0.078)	(0.075)	(0.027)	(0.169)
$\Delta E \times$ X		0.001	0.001	0.000	-0.012***
		(0.001)	(0.001)	(0.000)	(0.003)
L.$\Delta E \times$ X		-0.001	-0.001	0.000	-0.007**
		(0.001)	(0.001)	(0.000)	(0.003)
L2.$\Delta E \times$ X		-0.002**	-0.002**	-0.000	0.002
		(0.001)	(0.001)	(0.000)	(0.003)
Output gap (g)	0.080	0.122	0.114	0.075	0.060
	(0.044)	(0.102)	(0.101)	(0.058)	(0.044)
Inflation expectation ($\mathbb{E}\pi$)	0.661***	0.734***	0.729***	0.653***	0.484*
	(0.073)	(0.082)	(0.082)	(0.074)	(0.229)
Country FE	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty
R^2	0.51	0.63	0.63	0.53	0.49
Country-Year	5,895	2,460	2,460	4,689	1,424
Countries	170	69	69	128	151
Countries: AE	35	31	31	34	32
Countries: EM	86	35	35	67	75
Countries: LIC	49	3	3	27	44
Start	1973	1973	1973	1973	2010
End	2022	2022	2022	2022	2022

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 11: Regression results when defining ΔE simply using USD fossil-fuel prices and exchanges rates and no composition effects as in equation (4). The results are unchanged

	(1)	(2) RE	(3) LC	(4) IMP	(5) SUB
ΔE	0.110***	0.114***	0.112***	0.113***	0.108***
	(0.009)	(0.016)	(0.017)	(0.010)	(0.011)
L.ΔE	0.072***	0.084***	0.088***	0.074***	0.075***
	(0.006)	(0.012)	(0.014)	(0.007)	(0.011)
L2.ΔE	0.027***	0.055***	0.060***	0.029***	0.002
	(0.005)	(0.013)	(0.014)	(0.007)	(0.006)
X		0.158*	0.063	-0.002	0.045
		(0.069)	(0.060)	(0.023)	(0.174)
$\Delta E \times$ X		0.001	0.001	0.000*	-0.012***
		(0.001)	(0.001)	(0.000)	(0.003)
L.$\Delta E \times$ X		-0.000	-0.000	0.000	-0.006**
		(0.001)	(0.000)	(0.000)	(0.002)
L2.$\Delta E \times$ X		-0.002**	-0.002**	-0.000	0.001
		(0.001)	(0.001)	(0.000)	(0.002)
Output gap (g)	0.072*	0.120	0.111	0.065	0.060
	(0.036)	(0.075)	(0.074)	(0.047)	(0.044)
Inflation expectation ($\mathbb{E}\pi$)	0.538***	0.607***	0.601***	0.527***	0.443*
	(0.054)	(0.058)	(0.058)	(0.055)	(0.200)
Country FE	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty
R^2	0.50	0.63	0.63	0.52	0.49
Country-Year	5,895	2,460	2,460	4,689	1,424
Countries	170	69	69	128	151
Countries: AE	35	31	31	34	32
Countries: EM	86	35	35	67	75
Countries: LIC	49	3	3	27	44
Start	1973	1973	1973	1973	2010
End	2022	2022	2022	2022	2022

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 12: Regression results when defining ΔE simply using USD fossil energy prices and no exchange rates. ΔE is therefore the same for all countries at any specific date. The positive, statistically significant but economically insignificant parameters of the interaction terms point to the fact that countries with high-renewables experience higher currency depreciation when facing a fossil energy price increase.

	(1)	(2) RE	(3) LC	(4) IMP	(5) SUB
ΔE	0.068***	0.039**	0.033*	0.061***	0.085***
	(0.008)	(0.014)	(0.015)	(0.008)	(0.010)
L.ΔE	0.056***	0.045**	0.042**	0.051***	0.078***
	(0.006)	(0.013)	(0.014)	(0.006)	(0.011)
L2.ΔE	0.020***	0.024	0.024	0.016*	-0.009
	(0.005)	(0.013)	(0.016)	(0.007)	(0.005)
X		0.133	-0.096	0.002	0.049
		(0.075)	(0.107)	(0.023)	(0.167)
$\Delta E \times$ X		0.002***	0.002***	0.001***	-0.012***
		(0.001)	(0.000)	(0.000)	(0.003)
L.$\Delta E \times$ X		0.001	0.001	0.000***	-0.009***
		(0.001)	(0.001)	(0.000)	(0.002)
L2.$\Delta E \times$ X		-0.001	-0.001*	0.000	0.001
		(0.001)	(0.001)	(0.000)	(0.002)
Output gap (g)	0.100*	0.232	0.215	0.101	0.055
	(0.045)	(0.116)	(0.112)	(0.058)	(0.045)
Inflation expectation ($\mathbb{E}\pi$)	0.666***	0.753***	0.742***	0.658***	0.431*
	(0.053)	(0.061)	(0.063)	(0.055)	(0.200)
Country FE	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty
R^2	0.47	0.57	0.57	0.48	0.46
Country-Year	6,025	2,518	2,518	4,814	1,443
Countries	172	70	70	130	153
Countries: AE	35	31	31	34	32
Countries: EM	87	36	36	68	76
Countries: LIC	50	3	3	28	45
Start	1973	1973	1973	1973	2010
End	2022	2022	2022	2022	2022

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 13: Regression results when adding year fixed effects, which absorb the USD fossil energy price change, which is the same for all countries in any specific year. ΔE therefore captures the change in exchange rates only. The results are unchanged.

	(1)	(2) RE	(3) LC	(4) IMP	(5) SUB
ΔE	0.231***	0.243***	0.237***	0.232***	0.156***
	(0.030)	(0.040)	(0.039)	(0.034)	(0.029)
L.ΔE	0.120***	0.158***	0.163***	0.121***	0.116**
	(0.020)	(0.028)	(0.028)	(0.022)	(0.040)
L2.ΔE	-0.012	0.030	0.033	-0.015	0.036
	(0.021)	(0.027)	(0.027)	(0.023)	(0.031)
X		0.108	0.032	0.007	0.335
		(0.085)	(0.060)	(0.020)	(0.186)
$\Delta E \times$ X		0.001	0.001*	0.000**	-0.014***
		(0.001)	(0.001)	(0.000)	(0.003)
L.$\Delta E \times$ X		-0.000	-0.000	0.000	-0.009**
		(0.001)	(0.000)	(0.000)	(0.003)
L2.$\Delta E \times$ X		-0.002**	-0.002**	-0.000*	0.001
		(0.001)	(0.001)	(0.000)	(0.002)
Output gap (g)	0.054	0.095	0.088	0.048	0.170***
	(0.038)	(0.092)	(0.091)	(0.050)	(0.048)
Inflation expectation ($\mathbb{E}\pi$)	0.445***	0.473***	0.472***	0.437***	0.463**
	(0.063)	(0.067)	(0.067)	(0.064)	(0.176)
Country FE	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty
R^2	0.54	0.68	0.68	0.56	0.59
Country-Year	5,895	2,460	2,460	4,689	1,424
Countries	170	69	69	128	151
Countries: AE	35	31	31	34	32
Countries: EM	86	35	35	67	75
Countries: LIC	49	3	3	27	44
Start	1973	1973	1973	1973	2010
End	2022	2022	2022	2022	2022

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 14: Regression results using a variation of the modulating variables: RE and LC are defined as fraction of electricity production rather than fraction of total energy consumption. Columns (1), (4), and (5) are unchanged because unaffected by this change. Results in columns (2) and (3) are unchanged.

	(1)	(2) RE	(3) LC	(4) IMP	(5) SUB
ΔE	0.109***	0.092***	0.085***	0.112***	0.105***
	(0.009)	(0.012)	(0.012)	(0.010)	(0.010)
L.ΔE	0.074***	0.062***	0.059***	0.076***	0.079***
	(0.006)	(0.010)	(0.011)	(0.007)	(0.012)
L2.ΔE	0.026***	0.052***	0.058***	0.028***	-0.001
	(0.005)	(0.012)	(0.014)	(0.007)	(0.006)
X		0.049*	0.031	-0.004	0.027
		(0.021)	(0.023)	(0.023)	(0.169)
$\Delta E \times$ X		-0.000	0.000	0.000*	-0.011***
		(0.000)	(0.000)	(0.000)	(0.003)
L.$\Delta E \times$ X		-0.000	0.000	0.000	-0.007**
		(0.000)	(0.000)	(0.000)	(0.002)
L2.$\Delta E \times$ X		-0.001***	-0.001***	-0.000	0.001
		(0.000)	(0.000)	(0.000)	(0.002)
Output gap (g)	0.069	0.064	0.065	0.060	0.058
	(0.036)	(0.038)	(0.038)	(0.047)	(0.044)
Inflation expectation ($\mathbb{E}\pi$)	0.539***	0.570***	0.572***	0.528***	0.443*
	(0.054)	(0.058)	(0.058)	(0.055)	(0.200)
Country FE	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty
R^2	0.50	0.51	0.51	0.52	0.49
Country-Year	5,895	4,095	4,095	4,689	1,424
Countries	170	169	169	128	151
Countries: AE	35	35	35	34	32
Countries: EM	86	85	85	67	75
Countries: LIC	49	49	49	27	44
Start	1973	1985	1985	1973	2010
End	2022	2022	2022	2022	2022

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 15: Regression results on the sub-period 1985-2019 excluding the oil price and COVID shocks. The results are unchanged for RE and LC, SUB no longer significant.

	(1)	(2) RE	(3) LC	(4) IMP	(5) SUB
ΔE	0.092***	0.114***	0.108***	0.097***	0.045***
	(0.010)	(0.021)	(0.022)	(0.011)	(0.009)
L.ΔE	0.050***	0.077***	0.078***	0.052***	0.006
	(0.007)	(0.014)	(0.016)	(0.008)	(0.006)
L2.ΔE	0.018**	0.057***	0.062**	0.020**	0.005
	(0.006)	(0.016)	(0.018)	(0.007)	(0.006)
X		-0.046	-0.071	0.012	0.143
		(0.071)	(0.080)	(0.028)	(0.166)
$\Delta E \times$ X		-0.001	-0.000	0.000	-0.004
		(0.001)	(0.001)	(0.000)	(0.003)
L.$\Delta E \times$ X		-0.001	-0.001	0.000	0.003
		(0.001)	(0.001)	(0.000)	(0.003)
L2.$\Delta E \times$ X		-0.003**	-0.002**	-0.000	0.000
		(0.001)	(0.001)	(0.000)	(0.002)
Output gap (g)	0.038	0.106	0.104	0.036	0.044
	(0.042)	(0.079)	(0.079)	(0.055)	(0.026)
Inflation expectation ($\mathbb{E}\pi$)	0.511***	0.577***	0.572***	0.502***	0.189**
	(0.051)	(0.056)	(0.056)	(0.051)	(0.069)
Country FE	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty
R^2	0.50	0.63	0.63	0.51	0.57
Country-Year	4,537	1,928	1,928	3,607	1,151
Countries	169	68	68	127	148
Countries: AE	35	31	31	34	32
Countries: EM	86	35	35	67	74
Countries: LIC	48	2	2	26	42
Start	1985	1985	1985	1985	2010
End	2019	2019	2019	2019	2019

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 16: Regression results on the sub-period 2000-2022 in which the shares of renewable energy had increased in many countries (see Figure 7). The results are unchanged.

	(1)	(2) RE	(3) LC	(4) IMP	(5) SUB
ΔE	0.077***	0.073***	0.067***	0.078***	0.105***
	(0.007)	(0.014)	(0.017)	(0.007)	(0.010)
L.ΔE	0.043***	0.050***	0.050***	0.042***	0.079***
	(0.005)	(0.012)	(0.011)	(0.006)	(0.012)
L2.ΔE	0.011	0.029*	0.031*	0.009	-0.001
	(0.006)	(0.012)	(0.015)	(0.007)	(0.006)
X		0.396***	0.276**	0.002	0.027
		(0.089)	(0.090)	(0.024)	(0.169)
$\Delta E \times$ X		0.002**	0.002*	0.000***	-0.011***
		(0.001)	(0.001)	(0.000)	(0.003)
L.$\Delta E \times$ X		0.001	0.000	0.000**	-0.007**
		(0.001)	(0.001)	(0.000)	(0.002)
L2.$\Delta E \times$ X		-0.002*	-0.002*	-0.000	0.001
		(0.001)	(0.001)	(0.000)	(0.002)
Output gap (g)	0.042	0.155***	0.146***	0.014	0.058
	(0.025)	(0.040)	(0.039)	(0.037)	(0.044)
Inflation expectation ($\mathbb{E}\pi$)	0.626***	0.586*	0.583*	0.620***	0.443*
	(0.150)	(0.229)	(0.230)	(0.164)	(0.200)
Country FE	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty
R^2	0.38	0.49	0.48	0.40	0.49
Country-Year	3,443	1,406	1,406	2,697	1,424
Countries	170	66	66	128	151
Countries: AE	35	30	30	34	32
Countries: EM	86	33	33	67	75
Countries: LIC	49	3	3	27	44
Start	2000	2000	2000	2000	2010
End	2022	2022	2022	2022	2022

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 17: Regression results on the sub-sample of advanced economies. The results are unchanged.

	(1)	(2) RE	(3) LC	(4) IMP	(5) SUB
ΔE	0.149***	0.121***	0.130***	0.129***	0.159***
	(0.014)	(0.017)	(0.020)	(0.012)	(0.023)
L.ΔE	0.103***	0.111***	0.127***	0.084***	0.091**
	(0.010)	(0.014)	(0.016)	(0.011)	(0.031)
L2.ΔE	0.015*	0.034**	0.045**	0.010	-0.005
	(0.007)	(0.012)	(0.014)	(0.007)	(0.012)
X		0.303***	0.151*	0.004	-1.975
		(0.072)	(0.058)	(0.026)	(3.500)
$\Delta E \times$ X		0.000	0.000	0.000*	0.006
		(0.001)	(0.001)	(0.000)	(0.052)
L.$\Delta E \times$ X		-0.001	-0.001*	0.000**	0.085
		(0.001)	(0.001)	(0.000)	(0.055)
L2.$\Delta E \times$ X		-0.001	-0.001*	0.000	-0.019
		(0.001)	(0.001)	(0.000)	(0.036)
Output gap (g)	0.092**	0.141*	0.112	0.067	0.110
	(0.031)	(0.059)	(0.057)	(0.049)	(0.121)
Inflation expectation ($\mathbb{E}\pi$)	0.545***	0.551***	0.520***	0.526***	0.121
	(0.041)	(0.040)	(0.040)	(0.040)	(0.352)
Country FE	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty
R^2	0.61	0.61	0.61	0.62	0.63
Country-Year	1,571	1,278	1,278	1,550	395
Countries	35	31	31	34	32
Countries: AE	35	31	31	34	32
Countries: EM	0	0	0	0	0
Countries: LIC	0	0	0	0	0
Start	1973	1973	1973	1973	2010
End	2022	2022	2022	2022	2022

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 18: Regression results on the sub-sample of emerging markets and low-income countries. The economic significant of the two-lag interaction term is marginal: higher shares in renewables and low-carbon energy lead to a somewhat lower co-movement with a two-year lag.

	(1)	(2) RE	(3) LC	(4) IMP	(5) SUB
ΔE	0.094***	0.094**	0.076**	0.101***	0.054***
	(0.010)	(0.027)	(0.025)	(0.013)	(0.012)
L.ΔE	0.064***	0.062**	0.060**	0.067***	0.049**
	(0.007)	(0.019)	(0.021)	(0.009)	(0.015)
L2.ΔE	0.029***	0.075**	0.078**	0.028**	0.004
	(0.007)	(0.022)	(0.025)	(0.010)	(0.008)
X		-0.283	-0.310	-0.008	0.074
		(0.186)	(0.200)	(0.031)	(0.161)
$\Delta E \times$ X		0.002	0.003	0.000	-0.005*
		(0.002)	(0.002)	(0.000)	(0.002)
L.$\Delta E \times$ X		0.001	0.001	0.000	-0.004
		(0.001)	(0.001)	(0.000)	(0.002)
L2.$\Delta E \times$ X		-0.005**	-0.004**	-0.000	0.000
		(0.001)	(0.001)	(0.000)	(0.002)
Output gap (g)	0.051	0.084	0.077	0.046	0.013
	(0.042)	(0.091)	(0.093)	(0.053)	(0.039)
Inflation expectation ($\mathbb{E}\pi$)	0.542***	0.628***	0.625***	0.535***	0.456*
	(0.062)	(0.071)	(0.074)	(0.061)	(0.202)
Country FE	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty
R^2	0.49	0.63	0.63	0.50	0.50
Country-Year	4,324	1,182	1,182	3,139	1,029
Countries	135	38	38	94	119
Countries: AE	0	0	0	0	0
Countries: EM	86	35	35	67	75
Countries: LIC	49	3	3	27	44
Start	1973	1973	1973	1973	2010
End	2022	2022	2022	2022	2022

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 19: Regression results using the producer price index (PPI) inflation as the dependent variable. The results are unchanged.

	(1)	(2) RE	(3) LC	(4) IMP	(5) SUB
ΔE	0.178***	0.179***	0.185***	0.188***	0.160***
	(0.014)	(0.026)	(0.028)	(0.018)	(0.017)
L.ΔE	0.081***	0.081***	0.088***	0.083***	0.066***
	(0.007)	(0.013)	(0.016)	(0.008)	(0.010)
L2.ΔE	0.013	0.006	0.018	0.009	-0.013
	(0.009)	(0.018)	(0.017)	(0.008)	(0.011)
X		0.193**	0.153	-0.027	0.025
		(0.071)	(0.077)	(0.024)	(0.649)
$\Delta E \times$ X		-0.000	-0.001	-0.000	0.003
		(0.001)	(0.001)	(0.000)	(0.006)
L.$\Delta E \times$ X		0.000	-0.000	0.000	0.003
		(0.001)	(0.001)	(0.000)	(0.002)
L2.$\Delta E \times$ X		0.000	-0.001	0.000	-0.002
		(0.001)	(0.001)	(0.000)	(0.006)
Output gap (g)	0.013	0.047	0.043	0.023	-0.430***
	(0.057)	(0.081)	(0.080)	(0.056)	(0.117)
Inflation expectation ($\mathbb{E}\pi$)	0.454***	0.472***	0.468***	0.454***	0.300
	(0.039)	(0.045)	(0.045)	(0.037)	(0.152)
Country FE	Y	Y	Y	Y	Y
Cluster	cty	cty	cty	cty	cty
R^2	0.64	0.63	0.63	0.64	0.59
Country-Year	3,005	2,155	2,155	2,945	979
Countries	109	66	66	104	93
Countries: AE	35	32	32	35	33
Countries: EM	54	31	31	54	47
Countries: LIC	20	3	3	15	13
Start	1973	1973	1973	1973	2010
End	2022	2022	2022	2022	2022

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

PUBLICATIONS

Do Renewables Shield Inflation from Fossil Fuel-Price Fluctuations?

Working Paper No. WP/2024/111