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The Asymmetric Impact of Economic Policy and Oil Price Uncertainty on Inflation: Evidence from Developed and Emerging Economies

Abstract

This paper examines the asymmetric impact of economic policy uncertainty (EPU) and oil price uncertainty (OPU) on inflation by using a Nonlinear ARDL (NARDL) model, which is compared to a benchmark linear ARDL one. Using monthly data from the 1990s until August 2022 for a number of developed and emerging countries, we find that the estimated effects of both EPU and OPU shocks are larger when allowing for asymmetries in the context of the NARDL framework. Further, EPU shocks, especially negative ones, have a stronger impact on inflation than OPU ones and capture some of the monetary policy uncertainty, thereby reducing the direct effect of interest rate changes on inflation. Since EPU shocks reflect, at least to some extent, monetary policy uncertainty, greater transparency and more timely communications from monetary authorities to the public would be helpful to anchor inflation expectations.

JEL-Codes: C220, E310, E600.

Keywords: inflation, asymmetries, NARDL, oil price uncertainty, economic policy uncertainty.

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1. Introduction

Understanding the determinants of inflation is crucial for establishing the empirical relevance of alternative theoretical models and for designing appropriate policies. Numerous studies have analysed this topic and provided evidence on the importance of factors such as domestic demand shocks (Lim and Sek, 2015; Deniz et al., 2016), domestic supply shocks (Boschi and Girardi, 2007; Lagoa, 2017), monetary policy changes (Dhakal et al., 1994; Baldin and Poplawski-Ribeiro, 2011) and oil prices (Greenidge and DaCosta, 2009; Eftekhari-Mahabadi and Kiaee, 2015). In recent decades, the world economy has also experienced deeper uncertainty, which has affected the decision-making process of agents and thus the macroeconomy. Most existing studies, however, fail to take into account its possible effects on inflation – in particular, only a few of them have assessed the impact on inflation, as well as on economic activity, of economic policy uncertainty (EPU) (see Al-Thaqeb and Algharabali, 2019 for a review of the literature), or of demand uncertainty related to output growth and inflation, which has been found to have mixed effects on the latter (Grier and Perry, 1998; Neanidis and Savva, 2013); more recent evidence suggests that the transmission of economic uncertainty shocks to inflation is asymmetric (Istiak and Serletis, 2018; Wen et al., 2021; Long et al., 2022). Oil price uncertainty has also been shown to affect negatively economic activity, whilst its impact on inflation has often been overlooked (Elder and Serletis, 2010; Jo, 2014). To our knowledge, no existing study provides a comprehensive analysis of the impact of both types of shocks on inflation.

The present paper aims to fill this gap in the literature by assessing the possible role of both economic policy uncertainty (EPU) and oil price uncertainty (OPU) shocks as inflation drivers. The analysis is carried out for some of the main developed and emerging economies, namely the US, the UK, Canada, Australia, New Zealand, Denmark, Japan, Sweden, Brazil, Chile, Mexico and Russia, using monthly data spanning the period from the 1990s until August 2022. Initially, an Autoregressive Distributed Lag (ARDL) model is estimated as a benchmark. Then, given some recent evidence on asymmetries in the transmission of uncertainty shocks (see, e.g., Karaoğlu and Demirel, 2021; Munir, 2022), a Nonlinear ARDL (NARDL) model is also employed to allow for nonlinearities in the responses to shocks.

Therefore, in comparison to earlier studies ours makes a threefold contribution to this area of the literature. First, it considers asymmetries in the transmission of uncertainty shocks to inflation in both the short and the long run. Second, it includes uncertainty originating from both policymaking and the supply side, both of them having become increasingly relevant as inflation drivers in recent years, especially during the Covid-19 pandemic and the Russia-Ukraine conflict. Third, it covers a wide range of developed and emerging economies.

The remainder of this paper is structured as follows: Section 2 briefly reviews the relevant literature; Section 3 outlines the econometric methods used for the analysis; Section 4 describes the data and discusses the empirical results; Section 5 offers some conclusions and policy recommendations.

2. Literature Review

There is a substantial body of literature analysing the pass-through of domestic and foreign shocks to inflation, but only recently the focus has shifted towards capturing asymmetries and nonlinearities in the transmission mechanism. In order to capture the asymmetric effects of a wide range of shocks on inflation the Nonlinear ARDL (NARDL) model is often estimated. This approach has been used to analyse the exchange rate pass-through for various countries (Karaoğlu and Demirel, 2021; Munir, 2022), economic activity shocks for the G7 economies (Laxton et al., 1995), and current account balance shocks on inflation in Turkey (Yildirim and Vicil, 2022). All these studies found significant evidence of both short- and long-run asymmetries.

Amongst the various possible determinants of inflation, economic uncertainty, despite its increasing relevance, has only been considered by a limited number of papers. For instance, Bloom (2009) found that macroeconomic uncertainty, which increases after major economic and political shocks, affects inflation significantly. Balcilar et al. (2014) used a vector fractionally integrated autoregressive moving average model and concluded that forecasting models of US inflation including economic policy uncertainty (EPU) outperform standard ones. Other studies have found evidence of asymmetries in the transmission of positive and negative economic uncertainty shocks to economic activity indicators (Foerster, 2014; Istiak and Serletis, 2018; Murad et al., 2021). Using a NARDL model, Wen et al. (2021) showed that negative EPU shocks have a stronger effect than positive ones on food price inflation in China. Long et al. (2022) applied the same methodology to assess the impact of global EPU on international grain prices, and reported that a rise (fall) in global EPU tends to increase (decrease) them, with the negative effect being stronger in the long run.

Oil price shocks have also been found to affect inflation. Choi et al. (2018) ran a panel regression including 72 countries and estimated that a 10% increase in global oil inflation increases consumer price inflation in most developed and developing countries by 0.4 percentage points, but this effect declines over time with an increase in central bank credibility. Köse and Ünal (2021) estimated a structural VAR model and provided evidence that oil prices and oil price volatility are important determinants of inflation dynamics in Turkey. Several studies using the NARDL approach have shown that oil price shocks are the most important determinants of inflation and inflation variability in developed and emerging countries in both the short and the long run (Lily et al., 2019; Lacheheb and Sirag, 2019; Ali, 2020; Deluna et al., 2021). An exception are the BRICS countries, for which there is only limited evidence of an asymmetric impact of oil shocks on inflation (Li and Guo, 2022), with only Abu-Bakar and Masih (2018) reporting an asymmetric pass-through for India, and Long and Liang (2018) for China. Finally, Bala and Chin (2018) showed that for African OPEC members higher rates of inflation are associated with a decrease in oil prices, while Husaini and Lean (2021) found that oil price shocks have a strong positive impact on inflation in the South East Asian economies.

The above mentioned studies mainly assess the impact of oil price changes on inflation, whilst they usually overlook the possible role of oil price uncertainty. The latter variable is usually measured by computing the standard deviation (Elder and Serletis, 2010; Jo, 2014) or by estimating a GARCH (1,1) model (Elder and Serletis, 2010; Wang et al., 2017), but its asymmetric impact on inflation has not been assessed to date. By contrast, the nonlinear framework we use explicitly allows for this possibility and provides evidence on asymmetries for both OPU and EPU shocks.

3. Empirical Framework

3.1 The Linear ARDL Model

To investigate the issue of interest we begin by estimating a linear Autoregressive Distributed Lag (ARDL) benchmark model of the following form:

$$y_t = \sum\nolimits_{i=1}^{p} \gamma_i y_{t-i} + \sum\nolimits_{i=1}^{q} \theta_i x_{t-i} + u_t \qquad (1)$$

where y_t is the regressand and x_t is a vector of multiple regressors integrated of order $I(0)$ or $I(1)$. The specific model we estimate including an error correction term is the following:

$$\begin{aligned} \Delta\pi_t = \mu &+ \sum_{i=1}^{p} \gamma_i \Delta\pi_{t-i} + \sum_{i=1}^{q1} \varphi_{1,i} \Delta i_{t-i} + \sum_{i=1}^{q2} \varphi_{2,i} \Delta y_{t-i} + \sum_{i=1}^{q3} \varphi_{3,i} \Delta epu_{t-i} \\ &+ \sum_{i=1}^{q4} \varphi_{4,i} \Delta opu_{t-i} + \sum_{i=1}^{q5} \varphi_{5,i} \Delta s_{t-i} + \rho ecm_{t-1} + \theta_1 i_{t-1} + \theta_2 y_{t-1} \\ &+ \theta_3 epu_{t-1} + \theta_4 opu_{t-1} + \theta_5 s_{t-1} + u_t \end{aligned} \qquad (2)$$

where π_t is the inflation rate, i_t is the official central bank policy rate, y_t is the output gap[1], epu_t stands for economic policy uncertainty, opu_t denotes oil price uncertainty, s_t is the real effective exchange rate and u_t is an iid error term; also, Δ is the difference operator and ecm_{t-1} the error correction term. We follow a similar approach to that of Shin et al. (2014) by initially setting the number of lags p and q equal to 4 and then dropping the insignificant ones.

Our measure of oil price uncertainty is the estimate of oil price volatility yielded by a Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model of the following form:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} e_{t-i}^2 + \sum_{i=1}^{q} \alpha_{2i} \sigma_{t-i}^2 + \varepsilon_t \qquad (3)$$

where σ_t^2 is the conditional variance, e_{t-i}^2 are i lags of the past squared error terms and σ_{t-i}^2 are i lags of the past variance. The number of lags p and q is determined using the Akaike information criterion, with $1 \le p \le 4$ and $1 \le q \le 4$. The GARCH measure of oil price uncertainty is well known to be preferable to others, such as the standard deviation, since it can detect volatility clustering in oil returns (Wang et al., 2017).

[1] The output gap is measured by using the Hodrick-Prescott filter for real GDP (Hodrick and Prescott, 1997).

The ARDL model is a fairly novel addition to the class of cointegration models, previously including those by Engle and Granger (1987) and Johansen (1992), and is an attractive option to test for the presence of a long-run cointegration relationship between variables with mixed orders of integration, i.e. *I(0)* and *I(1)* (Aimer and Lusta, 2021). However, it is unsuitable for variables with higher orders. For this reason, we test the order of integration of all variables in the model by using the Augmented Dickey-Fuller Generalised Least Squares (ADF-GLS) test for the unit root null against the alternative of trend stationarity. The lag structure is selected according to the Ng-Perron criterion and the model is estimated by Ordinary Least Squares (OLS). Since ARDL models can suffer from a range of misspecification issues, we carry out the Breusch-Pagan test for heteroscedasticity, the Breusch-Godfrey Lagrange Multiplier (LM) test for serial correlation and the Cumulative Sum (CUSUM) test of parameter constancy to assess data congruency.

3.2 The Nonlinear ARDL (NARDL) Model

There are various possible reasons why the response of inflation to various types of economic shocks might not be linear. If, for instance, interest rate decreases lead to higher prices by stimulating investment, there is no guarantee that equivalent increases will result in price falls of the same size (Deluna Jr et al., 2021). The linear ARDL model does not allow for the possibility of positive and negative shocks affecting the inflation rate differently, and thus it overlooks any asymmetries in the short- and long-run transmission of uncertainty shocks. By contrast, the NARDL framework accounts for hidden cointegration (i.e. between the positive and negative components of individual time series), and therefore it is an attractive extension to the linear ARDL model allowing for possible nonlinearities (Liang et al., 2020). It also has advantages over other nonlinear frameworks. First, it distinguishes between short- and long-run asymmetries. Second, it estimates separately the impact of positive and negative shocks under non-stationarity. Third, it provides a flexible approach to establishing long-run relationships between variables with mixed integration orders.

As a starting point we test for nonlinear dependence in the ARDL model residuals using the Brock, Dechert, Scheinkman and LeBaron (BDS) test (Brock et al., 1996). Under the null hypothesis the residual sequence is independent and identically distributed; therefore a rejection of the null implies that a nonlinear model is more suitable than a linear one, given the existing dependence structure.

The general Nonlinear ARDL model takes the following form:

$$y_t = \sum_{i=1}^{p} \gamma_i y_{t-i} + \sum_{i=1}^{q} (\theta_i^{+'} x_{t-i}^{+} + \theta_i^{-'} x_{t-i}^{-}) + u_t \tag{4}$$

where y_t is the regressand and x_t is a vector of multiple regressors integrated of order $I(0)$ or $I(1)$ defined as before, but now the x_t are decomposed into their partial sum processes of negative and positive changes around a threshold of zero as $x_t = x_0 + x_t^+ + x_t^-$. Also, γ_i is the autoregressive parameter on the lagged dependent variable, θ_i^+ and θ_i^- are the asymmetric distributed lag parameters, and u_t is an iid error process.

The specific NARDL model with error correction specification we estimate can be represented as follows:

$$\begin{aligned}\Delta\pi_t = \mu &+ \sum_{i=1}^{p} \gamma_i \Delta\pi_{t-i} + \sum_{i=1}^{q1} \varphi_{1,i}^{+'} \Delta i_{t-i}^{+} + \sum_{i=1}^{q1} \varphi_{1,i}^{-'} \Delta i_{t-i}^{-} + \sum_{i=1}^{q2} \varphi_{2,i}^{+'} \Delta y_{t-i}^{+} + \sum_{i=1}^{q2} \varphi_{2,i}^{-'} \Delta y_{t-i}^{-} \\ &+ \sum_{i=1}^{q3} \varphi_{3,i}^{+'} \Delta epu_{t-i}^{+} + \sum_{i=1}^{q3} \varphi_{3,i}^{-'} \Delta epu_{t-i}^{-} + + \sum_{i=1}^{q4} \varphi_{4,i}^{+'} \Delta opu_{t-i}^{+} + \sum_{i=1}^{q4} \varphi_{4,i}^{-'} \Delta opu_{t-i}^{-} \\ &+ \sum_{i=1}^{q5} \varphi_{1,i}^{+'} \Delta s_{t-i}^{+} + \sum_{i=1}^{q5} \varphi_{1,i}^{-'} \Delta s_{t-i}^{-} + \rho ecm_{t-1} + \theta_1^{+'} i_{t-1}^{+} + \theta_1^{-'} i_{t-1}^{-} + \theta_2^{+'} y_{t-1}^{+} \\ &+ \theta_2^{-'} y_{t-1}^{-} + \theta_3^{+'} epu_{t-1}^{+} + \theta_3^{-'} epu_{t-1}^{-} + \theta_4^{+'} opu_{t-1}^{+} + \theta_4^{-'} opu_{t-1}^{-} + \theta_5^{+'} s_{t-1}^{+} \\ &+ \theta_5^{-'} s_{t-1}^{-} + u_t\end{aligned} \tag{5}$$

where all variables are defined as before. φ_i^+ and φ_i^- are the asymmetric short-run parameters and ecm_{t-1} is the nonlinear error correction term, where $\beta^+ = \frac{-\theta^+}{\rho}$ and $\beta^- = \frac{-\theta^-}{\rho}$ are the asymmetric long-run parameters. We allow for asymmetries in both the short and the long run by capturing "reaction asymmetry" with the long-run parameters and "impact asymmetry" with the asymmetric short-run coefficients of the short-run first differences. In addition, "adjustment asymmetry" is measured by taking into account the interaction between impact and reaction asymmetries through the adjustment parameter ρ defined as $\rho = \pi_t - \beta^{+\prime} x_t^+ - \beta^{-\prime} x_t^-$. In this way, the model does not directly estimate asymmetric error correction, but rather evaluates patterns of dynamic adjustment towards equilibrium (Shin et al., 2014). Similarly to the linear ARDL model, the NARDL one can be estimated using standard OLS, since the it is nonlinear in the variables only, but linear in the parameters. We also calculate asymmetric cumulative dynamic multipliers, which show the asymmetric adjustment patterns of inflation following positive and negative shocks to economic policy and oil price uncertainty.

One can test for the existence of a long-run relationship by using the dynamic bounds testing procedure which is based on an F-test with the null hypothesis $H_0 = \rho = \theta^+ = \theta^- = 0$. This test is adapted to account for hidden cointegration. Pesaran et al. (2001) suggest two sets of asymptotic critical values, the first assuming that all variables are $I(0)$ and the other that they are all $I(1)$. The null hypothesis of no cointegration is rejected if the computed F-statistic exceeds the upper bound of the critical value. However, in small sample sizes the asymptotic critical values are unsuitable and thus empirical critical values should be used (Pesaran and Shin, 1998). Therefore we compute the latter and their confidence intervals by using the recursive bootstrap method suggested by McNown et al. (2018).

3.3 Model Mis-specification and Robustness Tests

When employing a NARDL model, one needs to test for short- and long-run asymmetries in the parameters of the positive and negative partial sum components by using a Wald test of for the null of symmetry against the alternative of asymmetry. If $\varphi_i^+ = \varphi_i^-$, the effect is symmetric in the short run, and similarly, if $\theta_i^+ = \theta_i^-$, the effect is symmetric in the long run. In such a case the linear ARDL model is sufficient to capture the behaviour of the variables.

In order to test the adequacy of the NARDL model, we carry out a number of mis-specification tests. In particular, we test for serial correlation of the residuals by using the Lagrange Multiplier (LM) test; for ARCH effects by carrying out the ARCH-LM test; for parameter stability by implementing the Cumulative Sum (CUSUM) test. Finally, we compare the in-sample and out-of-sample predictive accuracy of the forecasts generated by the NARDL model with those from the linear ARDL model by performing the Diebold and Mariano test (Diebold, 2015), which uses the Mean Square Prediction Error (MSPE) to test the null of equal predictive accuracy of both forecasts against the one-sided alternative of higher predictive accuracy of the nonlinear model forecast.

4. Data and Empirical Results

4.1 Data Description

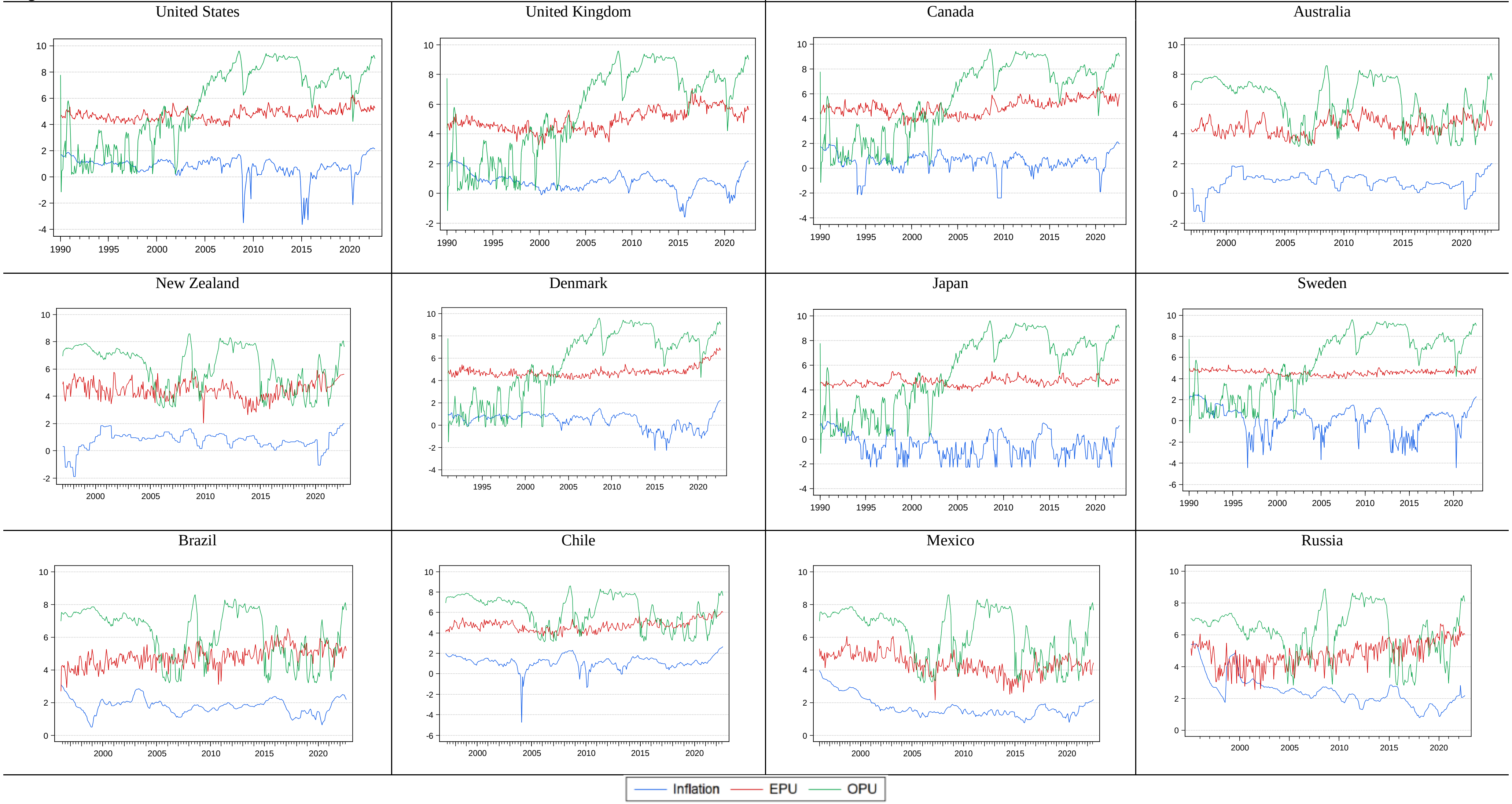
We analyse monthly series over a sample period with a different start date for each country depending on data availability (see Appendix A for details) and ending in August 2022. The set of countries considered includes both developed and emerging economies, specifically the US, the UK, Canada, Australia, New Zealand, Denmark, Japan, Sweden, Brazil, Chile, Mexico and Russia.

Inflation is measured as the percentage price change in the consumer price index (CPI) series obtained from the Organisation of Economic Cooperation and Development (OECD) inflation and CPI database for all countries except Australia and New Zealand, for which the series are taken from the Bank for International Settlements Consumer Price Index database. The source for the Brent oil price index (measured in US dollars per barrel) is the Federal Reserve Bank of St Louis (FRED) economic database. The output gap is constructed using the real normalised GDP series taken from the OECD Monthly Economic Indicators database. The central bank policy rates as well as the real effective exchange rate series are obtained from the Bank for International Settlements (BIS) Statistics database. The economic policy uncertainty index data for all countries is from the Baker, Bloom and Davies website; [2] as explained by Baker et al. (2016), it is based on the frequency of news coverage in the form of newspaper articles containing keywords concerning all components of economic policy uncertainty, and is the most comprehensive measure of this variable currently available. All series are transformed into logarithmic form.

Oil price uncertainty (OPU) is the estimated oil price volatility from a GARCH (1,1) model selected on the basis of various selection criteria (these results are not reported to save space). This is consistent with most of the literature, which generally finds that the optimal lag length for GARCH models is 1 (Hansen and Lunde, 2005). Figure 1 displays the inflation, EPU and OPU series for all countries. It can be seen that there are periods when inflation is stable and others when it falls, the latter coinciding with economic downturns such as the global financial crisis and the recent Covid-19 pandemic; further, this variable appears to be more volatile in some of the countries under examination, namely Canada, Japan and Sweden. Although OPU also fluctuates considerably, EPU is the most volatile series.

[2] https://www.policyuncertainty.com/index.html

Figure 1. Inflation, EPU and OPU Plots



Formal ADF-GLS tests (see Table 1) indicate that all variables are at most $I(1)$, as required for the estimation of an ARDL model.

Table 1. ADF-GLS Test Results for Individual Series

	Level series				
	π	i	y	epu	s
United States	-2.439	-3.864***	-4.703***	-2.982	-1.622
United Kingdom	-1.201	-0.906	-4.207***	-2.902**	-2.716
Canada	-0.808	-1.321	-3.524***	-2.146	-1.364
Australia	-2.730*	-4.577***	-3.640***	-3.243**	-1.521
New Zealand	-1.446	-1.700	-4.257***	-2.274	-1.871
Denmark	-1.983	-2.587*	-4.873***	-0.259	-2.576
Japan	-3.068**	-1.134	-4.928***	-3.929***	-2.015
Sweden	-0.556	-1.662	-5.380***	-1.606	-2.520
Brazil	-1.828	-3.528***	-3.964***	-1.881	-1.551
Chile	-3.162**	-3.145**	-4.061***	-1.632	-1.935
Mexico	-3.088**	-2.595*	-3.589***	-2.153	-1.972
Russia	-1.386	-1.171	-5.387***	-1.667	-2.522
	Differenced series				
	$\Delta\pi$	Δi	Δy	Δepu	Δs
United States	-5.183***	-3.893***	-7.273***	-2.982	-5.711***
United Kingdom	-4.232***	-3.984***	-6.548***	-2.902**	-6.629***
Canada	-8.198***	-4.205***	-9.133***	-2.146	-5.824***
Australia	-4.857***	-8.065***	-4.179***	-4.308***	-6.425***
New Zealand	-5.134***	-3.815***	-6.409***	-2.274	-6.058***
Denmark	-6.049***	-6.137***	-7.573***	-4.426***	-5.101***
Japan	-4.687***	-12.238***	-5.856***	-6.678***	-4.022***
Sweden	-3.805***	-10.419***	-6.847***	-1.606	-6.117***
Brazil	-4.449***	-4.684***	-9.009***	-3.573***	-4.697***
Chile	-8.642***	-5.606***	-4.820***	-3.323**	-8.845***
Mexico	-3.767***	-4.524***	-6.292***	-2.153	-6.533***
Russia	-4.121***	-4.576***	-9.386***	-1.667	-10.999***
	Level series		**Differenced series**		
OPU	-1.682		-3.039**		

* significant at 10% level, ** significant at 5% level, *** significant at 1% level.

ADF-GLS Test hypothesis:
H_0: $series\ contains\ a\ unit\ root$
H_1: $series\ is\ stationary$

Case II: constant and linear trend.
Lag selection according to the Ng-Perron sequential t-test.

4.2 Results for the Linear ARDL Model

The results of the linear ARDL estimation are reported in Table 2. Economic policy and oil price uncertainty only affect inflation in some countries – specifically, EPU does not have any impact on inflation in the short run in the US, the UK, Canada, Denmark, Sweden and Chile, while OPU has no short-run effect in Australia, Denmark and Russia. Further, the estimated effect tends to be small, with inflation increasing by 0.5% to 0.7% respectively in response to a 1% short-run EPU and OPU shock. One percent changes in the output gap have a positive effect on inflation ranging between 0.07% and 0.25% in the short run in a number of countries, and none for Canada, Australia, Japan and Chile. Inflation decreases by up to 0.63% following a 1% increase in the short-run interest rate; this occurs only with a lag of one to two months, but indicates the effectiveness of contractionary monetary policy. Exchange rate changes of 1% have a strong negative impact of -0.58% on inflation in the short run with a two-month lag. The long-run relationship between inflation and the other variables in model is weak and insignificant for most countries, which suggests that inflation is affected primarily by short-run changes in the fundamentals in the linear model.

Table 2. Linear Autoregressive Distributed Lag Model Results

	United States	United Kingdom	Canada	Australia	New Zealand	Denmark
μ	0.709401	0.318465	-0.142323	0.252475	0.426383	-0.413164
$\Delta\pi_{t-1}$	0.000426	0.129529***	0.125620***	0.045606	-	-0.076852
$\Delta\pi_{t-2}$	-0.143932***	0.068084	-	0.043728	-	-0.086315*
$\Delta\pi_{t-3}$	-	0.153983***	-	0.165859***	-	0.084751*
Δi_{t-1}	0.625437***	-	0.291223**	-	0.109316	-0.206436***
Δi_{t-2}	0.631034***	-	0.473134***	-	0.211697**	0.147979**
Δy_{t-1}	-0.204148**	0.069859*	-	-	0.195963***	0.107276***
Δy_{t-2}	0.277672***	-0.115875***	-	-	-0.045825	-
Δepu_{t-1}	-	-	-	0.054041*	-0.000518	-
Δepu_{t-2}	-	-	-	0.054480*	0.000815	-
Δopu_{t-1}	0.071053**	0.074406***	0.023731	-	-0.003177	-
Δopu_{t-2}	-	0.041712**	-0.022012	-	0.000203**	-
Δs_{t-1}	-0.284942**	-	-	0.116540***	-	-0.562495
Δs_{t-2}	-0.237333*	-	-	-	-	-0.183001**
ecm_{t-1}	-0.129143***	-0.020658**	-0.165085***	-0.080081***	-0.063528***	-0.076884***
i_{t-1}	0.025370	0.000154	0.003182	-0.015553	-0.007730	0.037618**
y_{t-1}	0.721447	0.018680*	3.144135	0.033641	0.069058**	2.075947*
epu_{t-1}	0.050641	-0.066251	0.004648	-0.021766	0.000707	0.054340**
opu_{t-1}	0.001103	0.010157	-0.006101	0.003258	-0.008456	0.004857
s_{t-1}	-0.182918	-0.002291	0.056076	-0.019118	-0.002753	0.031126

	Japan	Sweden	Brazil	Chile	Mexico	Russia
μ	0.218686	0.143164	0.394890***	-1.245201	0.532261***	0.311457*
$\Delta\pi_{t-1}$	-	-0.207609***	0.472513***	-0.256219***	0.329871***	0.528824***
$\Delta\pi_{t-2}$	-	0.168275**	-	-	-0.067871	-
$\Delta\pi_{t-3}$	-	0.135423**	-	-	-	-
Δi_{t-1}	-	0.480958***	0.072201	0.244337	0.048290	-0.140076***
Δi_{t-2}	-	0.508915***	0.048152	0.345370*	0.106291**	0.155587***
Δy_{t-1}	-	0.383650***	0.248791**	-	-0.954731***	-
Δy_{t-2}	-	-	0.201058*	-	0.616174***	-
Δepu_{t-1}	-0.001972**	-	-0.013479*	-	-0.026142**	0.033547***
Δepu_{t-2}	-	-	-	-	-0.028798**	0.023621**
Δopu_{t-1}	0.006425**	-0.100779***	-	0.061031	0.007289	-
Δopu_{t-2}	-	-0.007703	-0.007696*	-	-0.023231***	-
Δs_{t-1}	0.011465	-0.271917*	-0.019353	0.865090	-	0.137251***
Δs_{t-2}	-	-0.215991	-0.376591***	-0.226991**	-	-0.589686***
ecm_{t-1}	-0.097649***	-0.102371***	-0.036142***	-0.246285***	-0.058605***	-0.040870***
i_{t-1}	0.051461***	0.201089***	-0.006323	0.089109*	0.023941	0.018744
y_{t-1}	0.053231***	-0.687791	0.319930	0.634839	0.535657	-0.077845
epu_{t-1}	-0.000530	-0.146793	-0.005867	0.161876***	0.014348	0.002801
opu_{t-1}	0.001704***	0.037402**	0.003294	-0.018088	0.011004***	0.007188*
s_{t-1}	-0.002033	0.025324	-0.071072***	0.167794	-0.134323***	-0.073769**

* significant at 10% level, ** significant at 5% level, *** significant at 1% level.

To assess the adequacy of the linear ARDL model, we conduct several mis-specification tests; these results are reported in Table 3 and imply that this specification is not data congruent. Given this evidence, we perform a BDS test of linear dependence in the variables and the residuals of the ARDL model; the null of linear dependence is strongly rejected (see Table 4), which suggests that a nonlinear model might be more suitable. Therefore, we proceed to estimate a nonlinear ARDL model in the following section.

Table 3. ARDL Model Specification Tests			
	Breusch-Pagan Test	**Breusch-Godfrey Test**	**CUSUM Test**
United States	0.0000***	0.0141**	0.3221
United Kingdom	0.0001***	0.0077***	0.2393
Canada	0.1614	0.3142	0.2841
Australia	0.0000***	0.3150	0.1558
New Zealand	0.0000***	0.0000***	0.4514
Denmark	0.0000***	0.0093***	0.2197
Japan	0.1143	0.1491	0.3446
Sweden	0.0000***	0.0019***	0.3084
Brazil	0.0002***	0.0389**	0.0722*
Chile	0.0015***	0.6727	0.3758
Mexico	0.0055***	0.8550	0.6716
Russia	0.0000***	0.0010***	0.0951*

* significant at 10% level, ** significant at 5% level, *** significant at 1% level.

Breusch-Pagan Test for Heteroscedasticity:	Breusch-Godfrey LM Test for serial correlation:	CUSUM Test for parameter constancy:
H_0: *homoscedastic errors*	H_0: *no serial correlation*	H_0: *no parameter constancy*
H_1: *heteroscedastic errors*	H_1: *serial correlation*	H_1: *parameter constancy*

Table 4. BDS Test Results for Individual Variables and ARDL Model Residuals										
	M=2	**M=3**	**M=4**	**M=5**	**M=6**	**M=2**	**M=3**	**M=4**	**M=5**	**M=6**
	Inflation Rate					**Policy Rate**				
United States	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
United Kingdom	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Canada	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Australia	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
New Zealand	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Denmark	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Japan	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Sweden	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Brazil	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Chile	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Mexico	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Russia	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
	Output Gap					**Economic Policy Uncertainty**				
United States	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
United Kingdom	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Canada	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Australia	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
New Zealand	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Denmark	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Japan	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Sweden	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Brazil	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Chile	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Mexico	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Russia	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
	Real Effective Exchange Rate					**ARDL Model Residuals**				
United States	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
United Kingdom	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0234**	0.0015***	0.0000***	0.0000***	0.0000***
Canada	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Australia	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0027***	0.0000***	0.0508*	0.0500*	0.0460**
New Zealand	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0079***	0.0025***	0.0389**	0.0069***	0.0451**
Denmark	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Japan	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0068***	0.0074***	0.0057***	0.0046***	0.0071***
Sweden	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Brazil	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0014***	0.0000***	0.0000***	0.0000***
Chile	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0099***	0.0097***	0.0096***	0.0094***	0.0093***
Mexico	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0066***	0.0012***	0.0001***	0.0001***	0.0001***
Russia	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
	Oil price uncertainty									
	M=2		**M=3**		**M=4**		**M=5**		**M=6**	
	0.0000***		0.0000***		0.0000***		0.0000***		0.0000***	

* significant at 10% level, ** significant at 5% level, *** significant at 1% level.

4.3 NARDL Model Results

The results for the NARDL model are reported in Tables 5 and 6 and show that the relationship between inflation and the explanatory variables is indeed asymmetric. The existing literature reports mixed effects of economic uncertainty on inflation (Grier and Perry, 1998; Neanidis and Savva, 2013). We find that both EPU and OPU shocks appear to be more important drivers of inflation in a nonlinear framework. More specifically, in the short run, positive EPU shocks of 1% increase inflation by up to 0.15%, and negative ones by 0.1% to 0.29%. The estimated stronger effect of negative EPU shocks is consistent with previous evidence (Wen et al., 2021; Long et al., 2022). Inflation in Chile is the most affected by economic policy uncertainty, with positive (negative) EPU shocks increasing it by up to 0.87% (1.27%). OPU shocks have a smaller impact on inflation, with increases between less than 0.01% and up to 0.19% resulting from positive one percent shocks, and decreases by up to 0.13% from negative ones. A plausible explanation for this finding is that oil prices and oil price uncertainty tend to affect producer prices rather than the consumer prices we investigate in this paper (Husaini and Lean, 2021). The estimated coefficients imply that output now has a much stronger effect (ranging between 0.1% and 0.96%) on inflation compared to the linear case. Contrary to what one would expect (Watanabe, 1997), a positive (negative) change in the output gap causes inflation to decrease (increase) in the short run with one lag. However, after more lags positive (negative) output gap changes tend to increase (reduce) inflation, which is in line with the previous findings in the literature (Clark and McCracken, 2006; Calza, 2009; Tiwari et al., 2014).

The effects of short-run interest rate changes on inflation are significant and of a similar size to the linear case, but only with a lag. Some of the uncertainty related to interest rate changes might in fact be captured by the now significant EPU variable. Uncertainty regarding the monetary policy stance or future policy decisions might delay or accelerate spending decisions by agents and therefore affect the inflation rate before any interest rate decision is made (Balcilar et al., 2014). As expected, interest rate decreases (increases) lead to a higher (lower) inflation rate in the short run, but only in some countries. For the US, the UK, Brazil and Chile inflation only reacts to negative interest rate changes in the short run, which indicates that prices are more sensitive to expansionary monetary policies, with a reduction in interest rates leading to higher inflation as expected. Finally, the exchange rate effect on inflation is similar to that in the linear model.

Table 5. Nonlinear Autoregressive Distributed Lag Model Results						
	United States	**United Kingdom**	**Canada**	**Australia**	**New Zealand**	**Denmark**
μ	0.224999	0.415152***	0.783950***	0.147821	0.179250	0.137532*
$\Delta\pi_{t-1}$	-	-	0.105525**	-0.020000*	-	-
$\Delta\pi_{t-2}$	-0.084626*	-0.127105**	-	-	-	-
$\Delta\pi_{t-3}$	-	0.127172**	-	-	0.144026**	-
Δi^{+}_{t-1}	-	-	-	0.120276**	-	-
Δi^{+}_{t-2}	-	-	-	-	-	-
Δi^{-}_{t-1}	0.1069886***	0.333648**	-	-	-	-
Δi^{-}_{t-2}	0.916893***	-0.278232**	-	-0.106121**	-	-
Δi^{-}_{t-3}	-0.267274*	0.212204**	-	-	-	-
$\Delta \mathrm{y}^{+}_{t-1}$	-0.290178*	-	-	0.703586**	-	-
$\Delta \mathrm{y}^{+}_{t-2}$	-	-0.125415**	-	-0.376567**	-	-
Δy^{-}_{t-1}	-0.491909***	-0.108718**	0.166517***	-	0.430419***	-
Δy^{-}_{t-2}	-	0.288343***	-	-	-0.311462***	-
Δy^{-}_{t-3}	0.486540***	-0.346671***	-	-0.133349**	-0.192584**	-
Δy^{-}_{t-4}	-0.572015***	-	-	-	-	-
$\Delta \mathrm{epu}^{+}_{t-1}$	-	0.154766**	0.001590**	0.129045**	-	-
$\Delta \mathrm{epu}^{+}_{t-2}$	-	-	-	0.021499*	0.001181**	-
$\Delta \mathrm{epu}^{+}_{t-3}$	-	-	0.001585**	-	-	-
Δepu^{-}_{t-1}	-0.294795**	-	-	-	-	-0.001896***
Δepu^{-}_{t-2}	-0.198229*	-	-	0.119316**	0.040754**	-
$\Delta \mathrm{opu}^{+}_{t-1}$	-	0.000130***	0.000136**	-0.054900**	0.047605**	0.000117***
$\Delta \mathrm{opu}^{+}_{t-2}$	-	-	-	-	-	0.000103**
$\Delta \mathrm{opu}^{+}_{t-3}$	-	0.009625**	-	-	-	0.009821**
Δopu^{-}_{t-1}	0.089667**	0.007612**	-	-	-	-0.007464**
Δopu^{-}_{t-2}	-	-	-	0.015648**	-	0.005742**
Δs^{+}_{t-1}	-0.437976**	-	0.066154**	-	-	-
Δs^{+}_{t-2}	-0.416752**	-	-0.074060**	-	-	-
Δs^{-}_{t-1}	-	-	0.069133**	0.185998***	-	-
Δs^{-}_{t-2}	-	-	0.050317*	-	-	-
ecm_{t-1}	-0.211082***	-0.058212***	-0.137974***	-0.108567**	-0.173740***	-0.123053***
i^{+}_{t-1}	0.135144***	0.042891	0.042755	-0.156254**	0.112728***	-0.043191**
i^{-}_{t-1}	0.029995	0.038884**	0.085286***	-0.055289	0.054959**	-0.041903***
y^{+}_{t-1}	0.437649	0.052935***	0.038516	0.208022	0.103495**	0.046312***
y^{-}_{t-1}	0.336926	0.026033**	-0.020000	0.140415**	0.063077	0.045399***
epu^{+}_{t-1}	0.131180**	0.017722	-0.001301**	0.053485**	0.236095**	0.001435***
epu^{-}_{t-1}	0.145747**	0.044861	-0.001106**	0.050590	0.241588	0.001301**
opu^{+}_{t-1}	0.000977	0.006792	0.001321	-0.015326**	0.006510*	-0.008777
opu^{-}_{t-1}	-0.005896	0.003596	0.002785	-0.010913	0.005075	-0.002096
s^{+}_{t-1}	-0.756316	-0.002608	-0.007118	0.305662	-0.014852*	-0.010328
s^{-}_{t-1}	-0.173523	-0.007112**	-0.019327*	0.381646	-0.011906	-0.001581
Bounds Test	4.126936#	6.799948#	4.070641#	5.4343#	4.911375#	6.855136#
LM Test	0.4852	0.9130	0.7834	0.8983	0.3230	0.7663
ARCH Effects	0.0638*	0.0126**	0.7117	0.2677	0.5402	0.5258

* significant at 10% level, ** significant at 5% level, *** significant at 1% level.

[#] F-statistic exceeds the empirical critical values at the 5% significance level.

LM Test for serial correlation:
H_0: $no\ serial\ correlation$
H_1: $serial\ correlation$

ARCH-LM Test for ARCH effects:
H_0: $no\ ARCH\ effects$
H_1: $ARCH\ effects$

Table 7 reports the estimated long-run asymmetries, namely the coefficients associated with positive and negative long-run changes in the explanatory variables. In the long run, positive and negative EPU shocks affect inflation with the same sign and similar magnitude, more precisely, positive and negative EPU shocks increase inflation in the US, the UK, Australia, New Zealand, Denmark and Russia, while they both reduce it in all other countries. On the whole, in the long run inflation appears to be highly sensitive to changes in economic uncertainty. Positive and negative long-run OPU shocks both reduce inflation in the UK, Australia, Denmark and Russia but increase it in all other countries, although their effects are less significant than in the short run. The long-run relationship between the interest rate and inflation indicates that contractionary monetary policies influence inflation more strongly than expansionary ones, whilst the opposite holds in the short run. Output does not seem to have any significant long-run impact on inflation, while both appreciations and depreciations of the exchange rate have a negative effect.

Table 6. Nonlinear Autoregressive Distributed Lag Model Results

	Japan	**Sweden**	**Brazil**	**Chile**	**Mexico**	**Russia**
μ	1.062244***	0.591267**	0.160685**	-0.164135	0.394830***	0.440838***
$\Delta\pi_{t-1}$	0.082333	-0.175655***	0.465928***	0.308515***	0.337699***	0.365796***
$\Delta\pi_{t-2}$	-	0.097502	-	-	-	0.032193
$\Delta\pi_{t-3}$	-	0.131192**	-	-	-0.149606***	0.117578**
Δi^+_{t-1}	-0.245809**	-	-	-	-	-0.108157*
Δi^+_{t-2}	-	0.767409**	-	-	-	0.180056***
Δi^+_{t-3}	-0.919755**	-	-	-	-	-
Δi^-_{t-1}	0.917439***	1.114143***	0.302497**	-0.218398**	-	-
Δi^-_{t-2}	-	-	-	0.223901**	-	-
Δi^-_{t-3}	-	-	-	-	-	-
Δy^+_{t-1}	-	-	-	-	-0.839206**	-0.902457**
Δy^+_{t-2}	-	-0.386793**	-	-	-	-
Δy^+_{t-3}	-	-	-	-	0.774673**	-
Δy^+_{t-4}	-	-	-	-	-0.111254***	-
Δy^-_{t-1}	0.230890**	0.319710**	0.212654**	0.234803**	0.747675***	0.134661***
Δy^-_{t-2}	-	-	0.443753***	-	-0.756619***	-0.967252**
Δy^-_{t-3}	-	-	-	-	-	-
Δepu^+_{t-1}	-	-	-0.038254**	0.606786*	-	-
Δepu^+_{t-2}	-	-	-	0.877205***	-	-
Δepu^+_{t-3}	-	-	-	0.537272**	-0.049248***	-
Δepu^-_{t-1}	0.627763**	0.114316**	0.018007**	1.276981***	-	0.053867***
Δepu^-_{t-2}	-	-	-	1.093314***	-	0.021168*
Δepu^-_{t-3}	-	-	-	0.702194***	-	-
Δopu^+_{t-1}	0.199609***	0.052903*	0.010643**	-	-	-0.012885**
Δopu^+_{t-2}	-	-0.154646***	-	-	-	-
Δopu^+_{t-3}	-	-	-	-	-0.055825***	-
Δopu^+_{t-4}	-	-	-	-	-	-
Δopu^-_{t-1}	-	-0.130343**	-	-	-	-0.013759**
Δopu^-_{t-2}	-	-0.088973*	-0.016759**	-	-	0.021457**
Δs^+_{t-1}	-	-	-	-	0.530311*	0.127691***
Δs^+_{t-2}	-	-	-	-	-	-
Δs^+_{t-3}	-	-	-	-	-	-
Δs^-_{t-1}	0.026560*	0.366084**	-0.569195***	-0.044161**	-	-0.228051***
Δs^-_{t-2}	-	-0.530036**	-	-	-	0.101870***
Δs^-_{t-3}	0.027749*	-	-	-	-	-0.451663**
Δs^-_{t-4}	0.025618*	-	-	-	-	-
ecm_{t-1}	-0.163816***	-0.199799***	-0.052854***	-0.064138***	-0.109372***	-0.084990***
i^+_{t-1}	-0.294386	-0.030991	-0.011247	0.016219	0.067719***	0.040850*
i^-_{t-1}	-0.029240	-0.005867	0.009536	0.024723	0.074556***	-0.001269
y^+_{t-1}	0.428426**	0.375950	-0.233064	0.050727*	0.822540	0.664440**
y^-_{t-1}	0.436307**	-0.086627	-0.523656	0.053455*	-0.815932	0.807872
epu^+_{t-1}	-0.675221	-0.101802	-0.032564**	-1.092160***	-0.001495	0.009732*
epu^-_{t-1}	-0.549040	-0.230642	-0.033947**	-1.219364***	-0.010274	0.007007
opu^+_{t-1}	0.443513***	0.038692**	0.005473	0.002885	0.008401**	0.006282
opu^-_{t-1}	0.318002***	0.033109**	0.007313	0.005330	0.014378***	-0.000182*
s^+_{t-1}	-0.106375	-1.864043**	-0.070043	-0.009141	-0.337470***	-0.344750***
s^-_{t-1}	-0.072241	0.574644	-0.091486**	0.009134	-0.167691*	-0.096197
Bounds Test	5.384992#	5.884522#	4.133178#	4.387869#	5.927781#	4.014706#
LM Test	0.1416	0.4144	0.1101	0.0417**	0.6480	0.9036
ARCH Effects	0.7554	0.7682	0.0870*	0.0522*	0.8759	0.4277

* significant at 10% level, ** significant at 5% level, *** significant at 1% level.

F-statistic exceeds the empirical critical values at the 5% significance level.

LM Test for serial correlation:
$H_0: no\ serial\ correlation$
$H_1: serial\ correlation$

ARCH-LM Test for ARCH effects:
$H_0: no\ ARCH\ effects$
$H_1: ARCH\ effects$

Table 7. Long-Run Asymmetries						
	United States	**United Kingdom**	**Canada**	**Australia**	**New Zealand**	**Denmark**
Li^{+}	0.640243***	0.736810	0.309876	-1.439236	0.648832***	-0.350992**
Li^{-}	0.142099	0.667969***	0.618134***	-0.509257**	0.316332**	-0.340529***
Ly^{+}	2.073366	0.909345***	0.279153	19.16072	0.595689**	0.376362***
Ly^{-}	1.596186	0.447212*	-0.144952	12.93349	0.363056	0.368942***
$Lepu^{+}$	0.621465**	0.304438	-0.009430**	0.492647	1.358903	0.011658***
$Lepu^{-}$	0.690475**	0.770641**	-0.008017**	0.465978**	1.390516	0.010573**
$Lopu^{+}$	0.004628	-0.009400	0.009562	-0.141165**	0.000375**	-0.007133
$Lopu^{-}$	-0.027934	-0.004247	0.000202	-0.100519	0.000292	-0.001700
Ls^{+}	-3.583045	-0.044793	-0.051590	2.815412***	-0.085486**	-0.083930
Ls^{-}	-0.822063	-0.122181**	-0.140077*	3.515292	-0.068531	-0.012848
	Japan	**Sweden**	**Brazil**	**Chile**	**Mexico**	**Russia**
Li^{+}	-1.797054	-0.155111	-0.212802	0.252877	0.619166***	0.480646**
Li^{-}	-0.178492	-0.029363	0.180429	0.385469	0.681675***	-0.014926
Ly^{+}	0.261527*	1.881642	-4.409564	0.790901	7.520567	7.817825
Ly^{-}	0.266333**	-0.433569**	-9.907555	0.833432	-7.460154	9.505451
$Lepu^{+}$	-0.412099	-0.509520	-0.616115**	-0.170282**	-0.013669	0.114507**
$Lepu^{-}$	-0.335376	-1.154370**	-0.642280**	-0.190115**	-0.093940	0.082442
$Lopu^{+}$	0.271401***	0.193654**	0.103542	0.000449	0.076808**	0.073918
$Lopu^{-}$	0.194446***	0.165713**	0.138362**	0.000831	0.131464***	-0.002140
Ls^{+}	-0.064934***	-9.329588**	-1.325215	-0.142519	-3.085528***	-4.056343***
Ls^{-}	-0.044101***	2.876109	-1.730910**	0.142409	-1.533220*	-1.131859

* significant at 10% level, ** significant at 5% level, *** significant at 1% level.
L^{+} and L^{+} denote the positive and negative long run coefficients, which are defined by $\beta^{+} = -\frac{\theta^{+}}{\rho}$ and $\beta^{-} = -\frac{\theta^{-}}{\rho}$

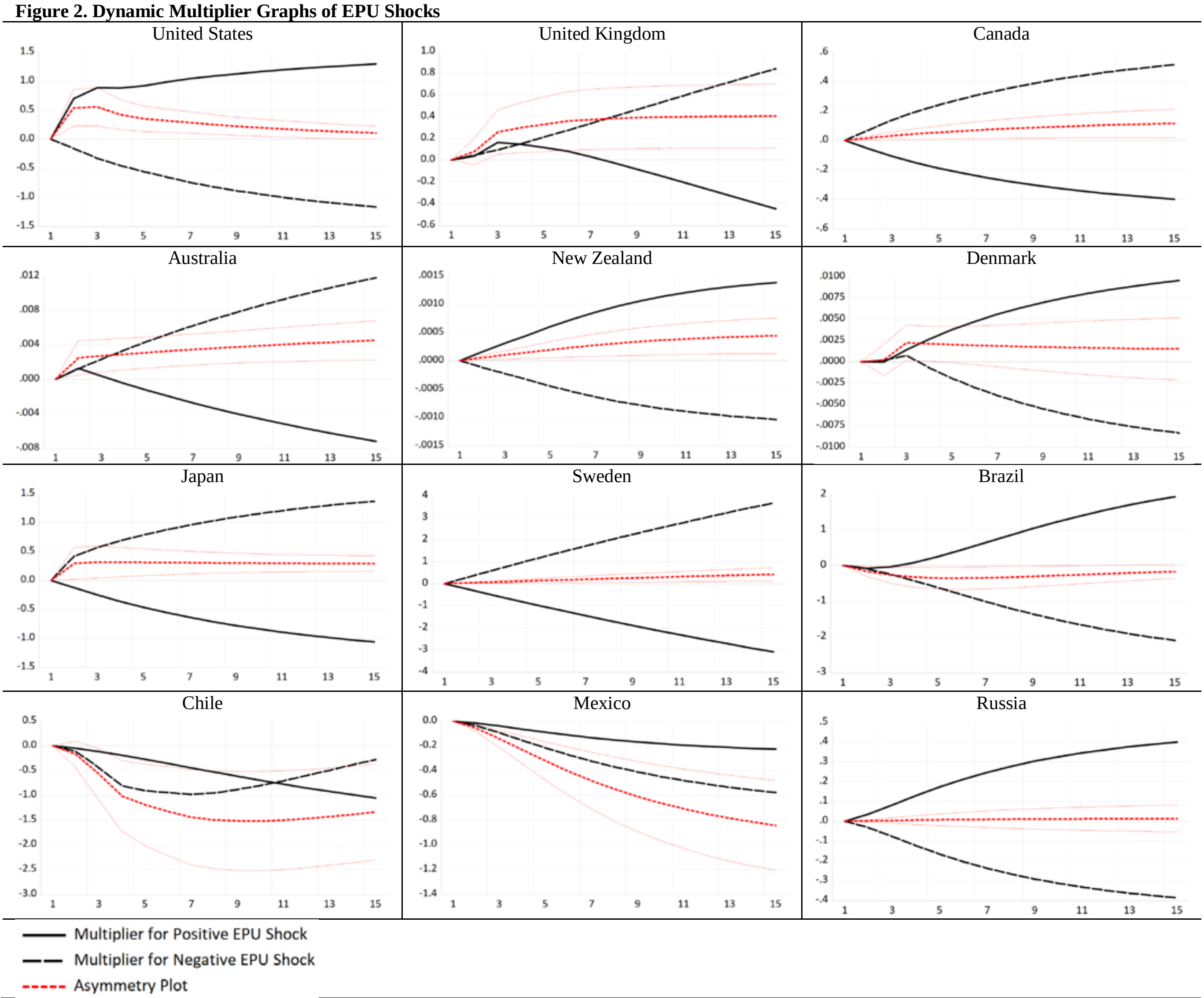
Table 8 reports the results of the Wald test of parameter symmetry, which provide clear evidence of both short- and long-run asymmetries and thus of the need for a suitable nonlinear model such as the NARDL one to capture them.

Table 8. Wald Test of Parameter Symmetry		
	Wald Test for short run symmetry	**Wald Test for long run symmetry**
United States	0.0000***	0.0447**
United Kingdom	0.0600*	0.0415**
Canada	0.0235**	0.0441**
Australia	0.0532*	0.0091***
New Zealand	0.0474**	0.0000***
Denmark	0.0012***	0.0031***
Japan	0.0544*	0.0143**
Sweden	0.0003***	0.0586*
Brazil	0.0021***	0.0274***
Chile	0.0032***	0.0051***
Mexico	0.0262**	0.0724*
Russia	0.0003***	0.0009***

* significant at 10% level, ** significant at 5% level, *** significant at 1% level.
Wald test of the null hypothesis of parameter symmetry.
$H_0: parameter\ symmetry$
$H_1: no\ parameter\ symmetry$

Figure 2 and 3 display the dynamic multipliers for EPU and OPU shocks to inflation respectively. The adjustment of inflation following an EPU shock appears to be rather slow, in most countries a new equilibrium being reached not before 15 months. Positive (negative) EPU shocks cause an increase (decrease) in inflation in the US, New Zealand, Denmark, Brazil and Russia, while the opposite holds for the UK, Canada, Australia, Japan and Sweden. In the UK and Australia positive EPU shocks increase inflation on impact, while in the long run they have a negative effect. The same holds for inflation in Denmark following a negative EPU shock. In Mexico and Chile both positive and negative EPU shocks reduce inflation initially, but in Chile the effect of a negative EPU shock increases inflation in the long run.

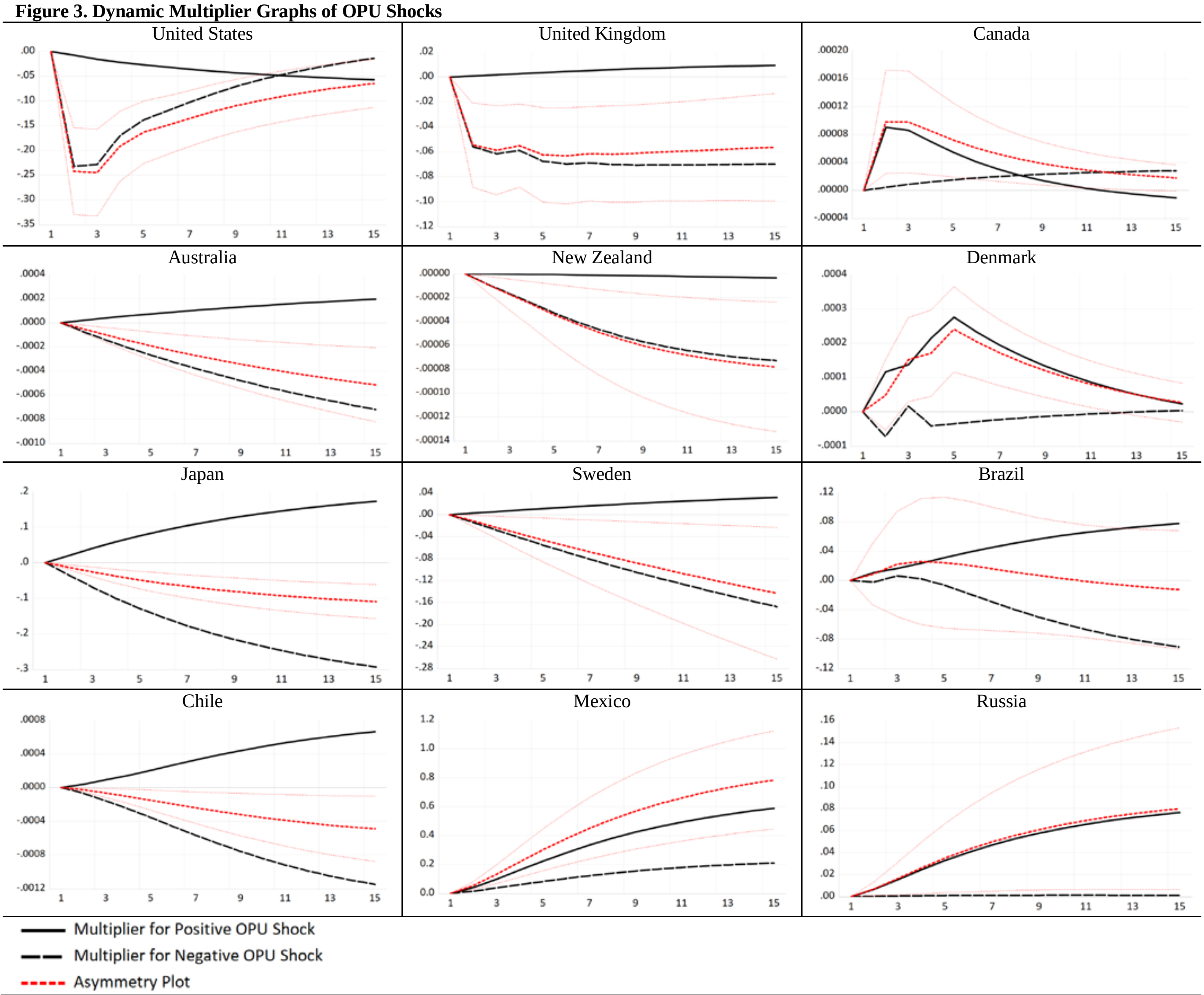
Figure 2. Dynamic Multiplier Graphs of EPU Shocks



The adjustment of inflation to the new long-run equilibrium following an OPU shock takes longer than after an EPU one, and in some instances positive OPU shocks only have an impact after a few months. A positive (negative) OPU shock leads to higher (lower) inflation in Australia, Japan, Sweden, Brazil and Chile. In the UK and in New Zealand the effect of positive OPU shocks on inflation are neutral, while negative ones reduce inflation. In Mexico and Russia the opposite holds, namely positive OPU shocks increase inflation while negative ones have no significant impact. In the US, negative OPU shocks initially have a very strong negative effect, whilst the long-run ones are close to zero. In Canada and Denmark, positive

OPU shocks have an initial strong positive effect on inflation, which converges to zero after two months in the former and after five months in the latter.

Figure 3. Dynamic Multiplier Graphs of OPU Shocks



Finally, for robustness purposes we evaluate the in-sample and out-of-sample predictive accuracy of the NARDL model forecasts relative to those of the linear ARDL model by using a Diebold-Mariano test; these results are reported in Table 9. It can be seen that the NARDL model outperforms the linear ARDL one in terms of forecast accuracy. We also test for parameter constancy in the NARDL model by using the CUSUM test. The CUSUM graphs are reported in Figure B1 in Appendix B and suggest that none of the estimated models suffer from parameter instability.

Table 9. Diebold-Mariano test results

	In-sample Performance	Out-of-sample Performance
United States	0.0049**	0.0361**
United Kingdom	0.0000**	0.0000**
Canada	0.0018**	0.0002**
Australia	0.0120**	0.0361**
New Zealand	0.0270**	0.0539*
Denmark	0.0000**	0.0000**
Japan	0.0000**	0.0216**
Sweden	0.0469**	0.0108**
Brazil	0.0000**	0.0015**
Chile	0.0010**	0.2910
Mexico	0.0000**	0.3428
Russia	0.0000**	0.0877

** significance at 5%
Diebold-Mariano test statistic comparing the MSPE of the NARDL model forecast with the MSPE of the linear ARDL model forecast.
t-Test hypotheses:
$H_0: MSPE_{ARDL} = MSPE_{NARDL}$
$H_1: MSPE_{ARDL} > MSPE_{NARDL}$

5. Conclusions

This paper investigates the impact of EPU and OPU shocks on inflation using monthly data from the 1990s up until August 2022 for a number developed and emerging economies, specifically the US, the UK, Canada, Australia, New Zealand, Denmark, Japan, Sweden, Brazil, Chile, Mexico and Russia. It contributes to the existing literature by allowing for both short- and long-run asymmetries, considering two different types of uncertainty shocks, and providing wide country coverage. More specifically, in the first instance a benchmark ARDL model is estimated and found not to be data congruent. A nonlinear ARDL (NARDL) framework is then adopted with the aim of capturing possible asymmetries in the effects on inflation of the shocks considered. This specification is shown to have a superior in-sample and out-of-sample performance relative to the linear ARDL one and to be appropriate for modelling both short- and long-run asymmetric responses of inflation to uncertainty shocks.

The analysis produces the following findings. First, the estimated effects of both types of uncertainty shocks (EPU and OPU) are larger when using the NARDL model (which distinguishes between positive and negative ones) as opposed to the linear ARDL one (which does not allow for asymmetries). Second, although the nonlinear results imply that both EPU and OPU shocks are important drivers of inflation, the former are found to have more sizeable effects. Third, inflation responds more to negative than to positive EPU shocks, which is consistent with previous findings in the literature (Wen et al., 2021; Long et al., 2022). Fourth, inflation reacts more strongly to interest rate decreases in the short run and to interest rate increases in the long run.

On the whole, our results provide extensive evidence that economic policy uncertainty (EPU) is a key determinant of inflation, and have some important policy implications. In particular, since EPU reflects, at least to some extent, uncertainty related to monetary policy (which possibly influences inflation expectations, see Al-Thaqeb and Algharabali, 2019), it would appear that a greater degree of transparency and more timely communications from monetary authorities to the public would be helpful to anchor inflation expectations (Istiak and Alam, 2019).

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Appendix A

Estimation time period for each country:

Country	Sample Start Date	Sample End Date
United States	January 1990	August 2022
United Kingdom	January 1990	August 2022
Canada	January 1990	August 2022
Australia	January 1997	August 2022
New Zealand	January 1997	August 2022
Denmark	January 1991	August 2022
Japan	January 1990	August 2022
Sweden	January 1990	August 2022
Brazil	February 1996	August 2022
Chile	February 1997	August 2022
Mexico	January 1996	August 2022
Russia	February 1995	August 2022

Appendix B

Figure B1. CUSUM Graphs