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War-associated geopolitical risks and uncertainty: Implications for real wages

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Abstract

This paper studies the effects of geopolitical risks and uncertainty on real wages. Employing UK data from 2000: Q1 to 2022: Q2 and a partial Nonlinear-Autoregressive Distributed Lag (NARDL) framework, we find that war-associated geopolitical risks and uncertainty have a statistically significant though mild positive impact on real wages. We find that domestic factors including economic policy uncertainty, productivity, economic growth, unemployment, inflation expectations and unionization play a stronger role in affecting real wages. Our findings suggest that the direct effects of war-associated geopolitical risks and uncertainty on real wages are temporary. From a policy perspective, the course of real wages will depend more on inflation expectations, productivity and most importantly unionization. We conclude that if real wages in the UK are to rise on a consistent basis then workers and particularly unions will have to gain more bargaining leverage.

KEYWORDS

unionization, economic uncertainty, geopolitical risks, inflation expectations, real wages, unemployment productivity, wage-inflation spiral, wars

1 | INTRODUCTION

The recovery of the global economy from COVID-19 has been disrupted by the Russian invasion of Ukraine. The resulting escalation of the war between Russia and Ukraine has coincided with a sharp increase in inflation. This increase has ended the three-decades-long period of relative price stability and has placed downward pressure on real living standards in many countries. Uncertainty has increased, constraining firm investment and household consumption. Slow and stagnant growth rates have occurred. The long-term effects of the war remain uncertain, but there are immediate consequences for economic agents through higher inflationary expectations and claims for higher wages.

In this paper, we explore the link between uncertainty and real wages. We focus on war-associated geopolitical risks, in particular. We draw on the measure of geopolitical risks developed by Caldara and Iacoviello (2022). It is hypothesised that greater geopolitical risks and uncertainty linked to war create higher inflation, both directly by disrupting supply chains and raising commodity prices and indirectly by fuelling higher inflation expectations and higher wage demands. The Russia-Ukraine war offers a way to examine this hypothesis directly. It also adds to our understanding of the specific effects of war on real wages. In this study, we focus on the UK – an interesting case study given its relative openness to trade and relatively flexible labour market.

Since the Global Financial Crisis (GFC) of 2008–09, wage growth in a number of developed countries, particularly in the UK, has been stagnant (ILO, 2018). The situation of wages post-crisis has been so dire that by April 2019, median earnings were still 2% below their April 2008 levels (Cribb & Johnson, 2019). An extended period spanning over a decade was not enough to bring median earnings back to pre-GFC levels. The wage stagnation has also widened existing economic inequalities (Giupponi et al., 2022; Cribb et al. 2022). Since the onset of the Russian invasion of Ukraine in 2022, there has been a sharp increase in inflation. Central banks across the world that have enjoyed prolonged periods of price stability for years and often claimed credit for taming inflation are now facing the high tides of inflation that have brought back the memories of the 1970s and 80s. To some commentators, the central banks are facing a difficult trade-off between inflation and employment, though the existence of such a trade-off is questionable (Ratner & Sim, 2022). But most crucially, inflation has also been putting a substantial squeeze on living standards and has depressed real wages (Resolution Foundation, 2022). In the UK, the poorest households are being hit hardest as reported by the Institute for Fiscal Studies (Karjalainen & Levell, 2022). It is therefore vital that wages rise in step with inflation rises.

Only a few studies have addressed the direct effects of war on real wages. For instance, Edo (2020) reported a decrease in real wages in France due to the influx of migrants caused by the Algerian Independence War. The explanation given was the sheer increase in the supply of labour that depressed real wages. Yet, wars do not always lead to an increase in immigration: most prominently, the conflicts in Afghanistan and Iraq did not lead to immigration into the UK and the USA, despite their direct involvement in these conflicts. The Russia-Ukraine war has led to some modest immigration into the UK, though not to the same extent as other EU countries. However, these immigrants, mostly women and children, are considered *refugees* and are not legally allowed to take paid jobs on their arrival. Any immigration effect due to the Russia-Ukraine war is, therefore, likely to be non-existent in the UK.[1] Furthermore, contrary to earlier studies by Lester (1943) and Acemoglu et al. (2004) that reported changes in the participation rate in the US labour market as a result of World War II, which affected wages, we do not expect the Russia-Ukraine war to affect the participation rate or gender participation ratios in the UK labour market. There has been no conscription or army drafting due to the Afghanistan and Iraq wars or the Russia-Ukraine war.

Of course, there are numerous domestic factors that influence real wages. Since Hicks (1932) seminal work *The Theory of Wages*, real wages can be seen to vary with labour productivity, the supply of and demand for labour, and unionization. Very often, the increase in real wages is considered contingent and associated with the increase in the productivity of labour (Tenreyro, 2018). Firms are more able to pay higher wages and workers more able to secure higher wages if productivity is high and rising. However, evidence suggests that associating real wage rises solely with the productivity of labour is an oversimplification and that other factors such as economic growth, unemployment and inflation mediate the relationship between real wages and productivity (Nasir et al., 2022). In terms of the real wage-productivity nexus, there are theoretical differences: for instance, *tournament theory* suggests that the wage differences are not merely due to the marginal productivity of workers but due to the rank orders of the individual in an organization (see, Lazear et al 1981, Connelly et al 2014). From a different standpoint, the 'fair wage-effort' hypothesis put forward by Akerlof and Yellen (1990) postulates that the productivity of workers is influenced by the perception of fairness in the payment of wages. This implies that a productive worker needs to be compensated through the payment of fair wages to sustain productivity.

It is also important to examine the capacity of workers to translate productivity gains into real wage rises. This brings into focus variables, such as unionization as influences on the bargaining power of workers. Empirical evidence clearly shows that the falling bargaining power of workers across developed economies has resulted in the decline of the wage share as well as an increase in profitability (Guschanski & Onaran, 2022; Stansbury & Summers, 2020). In addition, inflationary expectations together with employment and economic growth affect the extent to which workers are able to push for higher real wages and the scope for employers to pay higher real wages. These variables can be seen to matter in the context of war, where the external pressures from higher inflation place new demands on workers and employers to re-negotiate wages. Specifically, in a forward-looking Philips-Curve relationship implying an inverse relationship between wages, inflation and unemployment, the expected increase in inflation will translate into higher wage demands.

While the implications of uncertainty for the economy and financial sector have been discussed at length in the existing literature, uncertainty remains a concept that is not easy to grasp (see, Keynes, 1921; Knight, 1921; Zappia, 2021). In a more uncertain environment, firms will be reluctant to invest and households may become thriftier. Uncertainty also has implications for the global economy and financial sectors (Huynh et al., 2020; Nasir, 2020; Nasir & Morgan, 2018; Tiwari et al., 2021).

Some authors have looked at the implications of uncertainty for real wages. Cacciatore and Ravenna (2021) found that TFP volatility as a measure of uncertainty was negatively related to real wages in the US. Similarly, Maggio et al. (2022) reported that firm-level uncertainty can reduce the compensation of workers and household consumption in the US. In our paper, we use a different measure of economic uncertainty and geopolitical risk and uncertainty and examine its relationship to real wages.

More directly, we examine the different influences on real wages, from war-associated geopolitical uncertainty to domestic factors. Our data runs from 2000:Q1 to 2022:Q2 and relates to the UK. This allows us to account for the period encompassing the UK's engagement in the Afghanistan and Iraq wars as well as the impact of the Russian invasion of Ukraine.

We make several contributions to the literature on real wage dynamics. First, we consider directly the implications of war-associated geopolitical risks and uncertainty for real wages. Second, we employ a partial-NARDL framework that accounts for the asymmetries and nonlinearities in the relationship between real wages and their determinants as well as long and short-term dynamics. Third, we include inflation expectations in our study to assess how the expected rate of inflation may influence real wages. Fourth, we consider the macroeconomic and labour market outlook and their influence on real wages. Lastly, we focus on the role of unionization and analyse how union participation by workers influences real wages.

Our key results are as follows. We find a positive and statistically significant but mild effect of war-associated geopolitical risks on real wages. Our hypothesis of an effect of war on real wages is supported though the magnitude of the impact is not substantial. Instead, we find that real wages are explained more substantially by domestic factors, including productivity, economic growth, labour market outlook (unemployment), inflation expectations and unionization. The measures of inflation expectations and labour market slack (unemployment) suppress real wages. Out of all the variables, unionization has the strongest direct effect on real wages. From a policy perspective, the results suggest the importance of union strength in combatting the negative effects of inflation on real wages. Workers benefit from union membership in terms of raising real wages. Policy-makers (including the Bank of England) must be mindful of how any pass-through of inflation to real wage growth is contingent on union strength and how higher real living standards rest on workers gaining the power to meet their wage demands. We conclude that future rises in real wages will depend on workers and their unions maintaining bargaining leverage.

The remainder of the paper is organized into three sections. Section 2 discusses the methodology and sets out the NARDL framework. Section 3 presents the main analysis and findings. Section 4 contains the conclusions and policy implications.

2 | METHODOLOGY AND DATA

2.1 | Methodology

We employ a partial Nonlinear Auto-Regressive Distributed Lag (NARDL) approach to analyse the effects of geopolitical uncertainty, productivity, inflation expectations, unionization, economic uncertainty and labour market outlook on real wages. The novelty of the chosen approach is that it accounts for potential nonlinearities and asymmetries among the underlying variables (Shin et al., 2014). In our case, the variables of interest are the war-associated geopolitical risks, real wages and their determinants. There are also other benefits including the model being a dynamic one that accounts for the relationship over time with lag effects. It also combines the short and long-run relationship and overcomes the problem of serial correlation (Pesaran et al., 2001; Pesaran & Shin, 1999). We start with the following specification; –

$$\begin{aligned} Real.Wages_t = &+\beta_{Real.\,wages} Real.Wages_{t\_i} \\ &+\beta_{Prod} Productivity_{t-i} \\ &+\beta_{GPU} GeoPolitical.Uncertanity_{t-i} \\ &+\beta_{Inf.Exp} Inflation.Expectations_{t-i} \\ &+\beta_{unemp} Unemployment_{t-i} \\ &+\beta_{union} Unionisation_{t-i} + \beta_{GDP} GDP_{t-i} \\ &+\beta_{EPU} EconomicUncertainity_{t-i} + e_t \end{aligned} \quad (1)$$

$$e_t \sim i.i.d\, n\left(0, \sigma^2\right)$$

where $Real.Wages_t$ are affected by past wage-setting behaviour (incorporating an element of persistence via $Real.Wages_{t-i}$), labour productivity (Prod), war-associated geopolitical risks and uncertainty (GPU), the outlook of the economy and labour market depicted by the GDP growth rate and spare capacity or unemployment rate, expected rate of inflation over the period of next year (Inflation Expectations), unionization as the proportion of workforce with union membership and economic uncertainty measured as economic policy uncertainty (EPU) index (details to follow in section 2.2).

Following the specification in Equation 1, we can re-specify our model of real wage determination in the long-run form:

$$Real.Wages_t = a_0 + a_1 Productivity_t^+ + a_2 Productivity_t^- + a_3 GPU_t^+ + a_4 GPU_t^- + a_5 INF.EXP_t^+ + a_6 INF.EXP_t^- + a_7 Unemployment_t^+ + a_8 Unemployment_t^- + a_9 Unionisation_t^+ + a_{10} Unionisation_t^- + a_{11} GDP_t^+ + a_{12} GDP_t^- + a1_3 EPU_t^+ + a_{14} EPU_t^- + +e_t \quad (2)$$

where Real.$Wages_t$ are the function of their determinants as specified in equation (1) and $a = (a_0 - a_{14})$ is a co-integrating vector of long-run parameters. In Equation 2 explanatory variables with $_t^+$ and $_t^-$ are the partial sums of positive and negative changes in the determinants of real wages.

Let's call Z_t an explanatory variable, the positive and negative changes can be specified as;-

$$Z_t^+ = \sum_{i=1}^{t} \Delta Z_i^+ = \sum_{i=1}^{t} \max(\Delta Z_i, 0) \quad (3)$$

and

$$Z_t^- = \sum_{i=1}^{t} \Delta Z_i^- = \sum_{i=1}^{t} \min(\Delta Z_i, 0) \quad (4)$$

Z_t^+ represents the increase in the explanatory variables whereas the Z_t^- depicts the decrease. If the relationship is symmetric that would imply that the positive shocks $_t^+$ will have a positive combined effect and the negative shocks will have a negative combined impact on real wages and hence Z_t^- is also expected to have positive coefficient signs. In simple words, it would mean that the decrease in the explanatory variable will lead to a decrease in real wages and hence the coefficient will be positive due to the movement in the same direction. The symmetry may also imply that the magnitude of the positive and negative shocks remains the same and hence the long-run parameters will be the same $a_1 = a_2\ or = a_3 = a_4$. However, if that is not the case, it would imply upward or downward rigidity in real wages as well as asymmetry to their corresponding determinant or explanatory variable.

From this point, we can frame Equation 2 in a NARDL setting as follows[2]:

$$\begin{aligned}\Delta Real.Wages_t = {} & a + \beta_1 Real.Wages_{t-1} + \beta_2 Productivity_{t-1}^+ \\ & + \beta_3 Productivty_{t-1}^- + \beta_4 GPU_{t-1}^+ + \beta_5 GPU_{t-1}^- \\ & + \beta_6 Inf.Exp_{t-1}^+ + \beta_7 Inf.Exp_{t-1}^- + \beta_8 Unemployment_{t-1}^+ \\ & + \beta_9 Unemployment_{t-1}^- + \beta_{10} Unionisation_{t-1}^+ \\ & + \beta_{11} Unionisation_{t-1}^- + \beta_{12} GDP_{t-1}^+ + \beta_{13} GDP_{t-1}^- \\ & + \beta_{14} EPU_{t-1}^+ + \beta_{15} EPU_{t-1}^- + \sum_{i=1}^{p} \emptyset_i \Delta Real.Wage_{t-i} \\ & + \sum_{i=0}^{q} \left(\theta_i^+ \Delta Productivity_{t-i}^+ + \theta_i^- \Delta Productivity_{t-i}^-\right) \\ & + \sum_{i=0}^{r} \left(\gamma_i^+ \Delta GPU_{t-i}^+ + \gamma_i^- \Delta GPU_{t-i}^-\right) \\ & + \sum_{i=0}^{s} \left(\delta_i^+ \Delta Inf.Exp_{t-i}^+ + \delta_i^- \Delta Inf.Exp_{t-i}^-\right) \\ & + \sum_{i=0}^{u} \left(\Omega_i^+ \Delta Unemployment_{t-i}^+ + \Omega_i^- \Delta Unemployment_{t-i}^-\right) \\ & + \sum_{i=0}^{v} \left(\lambda_i^+ \Delta Unionisation_{t-i}^+ + \lambda_i^- \Delta Unionsination_{t-i}^-\right) \\ & + \sum_{i=0}^{w} \left(\varphi_i^+ \Delta GDP_{t-i}^+ + \varphi_i^- \Delta GDP_{t-i}^-\right) \\ & + \sum_{i=0}^{x} \left(\phi_i^+ \Delta EPU_{t-i}^+ + \phi_i^- \Delta EPU_{t-i}^-\right) + e_t \end{aligned} \quad (5)$$

In the above NARDL specification, that combines the short and long-run relationship between real wages and their determinants, all the variables are defined as above; however, p, q, r, s, u, v, w and x are lag orders. The $a_1 = -\beta_2/\beta_1$, $a_2 = -\beta_3/\beta_1$......... $a_{14} = -\beta_{15}/\beta_1$ are the earlier mentioned long-run impacts of positive and negative changes in the determinants of real wages.

In Equation 5, the $\sum_{i=0}^{q} \theta_i^+$ measures the short-run impacts of an increase in productivity on real wages whereas $\sum_{i=0}^{q} \theta_i^-$ measures the short-run impacts of a decrease in productivity on real wages. Similarly, $\sum_{i=0}^{r} \gamma_i^+$, $\sum_{i=0}^{s} \delta_i^+$, $\sum_{i=0}^{u} \Omega_i^+$, $\sum_{i=0}^{v} \lambda_i^+$, $\sum_{i=0}^{w} \varphi_i^+$ and $\sum_{i=0}^{x} \phi_i^+$ capture the short-term impacts of the increase in war-associated geopolitical uncertainty, inflation expectations, unemployment, unionization, economic growth and economic policy uncertainty on real wages. By contrast, $\sum_{i=0}^{r} \gamma_i^-$, $\sum_{i=0}^{s} \delta_i^-$, $\sum_{i=0}^{u} \Omega_i^-$, $\sum_{i=0}^{v} \lambda_i^-$, $\sum_{i=0}^{w} \varphi_i^-$ and $\sum_{i=0}^{x} \phi_i^-$ capture the short-term impact of the decrease in geopolitical uncertainty, inflation expectations, unemployment, unionization, economic growth and economic uncertainty on real wages.

Overall, in this framework, we are able to identify the potential asymmetric long-run as well as asymmetric short-run effects of real wage determinants.

The implementation of the NARDL framework and robustness and diagnostic testing will be carried out in the following steps. To start with, unit root testing is performed to determine the order integration $I(d)$ of the dataset. One of the novelties of the NARDL framework is that it can be employed and remains valid if the series are $I(0)$ or $I(1)$; however, we need to confirm that there is no series with $I(2)$ as $I(2)$ could invalidate F-statistics computation for the cointegration testing (Ibrahim, 2015). Hence, to find the order of integration, the ADF unit root test will be performed, which will also account for any potential structural break in the series. Accounting for structural breaks in the data series is vital as ignoring them could lead to biased results (see Perron 1989 or more recently Nasir et al., 2018 for further discussion). We will then perform the estimation of Equation 5 employing the OLS method. However, before proceeding to further testing, we will perform symmetry testing to confirm the specification and possibility of an asymmetric relationship. Another novelty of the NARDL framework is that it accounts for the full as well as partial asymmetric relationship between real wages and their determinants. The advantage of partial asymmetric NARDL instead of the full NARDL is that the former is more efficient, avoids over-parameterisation and estimation comes with lower variance. We will perform the long-run, short-run and joint symmetry of the relationship between real wages and their determinants (Figure A1).

To specify the hypothesis for the long-run and short-run symmetries, let's call Z_t an explanatory variable that has the asymmetric decomposition Z_t^+ and Z_t^- and corresponding level coefficients $\beta^+ \, and \, \beta^-$ and corresponding asymmetric short-run parameters θ_i^+ and θ_i^- for $i = 1$.........., q. Partial long and short-run asymmetries can be tested by imposing the following restrictions:

$$\beta = \beta^+ = \beta^-$$

$$\theta_i = \theta_i^+ = \theta_i^-$$

Employing a Wald-like parameter restrictions test, partial asymmetries can be tested through the following hypothesis:

$$\text{Long} - \text{run symmetry}\, H_0 : \beta^+ = \beta^-$$

$$\text{Short run symmetry}\, H_0 : \begin{cases} \theta_i^+ = \theta_i^- \text{ for each } \theta_i \\ or \\ \sum_{i=1}^{q} \theta_i^+ = \sum_{i=0}^{q} \theta_i^- \end{cases}$$

$$\text{Joint long and Short} - \text{run symmetry} H_0 : \begin{cases} \beta^+ = \beta^- \, and \, \theta_i^+ = \theta_i^- \text{ for each } \theta_i \\ or \\ \beta^+ = \beta^- \, and \sum_{i=1}^{q} \theta_i^+ = \sum_{i=0}^{q} \theta_i^- \end{cases}$$

Once the assumption of asymmetry is tested, we will proceed with further testing; however, if there is a variable that shows a symmetric relationship, we will modify the NARDL accordingly and revert to the partial NARDL framework. Once the estimation is carried out, we will proceed to apply the bound testing approach to cointegration and analyse the presence of long-run association among the underlying variables (see Pesaran et al. (2001) and Shin et al. (2014) for discussion). For this purpose, we will perform the Wald F-test with the null hypothesis, $\beta_1 = \beta_2 = \ldots\ldots = \beta_{15} = 0$. We will also perform a series of robustness and diagnostic tests including serial correlation, heteroskedasticity, residual normality, model specification and parameter stability tests. Finally, to analyse the long and short-run asymmetries and the dynamic of real wages under the influence of their determinants, we will conduct a cumulative dynamic multiplier analysis. Specifically, it will provide us with the cumulative dynamic effects of a 1% change in productivity, geopolitical uncertainty, inflation expectation, economic growth, unemployment rate, economic uncertainty and unionization on real wages over the horizon of the given time period. It will be positive (Z_{t-i}^+) and negative $\left(Z_{t-i}^-\right)$ specified as:

$$m_h^+ = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{Z_{t-i}^+}, m_h^- = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{Z_{t-1}^-}, h = 0, 1, 2, 3, \ldots\ldots\ldots \quad (6)$$

It is worth noting that h approaches ∞, the cumulative dynamic multiplier converges to the long-run (cointegrating) coefficients that is, $m_h^+ \to a_z^+ \, and \, m_h^- \to a_z^-$.

2.2 | Data

We employ quarterly data from 2000:Q1 to 2022:Q2 for the UK. For our measure of real wages, we use the data on real average weekly earnings (adjusted for seasonality and inflation). For productivity, we use the percentage change in the output per hour worked for the whole economy (again seasonally adjusted). To measure the impact of the expected rate of inflation on wages, we employ the Bank of England's survey data that focuses on inflation expectations over the next year. For economic uncertainty, the economic policy uncertainty (EPU) index is used. More directly, we use the geopolitical risk

(GPR) index devised by Caldara and Iacoviello (2022) that takes into account geopolitical risks associated with wars and conflicts. We also consider the labour market outlook and its implication for real wages. In this case, we employ the unemployment rate that is also seasonally adjusted. Lastly, for union participation, we employ trade union membership as a proportion of the total number of employees. Annual frequencies on the proportion of union membership are transformed to quarterly frequencies through extrapolation and Catmull–Rom spline interpolation.[3] The data are taken from the Office for National Statistics, Bank of England and matteoiacoviello.com for the GPR. All the series are presented in the following Figure 1:-

The graphical presentation of data shows some obvious dynamics. The decline in economic growth around the GFC and COVID-19 is obvious. Most importantly, the geopolitical risk and uncertainty show clear spikes around 9/11, the Afghanistan and Iraq wars and the Russian invasion of Ukraine. Economic uncertainty, for

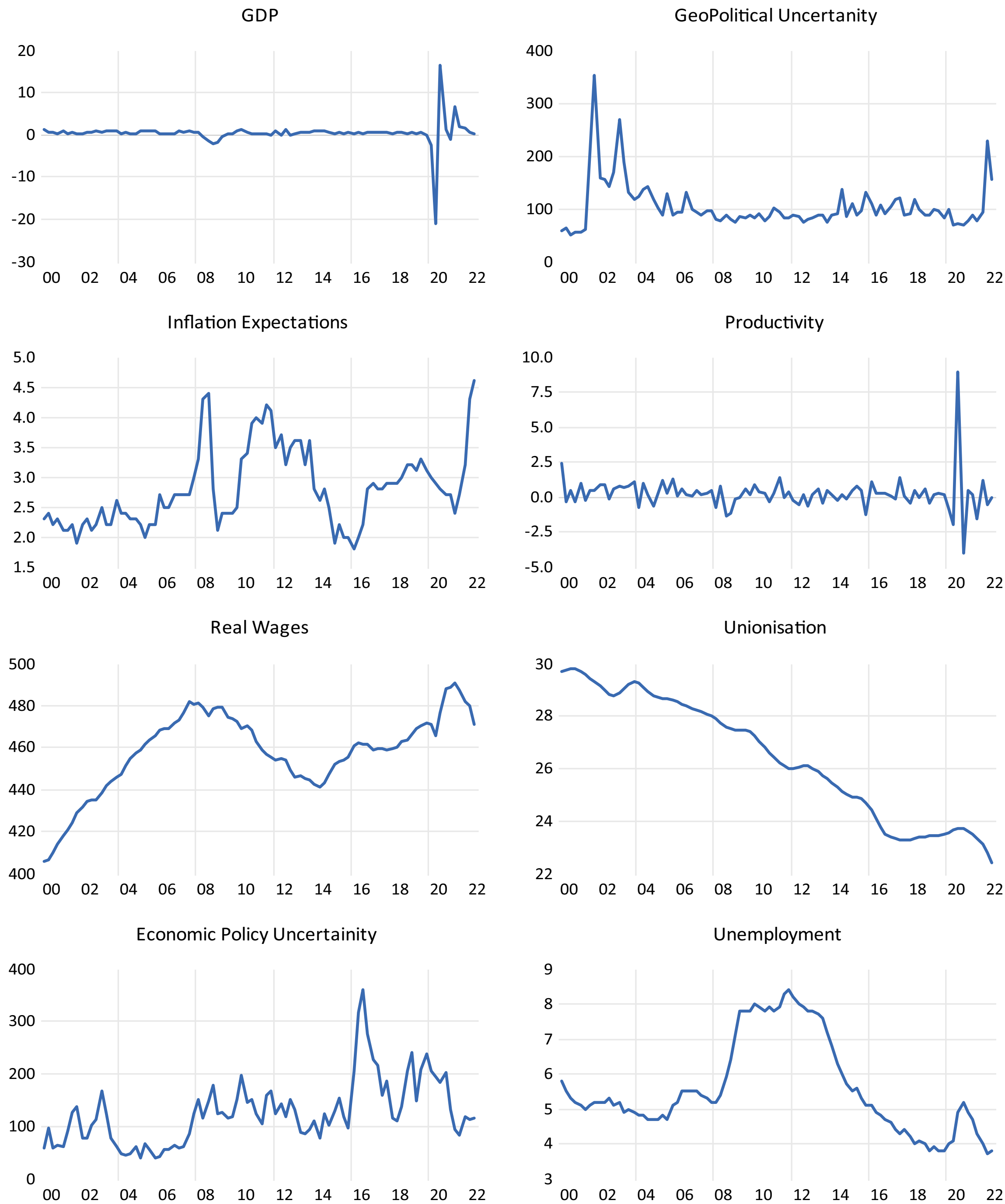

FIGURE 1 Graphical presentation of data from 2000:Q1 to 2022:Q2. [Colour figure can be viewed at wileyonlinelibrary.com]

which we have used the economic policy uncertainty (EPU) index, spiked around the Brexit referendum and COVID-19. One of the interesting observations is unionization, which has shown a persistent decline over the years. Inflation expectations spiked in recent times, reflecting the current higher level of inflation. Real wages have also declined in the later stages of the period, as higher inflation has risen faster than wages.

3 | ANALYSIS AND FINDINGS

We start our analysis with the application of unit-root testing and determining the order of integration of the underlying data series. For this purpose, the ADF Unit root test that accounts for any structural break (Hansen, 2001; Nasir, 2021; Nasir et al., 2018) is chosen. Instead of giving a pre-determinant date, we let the data speak and determine the structural break endogenously. While applying the ADF unit root test, alternative maximum and minimum test-statistics options are chosen to evaluate one-sided alternatives. We find different critical values for the final Dickey-Fuller test statistic and tests with greater power than the non-directional alternatives.[4] We also use the ADF test with both Innovative Outliers (IO) and Additive Outliers (AO).[5] The Schwarz Information Criteria (SIC) criterion is used to determine the optimal number of lags as it is an appropriate criterion in the presence of a structural break (Asghar and Abid, 2007). The results of unit root testing are presented in Table 1:

The unit root test results suggest that, with the exception of geopolitical uncertainty, productivity and GDP, there is no other variable that is stationary at level. The structural break date for the geopolitical uncertainty coincides with the 2001 Q4, which is the period that was associated with the 9/11 terror attacks and the American invasion of Afghanistan. It is obvious that in that period war-related risks and uncertainty were the highest in this century. The data also suggest a structural break in labour productivity corresponding to the second half of 2008: a period that included the GFC of 2008. The economic uncertainty measure had a structural break around the end of 2015 and mid-2016. This can be associated with the announcement of the Brexit Referendum, negotiation with the EU and the Referendum results in June 2016. The unionization variable also shows a structural break in 2009, which is the post-GFC 2008 period. The sluggishness of real wages can be associated with the relatively weak bargaining power of workers in the post-crisis period. Economic growth shows a structural break at the beginning of 2021: a period where economic activity was influenced by the changes in the COVID-19-related restrictions on economic activities and the reopening of large parts of the economy.

TABLE 1 ADF Test with Structural Break: Additive & Innovative Outliers.

Variables	ADF Test Statistic (IO)	*P*-values	ADF Test Statistic (AO)	*P*-values	Break-date
At Level					
Geopolitical uncertainty	−6.969*	< 0.01	−7.424*	< 0.01	2001Q4
Labour productivity	−6.985*	< 0.01	−8.148*	< 0.01	2008Q3
Real wages	−4.013	0.511	−4.097	0.547	2013Q2
Inflation expectations	−4.759	0.137	−5.042	0.071	2013Q3
Unemployment rates	−4.279	0.348	−3.858	0.613	2008Q1
Economic uncertainty	−5.294**	0.036	−5.331**	0.033	2015Q4
Unionization	−4.172	0.412	−4.213	0.385	2009Q3
GDP	−12.911*	< 0.00	−13.462*	< 0.00	2021Q1
1st Difference					
Geopolitical uncertainty	−14.712*	< 0.01	−15.140*	< 0.01	2001Q4
Labour productivity	−20.566*	< 0.01	−16.165*	< 0.01	2001Q1
Real wages	−7.054*	< 0.01	−8.505*	< 0.01	2021Q4
Inflation expectations	−9.423*	< 0.01	−9.548*	< 0.01	2008Q4
Unemployment rates	−6.185*	< 0.01	−6.322*	< 0.01	2009Q2
Economic uncertainty	−10.090*	< 0.01	−10.281*	< 0.01	2016Q2
Unionization	−3.503*	< 0.01	−8.616*	< 0.01	2007Q2
GDP	−17.844*	< 0.01	−18.275*	< 0.01	2001Q1

Note: *1% level of significance ** 5% level of significance ***Vogelsang (1993) asymptotic one-sided *p*-values.

3.1 | Determinants of wage NARDL model

We start our analysis by estimating the NARDL model (Equation 5). In so doing, we treat all the explanatory variables as asymmetric in terms of their cointegrating and adjustment dynamics. To identify optimal lag order (p, q1...... q7), we use the Akaike information criterion. The results are presented in Table 2:

The estimation results presented in Table 2 show the impact of various determinants of real wages at different lags. The initial nine coefficients of the explanatory variables present the long-run or cointegrating relationship dynamics. The remaining coefficients represent the adjusting or short-run relationship dynamics. In these results, we have based our analysis on the assumption of asymmetry, which requires validation through coefficients' symmetry testing before we can draw any inferences. Our specification in Equation 5 suggests that in both short and long-run dynamics, all our distributed lag variables are asymmetric; however, the NARDL model can easily accommodate the presence of partial asymmetry. The variables can manifest asymmetry either in the short-run (adjusting) or long-run (co-integrating) relationship dynamics, yet not in both. Therefore, we perform the asymmetry test and the results are presented in Table 3:

The results of the coefficients symmetry test with the null hypothesis of a "symmetric" relationship suggest

TABLE 2 NARDL Estimation 2000Q1 – 2022Q2.

Variable	Coefficient	Std. error	*t*-statistic	Prob.*
$Wages_{t-1}$	−0.419	0.260	−1.614	0.135
GDP^{+}_{t-1}	0.024**	0.009	2.680	0.021
GDP^{-}_{t-1}	0.027*	0.010	2.785	0.018
GPU^{+}_{t-1}	−0.001	0.008	−0.091	0.929
GPU^{-}_{t-1}	−0.041**	0.019	−2.180	0.052
$Inflation.Expectations^{+}_{t-1}$	0.015	0.019	0.817	0.431
$Inflation.Expectations^{-}_{t-1}$	0.007	0.009	0.830	0.424
$Productivity^{+}_{t-1}$	−0.019	0.017	−1.132	0.282
$Productivity^{-}_{t-1}$	−0.024**	0.009	−2.611	0.024
$Unionisation^{+}_{t-1}$	0.071**	0.027	2.622	0.024
$Unionisation^{-}_{t-1}$	0.020	0.012	1.650	0.127
EPU^{+}_{t-1}	−0.009	0.022	−0.396	0.700
EPU^{-}_{t-1}	0.046	0.028	1.673	0.123
$Unemployment^{+}_{t-1}$	−0.002	0.015	−0.107	0.917
$Unemployment^{-}_{t-1}$	−0.025**	0.009	−2.668	0.022
Constant (a)	1.874	1.163	1.612	0.135
$\Delta Wages_{t-1}$	−0.040	0.225	−0.176	0.864
$\Delta Wages_{t-2}$	−0.350	0.214	−1.631	0.131
ΔGDP^{+}_{t}	0.009*	0.003	2.814	0.017
ΔGDP^{-}_{t}	0.000	0.001	−0.195	0.849
ΔGDP^{+}_{t-1}	−0.014*	0.005	−2.863	0.015
ΔGDP^{-}_{t-1}	−0.013	0.008	−1.619	0.134
ΔGDP^{+}_{t-2}	−0.003	0.003	−1.056	0.314
ΔGDP^{-}_{t-2}	−0.012*	0.004	−3.065	0.011
ΔGDP^{+}_{t-3}	−0.003	0.002	−1.454	0.174
ΔGDP^{-}_{t-3}	−0.001	0.002	−0.277	0.787
ΔGPU^{+}_{t}	0.004	0.004	0.876	0.400
ΔGPU^{-}_{t}	−0.032*	0.010	−3.346	0.007
ΔGPU^{+}_{t-1}	0.008	0.010	0.849	0.414

TABLE 2 (Continued)

Variable	Coefficient	Std. error	t-statistic	Prob.*
ΔGPU^{-}_{t-1}	−0.004	0.015	−0.246	0.810
ΔGPU^{+}_{t-2}	0.001	0.010	0.152	0.882
ΔGPU^{-}_{t-2}	−0.013	0.013	−1.016	0.332
ΔGPU^{+}_{t-3}	−0.002	0.008	−0.277	0.787
ΔGPU^{-}_{t-3}	−0.010	0.009	−1.124	0.285
$\Delta Inflation.Expectations^{+}_{t}$	0.000	0.006	0.030	0.977
$\Delta Inflation.Expectations^{-}_{t}$	0.003	0.005	0.600	0.561
$\Delta Inflation.Expectations^{+}_{t-1}$	−0.019	0.014	−1.385	0.193
$\Delta Inflation.Expectations^{-}_{t-1}$	0.001	0.008	0.113	0.912
$\Delta Inflation.Expectations^{+}_{t-2}$	−0.018	0.011	−1.701	0.117
$\Delta Inflation.Expectations^{-}_{t-2}$	0.006	0.006	1.021	0.329
$\Delta Inflation.Expectations^{+}_{t-3}$	−0.003	0.005	−0.622	0.547
$\Delta Inflation.Expectations^{-}_{t-3}$	0.009**	0.005	1.905	0.083
$\Delta Productivity^{+}_{t}$	−0.005	0.004	−1.189	0.260
$\Delta Productivity^{-}_{t}$	−0.002	0.002	−0.920	0.377
$\Delta Productivity^{+}_{t-1}$	0.008	0.010	0.766	0.460
$\Delta Productivity^{-}_{t-1}$	0.017**	0.007	2.433	0.033
$\Delta Productivity^{+}_{t-2}$	0.005	0.006	0.760	0.463
$\Delta Productivity^{-}_{t-2}$	0.009***	0.005	1.927	0.080
$\Delta Productivity^{+}_{t-3}$	−0.001	0.003	−0.511	0.619
$\Delta Productivity^{-}_{t-3}$	0.005***	0.003	1.945	0.078
$\Delta Unionisation^{+}_{t}$	0.093	0.065	1.433	0.180
$\Delta Unionisation^{-}_{t}$	0.034	0.054	0.634	0.539
$\Delta Unionisation^{+}_{t-1}$	−0.201***	0.100	−1.997	0.071
$\Delta Unionisation^{-}_{t-1}$	−0.138	0.088	−1.573	0.144
$\Delta Unionisation^{+}_{t-2}$	−0.012	0.112	−0.108	0.916
$\Delta Unionisation^{-}_{t-2}$	0.112	0.090	1.234	0.243
$\Delta Unionisation^{+}_{t-3}$	−0.059	0.084	−0.700	0.499
$\Delta Unionisation^{-}_{t-3}$	−0.029	0.048	−0.598	0.562
ΔEPU^{+}_{t}	−0.004	0.008	−0.588	0.568
ΔEPU^{-}_{t}	0.017***	0.008	2.046	0.065
ΔEPU^{+}_{t-1}	0.000	0.016	−0.010	0.993
ΔEPU^{-}_{t-1}	−0.026	0.020	−1.309	0.217
ΔEPU^{+}_{t-2}	−0.002	0.012	−0.154	0.881
ΔEPU^{-}_{t-2}	−0.009	0.017	−0.512	0.619
ΔEPU^{+}_{t-3}	−0.007	0.009	−0.772	0.456
ΔEPU^{-}_{t-3}	0.001	0.010	0.075	0.941
$\Delta Unemployment^{+}_{t}$	0.008	0.011	0.703	0.497
$\Delta Unemployment^{-}_{t}$	−0.008	0.010	−0.786	0.448
$\Delta Unemployment^{+}_{t-1}$	0.031***	0.015	2.118	0.058
$\Delta Unemployment^{-}_{t-1}$	0.015	0.011	1.345	0.206
$\Delta Unemployment^{+}_{t-2}$	0.036**	0.014	2.504	0.029

(Continues)

TABLE 2 (Continued)

Variable	Coefficient	Std. error		*t*-statistic	Prob.*
$\Delta Unemployment^{-}_{t-2}$	0.014		0.010	1.363	0.200
$\Delta Unemployment^{+}_{t-3}$	0.016		0.011	1.445	0.176
$\Delta Unemployment^{+}_{t-3}$	0.019**		0.008	2.544	0.027
R^2	0.979	Durbin-Watson stat		2.838	
F-statistic	6.923*	Prob(F-statistic)			0.001

Note: * **Based on AIC, Selected model: ARDL (3,4,4,4,4,4,4,4), Number of models evaluated: 312500.** *1% level of significance ** 5% level of significance, *** 10% level of significance.

TABLE 3 Coefficients symmetry test NARDL.

Variable	Statistic	Value	Probability
Long-run			
GDP	F-statistic	0.590407	0.4584
	Chi-square	0.590407	0.4423
Inflation Expectations	F-statistic	0.107041	0.7497
	Chi-square	0.107041	0.7435
GPU	F-statistic	3.93802***	0.0727
	Chi-square	3.93802**	0.0472
EPU	F-statistic	1.39241	0.2629
	Chi-square	1.39241	0.238
Productivity	F-statistic	0.16179	0.6952
	Chi-square	0.16179	0.6875
Unionization	F-statistic	2.710711	0.1279
	Chi-square	2.710711	0.0997
Unemployment	F-statistic	1.23351	0.2904
	Chi-square	1.23351	0.2667
Short-Run			
GDP	F-statistic	2.446715	0.1461
	Chi-square	2.446715	0.1178
Inflation Expectations	F-statistic	2.779686	0.1237
	Chi-square	2.779686	0.0955
GPU	F-statistic	2.174613	0.1683
	Chi-square	2.174613	0.1403
EPU	F-statistic	0.003915	0.9512
	Chi-square	0.003915	0.9501
Productivity	F-statistic	1.505389	0.2455
	Chi-square	1.505389	0.2198
Unionization	F-statistic	2.575105	0.1369
	Chi-square	2.575105	0.1086
Unemployment	F-statistic	2.436139	0.1469
	Chi-square	2.436139	0.1186
Joint (Long-Run and Short-Run)			
GDP	F-statistic	1.503812	0.2646
	Chi-square	3.007623	0.2223

TABLE 3 (Continued)

Variable	Statistic	Value	Probability
Inflation Expectations	F-statistic	2.275624	0.1489
	Chi-square	4.551249	0.1027
GPU	F-statistic	5.526595**	0.0218
	Chi-square	11.05319*	0.004
EPU	F-statistic	2.419268	0.1347
	Chi-square	4.838536	0.089
Productivity	F-statistic	1.018605	0.3928
	Chi-square	2.037211	0.3611
Unionization	F-statistic	1.794877	0.2115
	Chi-square	3.589754	0.1661
Unemployment	F-statistic	2.056953	0.1742
	Chi-square	4.113905	0.1278

Note: Null hypothesis: Coefficient is symmetric, Degrees of freedom (simple tests): F (1, 11), Chi-square (1), Degrees of freedom (joint tests): F (2, 11), Chi-square (2). *1% level of significance ** 5% level of significance, *** 10% level of significance.

that only Geopolitical Risk and Uncertainty (GPU) is found to have an asymmetric relation with real wages. The null of the "symmetric" relationship is only rejected in the cases of GPU in the long-run. This implies that we need to re-specify and re-estimate the model by accounting for the asymmetric effects in the GPU variable and the results are presented in Table 4:

Similar to the earlier estimation with the assumption of full asymmetry for all the explanatory variables' behaviour, we did the coefficient symmetry test again for our second estimation on the partial NARDL model. The results are presented in Table 5:

The result of the second coefficient symmetry test (Table 5) confirms the findings of the earlier test (Table 3). It means that our specification is reliable, and we can proceed with further testing and use this model with an appropriate accounting of asymmetry in the relationship.

Next, we proceed to the analysis of cointegration. To investigate the presence of cointegration or a long-term relationship between real wages and their determinants, we perform the bound testing approach to cointegration. The results are presented in Table 6:

The results show that our F-bounds test statistics for cointegration are greater than the benchmark values (3.15) at a 5% level of significance.[6] Hence, there is evidence of cointegration or a long-run relationship between real wages and their determinants. For further confirmation, we also consider the T-bound (Wald) test for cointegration and the results once again lead to the conclusion that there is significant evidence of cointegration or a long-run relationship at the first order of integration of *I* (1). Nevertheless, to rule out the possibility of degenerate co-integration, we conduct the Wald test for joint parameter significance for parameters related to distributed lag or explanatory variables. The possibility of degenerate cointegration could arise due to the endogeneity issue, which could be overlooked if we solely rely on the *F*-test (See McNown et al., 2018). The results for T-bound (Wald) test are presented in Table 7:

The above Table 7 shows that all the parameters are jointly significant and hence we rule out the concern of degenerate cointegration. We also perform the parameter stability (CUSUM and CUSUM of Squares) tests to see if the model and estimates are stable over time. The results are presented in Figure 2:

Our results of parameter stability tests show that the CUSUM and CUSUM of Squares (CUSUMQ) graphs remain within the 5% significance bounds, which implies that there is neither a positive anomaly (exceeding upper bound) nor negative anomaly (exceeding lower bounds) in the parameters. Thus, the parameters and estimation are stable over time.

It is important to identify the effects on real wages from shocks linked to geopolitical risks and uncertainty as well as the other determinants. Therefore, in the next and final step of the analysis, we conduct a partial asymmetry NARDL cumulative dynamic multiplier analysis. The results are presented in Figure 3:

The results of the partial asymmetry NARDL cumulative dynamic multiplier analysis reported in Figure 3 suggest that the rate of economic growth only has a very mild short-term positive impact and does not lead to an increase in real wages in the long-term. In fact, the

TABLE 4 Partial asymmetric NARDL estimation.

Variable	Coefficient	Std. error	*t*-statistic	Prob.*
$Wages_{t-1}$	−0.107*	0.031	−3.493	0.001
GDP_{t-1}	−0.180*	0.069	−2.599	0.012
$Inflation.Expectations_{t-1}$	−0.130	0.112	−1.160	0.251
$Productivity_{t-1}$	0.362***	0.189	1.913	0.061
$^{\times}Unionisation_{t-1}$	0.466*	0.176	2.641	0.011
EPU_{t-1}	−0.046	0.195	−0.235	0.815
$^{\times}Unemployment_{t-1}$	−0.261*	0.053	−4.883	0.000
$^{\times}GPU^{+}_{t-1}$	0.045	0.179	0.251	0.803
$^{\times}GPU^{-}_{t-1}$	−0.537**	0.243	−2.208	0.031
Constant	−1.426	3.907	−0.365	0.716
$\Delta Wages_{t-1}$	−0.055	0.119	−0.463	0.645
$\Delta Wages_{t-2}$	−0.179	0.114	−1.571	0.121
ΔGDP_{t}	0.085*	0.021	4.029	0.000
ΔGDP_{t-1}	0.279*	0.062	4.538	0.000
ΔGDP_{t-2}	0.184*	0.049	3.774	0.000
ΔGDP_{t-3}	0.090*	0.030	3.051	0.003
$\Delta Inflation.Expectations_{t}$	−0.423*	0.147	−2.872	0.006
$\Delta Inflation.Expectations_{t-1}$	−0.288***	0.158	−1.821	0.074
$\Delta Productivity_{t}$	0.042	0.082	0.507	0.614
$\Delta Productivity_{t-1}$	−0.329*	0.126	−2.611	0.011
$\Delta Productivity_{t-2}$	−0.251&	0.101	−2.490	0.016
$\Delta Productivity_{t-3}$	−0.137*	0.053	−2.597	0.012
ΔEPU_{t}	0.436*	0.180	2.425	0.018
ΔEPU_{t-1}	0.379**	0.187	2.025	0.047
ΔEPU_{t-2}	0.338**	0.173	1.962	0.054
ΔEPU_{t-3}	0.412**	0.172	2.396	0.020
Diagnostic				
R-squared	0.808			
F-statistic	10.095*			0.000
ECT	−0.107*	0.012	−8.782	0.000
Jarque-Bera Test	2.442			0.294
Durbin-Watson Stat.	1.882			
Breusch-Godfrey – LM Test	0.008			0.926
Breusch-Pagan-Godfrey Test	24.563			0.487
White Test	27.035			0.354
Ramsey REST Test	0.025			0.8737

Note: Optimal lag selection is based on AIC. *1% level of significance ** 5% level of significance ***10% level of significance, $^{\times}$ interpreted as $z_t = z_{t-1} + \Delta z$. White heteroskedasticity-consistent standard errors & covariance.

increase in real wages associated with the GDP growth rate is only temporary and up to four quarters or a year, thereafter there is a negative impact. The negative effect could reflect the rise in inflation (associated with higher economic growth) that suppresses real wages. This result can be compared with the instances of economic growth that did not lead to an increase in the real wages in the long-term. Inflation expectations also seem to have a negative impact on real wages. A 1% increase in inflation is expected to reduce real wages by 1.2%. This finding

TABLE 5 Coefficients symmetry test partial NARDL.

Variable	Statistic	Value	Probability
Long-run			
GPU	F-statistic	6.971*	0.011
	Chi-square	6.971*	0.008

Note: Null hypothesis: Coefficient is symmetric, Degrees of freedom (simple tests): F (1, 60), Chi-square (1). *1% level of significance ** 5% level of significance, *** 10% level of significance.

implies that inflation expectations, which are strongly connected to actual inflation (Nasir, 2020), are a portent of real wage decreases. The productivity variable is in line with expectations: that is, it has a strong positive impact on real wages. A 1% increase in productivity is associated with an almost 3.5% increase in real wages in the long-term.

However, unionization is found to be the most crucial factor with the highest positive impact on real wages. A 1% increase in unionization is linked to a 4.4% increase in real wages in the long-term. The significant decrease in unionization during the period of the study explains the stagnation of real wages. Furthermore, the finding that inflation expectations are negatively linked to real wages shows how workers cannot always raise wages to match higher expected levels of inflation. This reinforces the view that lower union power and weaker worker bargaining are key to explaining the sluggishness in real wages in the UK.

The economic uncertainty variable has a short-term positive impact on real wages that turns negative in the long term. An increase of 1% in economic policy uncertainty suppresses real wages by 0.4% in the long-term. These findings are consistent with the studies of Cacciatore and Ravenna (2021) and Maggio et al. (2022) based on US data. Both reported a negative impact and our results complement theirs by employing a broader economy-wide measure of uncertainty. Unemployment also has a strong negative impact. A 2.5% decrease in real wages is associated with a 1% increase in the unemployment rate. Workers are less able to protect real wages where unemployment is high. This adds to the argument that a tight labour market with a low unemployment rate can lead to higher real wages (see e.g., Domash & Summers, 2022).

Lastly, our main variable of interest, the geopolitical risk and uncertainty associated with the war (GPU), shows an asymmetric (and statistically significant) relationship with real wages. An increase in war-associated geopolitical risk (GPU) of 1% is linked to a short-term increase in real wages of 0.4%. There are no previous studies to compare this result with. However, in terms of the very limited evidence that we acknowledged above, our results can be contrasted with Edo (2020) who reported a decrease in real wages in France due to the influx of migrants caused by the Algerian Independence War. Similarly, studies by Lester (1943) and Acemoglu et al. (2004) that reported changes in the participation rate in the US labour market as a result of World War II, which affected wages, can also be contrasted with our results. An obvious factor is that the Afghanistan, Iraq and Russia-Ukraine wars have not affected the participation rate or gender participation ratios in the UK labour market. There have also been no conscription or army drafting due to these wars, which might explain their relatively mild impacts on real wages. The positive effect implies some success for workers in offsetting the negative impact of higher prices on real wages.

Overall, as a contribution to the empirical literature, our findings show how uncertainty and risks associated with wars can impact real wages but that this impact is small relative to the influence of domestic factors. For the UK at least, real wages seem to be influenced more by the extent of unionization and the strength of workers' bargaining power than by the transitory effects of war. For real wages to grow beyond the war, therefore, workers and their unions will have to retain bargaining power. The UK government and policymakers at the Bank of England should be relaxed about such patterns if they want to see real living standards rise.

TABLE 6 Bounds test for the Nonlinear Cointegration.

F-bounds test statistic	**F-statistic**			**6.706***		
Number of co-integrating variables: 8	**10%**		**5%**		**1%**	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
80	−1	−1	−1	−1	−1	−1
Asymptotic	1.85	2.85	2.11	3.15	2.62	3.77
T-Bound Test Statistic	**T-Statistic**			**−3.493***		

Note: *1% level of significance ** 5% level of significance ***10% level of significance.

TABLE 7 T-bound (Wald) test for degenerate Co-integration.

Test statistic	Value	d.f	Probability
F-statistic	7.220972*	(8, 60)	0.000
Chi-square	57.76777*	8	0.000

Note: *1% level of significance, ** 5% level of significance, ***10% level of significance.

4 | CONCLUSION & IMPLICATIONS

In this paper, we have analysed the implications of geopolitical uncertainty, economic policy uncertainty, unionization, economic growth, inflation expectations and productivity for real wages in the UK. The period of observation corresponds to one where the UK was directly involved in the war in Afghanistan and Iraq, and also provided active support to Ukraine in the recent Russian invasion. In these military engagements, the UK did not witness the influx or outflow of workers though it was exposed to the effects of higher commodity price inflation.

Our results lead us to conclude that the geopolitical risks and uncertainty associated with the Russia-Ukraine war have had some impact on the UK economy. In terms of real wages, this impact has been positive though very mild. This implies that in the scenarios where the geopolitical risk and uncertainty associated with wars are high and there is no great influx of workers or outflow of

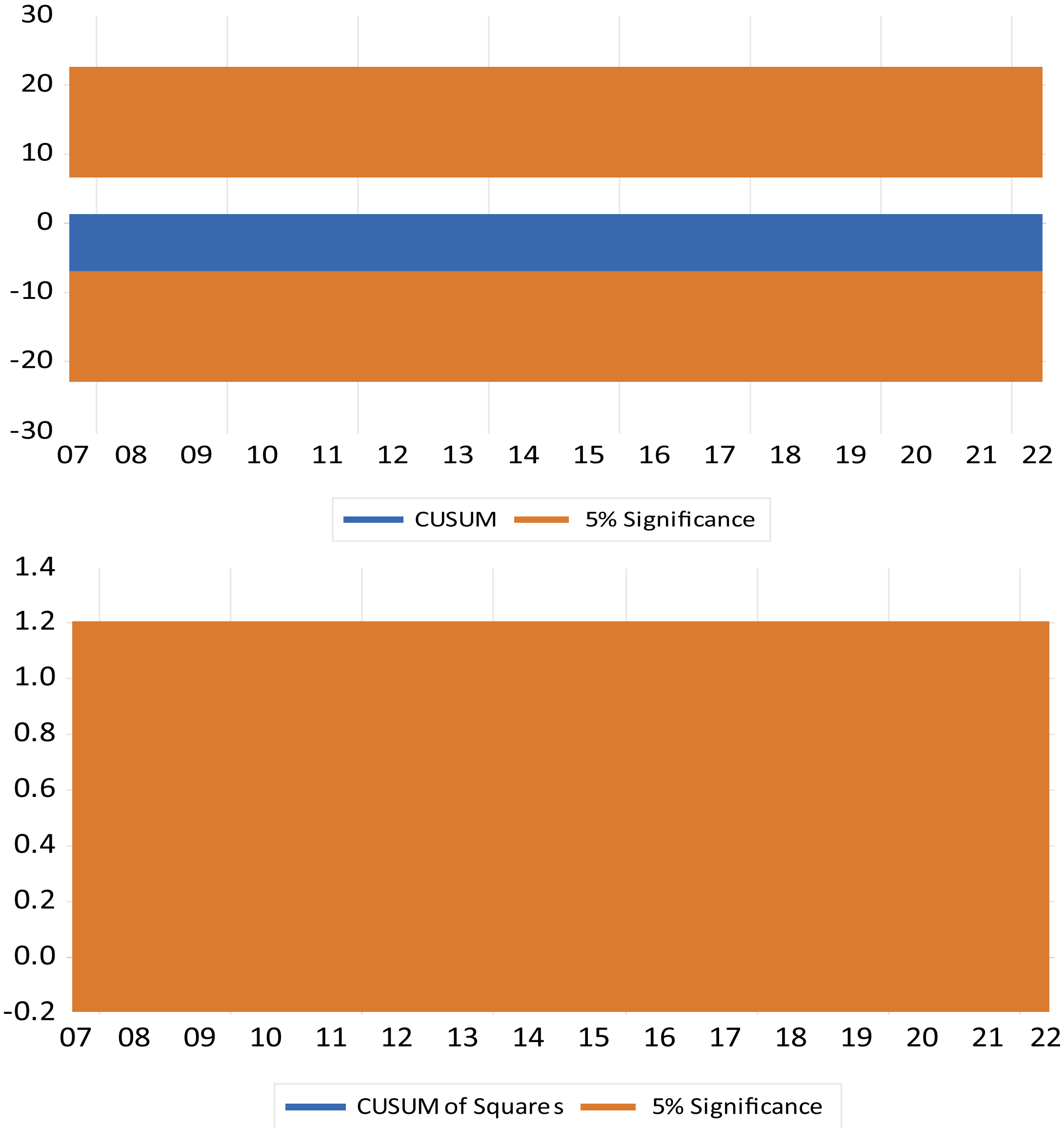

FIGURE 2 Parameters' stability (CUSUM & CUSUMQ of Squares) tests for the Partial NARDL model of real wages. [Colour figure can be viewed at wileyonlinelibrary.com]

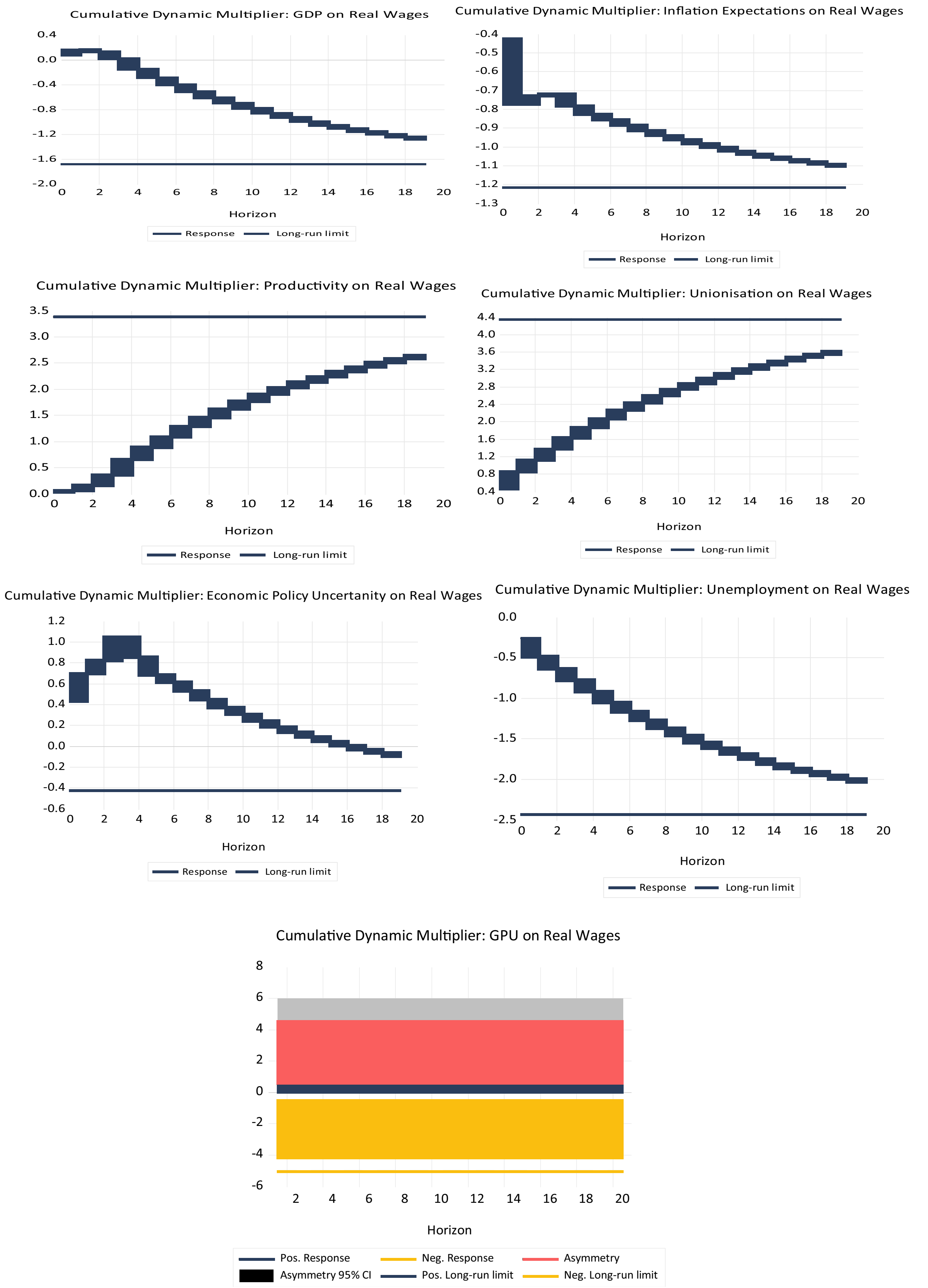

FIGURE 3 Partial Asymmetry NARDL cumulative dynamic multiplier analysis and response of real wages (%). [Colour figure can be viewed at wileyonlinelibrary.com]

workers through military conscription or drafting, there seem to be very modest positive effects on real wages. If there were outflows of labour e.g., through large-scale conscription or influxes of labour due to large immigration from war zones, the effect on real wages might be very different. Furthermore, we also conclude that domestic factors seem to matter more for real wages. In particular, we have found that unionization is a particularly important factor. The threat for workers from higher inflation and a real wage squeeze due to a surge in inflation as a result of the Russia-Ukraine war have been magnified by the relative weakness of unions. The lack of unionization has also prevented a wage-price spiral as a consequence of the war itself. In terms of policy, it also implies that fears about a wage-price spiral (as expressed by the Bank of England) were overblown and hence not a good reason for the monetary policy tightening and calls for wage restraint that have accompanied the recent inflation spike.

While the impact of the war on inflation and real wages may prove short-lived, there are broader implications for workers and policy-makers in ensuring real wages grow. Without such growth, workers will face hardship and the economy will stagnate through lack of demand. Policymakers can act to promote higher real wages by rebuilding collective bargaining institutions and enabling union organization. Not acting in this way risks more years of stagnant real wages. The broader lesson of our analysis is that the return of growth in real wages will require a strengthening of workers' bargaining power.

Further studies can focus on other economies, including developed and developing countries to see how geopolitical uncertainty and risks associated with war impact wages. Future work can also be focused on the different sectors of the economy and comparative analysis of wage growth in different countries and sectors.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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ENDNOTES

[1] By the end of November 2022, UK took about 147,000 refuges due to the Russia-Ukraine war. See https://www.gov.uk/government/publications/ukraine-family-scheme-application-data.
These are war-fleeing refugees, mostly women and children. According to UK's labour laws, asylum seekers are not allowed to work. In the future, they may go back to their country or stay but either way their impact on the labour market will be negligible.

[2] For details, see Shin et al. (2011) and earlier work by Pesaran and Shin, (1999) and Pesaran et al. (2001).

[3] See, Yuksel et al. (2011) for details on Catmull-Rom spline interpolation and its advantages.

[4] See, Zivot and Andrews (1992), Banerjee et al. (1992) and Vogelsang and Perron (1998) for discussion and support of this practise.

[5] See, Fox (1972) and Tsay (1988).

[6] Our test statics value or F-Test value is even greater than those proposed by the Narayan and Narayan (2005) and Narayan (2005) for the 95% confident that is, 3.11 and 4.31 for lower and up bounds respectively. They are also higher than those proposed more recently by Kripfganz and Schneider (2020) that is, 2.38. Therefore, our results are robust regardless of which benchmark we may use.

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APPENDIX A: COINTEGRATION SERIES

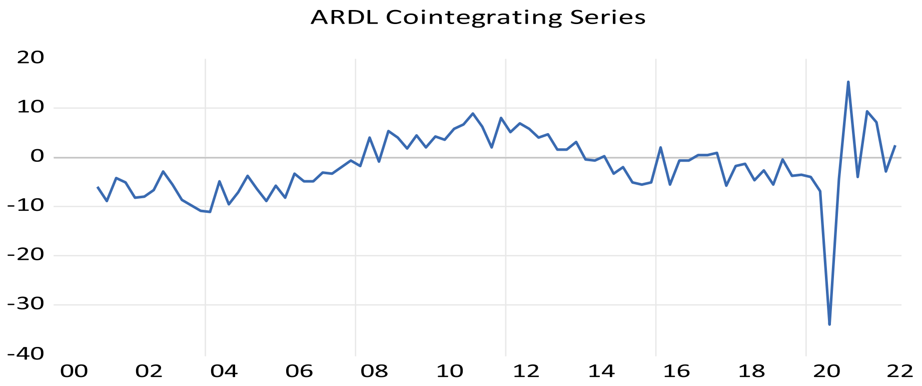

FIGURE A1 Partial asymmetry NARDL (3,4,2,4,0, 4,0,0) Co-integrating relation. [Colour figure can be viewed at wileyonlinelibrary.com]