Inflation targeting & implications of oil shocks for inflation expectations in oil importing & exporting economies: Evidence from three Nordic Kingdoms

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Abstract

In the context of the debate on inflation targeting, this paper analyses the impact of oil shock for inflation expectations in three Nordic Kingdom. A NARDL framework is applied to data from Jan 1994 to June 2018 on the Kingdoms of Norway, Sweden and Denmark. Our key findings suggest that there are considerable asymmetries and nonlinearities in the relationship between inflation expectations, oil shocks and economic determinants of inflation expectations. The expectations formulated in the past have a very significant negative impact on future inflation expectations (adaptive expectations) and there is heterogeneity in the adaptiveness pace. The country's net oil trade position seems to reflect in the impact of oil price shocks on the inflation expectations and there is asymmetry and downwards inflation expectations rigidity. There is strong evidence of exchange rate pass-through to inflation expectations. Prevailing regimes of price stability can support to anchor future inflation expectations. Reduction in fiscal deficit and increases in money supply has a positive while unemployment has a negative impact on inflation expectations. The cumulative multiplier analysis showed that the impact of oil shock was symmetric in Sweden and Denmark but asymmetric in Norway which is a large net oil exporter. Besides the adoption of explicit inflation targeting regime by Sweden and Norway, the inflation expectations in the underlying economies are prone to the oil price shocks and macroeconomic determinants. These shocks pose a whole set of challenges to monetary authorities in these economies and the findings in the subject treatise provide some guidance on how each shock may transmit.

Key Words: Inflation Targeting, Zero Lower Bound, Oil Shocks, Exchange Rate Pass-Through, Inflation, Inflation Expectations, Nonlinear ARDL, NKPC.
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1. Introduction:

After the episode of Great Inflation in the 1970-80s a number of the monetary authorities chose to adopt the strategy of explicit inflation targeting. Pioneered by New Zealand and adopted by around 28 economies (including Sweden and Norway) by the time of writing of this paper, the explicit inflation targeting entails estimation and then the public announcement of an objective and quantifiable rate of inflation as the "*Target*" (Jahan, 2017). The benefit of having an explicit inflation target is that it provides a "*nominal anchor*" which then acts as a guide to monetary policymakers to render their efforts to achieve this target in the medium to long-term. A novel aspect of inflation targeting strategy is that it possesses the features of both "*rules*" and "*discretion*" in the monetary policy framework and for this reason in Bernanke (2003) words, its "*constrained discretion*" with two distinct features i.e. a precise numerical target for inflation and discretion in the response to the economic shocks. In the explicit inflation-targeting framework where the cards have been put on the table, for a transparent and independent monetary authority's commitment to the achievement of its statutory objective, it is expected that the inflation, as well as inflation expectations, will be well anchored. This strength of the credibility and commitment shall harbour the price stability by achieving the inflation target.

Since its inception, the idea of inflation targeting has gathered steady popularity. Proponents have discussed and emphasised the benefits of adopting explicit inflation targeting, arguing that it is a simple, transparent and flexible strategy accompanied by the aspect of increased accountability of policymakers (see Bernanke et al, 2001 for an in-depth insight). Nonetheless, it can also overcome the problem of time-inconsistency (Mishkin, 2000), mitigate the inflationary bias (Herrendorf, 1998), lower risk premiums (Lee, 2011; Lanzafame, 2016), higher real wages (Seim and Zetterberg, 2013) and lead to the increased credibility of monetary authority which concomitantly reduces the output sacrifices required to bring inflation down (Corbo et al, 2001). Svensson (1996) argued that inflation targeting simplifies monetary policy formulation and monitoring. Among other vocals, Williams (2014) argued that the explicit as well as implicit inflation targeting is helpful in anchoring expectations and achieving price stability. Similarly, Obstfeld (2014) also supported the notion of inflation targeting for price stability while Minea and Tapsoba (2014) argued that inflation targeting can, in fact, contribute to fiscal discipline. However, proponents of inflation targeting have also acknowledged its limitation as inflation targeting is *not a panacea* and strategy depends on how it is implemented (Bernanke, 2001), nonetheless, it may not be an appropriate strategy for all the countries (Mishkin, 2000). Despite, overarching support there are critics who argued that inflation targeting has some serious limitations and in fact, Post-Global Financial Crisis (GFC), the idea of inflation targeting has died (see, Frankel, 2012; Quiggin, 2012). Some studies showed very little evidence on the role of inflation targeting in reducing inflation (Angeriz and Arestis, 2008; Alpanda and Honig, 2014). On the other hand, there is still strong support for inflation targeting and the notion that it is still valid in the Post-GFC era (Reichlin and Baldwin, 2013; Anderson et al 2015). In specific to GFC and the Great Recession, Anderson et al (2015) argued that the inflation targeting countries have weathered the crisis much better than non-targeting economies. Similarly, Williams (2014) argued that in the Post-GFC world, the explicit, as well as implicit inflation targeting has been successful in bringing price stability and anchoring inflation expectation. However, there are two vital challenges, the constraint of the Zero Lower Bound (ZLB) on nominal interest rates and the appropriate role of monetary policy in supporting financial stability. On the aspect of ZLB, there is prima facie evidence that it limits the ability of monetary policy to manoeuvre and use its *most tried and tested instrument* i.e. policy rates. However, one may argue that there is not such a thing as ZLB as the central banks for instance; the Bank of Japan, European Central Bank (ECB) and the Riksbank have defied the bounds on the nominal rates by adopting negative interest rates (Nasir, 2017). However, it is also obvious that they did not go very far below Zero.

While there could be a difference of opinion on the success and usefulness of inflation targeting as a strategy, those who support the adoption of this strategy argue that it is not beneficial per see, but for some good reasons. These reasons and benefits are transparency, accountability and flexibility that make them

influence the inflation as well as inflation expectations (see Bernanke, 2001 and 2003; Morgan, 2009)[1]. Hence, there is a strong element of trust and credibility which anchors the expectations of the household and firms. The arguments in favour and against inflation targeting are interesting, only some empirical facts and findings can clear the fog and lead to conclude whether the inflation targeting has been successful in anchoring inflation expectations. Specifically, if the GFC and ZLB have led to diminish or deteriorate the credibility of the inflation targeting monetary authorities, it is logical to expect that in that world the *unguarded inflation expectations* should have become more responsive to its determinants.

In terms of its determinants, theoretical explanation and empirical evidence suggests that the inflation dynamics are shaped by the aggregate demand (output gaps), outlook of labour market (slack or spare capacity) supply and cost shocks, exchange rate movement, degree of fiscal discipline, past behaviour of inflation, and inflation expectations (discussion in next section). Among these factors, inflation expectation is perceived to be one of the most crucial factors and a considerable amount of theoretical and empirical studies have voiced this argument, for example, Friedman (1968) and Phelps (1967) to most recently Marfatia (2018). In this regard, inflation targeting plays or is intended to play the most crucial role, particularly in terms of anchoring and mooring the inflation expectations and increasing the credibility of monetary authorities. Perhaps, the notion of inflation targeting is embedded in the logic of credibility, accountability and transparency (Morgan, 2009). However, at the ZLB the monetary authorities are constrained to deliver on their promise. It is nothing but logical to entertain the thought that the ZLB may influence the credibility or at least the ability and perceived ability of the monetary policy to act to stabilize the inflation and output. In its essence, inflation targeting is a "*Game of managing inflation expectation*" rather than solely the management of inflation. From Bernanke et al (2001) to Williams (2014), among the proponents of those who supported the notion of adopting explicit inflation targeting, the most frequently used argument was anchoring expectation. However, given that the monetary policy is at ZLB, how may it affect the inflation expectation, particularly in face of any shocks emerging from its determinants? Keeping that in context, in this study we analyse the implication of oil shock and other economic determinants of inflation expectations in three largest Scandinavian economies including the Kingdom of Denmark, Kingdom of Norway and the Kingdom of Sweden. The latter two have opted for explicit inflation targeting while among these only the Norway is a large oil exporter. Nonetheless, in the case of Norway the policy rates have remained close but just above zero whereas in Sweden and Denmark, they are sub-zero at -0.25% and -0.65% respectively by the writing of this paper. These facts suggest some differences in these economies in terms of their net oil export position as well as monetary policy framework and practices which intrigued us to carry to this study. Concomitantly, we employed a Nonlinear Autoregressive Distributed Lag (N-ARDL) framework on the data from subject economies. Contingent on the obtainability of data on inflation expectations, we choose the monthly observations from Jan 1994 - June 2018 for Denmark, March 2002 - June 2018 for Norway and Dec 1999 - June 2018 for Sweden. Our key findings suggest that there are short-run asymmetries and nonlinearities in the relationship between inflation expectations, oil shocks and economic determinants of inflation expectations. The expectations formulated in the past have a very significant negative impact on future inflation expectations (adaptive inflation expectations) and there is heterogeneity in the adaptiveness pace. The country's net oil trade position seems to reflect on the impact of its prices on the inflation expectations suggesting heterogeneity in these countries. The positive and negative oil shocks also transmit differently suggesting asymmetry and downwards the inflation expectations rigidity. There is significant evidence of exchange rate pass-through to inflation expectations. Strong nexus between actual inflation and future inflation expectation implies that the regimes of price stability could actually support to anchor the inflation expectations. Reduction in fiscal deficit and increases in money supply has a positive while unemployment has a negative impact on inflation expectations. The cumulative multiplier analysis showed that the impact of oil shock was symmetric in Sweden and Denmark but asymmetric in Norway which is a large net oil exporter. Besides the adoption of an explicit inflation targeting regime, the inflation expectations in the underlying economies are prone to the oil price shocks and macroeconomic

[1] In a wider context, Chortareas et al (2002) argued that the increased transparency of monetary policy can decrease in the inflation and sacrifice ratio.

determinants. These shocks pose a whole set of challenges to monetary authorities in these economies and the findings in the subject treatise provide some guidance on how each shock may transmit.

The rest of the paper proceeds as follows, in section 2, we will revisit the existing evidence on the Inflation targeting and ZLB as well as the determinants of inflation and inflation expectations Section 3 will set out a Nonlinear-ARDL framework as a means of analysing the nexus between inflation and inflation expectation and their explanatory factors. Section 4 will present the results of empirical analysis and discussion of results which will lead us to conclude and draw on the policy implication in section 5.

2.1 Inflation Targeting

The strategy of Inflation Targeting was pioneered by New Zealand in 1990 and was soon followed by Canada (1991), UK (1992) and Sweden and Australia (1993) a bit later by Norway in 2001. While Denmark adopted a slightly different path being a country with a fixed exchange rate vis-a`-vis the euro. Big players like Fed and ECB were not at the forefront of the monetary authorities adopting the explicit inflation targeting, there was some strong support for doing so[2]. For instance, Bernanke et al (2001) strongly urged the Fed and the ECB to adopt the inflation targeting, as there are clear benefits of simplicity, transparency and accountability to the public. So the flexibility of discretion as well as the accountability with the explicit target, making two together as "constrained discretion" (Bernanke, 2003). In their support of inflation targeting, Bernanke et al (2001) drew on the evidence of inflation in a number of countries to argue that inflation-targeting countries have typically seen *lower inflation and lower inflation expec*tations. However, they also cautioned that the inflation Target is *not a Panacea* and is contingent on the operational details. Perhaps, as Obstfeld (2014) suggested an inflation-targeting framework that entailed a *well-anchored inflation target* is helpful in delivering a moderate and stable rate of inflation.

In its essence, the Inflation Targeting involves a) an explicit central bank mandate to pursue price stability as the primary objective of monetary policy and a high degree of operational autonomy[3] b) a quantified target c) accountability of central bank through transparency and d) *forward-looking assessment of inflation* (Roger, 2010). Undoubtedly, the success of any strategy is dependent on the quality of intuitions, so does for the successful inflation targeting for price stability, it is the institutional architect of monetary authorities (Huang and Wei, 2006). The economies which have adopted the strategy of inflation targeting and those considered in this study are developed countries with well-developed intuitional frameworks and established central banks. If we gauge the performance of the adopters of inflation targeting, according to a position postulated by Williams (2014), though in pursuit of price monetary authorities have lost the sight of financial stability, they have delivered the promise of delivering price stability which is evident in the behaviour of inflation since crises. However, this line of reasoning and assertions by Williams (2014) requires to be tested against a robust empirical and analytical framework. Given the fact that in the Post-GFC and globally low-interest rate regime (Haldane, 2015; Nasir, 2017), the inflation outlook has been very serene which could be due to the several factors (including modest demand pressure, secular stagnation and low oil energy prices) how much of it we can associate with inflation targeting? nonetheless, among do the oil price shocks and shocks from other determinants transmit differently in the inflation targeting and non-targeting economics? and does being a net oil export position makes any difference!

2.2 Determinants of Inflation and Inflation Expectations

In terms of their determinants, the inflation dynamics are defined by the supply and demand shocks. Though the monetary policies may or may not influence inflation and its expectation, the policy variables are a response to inflation or expected inflation. Moreover, since the GFC and at the ZLB there is not

[2] In case of ECB, there were some logical concerns around the country level inflation differentials and their implications for the ECB's credibility and success in inflation targeting (Artis and Kontolemis, 1998).

[3] Although, Alpanda and Honig (2014) argued that the independence of central bank is not a prerequisite for decline in inflation Post adoption of I.T.

much manoeuvrability by the monetary authorities that one might have witnessed[4]. Hence, the focus of this study is on the variables which are traditionally held accountable for the inflation dynamics rather than the effects of policy rates. In terms of demand shocks, an increase in the aggregate demand and an adverse supply shock shall cause the upward inflation pressures. In a remarkable study, Gali and Gertler (1999) argued that the current inflation rate is also affected by past inflation, future inflation expectations and aggregate demand pressure. Among the noteworthy studies investigating the determinants of inflation in developed countries, Canova et al (2007) showed that in the US these are the demand shocks while in the Euro Area supply shock were found to be significant contributory factors. However, they also reported that in the case of UK demand shocks, supply shocks and the monetary policy had significant effects. In evidence from the Euro Area, McAdam and Willman (2004) and Lagoa (2017) reported significant effects of supply (cost) shocks, while Boschia and Girardi (2007) showed that both in the short and long run the supply (cost) and demand (output gap) shocks affect inflation. Contrarily, in evidence from the Euro Area using sectoral level as well as country-level data Norkute (2015) reported there is no significant evidence to support the notion that there is a positive relation between cost shocks and inflation. Similarly, studies on the developing economies also suggest mixed evidence, (for instance, contrast, Coe and McDermott (1997), Mohanty and Klau (2001), Domaç and Yücel (2005) Unsal and Osorio (2013) and Mohanty and John (2015). In specific to oil shocks and their impact on the inflation expectations there is mixed and contrasting evidence. For instance, Elliott et al (2018) empirical showed that there is statistically significant evidence that a link exists for the US and Eurozone, but not for the UK (also see Conflitti and Cristadoro, 2018 and Istiak and Alam, 219). Concomitantly, these mixed and inconclusive results on the nexus between inflation, inflation expectations and their determinants in the developed as well as developing countries provide a rationale to further exploration of explanatory and moderating factors. In the subject case, it is the strategy of inflation targeting and differences between net oil export position.

The transparency of central banking which is one of the claimed benefits of inflation targeting may contribute to anchoring inflation expectations and inflation. While acknowledging this notion, Weber (2016) argued that transparency alone might not bring price stability. Furthermore, that effect on inflation mainly comes from reduced inflation expectations. Among the earlier proponents of the role of expectations, Friedman (1968) and Phelps (1967) attributed to the role of expectations in determining inflation behaviour. Later studies empirically investigated the channel and nexus between inflation and inflation expectations. For instance, a study by Mehra and Herrington (2008) on the US reported that the inflation and inflation expectations were affected by the past inflation, expected inflation, supply (oil price) and demand (unemployment) shocks. In a comparative analysis, Ueda (2010) compared the response of inflation expectations to price shocks in the US and Japan and reported that inflation expectations adjust more quickly than does the realised inflation. Compared with Japan, the effects of exogenous prices on inflation and inflation expectations in the US are not only large but also long-lasting and shocks to expectations have self-fulfilling effects on inflation. On the contrary, Fuhrer (2011) reported that short-run inflation expectations play an important part in explaining U.S. inflation. However, in the long run, expectations generally do not appear to have a direct influence on U.S. inflation. A study by Lagoa (2017) on the Euro Area reported that the exchange rate movements and inflation expectations play an important part in explaining inflation. In the most recent case in the UK, Marfatia (2018) showed that future inflation expectations (derived from the bond index) play a significant role in explaining the actual inflation dynamics. Posen (2011) discussing the inflation expectation in specific to the British economy, argued that reliable forecasts for domestically generated inflation can be made taking inflation expectations as anchored. Furthermore, the movements in measured short-term inflation expectations are uninformative for forecasts. However, these assertions by Posen (2011) need to be tested against empirical evidence. Nonetheless, if the inflation expectation had been anchored to that extent the recent exchange rate shocks in the UK would not have caused the surge in inflation and the very poor performance of the Bank of England's forecast (See, Broadbent, 2017; Haldane, 2017 and Nasir, 2017b).

[4] Unconventional measures of Asset Purchase Programmes or Q.Es are exceptions and there is no doubt that they were focused on the output and financial stabilisation rather price stabilisation. There are a number of studies which have looked at the impact of these measures of inflation (see, Haldane, 2015 and Nasir, 2017 for a survey of literature on this subject).

A crucial and highly debatable factor which may have inflationary consequences is the stance of fiscal policy. On this aspect, in their seminal paper, Sargent and Wallace (1981) argued that the conduct of the fiscal policy has significant implications for inflation; however, Fischer et al (2002, page 34) using data of 133 countries reported, "*positive relationship between fiscal deficits and inflation is not always detectable in the historical data*". Nonetheless, this relationship is found to be more significant in the high inflation countries than low inflation countries. On the contrary, Catao and Terrones (2005) employing an even richer dataset of 107 reported the fiscal deficit to be inflationary in most of the economies. Later, Lin and Chu (2013) also supported the inflationary impact of fiscal deficit. The role of fiscal stance is critical in determining inflation and inflation expectations (Sargent and Wallace, 1986), hence the importance of fiscal policy in supporting inflation targeting (Mikek, 2004; Alpanda and Honig, 2014). With regards to inflation targeting, Minea and Tapsoba (2014) reported that in fact, it can harbour fiscal discipline which is often considered as a precondition for successful inflation targeting. On this nexus, while analysing Brazilian data, Minella et al (2003) and later Cerisola and Gelos (2009) suggested that since the adoption of inflation targeting, the inflation expectations have been anchored including in the period of uncertainty. Furthermore, the fiscal policy stance is an important factor in influencing inflation expectations while past inflation does not affect inflation expectations. Similar to Corbo et al (2001), they also suggested the absence of inertia in the inflation process which is contrary to the argument put forward by Gali and Gertler (1999). Specific to inflation expectations Yigit (2010) also reported a reduction in persistence post adoption of inflation targeting. Keeping this mixed evidence in context, in this study, we will consider the fiscal stance as well as the past behaviour of inflation and inflation expectations in determining the current level of inflation and inflation expectations in Pre and Post ZLB periods.

The high Exchange Rate Pass-Through (ERPT) can pose challenges to monetary policy in her efforts towards the attainment of inflation targets (Fraga et al 2003). There has been a notion that the ERPT might have declined due to inflation targeting (see e.g. Goldfajn and Muinhos (2003) on Brazil). Supporting this point of view, some scholars focusing on the Pre-GFC period, argued that the ERPT might have declined due to the increased credibility and gains due to the inflation targeting which can keep the inflation expectations low after depreciation (see Mishkin and Savastano (2001), Eichengreen (2002) and Schmidt-Hebbel and Werner (2002). Similarly, a later study by Junior (2017) argued that the ERPT has declined since the start of inflation targeting in emerging economies, though it was also suggested that it should be not be inferred that the ERPT has become non-existent, particularly in the long run. On the contrary, some empirical studies strongly refuted the argument that the ERPT has declined and suggested that it is the other way around (See Forbes et al (2015), Forbes (2016), Forbes et al (2017), Nasir and Simpson (2018). Nonetheless, there is also some empirical evidence that suggests that the ERPT in some economies has in fact increased under inflation targeting (Nasir, 2018). Concomitantly, in the context of the subject study, this notion requires further exploration and empirical validation. Specifically, given the fact that the policy rates in the subject Nordic countries have been in closely above and below zero, is inflation targeting still ample to anchor the inflation expectations in the face of shocks from the oil prices, the exchange rate (ERPT) and other determinants of inflation and inflation expectations? Perhaps, in the light of the literature and empirical evidence discussed hitherto, the very idea of inflation targeting is embedded in the notion of credibility, accountability and transparency. These traits are expected to be useful in anchoring and taming inflation expectations. However, to what extent the inflation and its expectations remained anchored in the face of the shocks from their determinants while close to the ZLB is the question? Nonetheless, in the subject economies, Norges Bank has kept the policy rates close but just above zero whereas in Sweden and Denmark, they are sub-zero at -0.25% and -0.65% respectively. In the next section, we will elaborate on our empirical framework which will be used as a mean to answer these questions.

3.1 Methodology

An Auto-Regressive Distributed Lag (ARDL) framework is employed to estimate and analyse the shocks to inflation and inflation expectations caused by their potential determinants, namely output growth, labour market, cost or supply (oil) shocks, real exchange rate, money supply and fiscal deficit. This relationship can be specified in the form of an open economy NKPC; -

$$\pi_t = \beta_\pi \pi_{t-i} + \beta_{Oil} Oil_{t-i} + \beta_{E\pi} E\pi_{t+i} + \beta_{OG} OG_{t-i} + \beta_{LMS} LMS_{t-i} + \beta_{Fiscal} Fiscal_{t-i} + \beta_{Ex} EX_{t-i} + \beta_{MS} MS_{t-i} + e_t \quad (1)$$

Where the inflation is determined by its past values (persistence element,π_{t-i}), its expectations ($E\pi$), output growth (OG), labour market slack or spare capacity (LMS), fiscal stance (deficit/surplus), Oil shocks (Oil), Money Supply (MS) and exchange rate pass-through (EX). Given that these factors are theoretically perceived and often empirical proved to be the determinants of inflation, the expectations of inflation are also influenced by these factors and their dynamics. Hence,

$$E\pi_t = \beta_\pi \pi_{t-i} + \beta_{Oil} Oil_{t-i} + \beta_{E\pi} E\pi_{t+i} + \beta_{OG} OG_{t-i} + \beta_{LMS} LMS_{t-i} + \beta_{Fiscal} Fiscal_{t-i} + \beta_{Ex} EX_{t-i} + \beta_{MS} MS_{t-i} + e_t \quad (2)$$

The novelty of the employed N-ARDL approach is that it takes into account the asymmetries and nonlinearities in the relationship between oil shock, inflation expectations and their determinants. The N-ARDL cointegration approach is based on the seminal work by Shin et al (2011) which found its roots in the contributions by Pesaran and Shin (1999) and Pesaran et al. (2001). To start with, we can specify the Eq. (1 & 2) in the following long-run model of inflation and inflation expectations; -

$$\pi_t = a_0 + a_1 Oil_t^+ + a_2 Oil_t^- + a_3 E\pi_t + a_4 OG_t + a_5 LMS_t + a_6 Fiscal_t + a_7 EX_t + e_t \quad (3)$$

$$E\pi_t = a_0 + a_1 Oil_t^+ + a_2 Oil_t^- + a_3 \pi_t + a_4 OG_t + a_5 LMS_t + a_6 Fiscal_t + a_7 EX_t + e_t \quad (4)$$

Where π_t is inflation and $E\pi_t$ are inflation expectations and their determinants are as specified in equation (1 & 2), $a = (a_0 - a_7)$ is a co-integrating vector of long-run parameters. In Eq. (3 & 4) the Oil_t^+ and Oil_t^- are partial sums of positive and negative changes in the oil prices, it can be specified as;-

$$Oil_t^+ = \sum_{i=1}^{t} \Delta Oil_i^+ = \sum_{i=1}^{t} \max(\Delta Oil_i, 0) \quad (5)$$

and

$$Oil_t^- = \sum_{i=1}^{t} \Delta Oil_i^- = \sum_{i=1}^{t} \min(\Delta Oil_i, 0) \quad (6)$$

In the light Eq. 4, the relationship between oil shocks and inflation expectations ($E\pi_t$) is expected to be positive (a_1). However, a_2 captures the association between negative oil shocks and inflation expectations. As the oil prices and its expectations are expected to show co-movement, estimates of a_2 are expected to have positive signs. Furthermore, we also posit that the increase in the oil prices leads to a higher increase in the inflation expectations than the decrease in oil prices which may lead to a decrease in the expected rate of inflation. In simple words, the positive shocks will have a greater impact than the negative shocks i.e. $a_1 > a_2$. This implies downward inflations expectations rigidity. Concomitantly, the long run relationship presented in the Eq. (3&4) is expected to reflect an asymmetric oil price pass through. At this juncture, we can frame the Eq. 3 and 4 into a NARDL setting (see, Shin et al. (2011) Pesaran and Shin (1999) and Pesaran et al. (2001) as follows; -

$$\Delta\pi_t = a + \beta_1\pi_{t-1} + \beta_2 Oil^{+}_{t-1} + \beta_3 Oil^{-}_{t-1} + \beta_4 E\pi_{t-1} + \beta_5 OG_{t-1} + \beta_6 LMS_{t-1} + \beta_7 Fiscal_{t-1} + \beta_8 EX_{t-1} + \beta_9 MS_{t-1} + \sum_{i=1}^{p} \emptyset_i \Delta\pi_{t-i} + \sum_{i=0}^{q} (\theta_i^{+}\Delta OP^{+}_{t-i} + \theta_i^{-}\Delta OP^{-}_{t-i}) + \sum_{i=0}^{s} \gamma_i \Delta OG_{t-i} + \sum_{i=0}^{v} \delta_i \Delta LMS_{t-i} + \sum_{i=0}^{w} \Omega_i \Delta Fiscal_{t-i} + \sum_{i=0}^{x} \varphi_i \Delta E\pi_{t-i} + \sum_{i=0}^{z} \delta_i \Delta EX_{t-i} + \sum_{i=0}^{m} \psi_i \Delta MS_{t-i} + e_t \qquad (7)$$

And

$$\Delta E\pi_t = a + \beta_1 E\pi_{t-1} + \beta_2 Oil^{+}_{t-1} + \beta_3 Oil^{-}_{t-1} + \beta_4 \pi_{t-1} + \beta_5 OG_{t-1} + \beta_6 LMS_{t-1} + \beta_7 Fiscal_{t-1} + \beta_8 EX_{t-1} + \beta_9 MS_{t-1} + \sum_{i=1}^{p} \emptyset_i \Delta E\pi_{t-i} + \sum_{i=0}^{q} (\theta_i^{+}\Delta OP^{+}_{t-i} + \theta_i^{-}\Delta OP^{-}_{t-i}) + \sum_{i=0}^{s} \gamma_i \Delta OG_{t-i} + \sum_{i=0}^{v} \delta_i \Delta LMS_{t-i} \sum_{i=0}^{w} \Omega_i \Delta Fiscal_{t-i} + \sum_{i=0}^{x} \varphi_i \Delta\pi_{t-i} + \sum_{i=0}^{z} \delta_i \Delta EX_{t-i} + \sum_{i=0}^{m} \psi_i \Delta MS_{t-i} \; e_t \qquad (8)$$

Where we have defined all the variables earlier and $p, \mathrm{q}, \mathrm{s}, \mathrm{v}, \mathrm{w}, \mathrm{x}, z \; and \; m$ are lag orders and $a_1 = -\beta_2/\beta_1 \; a_2 = -\beta_3/\beta_1$ are the earlier mentioned long-run impacts of increase/decrease in the oil prices on inflation e (Eq. 9) and the impact of positive and negative shocks on inflation expectations (Eq.10). In Eq. 9, the $\sum_{i=0}^{q} \theta_i^{+}$measures the short-run impacts of an increase in oil prices on inflation whereas $\sum_{i=0}^{q} \theta_i^{-}$ measures the short-run impacts of a decrease in oil prices on inflation. On the other hand, in Eq. 10 $\sum_{i=0}^{q} \theta_i^{+}$measures the short-run impacts of an increase in oil prices on inflation expectations whereas $\sum_{i=0}^{q} \theta_i^{-}$ measures the short-run impacts of a decrease in oil prices on the inflation expectations. Concomitantly, in this setting, we capture the asymmetric long-run as well as the asymmetric short-run relationship between oil shocks and inflation expectations.

The implementation of the employed NARDL framework will be entailed on the following steps. At first, we will perform the unit root test to determine the order integration of underlying data series. It is worth acknowledging that the ARDL approach to cointegration is valid whether the series are I (0) or$I$ (1), however, it is still important to perform to unit root test to confirm that there is no I (2) variable. This is an important aspect to consider as I (2) invalidates the computation of F-statistics to test the cointegration (Ibrahim, 2015). We would perform the ADF unit root test with a structural break to find the order of integration. Thereafter we would estimate the Equation 9 & 10 using the OLS method. After estimation of our NARDL model, we would be applying the bound testing approach proposed by Pesaran et al. (2001) and Shin et al. (2011) to test for the presence of cointegration among underlying data series. In so doing, we would perform the Wald F-test with the null hypothesis, $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = 0$. In the last and final step of the analysis, we would examine the long and short run asymmetries in the relationship between oil shocks and inflation expectations, we would also discuss the impact of other explanatory variables in the model. With specific to the oil price shocks and inflation expectations, we would derive the asymmetric cumulative dynamic multiplier effects of a 1% change in the oil prices i.e. Oil^{+}_{t-1} and Oil^{-}_{t-1} respectively as; -

$$m_h^+ = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{OP_{t-1}^+}, m_h^- = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{OP_{t-1}^-}, h = 0,1,2 \ldots \ldots \ldots \quad (10)$$

It is worth noting that as $h \rightarrow \infty, m_h^+ \rightarrow a_1 \; and \; m_h^- \rightarrow a_2$.

3.2 Data

The data was collected on the inflation, inflation expectations, fiscal stance, output growth, labour market, real exchange rate, Money Supply and supply/cost (oil) shocks. Necessary transformations/calculations were made to estimate the output gap and labour market slack. To match the frequency, we also performed the linear interpolation for the quarterly observations where necessary. Depending on the availability, the time horizon of analysis varied among the Kingdoms of Norway, Sweden and Denmark, though we tried our best to gather the longest possible series in each case. Details of each proxy for each country is as follows: -

Inflation: For inflation, we used the monthly data on the consumer price index, percentage change year on year. The choice of using this measure is also informed by the fact that it is the official measure which is often used and targeted in an inflation targeting regime**.**

Inflation Expectations: Inflation expectations which are our prime variable of interest we have collected by different agencies about the future inflation expectations. For Denmark, we collected the data on the Development of consumer prices over the next 12 months, from the Ministry of Economic Affairs and the Interior. For Norway, we collected the data, from the Norges Bank's surveys on expectations for inflation. For Sweden, we collected the data from the survey on inflation expectations conduction by Kantar Sifo which his commissioned by the Sveriges Riksbank (Central Bank of Sweden).

Output growth: The output growth was measured by the Real GDP growth percentage change year on year which was also seasonally adjusted.

Labour Market (Unemployment): The labour market outlook was measured by the spear capacity or labour market slack. We used the unemployment rate for all three countries.

Fiscal Stance (Surplus/Deficit): To represent the fiscal stance, we used the budget deficit/surplus of the central government for all three countries.

Real Exchange Rate: The real exchange rate was measured by the real effective exchange rate which is trade-weighted.

Money supply: For money supply, we used the most broader measure available i.e. the M3 in all three countries.

Oil (cost) Shocks: To represent the cost or oil shocks we used the data on the oil prices. The data on the Crude Oil Prices i.e. West Texas Intermediate (WTI) was collected from the from FRED, Federal Reserve Bank of St. Louis.

4.1 Analysis, Findings and Discussion

4.2 Test of stationary

To start with, we employed the unit root test with a structural break following the Zivot-Andrews (1992) approach. The basic notion of this approach is to augment the presence of the endpoints, which might capture asymptotic distribution. The Zivot-Andrews test unit root test with a drift that includes any structural break.

Table 1. Unit Root Testing with structural break by Zivot-Andrews in level I(0)

Variables	Denmark	Norway	Sweden
Inflation Expectation ($E\pi$)	-4.238 [July 2008]	-3.779 [July 2007]	-3.383 [January 2009]
Inflation (π)	-4.416 [December 2012]	-5.484*** [January 2011]	-3.298 [January 2011]
GDP	-4.909** [October 2010]	-3.567 [January 2008]	-3.808 [January 2008]
REX	-4.316 [May 2002]	-4.564 [October 2014]	-3.386 [April 2014]
Unemployment	-6.734*** [September 2008]	-4.269 [November 2005]	-2.385 [October 2008]
Money Supply	-4.593** [July 2001]	-3.943 [April 2006]	-4.206 [August 2008]
Oil Price	-4.555 [August 2014]	-4.546 [October 2014]	-4.477 [August 2014]
Fiscal (Surplus/Deficit)	-5.859** [December 2009]	-5.906*** [October 2008]	-6.206 [October 2008]

*The symbols *, **, and *** denote the significance at 10%, 5%, and 1% levels, respectively. Critical values: 1%: -5.34 5%: -4.80 10%: -4.58. Structural break times of the corresponding t-statistics are presented in square brackets.*

Table. Unit Root Testing with structural break by Zivot-Andrews in first-difference I(1)

Variables	Denmark	Norway	Sweden
Δ Inflation Expectation ($E\pi$)	-21.045*** [March 2009]	-5.485*** [July 2011]	-5.985*** [October 2008]
Δ Inflation (π)	-16.287*** [September 2008]		-10.531*** [October 2008]
ΔGDP		-6.731*** [January 2010]	-4.627* [April 2009]
Δ.REX	-11.879*** [December 2000]	-8.186*** [January 2016]	-7.618*** [April 2009]
Δ Unemployment		-5.920*** [May 2008]	-7.504*** [May 2008]
Δ Money Supply		-4.632*(1) [January 2008]	-14.137*** [March 2009]
Δ Oil Price	-8.264*** [July 2008]	-7.866*** [January 2016]	-11.349*** [July 2008]
Δ Fiscal (Surplus/Deficit)		-5.906*** [June 2009]	-12.224*** [October 2009]

*The symbols *, **, and *** denote the significance at 10%, 5%, and 1% levels, respectively. Critical values: 1%: -5.34 5%: -4.80 10%: -4.58. Structural break times of the corresponding t-statistics are presented in square brackets.*
(1) We do not employ the stationary test for the variables which are stationary in the original level I(0) in Table 1.

The chosen ARDL approach does not strictly require the condition of *I* (0) or *I* (1) (Pesaran, Shin, Smith, 2001). However, it is vital to assure that there is no *I* (2) co-integration because 'bounds test' for nonlinear cointegration will be only passed under *I* (0) or *I* (1). From the results presented in Table 1 and Table 2, it is evident that all our variables are stationary at the original level or first-difference, which allows us to perform the further assessment (Ouattara, 2004).

4.3 Bound testing for Nonlinear Co-integration

The results of Bounds testing for the nonlinear Cointegration for Denmark, Norway and Sweden are summarised in Table 3.

Table 3. Bounds test for the Nonlinear Cointegration

Dependent variable	F-statistics	K	Lower-Bound (95%)	Upper-Bound (95%)	Conclusion
$Inflation\ \ Expectation\ (E\pi)$ Denmark	5.759145	8	2.11	3.15	Cointegration
$Inflation\ \ Expectation\ (E\pi)$ Norway	3.592085	8	2.11	3.15	Cointegration
$Inflation\ \ Expectation\ (E\pi)$ Sweden	3.857600	8	2.11	3.15	Cointegration

It showed that the F-statistics were higher than upper bound at 95% level of statistical significance. Therefore, the results implied that there exists the long-run relationship between the inflation expectations and its determinants in three Scandinavian countries (Denmark, Norway and Sweden). Hence, we can further investigate their association and proceed with the estimation.

4.4. Inflation Expectations - N-ARDL

The results of Nonlinear Autoregressive Distributed Lag (N-ARDL) for three countries (based on AIC lag-order selection criteria) are presented in Table 4.

Table 4. N-ARDL Short-run Estimates

Variables	Denmark	Norway	Sweden
$Inflation\ \ Expectations\ (E\pi)_{t-1}$	-0.215291*** [-5.068335]	-0.110639*** [-4.635992]	-0.065642*** [-3.809682]
$\hat{}Oil\ price_t^+$	1.186301 [1.275158]	0.011119 [0.623071]	0.023581** [2.405294]
$Oil\ price_{t-1}^-$	0.290149 [0.258129]	-0.005039 [-0.222285]	0.031344*** [2.675563]
$\hat{}REX_t$	-53.14538*** [-3.063723]	0.360694** [2.509014]	-0.146632 [-1.442084]
$\hat{}Inflation_t(\pi)$	0.298379 [0.625834]		
$Inflation_{t-1}(\pi)$		0.008442 [1.574883]	0.030530*** [3.244688]
$\hat{}GDP_t$	0.014788 [0.067412]	-0.012005*** [-2.935569]	
GDP_{t-1}			0.006134*** [3.726546]
$\hat{}Fiscal_t$	2.63* [1.707049]	6.82 [0.075181]	1.51 [1.491941]
$\hat{}Money\ Supply_t$	0.072087** [2.167096]		
$\hat{}Money\ Supply_{t-1}$		-0.000952 [-0.622218]	
$Money\ Supply_{t-1}$			0.000702* [1.826129]
$Unemployment\ rate_t$			-0.005162 [-1.113795]
$\hat{}Unemployment\ rate_{t-1}$	-0.024188 [-1.330043]		
$Unemployment\ rate_{t-1}$		-0.036260** [-2.462789]	
$\Delta Inflation\ \ Expectations\ (E\pi)_{t-1}$	-0.201656*** [-3.458886]	0.612291*** [9.355917]	0.448478*** [7.451184]
$\Delta Inflation\ \ Expectations\ (E\pi)_{t-2}$		0.063148 [0.833688]	0.071835 [1.019286]
$\Delta Inflation\ \ Expectations\ (E\pi)_{t-3}$		-0.335279*** [-5.102464]	-0.262267*** [-4.451966]
$\Delta Oil\ price_t^-$	26.96770*** [4.612870]	-0.159997** [-2.078229]	-0.061381 [-1.168674]
$\Delta Oil\ price_{t-1}^-$	22.57352*** [3.619523]		

$\Delta Oil\ price_{t-2}^{-}$			0.058206 [1.080872]
$\Delta Oil\ price_{t-3}^{-}$			0.192678*** [3.665723]
$\Delta Inflation_t(\pi)$		0.016981** [2.260562]	0.018067** [1.900506]
$\Delta Inflation_{t-1}(\pi)$			-0.008359 [-0.742850]
$\Delta Inflation_{t-2}(\pi)$		0.019322** [2.427761]	0.014657 [1.361152]
$\Delta Inflation_{t-3}(\pi)$		-0.017444** [-2.136144]	0.026235*** [2.614776]
$\Delta Money\ Sumpply_t$		0.035603** [2.068340]	0.001552*** [3.005978]
$\Delta Money\ Sumpply_{t-1}$		-0.027042 [-1.595704]	0.000997* [1.881725]
$\Delta Unemployment\ rate_t$		-0.024442 [-0.680262]	
$\Delta Unemployment\ rate_{t-1}$		-0.000773 [-0.021848]	
$\Delta Unemployment\ rate_{t-2}$		0.001119 [0.032741]	
$\Delta Unemployment\ rate_{t-3}$		-0.078351** [-2.249998]	
ΔGDP_t			-0.006566 [-0.653751]
ΔGDP_{t-1}			-0.005401 [-0.455443]
ΔGDP_{t-2}			-0.013670 [-1.185888]
ΔGDP_{t-3}			0.029381*** [3.019443]
Constant	239.5037*** [3.026201]	-1.082836* [-1.654640]	0.791751* [1.663114]

*The symbols *, **, and *** denote the significance at 10%, 5%, and 1% levels, respectively.*ˆ interpreted as $z_t = z_{t-1} + \Delta z$. *T-statistics of the corresponding coefficients are presented in square brackets.*

The results of NARDL presented in Table 4, suggests prima facie evidence of the short-run asymmetries and nonlinearities in the relationship between inflation expectations, oil shocks and economic determinants of inflation expectation. There are five aspects of these findings certainly merits attention. *Firstly*, the lagged values of inflation expectations i.e. the inflation expectations formulated in the previous period have been found to have a very significant negative impact at 1% level of statistically significant in all three Scandinavian countries. This implies an inherent correction mechanism of inflation expectations or adaptive inflation expectations. Nonetheless, the short-run estimates also showed some heterogeneity in the impact of past-inflation expectations. For instance, for Denmark the short-run impact was negative and statistically significant to start with, however, the shocks in Norway and Sweden of inflation expectation initially has a positive and not very significant influence on inflation expectation. However, with a couple of lags, it turned into negative and statistically significant at 1% level. Therefore, it would be intuitive to infer that although there are a correction mechanism and revisions of future expectations in the light of past inflation expectations experience, the pace of these revisions of expectations varies among these countries.

Secondly, the coefficients of oil price shocks (positive and negative) showed heterogeneities and asymmetries in their impact. Specifically, the positive shocks found to have a positive impact in all three countries, however, the negative shock, showed a positive impact in the Denmark and Sweden but a negative and significant impact on inflation expectations in Norway. This is interesting findings as the difference in the country's net oil trade position seems to reflect on the impact of its prices on the inflation expectations suggesting heterogeneity in these countries. Nonetheless, the positive and negative shocks also transmit differently which is evident in asymmetry and price-rigidness in the inflation expectations. *Thirdly*, the real effective exchange rate found to have a significant impact in all three countries suggesting the exchange rate pass-through to inflation expectation. Interesting, Denmark and Sweden

showed a short-term negative impact of real exchange rate appreciation, while Norway showed a positive impact on inflation expectation. This suggests that inflation pass-through to inflation expectations varies in the underlying economies. Fourthly, the actual inflation if found to have a positive on the inflation expectations suggesting that if the inflation increases it influence the expectations of future inflation. These effects are quite clear in Norway and Sweden (targeting countries) while Denmark the non-targeting have weak evidence. It can be interpreted that the regimes of price stability could actually support to anchor the inflation expectations. Otherwise, the instability of the actual price level could cause future expectations of inflation exacerbating and this may then cause future price instability. L*astly*, among other macroeconomic variables, we found the evidence of the positive impact of fiscal stance (surplus/deficit) on three economies. Specifically, the increase in surplus or decrease in deficit showed a positive impact on the inflation expectations, though results were only statistically significant in Denmark. The empirical signs of coefficients for money supply are also consistent with fiscal balance. The results on the money supply are also intuitive because the increase in money supply can cause an increase in inflation expectations. There is no surprising result from the coefficients of the unemployment rate either which is found to be negative. The short-run effects of Norwegian unemployment were found to be significant at a 5% significance level whereas the negative short-run coefficients of Denmark and Sweden are insignificant. The findings contribute to the empirical evidence on the inverse relationship between the unemployment rate and inflation i.e. by Phillips (1958) curve. In specific to the subject case, it implies that as unemployment increases in underlying economies, the expected inflation rate decreases. After short-run estimates, the long-run estimates of oil price shocks and other determinants of inflation expectations are summarised in Table 5: -

Table 5. N-ARDL Long-run Estimates

Variables	Denmark	Norway	Sweden
$Oil\ price_t^+$	5.510230 [1.319727]	0.100498 [0.640973]	0.359227*** [2.698272]
$Oil\ price_t^-$	1.347711 [0.258566]	-0.045542 [-0.225136]	0.477497*** [3.134757]
REX_t	-246.8541*** [-3.557104]	3.260098*** [2.712480]	-2.233807 [-1.356293]
$Inflation_t(\pi)$	-3.557104 [0.637488]	0.076302 [1.617461]	0.465095*** [4.652269]
GDP_t	0.068687 [0.067335]	-0.108509*** [-2.648350]	0.093438*** [3.125753]
$Fiscal_t$	1.22* [1.666921]	6.17 [0.075194]	2.30 [1.373059]
$Money\ Supply_t$	0.334835*** [2.720692]	-0.008601 [-0.657917]	0.010689* [1.924842]
$Unemployment\ rate_t$	-0.112348 [-1.451559]	-0.327730*** [-3.384125]	-0.078633 [-1.135297]
Constant	1112.467*** [3.479649]	-9.787115 [-1.646982]	12.06159 [1.570851]

*The symbols *, **, and *** denote the significance at 10%, 5%, and 1% levels, respectively. T-statistics of the corresponding coefficients are presented in square brackets.* Note: White heteroskedasticity-consistent standard errors & covariance

The long-run estimates showed the positive impact of positive oil prices shocks ($Oil\ price_t^+$) on inflation expectations. However, for only Sweden, the results were statistically significant at 1% level. With regards to the negative oil price shocks ($Oil\ price_t^-$), Norwegian inflation expectation showed a negative response; though long-run coefficients were insignificant. Meanwhile, inflation expectations by Denmark and Sweden are positively affected by negative oil prices, though the results were only significant for Sweden. In general, both cases of oil prices shocks cast significant influence on the inflation expectations in the long run. The long-run coefficients of the association between inflation expectations and other determinants suggest that the appreciation of Danish Krone and Swedish Krona leads to a decrease in the inflation expectations while Norway will experience the increase in inflation expectations due to positive shocks from a real effective exchange rate of Norwegian Krone. The results were also highly significant for Denmark and Norway. The real inflation significantly influences on inflation expectations in Sweden, which implied the positive association between actual and expected inflation. However, Norway and

Demark did not yield very significant long-run coefficients of actual inflation. When it comes to GDP, Norway and Sweden significant but opposite in direction impact on inflation expectations. In Norway, the increase in the GDP had a negative impact on inflation expectations. This finding may be contrary to an economic theory where the recession is supposed to come with deflationary impact, however, given the fact that these inflation expectations and the household may perceive the inflation to be higher when the incomes are squeezed. This aspect may require further exploration in future research which is interesting but beyond the scope of the subject treatise. The Demark and Sweden, however, showed a positive impact of GDP on inflation expectations and the results were statistically significant for Sweden. The Fiscal stance showed a positive impact on the inflation expectations, all three countries. The money supply showed a positive and statistically significant impact on inflation expectations in both Denmark and Sweden, though the results for Norway were not very significantly. It implies that the increase in money supply will trigger an increase in the expected inflation in Denmark and Sweden at 1% level of statistical significance. lastly, the unemployment rate long term coefficients are found to be negative for all three countries suggesting the deflationary impact of unemployment on inflation expectations. Overarchingly, although Denmark, Norway and Sweden are in the same region of Scandian, the effects of oil prices, real effective exchange rate, prevailing inflation, economic growth, fiscal stance, money supply and unemployment rate on inflation expectations varies. These heterogeneities are of importance to the monetary policy formulation.

After estimation, we undertook a set of dialogistic tests to examine the robustness of our models and estimates. Firstly, the adjusted R^2 showed that explanatory variables in three models representing three economies could explain over 90% of the variation in expected inflation. All Error Correction Terms (ECTs) showed negative values, which are also significant at 1% level. It implies the stability of the model and pace of adjustment. Importantly, the F-statistics prove to reject the null hypothesis that all coefficients are zero. The residuals in the Denmark model showed non-normality, no autocorrelation, homogenous. The residuals in the Norway model showed normality, no autocorrelation and heteroscedasticity. The residuals in Sweden showed non-normality, no autocorrelation and heteroscedasticity. It worth mentioning that we used White approach which yield heteroskedasticity-consistent standard errors and covariance. Lastly, the Ramsey-REST test for misspecification was performed. We failed to reject the null hypothesis that there is no misspecification. Overall, our initial dialogistic tests are reliable to ensure the robustness of our models.

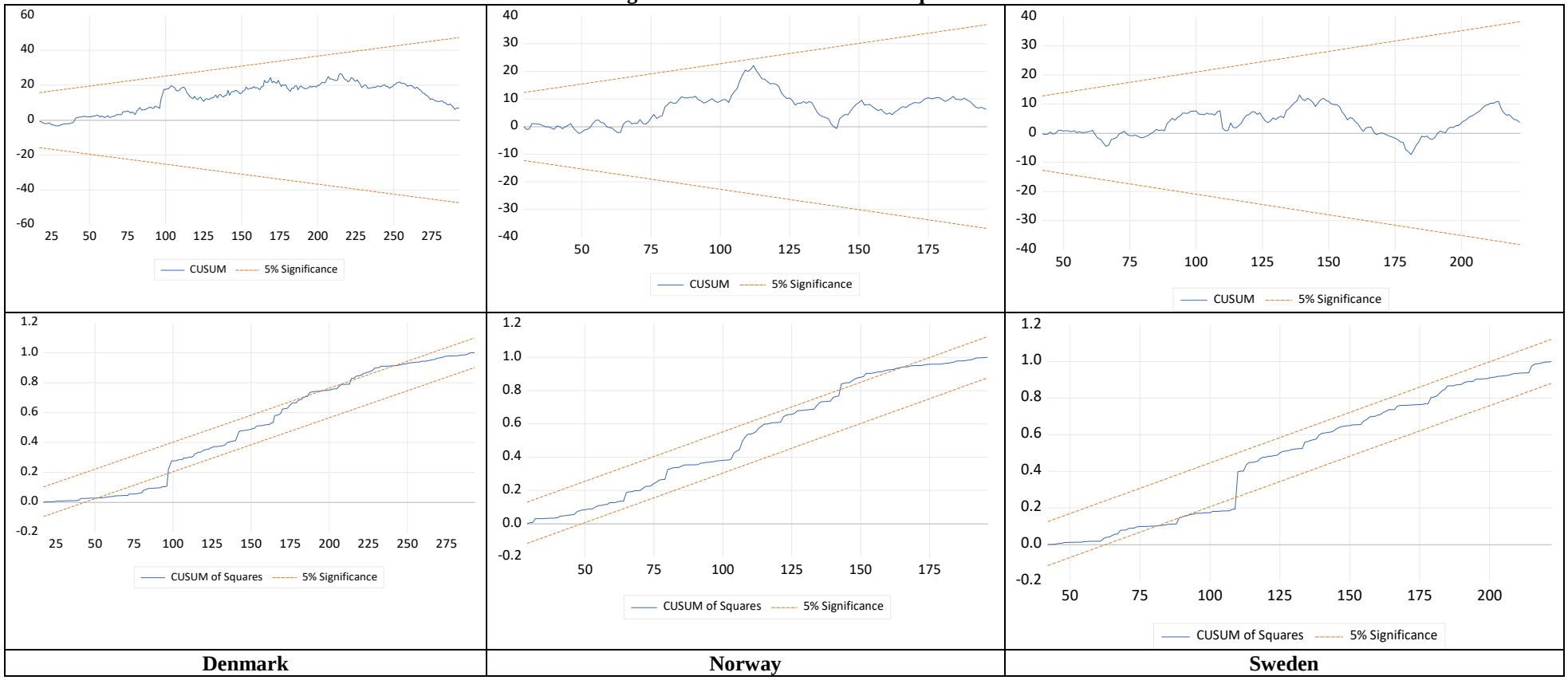
Table 6. Diagnostic Testing

Test	Denmark	Norway	Sweden
R^2	0.913464	0.987333	0.994299
F-test	243.6653***	569.3448***	1214.051***
ECT	-0.21529*** [-7.711203]	-0.1106*** [-6.151844]	-0.0656*** [-6.363501]
Jarque-Bera (JB) residuals normality test	386.67***	3.02315	115.97***
Breusch-Godfrey (BG)LM test	0.132518	1.3414	1.4741
Durbin Watson test	1.788942	1.935929	2.022650
Breusch-Pagan-Godfrey (BPG) residual test	1.234395	1.856795**	5.072316***
Ramsey REST Test	0.976947	1.399922	0.061162

*The symbols *, **, and *** denote the significance at 10%, 5%, and 1% levels, respectively. BG LM test with two lags for auto-correlation. Note: Huber-White Hinkley heteroskedasticity-consistent standard errors & covariance.*

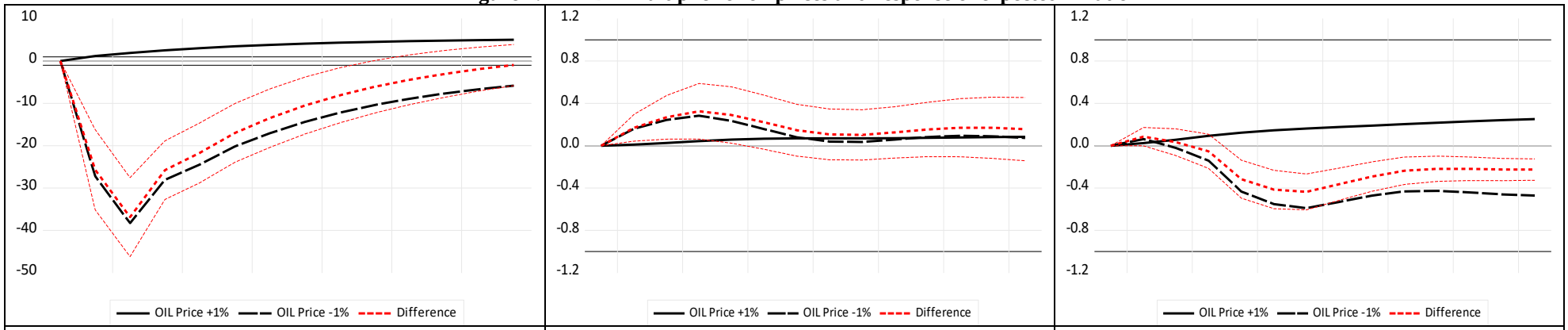
In addition to the diagnostic and robustness testing, we performed the CUSUM and CUSUM Square parameter stability test (Figure 1). The results for the CUSUM test showed the parameters are stable, for the entire period in all three economies. The results of CUSUM of Squared test suggested some periods where the parameters reached out the 5% level, however, they remained in closer to the bound within 10% level and reverted to the 5% level suggesting and overall confidence in the stability of estimates.

Figure 1. CUSUM and CUSUM Square test



Denmark	Norway	Sweden

Figure 2. NARDL Multiplier of oil prices and response of expected inflation



Denmark	Norway	Sweden

As the last step of the empirical exercise, we performed the cumulative multiplier analyse to investigate the cumulative impact of positive and negative oil price shocks on the inflation expectations. The results presented in Figure 2. In showed that in Demark, the positive oil shocks (1% increase) led to an increase in the inflation expectations (index) by about 5 points. On the other hand, the negative oil price shocks (1% decrease) led to a sharp decrease in the inflation expectation (index). Similarly, in Sweden, the positive oil price shock (1% increase) lead to a gradual and consistent increase in the inflation expectations rate by about 0.3%. This suggests that a one per cent increase in the oil price lead to Swedish household expecting the inflation rate to increase by about 1/3rd per cent. The negative shock to the oil prices (1% decrease) led to a decrease of about 0.6% in the expected inflation rate suggesting that a one per cent decrease in the oil price leads to 2/3rd of a per centage point decrease in the expected inflation rate in Sweden. Interestingly, the oil price shocks showed a very different transmission to the inflation expectations in Norway which to reiterate one of the large net oil exporting country. It showed that a positive oil shock or a one per cent increase led to a minor increase in the expected inflation rate of about 0.1%. However, the negative shock to the oil prices also showed a positive impact on the expected rate of inflation. To be precise, the expected Norwegian inflation rate increase by about 0.3% in the face of a negative oil price shocks. This heterogeneity in the response of the inflation expectations to the oil shocks is prima facie evidence that the oil price shocks transmits differently through inflation expectations in the underlying Nordic kingdom. To sum up, inflation expectations are found to be an important channel of oil shocks. This leads us to conclude.

5. Conclusion and Policy Implications

In this study, we analysed the impact of oil shocks on the inflation expectations in the three Scandinavian countries which included inflation targeting (Sweden and Norway) and Non-inflation targeting (Denmark) Nordic economies. In addition to the difference in the inflation targeting regime, there are also differences in the net oil exporting position of these economies where Norway is the only large oil exporter. We employed a Nonlinear ARDL framework to account for the asymmetries and nonlinearities in the impact of oil shocks as well as to account for differences in the short and long-term effects of the determinants of inflation expectations. Our empirical results lead us to conclude that there are short-run asymmetries and nonlinearities in the relationship between inflation expectations, oil shocks and economic determinants of inflation expectations. The expectations formulated in the past have a very significant negative impact on future inflation expectations which lead us to infer the existence of adaptive inflation expectations. We also conclude on the heterogeneity in the adaptiveness pace. The oil price shocks impact on the inflation expectations in the under-analysis economies has heterogeneities and asymmetries. The country's net oil trade position seems to reflect on the impact of its prices on the inflation expectations suggesting heterogeneity in these countries. Nonetheless, the positive and negative shocks also transmit differently which leads us to conclude on asymmetry and price-rigidness in the inflation expectations. We also conclude on significant evidence of exchange rate pass-through to inflation expectations, though intensity and magnitude vary in the underlying economies. There is also evidence of a strong nexus between actual inflation and future inflation expectation which implied that the regimes of price stability could actually support to anchor the inflation expectations. Otherwise, the instability of the actual price level could cause future expectations of inflation exacerbating and this may then cause future price instability. The fiscal consolidation and budgetary strength which one can associate with a reduction of fiscal deficit and the money supply were found to have a positive impact on the inflation expectations. Intuitively, the increases I the money supply aggregates can cause an increase in inflation expectations. There was no surprising or counterintuitive result from the impact of the unemployment rate either which seemed to reduce the expected rate of future inflation. The results on the long-run estimates lead us to conclude on the short and long run differences in the impact of oil shocks as well as asymmetries in the impact of negative and positive oil price shocks. In general, both cases of oil prices shocks cast significant influence on the inflation expectations. In addition to the oil

shocks, real effective exchange rate pass-through to inflation expectation was prima facie evidence in the long run with differences in the magnitude for each country. The actual inflation, GDP growth, fiscal stance, money supply and unemployment also showed a considerable impact on the inflation expectations in each country. This will imply that although Denmark, Norway and Sweden are in the same region of Scandia, the effects of oil prices, real effective exchange rate, prevailing inflation, economic growth, fiscal stance, money supply and unemployment rate on inflation expectations vary. These heterogeneities are of importance to the monetary policy formulation and posses a different set of challenging to each monetary authority. The cumulative multiplier analysis gave us further insight into the nexus between the oil shocks and inflation expectation. It led us to conclude on a symmetric impact of the oil shock in Sweden and Denmark where the positive oil shocks lead to increase and negative oil shocks lead to a decrease in the expected future inflation. However, for Norway which is one of the large exporters of oil, the oil price shocks transmit differently to inflation expectations and are concluded to be asymmetric. This implies that besides the adoption an explicit inflation targeting regime, the inflation expectations in the underlying economies are prone to the oil price shocks and macroeconomic determinants. The differences in the transmission of these shocks pose a whole set of challenges to monetary authorities in these economies and the findings in the subject treatise provide some guidance on how each shock may transmit.

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