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Inflation Targeting and Zero Lower Bound Risk: Cross-Country Evidence¹

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August 2026

Abstract

In the aftermath of the 2007-2009 global financial crisis, a growing body of research questioned the conventional inflation-targeting framework that has long guided monetary policy, arguing that the inflation targets adopted by major central banks may have been set too low. We evaluate the likelihood that advanced economies will become constrained by the effective lower bound on nominal interest rates in the future. Therefore, using end-quarter data over the period 1999Q1 to 2025Q4, we develop a counterfactual framework that quantifies how this risk changes under alternative scenarios with higher average inflation. Using a vector autoregression model and an ARDL-ECM framework, we estimate the cumulative probability of hitting the Zero Lower Bound (ZLB), that is, the probability that policy rates reach the constraint at least once during the projection horizon. Our results indicate that Switzerland and Japan face the highest risk of encountering the ZLB, whereas Sweden, the Euro Area, the United States, and Canada exhibit an intermediate level of risk. By contrast, the United Kingdom and Norway appear to be the least vulnerable. These findings are broadly consistent with cross-country differences in average inflation and nominal interest rate levels.

KEYWORDS: Inflation, Inflation Targeting, Monetary Policy, Zero Lower Bound, VAR, ARDL.
JEL CODES: E02, E31, E47, E52, E58.

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1. INTRODUCTION

Among all the available options, the adoption of an explicit numerical inflation target has come to represent, over the past three decades, the dominant paradigm for monetary authorities in response to the high inflation environment of the 1970s and the 1980s, which had forced central banks to consider alternative strategies for lowering inflation. Since its initial launch in the early 1990s in New Zealand and a handful of other countries, inflation targeting has become, in its various forms, the predominant and standard monetary policy approach across large advanced and emerging market economies.

Inflation targeting conveys the explicit acknowledgment that low and stable inflation is regarded as the overriding, if not exclusive, goal of monetary policy. Multiple motivations have justified the adoption of this approach. Firstly, inflation targeting performs the important function of improving communication between the policy makers and the public regarding the plans, objectives and decisions of the monetary authorities. Secondly, it is widely accepted that inflation targeting has made the strategy pursued by monetary policy authorities more transparent given the fact that the public easily understands it. This emphasis on transparency about communication outlook is based on the insight that the conduct of monetary policy can be defined as what [Svensson \(2010\)](#) referred to as the “management of expectations”: what really matters for the impact of monetary policy on the economy are the private sector’s expectations of future policy rates, both in the short and long-run, which shape both economic decisions and activity. Accordingly, it is widely believed that central banks independence has been mutually reinforced by the adoption of this policy framework ([Mishkin, 2001](#)). [Svensson \(2010\)](#) notes that, in practice, the numerical target is never “strict” but always “flexible”, as all the institutions that applied it not only pursue the primary aim of stabilizing inflation around the target, but also place considerable effort on the objective of stabilizing the real economy. Given the remarkable success that inflation targeting had in anchoring inflation and stabilizing both inflation and the real economy, it has spread quickly and has been adopted by a growing number of economies ([Kiley & Mishkin, 2025](#)), with an increasing consensus that inflation should not only be stable, but also very low, as most targets were set around two percent, in order to minimize the allocative costs associated with it ([Fischer, 1996](#); [Freedman & Laxton, 2009](#)). Setting the inflation rate to be slightly above zero percent also seemed to be a reasonable level to provide sufficient cushion against the problem of the Zero Lower Bound (ZLB), defined as the lower limit to which the level of the nominal interest rate can fall.

Yet, despite its remarkable diffusion and apparent success, the inflation targeting framework has been subject to growing scrutiny in the aftermath of recent major economic

shocks, most notably the financial crisis of 2007-2009. According to [Williams \(2014\)](#), the view broadly accepted by the literature in the pre-crisis period was that the ZLB could have potentially afflicted any economy subject to a sufficiently low inflation, but that such episodes would have been relatively infrequent and short-lived. [Wolman \(2005\)](#) had similarly warned about the consequences that would arise if monetary policy succeeded in keeping inflation very low, leaving nominal interest rates occasionally constrained at the binding. However, recent experiences have proved that the ZLB is a more serious problem than previously anticipated. The global financial crisis of 2007-2009 has challenged the science of monetary policy, requiring a substantial rethink, as a concern that had been theoretical soon became an empirical reality ([Mishkin, 2011](#)). With the sharp collapse in aggregate demand, the major central banks rapidly cut their policy rates towards zero and found themselves at the bound. To overcome the limits on traditional monetary policy imposed by the constraint on short-term interest rates, the central banks of several advanced economies deployed new policy tools, including the large-scale asset purchases – commonly known as quantitative easing – and forward guidance on the future path of interest rates ([Bernanke, 2020](#)). [Dell’Ariccia et al. \(2018\)](#) assess the implementation of these tools and conclude that these measures provided important relief, but many economists, namely [Rogoff \(2017\)](#), raise the concern that the so-called unconventional tools might be a poor substitute for conventional policy as their effects proved to be too weak and their side effects potentially larger than anticipated. Indeed, the experience with unconventional monetary policy thus leaves several questions unanswered.

The crisis showed that large adverse shocks can occur, exposing the flaws in the current prevailing policy framework, and the 2020 recession caused by the spread of Covid-19 reinforced these lessons. With historical ultra-low policy interest rates, several economists ([Blanchard et al., 2010](#); [Ball, 2014](#)) started to ask what major central banks would do should another prolonged global recession arise anytime soon. They began questioning whether, in response to the secular decrease in nominal interest rates, policy makers should thus aim for a higher inflation target to increase the room for monetary policy to react to large adverse shocks.

The primary reason to raise the inflation target is to ease the ZLB problem, the constraint on monetary policy arising from the fact that nominal interest rates cannot fall below zero: conventional monetary policy would then be able to provide more accommodation than it otherwise could under a lower target. Raising the target, after a period of transition, would presumably lead to a comparable rise in nominal interest rates, which would in turn expand the scope for cuts in the short-term rates and hence reduce the relevance of the ZLB ([Bernanke, 2017](#)). [Williams \(2009\)](#) and [Krugman \(2014\)](#) argue that, since inflation has been centred

around two percent in most economies since the 1990s, it was entirely predictable that the constraint on the interest rate would have eventually become an issue at some point.

Beyond the adoption of the inflation target regime, a broad branch of literature highlights how another important reason for the ZLB being a larger concern nowadays is the downward trend of the real interest rates, which have fallen to historically low levels. Several structural factors have been cited as contributing to the decline in the equilibrium real rate ([Holston et al, 2017](#); [Fischer, 2016](#); [Rogoff, 2016](#)): slower technological progress and productivity growth, demographic trends and shifts associated with population aging in advanced economies, persistent weakness in aggregate demand, tighter post-financial crisis regulation and risk aversion, as well as high savings from fast-growing emerging markets. This decline, together with a low inflation environment, has translated into a lower average nominal interest rate level through the Fisher equation, reducing the space available for conventional monetary policy implementation.

We contribute to the literature by addressing the question of whether a higher inflation target could reduce the likelihood of hitting the ZLB in the future. The analysis is conducted on a panel of advanced economies: two different parallel frameworks are developed from historical data, each carried forward under several alternative configurations, and a counterfactual exercise allowing for higher average levels of inflation is executed to quantify how the probability of reaching the bound changes, all else equal.

The remainder of this work is structured as follows. Section 2 provides the literature review. Section 3 outlines the empirical methodology adopted. Section 4 presents the empirical results, Section 5 concludes.

2. LITERATURE

The research question lies at the intersection of two distinct yet deeply interconnected bodies of research. The first concerns the theoretical debate on the optimal level of the inflation target, in particular how high inflation should be to reduce both the frequency and the duration of the ZLB episodes, therefore mitigating its associated costs. The optimal level is the one that balances the trade-off between the costs and the benefits of positive inflation ([Lockyer, 2022](#)). Overall, it is widely recognized that adopting a strictly positive target is preferable ([Summers, 1991](#)) and that there exists a decreasing relationship between the probability of encountering the constraint and the target levels set for inflation. However, the literature diverges in its estimates, primarily due to differences in modelling assumptions.

An early contribution assesses the relevance of the ZLB for the conduct of monetary policy when facing a low-inflation environment. Using a model that captures forward-looking behaviour based on post-war quarterly data for the U.S. economy, [Fuhrer & Madigan \(1997\)](#) compare different outlines characterised by different inflation targets and assess the ability of central bank action to mitigate recessionary consequences. Indeed, the analysis suggests that the constraint effectively reduces the central bank's room for manoeuvre. In the presence of small and temporary shocks, the differences between high- and low-inflation scenarios remain relatively limited; conversely, under large and persistent shocks, the ZLB may generate more significant macroeconomic implications in a zero-inflation environment. Consequently, a moderately positive target for inflation appears sufficient to provide enough operational flexibility to the authorities. For [Orphanides & Wieland \(1998\)](#), the effects of the constraint are negligible when the inflation target is set as low as two percent. However, these effects become significantly relevant for targets between zero and one percent as economic performance deteriorates substantially at such low target levels. Accordingly, the bound may have important implications on inflation and output when an economy operates in a low-inflation and depressed-interest rate environment while being exposed to shocks comparable in magnitude to those experienced during the eighties and the nineties.

Extending this evidence to the Euro Area, [Coenen \(2003\)](#) considers the likelihood that the short-term nominal interest rate may become constrained by the ZLB and examines how it may affect the behaviour of key macroeconomic variables for the Euro Area. The findings show that, under a Taylor rule, the implications of the bound remain limited for targets of one percent or higher when inflation persistence is moderate. On the other hand, if inflation persistence is sufficiently high, the bound may become a relevant concern once inflation falls below two percent.

In [Apergis et al \(2005\)](#) the performance of alternative policy rules under different inflation targets is evaluated in an IS-LM-AS framework applied to a panel of European countries over the period 1974-2001. They find that a positive target, as opposed to zero inflation, outperforms in terms of output losses and, indeed, they note that higher inflation targets are associated with larger inflation variability.

[Eggertsson & Woodford \(2003\)](#) show that the bound represents an important constraint on stabilization objectives and that the optimal inflation target is found to be a slightly positive value, sufficient to mitigate the distortions generated by the ZLB when the natural rate of interest turns negative, but not so high as to prevent the constraint from ever binding. Moreover, an intermediate numerical objective, say one percent, is associated with a substantial

recession when the natural rate of interest is negative and chronic inflation hits during normal times. As a result, no policy rule resolves entirely the problem posed by the binding constraint in environments where the natural rate of interest falls below zero.

Direct estimates of the optimal inflation rate are computed by [Billi & Kahn \(2008\)](#), who use a New Keynesian framework calibrated on quarterly U.S. data, claiming that previous research may have overstated the consequences of the lower bound. They estimate an optimal rate between 0.7 and 1.4 percent, depending on the assumed degree of uncertainty. New Keynesian models calibrated to broadly match the historical incidence of hitting the ZLB in the U.S. is the specification used by [Coibion et al \(2012\)](#) for finding the inflation rate that maximizes welfare. The results indicate that the optimal rate is typically moderate, below two percent a year. As the baseline model emphasizes the trade-off between higher inflation and the utility costs related to higher price dispersion and inflation volatility, such estimation can be interpreted as supportive of the current regimes and does not provide enough justification in favour of raising these targets.

A different perspective is provided by [Ngo \(2018\)](#), who investigates the optimal level of inflation in a dynamic stochastic New Keynesian framework featuring Rotemberg price adjustment and an occasionally binding ZLB on nominal interest rates consistently with data for the United States. The insights found document that the optimal inflation rate is a nonlinear function of the risk of reaching the bound and the degree of inflation indexation, and is estimated to be at 3.4 percent.

Similarly, [Blanco \(2021\)](#) addresses the question by implementing a DSGE model that accounts for menu costs and a ZLB on interest rates to reproduce the U.S. business cycle. With the aim of quantifying the main benefit of increasing the target in terms of macroeconomic stabilization, the optimal level of inflation is estimated at 3.5 percent, and it is determined by factors such as the relative insensitivity of price dispersion to the target. By contrast, shifting the framework to a Calvo model without idiosyncratic shocks lowers the optimal level of inflation to 1.3 percent.

Moreover, the optimal inflation rate is highly sensitive to the assumed distribution of ZLB events as demonstrated by [Carreras et al. \(2016\)](#), who stress that such episodes are infrequent but long lasting. To estimate the optimal inflation target, the authors calibrate a New Keynesian framework to match historical patterns and stochastic simulations are conducted to compute welfare costs, frequency and duration associated with ZLB episodes, under alternative inflation targets. The estimates for the optimal level of inflation range from 1.5 percent to 4 percent, depending on how often and how long the lower bound binds the economy.

The second strand of research literature turns to the empirical estimation of the probability of hitting the ZLB, providing estimates of the frequency and expected duration of episodes in which the economy is constrained, under different economic conditions and policy frameworks. The central narrative is one of progressive upward revision of the estimated likelihood of hitting the limit, driven by several interconnected factors such as the secular decline in real interest rates and the recognition that pre-crisis attention underestimated the risk. **Reifschneider & Williams (2000)** use the FRB/US model with the objective of quantifying the effect of the ZLB in terms of macroeconomic stabilization and proposing alternative policy design to minimize such effects. The study documents that, during rare periods characterised by severe contractions, standard open market operations might prove to be insufficient to restore macroeconomic equilibrium if deployed alone, suggesting that fiscal policy or other forms of stimulus may be required. Furthermore, in very low-inflation environments in which the implementation of monetary policy is conducted according to a traditional approach, the binding imposed on interest rates could prove to be a more significant constraint on policy than previously anticipated, as macroeconomic stability tends to deteriorate if the target rate of inflation falls below one or two percent combined with an equilibrium real rate of interest of around two percent.

Whether the two percent target remains adequate after the Great Financial Crisis is reviewed by **Williams (2009)**, who extends the research by examining the effects inflicted by the constraint during the recession. Counterfactual simulations with a higher steady-state inflation are conducted using the FRB/US model showing that the ZLB may lead to a significant deterioration in macroeconomic performance when the monetary authorities are implementing their policies following the classic Taylor rule and pursuing a very low inflation target. Hence, what emerges from the analysis is that an inflation goal of two percent may be insufficient to prevent the ZLB from imposing meaningful costs regarding macroeconomic stabilization.

The frequency and severity of the episodes in which the level of nominal interest rate reaches the lower bound are discussed by **Chung et al. (2012)**. By developing a range of models rather than relying on a single structural framework as in most previous research, their main conclusion states that there has been a systematic underestimation of the risk of hitting the ZLB: past estimates of the incidence and effects of such events were too low and biased downward by the literature, suggesting a need for general re-examination of the adequacy of standard models.

Kiley & Roberts (2017) reach a similar conclusion, documenting that both the frequency and duration of effective lower bound episodes under traditional policy rules are

estimated to be significantly higher than in previous studies. Simulations of a DSGE model and the FRB/US model are run with the purpose of revising the frequency and the potential costs of such episodes in a world characterised by low interest rates. A two percent inflation target combined with a low equilibrium real interest rate leads to substantial adverse consequences on economic and price stability when monetary policy is deployed following a traditional approach while facing the ZLB. Whether these adverse consequences could be defended, a higher inflation target depends upon two factors: the degree to which the policy strategies that differ significantly from the traditional strategy are feasible, and the implications of a broader array of the numerical target's effect on economic welfare.

Franta (2021) provides estimates of the probability of an economy hitting its effective lower bound on the nominal interest rate, as well as the expected duration of such events across a sample of eight advanced economies and exploiting the fact that many of them have recently been, or remain, constrained at zero. The estimation is based on quarterly data covering the period 1999-2016, using a mean-adjustment panel VAR. The variables included in the setup are real GDP growth, CPI inflation, short-term interest rate and the spread between the ten-year government bond yield and the policy rate. The outcomes obtained are country-specific and show the estimated effective lower bound frequency and duration over the short and the medium term, showing that the risk is the highest for Japan and Sweden, while it is estimated to be the lowest for Canada, Norway and the United States.

From a different methodological angle, **Lubik & Matthes (2019)** specify a TVP-VAR to investigate the likelihood that the United States economy may be subject to the ZLB. Using quarterly data for the timeframe 1963-2018, the estimated model is simulated forward based on the posterior distribution and joint evolution of its parameters, from which the likelihood of hitting the bound in the future is then computed. They find this probability to be small but not insignificant when considering a ten-year time horizon, while it is negligible over a two-year period. According to the authors, such results do not appear large enough to cause undue alarm.

A growing body of literature argues that the problem related to the fact that the two percent inflation target may provide an insufficient buffer against the ZLB can be addressed through an alternative route, rather than through a raise in the numerical targets. **Bernanke (2020)** reviews the existing evidence about the new tools of monetary policy, focusing primarily on quantitative easing and forward guidance. A simulation of the FRB/US model is run using data over the period 1970-2015 for the American economy. The analysis highlights that if the neutral rate is kept lower, then to overcome the effects of the lower bound additional measures

might be required, including a moderate increase in the inflation target, as well as a potentially greater reliance on fiscal policy for economic stabilization.

However, the case for scaling up the targets is not sufficiently supported by the evidence: if a target of two percent is implemented with a plausible combination of the new policy tools and their effectiveness, it appears to provide enough policy space relative to traditional frameworks. Overall, the use of the new policy tools seems clearly preferable to raising the inflation target. The FRB/US model is also used by [Reifschneider \(2016\)](#) to assess whether, in the event of a major economic contraction, asset purchases and forward guidance would be sufficient to compensate for the limited scope of the Federal Reserve to cut short-term interest rates in the future given the concern that, due to historically low interest rates, it might not have adequate scope to respond to future economic downturns, and thereby potentially making them deeper and more persistent. Simulations are conducted for alternative paths of policy implementation.

To summarise, results imply that, in the event of a future recession, policy makers would be able to use the new tools of monetary policy to compensate for a narrower ability to cut the federal funds rate once the bound is hit, even if the economic downturn turned out to be markedly severe compared to historical standards. The question of whether a higher inflation target could lead to greater macroeconomic stability by reducing the impact of the effective lower bound is considered by [Dorich et al \(2018\)](#). A New Keynesian model is deployed for the Canadian economy, alongside a large-scale DSGE (ToTEM), using historical data covering the period since the introduction of the two percent target in 1995. The empirical analysis displays that the potential benefits of higher targets concerning macroeconomic outcomes hinge critically on two main conditions: first, the availability and effectiveness of unconventional monetary policy tools that are implemented when the economy reaches the lower bound and, secondly, the level of the real neutral interest rate.

3. METHODOLOGY

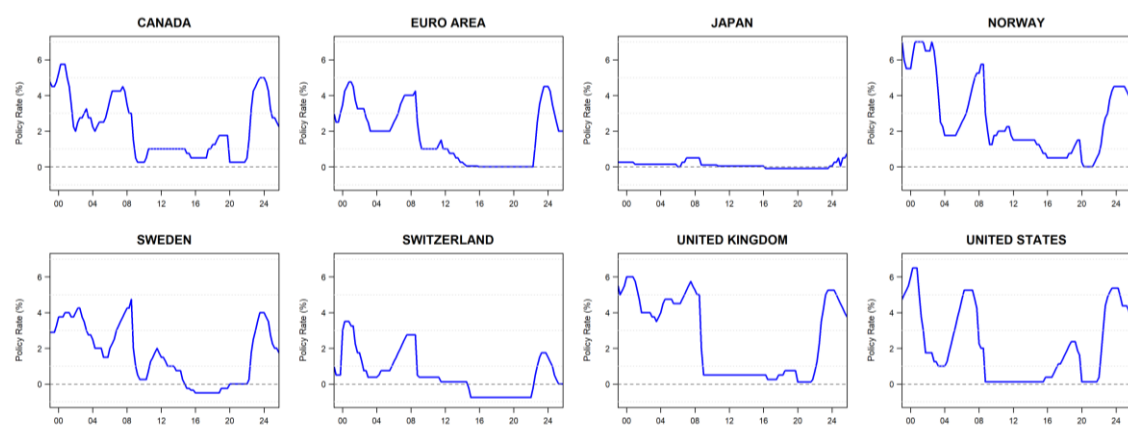
3.1. Baseline Data

The empirical strategy developed here builds on the existing literature of macroeconomic forecasting regarding the future path of interest rates to assess the probability of encountering the ZLB. The main source of inspiration is the work of [Franta \(2021\)](#), who proposes a modelling framework built on the Vector Autoregressive model (VAR) to estimate the likelihood of hitting the bound. The present work extends this approach by adopting a more recent sample period and developing counterfactual simulations to evaluate how the probability

changes under different average inflation rates. At the same time, the model definition and the estimation procedure differ slightly from the original due to the introduction of several modifications. Finally, a robustness check of the results is provided by developing a complementary framework, similarly to the approach followed by [Chung et al \(2012\)](#).

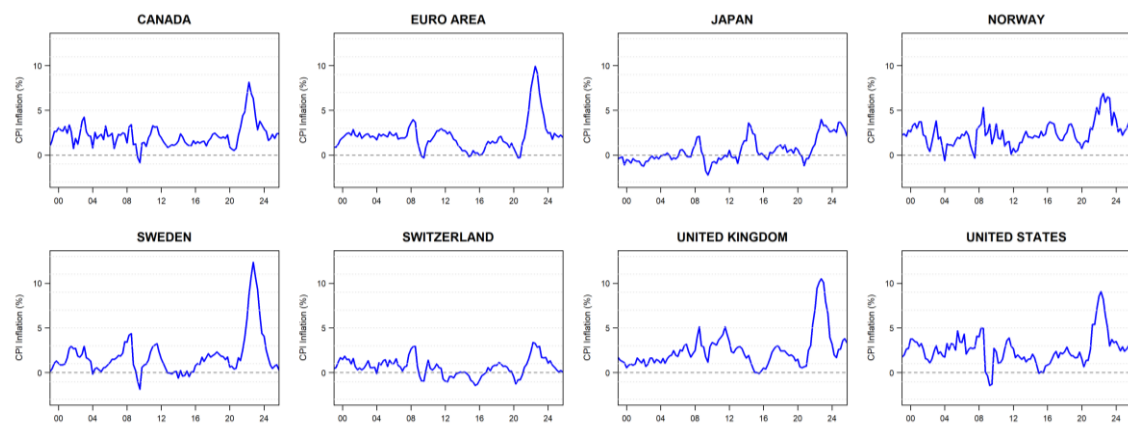
The analysis is based on a panel of eight advanced economies, the same set as [Franta \(2021\)](#), namely Canada, the Euro Area, Japan, Norway, Sweden, Switzerland, the United States and the United Kingdom, using end-quarter data over the period from the first quarter of 1999 to the last quarter of 2025, yielding a balanced panel of 108 observations per country, for a total of 864. Different monetary policy cycles are covered in the timeframe considered, including the early 2000s, the period of historically low interest rates that followed the 2008 financial crisis, the COVID-19 pandemic and the subsequent monetary policy tightening caused by the rise in inflation associated with the recovery and the developments of the war in Ukraine (Figure 1, Figure 2).

FIGURE 1: OVERVIEW OF CENTRAL BANKS' POLICY RATE LEVEL



Source: Bank for International Settlements.

FIGURE 2: OVERVIEW OF INFLATION RATE LEVEL



Source: Bank for International Settlements.

Four variables are included in the development of the models: the real GDP growth rate, the CPI inflation rate, the policy rate set by central banks and the spread between the 10-year government bond yield and the policy rate (similar to the slope of the yield curve). A first methodological departure from [Franta \(2021\)](#) concerns the definition of the variables capturing the lower bound constraint. The present analysis uses the central bank policy rate as the informative variable for the ZLB, shifting from the approach followed by [Franta \(2021\)](#), who poses emphasis on the Effective Lower Bound by including instead the short-term interbank interest rate.

The models are formulated in mean-adjusted form, as all the variables considered are demeaned by subtracting the country-specific time-series mean of the sample under consideration. The main purpose of such adjustment is to control for country-specific fixed effects. The estimation is developed by the Ordinary Least Squares (OLS) method, in contrast to [Franta \(2021\)](#), who employs a Bayesian approach. At the same time, a further methodological simplification is implied in the choice of not allowing for a regime change regarding the conduct of monetary policy.

The time series for the CPI inflation and the policy rate are retrieved from the Bank for International Settlements database, while the data for the real GDP growth rate are sourced from the OECD. For the construction of the variable spread, the 10-year government bond yields are obtained from the European Central Bank data portal in the case of the Euro Area and from Bloomberg for all the other countries considered (Table A I in the Appendix).

3.2. Vector Autoregression

Before specifying the model, the degree of cross-sectional dependence across the time series considered is assessed (Table A II in the Appendix), leading to an overall rejection of the null hypothesis. This finding is consistent with the expected synchronization of monetary policy across the economies under analysis and justifies the adoption of a pooled coefficient framework. Hence, the stationarity condition is verified by conducting the second generation panel unit root tests: in sum, the evidence rejects the null hypothesis, leading to the conclusion that, at a panel level, all variables are stationary across the timeframe examined (Table A III and Table A IV in the Appendix). The absence of problematic multicollinearity is confirmed by implementing a VIF analysis. As the main conditions required for a reliable estimation are satisfied, the model can be considered suitable for forecasting and for simulation purposes.

Thus, the panel mean-adjusted VAR model with pooled coefficients can be written as

$$\tilde{Y}_{n,t} = \sum_{j=1}^p A_j \tilde{Y}_{n,t-j} + \varepsilon_{n,t} \quad (1)$$

where $\tilde{Y}_{n,t}$ denotes the 4×1 vector of the $K = 4$ demeaned endogenous variables for each country n

$$\tilde{Y}_{n,t} = Y_{n,t} - \bar{Y}_n, \quad (2)$$

A_j is the matrix of autoregressive coefficients of order j and $\varepsilon_{n,t}$ represents the vector of random disturbances. No intercept is included as demeaning is applied. The optimal length of lag order p is selected by minimizing three information criteria, Schwarz criterion (BIC), Akaike criterion (AIC) and Hannan-Quinn criterion (HQ), for a grid of $p = 1, \dots, 8$ lags in the selection procedure, as in common practice when working with quarterly data. The three criteria select different values of lag for model specification, respectively $p = 5$ for the BIC and $p = 8$ for the AIC and the HQ, thereby returning parallel robust variants of the model. Estimation is performed equation by equation, and the stability of the model is assessed by verifying that all the eigenvalues of the companion matrix lie strictly inside the unit circle, ensuring that the forecast trajectory will not be explosive, hence validating the simulation of future paths.

The estimated VAR is used to jointly simulate the future trajectories for all four variables over a forecast horizon of 48 quarters (twelve years), sufficient to capture the medium-term dynamics of monetary policy cycles and the fact that the ZLB events are infrequent ([Carreras et al, 2016](#)), by running 100,000 independent forward paths. When simulating these paths, the level of the policy rate is censored at zero, as it cannot reach negative territory, representing a stricter constraint to the level that some countries, namely Japan, Sweden and Switzerland, reached over the sample. At each simulation path, the mean-adjusted policy rate is restored back in levels by adding back the country-specific average, so that the bound condition is verified consistently with the structural heterogeneity among the panel units, reflecting the initial condition of each economy for which those with a lower average interest rate are more likely to find themselves hitting the constraint.

Since the volatility of shocks is pooled across the set of economies considered, the only sources of differentiation are the country-specific initial conditions and the country-means regarding the variables. This choice resembles both the restriction about the homogeneity imposed across the coefficients of the model and the assumption that the economies are subject to similar macroeconomic shocks, as supported by the evidence of cross-sectional dependence of the time series.

Two different methods are used to generate the shocks of the VAR, producing two parallel sets of results for each specification of the model. The first specification adopts a Gaussian distribution of shocks. The limitation arising from assuming normally distributed errors is recognized by [Franta \(2021\)](#), who notes that it might not be too realistic and suggests extending the methodology in future research to include shocks exhibiting fat tails. Following [Kiley & Roberts \(2017\)](#) and [Chung et al \(2012\)](#), the second specification is therefore developed via a Bootstrap of the residuals from the model, drawing the shocks from the timeframe analysed, thus preserving their empirical distribution, as well as their stylized fat tail and asymmetry. Consequently, the bootstrap specification is expected to deliver higher estimated risks of hitting the threshold.

From the overall set of simulated paths for each economy, the cumulative probability of hitting the ZLB is computed as the fraction of simulations in which the country-specific level of the policy rate reaches the threshold of zero in any quarter, in line with [Lubik & Matthes \(2019\)](#). This represents a further difference from [Franta \(2021\)](#), where the threshold level imposed on the short-term interest rate for assessing the Effective Lower Bound is set separately for each country, given that in his specification the policy rate does not enter directly into the vector of endogenous variables. Furthermore, the evaluation developed differs in the metric adopted, as [Franta \(2021\)](#) assesses the per-quarter probability rather than the cumulative one.

The pivotal question of whether a higher inflation target reduces the likelihood of hitting the ZLB is addressed through a counterfactual simulation exercise. The underlying idea lies in the Fisher equation, according to which the nominal interest rate is defined as the sum of the real interest rate and the inflation rate:

$$i = r + \pi. \quad (3)$$

The fundamental hypothesis is therefore the following: holding a constant real rate over time, a higher level of inflation translates into a higher level of the nominal interest rate in the one-to-one relationship. Operationally, this counterfactual analysis is implemented by adjusting the average inflation rate for each country upward for alternative scenarios of allowed higher inflation. The assumption approximates the average inflation to the target pursued by central banks. Table I reports the average inflation rate in each economy considered, together with the corresponding target pursued.

It follows that five counterfactual scenarios are considered, with upward shifts in the country-specific mean inflation of 0.5, 1.0, 1.5, 2.0 and 2.5 percentage points, corresponding to hypothetical inflation targets of 2.5%, 3.0%, 3.5%, 4.0% and 4.5% respectively.

TABLE I: OVERVIEW OF SELECTED CENTRAL BANK INFLATION TARGETING REGIMES

Central Bank	Inflation Target	Adoption and evolution	Average inflation 1999 - 2025 (%)
Bank of Canada	2% point target with 1-3 percent tolerance over the medium term	Adopted a 2 percent target in 1991	2.21
Bank of England	2% point target with an accountability mechanism at 1-3 percent	Adopted a 2.5 percent target in 1992, lowered to 2 percent in 2003	2.51
Bank of Japan	2% point target	Informally adopted in 2006. Explicitly targeting 1 percent from 2012, and 2 percent from 2013	0.49
European Central Bank	2% point target over the medium term	Adopted a target “below 2 percent” with the creation of the currency union. Raised the target to 2 percent in 2021	2.11
Federal Reserve	2% targeted on average over the longer term	Informally adopted in 1996, explicitly targeting 2 percent since 2012. Average inflation targeting was adopted in 2020	2.58
Norges Bank	2% point target	First adopted a 2.5 percent target in 2001, and lowered the target to 2 percent in 2018	2.46
Swiss National Bank	Inflation Below 2% while avoiding a sustained period below 0 percent	Adopted a “below 2 percent” target in 2020	0.62
Sveriges Riksbank	2% point target with band of 1-3 percent tolerance	Adopted a 2 percent target ± 1 percent in 1993	1.84

Source: central banks’ websites, [Lockyer \(2022\)](#), and authors’ computations.

The objective is to assess how the probability of reaching the ZLB varies in response to the employment of higher target inflation rates, compared to the standard baseline of two percent pursued by the economies under examination, including a two percentage point increase as suggested by [Blanchard et al \(2010\)](#) and [Ball \(2014\)](#):

$$\tilde{\pi}_n^{CF} = \tilde{\pi}_n^B + \Delta\pi \quad (4)$$

$$\tilde{\imath}_n^{CF} = \tilde{\imath}_n^B + \Delta\pi \quad (5)$$

given

$$\Delta i = \Delta\pi \quad (6)$$

with r assumed constant in (3) and $\Delta\pi \in \{0.5, 1.0, 1.5, 2.0, 2.5\}$.

Therefore, the simulations are run with the same VAR dynamics, and accordingly the same coefficients, across the different scenarios. Imposing the same coefficients on the baseline and the counterfactual simulations represents an important limitation of the model.

The ordering of the endogenous variables considered in the VAR is defined from the most exogenous to the least exogenous one, with real GDP growth ordered first, followed by inflation, the spread and the policy rate. The orthogonalized impulse response functions (IRFs) are computed for addressing how each endogenous variable dynamically responds to an innovation in one of the structural shocks, holding all else equal. The sorting defined above determines the reaction of the variables to shocks to the others. The sample uncertainty is quantified by replicating the bootstrap distribution, using a 95% confidence interval. The IRFs are reported only for the VAR specification whose lag order is selected by the BIC.

3.3. Autoregressive Distributed Lag

A complementary framework is adopted to assess the probability that the selected advanced economies will reach the ZLB on nominal interest rates in the future and evaluate whether such risk is reduced by embracing higher inflation targets. Given the cross-sectional dependence identified across the panel, the second generation of unit root tests is used to assess the hypothesis of stationarity of all the endogenous variables of the VAR and to avoid the possibility of spurious results. However, when the first generation of unit root tests is applied, the results show that some variables are $I(0)$ while others are $I(1)$ (Table A V and Table A VI). Given these mixed results regarding stationarity, the same simulation exercise is replicated by using a panel Autoregressive Distributed Lag model with an Error Correction term (ARDL-ECM), to assess the sensitivity of the ZLB probability estimates to the choice of the econometric framework considered. Similarly to the VAR, the model is estimated using mean-adjusted variables by pooled OLS. The ARDL-ECM framework, unlike the VAR, does not treat all the variables symmetrically by capturing the endogenous response of one variable to another: the policy rate is modelled as the dependent variable, defined by its own lags and those of the remaining variables considered.

The ARDL model can be expressed in the following form:

$$\tilde{y}_{n,t} = \sum_{j=1}^p \alpha_j \tilde{y}_{n,t-j} + \sum_{k=0}^q \beta_k \tilde{X}_{n,t-k} + \varepsilon_{n,t} \quad (7)$$

where $\tilde{y}_{n,t}$ is the demeaned value for the policy rate, $\tilde{X}_{n,t-k}$ is the vector of the $K = 3$ exogenous variables, α_j and β_k are the coefficients of the lagged dependent variable and the exogenous variables respectively and $\varepsilon_{n,t}$ is the error term. p represents the optimal lag order of the dependent variable, while q refers to the lags related to the explanatory variables, and it is restricted to be the same across all of them.

After reparameterization, the ARDL-ECM equation is obtained as follows:

$$\Delta \tilde{y}_{n,t} = \sum_{j=1}^{p-1} \gamma_j \Delta \tilde{y}_{n,t-j} + \sum_{k=0}^{q-1} \lambda_k \Delta \tilde{X}_{n,t-k} + \varphi \tilde{y}_{n,t-1} + \delta \tilde{X}_{n,t-1} + \varepsilon_{n,t} \quad (8)$$

$\Delta \tilde{y}_{n,t}$ represents the first difference of the dependent variable and $\Delta \tilde{X}$ identifies the vector of first differences of the explanatory ones. φ stands for the speed of adjustment for the policy rate and δ is the vector of coefficients that captures the long-run relationship between the dependent variable and the independents. γ_j and λ_k are the coefficients on the differences for the lagged dependent variable and the explanatory ones respectively. The optimal lag orders p and q are selected by minimizing the three information criteria that are considered in the VAR framework (BIC, AIC and HQ) allowing for a number of lags equal to $p = 1, \dots, 8$ and $q = 0, \dots, 8$, so that three specifications can be carried forward to the simulation stage. As a result, the different dimensions of the ARDL (p, q) are (2,3), (7,7) and (4,5) respectively. In this case, the stability of the model is assessed by verifying that the speed of adjustment φ is negative, pointing that the error-correction mechanism is heading towards its equilibrium, implying a stable and monotonic adjustment.

One of the characteristics of the VAR approach used has to do with the fact that coefficients are pooled and constant. Hence, to allow for a more intuitive comparison across the two model definitions, the ARDL is specified in a dynamic fixed effect form, with both the short-run and the long-run coefficients held constant across the sample.

The ARDL framework allows for the existence of a long-run relationship between the dependent variable and the explanatory ones to be tested, which is given by the equilibrium response of the dependent variable to a unitary variation in any of the explanatory variables and is defined as

$$\theta = \frac{\delta}{\varphi}. \quad (9)$$

As the ARDL is specified as a single equation in which the policy rate depends on the level of the independent variables, the latter are projected forward over the horizon considered by modelling independent OLS autoregressive processes AR(s) on the demeaned data, whose optimal lag order is selected by minimizing solely the AIC over a grid $s = 1, \dots, 8$:

$$\tilde{X}_{n,t} = \sum_{j=1}^s A_j \tilde{X}_{n,t-j} + \varepsilon_{n,t}. \quad (10)$$

Respectively, for the real GDP growth, the CPI inflation and the spreads, processes AR (8), AR (8) and AR (4) are generated.

The simulation is run with the same specifications, characteristics and shock-generating methods as described in Section 3.2 under the assumptions expressed in equations (4) and (5). In this way, any difference in the estimation of the ZLB probability over the horizon considered can be attributed solely to the different model structure of the two frameworks.

4. RESULTS

4.1. Vector Autoregression

The results for the baseline simulations reveal a high degree of heterogeneity across the economies considered, reflecting the fact that cross-unit differentiation among the units originates from the country-specific initial conditions and from the country-specific means of the variables, as presented in Section 3. For the horizon considered, the economies that exhibit the highest cumulative probability of hitting the ZLB – that is, of hitting the bound at least once over the period under consideration – are Switzerland and Japan. A medium risk of hitting the constraint on interest rates is displayed by Sweden, the Euro Area, the United States and Canada, while the economies that seem to be the least exposed are the United Kingdom and Norway. These results are consistent with the country-specific average levels of inflation and nominal interest rates. As presented in Table I from Section 3, Japan and Switzerland are characterised by historically low levels of inflation, so that the ranking obtained is unsurprising.

As noted by [Franta \(2021\)](#) and reported in Figure 3, assuming a Normal distribution of shocks systematically understates the overall risk of reaching the bound relative to the bootstrap specification. Table II and Table III report the results of the simulations based on the VAR model whose optimal lag specification is selected by the BIC, for bootstrap and Gaussian shocks respectively. Table A VII, Table A VIII, Figure A 1 and Figure A 2 in the appendix show, instead, the robustness check returned by the results for the remaining specifications whose optimal number of lag order is selected via the AIC and the HQ.⁴

By construction, the counterfactual exercise indicates that the overall risk of reaching the lower bound decreases as a higher historical average inflation is allowed, reflecting the additional room for manoeuvre available for the conduct of monetary policy and, consequently, a lower probability of becoming constrained at the ZLB. The decline in the risk of hitting the bound differs across countries and shows a monotonic decrease in the average level of inflation. As shown in Figure 3, for most economies it is steep at the first increment and flattens afterwards, thereby exhibiting diminishing returns. An exception is represented by Japan and

⁴ Additional results are reported in the Online Appendix, across different specifications of the VAR and of the ARDL set up.

Switzerland, whose probabilities do not show a convex profile: with a country-specific inflation chronically below one percent, only a relatively large increase in the level of inflation would result in a lower risk of hitting the bound in the future.

TABLE II: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) – VAR (5)
[BIC], BOOTSTRAP SHOCKS

Country	Inflation Target					
	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%
Switzerland	98.6	90.9	77.3	60.5	44.8	31.3
Japan	97.4	91.6	80.9	65.8	50.0	35.8
Sweden	69.0	53.1	38.4	26.4	17.6	11.0
Euro Area	65.3	49.6	35.4	24.3	15.8	9.8
United States	51.3	37.0	25.4	16.7	10.4	6.2
Canada	49.9	35.7	24.7	15.9	9.8	6.0
United Kingdom	38.4	26.3	17.5	11.0	6.8	3.8
Norway	33.5	22.9	14.8	9.0	5.5	3.1
Panel average	62.9	50.9	39.3	28.7	20.1	13.4

Horizon: 48 quarters. Source: authors' computations.

TABLE III: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) – VAR (5)
[BIC], GAUSSIAN SHOCKS

Country	Inflation Target					
	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%
Switzerland	98.2	90.7	76.5	57.1	37.7	21.4
Japan	96.5	90.2	78.6	62.7	44.2	27.9
Sweden	66.8	47.7	29.9	16.3	8.1	3.4
Euro Area	62.2	43.3	26.5	14.3	6.6	2.8
United States	45.5	28.5	15.7	7.4	3.2	1.2
Canada	43.5	26.7	14.3	6.9	2.8	1.1
United Kingdom	30.2	16.7	8.2	3.7	1.4	0.5
Norway	24.5	13.0	6.2	2.6	1.0	0.3
Panel average	58.4	44.6	32.0	21.4	13.1	7.3

Horizon: 48 quarters. Source: authors' computations.

While the tables presented above highlight the cumulative probability of reaching the bound in each economy, the panel IRFs reveal the dynamic mechanism related to the propagation of the shocks before being absorbed. As recalled in Section 3, the orthogonalized IRFs depend on the ordering of the variables in the VAR's definition, which is set from the most exogenous to the least exogenous.

FIGURE 3: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) – VAR (5)
[BIC], BOOTSTRAP AND GAUSSIAN SHOCKS

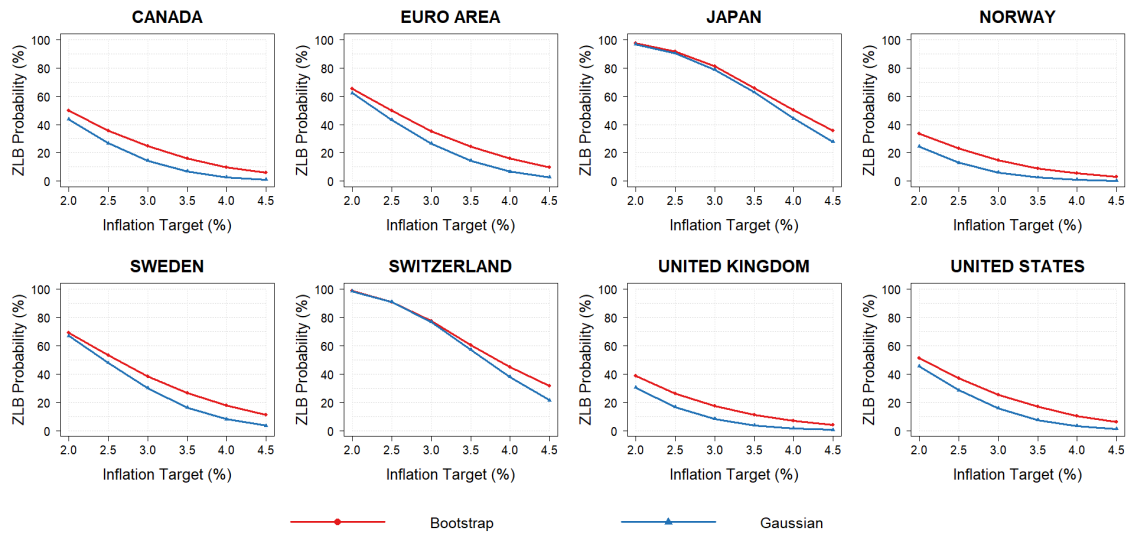
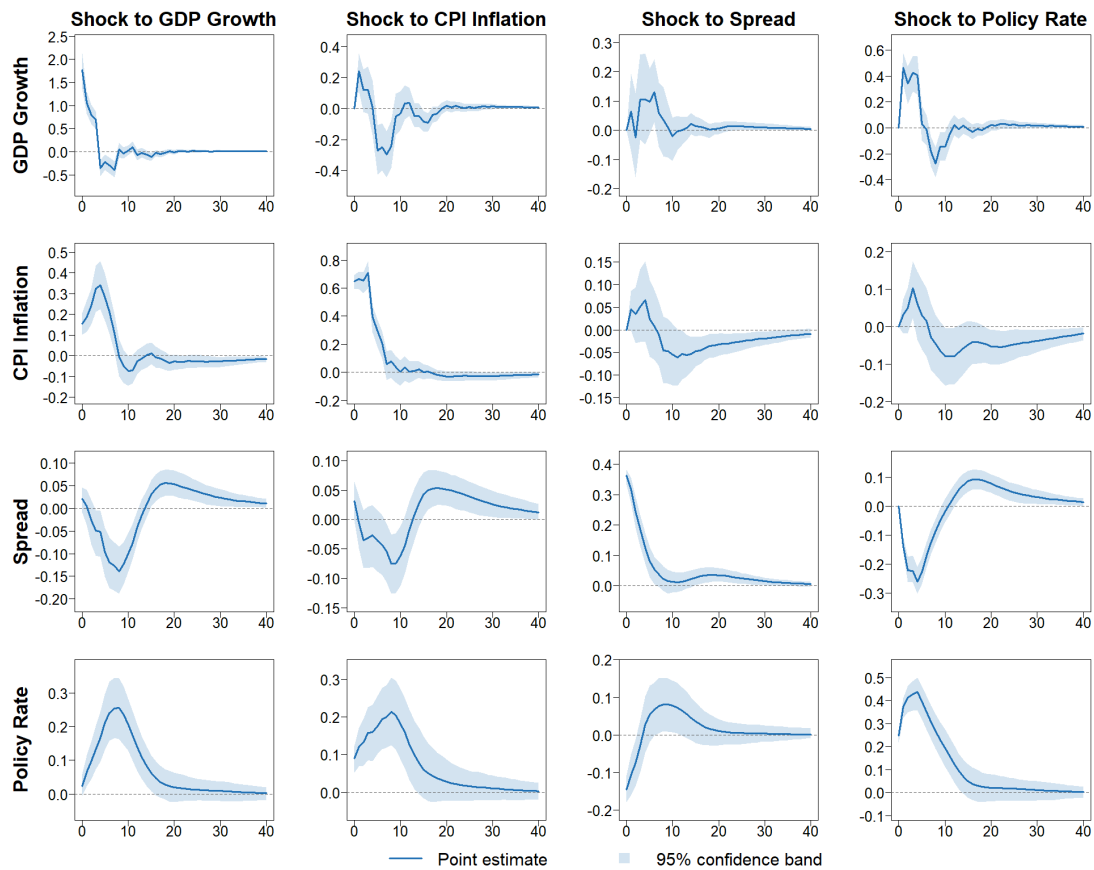


FIGURE 4: IMPULSE RESPONSE FUNCTIONS – VAR (5) [BIC]



Among the plots (Figure 4), the most informative response displays the reaction of the policy rate to an inflationary shock. Following the rise in inflation, the nominal interest rate is expected to increase for several consecutive quarters before gradually reverting to its baseline.

This reaction, and the consequent persistence of its propagation, is consistent with the traditional response to inflation displayed by monetary authorities.

4.2. Autoregressive Distributed Lag

Simulations obtained from the ARDL-ECM framework, with auxiliary AR (p) processes for the explanatory variables, deliver qualitative results that mirror those presented in Section 4.1. Both frameworks return the same monotonic decline in the likelihood of hitting the ZLB as higher average inflation is allowed for, a closely similar ranking of countries by their exposure to the risk and an analogous pattern of decreasing returns, with the same exception represented by Switzerland and Japan. The results presented in Table IV and Table V are referred to the model specification whose optimal number of lags is selected by the BIC, while the remaining specifications, obtained via the AIC and the HQ, are presented in Table A IX, Table A X, Table A XI, Table A XII, Figure A 3 and Figure A 4 available in the appendix. In addition, the gap in the cumulative probability between the bootstrap and Gaussian distribution of shocks, which has already been documented for the VAR, is reproduced under the ARDL as well, as Figure 5 shows.

Further considerations concern the long-run coefficient delivered by the estimated ARDL-ECM equation. As defined in Equation (9), this coefficient captures the long-run relationship between the dependent variable and the explanatory ones. In the present analysis, each related value differs across each model specification, depending on the different information criteria used to select the optimal lag orders. More specifically, the estimation based on the AIC and the HQ yields a long-run relationship between the policy rate and the level of inflation of $\theta_{\pi}^{AIC} = 0.9840$ and $\theta_{\pi}^{HQ} = 1.0059$ respectively, leading to an empirical support for the one-to-one transmission assumed in Equation (6) and adopted in the counterfactual exercises for the assessment of the reduction in the likelihood of hitting the bound given different average inflation. Across these two specifications, the coefficients are consistent with the long-run Fisher equation relationship set out in Equation (3). The BIC specification, by contrast, returns a higher value for the long-run coefficient, specifically $\theta_{\pi}^{BIC} = 1.5170$, implying a long-run response of the policy rate that is more than proportional to a unit change in the level of inflation, in line with the idea conveyed in the Taylor principle.

TABLE IV: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) – ARDL
(2,3) [BIC], BOOTSTRAP SHOCKS

Country	Inflation Target					
	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%
Switzerland	98.5	91.6	78.7	61.4	43.8	28.1
Japan	91.8	82.6	69.5	53.8	38.1	24.9
Sweden	64.6	47.0	31.3	19.1	11.0	5.9
Euro Area	57.5	41.1	26.9	16.1	9.1	4.6
Canada	41.8	27.4	16.4	9.2	4.7	2.2
United States	39.4	25.9	15.5	8.7	4.5	2.2
United Kingdom	25.2	15.2	8.5	4.5	2.2	1.0
Norway	23.3	13.6	7.5	3.8	1.9	0.8
Panel average	55.3	43.1	31.8	22.1	14.4	8.7

Horizon: 48 quarters. Source: authors' computations.

TABLE V: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) – ARDL
(2,3) [BIC], GAUSSIAN SHOCKS

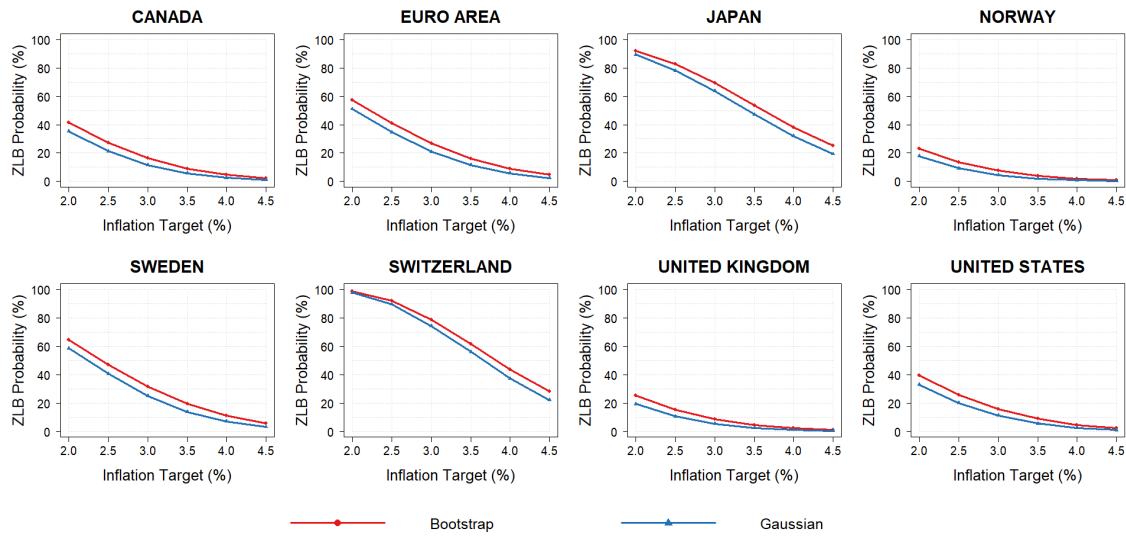
Country	Inflation Target					
	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%
Switzerland	97.7	89.2	74.4	55.8	37.3	22.0
Japan	89.2	78.1	63.7	47.2	31.8	19.4
Sweden	58.5	40.2	25.3	13.8	6.9	3.1
Euro Area	51.0	34.4	20.8	11.6	5.6	2.4
Canada	35.2	21.2	11.6	5.6	2.4	0.9
United States	32.9	19.9	11.3	5.4	2.3	1.0
United Kingdom	19.3	10.5	5.3	2.3	1.0	0.3
Norway	17.7	9.4	4.4	2.0	0.8	0.3
Panel average	50.2	37.9	27.1	18.0	11.0	6.2

Horizon: 48 quarters. Source: authors' computations.

Beyond supporting the methodology applied, the one-to-one assumption imposed in the simulations could be conservative, as it would understate the rise in the nominal interest rate and, consequently, the reduction in the likelihood of reaching the ZLB that is associated with higher rates of inflation⁵.

⁵ The long-run coefficients of inflation are statistically significant at 1% in all the specifications. The hypothesis $\theta_\pi = 1$ supports the counterfactual one-to-one assumption about the increase of the interest rate following an increase in inflation. The existence of a long-run relationship is confirmed by the bound Wald Test.

FIGURE 5: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) – ARDL
(2,3) [BIC], BOOTSTRAP AND GAUSSIAN SHOCKS



In addition, what emerges from this second framework adopted is an overall reduction in the absolute levels of the probability of reaching the constraint in each individual economy's simulation (Figure 6, Figure 7, Figure A 5, Figure A 6, Figure A 7 and Figure A 8).

This difference can be attributed to the way in which the two models propagate the shocks over time. In the VAR, all four variables are endogenous and are considered symmetrically, reacting to one another symmetrically. Conversely, the ARDL framework models a single equation for the policy rate and forecasts the explanatory variables through independent AR processes, thus ignoring interdependencies and the cross-variable feedback. Hence, the shocks are propagated with less inertia, driving the cumulative probability of reaching the ZLB downward so that the economy reaches the binding condition less frequently. Taken together, the results of the counterfactual exercises obtained across both frameworks quantify the reduction that a higher average inflation has on the likelihood of hitting the ZLB across the panel of economies considered. Although this decline can be considered as partly mechanical, as it follows directly from the assumption outlined in Equation (6), it still carries an informative value, as it assesses what the future risk would have been if a higher inflation target had been adopted at the inception of the regime.

FIGURE 6: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) – VAR (5)
[BIC] vs ARDL (2,3) [BIC] WITH BOOTSTRAP SHOCKS

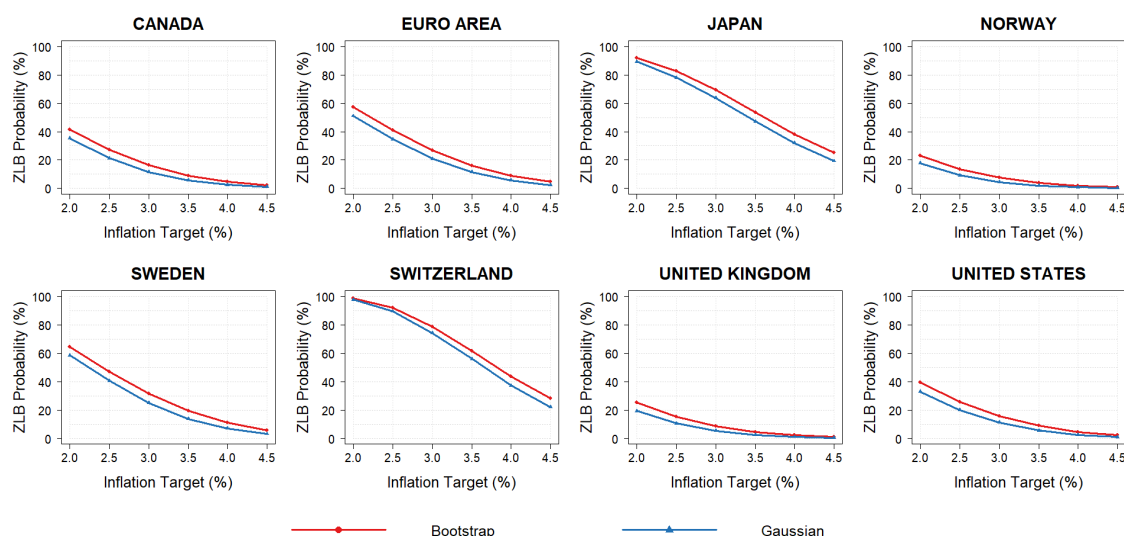
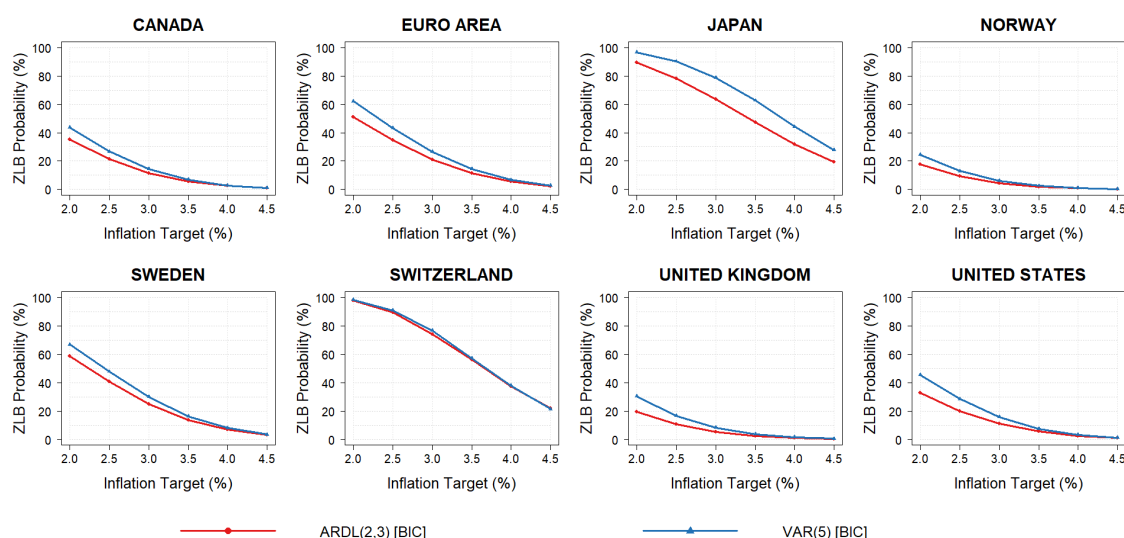


FIGURE 7: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) – VAR (5)
[BIC] vs ARDL (2,3) [BIC] WITH GAUSSIAN SHOCKS



5. CONCLUSION AND POLICY ISSUES

Following the financial crisis of 2008 and the Covid-19 pandemic, several advanced economies experienced the event of a ZLB. This empirical analysis addressed how likely such episodes are to happen again and how much this likelihood would change under a higher average historical level of inflation, as an approximation for the adoption of a higher inflation target. Two distinct frameworks were developed, each estimated under alternative specifications for robustness. Evidence indicated that the economies most exposed are those

historically characterised by a lower average inflation, leaving less room for manoeuvre in the event of a severe recession. *Ceteris paribus*, as the assumed level of inflation rises, the risk of finding the economy constrained at the bound declines, consistently with the one-to-one transmission assumed for the counterfactual exercises.

Our results indicate that Switzerland and Japan face the highest risk of encountering the ZLB, whereas Sweden, the Euro Area, the United States, and Canada exhibit an intermediate level of risk. By contrast, the United Kingdom and Norway appear to be the least vulnerable. These findings are broadly consistent with cross-country differences in average inflation and nominal interest rate levels.

Several limitations affect the methodology underlying the simulation exercise and the comparison between the two frameworks adopted in the present research. Firstly, the assumption of a constant real rate in the counterfactual scenario does not account for the general decline in its level, as it has been documented in the literature. To the extent that the level of r would still be declining, the estimated probability of hitting the ZLB in the future would be understated, since a declining real rate brings the economies even closer to the bound. Secondly, the pooled coefficients of both the VAR and the ARDL are estimated on historical data that embody the policy regime prevailing over the sample period: applying them in the counterfactual exercise carries the assumption that the macroeconomic dynamics would remain unchanged under the adoption of a different inflation target.

In addition, setting the policy rate's threshold at zero for all the economies represents a choice of methodological simplification that does not consider the fact that several economies have, in practice, experienced periods in which their respective policy rates were held in negative territory. Moreover, the pooled volatility adopted reflects the evidence of cross-sectional dependence across the economies but does not allow for country-specific heterogeneity in the shocks. Finally, as already discussed, the ARDL does not account for the interdependencies among the variables, so that the VAR and the ARDL may not be entirely comparable frameworks in terms of results.

Possible future research should extend the current methodology to address its limitations. The problem of not considering the interdependencies across variables in the ARDL framework could be addressed by replacing the auxiliary autoregressive processes for the explanatory variables with a VAR, or by adopting actual forecasts published by policy institutions. A further aspect to consider might be the inclusion of fiscal variables, such as the debt-to-GDP ratio. As the analysis developed here highlights the cumulative probability of reaching the constraint, a possible extension would assess the duration of ZLB events, as part

of the evaluation of whether the benefits of a higher inflation target would overcome the potential costs. A final strand of research concerns the welfare costs of higher targets, and whether these exceed those associated with the current one.

The political decision regarding the feasibility and desirability of a shift in the policy framework depends on a broader set of arguments that go beyond the scope of the present empirical evaluation. In considering the issue of raising the inflation rate target in the face of the ZLB problem, central banks need to weigh the benefits of occasional additional monetary stimulus against the continuous costs of maintaining higher average inflation ([McCallum, 2011](#)). [Blanchard et al \(2010\)](#) highlight that achieving low inflation has been a historical accomplishment and hence, aiming for a higher target implies carefully revisiting the lists of both benefits and costs associated with inflation, in particular the fact that inflation is distortionary, can be volatile and affects the economy through the dispersion of prices. [Rogoff \(2017\)](#) points out that the major central banks of the advanced economies have invested several decades in convincing the public that they are deeply committed to two percent inflation. Any transition to a higher target is likely to be disruptive in terms of credibility and transaction costs, and the new target will never be as credible ([Woodford, 2009](#); [Blanchard & Summers, 2017](#)): after all, if the authorities change their target once, what would stop them from doing so again? Even if a shift in the monetary policy regime were implemented, a significant transition period will be necessary.

[Ball \(2014\)](#) questions whether such effects are significantly larger when considering a slight increase in the target used. Furthermore, he recognises that the 2007-2009 events may have been unusual, producing an unusually deep recession that might not be enough to justify the adoption of a higher target as the binding phenomena are rare ([Carreras et al, 2016](#); [Williams, 2014](#)), so the benefits of a higher inflation target will not be very large because ZLB episodes only materialise infrequently ([Mishkin, 2011](#)). The qualitative importance of ZLB episodes hence depends on how often and how tightly the constraint will bind in the future ([Williams, 2009](#)). According to [Krugman \(2014\)](#) events such as the 2008 financial crisis will become more common and damaging if central banks continue to target low average inflation. The association between inflation, its volatility and political friction involved in moving to new targets are aspects brought up by [Tabellini \(2014\)](#), as they might lead to unanchored expectations which would harm the effectiveness of monetary policy.

Unconventional tools may represent a potentially effective supplement for easing the ZLB constraint in the future ([Sellon, 2003](#); [Bernanke, 2017](#); [Bernanke, 2020](#)): if such tools were to do a sufficiently good job in substituting for the traditional policy, then the reason to

raise the inflation target to allow for more monetary policy space in the face of deep recessions would weaken, with lower bound events becoming less of a concern, alongside the adoption of counter-cyclical fiscal policy ([Dorich et al, 2018](#)). Considerable uncertainty remains regarding the impact and the effectiveness of the new tools and there is not enough understanding of their side effects given the limited experience with their implementation. If it is established that such measures should remain part of the monetary toolkit of central banks as they can provide crucial relief in the face of future severe recessions, [Dell’Ariccia et al \(2018\)](#) note that it is crucial to design measures that are complementary to unconventional policy, including ways to reduce the likelihood that the constraint may become binding in the first place. [Mishkin \(2011\)](#) notes that, even though we can deploy alternative monetary policy tools, that does not imply that the ZLB problem is less serious. A final consideration concerns public aversion to inflation ([Lockyer, 2022](#)).

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APPENDIX

TABLE A I: SOURCES BREAKDOWN

Variable	Source	Available from
CPI inflation	Bank for International Settlements	https://data.bis.org/topics/CPI [Accessed: February 2026].
Policy Rate	Bank for International Settlements	https://data.bis.org/topics/CBPOL [Accessed: February 2026].
Real GDP Growth	OECD	https://data-explorer.oecd.org/?lc=en [Accessed: February 2026].
10-Year Government Bond Yield	Bloomberg	GCAN10YR Index GJGB10 Index GNOR10YR Index GSGB10YR Index GSWISS10 Index GUKG10 Index USGG10YR Index [Accessed: February 2026].
	European Central Bank	https://data.ecb.europa.eu/data/datasets/ [Accessed: February 2026].

Note: all data retrieved are in end-quarter form

TABLE A II: TESTS FOR CROSS-SECTIONAL DEPENDENCE

Test	CPI inflation	Policy rate	Real GDP growth	Spread
Breusch–Pagan LM	1355.260 (0.0000)	1876.669 (0.0000)	1749.625 (0.0000)	1136.673 (0.0000)
Pesaran scaled LM	177.3626 (0.0000)	247.0387 (0.0000)	230.0618 (0.0000)	148.1526 (0.0000)
Bias-corrected scaled LM	177.3252 (0.0000)	247.0014 (0.0000)	230.0244 (0.0000)	148.1152 (0.0000)
Pesaran CD	35.64434 (0.0000)	42.65977 (0.0000)	41.46411 (0.0000)	30.83150 (0.0000)

Sample: 1999Q1–2025Q4; T=108, N = 8.

Notes: test statistics with p-values in parentheses. The null hypothesis is no cross-sectional dependence across panel units.

TABLE A III: SECOND GENERATION PANEL UNIT ROOT TEST, CONSTANT

Test	CPI inflation	Policy rate	Real GDP growth	Spread
CIPS	-3.63295 (<0.01)	-3.03594 (<0.01)	-4.35788 (<0.01)	-2.74065 (<0.01)
Truncated CIPS	-3.63295 (<0.01)	-3.03594 (<0.01)	-4.17183 (<0.01)	-2.74065 (<0.01)

Sample: 1999Q1–2025Q4; T=108, N = 8.

Notes: test statistics with p-values in parentheses. The null hypothesis is the presence of a unit root. Critical values (CIPS, Trunc. CIPS): 1% (-2.53, -2.53), 5% (-2.32, -2.32), 10% (-2.21, -2.21).

TABLE A IV: SECOND GENERATION PANEL UNIT ROOT TEST, CONSTANT AND TREND

Test	CPI inflation	Policy rate	Real GDP growth	Spread
CIPS	-4.12924 (<0.01)	-2.96071 (<0.05)	-4.36546 (<0.01)	-2.72264 (<0.10)
Truncated CIPS	-4.12924 (<0.01)	-2.96071 (<0.05)	-4.20557 (<0.01)	-2.72264 (<0.10)

Sample: 1999Q1–2025Q4; T=108, N = 8.

Notes: test statistics with p-values in parentheses. The null hypothesis is the presence of a unit root. Critical values (CIPS, Trunc. CIPS): 1% (-3.03, -3.03), 5% (-2.83, -2.83), 10% (-2.72, -2.72).

TABLE A V: FIRST GENERATION PANEL UNIT ROOT TEST; INDIVIDUAL EFFECTS

Test	CPI inflation	Policy rate	Real GDP growth	Spread
Levin, Lin & Chu t	-0.28367 (0.3883)	-1.36213 (0.0866)	-11.1680 (0.0000)	-1.51495 (0.0649)
Im, Pesaran and Shin W-stat	-3.76316 (0.0001)	-2.57503 (0.0050)	-10.0766 (0.0000)	-4.38236 (0.0000)
ADF – Fisher Chi Square	44.1364 (0.0002)	31.5167 (0.0116)	140.066 (0.0000)	48.9527 (0.0000)
PP – Fisher Chi Square	57.7474 (0.0000)	22.0038 (0.1431)	109.661 (0.0000)	46.6381 (0.0001)

Sample: 1999Q1–2025Q4; T=108, N = 8.

Notes: test statistics with p-values in parentheses. The null hypothesis is the presence of a unit root.

TABLE A VI: FIRST GENERATION PANEL UNIT ROOT TEST; INDIVIDUAL EFFECTS,
INDIVIDUAL LINEAR TRENDS.

Test	CPI inflation	Policy rate	Real GDP growth	Spread
Levin, Lin & Chu t	0.58844 (0.7219)	-0.23509 (0.4071)	-11.7324 (0.0000)	-0.41724 (0.3382)
Breitung t-stat	-3.35966 (0.0004)	-1.21772 (0.1117)	-8.51722 (0.0000)	-3.26813 (0.0005)
Im, Pesaran and Shin W-stat	-3.16932 (0.0008)	-0.48362 (0.3143)	-8.74731 (0.0000)	-3.46954 (0.0003)
ADF – Fisher Chi Square	35.8050 (0.0031)	19.3281 (0.2520)	109.415 (0.0000)	39.8516 (0.0008)
PP – Fisher Chi Square	43.5004 (0.0002)	9.12762 (0.9081)	80.8735 (0.0000)	39.3419 (0.0010)

Sample: 1999Q1–2025Q4; T=108, N = 8.

Notes: test statistics with p-values in parentheses. The null hypothesis is the presence of a unit root.

ONLINE APPENDIX

TABLE A VII: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) –
VAR (8) [HQ = AIC], BOOTSTRAP SHOCKS

Country	Inflation Target					
	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%
Japan	97.6	92.2	81.5	66.1	50.4	36.3
Switzerland	97.5	87.1	71.4	54.6	39.3	26.9
Sweden	66.1	49.5	35.5	23.8	15.5	9.5
Euro Area	61.9	45.8	32.4	21.6	13.8	8.6
United States	48.4	34.3	23.1	15.0	9.2	5.5
Canada	46.6	32.8	21.9	14.1	8.6	5.2
United Kingdom	36.9	24.8	16.3	10.1	6.1	3.4
Norway	31.0	20.4	13.0	8.1	4.8	2.7
Panel average	60.7	48.4	36.9	26.7	18.5	12.3

Horizon: 48 quarters

Source: authors' computations.

TABLE A VIII: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) –
VAR (8) [HQ = AIC], GAUSSIAN SHOCKS

Country	Inflation Target					
	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%
Switzerland	97.2	87.3	70.7	50.6	31.4	17.1
Japan	96.7	91.0	79.7	63.7	45.7	28.6
Sweden	63.8	44.0	27.1	14.6	7.0	2.9
Euro Area	59.1	40.1	23.9	12.6	5.8	2.4
United States	42.9	26.4	14.3	6.8	2.8	1.1
Canada	40.8	24.3	12.7	5.8	2.4	0.9
United Kingdom	29.6	16.6	8.2	3.7	1.4	0.5
Norway	22.8	11.9	5.5	2.2	0.8	0.3
Panel average	56.6	42.7	30.2	20.0	12.2	6.7

Horizon: 48 quarters

Source: authors' computations.

TABLE A IX: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) –
ARDL (4,5) [HQ], BOOTSTRAP SHOCKS

Country	Inflation Target					
	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%
Switzerland	99.0	92.8	79.0	59.4	39.5	23.8
Japan	96.6	89.6	77.4	60.6	42.4	26.5
Sweden	65.8	46.5	29.3	16.3	8.4	4.1
Euro Area	60.4	42.1	26.1	14.5	7.3	3.5
United States	42.8	26.9	15.0	7.8	3.7	1.7
Canada	42.3	26.2	14.7	7.5	3.5	1.5
United Kingdom	27.6	15.6	8.1	3.9	1.8	0.7
Norway	23.6	12.9	6.7	3.0	1.4	0.5
Panel average	57.2	44.1	32.0	21.6	13.5	7.8

Horizon: 48 quarters

Source: authors' computations.

TABLE A X: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) –
ARDL (4,5) [HQ], GAUSSIAN SHOCKS

Country	Inflation Target					
	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%
Switzerland	97.9	88.5	70.9	48.6	28.3	14.2
Japan	93.5	83.6	68.0	49.0	31.2	17.1
Sweden	55.0	34.7	19.1	8.8	3.5	1.2
Euro Area	49.2	30.3	16.4	7.6	3.1	1.0
United States	31.5	16.9	8.0	3.1	1.1	0.3
Canada	30.6	16.1	7.4	3.0	1.1	0.3
United Kingdom	17.6	8.4	3.4	1.2	0.4	0.1
Norway	14.4	6.5	2.6	0.9	0.2	0.1
Panel average	48.7	35.6	24.5	15.3	8.6	4.3

Horizon: 48 quarters

Source: authors' computations.

TABLE A XI: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) –
ARDL (7,7) [AIC], BOOTSTRAP SHOCKS

Country	Inflation Target					
	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%
Switzerland	99.0	92.2	78.1	59.1	39.5	23.6
Japan	96.9	90.4	78.9	62.2	44.5	28.3
Sweden	67.2	48.2	31.3	18.0	9.6	4.6
Euro Area	62.2	43.6	27.1	15.8	8.3	4.0
United States	45.1	29.0	16.7	8.6	4.4	1.9
Canada	43.8	27.3	15.6	8.1	3.8	1.8
United Kingdom	29.7	17.3	9.1	4.5	2.2	0.9
Norway	25.5	14.4	7.5	3.5	1.6	0.7
Panel average	58.7	45.3	33.1	22.5	14.2	8.2

Horizon: 48 quarters

Source: authors' computations.

TABLE A XII: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) –
ARDL (7,7) [AIC], GAUSSIAN SHOCKS

Country	Inflation Target					
	2.0%	2.5%	3.0%	3.5%	4.0%	4.5%
Switzerland	97.7	88.0	69.9	47.8	28.1	14.3
Japan	93.8	84.6	69.7	51.2	33.1	18.8
Sweden	56.9	36.5	20.3	9.9	4.2	1.6
Euro Area	50.7	31.9	17.7	8.3	3.5	1.2
United States	33.2	18.7	9.0	3.8	1.3	0.4
Canada	31.9	17.6	8.3	3.4	1.3	0.4
United Kingdom	19.7	9.6	4.1	1.6	0.5	0.2
Norway	15.8	7.5	3.2	1.1	0.3	0.1
Panel average	50.0	36.8	25.3	15.9	9.0	4.6

Horizon: 48 quarters

Source: authors' computations.

FIGURE A 1: CUMULATIVE PROBABILITY OF REACHING THE ZLB ACROSS DIFFERENT SPECIFICATIONS OF THE VAR WITH BOOTSTRAP SHOCKS

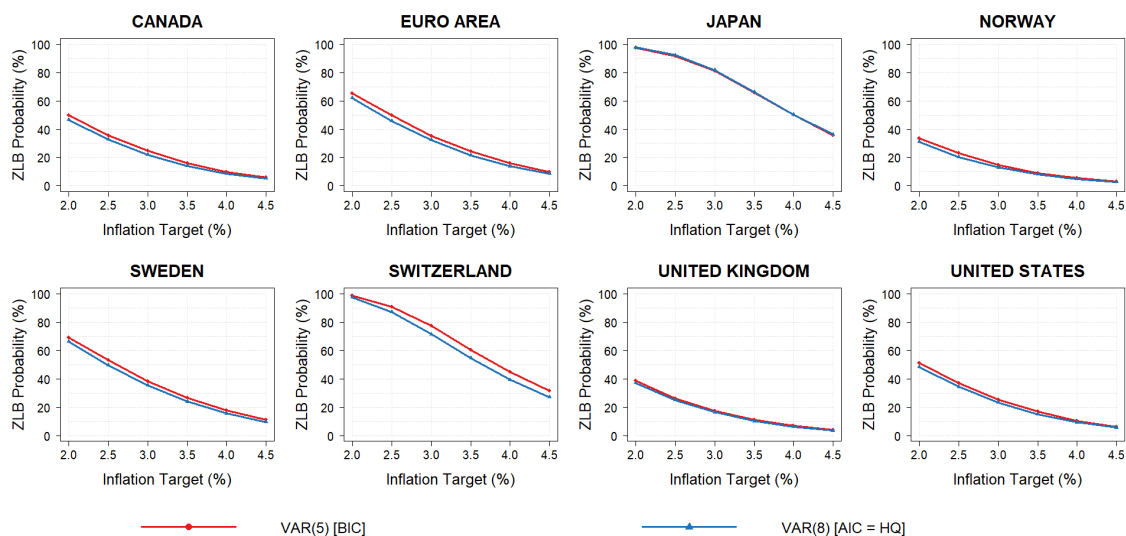


FIGURE A 2: CUMULATIVE PROBABILITY OF REACHING THE ZLB ACROSS DIFFERENT SPECIFICATIONS OF THE VAR WITH GAUSSIAN SHOCKS

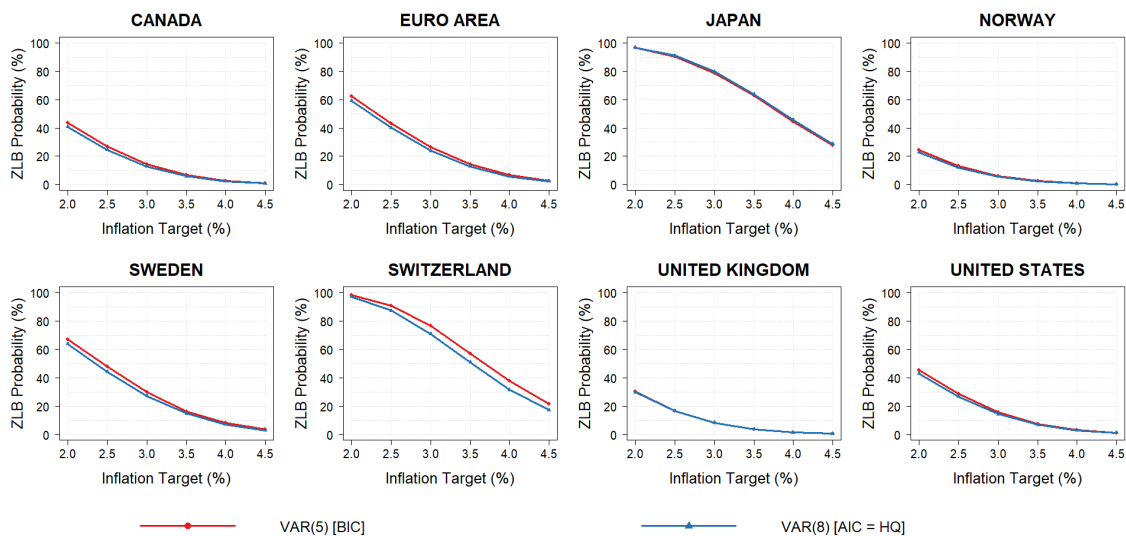


FIGURE A 3: CUMULATIVE PROBABILITY OF REACHING THE ZLB ACROSS DIFFERENT SPECIFICATIONS OF THE ARDL WITH BOOTSTRAP SHOCKS

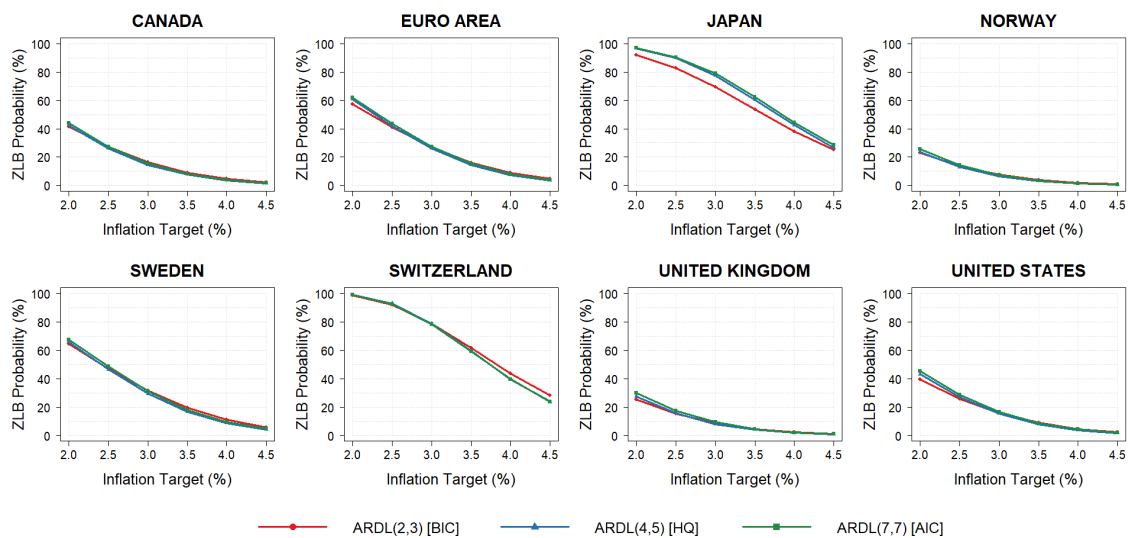


FIGURE A 4: CUMULATIVE PROBABILITY OF REACHING THE ZLB ACROSS DIFFERENT SPECIFICATIONS OF THE ARDL WITH GAUSSIAN SHOCKS

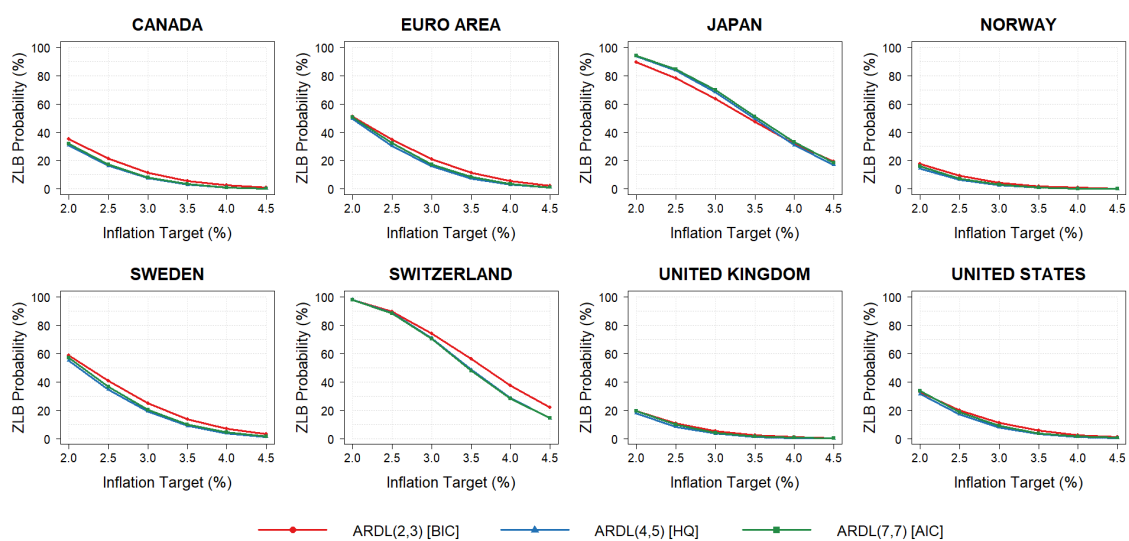


FIGURE A 5: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) –
VAR (8) [HQ] vs ARDL (4,5) [HQ], BOOTSTRAP SHOCKS

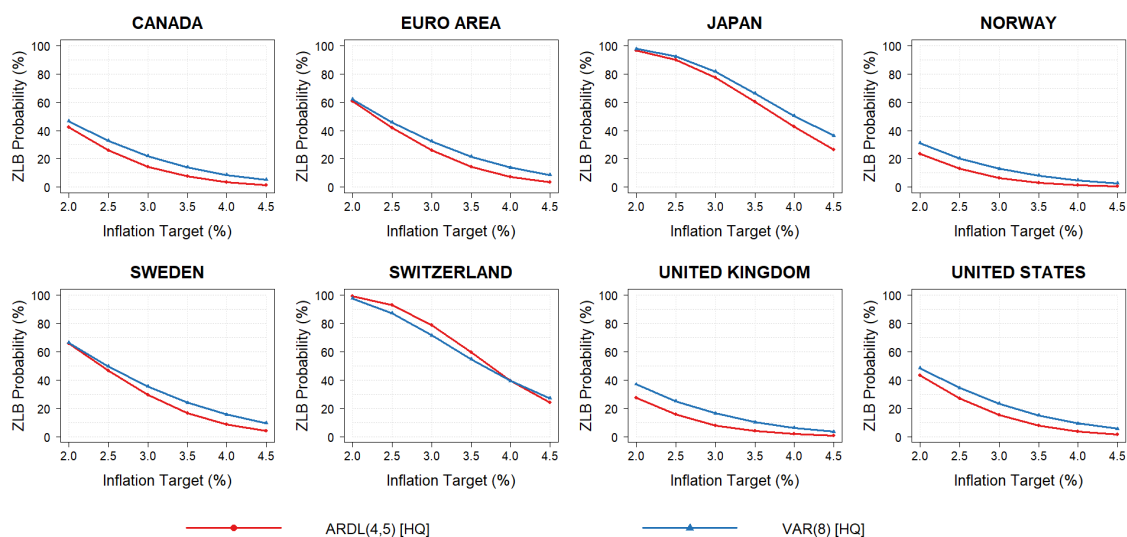


FIGURE A 6: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) –
VAR (8) [HQ] vs ARDL (4,5) [HQ], GAUSSIAN SHOCKS

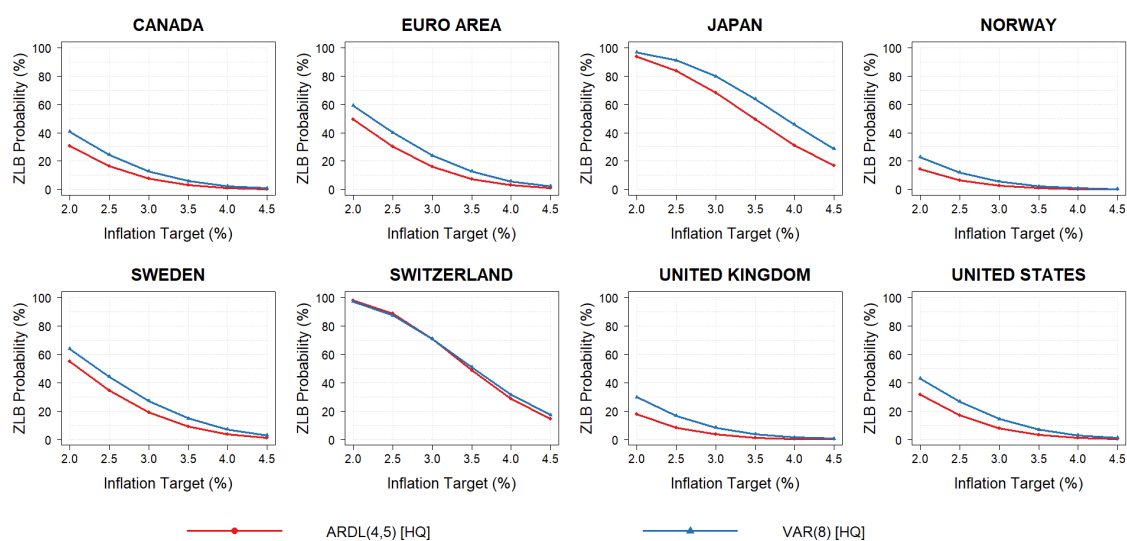


Figure A 7: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) –
VAR (8) [AIC] vs ARDL (7,7) [AIC], BOOTSTRAP SHOCKS

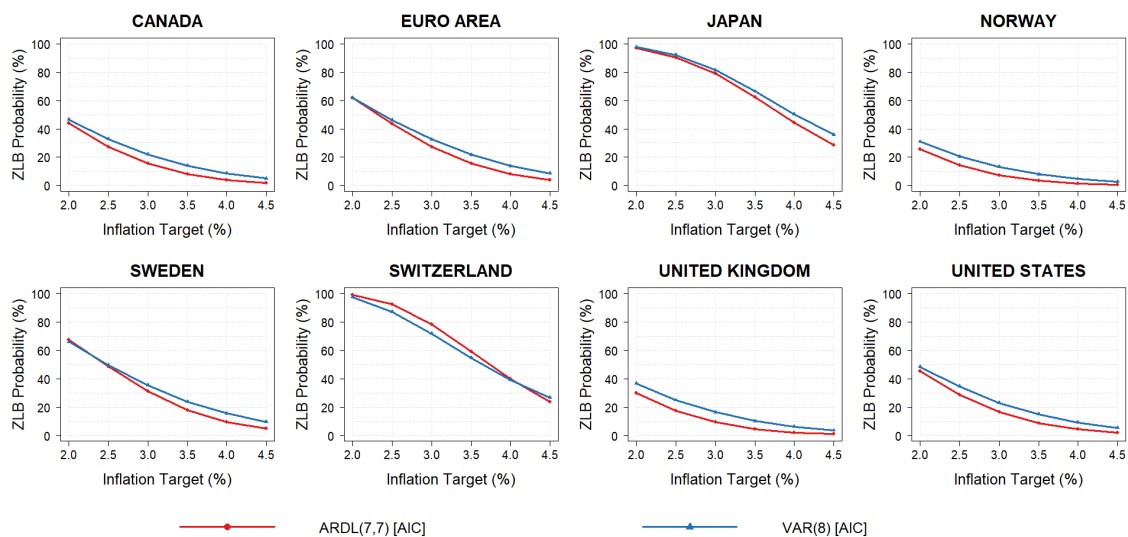


Figure A 8: CUMULATIVE PROBABILITY OF REACHING THE ZLB AT LEAST ONCE (%) –
VAR (8) [AIC] vs ARDL (7,7) [AIC], GAUSSIAN SHOCKS

