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Monetary Policy Reaction to Geopolitical Risks: Some Nonlinear Evidence⋆

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Abstract

How do geopolitical risk shocks impact monetary policy? Based on a panel of 20 economies, we develop and estimate an augmented panel Taylor rule via linear and nonlinear local projections (LP) regression models. First, the linear model suggests that the interest rate remains relatively unchanged in the event of an uncertainty shock. Second, the result turns out to be different in the nonlinear model, where the policy reaction is muted during an expansionary state, which is operating in a manner proportional to the transitory shock. However, geopolitical risks can amplify the policy reaction during a non-expansionary period.

Keywords: Monetary Policy, Linear and Nonlinear Local Projections, Geopolitical Risk, Economic Policy Uncertainty.
JEL: F44, E44

Highlights

- We estimate an augmented Taylor rule based on an uncertainty shock via panel linear and nonlinear LP models.
- The linear LP model indicates that a geopolitical risk shock corresponds to a delayed and insignificant policy reaction.
- Empirical results reveal the presence of a state dependence.
- A geopolitical risk shock leads to an amplification of the policy reaction during a non-expansionary state.

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1. Introduction

> *Escalation of these conflicts or a worsening in other geopolitical tensions could reduce economic activity and boost inflation worldwide, particularly in the event of prolonged disruptions to supply chains and interruptions in production. The global financial system could be affected by a pullback from risk-taking, declines in asset prices, and losses for exposed businesses and investors, including those in the U.S.* — Financial Stability Report – October 2023[1].

After the global financial crisis, international trade relations have been increasingly influenced by geopolitical considerations. Indeed, it is now widely recognized that geopolitical risks and bilateral political tensions can have a strong influence on the functioning of the economy (Caldara and Iacoviello, 2022). Geopolitical risk shocks affect the economy through different channels. Some of them are inflationary, such as the commodity price channel, especially the oil price (Mignon and Saadaoui, 2024), and the currency channel (Gopinath, 2015). In addition, other channels are deflationary, such as the consumer sentiment channel and the financial condition channel (Forbes and Warnock, 2012). It is difficult to determine ex ante whether geopolitical risk shocks are inflationary or deflationary. Recent research suggests that geopolitical shocks tend to be inflationary throughout history (Caldara et al., 2022).

In a more fragmented world, geopolitical risks may be a new and an important factor that contributes to inflation pressures at the global level. The challenges raised by these new risks will become increasingly important to monetary policy and central bankers. These surges in geopolitical risks are also the by-product of changes in the global economy. During the last 20 years, the global economy has experienced several important changes. The weight of emerging countries in global GDP, the BRICS country group[2] for example, is now much larger than it was when China became a member of the WTO in December 2001. Therefore, the analysis of the reaction of monetary policy to geopolitical risks must be conducted at the global level instead of focusing exclusively on advanced economies with highly developed financial markets and sound financial institutions. Consequently, considering a large sample of emerging and industrialized countries will be especially relevant to our research question.

Since the early 2000s, the world economy has faced numerous geopolitical events (e.g., 9/11, the first war in Ukraine, the China-U.S. trade dispute, the COVID-19 pandemic, and the second war in Ukraine), which underscore how geopolitical risks may impact an increasingly interconnected global economy. The integration of economies, facilitated by international trade, finance, and technology, can amplify the effects of these global events. Several authors found convincing evidence of a global business cycle (e.g., Kose et al., 2003, Monfort et al., 2003, Ciccarelli and Mojon, 2010, Ginn, 2023*a*, Ginn, 2023*b*). Furthermore, global uncertainty is an important driver of economic conditions, where domestic uncertainty plays a smaller role (Berger et al., 2016, Biljanovska et al., 2021). Ahir et al. (2022) find that the economic uncertainty measured with the economic policy uncertainty index (EPU) increases around major events. Moreover, Miranda-Agrippino and Rey (2020) have demonstrated the existence of a global financial cycle, where the dollar and US monetary

[1] Source: https://www.federalreserve.gov/publications/2023-october-financial-stability-report-near-term-risks.htm

[2] The BRICS countries are Brazil, Russia, India, China, and South Africa, Egypt, Ethiopia, Iran, Saudi Arabia and the United Arab Emirates (UAE).

policy play a pivotal role, especially after the Global Financial Crisis (GFC). The global business cycle and the global financial cycle signify that economic and financial conditions are not isolated events within individual countries but are part of a larger global phenomenon. Policymakers can respond to global shocks by implementing accommodating monetary policies to counteract negative impacts on economic activity and limiting international financial spillovers.

Elevated uncertainty can affect the economic decision-making of individuals and companies, underpinned by the theory of real options (Bernanke, 1983), where uncertainty can increase the option value of waiting (Bloom, 2009). Empirical evidence suggests that when the EPU is high, it can suppress investment for firms (e.g., Kang et al., 2014, Handley and Limao, 2015), equity returns (e.g., Antonakakis et al., 2013, Kang and Ratti, 2013, Arouri et al., 2016, Ginn, 2023*a*); employment (e.g., Caggiano et al., 2014, Caggiano et al., 2017); and production (Baker et al., 2016). Azzimonti and Talbert (2014) find that emerging market economies are more polarized and exhibit greater uncertainty, leading to polarized business cycles. We can underline that the EPU index is not perfectly correlated with the GPR index. Therefore, our empirical investigation will focus on the effects of geopolitical risks as an exogenous source of uncertainty. In this sense and more directly related to our study, Eckstein and Tsiddon (2004) find that wars and periods of terrorism can lead to a contraction by reducing the value of the future relative to the present. Consequently, geopolitical uncertainty leads to a "wait-and-see" approach, thereby influencing the decision of economic agents. This could be illustrated by the consumer sentiment channel explored in Caldara et al. (2022).

This cautious behavior may be more elevated during states of high geopolitical risk, further exacerbating economic downturns. Elevated geopolitical risks can, in turn, raise the stakes for policy makers who are faced with ways of maintaining macroeconomic stability. Alan Greenspan, the US Federal Reserve Chair from 1987 to 2006, stated that "uncertainty is not just a pervasive feature of the monetary policy landscape; it is the defining characteristic of that landscape."[3] The effect of geopolitical risks is not confined to individual countries and can spill over to other countries and regions of the world economy. Domestic financial conditions can become vulnerable to global shocks, which can complicate monetary policy decision making (Kamin, 2010). Increased interconnectivity can make countries more susceptible to financial contagion that can originate domestically or abroad and jeopardize economic stability. Although comovement in domestic inflation rates may be related to cyclical fluctuations in the world economy, as shown Woodford (2007), globalization does not affect central banks' ability to control domestic inflation through national monetary policy.

The US Federal Reserve Chair, Jerome Powell, identifies GPR as a major challenge of monetary policy (Powell, 2019). Carney (2016) posits that there are three components, namely geopolitical risk, economic uncertainty, and policy uncertainty, established as an "uncertainty trinity", which could have adverse effects on economic conditions. Since 2017, the European Central Bank [4] and the International Monetary Fund[5] have identified geopolitical tensions and geoeconomic fragmentation as a major risk to macroeconomic and financial stability.

An important question is whether changing states of economic conditions can influence monetary policy. Understanding how monetary policy is influenced by geopolitical conditions is of paramount

[3] See https://www.federalreserve.gov/boarddocs/speeches/2004/20040103/default.htm.

[4] See e.g. the first issue of the ECB's Economic Bulletin in 2024.

[5] See e.g. the October 2023 edition of the IMF's World Economic Outlook.

interest, both from the perspective of policy makers and from the perspective of the general public. This paper provides two novelties to the literature. First, we examine the macroeconomic effects of a geopolitical risk shock on policy reaction through a balanced panel LP model based on a rich data set of 20 economies that represent around 82% global output (in nominal terms based on IMF data for 2022). Second, this is the first paper to test the hypothesis that the effect of a geopolitical risk shock on monetary policy is state-dependent, with the expectation that geopolitical risk is likely to be relatively more pronounced as it impacts interest rates during non-expansionary states.

Consequently, periods marked by high geopolitical risk have potentially adverse consequences for an economy. Central banks, when implementing monetary policy, take into account the prevailing economic conditions, including states of uncertainty. The Taylor Rule provides a framework for central banks to adjust interest rates based on economic indicators, and this adjustment can be influenced by the level of the GPR (Taylor, 1993). Our main results are highlighted as follows: (i) we estimate an augmented Taylor rule based on a geopolitical risk shock via panel linear and nonlinear LP models; (ii) the linear LP indicates that a geopolitical risk shock corresponds to a delayed and statistically insignificant policy reaction; (iii) empirical results reveal presence of state dependence; (iv) an geopolitical risk shock leads to an attenuation (amplification) of the policy reaction during a state of high GPR (state of low GPR). The rest of the paper is structured as follows. Section 2 describes the data. Section 3 discusses the empirical results. Section 4 concludes.

Table 1: Variable Selection

Variable	Symbol	Source	Description
Output	$\ln Y_{i,t}$	OECD/FRED	Industrial Production
Aggregate CPI	$\ln P^G_{i,t}$	OECD	CPI: All items
Interest Rate	$R_{i,t}$	OECD/FRED	Short-term interest rate
Geopolitical Risk	$\ln(1 + GPR_{i,t})$	Iacoviello's website	GPR
Policy Uncertainty	$\ln EPU_{i,t}$	FRED	EPU
Recession Indicator	$\delta_{i,t}$	NBER/OECD	Recession Dummy

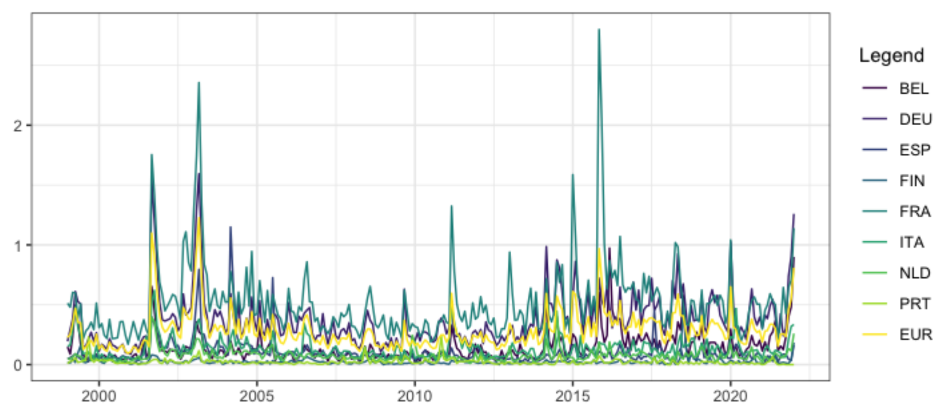
2. Data

To consider the global impact of geopolitical risk, we use a rich data set for industrial production, consumer price index (CPI), short-term interest rate, GPR and EPU for 20 economies that represent around 82% of global GDP to analyze the effect of GPR on interest rates. These twenty economies include: Brazil (BRA), Switzerland (CHE), Chile (CHL), Canada (CAN), China (CHN), Columbia (COL), Czech Republic (CZE), Euro zone (19 countries; EUR), United Kingdom (GBR), Hungary (HUN), Ireland (IRL), India (IND), Israel (ISR), Japan (JPN), Mexico (MEX), South Korea (KOR), Poland (POL), Russia (RUS), Sweden (SWE) and the United States (USA). We used monthly data that cover January 1999 to February 2022. The growth variables are defined as year-on-year. The data are summarized in Table 1. All variables are converted to logarithm and, where appropriate, seasonally adjusted using the ARIMA X-12 algorithm of the US Census Bureau, except for the interest rate. The economic uncertainty is measured with the EPU data (Baker et al., 2016).

The GPR data for these 20 economies are taken from Matteo Iacoviello's website[6]. Although the GPR data do not include a measure for the Euro area, we construct a Euro area GPR index based on sampled economies within the Euro area using a nominal GDP weighted index. The Euro area GPR indicator includes the GPR indices of Belgium, Finland, France, Germany, Italy, the Netherlands, Portugal, and Spain. The weight of each economy in the index is derived from its economic size (proxied using quarterly nominal GDP data). We then apply the weights to each of the respective global indicators in the respective month, considering that the data are monthly. We plot the individual economies of the Euro area and the constructed euro GPR index in Figure 1.

The international data for the explained and explanatory variables of the 20 economies are shown in Figure 2. In the output growth data, we can clearly see three episodes of global slowdown, namely the Internet Bubble in 2001, the Global Financial Crisis in 2008-2009 and the pandemic in 2020. The graphs for inflation show a more dispersed situation over time and between countries, except for the Global Financial Crisis and after the pandemic. In terms of monetary tightening and loosening, we also observe that the monetary cycles induced by the Global Financial Crisis (loosening) and after the pandemic (tightening) are the most synchronized episodes. Furthermore, Economic Policy Uncertainty is higher after the pandemic. During the most recent period, we can observe elevated levels of GPR due to the War in Ukraine. More generally, the GPR has known large spikes around 2001 due to 9/11 and after 2009 due to rising tensions between the United States and China and the election of Donald Trump, as discussed in Mignon and Saadaoui (2024).

Figure 1: Euro Area GPR Indexes



3. Empirical Specification

The Taylor rule is designed to capture the reaction of central banks to deviations in inflation and output (Taylor, 1993). By examining the rule in expansionary and non-expansionary states, this research may offer insight into how central banks adjust interest rates in response to economic conditions in the presence of uncertainty shocks. The LP model, developed by Jordà (2005), is used to estimate an augmented Taylor rule based on a GPR shock. Periods marked by high GPR have potentially adverse consequences for an economy. Central banks, when implementing monetary policy, take into account the prevailing economic conditions, including states of uncertainty. The

[6] https://www.matteoiacoviello.com/gpr.htm

Taylor Rule provides a framework for central banks to adjust interest rates based on economic indicators, where we test whether this adjustment can be influenced by the level of the GPR.

Figure 2: International Economic Data

3.1. Linear Baseline Model

In the linear specification, we estimate the nominal interest rate for country i at time t as follows:

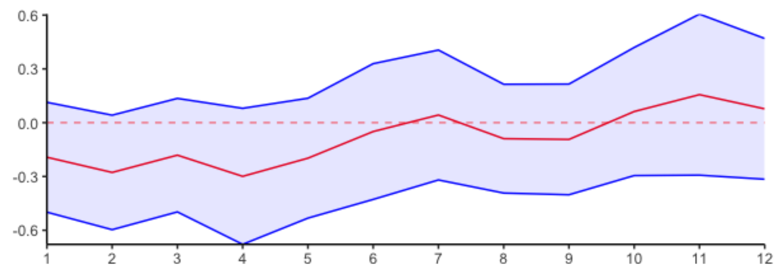
$$R_{i,t+h} = \alpha_i + \gamma_t + \rho_i R_{i,t-1} + \beta_h S_{i,t-k} + \sum_{j=1}^{k} \nu_j X_{i,t-j+1} + \epsilon_{i,t+h} \quad (1)$$

where α_i are country fixed effects to control for unobserved cross-country heterogeneity, γ_t are time fixed effects, ρ_i is an autoregressive term to account for persistence[7] and $S_{i,t}$ is a one standard deviation shock to changes in GPR (i.e., $\Delta \ln(1 + GPR_{i,t})$). This paper explores the Taylor rule linking the interest rate response to changes in output and inflation. Thus, the augmented Taylor rule is used as a benchmark for analyzing monetary policy based on a vector $X_{i,t}$ of control variables which include the contemporaneous and lag of the log difference of output and inflation (i.e., we

[7] The autoregressive term ρ_i is further justified to account for policy inertia.

set $k = 2$). $\epsilon_{i,t}$ relates to the error term. The coefficient β_h in Equation (1) traces the effect of a GPR shock at time t on the policy reaction at time $t+h$. As serial correlation is present in error terms, the Newey-West correction is used for standard errors. Impulse response functions (IRF) are presented in Figure 3 using a 90% confidence band. Consequently, the IRFs suggest that a GPR shock corresponds to a lower interest rate, albeit the effect is not statistically significant.

Figure 3: GPR on Interest rates (Baseline Model)



Note: the shock is a one standard deviation shock to changes in GPR (i.e., $\Delta \ln(1 + GPR_{i,t})$).
Source: authors' calculations.

3.2. Non-Linear Baseline Model

We extend the linear LP model to include non-linear regime-switching to examine whether a GPR shock is state-dependent:

$$R_{i,t+h} = \alpha_i + \gamma_t + \rho_i R_{i,t-1} + \beta_h^E S_{i,t-k} \times F(\zeta_{i,t-1}) + \beta_h^{NE} S_{i,t-k} \times (1 - F(\zeta_{i,t-1})) + \sum_{j=1}^{k} \nu_j X_{i,t-j+1} + \epsilon_{i,t+h} \quad (2)$$

where $F(\zeta_{i,t-1})$ in Equation (2) governs the transition between an expansionary ("E") and a non-expansionary ("NE") regime and is estimated via logistic function:

$$F(\zeta_{i,t}) = \frac{\exp(-\gamma\zeta_{i,t})}{1 + \exp(\gamma\zeta_{i,t})}, \quad \gamma > 0, \quad |\zeta_t| < \infty \quad (3)$$

ζ_t is a standardized transition variable and γ controls the degree of smoothness of the transition between states. Following Auerbach and Gorodnichenko (2013) and Ramey and Zubairy (2018), the transition variable is standardized by taking the cyclical component using the Hodrick and Prescott filter.[8] The transition function is dated $t-1$ in Equation (2) to avoid contemporaneous feedback with regard to the state of economic conditions. The transition variable for the baseline model is based on the twelve-month centered moving average of the output growth rate for the baseline nonlinear model.[9]

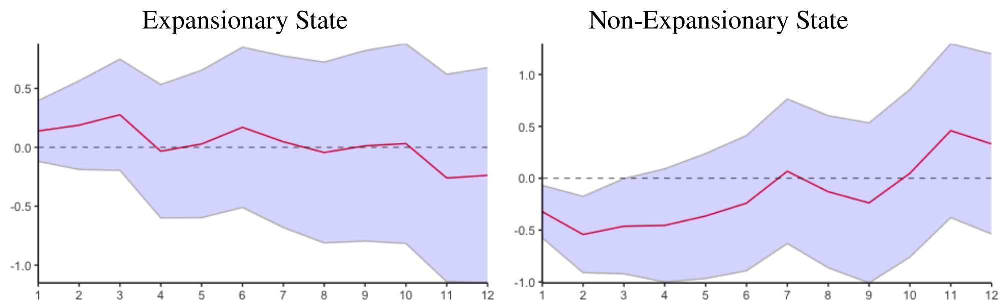
The IRFs of the baseline nonlinear model are presented in Figure 4. The transition function is presented in Figure 5, where the plot shows that the "high" value of the transition variable

[8]The smoothing parameter λ of the HP filter is equal to 129,600 for monthly data as in Ravn and Uhlig (2002).
[9]The output gap is estimated for each of the twenty economies via the HP filter.

corresponds to periods of non-expansionary growth. The left panel of Figure 4 indicates that the policy reaction is muted, operating in a manner that is proportional to the transitory nature of a GPR shock during an expansionary state. The duration and magnitude of the GPR coupled with the lags with which monetary policy can influence economic conditions (e.g., Friedman, 1961, Batini and Nelson, 2001, Bernanke et al., 1998) may explain the policy restraint.

The policy reaction, however, turns out to respond differently during a non-expansionary state. Consequently, the right panel of Figure 4 reveals that the response becomes more accommodative at the onset of the shock and is statistically significant for periods 1 to 3, which takes until around period 7 to return to pre-shock levels. This finding implies that it is the amplification, as opposed to attenuation, of the policy reaction to GPR schoks during a non-expansionary state. The occurrence of GPR shocks during a non-expansionary state may act as an incentive for the Central Bankers to further reduce the interest rate in order to cope with possible future adverse geopolitical events.

Figure 4: GPR on Interest Rate (Baseline Non-Linear Model)



Note: the shock is a one standard deviation shock to changes in GPR (i.e., $\Delta \ln(1 + GPR_{i,t})$).
Source: authors' calculations.

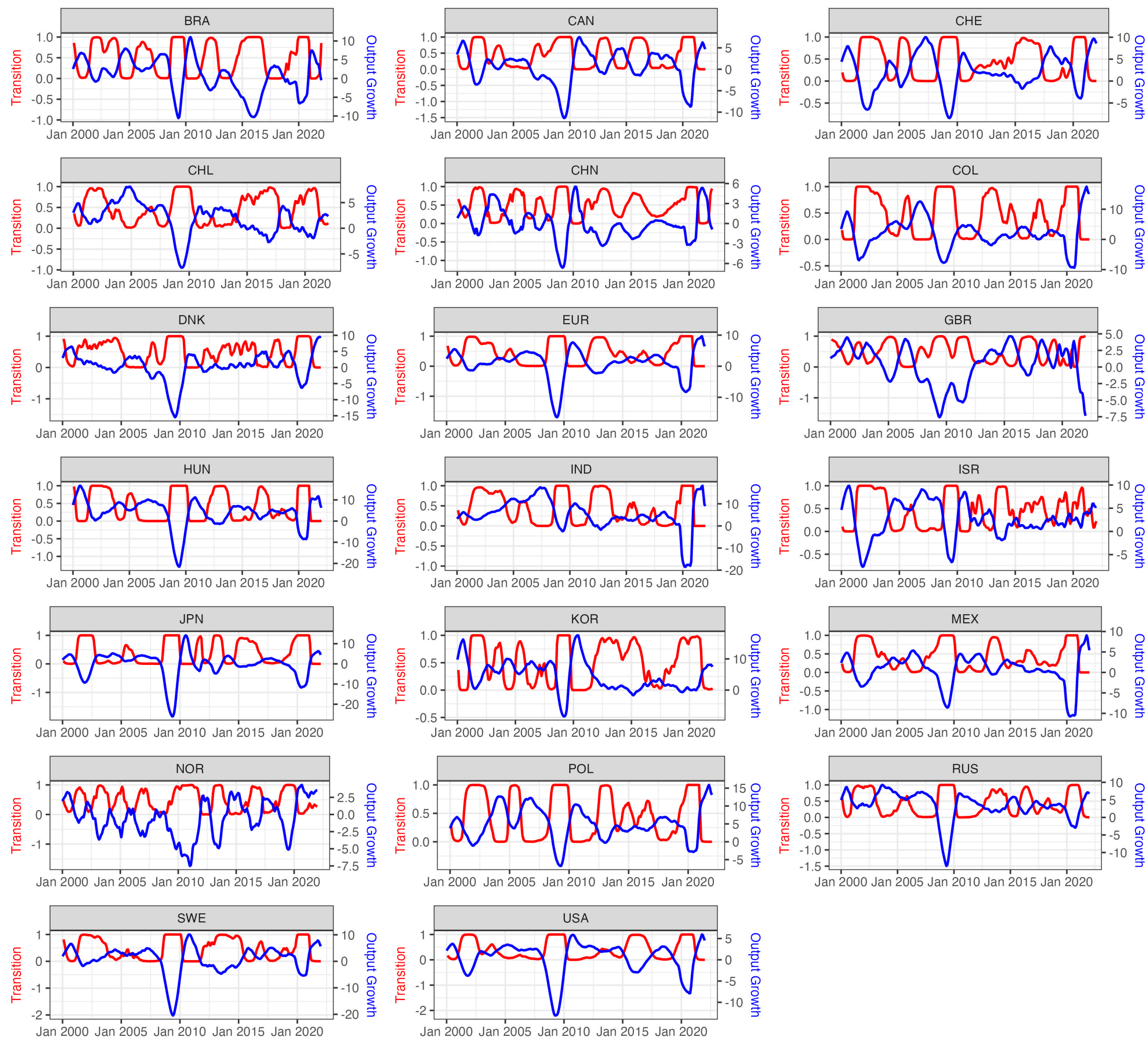
To enrich the robustness of the empirical findings of the economic analysis, we include four alternative models. First, we estimate the baseline model based on setting the lag equal to one. The IRFs are provided in the Appendix (see Figure A.1). Second, we estimate the baseline model where the output gap based on the HP filter is used as a measure of state dependence. The IRFs and transition function are provided in the Appendix in Figures A.2 and A.3, respectively. Third, we estimate the baseline model where a recession indicator is used as a measure of state dependence. See Figure A.4. The model is based on 19 economies[10] The IRFs and transition function are provided in the appendix through Figures A.4 and Figures A.5, respectively. Fourth, we estimate the baseline model where the twelve-month centered moving average of EPU is used as a measure of state dependence. The model is based on fourteen economies.[11] The IRFs and transition function are provided in the Appendix through Figures A.6 and A.7, respectively.

Our findings show that the baseline model and four alternative models are quantitatively similar. Therefore, the linear model in Equation (1) may be misspecified by masking substantial asymmetry

[10]The nineteen economies are based on the economies sampled in the baseline model, with the exception that Colombia is excluded considering no recession indicator is available for that country.

[11]The fourteen economies are based on the economies sampled in the baseline model, with the exception that Denmark, Hungary, Israel, Norway, Poland and Switzerland are excluded considering EPU is not available for these countries.

Figure 5: Transition Function Based on State Dependence (Baseline Model)



Note: The blue line shows the centered moving average of the output growth. The red line shows the weighted regime (i.e., $F(z)$), where a high value of the transition variable corresponds to periods of non-expansionary growth.

in the policy reaction depending on the underlying economic regime. Overall, our findings reveal that state dependence matters in relation to how the monetary policy reaction responds, depending on the state of economic conditions in the presence of a GPR shock. A GPR shock leads to attenuation (amplification) of the policy reaction during an expansionary (non-expansionary) state.

As US Federal Reserve Chair Jerome H. Powell states[12], "[a]s is often the case, we are navigating by the stars under cloudy skies. In such circumstances, risk management considerations are critical." In this context, our analysis provides empirical evidence suggesting that an increase in GPR shocks leads to increased risk aversion among policymakers, who become more cautious especially during

[12] See https://www.federalreserve.gov/newsevents/speech/powell20230825a.htm.

recessions and uncertain times. One of the main conclusions is that policy makers include the influence of geopolitical risks in their decisions amongst the major economies of the world.

4. Conclusion

This paper analyzes the effect of a GPR shock on the interest rate response via linear and non-linear LP model. The models are estimated based on a balanced panel of twenty economies observed between January 1999 and February 2022. This paper contributes to the literature on the conduct of monetary policy in two broad ways. The first is methodological, where our contribution introduces an augmented Taylor Rule with GPR shocks. This augmented Taylor Rule is estimated with panel LP models. This paper attempts to shed light on the impact of a GPR shock on monetary policy based on a linear and non-linear LP panel model, controlling for endogenous relationships. The modeling framework used in this paper further relaxes the assumption that the effect of a GPR shock is linear. The baseline model is extended to capture the possible non-linear relationships in the data during periods of economic expansion.

The second contribution is empirical. The linear LP model demonstrates a negative relationship between monetary policy reaction and GPR shocks, where the policy reaction declines and is statistically insignificant. The non-linear model demonstrates that a GPR shock results in a muted interest rate policy response during an expansionary state. There is no policy dilemma, where the interest rate response is operating in a manner that is proportional to the transitory nature of the shock and considering the effect of monetary policy comes with a lag. The impact of a GPR shock on monetary policy turns out to be different during a non-expansionary state. The findings show that the response becomes accommodative and is statistically significant for numerous periods.

Overall, the empirical results confirm that the state of economic conditions matters in relation to how a GPR influences policy reaction, with nuanced implications with regard to movements for GPR depending on the state of the economy. GPR can influence how central banks apply the Taylor Rule. During periods of uncertainty in a non-expansionary state, central banks may choose to be more accommodative to counteract the negative effects of uncertainty on economic activity.

The findings of this area of research are of historical interest with respect to policy implications. A starting point for short-term policy is to establish sources of vulnerability that could create economic risks. The findings of this paper serve to do just that, by offering new insights via analyzing the propagation mechanisms through which GPR shocks influence economic conditions as a source of vulnerability. Global financial conditions can affect a country's financial stability. Policymakers should be vigilant about developments in global financial markets, as shocks originating at home or abroad can quickly spill over to domestic institutions, affecting overall financial stability.

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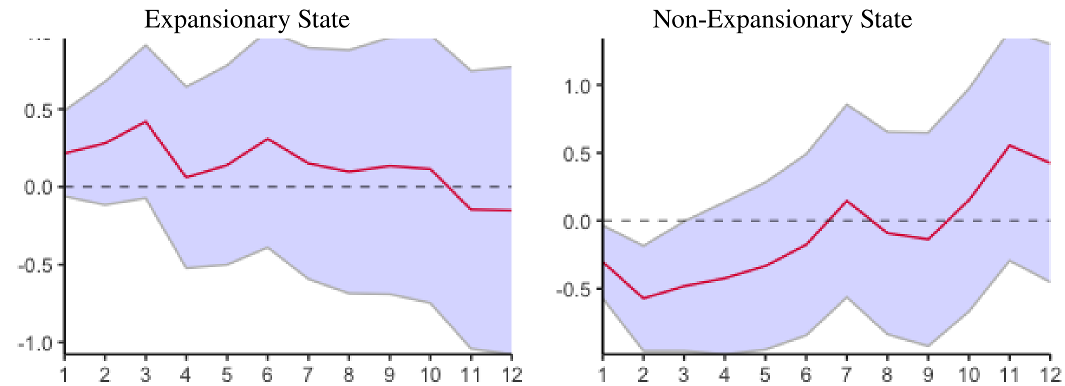
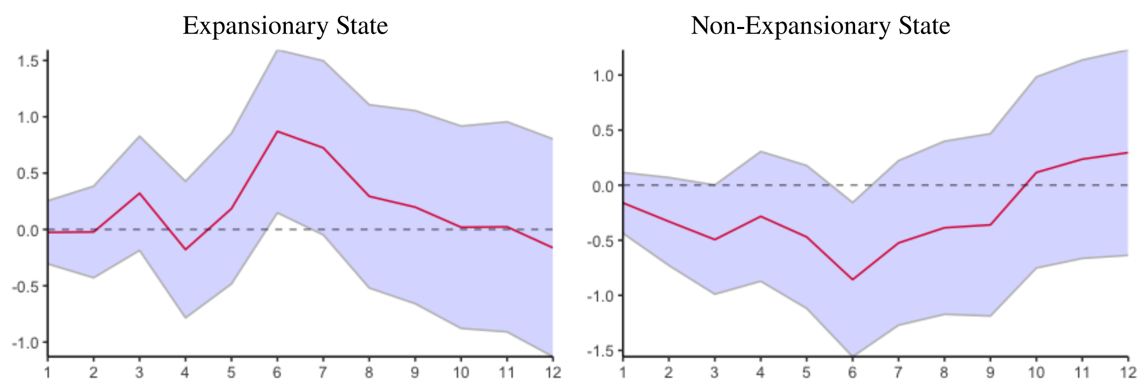
Appendix A. Alternative Non-Linear Models

Figure A.1: GPR on Interest Rate (Alternative Model I)



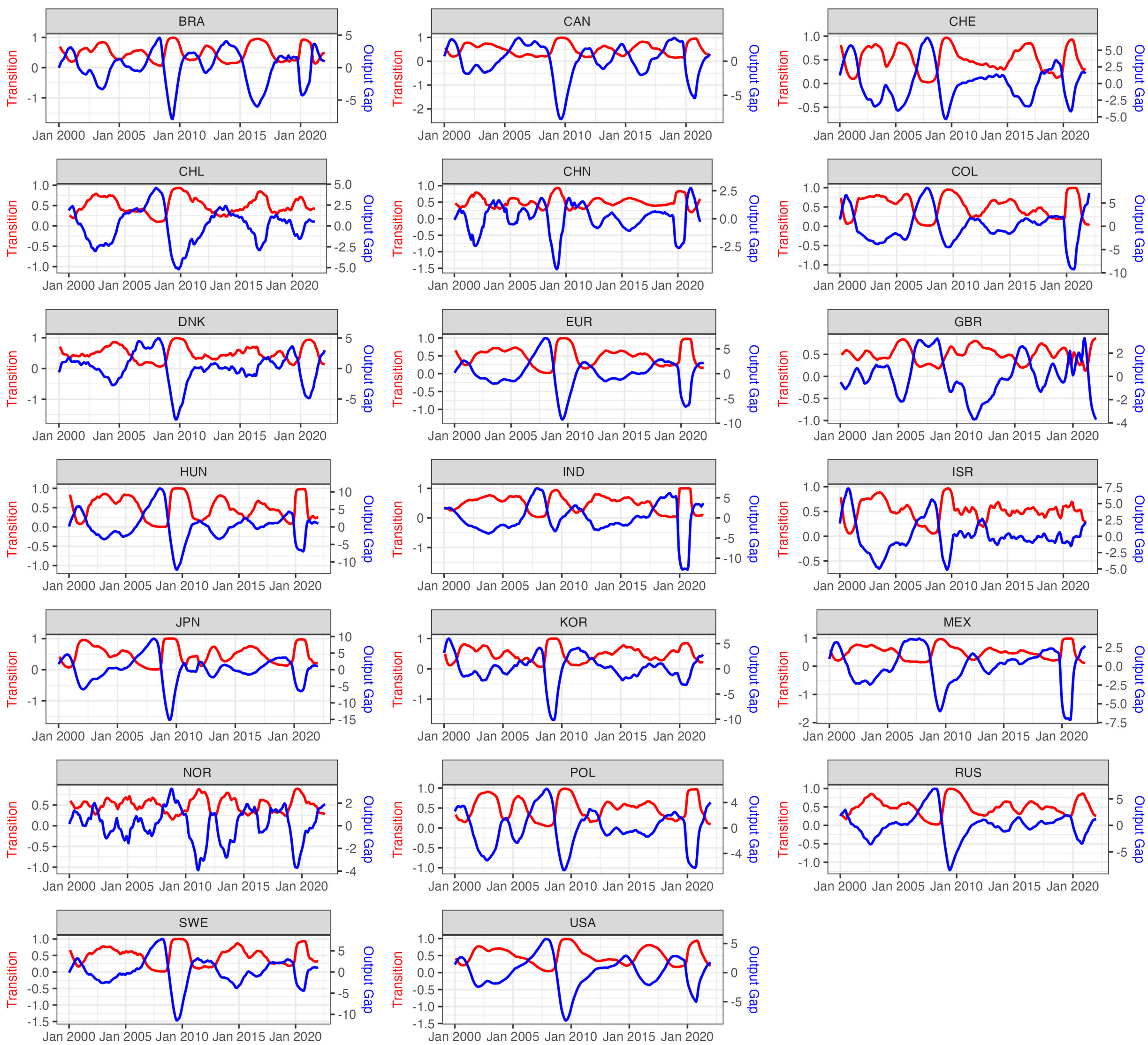
Note: Alternative Model I is based on Baseline Model where we set the lag order to one. The shock is a one standard deviation shock to changes in GPR (i.e., $\Delta \ln(1 + GPR_{i,t})$). Source: authors' calculations.

Figure A.2: GPR on Interest Rate (Alternative Model II)



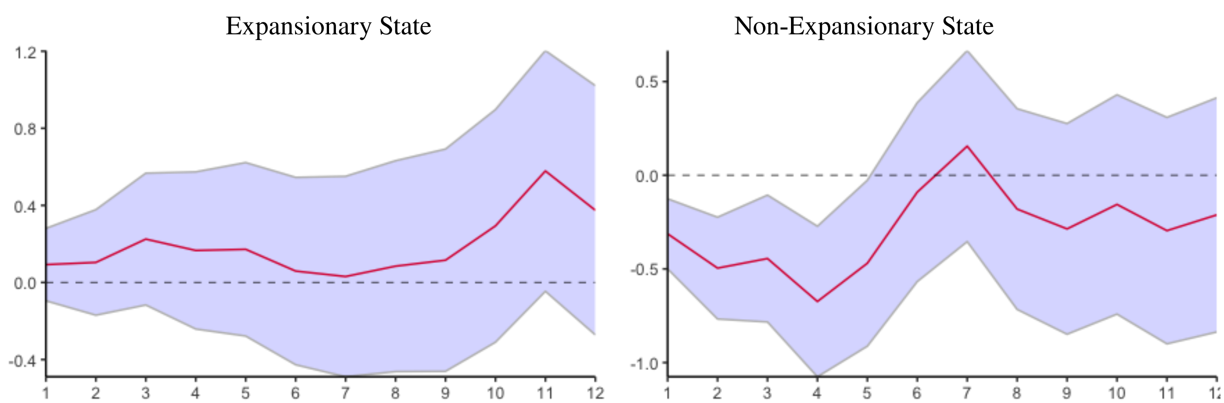
Note: Alternative Model II is based on Baseline Model where state dependence is based on the output gap. The shock is a one standard deviation shock to changes in GPR (i.e., $\Delta \ln(1 + GPR_{i,t})$). Source: authors' calculations.

Figure A.3: Transition Function Based on State Dependence (Alternative Model II)



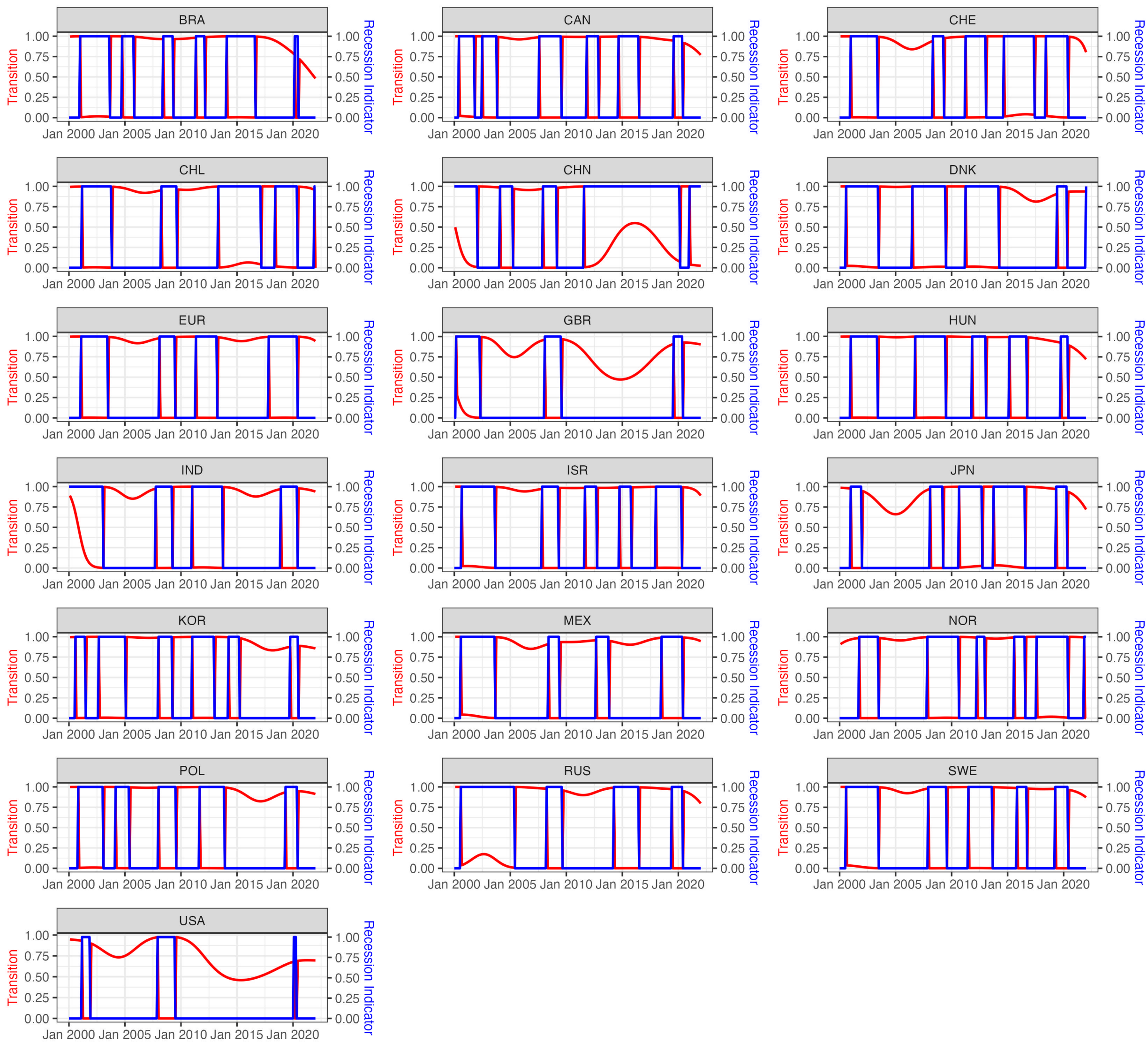
Note: The blue line shows output gap. The red line shows the weighted regime (i.e., $F(z)$), where a high value of the transition variable corresponds to periods of non-expansionary growth. Source: authors' calculations.

Figure A.4: GPR on Interest Rate (Alternative Model III)



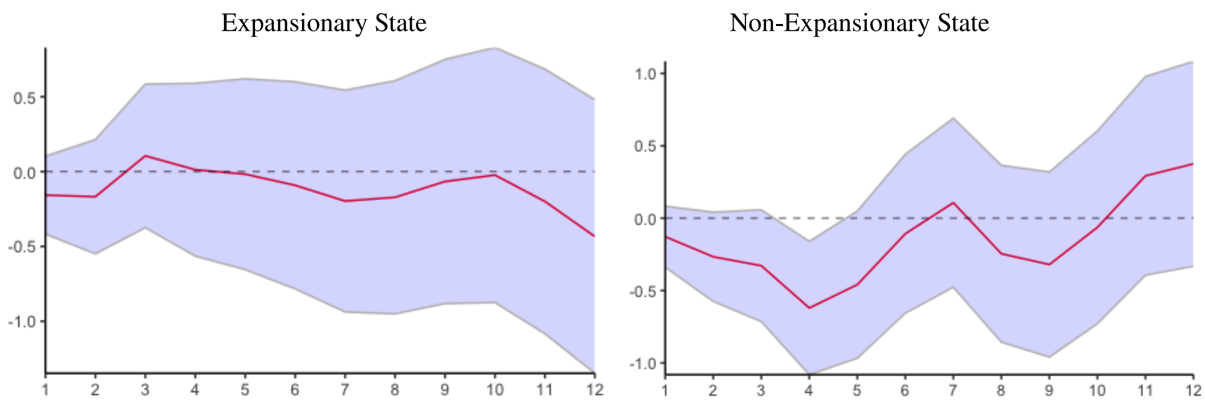
Note: Alternative Model III is based on Baseline Model where state dependence is based on a recession indicator. the shock is a one standard deviation shock to changes in GPR (i.e., $\Delta \ln(1+GPR_{i,t})$). Source: authors' calculations.

Figure A.5: Transition Function Based on State Dependence (Alternative Model III)



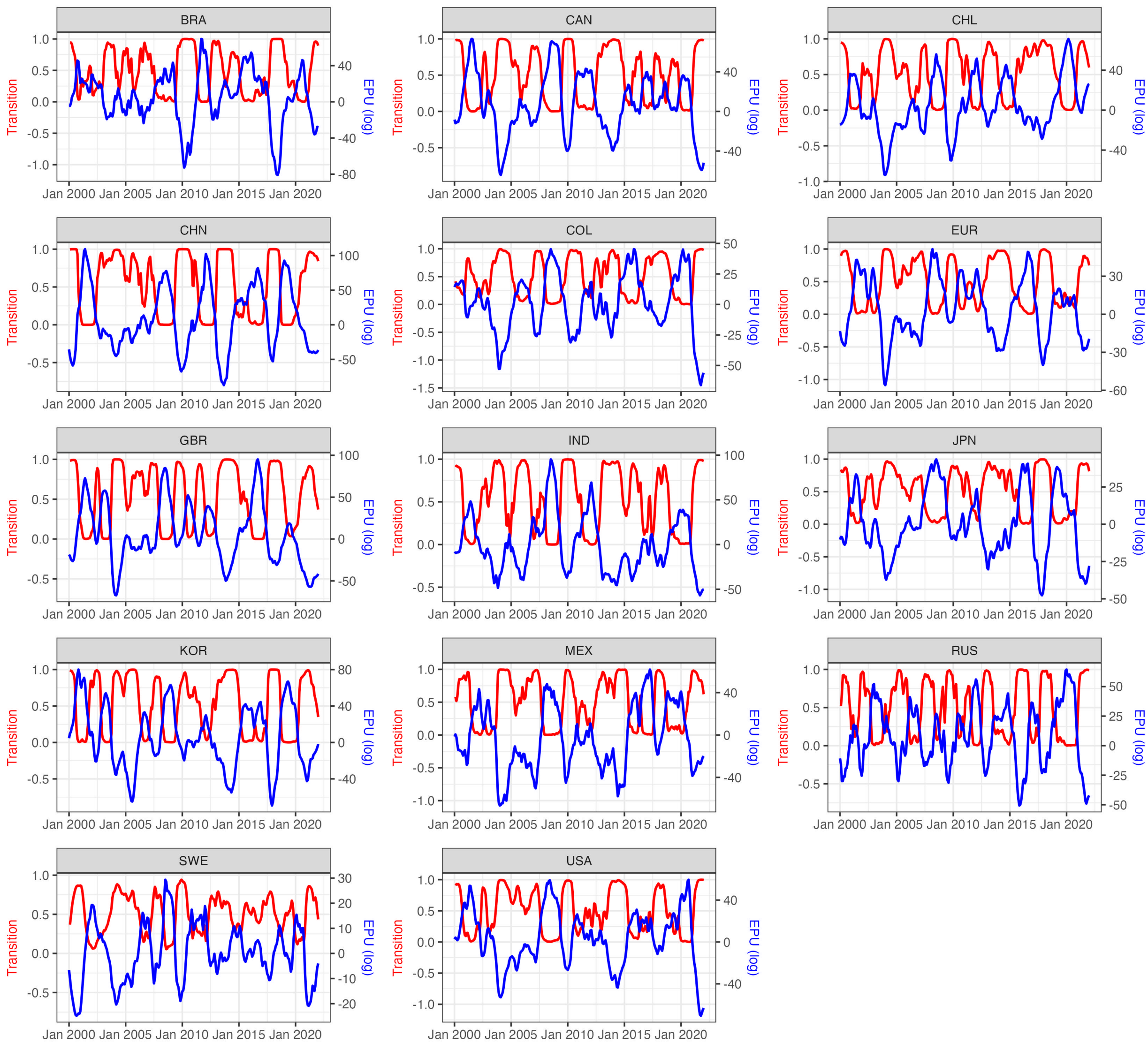
Note: The blue line plots the recession indicator (i.e., a value equal to one indicates a recessionary period). The red line shows the weighted regime (i.e., $F(z)$), where a low value of the transition variable corresponds with a recessionary period. Source: authors' calculations.

Figure A.6: GPR on Interest Rate (Alternative Model IV)



Note: Alternative Model IV is based on Baseline Model where state dependence is based on the 12-month centered moving average of (log) EPU. The shock is a one standard deviation shock to changes in GPR (i.e., $\Delta \ln(1+GPR_{i,t})$).

Figure A.7: Transition Function Based on State Dependence (Alternative Model IV)



The blue line plots the 12-month centered moving average of log of EPU. The red line shows the weighted regime (i.e., F(z)), where a low value of the transition variable corresponds with a non-expansionary period.