Political Stability and Credibility of Currency Board*

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Abstract: Do currency boards offer protection against self-fulling speculative attacks? This paper examines the credibility of currency boards of Argentina, Bulgaria, Estonia, Hong Kong, Latvia, and Lithuania. We employ a Bayesian Markov regime-switching model to analyze the role of economic fundamentals and self-fulfilling expectations in accounting for the credibility of the currency board. We find that the credibility of our sample currency boards is all subject to self-fulfilling runs. We also find that the political stability of adopting economies relates to the credibility of their currency boards and explains a few self-fulfilling runs of their currency boards.

Keywords: Fixed Exchange Rate, Regime Switching, Political Economy

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1 Introduction

Calvo and Reinhart (2002) find that a fixed exchange rate is a popular choice of exchange rate policy for developing economies. According to the IMF's Annual report on Exchange Arrangements and Exchange Restrictions (IMF 2020), 53 economies, mostly developing economies, de facto adopted a fixed exchange regime as of April 30, 2020. Among this group of economies, 11 of them adopted currency board arrangements.[1] The currency board arrangement is mainly characterized by a fixed nominal exchange rate against some anchor currency and the full backing of domestic central bank liabilities by foreign reserves.[2]

The main advantage of a currency board system over a standard pegged exchange rate regime is the gain in the credibility of monetary policy.[3] A series of currency crises in the 1990s—in Europe, Latin America, and East Asia—show that a pegged exchange rate regime is prone to speculative attacks since the possibility of adjustment under a currency peg can create an expectation of adjustment that is self-fulfilling (Obstfeld 1996, Jeanne 1997). Under a currency board arrangement, the domestic monetary base is changed only through buying and selling the anchor currency at a fixed nominal exchange rate, removing discretion over monetary policy, and disciplining the monetary authorities. Moreover, a currency board arrangement is usually codified in a law, which further increases the credibility of the system since any change would involve parliamentary or constitutional changes. Currency board arrangements have often been introduced to reestablish currency credibility following a currency crisis. The enhanced credibility of monetary policy offered by currency boards generally leads to better macroeconomic performances. Ghosh, Gulde, and Wolf (2000), for example, document

[1] Altogether, there are 117 economies that adopted some forms of managed exchange rate regimes.

[2] "For a regime to qualify as a currency board, it must have three defining characteristics. First, the nominal exchange rate must be fixed against some anchor currency. Second, domestic central bank liabilities must be substantially and de jure backed by foreign reserves, and the local currency must be freely convertible (at least for current transactions) into foreign exchange. Third, changing the first two features must require clearing nontrivial legal and political hurdles" (Ghosh, Gulde, and Wolf 2020, p. 689).

[3] The advantages of hard pegs, especially of currency board that is the strongest form of de jure fixed exchange rate, have been discussed extensively. See, for example, Williamson (1995) and Wolf et al. (2008).

that economies that adopted currency boards experienced lower inflation compared to those with floating regimes or simple pegs. Rivera-Batiz and Sy (2013) find that currency boards had lower currency market spreads, lower inflation, and greater short-term interest rate stability than comparable pegged or floating rate regimes.

Obviously, the credibility of monetary policy for a currency board lies in the credibility of the currency board itself, which is, still, imperfect. A currency board can be abandoned if the costs of maintaining it—for example, in case of an economic crisis or political upheaval—exceed its benefits, as evidenced by the end of the Argentina currency board in 2001. Therefore, the credibility of the currency board depends on the public's perception of policymakers' commitment to the regime - and on the economic and political costs of exiting the arrangement during times of stress (Ghosh, Gulde, and Wolf 2020).

Do currency boards offer protection against self-fulling speculative attacks? This paper examines the credibility of currency boards in Argentina, Bulgaria, Estonia, Hong Kong, Latvia, and Lithuania for which long data series is available for empirical analysis. Krugman (1979) and Obstfeld (1996) argue that economic fundamentals and market expectations are the key determinants in maintaining a fixed exchange rate regime, respectively. Jeanne and Masson (2000) propose a Markov switching model to test the role of self-fulfilling behaviors in determining the devaluation probability of a fixed exchange rate regime. Following this strand of literature, for a currency board, we use the interest rate differential between the adopting economy and the anchoring economy as a proxy for the expected rate of depreciation, which is usually used to proxy the credibility of the currency board. More specifically, we employ a Markov switching model to analyze the role of economic fundamentals and self-fulfilling expectations in accounting for the variation in the credibility of the currency board. Our results show that, in addition to economic fundamentals, self-fulfilling expectations are important drivers of the credibility of the currency board.

After documenting the important role of economic fundamentals and self-fulfilling expectations in driving the credibility of currency boards, we proceed to investigate the relationship between the credibility of the currency board and the political stability of the adopting economy. A high degree of political instability often results in policy uncertainty and even discontinuity, for example, due to frequent cabinet changes and government crises. This weakens the market's confidence in the ability of the government to govern. (Aisen and Veiga 2006). We hypothesize that there is a positive relationship between the credibility of the currency board and the political stability of adopting economies and find some evidence to support it. Further, we find that the political stability explains few self-fulfilling runs of their currency boards.

Our paper contributes to the literature on the credibility of currency board arrangements. Mulino (2002) and Irwin (2004) explore theoretically how a currency board can become vulnerable to speculative attacks and currency crises. Feuerstein and Grimm (2006) and Rivera-Batiz and Sy (2013) compare the credibility of currency boards and standard currency pegs. Empirical work has mainly focused on individual currency boards. Boinet, Napolitano, and Spagnolo (2005) and Alvarez-Plata and Schrooten (2006), for example, employ Markov regime-switching models to examine the role of self-fulfilling behaviors in the currency board of Argentina. In a study that is close to our paper, Begović, Adnett, and Pugh (2016) discuss the role of institutional factors in driving the credibility of the currency board. Using expectations about the local currency's stability as an indicator of credibility, they show that the currency board arrangements in Bosnia and Herzegovina and Bulgaria have contributed to the credibility of the monetary authorities. The positive role of currency board arrangement is more prominent when there is low trust in government. Blagov and Funke (2016, 2019) investigate the credibility of Hong Kong's currency board using a two-regime Markov-switching vector autoregressive (VAR) model and a Markow regime-switching DSGE model, respectively. The former work finds economic policy uncertainty in China affects the regime switching, while the latter work reports that the impacts of risk premium on macroeconomic variables depend on the credibility of the currency board.

We extend this literature in two aspects. First, although there are studies discussing the credibility of the currency board from a cross-economies perspective (Ho 2003, Ghosh 2020), there is no study examining this issue empirically. We provide the first attempt to examine the credibility of the currency board for six economies adopting currency boards. Our cross-economy study has two advantages over the existing economy-specific studies. We are able to find that some economic factors, such as trade balance, inflation rate, and real GDP growth rate, consistently drive the credibility of currency boards across economies. We are also able to find that financial crises at global or regional levels damage the credibility of currency boards by driving self-fulfilling behaviors. Second, we show that the credibility of currency boards decreases with the political stability of adopting economies. Although existing works have shown that the credibility of the currency board is driven by self-fulfilling behaviors, there are few works exploring the institutional factors that drive the credibility of currency boards. Our work contributes to the literature by showing that political stability is a determinant of the credibility of currency boards.

Our paper also adds to the literature on the economic implications of political (in)stability. First, Acemoglu et al. (2003) report that institution quality plays an important role in explaining economic volatility and crises across countries. Specifically, recent research shows that political instability relates to a higher inflation rate and volatility (Aisen and Veiga 2006, 2008a), a greater reliance on seigniorage (Aisen and Veiga 2008b), a higher probability of currency crisis (Leblang and Satyanath 2008) and a lower FDI inflow (Bekaert et al. 2014). We extend the literature by showing that political stability affects the credibility of an exchange rate arrangement. Our work provides further evidence to support the positive roles of the institution on economic performance.

The remainder of the paper proceeds as follows. Section 2 describes the empirical methodology and the data. Section 3 presents the empirical results. Section 4 concludes.

2 Empirical Methodology and Data

2.1 Empirical Methodology

To investigate the credibility of a currency board, the variable of interest should be, in principle, the devaluation probability of the currency of the adopting economy. However, since we do not observe the devaluation probability, we proxy it with the expected rate of depreciation, which is measured by the interest rate differential between the adopting economy and the anchoring economy (Jeanne 1997, Jeanne and Masson 2000).[4] More specifically, $\pi = i_{Adopting} - i_{Anchoring}$, where π denotes the expected rate of depreciation, and $i_{Adopting}$ and $i_{Anchoring}$ denote the interest rate of the adopting economy and the anchoring economy, respectively. A positive (negative) value of the interest rate differential indicates depreciation (appreciation) pressure as suggested by the uncovered interest rate parity condition.[5] For ease of exposition, we use the term expected rate of depreciation throughout the rest of the paper.

Following Jeanne and Masson (2000) and subsequent studies on the credibility of currency boards (Boinet, Napolitano, and Spagnolo 2005, Alvarez-Plata and Schrooten 2006), we employ the Markov-switching regression model to detect switches between periods with low and high probabilities of devaluation.[6] Let π_t denote the expected rate of depreciation at time *t*. Our empirical model can be written as

$$\pi_t = \alpha_{s_t} s_t + \boldsymbol{x}_{t-1}\boldsymbol{\beta}_{s_t} + \sigma_{s_t}\varepsilon_t, \qquad (1)$$

$$\alpha_{s_t} = \alpha_0 + \alpha_1 s_t, \boldsymbol{\beta}_{s_t} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 s_t, \sigma_{s_t} = \sigma_0 + \sigma_1 s_t$$

where ε_t is an identically and independently distributed standard normal error. Model (1) decomposes

[4] Boinet, Napolitano, and Spagnolo (2005) and Alvarez-Plata and Schrooten (2006), Blagov (2018), and Blagov and Funke (2016, 2019) take this approach in their studies on currency boards of Argentina, Estonia, and Hong Kong, respectively. The interest rate differential has also been used as a proxy for the credibility of the European Monetary System or comparable exchange rate regimes (Weber, Baldwin, and Obstfeld 1991, Drazen and Masson 1994, Gomez-Puig and Montalvo 1997, Cipollini, Mouratidis, and Spagnolo 2008).

[5] We examine whether the interest rate differential is a good measure of the expected rate of depreciation in Appendix B.

[6] The Markov-switching regression model has also been used to examine the credibility of the European Monetary System (Gomez-Puig and Montalvo 1997, Dahlquist and Gray 2000, Cipollini, Mouratidis, and Spagnolo 2008).

the determinants of the expected rate of depreciation into two parts: economic fundamentals and self-fulfilling behaviors.[7] The vector of variables $\boldsymbol{x}_{t-1}$ is used to measure the economic fundamentals of the adopting economy at time $t-1$, which are expected to drive the expected rate of depreciation at time t. We defer the discussion on the measurement of interest rates and economic fundamentals to the next subsection, where we discuss the data.

The expected rate of depreciation also depends on the unobserved realization of a stochastic process (s), which captures the shift in self-fulfilling market expectations. Let s_t denotes the realization at time t, which takes value zero (for the regime with low devaluation expectations) or one (for the regime with high devaluation expectations).[8] The economy is in one of the two possible regimes at each point in time. We assume that the unobserved variable s_t is governed by a first-order 2-state Markov chain with the transition probability matrix given by

$$\boldsymbol{P} = \begin{bmatrix} \mathrm{P}(s_t = 0 | s_{t-1} = 0) & \mathrm{P}(s_t = 0 | s_{t-1} = 1) \\ \mathrm{P}(s_t = 1 | s_{t-1} = 0) & \mathrm{P}(s_t = 1 | s_{t-1} = 1) \end{bmatrix} = \begin{bmatrix} p_{00} & 1 - p_{11} \\ 1 - p_{00} & p_{11} \end{bmatrix}, \tag{2}$$

where p_{00} and p_{11} are constants. This implies that the unconditional probabilities of being in regime 0 and regime 1 at any time are also constant and given by $\mathrm{P}(s_t = 0) = (1 - p_{11})/(2 - p_{00} - p_{11})$ and $\mathrm{P}(s_t = 1) = (1 - p_{00})/(2 - p_{00} - p_{11})$, respectively.

The Markov-switching regression model specified by (1) and (2) is a generalization of the model used in Jeanne and Masson (2000). We consider restricted versions of this general model in the model comparison exercise. Model (1) reduces to the model used by Jeanne and Masson (2000) when $(\boldsymbol{\beta}'_1, \sigma_1) = \mathbf{0}$, and reduces to a linear model without self-fulfilling behaviors (i.e., the purely fundamentals-based model) when $(\alpha_1, \boldsymbol{\beta}'_1, \sigma_1) = \mathbf{0}$.

There are two major approaches to estimating Markov-switching regression models, i.e., the

[7] Theoretically, the second-generation models on currency crisis argue that expectations of a devaluation can be self-fulfilling and that a devaluation can occur even if fundamentals are sound (Obstfeld 1996, Jeanne 1997).
[8] The two-regime Markov switching framework is used in previous studies on the credibility of currency boards; see Boinet, Napolitano, and Spagnolo (2005), Alvarez-Plata and Schrooten (2006), and Blagov and Funke (2016, 2019). For ease of exposition and without loss of generality, we assume $\alpha_1 > 0$.

likelihood maximization method and the Bayesian method. The likelihood maximization method is usually carried out with the Expectation-Maximization (EM) algorithm (Hamilton 1990), which is numerically more robust than typical numerical search methods. The Bayesian estimation method is usually implemented with the Gibbs sampler, which uses draws from conditional distributions to approximate joint and marginal distributions. The likelihood maximization estimation is computationally efficient, while the Bayesian method is typically used to overcome over-parameterization concerns. Given the small number of observations available for most of our sample currency boards, we employ the Bayesian method with the multi-move Gibbs sampler to estimate the Markov-switching regression models for our analysis. Another motivation to use the Bayesian method is that it allows us to compare models using the marginal likelihood.[9]

Testing linearity against the alternative of a Markov regime switching is challenging due to the presence of nuisance parameters (p_{00} and p_{11}) that are not identified under the null hypothesis of no regime switching and the singularity of the information matrix at the null. Standard likelihood ratio (LR) statistics under the null hypothesis do not have the usual limiting chi-squared distributions. To address this issue, we use the likelihood-based ratio test (QZ test hereafter) proposed by Qu and Zhuo (2021) to test the fundamental model with no regime switching against the two-regime switching model. The QZ test has two major advantages. First, the QZ test is designed specifically to detect Markov regime switching, having substantially a higher power than alternative general tests for parameter homogeneity against heterogeneity (Cho and Whit 2007, Carrasco, Hu, and Ploberger 2014). Second, the QZ test allows multiple parameters to be regime dependent.

2.2 Data

The quarterly data on Argentina, Bulgaria, Estonia, Hong Kong, Latvia, and Lithuania are

[9] See Online Appendix A for details on Bayesian estimations and model comparisons.

obtained from various sources. Our analysis covers those six economies adopting currency boards because they have sufficiently long data series available for empirical analysis.

Table 1 reports the anchoring currency and the time of operation of our sample currency boards. Argentina and Hong Kong established their currency boards using the U.S. dollar as anchoring currency in 1991 and 1983, respectively. Argentina abolished its currency board in 2001 during its economic crisis. On June 20, 1992, Estonia became the first country from the former Soviet Union to abandon the Russian ruble and introduce its national currency, establishing a currency board that pegged the Estonia kroon to the Germany deutsche mark (DM). Influenced by Estonia's success, Lithuania introduced a currency board on April 1, 1994, pegging the Lithuania litas to the U.S. dollar (De Haan, Berger, and Van Fraassen 2001). In response to the severe banking and currency crises in late-1996 and early-1997, Bulgaria introduced the currency board pegging the Bulgaria leva to the DM on July 1, 1997 (Nenovsky and Hristov 2002). Bulgaria, Estonia, and Lithuania established their latest currency boards using the Euro as the anchoring currency in 1999, 1999, and 2002, respectively. Estonia and Lithuania abandoned their currency boards to adopt Euro as their currency in 2010 and 2014, respectively. Latvia entered a peg to the Euro in 2005 and joined the Eurozone in 2014. While Latvia did not establish a formal currency board arrangement, it in practice followed currency board rules including full foreign reserve coverage. Therefore, the exchange rate regime in Latvia was regarded as a de facto or quasi currency board (Ghosh, Gulde, and Wolf 2020).

[Insert Table 1 about here]

Following Calvo and Reinhart (2002), we use the money market interest rate to measure the interest rate. We use the 3-month money market interest rate for Argentina, Bulgaria, Estonia, Latvia, and Lithuania, and the 3-month Hong Kong Interbank Offer Rate (HIBOR) for Hong Kong. For the interest rate of the anchoring economy, we use the 3-Month London Interbank Offered Rate (LIBOR) based on U.S. dollar for Argentina and Hong Kong, and the 3-month money market interest rate of Euro Area for Bulgaria, Estonia, Latvia, and Lithuania.

We include among the economic fundamentals of the adopting economy ($\boldsymbol{x}_{t-1}$) the real GDP growth rate (*Real GDP Growth*), the CPI inflation rate (*Inflation*), the trade balance to GDP ratio (*Trade*, positive for surplus), and the fiscal balance to GDP ratio (*Fiscal*, positive for surplus). It is expected that, other things being equal, higher values of *Real GDP Growth*, *Trade*, and *Fiscal* should compress the interest rate differential while higher values of *Inflation* should widen the interest rate differential.[10]

The sample periods of our analysis for Argentina, Bulgaria, Estonia, Hong Kong, Latvia, and Lithuania are 1991Q2-2001Q4, 1999Q1-2018Q2, 1996Q1-2010Q4, 1983Q4-2021Q1, 2005Q1-2013Q4, and 1999Q1-2014Q4, respectively. The starting period of each economy is the quarter its currency board was established or the earliest quarter of data availability. The ending period of each economy is the quarter their latest currency boards were abolished or the latest quarter of data availability.[11]

Table 2 reports the mean and standard deviation of variables used in our empirical analysis. The average interest rate differential is positive for all economies except Hong Kong. The interest rate differential was positive at most times over the sample period for Argentina, Bulgaria, Estonia, Latvia, and Lithuania, suggesting that markets persistently anticipated a depreciation of the domestic currency for those economies. The question is whether the depreciation expectation was due to deterioration in economic fundamentals, self-fulfilling market speculation, or both, which we try to answer in the next section.

[10] Jeanne and Masson (2000) do not include fiscal variables in the set of economic fundamentals in their study on self-fulfilling speculation of the French franc in the 1979-1986 period. They argue that fiscal variables were not likely to be important factors in explaining the expected rate of depreciation of the French franc, given that France had a negligible amount of seigniorage and a low level of public debt. Nonetheless, their argument may not be applicable to emerging markets, where the levels of inflation and public debt are usually high.

[11] Owing to the data limitation, our samples do not cover the earlier periods of some currency boards (see Table 1), when the credibility is often in doubt. Consequently, our analysis may underestimate the extent of the incredibility of those currency boards. See Appendix A for details on data sources.

[Insert Table 2 about here]

3 Empirical Results

3.1 Linear Model

We first consider model (1) with $(\alpha_1, \boldsymbol{\beta}_1', \sigma_1) = \mathbf{0}$—the linear model—for each economy to examine whether economic fundamentals ($\boldsymbol{x}_{t-1}$) alone can account for the evolution of the expected rate of depreciation. Table 3 reports the ordinary least squares (OLS) estimation results for linear models along with the results of Cumby-Huizinga tests for autocorrelation in residuals (Cumby and Huizinga 1992).[12] For all economies except Argentina, the coefficients of *Real GDP Growth* and *Trade* are significantly negative, suggesting that a rise in economic growth rate and an increase in trade surplus reduce the expected rate of depreciation. For each economy, the heteroskedasticity-robust Cumby-Huizinga test for autocorrelation rejects the null hypothesis that the residual is serially uncorrelated at the 10% significance level, which suggests the presence of serial correlation in the residual and hence a lack of fit of the linear model.

Figure 1 plots the actual expected rate of depreciation and the expected rate of depreciation predicted by the linear model, which again shows that the linear model does not have a good fit for any economy. Overall, the predicted values (dash lines) follow the actual values (solid lines) in general but fail to capture some sharp hikes in the expected rate of depreciation. There are substantial divergences in the predicted and actual expected rate of depreciation for Argentina at the beginning of its currency board over 1991-1992 and close to the end of its currency board in 2001, for Bulgaria and Latvia during the Global Financial Crisis around 2009, for Estonia and Lithuania following the Russian

[12] Extending earlier tests for autocorrelation like the Q test (Box-Pierce-Ljung-Box test) and Breusch-Godfrey test, the Cumby-Huizinga test is robust to the presence of conditional heteroskedasticity in the error term (Baum and Schaffer 2013).

financial crisis around 1999, and for Hong Kong at the beginning of its currency board over 1983-1984 and during the Asian Financial Crisis around 1998.

[Insert Table 3 and Figure 1 about here]

In summary, for all our sample currency boards, the linear model (i.e., purely fundamentals-based model) fits well the movements in the expected rate of depreciation at most times but fails to capture some sharp hikes. This suggests that the economic fundamentals are important drivers of the expected rate of depreciation but cannot fully account for all sudden jumps in the expected rate of depreciation.

3.2 Markov Switching Model

We now consider model (1) with $(\alpha_1, \boldsymbol{\beta}'_1, \sigma_1) \neq \mathbf{0}$—the two-regime Markov-switching regression model—for each economy to examine the role of self-fulfilling behaviors in accounting for the evolution of the expected rate of depreciation.

We consider three versions of the general model specified by (1): (i) the model in which only the constant is regime dependent, i.e., $(\boldsymbol{\beta}'_1, \sigma_1) = \mathbf{0}$,[13] (ii) the model in which the constant and all coefficients are regime dependent, i.e., $\sigma_1 = 0$, (iii) the model in which the constant, all coefficients, and the variance are regime dependent. We select the model based on the Bayesian log marginal likelihood. For Argentina, Bulgaria, Estonia, and Latvia, the best model is the one in which only the constant is regime-switching. The most general model is the best for Hong Kong and Lithuania. Table 4 reports the results from estimating the best model for each sample economy.

Overall, the Markov-switching model fits the data better than the linear model, as evidenced by Table 4 and Figure 2. First, for all economies, the QZ test rejects the null hypothesis of no state

[13] This is the model used in Jeanne and Masson (2000) and Boinet, Napolitano, and Spagnolo (2005).

switching at the 1% significance level. Second, for all economies, the difference in the constant between two regimes (α_1) is statistically significantly positive. Third, the heteroskedasticity-robust Cumby-Huizinga test for autocorrelation fails to reject the null hypothesis that the residual is serially uncorrelated at the 5% significance level for Latvia, and at the 10% significance level for Estonia, Hong Kong, Latvia, and Lithuania. Forth, Figure 2 depicts that the predicted values (dash lines) of the expected rate of depreciation from the Markov-switching models not only fit their actual values (solid lines) well during the normal times, but also capture most of the sharp movements in the actual values.

[Insert Table 4 and Figure 2 about here]

The impact of the economic fundamentals on the expected rate of depreciation differs substantially across economies. For Argentina, Bulgaria, Estonia, and Latvia, the significant coefficients on *Real GDP Growth* and *Trade* are consistently negative, and the significant coefficients on *Inflation* are consistently positive. A rise in economic growth rate and improvements in trade balances reduce the expected rate of depreciation, while an increase in inflation rate raises the expected rate of deprecation. *Fiscal balance* is not playing a significant role in driving the expected rate of depreciation for any of those four currency boards.

For Hong Kong and Lithuania, the impact of economic fundamentals on the expected rate of depreciation is regime dependent. In the regime with low devaluation expectations, a higher economic growth rate and improvements in fiscal and trade balances reduce the expected rate of depreciation, while a higher inflation rate leads to a rise in the expected rate of depreciation. *Real GDP growth* and *Fiscal balance* are important determinants of the expected rate of depreciation for both economies. The impact of economic fundamentals on the expected rate of depreciation is generally larger in magnitude in the regime with high devaluation expectations than that in the regime with low devaluation expectations. For example, while a 1% increase in trade balances has a negligible impact for the regime with low devaluation expectations, it raises the expected rate of depreciation for Hong Kong and Lithuania by 18 and 51 basis points for the regime of high devaluation expectations, respectively. Notably, a decrease in fiscal balances (i.e., an increase in fiscal spending) reduces the expected rate of depreciation for Lithuania in the regime with high devaluation expectations. This reflects the two opposite effects of fiscal spending on the expected rate of expectation. On one hand, higher fiscal spending raises concern for debt sustainability, which weakens the credibility of the currency board. On the other hand, higher fiscal spending helps to stimulate the economy during bad times, which enhances the credibility of the currency board. Our results suggest that the latter effect dominates the former one in this case.[14]

Notably, the difference in the constant between two regimes (α_1) is statistically significantly positive for all of our sample currency boards. For the same level of economic fundamentals, a jump in the devaluation expectations leads to a rise in the expected rate of depreciation. Since the market expectations are important in determining the expected rate of depreciation of our sample currency boards, it suggests those currency boards suffer self-fulfilling runs in some episodes.

Figure 2 also displays the filtered probabilities that each economy was in the regime with high devaluation expectations during the sample period. Overall, the filtered probabilities match largely the deviation between predicted and actual expected rate of depreciation in Figure 1 quite well. Panel A of Figure 1 shows that the filtered probability of being in the regime of high devaluation expectations for Argentina was very high in 2001, when the currency board collapsed (Boinet, Napolitano, and Spagnolo 2005, Alvarez-Plata and Schrooten 2006). In addition, Argentina also experienced a temporary and small rise in the probability of being in the regime of high devaluation expectations following the Mexico crisis of late 1994.

Panel B of Figure 2 plots that the filtered probability of being in the regime of high devaluation

[14] This is consistent with what Christine Lagarde, the former managing director of the International Monetary Fund, said in August 2011 that “markets dislike low growth even more than high debt.”

expectations for Bulgaria experienced a surge in 1999, the year Bulgaria shifted the anchoring currency from the German DM to the Euro, and over the period 2008-2012 during and after the Global Financial Crisis. Notably, the filtered probability of being in the regime of high devaluation expectations dropped sharply after 1999. This finding is consistent with the survey finding from Carlson and Valev (2001), in which they report that surveyed respondents are optimistic about the role of the currency board in bringing down inflation.

In the case of Estonia and Lithuania (Panel C and F of Figure 2), the filtered probability of being in the regime of high devaluation expectations shared a similar experience following the Russian Financial Crisis around 1999. Russia remained a key trading partner of all three Baltic economies (Estonia, Latvia, and Lithuania) after their declaration of independence. Following the Russian Financial Crisis, the Baltic economies experienced a steep decline in exports and economic growth. Estonia experienced a banking crisis in the period 1998-1999. However, Panel C and F of Figure 1 suggest that the deterioration in economic fundamentals did not fully account for the jump in the expected rate of depreciation over this period. Our results from Markov-switching regression models show that the self-fulfilling devaluation expectation was an important driver for the expected rate of depreciation over this episode.

Around the Global Financial Crisis, the filtered probability of being in the regime of high devaluation expectations for Latvia and Lithuania jumped sharply (Panel E and F of Figure 2). In contrast, Estonia did not experience any substantial rise in the filtered probability of being in the regime of high devaluation expectations, although it saw a moderate surge in the interest rate (Panel C of Figure 2). Panel C of Figure 1 also provides support for this since the linear model fits the movement of the rate of expected depreciation around the Global Financial Crisis very well. The Estonian economy deteriorated sharply in the wake of the financial crisis, suffering a double-digit GDP decline along with a surge in inflation. However, speculative pressures on budgetary consolidation were mostly directed at Latvia, although contagion was felt in Lithuania and, to a lesser extent, in Estonia (Purfield and Rosenberg 2010). Consistent with those developments, our model suggests that the credibility of the currency boards in Estonia around the Global Financial Crisis was not subject to self-fulfilling run and that the expected rate of depreciation was mostly accounted for by deterioration in economic fundamentals.

Panel D of Figure 2 displays the filtered probability of being in the regime of high devaluation expectations for Hong Kong. It experienced surges in many episodes, including the initial period of adopting the currency board over 1983-1984, the period around the Asian Financial Crisis in 1997-1998, and the period around the Global Finance Crisis in 2008. Our results are consistent with those in Blagov and Funke (2016),[15] who employ a two-regime Markov-switching VAR model to describe the time-varying credibility of Hong Kong's currency board system.

In summary, for the six currency boards examined, our Markov switching regression model fits well the movement of the expected rate of depreciation. In addition to economic fundamentals, self-fulfilling behavior is an important driver of the expected rate of deprecation. Our results are generally in line with the empirical facts documented in earlier studies. Appendix C reports several robustness checks of this Markov switching regression model.

3.3 Markov Switching Model with Political Stability

Our analysis above shows that the credibility of our sample currency boards is subject to economic fundamentals and self-fulfilling runs. In this subsection, we investigate the relationship between the credibility of the currency board and the political stability of those adopting economies.

3.3.1 Measure of Political Stability

To measure political stability, we use data from International Country Risk Guide (ICRG). The ICRG data has two major advantages. First, the ICRG rating is based on a set of 22 components

[15] See Figure 5 in Blagov and Funke (2016).

grouped into three categories of risk: political, financial, and economic. Therefore, the ICRG political risk rating is designed to only reflect political risk as the ICRG has separate ratings on economic and financial risk. Second, quarterly data is available from ICRG since it provides ratings for 140 developed, emerging, and frontier markets monthly since 1984.[16]

The ICRG political risk rating comprises 12 components covering both political and social attributes. Each component is assigned a numerical value (an integer), with the highest number of points indicating the lowest potential risk for that component and the lowest number (0) indicating the highest potential risk. Among 12 components of ICRG political risk rating, Government Stability is an assessment both of the government's ability to carry out its declared program(s), and its ability to stay in office.[17]

We employ the ICRG Governmental Stability index as our measure of political stability.[18] This monthly index is an integer between 0 to 12, where a higher score implies a more stable government. We calculate the quarterly average using the monthly data. Following Bekaert et al. (2014) and Filippou, Gozluklu, and Taylor (2018), we examine the government stability of a currency board relative to that of the U.S. More precisely, let

$$PS = 100 \times \left(\frac{\text{ICRG Government Stability of an adopting economy}}{\text{ICRG Government Stability of the U.S.}} - 1\right).$$

PS is the percentage difference of ICRG Government Stability of an adopting economy relative to that of the U.S. The normalization with the index value of the U.S. aims to control the aggregate fluctuations of the index. Appendix C reports that our results are robust to the use of an alternative normalization.

The data on ICRG Governmental Stability index for Estonia and Hong Kong start from 1998Q4

[16] There are several commonly used data sources for political stability, including Cross National Time Series Data Archive (Aisen and Veiga, 2006; 2008), World Bank's Database of Political Institutions (Leblang and Satyanath, 2008), and International Country Risk Guide (ICRG) (Bekaert et al. 2014). However, the former two data sets only provide annual data. Our analysis employs quarterly data afforded by ICRG.

[17] For more details on ICRG data, see https://www.prsgroup.com/explore-our-products/international-country-risk-guide/.

[18] Examples of recent works using the ICRG Governmental Stability index as a measure of political stability include Julio and Yook (2012) on corporate investment, Bekaert et al. (2014) on FDI, Lehkonen and Heimonen (2015) on stock return, and Filippou, Gozluklu, and Taylor (2018) on the foreign exchange market.

and 1984Q1, respectively. Since our analysis employs PS lagged for one quarter, the sample periods of our analysis for Argentina, Bulgaria, Estonia, Hong Kong, Latvia, and Lithuania are 1991Q2-2001Q4, 1999Q1-2018Q2, 1999Q1-2010Q4, 1984Q2-2021Q1, 2005Q1-2013Q4, and 1999Q1-2014Q4, respectively. Figure 3 plots the PS along with the expected rate of depreciation for our sample economies. We find negative correlations between PS and the expected rate of depreciation for Argentina, Bulgaria, Hong Kong, and Lithuania at -0.304 (0.048), -0.162 (0.156), -0.150 (0.068), and -0.056 (0.661) respectively, where the p-values are in the parentheses. Nonetheless, the correlations are positive but insignificant at 0.038 (0.797) and 0.018 (0.917) for Estonia and Latvia, respectively. These observations point to the potential positive relationship between the credibility of currency boards and the political stability of adopting economies.

[Insert Figure 3 about here]

3.3.2 Political Stability and Currency Board Credibility

To analyze how the variation of relative political stability (PS) over time affects the credibility of currency boards, we extend model (1) as follows:

$$\pi_t = \alpha_{s_t} s_t + \boldsymbol{x}_{t-1}\boldsymbol{\beta}_{s_t} + \varphi_{s_t} PS_{t-1} + \sigma_{s_t}\varepsilon_t, \tag{3}$$

$$\alpha_{s_t} = \alpha_0 + \alpha_1 s_t, \boldsymbol{\beta}_{s_t} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1 s_t, \varphi_{s_t} = \varphi_0 + \varphi_1 s_t, \sigma_{s_t} = \sigma_0 + \sigma_1 s_t$$

We consider three versions of the general model specified by (3): (i) the model in which only the constant is regime dependent, i.e., $(\boldsymbol{\beta}'_1, \varphi_1, \sigma_1) = \boldsymbol{0}$,[19] (ii) the model in which the constant and all coefficients are regime dependent, i.e., $\sigma_1 = 0$, (iii) the model in which the constant, all coefficients, and the variance are regime dependent.

The estimation results are reported in Table 5, which are in line with the benchmark results

[19] This is the model used in Jeanne and Masson (2000) and Boinet, Napolitano, and Spagnolo (2005).

reported in Table 4 in many aspects.[20] The best model for Hong Kong and Bulgaria is the model in which all model parameters are regime dependent, while the best model for other economies is the model in which only the constant is regime dependent. For all economies, the QZ test rejects the null hypothesis of no state switching at the 1% significance level and the difference in the constant between two regimes (α_1) is statistically significantly positive.

The coefficients of *PS* are significantly negative for Bulgaria, Hong Kong, and Lithuania, while there is no substantial change in other coefficients compared to those in Table 4. More specifically, the standard deviation of relative political stability for Bulgaria, Hong Kong, and Lithuania over the sample period is 19.24, 27.88, and 15.20, respectively. A one standard deviation decrease in the relative political stability raises the expected rate of depreciation of Bulgaria, Hong Kong, and Lithuania by 0.58, 0.28, and 0.15 percentage points (or by 0.49, 0.28, and 0.05 of its standard deviation), respectively. Notably, the political stability does not have a significant impact on the expected rate of depreciation in the regime with high devaluation expectations.

[Insert Table 5 and Figure 4 about here]

For Bulgaria, the negative correlation between *PS* and the expected rate of depreciation is consistent with several drops in *PS* over the sample period. The first drop in *PS* started in 2002, which was followed by several bumps in the expected rate of depreciation in the later few years (Panel B of Figure 3). Panel B of Figure 4 shows that the filtered probability of being in the regime with high devaluation expectations for Bulgaria over 2002-2005 was lower than that for the Markov-switching model without political stability (Panel B of Figure 2). It suggests that political stability rather than self-fulfilling behaviors drove the expected rate of depreciation over that time period. Further, Bulgaria

[20] In this subsection, we estimate models with trimmed samples for Estonia and Hong Kong because of the data limitation of political stability. To ensure the results of this subsection are not driven by alternative samples, we re-estimate model (1)-(2) with trimmed samples for Estonia and Hong Kong and find that the estimates are qualitatively similar to those in Table 4. See Appendix D for more details.

and Lithuania experienced episodes of increase in the expected rate of depreciation between 2008-09 and a decline in political stability.

For Hong Kong, the negative correlation between *PS* and the expected rate of depreciation is consistent with several large swings in *PS*. First, the *PS* deteriorated sharply in early 1989, which was followed by several bumps in the expected rate of depreciation in the early 1990s (Panel D of Figure 3). Panel D of Figure 4 shows that the filtered probability of being in the regime with high devaluation expectations for Hong Kong over 1989-1993 was lower than that for the Markov-switching model without political stability (Panel D of Figure 2). It suggests that political stability rather than self-fulfilling behaviors drove the expected rate of depreciation over that time period. Second, Panel D of Figure 3 depicts that the *PS* trended up from 2006Q2 to 2008Q1 and dropped sharply from 2008Q1 to 2009Q3. The expected rate of depreciation started to move up in 2007Q4 until it stabilized in 2011.

3.3.3 Political Stability and Self-fulfilling Behaviors

The previous section finds that political stability acts as an independent institutional factor to affect the credibility of currency boards of our sample economies. Given the existing works have shown that the credibility of currency boards is driven by self-fulfilling behaviors (Boinet, Napolitano, and Spagnolo 2005, Alvarez-Plata and Schrooten 2006), we also explore whether political stability drives the self-fulfilling behaviors. Our benchmark model assumes that the transition probabilities are time-invariant. To examine whether political stability drives the self-fulfilling behaviors of currency boards, we postulate the transition probability as a function of lagged *PS* as follows:

$$\mathrm{P}[s_t = 1 | s_{t-1}] = p_{00,t} = \mathrm{P}(s_t^* < 0) \tag{4}$$

$$s_t^* = \gamma_0 + \lambda PS_{t-1} + \gamma s_{t-1} + u_t, \qquad u_t \sim \mathrm{N}(0,1)$$

where s_t^* is an unobserved latent variable. Given the normality of u_t, the transition probabilities can be calculated as follows:

$$\mathrm{P}[s_t = 0 | s_{t-1} = 0] = p_{00,t} = \mathrm{P}(\gamma_0 + \lambda PS_{t-1} + \gamma s_{t-1} + u_t \geq 0 | s_{t-1} = 0)$$

$$= 1 - P(u_t < -\gamma_0 - \lambda PS_{t-1}) = 1 - \Phi(-\gamma_0 - \lambda PS_{t-1})$$

$$\mathrm{P}[s_t = 1 | s_{t-1} = 1] = p_{11,t} = \mathrm{P}(\gamma_0 + \lambda PS_{t-1} + \gamma_1 s_{t-1} + u_t < 0 | s_{t-1} = 1)$$

$$= P(u_t < -\gamma_0 - \lambda PS_{t-1} - \gamma_1) = \Phi(-\gamma_0 - \lambda PS_{t-1} - \gamma_1)$$

where $\Phi(\cdot)$ denote the cumulative distribution function of the standard normal distribution. A positive λ indicates that a decrease in *PS* leads to a higher probability of switching from the regime with low devaluation expectations to the regime with high devaluation expectations and a higher probability of staying in the regime with high devaluation expectations.

We estimate the model specified by (1) and (4) and report the results in Table 6. The estimate of λ is significantly positive for Bulgaria, which suggests that a less politically stable environment there leads to a higher probability of being in the regime with high devaluation expectations. However, such a result cannot be found in other sample economies. It suggests that political stability does not usually affect the credibility of currency boards through self-fulling behaviors but as an institutional factor.

[Insert Table 6 about here]

4 Conclusion

The main advantage of a currency board system over a standard pegged exchange rate regime is the gain in the credibility of monetary policy. Do currency boards offer protection against self-fulling speculative attacks? This paper examines empirically the credibility of currency boards in Argentina, Bulgaria, Estonia, Hong Kong, Latvia, and Lithuania using a Markov switching model to test the role of self-fulfilling behavior in determining the devaluation probability of a currency board. Our analysis covers those six economies adopting currency boards because they have sufficiently long data series available for empirical analysis. We find that the credibility of currency boards for this panel of economies is subject to economic fundamentals and self-fulfilling behavior. Importantly, we also find that the credibility of currency boards positively relates to the political stability for some economies.

Our empirical results have policy implications for maintaining a stable currency board regime. Maintaining political stability in the adopting economy is conducive to the credibility of its currency board. Essentially, this is because higher political stability ensures policy coherence and thus improves the predictability and credibility of the government. From a broader perspective, our results add to the debate about the role of institutions in economic performance. The causes of an uncredible currency board are not only poor economic policy but also deeper institutional problems.

Because our research is based on six economies, the question remains whether our results can be generalized to other economies adopting currency boards, such as Bosnia and Herzegovina and Eastern Caribbean Currency Union. On one hand, our sample economies, such as Estonia and Latvia, have economic and geographical characteristics not too different from other adopting economies, such as Bosnia and Herzegovina. On the other hand, generalizing our results to other economies must consider the differences in economic fundamentals and political stability between those economies and our sample economies. For example, it is challenging to generalize our results to Eastern Caribbean Currency Union, which is a much smaller economy than our sample economies. Future research may explore data from the other economies adopting currency boards and examine their credibility.

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Table 1 Anchoring Currency and Time of Operation of Currency Boards

Adopting economy	Anchoring Currency	Exchange Rate	Time of Operation	Sample Period
Argentina	USD	1 Peso/USD	1991Q2-2001Q4	1991Q2-2001Q4
Bulgaria	DM	1 Leva/DM	1997Q3-1998Q4	1999Q1-2018Q2[a]
	Euro	1.96 Leva/Euro	1999Q1-Present	
Estonia	DM	8 Krooni/DM	1992Q2-1998Q4	1996Q1-2010Q4[b]
	Euro	15.6 Krooni/Euro	1999Q1-2010Q4	
HK	USD	7.78 HKD/USD	1983Q4-Present	1983Q4-2021Q1[c]
Latvia	Euro	0.703 Lats/Euro	2005Q1-2013Q4	2005Q1-2013Q4
Lithuania	USD	4 Litas/USD	1994Q2-2001Q4	1999Q1-2014Q4[d]
	Euro	3.45 Litas/Euro	2002Q1-2014Q4	

Note: USD: United States dollar; DM: Germany deutsche mark; HKD: Hong Kong dollar.

[a] While the Bulgaria currency board started in 1997Q3 and is still in operation, the data on the 3-month money market rate are only available over the period 1999Q1-2018Q2. Since July 1, 2018, the Bulgarian National Bank ceased to perform the activities related to the calculation and publishing of SOFIBOR (Sofia Interbank Offered Rate) and SOFIBID (Sofia Interbank Bid Rate) reference rates.[21]

[b] While the Estonia currency board started in 1992Q2, the data on 3-month money market are only available since 1996Q1.

[c] While the Hong Kong currency board is still in operation, our sample for Hong Kong stops at 2021Q1, through which the data on economic fundamentals is available.

[d] While the Lithuania currency board started in 1994Q2, the data on the 3-month money market rate are only available since 1999Q1.

Source: Ghosh, Gulde, and Wolf (2020), Ilzetzki, Reinhart, and Rogoff (2019), IMF (2020). The details on data sources are provided in Appendix A.

[21] https://www.bnb.bg/PressOffice/POPressReleases/POPRDate/PR_20170316_EN

Table 2 Descriptive Statistics

	Argentina	Bulgaria	Estonia	Hong Kong	Latvia	Lithuania
Dependent Variable ($\Delta\pi_t$)						
Expected rate of Depreciation (%)	5.47	1.47	2.28	-0.10	2.56	1.80
	[8.67]	[1.18]	[2.91]	[1.01]	[3.90]	[3.07]
Explanatory Variables (x_{t-1})						
Fiscal (%)	-0.51	-0.09	0.28	0.74	-3.44	-7.44
	[0.38]	[6.25]	[3.68]	[7.80]	[3.40]	[10.87]
Trade (%)	-1.10	-6.67	-5.84	4.97	-9.58	-5.51
	[1.55]	[9.69]	[5.49]	[5.67]	[7.37]	[5.13]
Inflation (%)	25.40	4.20	6.49	3.86	5.54	2.59
	[79.20]	[4.00]	[6.42]	[4.20]	[5.17]	[3.02]
Real GDP Growth (%)	3.91	3.05	4.44	4.06	2.88	4.15
	[8.35]	[4.01]	[7.25]	[4.67]	[8.85]	[6.00]
Sample Period	91:2-01:4	99:1-18:2	96:1-10:4	83:4-21:1	05:1-13:4	99:1-14:4
Observations	43	78	60	150	36	64

Note: We report the mean, which is followed by the standard deviation in the bracket. *Expected rate of depreciation* is measured by the interest rate differential between the adopting economy and the anchoring economy; *Fiscal* is the ratio of fiscal balance to GDP (positive for surplus); *Trade* is the ratio of trade balance to GDP (positive for surplus); *Inflation* is the year-over-year percentage change in CPI; *Real GDP Growth* is the year-over-year percentage change in real GDP.

Table 3 Linear Models

		Argentina	Bulgaria	Estonia	Hong Kong	Latvia	Lithuania
Economic	*Fiscal*	-5.09	-0.02	-0.07	-0.00	-0.07	0.08**
Fundamentals		[3.80]	[0.02]	[0.11]	[0.01]	[0.24]	[0.03]
(x_{t-1})	*Trade*	2.55***	-0.03*	-0.17*	-0.06***	-0.34***	-0.34***
		[0.90]	[0.01]	[0.09]	[0.01]	[0.12]	[0.06]
	Inflation	0.01	0.06	0.08	0.06***	0.09	-0.22**
		[0.02]	[0.04]	[0.06]	[0.02]	[0.12]	[0.10]
	Real GDP Growth	0.20	-0.15***	-0.16**	-0.05***	-0.43***	-0.45***
		[0.16]	[0.03]	[0.07]	[0.02]	[0.10]	[0.06]
	Constant (α)	4.59	1.50***	1.47**	0.17	-0.20	2.98***
		[3.12]	[0.18]	[0.55]	[0.13]	[1.46]	[0.55]
	σ	7.46	1.04	2.68	0.89	2.55	2.21
	Sample Period	91:2-01:4	99:1-18:2	96:1-10:4	83:4-21:4	05:1-13:4	99:1-14:4
	Observations	43	78	60	150	36	64
	R-squared	0.33	0.27	0.21	0.26	0.62	0.51
	Log-likelihood	-144.8	-110.9	-141.6	-192.3	-82.02	-138.9
Cumby-Huizinga	*q=1*	0.07	0.00	0.00	0.00	0.02	0.00
test	*q=2*	0.18	0.00	0.01	0.00	0.05	0.00
	q=3	0.32	0.00	0.02	0.00	0.05	0.01
	q=4	0.47	0.00	0.02	0.01	0.10	0.01

Note: This table reports the OLS estimation results of model (1) with $\alpha_0 = \alpha_1 = \alpha$, i,e, $\pi_t = \alpha + \beta x_{t-1} + \varepsilon_t$. Standard errors are in []. *, **, *** denote significance at the 10%, 5%, and 1% level, respectively. The last panel report the p-values of heteroskedasticity-robust Cumby-Huizinga test for autocorrelation in the residual. For a given value of q, the null hypothesis is that the residuals are serially uncorrelated, and the alternative hypothesis is that serial correlation is present at lags 1 to q.

Table 4 Markov-Switching Models

		Argentina	Bulgaria	Estonia	Hong Kong	Latvia	Lithuania
Economic Fundamentals ($\boldsymbol{\beta}_0$)	*Fiscal*	0.72	-0.00	-0.07	**-0.00**	-0.08	**-0.01**
		[3.25]	[0.01]	[0.05]	**[0.00]**	[0.31]	**[0.01]**
		[-4.48,6.00]	[-0.03,0.02]	[-0.15,0.01]	**[-0.01,0.00]**	[-0.50,0.40]	**[-0.02,-0.00]**
	Trade	0.89	**-0.02**	-0.02	0.00	**-0.20**	**-0.03**
		[0.64]	**[0.01]**	[0.04]	[0.01]	**[0.12]**	**[0.11]**
		[-0.16,1.92]	**[-0.04,-0.00]**	[-0.09,0.04]	[-0.01,0.01]	**[-0.36,0.00]**	**[-0.04,-0.00]**
	Inflation	**0.03**	0.02	**0.07**	**0.03**	0.08	-0.02
		[0.01]	[0.03]	**[0.03]**	**[0.01]**	[0.14]	[0.04]
		[0.01,0.05]	[-0.02,0.07]	**[0.02,0.12]**	**[0.01,0.04]**	[-0.13,0.25]	[-0.05,0.01]
	Real GDP Growth	0.12	-0.06	**-0.13**	**-0.02**	**-0.24**	**-0.04**
		[0.11]	[0.05]	**[0.03]**	**[0.01]**	**[0.13]**	**[0.06]**
		[-0.07,0.29]	[-0.14,0.01]	**[-0.19,-0.08]**	**[-0.04,-0.01]**	**[-0.44,-0.03]**	**[-0.06,-0.01]**
Economic Fundamentals ($\boldsymbol{\beta}_1$)	*Fiscal*				-0.02		**0.17**
					[0.03]		**[0.07]**
					[-0.06,0.02]		**[0.06,0.28]**
	Trade				**-0.18**		**-0.48**
					[0.04]		**[0.25]**
					[-0.24,-0.12]		**[-0.81,-0.17]**
	Inflation				**0.09**		-0.25
					[0.05]		[0.21]
					[0.02,0.16]		[-0.57,0.10]
	Real GDP Growth				-0.04		**-0.46**
					[0.03]		**[0.16]**
					[-0.09,0.01]		**[-0.67,-0.27]**
Constant	α_0	4.26	0.87	1.47	-0.05	-0.98	0.48
		[2.10]	[0.17]	[0.25]	[0.04]	[2.91]	[0.18]
		[0.53,7.51]	[0.60,1.16]	[1.05,1.87]	[-0.11,0.02]	[-6.60,2.46]	[0.32,0.66]
	α_1	**33.89**	**2.05**	**8.03**	**1.03**	**6.82**	**4.03**
		[6.33]	**[0.28]**	**[0.56]**	**[0.38]**	**[1.64]**	**[1.72]**
		[23.28,44.15]	**[1.55,2.47]**	**[7.08,8.90]**	**[0.42,1.64]**	**[4.37,9.59]**	**[1.14,6.84]**
Error Standard Deviation	σ_0	4.51	0.67	1.21	0.21	1.56	0.30
		[0.54]	[0.06]	[0.12]	[0.06]	[0.25]	[0.37]
		[3.66,5.38]	[0.57,0.77]	[1.02,1.40]	[0.15,0.26]	[1.16,1.93]	[0.20,0.31]
	σ_1				0.93		2.46
					[0.16]		[0.86]
					[0.74,1.12]		[1.69,3.45]
Transition Probabilities	p_{00}	0.91	0.92	0.93	0.90	0.88	0.90
		[0.03]	[0.03]	[0.03]	[0.03]	[0.05]	[0.04]
		[0.86,0.97]	[0.88,0.97]	[0.88,0.97]	[0.85,0.95]	[0.80,0.96]	[0.85,0.96]

	p_{11}	0.83	0.85	0.83	0.86	0.82	0.84
		[0.07]	[0.05]	[0.06]	[0.04]	[0.07]	[0.05]
		[0.73,0.94]	[0.77,0.94]	[0.73,0.93]	[0.79,0.93]	[0.72,0.93]	[0.76,0.93]
	Sample Period	91:2-01:4	99:1-18:2	96:1-10:4	83:4-20:3	05:1-13:4	99:1-14:4
	Observations	43	78	60	150	36	64
	Log likelihood	-93.7	-20.3	-51.6	30.8	-44.7	-6.3
	Log Mar likelihood	-123.9	-61.6	-90.4	-44.5	-76.8	-68.6
Cumby-Huizinga Test	q=1	0.04	0.00	0.42	0.30	0.15	0.85
	q=2	0.10	0.00	0.72	0.54	0.25	0.68
	q=3	0.10	0.00	0.80	0.26	0.08	0.46
	q=4	0.08	0.00	0.14	0.40	0.10	0.56
QZ test	SupLR	0.00	0.00	0.00	0.00	0.00	0.00

Note: The table reports the results of estimating the best version of the model specified by (1) and (2) for each economy. For model parameters, we report the posterior mean, and the posterior standard error and 90% high posterior density interval in []. The panel "Cumby-Huizinga test" report the p-values of heteroskedasticity-robust Cumby-Huizinga test for autocorrelation in the residual. For a given value of q, the null hypothesis is that the residuals are serially uncorrelated, and the alternative hypothesis is that serial correlation is present at lags 1 to q. The panel "QZ Test" reports the p-value of the SupLR test with the null hypothesis of $\alpha_1 = 0$ according to Qu and Zhuo (2021); critical values are simulated using 1,000 iterations.

Table 5 Markov-Switching Models with Political Stability

		Argentina	Bulgaria	Estonia	Hong Kong	Latvia	Lithuania
Economic Fundamentals ($\boldsymbol{\beta}_0$)	*Fiscal*	1.18	0.00	**-0.09**	**-0.00**	-0.10	**-0.01**
		[3.62]	[0.01]	**[0.04]**	**[0.00]**	[0.23]	**[0.02]**
		[-4.67,7.04]	[-0.02,0.02]	**[-0.15,-0.03]**	**[-0.01,0.00]**	[-0.36,0.26]	**[-0.01,-0.00]**
	Trade	0.86	**-0.03**	-0.01	**-0.01**	**-0.16**	-0.01
		[0.65]	**[0.01]**	[0.03]	**[0.01]**	**[0.08]**	[0.09]
		[-0.18,1.95]	**[-0.05,-0.01]**	[-0.05,0.04]	**[-0.02,-0.00]**	**[-0.30,-0.04]**	[-0.01,0.01]
	Inflation	**0.03**	-0.02	0.02	**0.01**	0.12	**-0.08**
		[0.01]	[0.02]	[0.06]	**[0.01]**	[0.10]	**[0.03]**
		[0.01,0.05]	[-0.05,0.02]	[-0.08,0.10]	**[0.00,0.03]**	[-0.04,0.28]	**[-0.10,-0.05]**
	Real GDP Growth	0.10	-0.03	**-0.13**	**-0.01**	**-0.20**	**-0.06**
		[0.12]	[0.02]	**[0.02]**	**[0.01]**	**[0.09]**	**[0.06]**
		[-0.10,0.29]	[-0.07,0.01]	**[-0.17,-0.09]**	**[-0.03,0.00]**	**[-0.35,-0.05]**	**[-0.06,-0.03]**
Economic Fundamentals ($\boldsymbol{\beta}_1$)	*Fiscal*				-0.05		**0.14**
					[0.04]		**[0.07]**
					[-0.11,0.02]		**[0.04,0.25]**
	Trade				**-0.24**		**-0.37**
					[0.05]		**[0.21]**
					[-0.31,-0.16]		**[-0.67,-0.11]**
	Inflation				**0.11**		-0.28
					[0.06]		[0.20]
					[0.01,0.21]		[-0.61,0.03]
	Real GDP Growth				-0.02		**-0.46**
					[0.04]		**[0.16]**
					[-0.08,0.04]		**[-0.66,-0.29]**
Political Stability	φ_0	-0.01	**-0.03**	0.01	**-0.01**	-0.03	**-0.01**
		[0.05]	**[0.00]**	[0.01]	**[0.00]**	[0.03]	**[0.01]**
		[-0.09,0.06]	**[-0.03,-0.02]**	[-0.01,0.02]	**[-0.01,-0.00]**	[-0.07,0.03]	**[-0.01,-0.01]**
	φ_1				0.01		-0.01
					[0.01]		[0.06]
					[-0.01,0.03]		[-0.10,0.09]
Constant	α_0	4.50	0.51	1.65	-0.09	-1.04	0.57
		[2.28]	[0.14]	[0.28]	[0.05]	[1.74]	[0.16]
		[0.74,8.22]	[0.28,0.75]	[1.22,2.14]	[-0.17,-0.01]	[-3.03,1.63]	[0.48,0.69]
	α_1	**33.63**	**2.22**	**7.43**	**1.42**	**6.65**	**4.17**
		[6.26]	**[0.20]**	**[0.84]**	**[0.41]**	**[1.16]**	**[1.86]**
		[23.07,43.82]	**[1.91,2.56]**	**[6.10,8.86]**	**[0.71,2.05]**	**[4.87,8.33]**	**[0.90,7.06]**
Error Standard Deviation	σ_0	4.56	0.57	0.79	0.27	1.42	0.20
		[0.56]	[0.05]	[0.09]	[0.05]	[0.23]	[0.41]
		[3.63,5.42]	[0.49,0.65]	[0.65,0.93]	[0.23,0.32]	[1.06,1.76]	[0.11,0.19]

	σ_1				0.84		2.62
					[0.16]		[0.90]
					[0.61,1.08]		[1.96,3.53]
Transition Probabilities	p_{00}	0.91	0.93	0.93	0.93	0.88	0.91
		[0.03]	[0.03]	[0.03]	[0.02]	[0.05]	[0.04]
		[0.86,0.97]	[0.89,0.97]	[0.89,0.98]	[0.90,0.97]	[0.81,0.95]	[0.85,0.97]
	p_{11}	0.83	0.86	0.81	0.85	0.82	0.87
		[0.07]	[0.05]	[0.07]	[0.05]	[0.06]	[0.04]
		[0.73,0.94]	[0.78,0.94]	[0.70,0.92]	[0.77,0.93]	[0.72,0.92]	[0.81,0.95]
	Sample Period	91:2-01:4	99:1-18:2	99:1-10:4	84:2-20:3	05:1-13:4	99:1-14:4
	Observations	43	78	48	148	36	64
	Log likelihood	-94.0	-8.4	-19.1	41.7	-42.3	5.0
	Log Mar likelihood	-130.4	-59.8	-65.8	-48.4	-82.5	-73.0
Cumby-Huizinga Test	q=1	0.06	0.04	0.03	0.10	0.14	0.18
	q=2	0.13	0.11	0.09	0.20	0.33	0.28
	q=3	0.15	0.17	0.18	0.36	0.31	0.21
	q=4	0.08	0.21	0.29	0.39	0.34	0.34
QZ test	SupLR	0.00	0.00	0.00	0.00	0.00	0.00

Note: The table reports the results of estimating the best version of the model specified by (3) and (2) for each economy. For model parameters, we report the posterior mean, and the posterior standard error and 90% high posterior density interval in []. The panel "Cumby-Huizinga test" report the p-values of heteroskedasticity-robust Cumby-Huizinga test for autocorrelation in the residual. For a given value of q, the null hypothesis is that the residuals are serially uncorrelated, and the alternative hypothesis is that serial correlation is present at lags 1 to q.The panel "QZ Test" reports the p-value of the SupLR test with the null hypothesis of $\alpha_1 = 0$ according to Qu and Zhuo (2021); critical values are simulated using 1,000 iterations.

Table 6 Time-Varying Transition Probabilities Markov-Switching Models

		Argentina	Bulgaria	Estonia	Hong Kong	Latvia	Lithuania
Economic	*Fiscal*	-0.06	0.00	-0.05	-0.00	-0.15	**0.07**
Fundamentals		[3.19]	[0.01]	[0.06]	[0.01]	[0.25]	**[0.04]**
($\boldsymbol{\beta}_0$)		[-5.04,5.43]	[-0.02,0.03]	[-0.14,0.04]	[-0.01,0.01]	[-0.54,0.29]	**[0.01,0.13]**
	Trade	1.01	**-0.03**	**-0.08**	**-0.04**	**-0.37**	**-0.30**
		[0.64]	**[0.01]**	**[0.05]**	**[0.01]**	**[0.12]**	**[0.10]**
		[-0.05,2.04]	**[-0.05,-0.01]**	**[-0.16,-0.00]**	**[-0.06,-0.02]**	**[-0.57,-0.17]**	**[-0.45,-0.12]**
	Inflation	**0.03**	0.02	0.05	**0.04**	0.14	-0.17
		[0.01]	[0.03]	[0.07]	**[0.01]**	[0.13]	[0.13]
		[0.01,0.04]	[-0.02,0.07]	[-0.07,0.16]	**[0.02,0.06]**	[-0.07,0.36]	[-0.38,0.05]
	Real GDP Growth	0.14	**-0.08**	**-0.18**	**-0.06**	**-0.40**	**-0.42**
		[0.11]	**[0.03]**	**[0.04]**	**[0.01]**	**[0.10]**	**[0.09]**
		[-0.04,0.32]	**[-0.14,-0.03]**	**[-0.24,-0.12]**	**[-0.08,-0.04]**	**[-0.57,-0.23]**	**[-0.56,-0.26]**
Constant	α_0	4.10	1.06	1.52	0.04	-1.78	2.66
		[2.08]	[0.17]	[0.35]	[0.09]	[1.96]	[0.73]
		[0.75,7.57]	[0.77,1.33]	[0.93,2.09]	[-0.11,0.18]	[-5.29,1.14]	[1.45,3.81]
	α_1	35.91	2.10	24.28	2.95	4.10	18.16
		[6.75]	[0.26]	[18.73]	[0.33]	[9.97]	[18.31]
		[24.1,46.4]	[1.65,2.61]	[0.03,51.0]	[2.42,3.50]	[0.00,5.12]	[0.01,45.2]
Error	σ_0	4.55	0.71	1.33	0.61	2.57	2.09
Standard		[0.56]	[0.07]	[0.15]	[0.04]	[0.34]	[0.34]
Deviation		[3.66,5.42]	[0.61,0.82]	[1.09,1.57]	[0.55,0.67]	[2.02,3.10]	[1.42,2.58]
Transition	γ	0.04	**0.03**	0.11	-0.00	2.68	0.10
Probability		[0.03]	**[0.02]**	[0.44]	[0.01]	[1.72]	[0.32]
Equation		[-0.02,0.08]	**[0.00,0.05]**	[-0.69,0.68]	[-0.02,0.01]	[-0.22,5.04]	[-0.41,0.59]
	Sample Period	91:2-01:4	99:1-18:2	99:1-10:4	84:1-20:3	05:1-13:4	99:1-14:4
	Observations	43	78	48	148	36	64
	Log likelihood	-93.5	-25.2	-37.9	-16.3	-52.3	-81.0
QZ test	SupLR	0.00	0.00	0.00	0.00	0.00	0.00

Note: The table reports the results of estimating the best version of the model specified by (1) and (4) for each economy. For model parameters, we report the posterior mean, and the posterior standard error and 90% high posterior density interval in []. The panel "Cumby-Huizinga test" report the p-values of heteroskedasticity-robust Cumby-Huizinga test for autocorrelation in the residual. For a given value of q, the null hypothesis is that the residuals are serially uncorrelated, and the alternative hypothesis is that serial correlation is present at lags 1 to q.The panel "QZ Test" reports the p-value of the SupLR test with the null hypothesis of $\alpha_1 = 0$ according to Qu and Zhuo (2021); critical values are simulated using 1,000 iterations.

Figure 1 Actual and Predicted Expected Rate of Depreciation: Linear Models

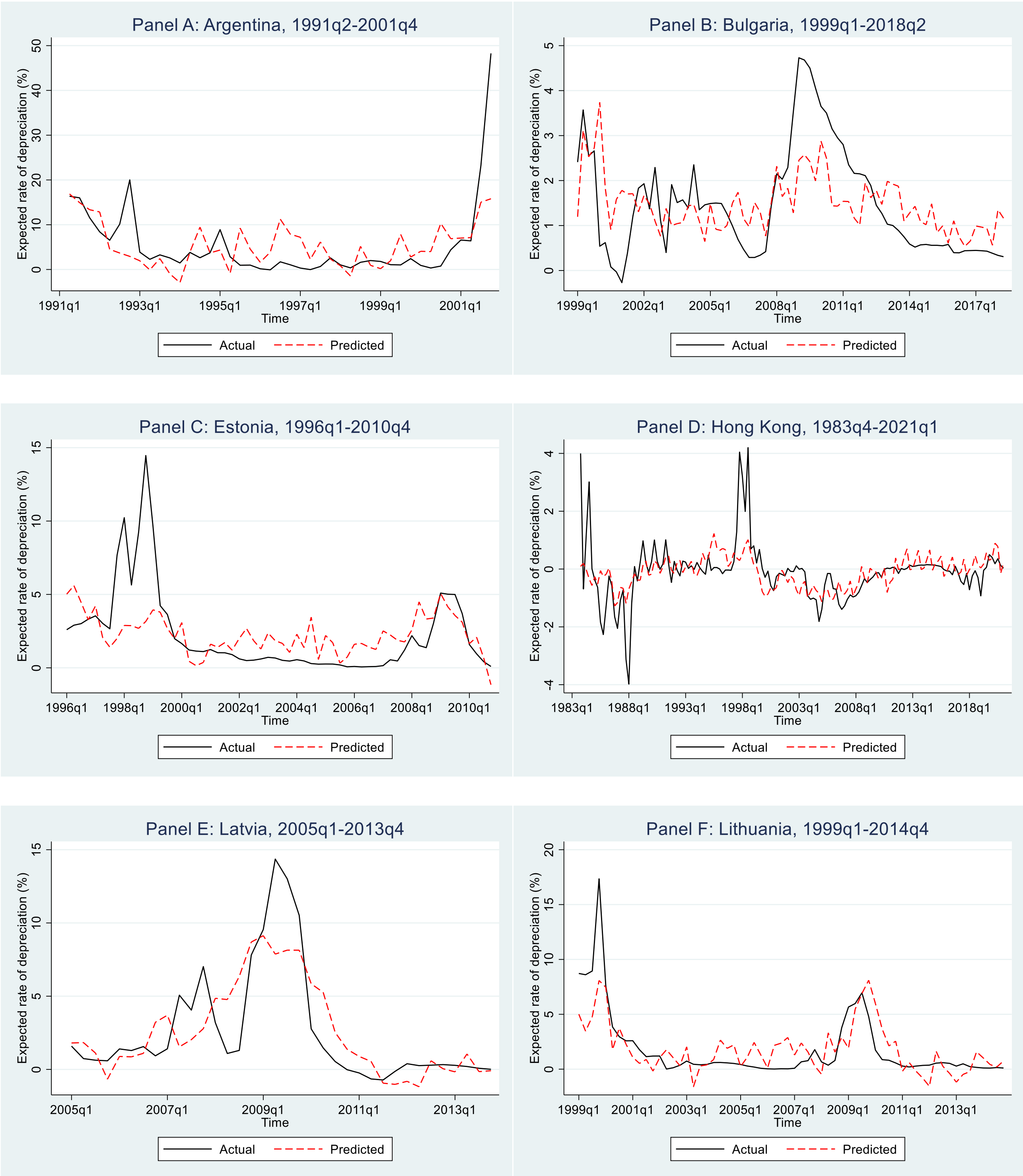


Figure 2 Actual and Predicted Expected Rate of Depreciation, and Filtered Probability of Being in the State of High Expected Rate of Depreciation: Markov-Switching Models

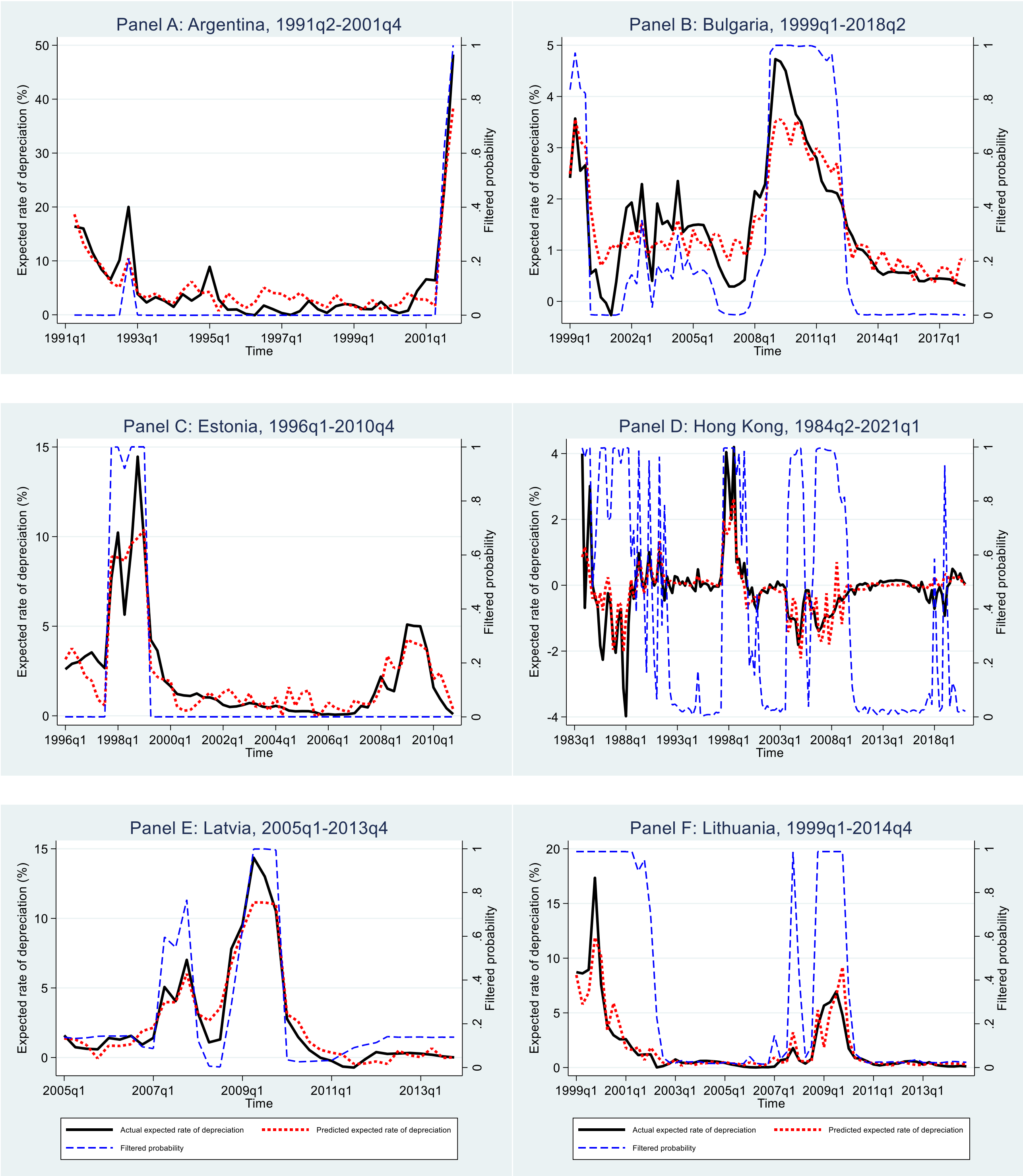
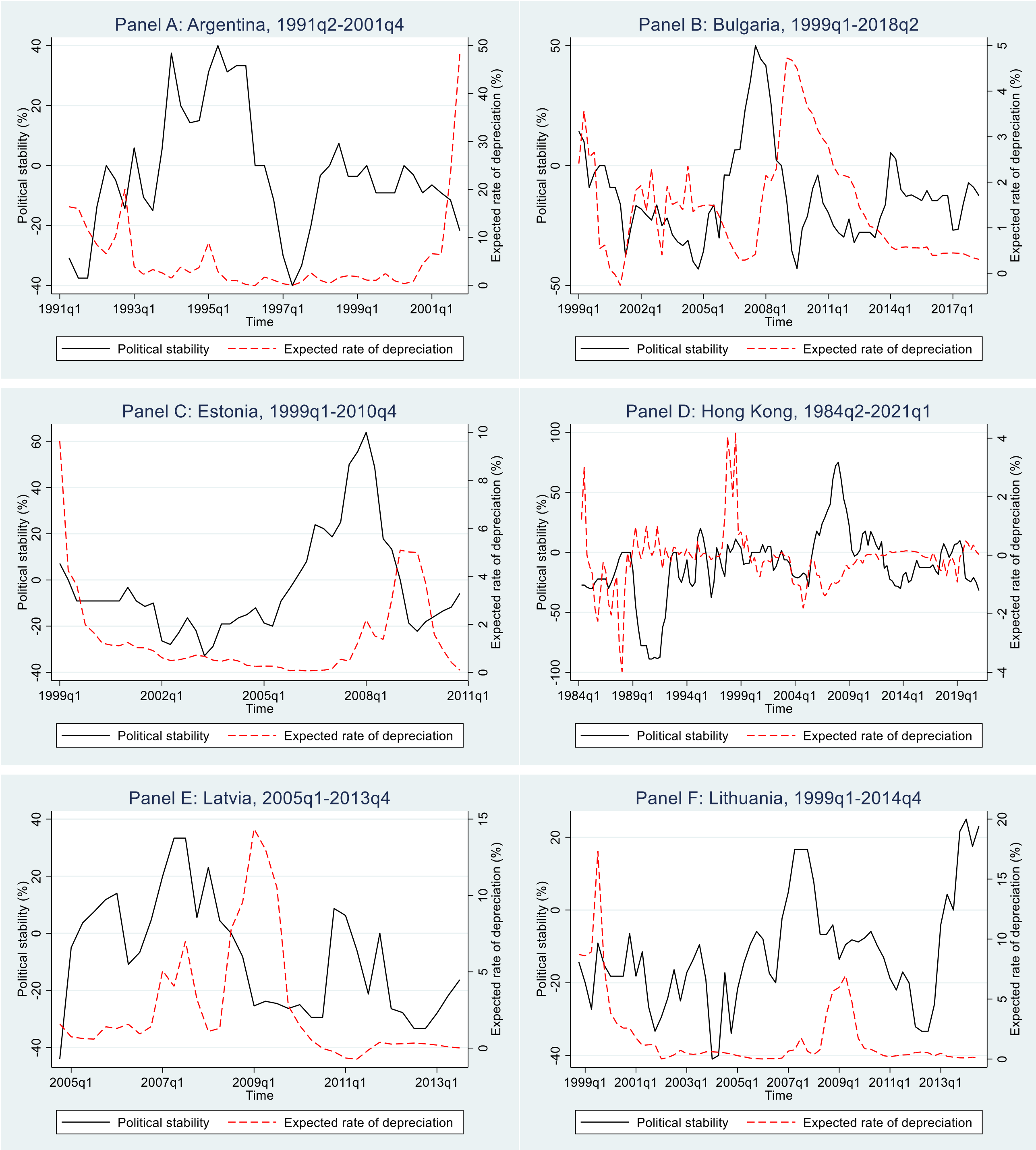
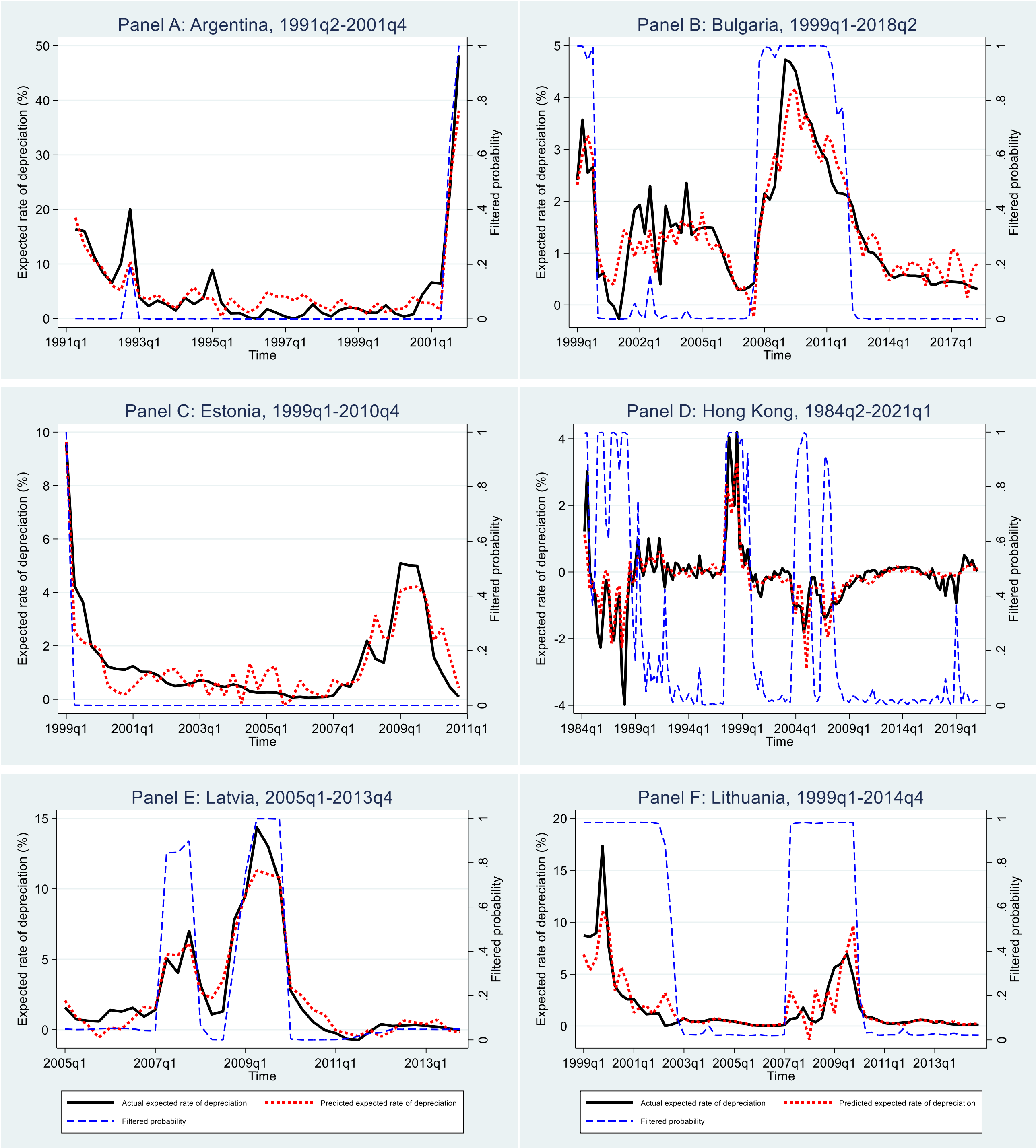


Figure 3 Political Stability



Note: The measure of political stability is calculated as the percentage difference of ICRG Government Stability of an adopting economy relative to that of the U.S. (see the definition of PS in the text). The political stability measure is lagged for one quarter. Due to data availability, the political stability measures for Estonia and Hong Kong start from 1998q4 and 1984q1, respectively.

Figure 4 Actual and Predicted Expected Rate of Depreciation, and Filtered Probability of Being in the State of High Expected Rate of Depreciation: Markov-Switching Models with Political Stability



Appendix A: Data

Macroeconomic Data

We mainly rely on data from International Finance Statistics (IFS) of the International Monetary Fund (IMF). When quarterly data for a variable is not available or is incomplete from IFS, we take quarterly data from other sources, calculate quarterly average using monthly data from other sources (including Bloomberg, DataStream, Penn World Table, Eurostat, Hong Kong Monetary Authority, Bank of International Settlements, and Federal Reserve Bank of St. Louis, FRED), take annual data from IFS, or take annual data from other sources. The sample periods of our analysis for Argentina, Bulgaria, Estonia, Hong Kong, Latvia, and Lithuania are 1991Q2-2001Q4, 1999Q1-2018Q2, 1996Q1-2010Q4, 1983Q4-2021Q1, 2005Q1-2013Q4, and 1999Q1-2014Q4, respectively. The table below provides details on data sources.

Sources of Macroeconomic Data

Interest rate [1]	IMF, IFS, "Financial, Interest Rates, Money Market, Percent per annum"
Exports [2]	IMF, IFS, "National Accounts, Expenditure, Gross Domestic Product, External Balance of Goods and Services, Exports of Goods and Services, Nominal, Domestic Currency"
Imports [3]	IMF, IFS, "National Accounts, Expenditure, Gross Domestic Product, External Balance of Goods and Services, Imports of Goods and Services, Nominal, Domestic Currency"
Nominal GDP [4]	IMF, IFS, "National Accounts, Expenditure, Gross Domestic Product, Nominal, Domestic Currency"
Real GDP growth rate [5]	IMF, IFS, "National Accounts, Expenditure, Gross Domestic Product, Real, Percent Change, Corresponding Period Previous Year, Percent"
Inflation rate [6]	IMF, IFS, "Prices, Consumer Price Index, All items, Percentage change, Corresponding period previous year, Percent"
Fiscal balance [7]	IMF, IFS, "Fiscal, General Government, Net Lending/borrowing [NLB], 2001 Manual, Domestic Currency"

Notes:

[1] Quarterly data for Euro Area are taken from Eurostat, Economy and Finance, "Interest rates (irt); Short-term interest rates (irt_st); Money market interest rates - quarterly data (irt_st_q)". Quarterly data for Estonia, Latvia, and Lithulinia are taken from Eurostat, Economy and Finance, "Interest rates - historical data (irt_h); 3-month rates for euro area countries (irt_h_mr3); 3-month rates for euro area countries - quarterly data (irt_h_mr3_q)". For Bulgaria, quarterly data from Eurostat, Economy and Finance, "Interest rates (irt); Short-term interest rates (irt_st); Money market interest rates - quarterly data (irt_st_q)" are available until 2015Q3. For data since 2015Q4, we calculate quarterly average using monthly data from Eurostat, Economy and Finance, "Interest rates (irt); Short-term interest rates (irt_st); Money market interest rates - monthly data (irt_st_m)".

Quarterly data since 1986 for the U.S. are taken from Federal Reserve Bank of St. Louis, FRED, "3-Month London Interbank Offered Rate (LIBOR), based on U.S. Dollar (USD3MTD156N)". Quarterly data before 1986 for the U.S. are taken from Federal Reserve Bank of St. Louis, FRED, "Effective Federal Funds Rate, Percent, Quarterly, Not Seasonally Adjusted (FEDFUNDS)".

Monthly data on the 3-Month Hong Kong Interbank Offer Rate (HIBOR) are taken from Hong Kong Monetary Authority, Monthly Statistical Bulletin, "Section 6: Exchange rates and interest rates; 6.3 Hong Kong Interbank Interest Rates; 6.3.2 Period average figures". The Hong Kong Association of Banks (HKAB) ceased reporting HIBOR since January 2013. For data after 2013, we use quarterly data on 3-Month Hong Kong Dollar Interest Settlement Rates, which are fixed by the HKAB by reference to market rates for Hong Kong dollar deposits in the Hong Kong interbank market. The quarterly interest rate is calculated as the quarterly average using monthly data.

[2,3,4] Only annual data are available for Argentina from 1991 to 1992.

[5] Annual data for Estonia in 1995Q4 is taken from the Penn World Table (version 10.0).

[6] Monthly data on CPI for Argentina are taken from Bank of International Settlements, Consumer Prices, "BIS long consumer price index (2010=100)." Quarterly CPI is calculated as the quarterly average using monthly data. The inflation rate is calculated as the year-over-year percentage change in quarterly CPI.

[7] Annual data for Argentina over 1991Q2-2001Q4, Estonia over 1996Q1-1998Q4, and Latvia over 2005Q1-2013Q4 are taken from IMF, Government Financial Statistics, Main Aggregates and Balances, "General Government, Net lending (+) / Net borrowing (-)". Quarterly data for Estonia over 1999Q1-2010Q4 are taken from Bloomberg, "Estonia Budget Net Lending or Net Borrowing (EEGGLNBR Index)". Quarterly data for Hong Kong are taken from DataStream, "Hong Kong, Government Balance, Hong Kong Dollar (HKXGBAL.A)."

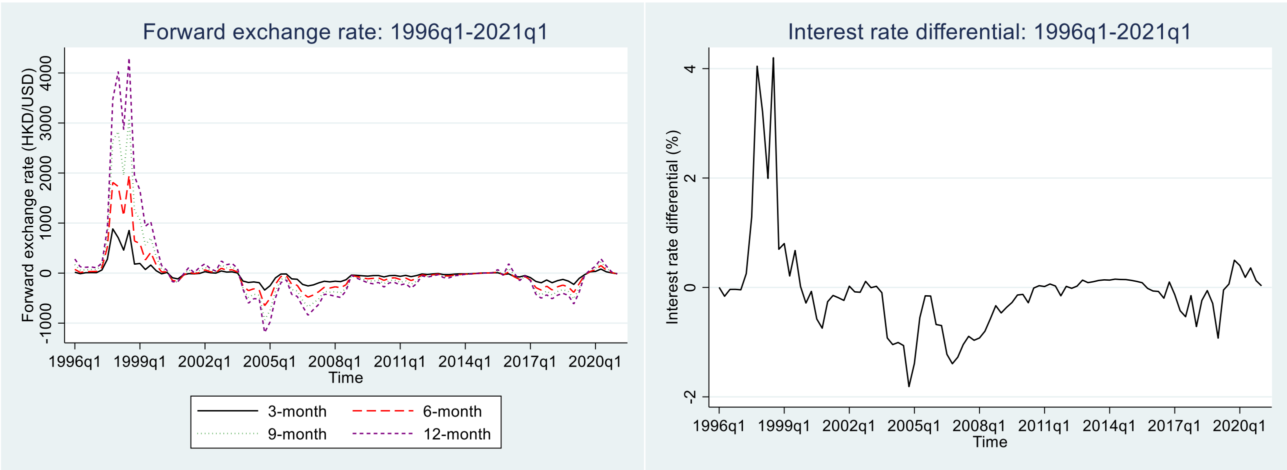
Appendix B: Testing the Uncovered Interest Parity (UIP)

In this appendix, we test the validity of UIP by comparing our measure of the expected rate of depreciation—the interest rate differential between the adopting economy and the anchoring economy—with the forward exchange rate, which is the exchange rate agreed upon now, for a foreign exchange market transaction that will occur at a specified date in the future. Unfortunately, data on the forward exchange rate is only available for Hong Kong since 1996Q1.[22] Therefore, we can only conduct the test for Hong Kong.

The left panel of Figure B1 shows the forward exchange rates for different horizons; the right panel of Figure B1 shows the interest rate differential. Since our interest rate differential is calculated using 3-month money market rates, Figure B2 puts together the 3-month forward exchange rate and the interest rate differential. This shows that the forward exchange rate evolved similarly as the interest rate differential over time, which supports the use of the interest rate differential as the measure for the expected rate of depreciation.

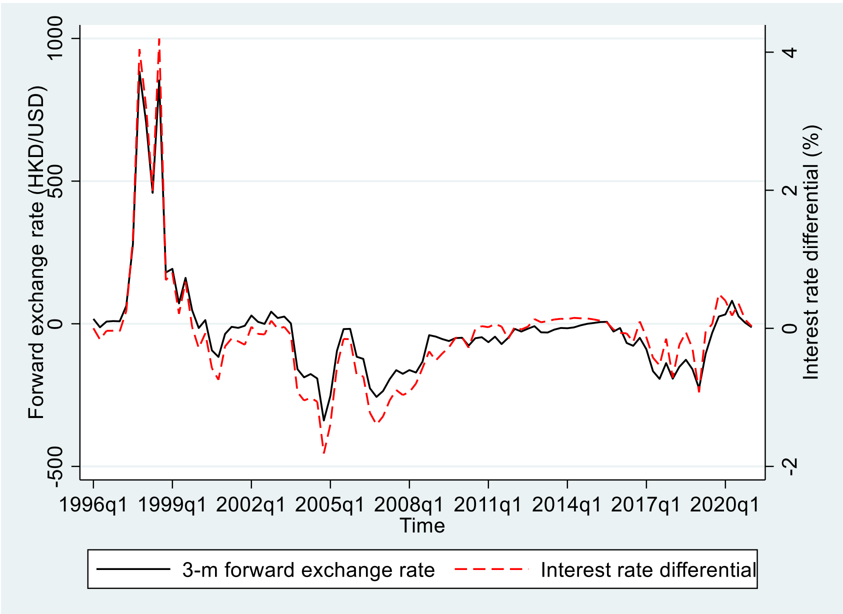
[22] Data for Hong Kong are taken from Hong Kong Monetary Authority, Monthly Statistical Bulletin, "Section 6: Exchange rates and interest rates; 6.2 Hong Kong dollar forward exchange rates; 6.2.2 Period average figures".

Figure B1 Forward Exchange Rate and Interest Rate Differential: Hong Kong



Note: HKD: Hong Kong dollar, USD: U.S. dollar.

Figure B2. 3-Month Forward Exchange Rate and Interest Rate Differential: Hong Kong, 1996q1-2021q1



Note: HKD: Hong Kong dollar, USD: U.S. dollar.

Appendix C: Robustness Checks for Markov-Switching Models

First, we include an indicator for the period 2007Q3-2008Q4 to account for the impact of the global financial crisis (GFC).

Table C1 Markov-Switching Models with GFC Indictor

		Bulgaria	Estonia	Hong Kong	Latvia	Lithuania
Economic Fundamentals ($\boldsymbol{\beta}_0$)	*Fiscal*	-0.01	-0.06	**-0.00**	0.14	**-0.01**
		[0.02]	[0.05]	**[0.00]**	[0.14]	**[0.03]**
		[-0.03,0.02]	[-0.15,0.02]	**[-0.01,0.00]**	[-0.08,0.37]	**[-0.02,-0.00]**
	Trade	**-0.02**	-0.03	-0.00	**-0.13**	**-0.03**
		[0.01]	[0.04]	[0.01]	**[0.06]**	**[0.12]**
		[-0.04,0.00]	[-0.10,0.04]	[-0.01,0.01]	**[-0.23,-0.04]**	**[-0.03,0.00]**
	Inflation	0.01	**0.08**	**0.03**	**0.31**	**-0.04**
		[0.03]	**[0.03]**	**[0.01]**	**[0.10]**	**[0.07]**
		[-0.03,0.06]	**[0.03,0.12]**	**[0.01,0.04]**	**[0.18,0.47]**	**[-0.09,-0.02]**
	Real GDP Growth	**-0.10**	**-0.14**	**-0.02**	**-0.33**	**-0.04**
		[0.06]	**[0.03]**	**[0.01]**	**[0.07]**	**[0.05]**
		[-0.18,-0.01]	**[-0.19,-0.08]**	**[-0.04,-0.01]**	**[-0.45,-0.22]**	**[-0.06,-0.01]**
	Financial Crisis	0.71	-0.40	**-0.65**	**-3.36**	0.49
		[0.67]	[0.56]	**[1.87]**	**[1.13]**	[7.34]
		[-0.23,1.84]	[-1.30,0.51]	**[-0.83,-0.49]**	**[-4.87,-1.94]**	[0.10,1.11]
Economic Fundamentals ($\boldsymbol{\beta}_1$)	*Fiscal*			-0.04		**0.24**
				[0.03]		**[0.09]**
				[-0.09,0.02]		**[0.13,0.36]**
	Trade			**-0.21**		**-0.59**
				[0.04]		**[0.26]**
				[-0.29,-0.15]		**[-0.89,-0.32]**
	Inflation			**0.09**		0.26
				[0.05]		[0.31]
				[0.00,0.17]		[-0.22,0.77]
	Real GDP Growth			-0.03		**-0.40**
				[0.03]		**[0.15]**
				[-0.08,0.03]		**[-0.60,-0.24]**
	Financial Crisis			0.56		**-7.46**
				[31.04]		**[8.31]**
				[-52.13,50.48]		**[-14.83,-0.76]**
Constant	α_0	0.92	1.49	-0.06	0.49	0.56
		[0.16]	[0.25]	[0.04]	[0.75]	[0.14]
		[0.66,1.20]	[1.06,1.90]	[-0.13,0.01]	[-0.82,1.66]	[0.41,0.75]
	α_1	**1.85**	**7.97**	**1.26**	**6.29**	**3.36**

		[0.30]	**[0.57]**	**[0.41]**	**[0.83]**	**[1.47]**
		[1.40,2.35]	**[7.02,8.89]**	**[0.62,1.96]**	**[5.09,7.23]**	**[0.74,5.60]**
Error Standard Deviation	σ_0	0.65	1.22	0.22	1.18	0.28
		[0.06]	[0.12]	[0.05]	[0.18]	[0.35]
		[0.56,0.76]	[1.02,1.41]	[0.17,0.27]	[0.91,1.45]	[0.18,0.29]
	σ_1			0.96		2.12
				[0.15]		[0.79]
				[0.74,1.17]		[1.40,2.99]
Transition Probabilities	p_{00}	0.91	0.93	0.91	0.88	0.90
		[0.04]	[0.03]	[0.03]	[0.04]	[0.04]
		[0.85,0.97]	[0.88,0.97]	[0.86,0.96]	[0.82,0.95]	[0.85,0.96]
	p_{11}	0.86	0.83	0.83	0.81	0.84
		[0.05]	[0.06]	[0.05]	[0.07]	[0.05]
		[0.78,0.94]	[0.74,0.93]	[0.76,0.91]	[0.70,0.91]	[0.76,0.93]
	Sample Period	99:1-18:2	96:1-10:4	83:4-20:3	05:1-13:4	99:1-14:4
	Observations	78	60	150	36	64
	Log likelihood	-20.1	-51.9	37.6	-36.5	-0.7
	Log Mar likelihood	-64.5	-94.2	-43.3	-74.4	-70.2
Cumby-Huizinga Test	*q=1*	0.00	0.44	0.53	0.52	0.95
	q=2	0.02	0.74	0.82	0.11	0.90
	q=3	0.03	0.79	0.42	0.07	0.34
	q=4	0.06	0.14	0.52	0.02	0.49
QZ test	SupLR	0.00	0.00	0.00	0.00	0.00

Note: The table reports the results of estimating the best version of the model specified by (1) and (2) for each economy. For model parameters, we report the posterior mean, and the posterior standard error and 90% high posterior density interval in []. The panel "Cumby-Huizinga test" report the p-values of heteroskedasticity-robust Cumby-Huizinga test for autocorrelation in the residual. For a given value of q, the null hypothesis is that the residuals are serially uncorrelated, and the alternative hypothesis is that serial correlation is present at lags 1 to q. The panel "QZ Test" reports the p-value of the SupLR test with the null hypothesis of $\alpha_1 = 0$ according to Qu and Zhuo (2021); critical values are simulated using 1,000 iterations.

Second, we include the lagged dependent variable as an explanatory variable.

Table C2 Markov-Switching Models with Lagged π_t

		Argentina	Bulgaria	Estonia	Hong Kong	Latvia	Lithuania
Economic Fundamentals ($\boldsymbol{\beta}_0$)	*Fiscal*	-2.97	-0.01	-0.04	0.00	-0.08	0.03
		[2.47]	[0.01]	[0.03]	[0.02]	[0.13]	[0.07]
		[-7.00,1.10]	[-0.02,0.01]	[-0.09,0.01]	[-0.01,0.01]	[-0.28,0.14]	[-0.02,0.14]
	Trade	0.45	0.00	-0.01	-0.02	-0.06	-0.11
		[0.53]	[0.01]	[0.03]	[0.04]	[0.07]	[0.27]
		[-0.40,1.37]	[-0.01,0.01]	[-0.05,0.03]	[-0.02,0.00]	[-0.17,0.06]	[-0.63,0.04]
	Inflation	-0.01	-0.02	0.05	0.03	0.07	0.05
		[0.04]	[0.02]	[0.02]	[0.06]	[0.14]	[0.19]
		[-0.09,0.04]	[-0.06,0.01]	[0.02,0.08]	[0.00,0.03]	[-0.11,0.36]	[-0.08,0.39]
	Real GDP Growth	0.14	0.03	-0.05	-0.02	0.02	-0.06
		[0.08]	[0.02]	[0.02]	[0.02]	[0.11]	[0.17]
		[0.01,0.26]	[-0.00,0.06]	[-0.09,-0.02]	[-0.04,-0.00]	[-0.16,0.19]	[-0.37,0.08]
Economic Fundamentals ($\boldsymbol{\beta}_1$)	*Fiscal*				-0.00		0.11
					[0.05]		[0.16]
					[-0.08,0.08]		[-0.18,0.32]
	Trade				-0.18		-0.05
					[0.11]		[0.49]
					[-0.34,-0.08]		[-0.85,0.76]
	Inflation				0.02		-0.10
					[0.12]		[0.38]
					[-0.16,0.21]		[-0.67,0.53]
	Real GDP Growth				0.01		-0.22
					[0.05]		[0.39]
					[-0.07,0.09]		[-0.79,0.47]
(π_{t-1})		**0.86**	**0.90**	**0.56**	**0.56**	**0.48**	**0.80**
		[0.39]	**[0.06]**	**[0.04]**	**[0.12]**	**[0.14]**	**[0.30]**
		[0.44,1.72]	**[0.80,1.00]**	**[0.49,0.62]**	**[0.42,0.73]**	**[0.26,0.72]**	**[0.40,1.32]**
					-0.27		-0.36
					[0.23]		[0.52]
					[-0.62,0.07]		[-1.21,0.48]
Constant	α_0	-4.89	-0.09	0.39	-0.04	-1.59	-0.60
		[10.01]	[1.10]	[0.17]	[0.16]	[2.29]	[1.61]
		[-26.14,4.22]	[-0.25,0.14]	[0.10,0.66]	[-0.11,0.07]	[-6.52,0.92]	[-2.42,0.40]
	α_1	**21.08**	**1.24**	**6.28**	**1.01**	**6.87**	**3.69**
		[4.75]	**[1.95]**	**[0.42]**	**[0.62]**	**[1.73]**	**[3.19]**
		[13.61,28.79]	**[0.87,1.48]**	**[5.60,6.99]**	**[0.00,1.78]**	**[4.76,8.91]**	**[0.01,7.40]**
Error	σ_0	3.41	0.37	0.72	0.34	1.25	0.91

Standard Deviation		[0.47]	[0.06]	[0.07]	[0.27]	[0.20]	[1.30]
		[2.66,4.16]	[0.29,0.46]	[0.61,0.83]	[0.19,0.34]	[0.92,1.56]	[0.13,3.03]
	σ_1				0.77		1.59
					[0.53]		[2.69]
					[0.55,1.36]		[-3.38,4.43]
Transition Probabilities	p_{00}	0.89	0.89	0.92	0.93	0.87	0.87
		[0.06]	[0.04]	[0.03]	[0.04]	[0.06]	[0.06]
		[0.81,0.97]	[0.83,0.95]	[0.87,0.96]	[0.88,0.98]	[0.79,0.96]	[0.77,0.96]
	p_{11}	0.84	0.75	0.79	0.85	0.83	0.83
		[0.07]	[0.07]	[0.07]	[0.06]	[0.07]	[0.07]
		[0.72,0.95]	[0.63,0.87]	[0.69,0.91]	[0.75,0.95]	[0.72,0.93]	[0.72,0.94]
	Sample Period	91:3-01:4	99:2-18:2	96:2-10:4	84:1-20:3	05:2-13:4	99:2-14:4
	Observations	42	77	60	149	35	63
	Log likelihood	-81.7	14.8	-24.0	51.2	-35.6	7.85
	Log Mar likelihood	-116.6	-34.5	-76.6	-13.3	-74.9	-115.3
Cumby-Huizinga Test	*q=1*	0.44	0.27	0.38	0.74	0.98	0.84
	q=2	0.06	0.32	0.24	0.50	0.59	0.93
	q=3	0.09	0.42	0.37	0.68	0.70	0.15
	q=4	0.16	0.51	0.01	0.70	0.75	0.18
QZ test	SupLR	0.00	0.00	0.00	0.00	0.00	0.00

Note: The table reports the results of estimating the best version of the model specified by (1) and (2) for each economy. For model parameters, we report the posterior mean, and the posterior standard error and 90% high posterior density interval in []. The panel "Cumby-Huizinga test" report the p-values of heteroskedasticity-robust Cumby-Huizinga test for autocorrelation in the residual. For a given value of q, the null hypothesis is that the residuals are serially uncorrelated, and the alternative hypothesis is that serial correlation is present at lags 1 to q. The panel "QZ Test" reports the p-value of the SupLR test with the null hypothesis of $\alpha_1 = 0$ according to Qu and Zhuo (2021); critical values are simulated using 1,000 iterations.

Third, we employ another denominator for computing PS. More precisely, let

$$PS = 100 \times \left(\frac{\text{ICRG Government Stability of an adopting economy}}{\text{ICRG Government Stability of the anchoring economy}} - 1\right).$$

Anchoring economy is the U.S. for Argentina and Hong Kong, while that is Germany for Bulgaria, Estonia, Latvia, and Lithuania.

Table C3 Markov-Switching Models with Alternative PS

		Argentina	Bulgaria	Estonia	Hong Kong	Latvia	Lithuania
Economic Fundamentals ($\boldsymbol{\beta}_0$)	*Fiscal*	1.18	**-0.00**	**-0.08**	**-0.00**	-0.11	**-0.01**
		[3.62]	**[0.01]**	**[0.03]**	**[0.00]**	[0.33]	**[0.03]**
		[-4.67,7.04]	**[-0.02,0.02]**	**[-0.14,-0.02]**	**[-0.01,0.00]**	[-0.58,0.42]	**[-0.02,-0.00]**
	Trade	0.86	-0.01	-0.01	**-0.01**	-0.18	**-0.08**
		[0.65]	[0.01]	[0.03]	**[0.01]**	[0.15]	**[0.23]**
		[-0.18,1.95]	[-0.03,0.01]	[-0.06,0.04]	**[-0.02,-0.00]**	[-0.41,0.01]	**[-0.04,0.00]**
	Inflation	**0.03**	0.02	0.04	**0.01**	0.07	-0.06
		[0.01]	[0.02]	[0.04]	**[0.01]**	[0.14]	[0.16]
		[0.01,0.05]	[-0.01,0.07]	[-0.03,0.11]	**[0.00,0.03]**	[-0.12,0.26]	[-0.07,0.02]
	Real GDP Growth	0.10	**-0.12**	**-0.13**	**-0.01**	-0.21	**-0.08**
		[0.12]	**[0.04]**	**[0.02]**	**[0.01]**	[0.17]	**[0.17]**
		[-0.10,0.29]	**[-0.18,-0.04]**	**[-0.17,-0.09]**	**[-0.03,0.00]**	[-0.47,0.08]	**[-0.07,0.00]**
Economic Fundamentals ($\boldsymbol{\beta}_1$)	*Fiscal*				-0.05		**0.16**
					[0.04]		**[0.10]**
					[-0.11,0.02]		**[0.03,0.30]**
	Trade				**-0.24**		**-0.46**
					[0.05]		**[0.42]**
					[-0.31,-0.16]		**[-0.99,-0.14]**
	Inflation				**0.11**		-0.35
					[0.06]		[0.37]
					[0.01,0.21]		[-0.97,0.16]
	Real GDP Growth				-0.02		**-0.48**
					[0.04]		**[0.34]**
					[-0.08,0.04]		**[-0.92,-0.23]**
Political Stability	φ_0	-0.01	**-0.02**	-0.01	**-0.01**	-0.00	-0.01
		[0.05]	**[0.01]**	[0.01]	**[0.00]**	[0.02]	[0.05]
		[-0.09,0.06]	**[-0.02,-0.01]**	[-0.02,0.01]	**[-0.01,-0.00]**	[-0.03,0.03]	[-0.01,0.01]
	φ_1				0.01		-0.05
					[0.01]		[0.10]
					[-0.01,0.03]		[-0.22,0.10]

Constant	α_0	4.50	0.68	1.53	-0.09	-0.98	0.57
		[2.28]	[0.15]	[0.22]	[0.05]	[2.93]	[0.16]
		[0.74,8.22]	[0.43,0.93]	[1.19,1.89]	[-0.17,-0.01]	[-5.41,2.91]	[0.48,0.69]
	α_1	**33.63**	**1.84**	**7.49**	**1.42**	**7.17**	**3.28**
		[6.26]	**[0.21]**	**[0.84]**	**[0.41]**	**[1.87]**	**[1.90]**
		[23.07,43.82]	**[1.47,2.14]**	**[6.14,8.92]**	**[0.71,2.05]**	**[4.61,10.30]**	**[0.01,5.79]**
Error Standard Deviation	σ_0	4.56	0.60	0.79	0.27	1.58	0.45
		[0.56]	[0.06]	[0.09]	[0.05]	[0.25]	[0.74]
		[3.63,5.42]	[0.51,0.70]	[0.65,0.93]	[0.23,0.32]	[1.17,1.97]	[0.19,0.34]
	σ_1				0.84		2.21
					[0.16]		[1.48]
					[0.61,1.08]		[1.51,3.84]
Transition Probabilities	p_{00}	0.91	0.89	0.93	0.93	0.88	0.90
		[0.03]	[0.04]	[0.03]	[0.02]	[0.05]	[0.04]
		[0.86,0.97]	[0.83,0.96]	[0.89,0.98]	[0.90,0.97]	[0.80,0.96]	[0.85,0.96]
	p_{11}	0.83	0.87	0.81	0.85	0.82	0.84
		[0.07]	[0.04]	[0.07]	[0.05]	[0.06]	[0.05]
		[0.73,0.94]	[0.80,0.94]	[0.70,0.92]	[0.77,0.93]	[0.72,0.92]	[0.76,0.93]
	Sample Period	91:2-01:4	99:1-18:2	99:1-10:4	84:2-20:3	05:1-13:4	99:1-14:4
	Observations	43	78	48	148	36	64
	Log likelihood	-94.0	-16.4	-19.1	41.7	-45.0	-7.2
	Log Mar likelihood	-130.4	-66.0	-65.6	-48.4	-84.0	-51.0
Cumby-Huizinga Test	*q=1*	0.06	0.02	0.03	0.10	0.16	0.85
	q=2	0.13	0.01	0.09	0.20	0.29	0.61
	q=3	0.15	0.01	0.17	0.36	0.11	0.40
	q=4	0.08	0.02	0.28	0.39	0.34	0.53
QZ test	SupLR	0.00	0.00	0.00	0.00	0.00	0.00

Note: The table reports the results of estimating the best version of the model specified by (3) and (2) for each economy. For model parameters, we report the posterior mean, and the posterior standard error and 90% high posterior density interval in []. The panel "Cumby-Huizinga test" report the p-values of heteroskedasticity-robust Cumby-Huizinga test for autocorrelation in the residual. For a given value of q, the null hypothesis is that the residuals are serially uncorrelated, and the alternative hypothesis is that serial correlation is present at lags 1 to q.The panel "QZ Test" reports the p-value of the SupLR test with the null hypothesis of $\alpha_1 = 0$ according to Qu and Zhuo (2021); critical values are simulated using 1,000 iterations.

Appendix D: Estimating Model (1)-(2) for Estonia and Hong Kong for Trimmed Samples

The data on ICRG Governmental Stability index for Estonia and Hong Kong start from 1998q4 and 1984q1, respectively. As a result, when estimating model (3)-(2), we trim the samples for Estonia and Hong Kong from 1996Q1-2010Q4 and 1983Q4-2021Q1 to 1999Q1-2010Q4 and 1984Q2-2021Q1, respectively.

To compare the results from estimating model (1)-(2) and (3)-(2), we re-estimate model (1)-(2) for Estonia and Hong Kong with trimmed samples and report the results in Table D1. There are some results worth mentioning. First, the results are qualitatively similar to those in Table 4, which reports the results from estimating (1)-(2) over 1996Q1-2010Q4 and 1983Q4-2021Q1 for Estonia and Hong Kong, respectively. Second, the estimated values of α_1 for both Estonia and Hong Kong are lower than those in Table 4. After dropping the first two quarters right after adopting the currency board, the restricted sample for Hong Kong does not contain the initial jump of the expected rate of depreciation (Panel D of Figure 1). The restricted sample for Estonia does not include the 1998-1999 episode around the Russian Financial Crisis, during which Estonia experienced a substantial rise in the expected rate of depreciation.

Table D1 Markov-Switching Models: Restricted Sample

		Estonia	Hong Kong
Economic Fundamentals ($\boldsymbol{\beta}_0$)	*Fiscal*	**-0.08**	**-0.00**
		[0.03]	**[0.00]**
		[-0.13,-0.02]	**[-0.01,0.00]**
	Trade	-0.01	0.00
		[0.03]	[0.01]
		[-0.06,0.03]	[-0.01,0.01]
	Inflation	0.05	**0.03**
		[0.04]	**[0.01]**
		[-0.02,0.12]	**[0.01,0.04]**
	Real GDP Growth	**-0.13**	**-0.02**
		[0.02]	**[0.01]**
		[-0.17,-0.10]	**[-0.04,-0.01]**
Economic Fundamentals ($\boldsymbol{\beta}_1$)	*Fiscal*		-0.01
			[0.02]
			[-0.05,0.03]
	Trade		**-0.18**
			[0.04]
			[-0.23,-0.12]
	Inflation		**0.08**
			[0.04]
			[0.01,0.15]
	Real GDP Growth		-0.04
			[0.03]
			[-0.08,0.01]
Constant	α_0	1.52	-0.04
		[0.21]	[0.04]
		[1.15,1.85]	[-0.11,0.02]
	α_1	**7.44**	**1.00**
		[0.83]	**[0.34]**
		[6.10,8.83]	**[0.43,1.57]**
	σ_0	0.79	0.20
		[0.09]	[0.05]
		[0.64,0.92]	[0.15,0.25]
	σ_1		0.83
			[0.12]
			[0.66,1.00]
Transition Probabilities	p_{00}	0.93	0.90
		[0.03]	[0.03]
		[0.89,0.98]	[0.85,0.95]
	p_{11}	0.81	0.86
		[0.07]	[0.04]
		[0.69,0.92]	[0.79,0.93]

	Sample Period	99:1-10:4	84:2-20:3
	Observations	48	148
	Log likelihood	-18.9	37.8
	Log Marginal likelihood	-57.7	-38.1
Cumby-Huizinga test	*q=1*	0.03	0.02
	q=2	0.08	0.05
	q=3	0.16	0.10
	q=4	0.27	0.16
QZ test	SupLR	0.00	0.00

Note: The table reports the Bayesian estimation results of model (1)-(2). Posterior mean is followed by posterior standard error and 90% high posterior density interval in []. The panel "Cumby-Huizinga test" report the p-values of heteroskedasticity-robust Cumby-Huizinga test for autocorrelation in the residual. For a given value of q, the null hypothesis is that the residuals are serially uncorrelated, and the alternative hypothesis is that serial correlation is present at lags 1 to q. The panel "QZ Test" reports the p-value of the SupLR test with the null hypothesis of $\alpha_1 = 0$ according to Qu and Zhuo (2021); critical values are simulated using 1,000 iterations.

Online Appendix A: Bayesian Estimation of Markov-Switching Regression Models using Gibbs Sampling

C. 1 Introduction

Our estimation of the Markov-switching regression models follows closely Blake and Mumtaz (2012). Here we only outline the key elements for estimation and model comparison, including the priors, the multi-move Gibbs sampling algorithm, and the calculations of log marginal likelihood. For more details like the derivations of posterior distributions, please refer to Blake and Mumtaz (2012).

We start from the constant transition probabilities Markov-switching (CPT-MS) regression model in which only the constant is switching. For other models, we only describe the parts that are different from those for the constant-switching model.

C.2 CPT-MS regression model in which only the constant is switching

C.2.1 Priors

The model specified by (1) and (2) in which $[\boldsymbol{\beta}_1', \sigma_1] = \mathbf{0}$ has four sets of unknowns: the coefficients $\boldsymbol{b} = [\boldsymbol{\beta}_0', \alpha_0, \alpha_1]'$, the variance $\sigma^2 = \{\sigma_0^2\}$, the transition probabilities $\boldsymbol{\tau} = \{p_{00}, p_{11}\}$, and the state variable $\boldsymbol{S} = [s_1, s_2, \cdots, s_T]'$. Bayesian estimation requires specifying the prior distributions for the model parameters. The prior distribution of $\boldsymbol{b}$ is a multivariate normal distribution given by

$$\boldsymbol{b} \sim \mathrm{N}(\underline{\boldsymbol{b}}, \underline{\boldsymbol{\Sigma}}),$$

where $\underline{\boldsymbol{b}}$ and $\underline{\boldsymbol{\Sigma}}$ are the prior mean and variance for $\boldsymbol{b}$, respectively. The prior distribution of σ_0^2 is an Inverse Gamma distribution given by

$$\sigma_0^2 \sim \Gamma^{-1}\left(\frac{\underline{\theta}}{2}, \frac{\underline{k}}{2}\right),$$

where $\underline{\theta}$ and $\underline{k}$ are the shape and scale parameter, respectively. The prior distributions of p_{00} and

p_{11} are Dirichlet distributions given by

$$(p_{00}, 1 - p_{00}) \sim D(a_{00}, a_{01})$$

$$(1 - p_{11}, p_{11}) \sim D(a_{10}, a_{11}).$$

We assume that the parameters are mutually independent, a priori.

C.2.2 Posterior Sampling

A Gibbs algorithm samples from the following conditional posterior distributions:

(1) Conditional on $\boldsymbol{b}$, σ^2, and $\boldsymbol{\tau}$, sample $\boldsymbol{S}$ from its conditional posterior distribution,

(2) Conditional on $\boldsymbol{S}$, sample $\boldsymbol{\tau}$ from its conditional posterior distribution,

(3) Conditional on σ^2 and $\boldsymbol{S}$, sample $\boldsymbol{b}$ from its conditional posterior distribution,

(4) Conditional on $\boldsymbol{b}$ and $\boldsymbol{S}$, sample σ^2 from its conditional posterior distribution.

The conditional posterior of $\boldsymbol{S}$. Step (1) is implemented with filtering algorithm developed to calculate the probability $\mathrm{P}(s_t|I_t)$ (Hamiton 1989), where I_t is the set of all data available until time t, and the method used to derive the Carter and Kohn recursion for state-space models (Kim and Nelson 1999).

The conditional posterior of $\boldsymbol{\tau}$. Given $\boldsymbol{S}$, the prior distributions of p_{00} and p_{11} are Dirichlet distributions given by

$$(p_{00}, 1 - p_{00})|\boldsymbol{S} \sim \mathrm{D}(a_{00} + \eta_{00}, a_{01} + \eta_{01})$$

$$(1 - p_{11}, p_{11})|\boldsymbol{S} \sim \mathrm{D}(a_{10} + \eta_{10}, a_{11} + \eta_{11}),$$

where η_{ji}, $i, j = 0, 1$, is the number of times regime j is followed by regime i.

The conditional posterior of $\boldsymbol{b}$. Given $\boldsymbol{S}$, letting $\boldsymbol{S}_0 = \{t_1, t_2, \cdots, t_{n_0}\}$ denote the dates in which $s_t = 0$ and $\boldsymbol{S}_1 = \{t_{n_0+1}, t_{n_0+2}, \cdots, t_T\}$ denote the dates in which $s_t = 1$, then

$$\boldsymbol{y} = \boldsymbol{X}\boldsymbol{b} + \boldsymbol{\epsilon}, \quad \boldsymbol{\epsilon} \sim \mathrm{N}(\boldsymbol{0}_T, \sigma_0^2 \boldsymbol{I}_T)$$

where $\boldsymbol{y} = \left[\pi_{t_1}, \cdots, \pi_{t_{n_0}}, \pi_{t_{n_0+1}} \cdots, \pi_{t_T}\right]'$, $\boldsymbol{\epsilon} = \left[\epsilon_{t_1}, \cdots, \epsilon_{t_{n_0}}, \epsilon_{t_{n_0+1}} \cdots, \epsilon_{t_T}\right]'$, and

$$\boldsymbol{X} = \begin{pmatrix} \boldsymbol{x}_{t_1-1} & 1 & 0 \\ \vdots & \vdots & \vdots \\ \boldsymbol{x}_{n_0-1} & 1 & 0 \\ \boldsymbol{x}_{t_{n_0+1}-1} & 0 & 1 \\ \vdots & \vdots & \vdots \\ \boldsymbol{x}_{t_T} & 0 & 1 \end{pmatrix}$$

Given σ^2 and $\boldsymbol{S}$, the posterior distribution of $\boldsymbol{b}$ is a multivariate normal distribution:

$$\boldsymbol{b}|\sigma^2, \boldsymbol{S}, \boldsymbol{y}, \boldsymbol{X} \sim \mathrm{N}(\overline{\boldsymbol{b}}, \overline{\boldsymbol{\Sigma}}),$$

where

$$\overline{\boldsymbol{b}} = \left(\underline{\boldsymbol{\Sigma}}^{-1} + \sigma_0^{-2}\boldsymbol{X}'\boldsymbol{X}\right)^{-1}\left(\underline{\boldsymbol{\Sigma}}^{-1}\underline{\boldsymbol{b}}, +\sigma_0^{-2}\boldsymbol{X}'\boldsymbol{y}\right),$$

$$\overline{\boldsymbol{\Sigma}} = \left(\underline{\boldsymbol{\Sigma}}^{-1} + \sigma_0^{-2}\boldsymbol{X}'\boldsymbol{X}\right)^{-1}.$$

The conditional posterior of σ^2. Given $\boldsymbol{b}$ and $\boldsymbol{S}$, the posterior distribution of σ_0^2 is an Inverse Gamma distribution given by

$$\sigma_0^2|\boldsymbol{b}, \boldsymbol{S}, \boldsymbol{y}, \boldsymbol{X} \sim \Gamma^{-1}\left(\frac{\overline{\theta}}{2}, \frac{\overline{k}}{2}\right),$$

where

$$\overline{\theta} = \underline{\theta} + T,$$

$$\overline{k} = \underline{k} + (\boldsymbol{y} - \boldsymbol{X}\boldsymbol{b})'(\boldsymbol{y} - \boldsymbol{X}\boldsymbol{b}).$$

C.2.4 Marginal Likelihood

Let $\Psi = (\boldsymbol{b}, \sigma^2, \boldsymbol{\tau})$ denote all the model parameters. Following the Chib (1995), we compute the log marginal likelihood of model M, denoted by $\log p(y|M)$, as

$$\log p(\boldsymbol{y}|M) = \log p(\boldsymbol{y}|\widehat{\Psi}, M) + \log p(\widehat{\Psi}|M) - \log p(\widehat{\Psi}|\boldsymbol{y}, M)$$

where $\widehat{\Psi}$ is the posterior mode. The evaluation of the log-likelihood function and the prior density at the posterior mode is straightforward. The log multivariate density of $\widehat{\Psi}$, $\log p(\widehat{\Psi}|\boldsymbol{y}, M)$, is estimated as

$$\log p(\widehat{\Psi}|\boldsymbol{y}, M) = \log p(\widehat{\sigma}^2|\boldsymbol{y}) + \log p(\widehat{\boldsymbol{b}}|\boldsymbol{y}, \widehat{\sigma}^2) + \log p(\widehat{\boldsymbol{\tau}}|\boldsymbol{y}, \widehat{\boldsymbol{b}}, \widehat{\sigma}^2),$$

where

$$p(\widehat{\sigma}^2|\boldsymbol{y}) = \int p(\widehat{\sigma}^2|\boldsymbol{y}, \boldsymbol{b}, \boldsymbol{\tau}, \boldsymbol{S}) p(\boldsymbol{b}, \boldsymbol{\tau}, \boldsymbol{S}|\boldsymbol{y}) d(\boldsymbol{b}, \boldsymbol{\tau}, \boldsymbol{S}),$$

$$p(\widehat{\boldsymbol{b}}|\boldsymbol{y}, \widehat{\sigma}^2) = \int p(\widehat{\boldsymbol{b}}|\boldsymbol{y}, \widehat{\sigma}^2, \boldsymbol{\tau}, \boldsymbol{S}) p(\boldsymbol{\tau}, \boldsymbol{S}|\boldsymbol{y}) d(\boldsymbol{\tau}, \boldsymbol{S}),$$

and

$$p(\widehat{\boldsymbol{\tau}}|\boldsymbol{y}, \widehat{\boldsymbol{b}}, \widehat{\sigma}^2) = \int p(\widehat{\boldsymbol{\tau}}|\boldsymbol{y}, \widehat{\boldsymbol{b}}, \widehat{\sigma}^2, \boldsymbol{S}) p(\boldsymbol{S}|\boldsymbol{y}) d\boldsymbol{S}.$$

The term $p(\widehat{\sigma}^2|\boldsymbol{y})$ is the marginal density ordinate, which can be estimated from the draws of the initial Gibbs run. The term $p(\widehat{\boldsymbol{b}}|\boldsymbol{y}, \widehat{\sigma}^2)$ is the reduced conditional density ordinate. To estimate this term, we continue the sampling with the complete conditional densities of $\{\boldsymbol{b}, \boldsymbol{\tau}, \boldsymbol{S}\}$, where in each of these full conditional densities, $\sigma^{\boldsymbol{2}}$ is set equal to $\widehat{\sigma}^2$. If the gth draw from the reduced complete conditional Gibbs run is denoted by $\{\boldsymbol{b}^{(g)}, \boldsymbol{\tau}^{(g)}, \boldsymbol{S}^{(g)}\}$, then an estimate of the term $p(\widehat{\boldsymbol{b}}|\boldsymbol{y}, \widehat{\sigma}^2)$ is

$$\frac{1}{G}\sum_{g=1}^{G} p(\widehat{\boldsymbol{b}}|\boldsymbol{y}, \widehat{\sigma}^2, \boldsymbol{\tau}^{(g)}, \boldsymbol{S}^{(g)}),$$

where G is the number of retained draws. The estimation of the term $p(\widehat{\boldsymbol{\tau}}|\boldsymbol{y}, \widehat{\boldsymbol{b}}, \widehat{\sigma}^2)$ is similar to that of $p(\widehat{\boldsymbol{b}}|\boldsymbol{y}, \widehat{\sigma}^2)$.

C.2.4 Estimation

For all estimations, we simulate 100,000 draws from the posterior distribution and drop the first 20,000 ones. To reduce autocorrelation between draws, we keep every 10th draw for posterior inference. We also impose regime identifying constraints to eliminate the label-switching problem using the permutation sampler (Frühwirth-Schnatter 2001).[23] Whenever the constraints are violated for any draw, we reorder all sampled state-dependent parameters and states in such a way that the

[23] While regime identifying constraints are typically imposed on the parameters through the prior to address the label-switching problem, they are often not sufficient to eliminate the problem.

constraints are fulfilled. In particular, we restrict $\alpha_1 > 0$ such that regimes 0 and 1 are identified as states with a low and high expected rate of depreciation, respectively.

Our priors for the model parameters are as follows. First, $\underline{\boldsymbol{b}} = \mathbf{0}$ and $\underline{\boldsymbol{\Sigma}} = 1000\mathbf{I}$. This is to let the data speak. Second, $\underline{\theta} = 0.1$ and $\underline{k} = 1$. Finally, $a_{00} = a_{11} = 25$ and $a_{01} = a_{10} =$5. This implies that both p_{00} and p_{11} have a prior mean of 0.83 and variance of 0.16. This is to capture the potential persistence in being in the state of a low and high expected rate of depreciation.

C.3 CPT-MS regression model in which the constant and all coefficients are switching

C.3.1 Priors

The model specified by (1) and (2) in which $\sigma_1 = 0$ has four sets of unknowns: the coefficients $\boldsymbol{b} = \{\boldsymbol{b}_j\}_{j=0,1} = \left\{[\boldsymbol{\beta}_j', \alpha_j]'\right\}_{j=0,1}$, the variances $\sigma^2 = \{\sigma_0^2\}$, the transition probabilities $\boldsymbol{\tau} = \{p_{00}, p_{11}\}$, and the state variable $\boldsymbol{S} = [s_1, s_2, \cdots, s_T]'$. The prior distribution of $\boldsymbol{b}_j$ is a multivariate normal distribution given by

$$\boldsymbol{b}_j \sim \mathrm{N}(\underline{\boldsymbol{b}}, \underline{\boldsymbol{\Sigma}}), j = 0, 1$$

where $\underline{\boldsymbol{b}}$ and $\underline{\boldsymbol{\Sigma}}$ are the prior mean and variance for $\boldsymbol{b}_j$, respectively.

C.3.2 Posterior Sampling

The conditional posterior of $\boldsymbol{b}$. Given $\boldsymbol{S}$, letting $\boldsymbol{S}_0 = \{t_1, t_2, \cdots, t_{n_0}\}$ denote the dates in which $s_t = 0$ and $\boldsymbol{S}_1 = \{t_{n_0+1}, t_{n_0+2}, \cdots, t_T\}$ denote the dates in which $s_t = 1$, then

$$\boldsymbol{y}_0 = \boldsymbol{X}_0 \boldsymbol{b}_0 + \boldsymbol{\epsilon}_0, \qquad \boldsymbol{\epsilon}_0 \sim \sigma_0^2 \mathrm{N}(\mathbf{0}_T, \mathbf{I}_{n_0})$$

$$\boldsymbol{y}_1 = \boldsymbol{X}_1 \boldsymbol{b}_1 + \boldsymbol{\epsilon}_1, \qquad \boldsymbol{\epsilon}_1 \sim \sigma_0^2 \mathrm{N}(\mathbf{0}_{T-n_0}, \mathbf{I}_{n_0})$$

where $\boldsymbol{y}_0 = \left[\pi_{t_1}, \cdots, \pi_{t_{n_0}}\right]'$, $\boldsymbol{X}_0 = \left[\boldsymbol{x}_{t_1-1}; \cdots; \boldsymbol{x}_{t_{n_0}-1}\right]$, $\boldsymbol{\epsilon}_0 = \left[\epsilon_{t_1}, \cdots, \epsilon_{t_{n_0}}\right]'$, $\boldsymbol{y}_1 = \left[\pi_{t_{n_0+1}} \cdots, \pi_{t_T}\right]'$,

$\boldsymbol{X}_1 = \left[\boldsymbol{x}_{t_{n_0+1}-1}; \cdots; \boldsymbol{x}_{t_T-1}\right]$, and $\boldsymbol{\epsilon}_1 = \left[\epsilon_{t_{n_0+1}} \cdots, \epsilon_{t_T}\right]'$.

Given σ^2 and $\boldsymbol{S}$, the posterior distribution of $\boldsymbol{b}_j$, $j = 0, 1$, is a multivariate normal distribution:

$$\boldsymbol{b}_j | \sigma^2, \boldsymbol{S}, \boldsymbol{y}_j, \boldsymbol{X}_j \sim \mathrm{N}(\overline{\boldsymbol{b}}_j, \overline{\boldsymbol{\Sigma}}_j),$$

where

$$\overline{\boldsymbol{b}}_j = \left(\underline{\boldsymbol{\Sigma}}^{-1} + \sigma_0^{-2} \boldsymbol{X}_j{}' \boldsymbol{X}_j\right)^{-1} \left(\underline{\boldsymbol{\Sigma}}^{-1} \underline{\boldsymbol{b}}, + \sigma_0^{-2} \boldsymbol{X}_j{}' \boldsymbol{y}_j\right),$$

$$\overline{\boldsymbol{\Sigma}}_j = \left(\underline{\boldsymbol{\Sigma}}^{-1} + \sigma_0^{-2} \boldsymbol{X}_j{}' \boldsymbol{X}_j\right)^{-1}.$$

The conditional posterior of σ^2. Let $\boldsymbol{y} = [\boldsymbol{y}_0' \ \boldsymbol{y}_1']', \boldsymbol{X} = [\boldsymbol{X}_0; \boldsymbol{X}_1]$, and $\boldsymbol{B} = [\boldsymbol{b}_0', \boldsymbol{b}_1']'$. Given $\boldsymbol{b}$ and $\boldsymbol{S}$, the posterior distribution of σ_0^2 is an Inverse Gamma distribution given by

$$\sigma_0^2 | \boldsymbol{b}, \boldsymbol{S}, \boldsymbol{y}, \boldsymbol{X} \sim \Gamma^{-1}\left(\frac{\overline{\theta}}{2}, \frac{\overline{k}}{2}\right),$$

where

$$\overline{\theta} = \underline{\theta} + T,$$

$$\overline{k} = \underline{k} + (\boldsymbol{y} - \boldsymbol{X}\boldsymbol{B})'(\boldsymbol{y} - \boldsymbol{X}\boldsymbol{B}).$$

C.4 CPT-MS regression model in which the constant, all coefficients, and the error variance are switching

C.4.1 Priors

The model specified by (1) and (2) has four sets of unknowns: the coefficients $\boldsymbol{b} = \{\boldsymbol{b}_j\}_{j=0,1} = \left\{[\boldsymbol{\beta}_j', \alpha_j]'\right\}_{j=0,1}$, the variances $\sigma^2 = \{\sigma_j^2\}_{j=0,1}$, the transition probabilities $\boldsymbol{\tau} = \{p_{00}, p_{11}\}$, and the state variable $\boldsymbol{S} = [s_1, s_2, \cdots, s_T]'$. The prior distribution of σ_j^2 is an Inverse Gamma distribution given by

$$\sigma_j^2 \sim \Gamma^{-1}\left(\frac{\underline{\theta}}{2}, \frac{\underline{k}}{2}\right), j = 0, 1$$

where $\underline{\theta}$ and $\underline{k}$ are the shape and scale parameter, respectively.

C.4.2 Posterior Sampling

The conditional posterior of $\boldsymbol{b}$. Given $\boldsymbol{S}$, letting $\boldsymbol{S}_0 = \{t_1, t_2, \cdots, t_{n_0}\}$ denote the dates in which $s_t = 0$ and $\boldsymbol{S}_1 = \{t_{n_0+1}, t_{n_0+2}, \cdots, t_T\}$ denote the dates in which $s_t = 1$, then

$$\boldsymbol{y}_0 = \boldsymbol{X}_0\boldsymbol{b}_0 + \boldsymbol{\epsilon}_0, \qquad \boldsymbol{\epsilon}_0 \sim \sigma_0^2\mathrm{N}\left(\mathbf{0}_{n_0}, \mathbf{I}_{n_0}\right)$$

$$\boldsymbol{y}_1 = \boldsymbol{X}_1\boldsymbol{b}_1 + \boldsymbol{\epsilon}_1, \qquad \boldsymbol{\epsilon}_1 \sim \sigma_1^2\mathrm{N}\left(\mathbf{0}_{T-n_0}, \mathbf{I}_{T-n_0}\right)$$

where $\boldsymbol{y}_0 = \left[\pi_{t_1}, \cdots, \pi_{t_{n_0}}\right]'$, $\boldsymbol{X}_0 = \left[\boldsymbol{x}_{t_1-1}; \cdots; \boldsymbol{x}_{t_{n_0}-1}\right]$, $\boldsymbol{\epsilon}_0 = \left[\epsilon_{t_1}, \cdots, \epsilon_{t_{n_0}}\right]'$, $\boldsymbol{y}_1 = \left[\pi_{t_{n_0+1}} \cdots, \pi_{t_T}\right]'$, $\boldsymbol{X}_1 = \left[\boldsymbol{x}_{t_{n_0+1}-1}; \cdots; \boldsymbol{x}_{t_T-1}\right]$, and $\boldsymbol{\epsilon}_1 = \left[\epsilon_{t_{n_0+1}} \cdots, \epsilon_{t_T}\right]'$.Given σ^2 and $\boldsymbol{S}$, the posterior distribution of $\boldsymbol{b}_j$, $j = 0, 1$, is a multivariate normal distribution:

$$\boldsymbol{b}_j | \sigma^2, \boldsymbol{S}, \boldsymbol{y}_j, \boldsymbol{X}_j \sim \mathrm{N}\left(\overline{\boldsymbol{b}}_j, \overline{\boldsymbol{\Sigma}}_j\right),$$

where

$$\overline{\boldsymbol{b}}_j = \left(\underline{\boldsymbol{\Sigma}}^{-1} + \sigma_j^{-2}\boldsymbol{X}_j'\boldsymbol{X}_j\right)^{-1}\left(\underline{\boldsymbol{\Sigma}}^{-1}\underline{\boldsymbol{b}}, + \sigma_j^{-2}\boldsymbol{X}_j'\boldsymbol{y}_j\right),$$

$$\overline{\boldsymbol{\Sigma}}_j = \left(\underline{\boldsymbol{\Sigma}}^{-1} + \sigma_j^{-2}\boldsymbol{X}_j'\boldsymbol{X}_j\right)^{-1}.$$

The conditional posterior of σ^2. Given $\boldsymbol{b}$ and $\boldsymbol{S}$, the posterior distribution of σ_j^2, $j = 0, 1$, is an Inverse Gamma distribution given by

$$\sigma_j^2 | \boldsymbol{b}, \boldsymbol{S}, \boldsymbol{y}_j, \boldsymbol{X}_j \sim \Gamma^{-1}\left(\frac{\overline{\theta}_j}{2}, \frac{\overline{k}_j}{2}\right),$$

where

$$\overline{\theta}_j = \underline{\theta} + T,$$

$$\overline{k}_j = \underline{k} + \left(\boldsymbol{y}_j - \boldsymbol{X}_j\boldsymbol{b}_j\right)'\left(\boldsymbol{y}_j - \boldsymbol{X}_j\boldsymbol{b}_j\right).$$

C.5 Time-varying transition probabilities MS regression models

C.5.1 Priors

The model specified by (1) and (4) has five sets of unknowns: the coefficients $\boldsymbol{b} = \left\{\boldsymbol{b}_j\right\}_{j=0,1} =$

$\{[\boldsymbol{\beta}_j', \alpha_j]'\}_{j=0,1}$, the variances $\sigma^2 = \{\sigma_j^2\}_{j=0,1}$, the coefficients $\boldsymbol{\Lambda} = [\gamma_0, \lambda, \gamma]'$, the latent variable $\boldsymbol{S}^* = [s_1^*, s_2^*, \cdots, s_T^*]'$, and the state variable $\boldsymbol{S} = [s_1, s_2, \cdots, s_T]'$. The prior distribution of $\boldsymbol{\Lambda}$ is a multivariate normal distribution given by

$$\boldsymbol{\Lambda} \sim \mathrm{N}(\underline{\boldsymbol{\Lambda}}, \underline{\boldsymbol{\Sigma}}_{\boldsymbol{\Lambda}}),$$

where $\underline{\boldsymbol{\Lambda}}$ and $\underline{\boldsymbol{\Sigma}}_{\boldsymbol{\Lambda}}$ are the prior mean and variance for $\boldsymbol{\Lambda}$, respectively.

C.5.2 Posterior Sampling

A Gibbs algorithm samples from the following conditional posterior distributions:

(1) Conditional on $\boldsymbol{b}$ and σ^2, sample $\boldsymbol{S}$ from its conditional posterior distribution

(2) Conditional on $\boldsymbol{S}$, sample $\boldsymbol{S}^*$ from its conditional posterior distribution

(3) Conditional on $\boldsymbol{S}$ and $\boldsymbol{S}^*$, sample $\boldsymbol{\Lambda}$ from its conditional posterior distribution

(4) Conditional on σ^2 and $\boldsymbol{S}$, sample $\boldsymbol{b}$ from its conditional posterior distribution

(5) Conditional on $\boldsymbol{b}$ and $\boldsymbol{S}$, sample σ^2 from its conditional posterior distribution

The conditional posterior of $\boldsymbol{S}^*$. Following Albert and Chib (1993), given $\boldsymbol{S}$, s_t^* can be sampled from the following truncated normal distributions for $t = 1, 2, \dots, T$:

$$s_t^* \sim \mathrm{N}_{\mathrm{RT}}(m_t, 1) \text{ if } s_t = 0$$

$$s_t^* \sim \mathrm{N}_{\mathrm{LT}}(m_t, 1) \text{ if } s_t = 1$$

where $m_t = \gamma_0 + \lambda PS_{t-1} + \gamma s_{t-1}$, and $\mathrm{N}_{\mathrm{RT}}(m_t, 1)$ and $\mathrm{N}_{\mathrm{LT}}(m_t, 1)$ are the $\mathrm{N}(m_t, 1)$ distribution left and right truncated at zero, respectively.

The conditional posterior of $\boldsymbol{\Lambda}$. Given $\boldsymbol{S}$ and $\boldsymbol{S}^*$, the probability equation is a simple linear regression with a known error variance:

$$s_t^* = z_t \boldsymbol{\Lambda} + u_t, \quad u_t \sim \mathrm{N}(0,1).$$

where $z_t = [1 \; PS_{t-1} \; s_{t-1}]$. Let $\boldsymbol{Z} = [z_1; \cdots, z_T]$. Given $\boldsymbol{S}^*$, the posterior distribution of $\boldsymbol{\Lambda}$ is a multivariate normal distribution:

$$\boldsymbol{\Lambda}|\boldsymbol{S}^{*}, \boldsymbol{Z} \sim \mathrm{N}(\overline{\boldsymbol{\Lambda}}, \overline{\boldsymbol{\Sigma}}_{\boldsymbol{\Lambda}}),$$

where

$$\overline{\boldsymbol{\Lambda}} = \left(\underline{\boldsymbol{\Sigma}}_{\boldsymbol{\Lambda}}{}^{-1} + \boldsymbol{Z}'\boldsymbol{Z}\right)^{-1}\left(\underline{\boldsymbol{\Sigma}}_{\boldsymbol{\Lambda}}^{-1}\underline{\boldsymbol{\Lambda}}, +\boldsymbol{Z}'\boldsymbol{S}^{*}\right),$$

$$\overline{\boldsymbol{\Sigma}}_{\boldsymbol{\Lambda}} = \left(\underline{\boldsymbol{\Sigma}}_{\boldsymbol{\Lambda}}{}^{-1} + \boldsymbol{Z}'\boldsymbol{Z}\right)^{-1}.$$

C.5.3 Estimation

We impose regime identifying constraints to eliminate the label-switching problem using the rejection sampler. Whenever the constraints are violated for any draw, we discard it. In particular, we restrict $\alpha_1 > 0$ such that regimes 0 and 1 are identified as states with a low and high expected rate of depreciation, respectively.

In addition to the priors specified in section C.2.4, we set $\underline{\boldsymbol{\Lambda}} = \boldsymbol{0}$ and $\underline{\boldsymbol{\Sigma}}_{\boldsymbol{\Lambda}} = 1000\mathbf{I}$.

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