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Two Crises and the Natural Rate of Interest: Evidence from Taiwan, Thailand, and Korea

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Abstract

By applying the Holston et al. (2017) methodology, we estimate the natural rates of interest for Taiwan, Thailand, and Korea. This paper discusses four main findings. First, we find evidence of time-variation in natural rates of interest for all three economies. Second, natural rates of interest for these economies declined during the past few decades. Third, Thailand's natural rate of interest fell substantially only after the Asian Financial Crisis, but Taiwan's natural rate of interest declined sharply only after the Global Financial Crisis. Meanwhile, Korea's natural rate of interest plummeted in the immediate aftermath of both the Asian Financial Crisis and the Global Financial Crisis. Fourth, the estimates of the natural rate of interest are highly uncertain.

Keywords: Natural rate of interest, Kalman Filter, Taiwan, Thailand, Korea, Asia

1. Introduction

Estimating the natural, neutral, or "equilibrium" rate of interest-hereafter referred to as the natural rate of interest-has been an important task for central bankers. Several definitions and models have been proposed. Laubach and Williams (2003) defined the natural rate of interest to be the real short-term interest rate consistent with output converging to potential, with potential being the level of output consistent with stable inflation. This definition is useful, especially for central bankers, because monetary policy feedback rules, including Taylor's (1993) rule, assume the natural rates of interest as the intercept term.

As the natural rate of interest cannot be observed, central bankers must estimate it. In a seminal paper, Laubach and Williams (2003) proposed the state-space model to estimate the US natural rate of interest as a latent variable. Holston et al. (2017b) (henceforth, this study will be referred to as HLW) adopted Laubach and Williams' model and applied it to advanced economies, including the US, UK, Euro Area, and Canada. In contrast to Woodford (2003), who assumed a longer-run natural rate of interest at a constant value, HLW assumed that the natural rate of interest fluctuates and that its rate is determined by the trend growth rate of the natural rate of output, along with other factors. After the Global Financial Crisis (GFC), many studies (e.g., Rachel and Summers 2019) investigated the movements of the natural rate of interest in advanced economies and showed that the natural rate had the potential to fall precipitously. Wynne and Zhang (2018b) also showed that the global economy's natural rate has been trending downward for the past few decades.

On another front, Asian economies experienced two changes after the Asian Financial Crisis (AFC) of 1997–1998: a marked and sustained decline in investment/GDP ratios (Reinhart et al. 2016) and an increasing savings ratio (Bernanke 2005). A decline in the investment/GDP ratio will lower the potential growth rate in the future. A higher savings ratio, which is related to the long-standing current account surplus, contributes to expectations about domestic currency appreciation and lowers the country's risk premium. In total, both a lower investment/GDP ratio and a higher savings ratio after the AFC might have led to the lower natural rates of interest in Asian economies.

There have been a few empirical studies on the natural rates of interest in Asian economies. Perrelli and Roache (2014) analyzed the sizeable decline in natural rates of interest among 24 emerging economies including Asian economies. They revealed that in emerging economies, the filtered real interest rates—the likely ranges for the natural rates of interest-dropped more than 200 basis points from 2002–2004 to 2010–2013. Zhu (2016) focused on the natural rates of interest in the Asia-Pacific region and found that in Asian-Pacific economies, the natural rates of interest declined substantially by over 400 basis points on average from the early- or mid-1990s to 2014.

Regarding individual economies, the International Monetary Fund (2017) estimated the natural rate of interest for Thailand using the Lubik and Matthes (2015) methodology. Kim and Park (2013) identified a decline in the natural rate of interest in Korea by expanding and applying the Laubach and Williams (2003) methodology.

In this paper, we apply HLW's approach to estimate the natural rates of interest in Asian economies. In particular, we focus on the impact from both the AFC and the GFC. This is because previous studies (e.g., Imai et al. 2013) have pointed out that economic activities, such as GDP per capita, private credit, and exports from Asia, were not affected by the GFC as much as by the AFC. This leads to the hypothesis that the natural rates of interest for Asian economies should have been less affected by the GFC than by the AFC. By comparing natural rates of interest in the Asian region, we investigate characteristics, parameters, and movements as well as the precision of the estimations.

Although HLW's approach needs longer-term observations, most Asian economies release limited data. Longer-term data including GDP, inflation, and policy rate on a quarterly basis can be obtained only in Taiwan and Korea. Meanwhile, in the time of the AFC, three countries including Indonesia, Thailand, and Korea were economically affected most (Furman and Stiglitz 1998). In the case of Thailand, while GDP data on a quarterly basis before 1993 were not released, both inflation and interest rates could be obtained. In the case of Indonesia, both quarterly GDP and interest rates could not be obtained. As described in the next section, by complementing GDP data in Thailand, we focus on Taiwan, Thailand, and Korea to gauge the impacts from both the AFC and the GFC.

The rest of this paper is organized as follows. In the second section, we describe our data and the model used to estimate the natural rates of interest for Taiwan, Thailand, and Korea. The third section presents our empirical results, mainly showing the movements of the natural rates of interest. The final section concludes the paper.

2. Model and Data

2.1 Model

There are two benefits from employing HLW's methodology. First, as HLW adopts a semi-structural econometric model, the estimated parameters are consistent with economic theory. More flexible approaches have been proposed, including a vector autoregressive model with time-varying parameters (TVP-VAR) (Lubik and Matthes 2015); statistical filters (Perrelli and Roache 2014); and frequency-domain techniques (Zhu 2016). However, a semi-structural econometric model describes the relationship between the natural rate of output, interest, and inflation more clearly. Second, fewer variables are needed for HLW's methodology compared to large macro-economic models, such as dynamic stochastic general equilibrium (DSGE) models. As Asian economies release fewer economic indicators than more advanced economies, HLW's methodology is considered more suitable for Asian economies.

A state-space model is applied to estimate the natural rates of interest. Since the model is linear, we can use the standard Kalman-filter approach to obtain estimates. Specifically, the model is given by the following set of equations:

$$\tilde{y}_t = a_{t,1}\tilde{y}_{t-1} + a_{t,2}\tilde{y}_{t-2} + \frac{a_r}{2}\sum_{j=1}^{2}(r_{t-j} - r^*_{t-j}) + \epsilon_{\tilde{y},t} \qquad \epsilon_{\tilde{y},t} \sim (0, \sigma^2_{\tilde{y}}) \qquad (1)$$

$$\pi_t = b_\pi \pi_{t-1} + (1 - b_\pi)\pi_{t-2,4} + b_y \tilde{y}_{t-1} + \epsilon_{\pi,t} \qquad \epsilon_{\pi,t} \sim (0, \sigma^2_\pi) \qquad (2)$$

$$y^*_t = y^*_{t-1} + g_{t-1} + \epsilon_{y^*,t} \qquad \epsilon_{y*,t} \sim (0, \sigma^2_{y*}) \qquad (3)$$

$$r^*_t = g_t + z_t \qquad (4)$$

$$g_t = g_{t-1} + \epsilon_{g,t} \qquad \epsilon_{g,t} \sim (0, \sigma^2_g) \qquad (5)$$

$$z_t = z_{t-1} + \epsilon_{z,t} \qquad \epsilon_{z,t} \sim (0, \sigma^2_z) \qquad (6)$$

y_t and y^*_t are the logarithms of the real GDP and the unobserved natural rate of output, respectively. $\tilde{y}_t$ shows the output gap, calculated from $\tilde{y}_t = 100 * (y_t - y^*_t)$. r_t is the real short-term interest rate, π_t denotes consumer price inflation, and $\pi_{t-2,4}$ is the average of the second to fourth lags. r^*_t is the law of motion for the natural rate of interest, while g_t is the trend growth rate of the natural rate of output and z_t captures other determinants of r^*_t. All of $\epsilon_{\tilde{y},t}$, $\epsilon_{\pi,t}$, $\epsilon_{y^*,t}$, $\epsilon_{g,t}$, and $\epsilon_{z,t}$ are disturbance terms, and the model assumes that both the growth rate g_t and the unobserved component z_t are random walk processes.

The interest rate gap is the difference between the short-term *ex ante* real interest rate and the unobserved natural rate of interest: if these two rates are identical, the output gap can be said to be closed and inflation remains static. A standard textbook on the New Keynesian model (e.g., Walsh 2010) describes a forward-looking version of the Phillips-curve and the so-called IS curve. However, where the inflation expectations of economic agents are assumed to be adaptive, that is to say, backward-looking, these two equations could be set at Equation (1) and (2).

Equation (1) is the so-called IS-curve, which specifies a relationship between the output gap and the real rate gap. Laubach and Williams (2003) noted that $\Sigma\, a_y$ to be less than unity in order to identify changes in r^* with low frequency shifts in the output gap-real rate relationship. They allowed the lag lengths in the output gap and inflation equations, equations (1) and (2), respectively, to be determined by the data. Then, they included two lags each of the output gap and the real rate gap in the output gap equation. In sum, with two lags, the constraint is assumed as follows: $a_1 + a_2 < 1$. Additionally, as HLW admitted that they did not know precise lead-lag relationships among the endogenous variables, they included the average real interest gap of the past two quarters in equation (1) to reduce the risk that natural rate estimates are affected by estimates of structural parameters based on potentially misspecified output gap and inflation dynamics.

Equation (2) represents a backward-looking version of the Phillips-curve, which specifies a relationship between the inflation rate and the output gap. As Walsh (2010) described, in order to capture the inflation persistence found in the data, it is common to augment the basic forward-looking inflation adjustment equation with the addition of lagged inflation. And, Walsh (2010) also noted that future inflation played little role once lagged inflation is added to the inflation adjustment equation. Laubach and Williams (2003) and Wynne and Zhang (2018a) included eight lags of inflation. However, these studies also revealed that the coefficients on lags 5-8 inflation to be small. Hence, HLW and we included inflation of the past four quarters. Additionally, for reasons of parsimony, we restrict the coefficients on lags 2 to 4 of inflation to be equal (e.g., Gordon (1998), Laubach and Williams (2003)). Furthermore, as we impose the restriction that the sum of the coefficients on lagged inflation must equal unity, the restriction is a standard restriction to ensure that the Phillips curve obeys the Natural Rate Hypothesis in the long run (Wynne and Zhang 2018a). By the inclusion of the lagged inflation, only the first lag of the output gap in this equation was proved sufficient by the data.

The set of equation is the closed economy model, although Taiwan, Thailand, and Korea are considered to be typical open economies. On the natural rate of interest in Korea, Kim and Park (2013) extended the closed model by Laubach and Williams (2003) into a small open economy version which uses modified interest parity condition and reflects global investors' behavior. In addition, a recent empirical study of Wynne and Zhang (2018a) used an open economy model by the extension of the Laubach and Williams' model. However, from the view of the natural rate of interest in the longer term, movements of the natural rate of interest estimated by a small open economy and an open economy versions (including Kim and Park (2013) and Wynne and Zhang (2018a)) are not much different from closed economy version. As this paper focuses on the regional aspect of influence of two crises in the longer term, a benchmark model by the HLW could be the applied at the first onset.

2.2 Parameter and Latent Variable Estimation

As we use the exact same procedures as in Holston et al. (2017a), this section describes the key points on the estimation. If the model was estimated simultaneously, using maximum-likelihood, Stock (1994) and Stock and Watson (1998) pointed out that the variance of one of the shocks to the latent state variables would peak at zero: the *pile-up* problem. To avoid the *pile-up* problem, our estimation method proceeds in sequential steps.

For each step, parameters are estimated by maximum likelihood. We use Stock and Watson's (1998) median unbiased estimator to obtain estimates of two ratios: $\lambda_g \equiv {}^{\sigma_g}/_{\sigma_{y^*}}$ and $\lambda_z \equiv {}^{a_r \sigma_z}/_{\sigma_{\tilde{y}}}$.

In the first step, we apply the Kalman filter to estimate the natural rate of output, omitting the real rate gap term from equation (1) and assuming that the trend growth rate, *g*, is constant. As described in the previous subsection, the constraint on a_1 and a_2 is assumed as follow: $a_1 + a_2 < 1$. From the first step, we could obtain the estimate of λ_g. In the second step, we estimate five equations (1)-(5) with assuming that *z* is constant. When estimating, we impose the estimated value of λ_g from the first step and include the real interest rate gap in equation (1). From the second step, we could obtain the estimate of λ_z. In the third step, we impose both λ_g and λ_z and estimate the remaining model parameters.

In addition to the constraint on a_1 and a_2, there are some constraints when estimating. From the theoretical viewpoint, the slope a_r of IS equation is negative and the slope b_y of Phillips curve is positive. As we apply computations for confidence intervals and corresponding standard errors for the estimates of the states using Hamilton's (1986) Monte Carlo procedure, we draw the parameter vectors from a normal distribution with the covariance matrix of the parameter vector computed as the outer products of the gradients. During these draws, imposing constraints on a_1 and a_2 is considered to reduce the width of the standard errors. On the other hand, past studies (e.g., Brand et al. 2018) revealed that estimated IS and Phillips curves are close to be flat. Hence, the constraints on both a_1 and a_2 should be close to zero. Following to the HLW, in all stages, we impose the constraint $b_y \geq 0.025$. In stages 2 and 3, we impose at $a_r \leq -0.0025$.

2.3 Data

We rely on the following observables: real GDP, the policy rate or interbank rate deflated with core inflation, and core inflation. All observables are seasonally adjusted prior to estimation. Details on the data are provided in the Appendix.

We try to use the longest sample size for the three economies. However, in all cases, it is worth mentioning that the above model cannot be run when the system has a singular matrix. Additionally, in the case of Thailand, GDP data are only available annually prior to 1993. The model could not be run using only data after 1993 due to the shortened sample size.

To solve these two problems, we adopt the following strategies:

1) Complementing the Thailand GDP data.

To complement the limited GDP data prior to 1993, we use estimated quarterly GDP data from Abeysinghe and Rajaguru (2004). The Appendix of Abeysinghe and Rajaguru (2004) shows quarterly real GDP estimates for Thailand since 1976. These were obtained using disaggregation techniques.

Abeysinghe and Rajaguru (2004) provide only real GDP growth rates on a year-on-year and non-seasonally adjusted basis. We obtain the original GDP on a non-seasonally adjusted and quarterly basis from 1993 to 2018 and extend this data set to 1976. Lastly, seasonally adjusted GDP data from 1976 to 2018 are derived by X-13 ARIMA.

2) Running the model for three economies in a sequential step

In the first step, we run the model with the full sample. Second, when estimation fails due to the singular matrix, we eliminate one of the oldest samples from the data set. In the third step, we try the estimation again. If the estimation fails, we return to the second step.

For example, in case of Korea, the data set spanned from 1992 Q1 to 2018 Q4. First, we try to run the model with the full sample. When the estimation fails, we delete the data from 1992 Q1. Third, we attempt to run the model using the data set from 1992 Q2 to 2018 Q4, but the trial fails again. Returning to the second and third steps, we run the model from 1992 Q3 to 2018 Q4. Then, the estimation succeeds.

3. Estimation Results

3.1 Parameter Estimates

Table 1 reports the estimation results for the three economies. Data availability and the sequential step in the estimation shown in the previous section require different starting points for data samples for the three economies: Taiwan in 1990 Q3; Thailand in 1978 Q2; and Korea in 1992 Q3. The sample end is the same for all three economies—2018 Q4.

The slope coefficient a_r for Thailand is reasonably large. On the other hand, the slope coefficient a_r for Taiwan is not large enough. The slope coefficients b_y for Taiwan and Thailand are close to zero and are estimated to their constraints at 0.025. This suggests that both the output gaps and real rate gaps for these economies are not well identified.

Meanwhile, in Thailand, inflation is not well explained by the lags and lagged output gap, as shown by the large standard deviation, σ_π. In the case of Taiwan and Korea, the standard deviations σ_π are comparatively small.

Similar to HLW's parameter estimates for the UK, the parameter estimates for Korea are different from those for Taiwan and Thailand in several ways. The output gap is estimated to be much less persistent, as shown by the smaller value for $\Sigma\, a_y$, but the inflation responds strongly to the transitory output gap fluctuations, with b_y being statistically significant. By contrast, this output gap estimate seems to bear little relation to the real rate gap, with a_r estimated to be close to zero.

The estimates of natural rate of interest are uncertain. A sample average standard error, which shows uncertainty for the estimates of the states, of 3.7 percentage points in Taiwan and 1.6 percentage points in Thailand. These are shown in the section of Table 1 labeled "S.E. (sample ave.)." In the case of Korea, the sample average standard error is larger at 6.4 percentage points.

Table 1. Parameter Estimates

Parameter	Taiwan	Thailand	Korea
Sample	1991Q1-2018Q4	1978Q2-2018Q4	1992Q3-2018Q4
Σa_y	0.875	0.905	0.755
a_r	-0.254	-0.198	-0.056
	(1.430)	(2.965)	(0.775)
b_y	0.025	0.025	0.373
	(0.609)	(0.395)	(3.853)
$\sigma_{\tilde{y}}$	1.306	1.050	1.005
σ_{π}	1.399	3.775	1.448
σ_{y*}	0.559	1.341	0.389
S.E. (sample ave.)			
$r*$	3.737	1.595	6.358
G	0.692	1.105	0.583
$y*$	3.335	3.644	1.098

Source: Author's calculation.

Notes: *t* statistics are in parentheses.

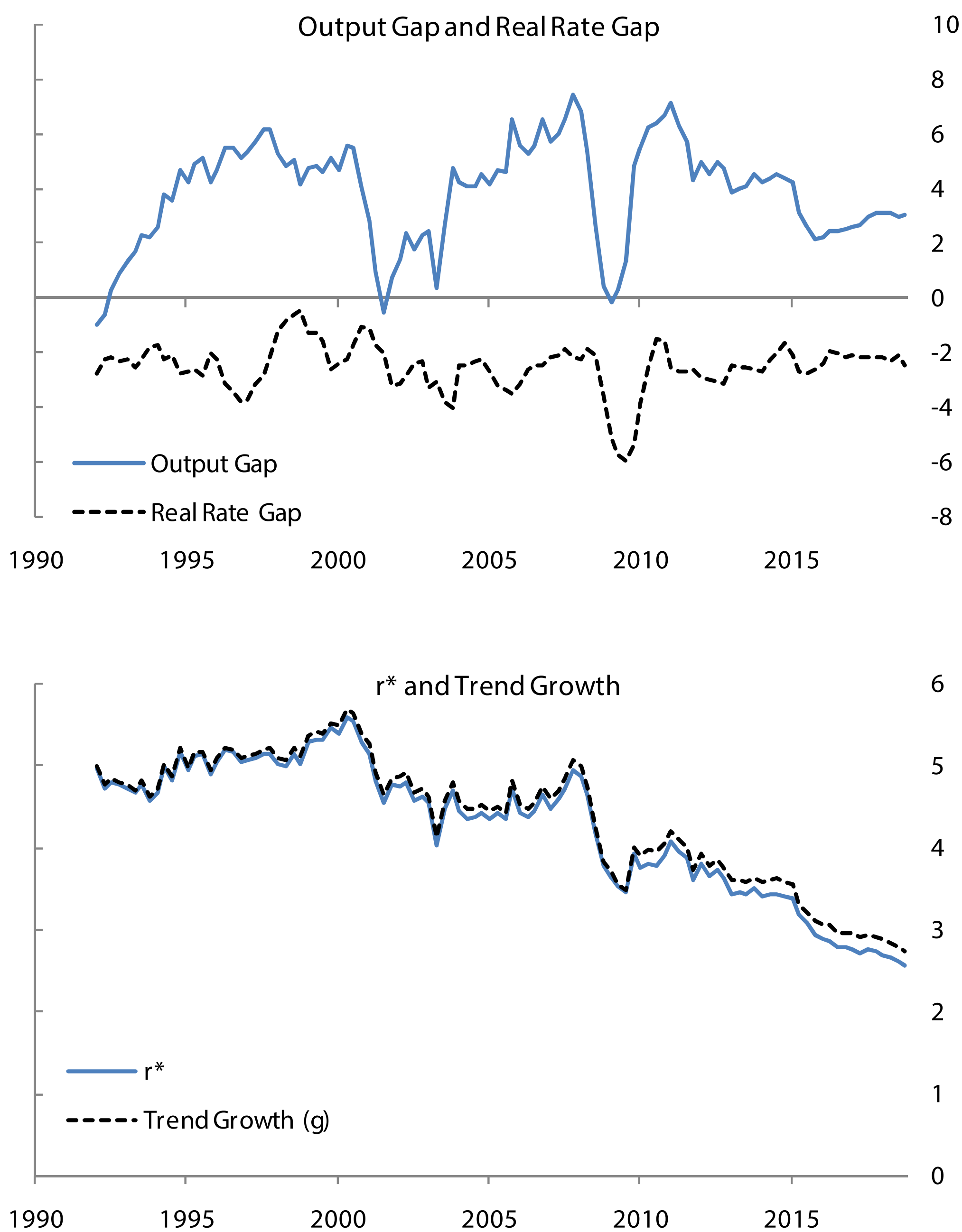
S.E. means standard errors for the estimates of the states using Hamilton's (1986) Monte Carlo procedure.

3.2 Estimates of Output Gap and Trend GDP Growth

The upper panels of Figures 1-3 show the filtered (one-sided) estimates of the output gap for the three economies. The movements of the output gaps in these economies are different. Taiwan's positive output gap shrank after the dot-com bubble burst in 2001 and again after the GFC, while it did not fluctuate much after the AFC. Thailand experienced a negative output gap after the AFC, but the output gap responded less to the GFC. Korea experienced a negative output gap after both the AFC and GFC.

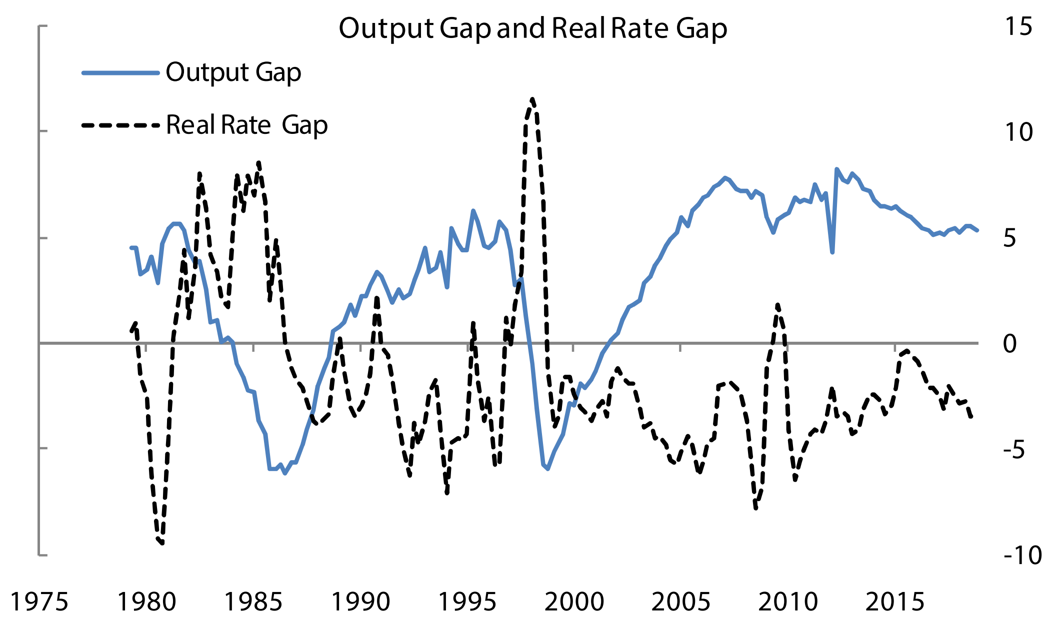
The upper panels also show the real interest rate gap, which is the difference between the ex ante interest rate and the filtered estimate of the natural rate of interest. In Taiwan, the real interest rate gap sunk during the estimation span. In the case of Thailand and Korea, when the real rate gap is positive (negative), the estimated output gap tends to decline (rise).

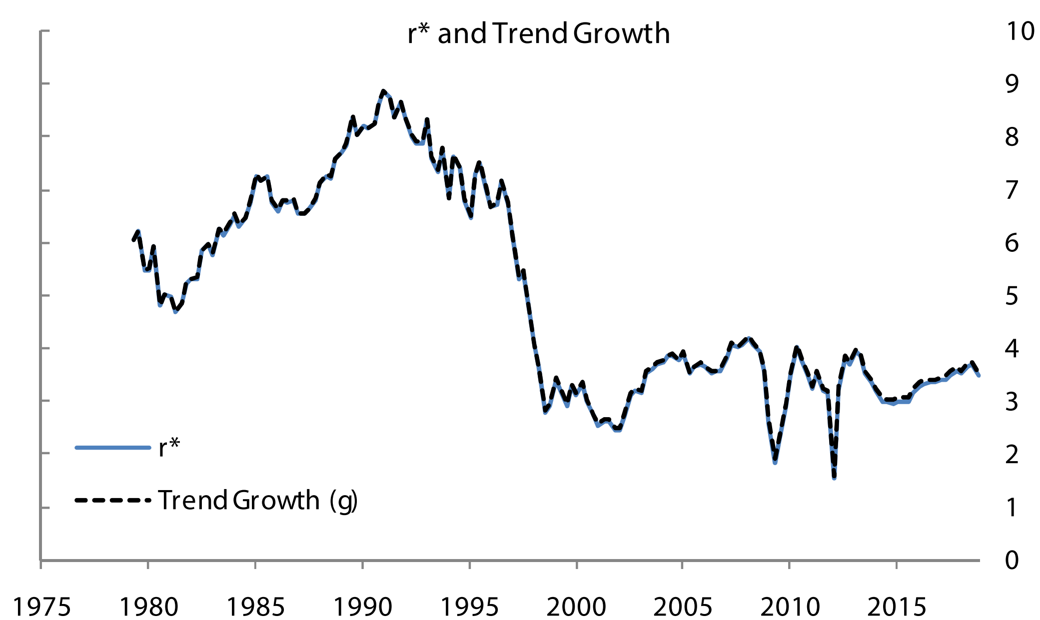
Figure 1. Estimation Results for Taiwan



Source: Author's estimation.

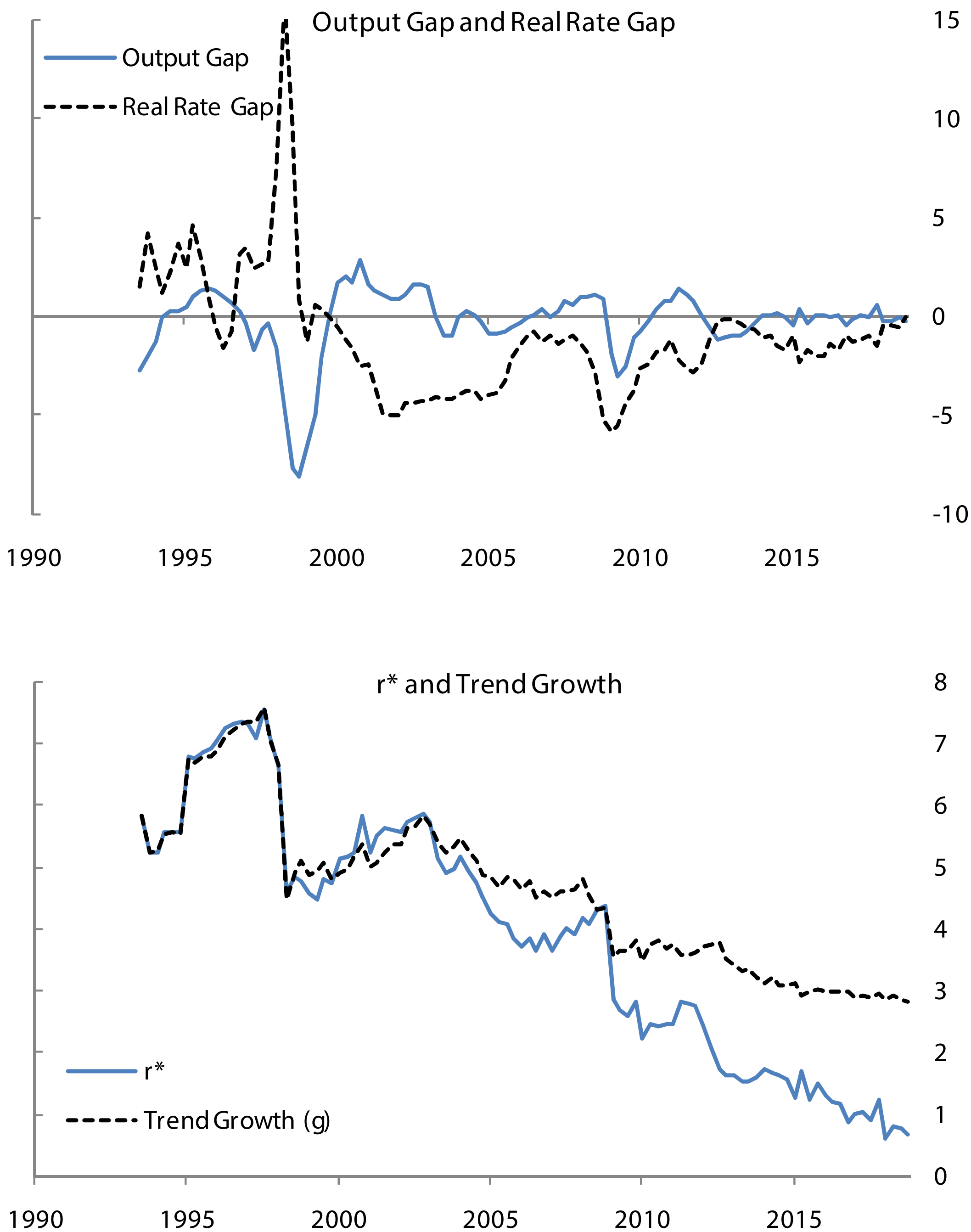
Figure 2. Estimation Results for Thailand





Source: Author's estimation.

Figure 3. Estimation Results for Korea



Source: Author's estimation.

A striking finding for the economies in Taiwan and Korea is the secular downward trend in the estimated trend growth rates of output over the past 25 years. In Taiwan, the decline is concentrated in the 2008–09 period of the GFC. In Korea, the decline is observed in the 1997–1998 period of the AFC and the 2008–2009 period of the GFC.

The estimated trend growth rate in Thailand declined sharply after the AFC. However, the estimated trend growth rate temporarily declined around the time of the GFC and the massive floods of 2011.

In 2018, the estimated trend growth rates for the three economies-Taiwan Thailand, and Korea—are 2.8%, 3.7%, and 2.9%, respectively. For reference, according to the IMF World Economic Outlook (2019), the estimated 5-year forecasts for real GDP growth for these economies are as follows: 2.1%, 3.6%, and 2.9%, respectively.

3.3 Estimated Natural Rate of Interest

The lower panels of Figures 1-3 show the estimated natural rates of interest for the economies.

Movements of the natural rates of interest for Taiwan and Thailand are very similar to the movements of the trend growth rate. This means that , which includes other determinants of , has little impact on the natural rates of interest for these economies. Taiwan's trend growth rate and the natural rate of interest were estimated at 4.5% in 2005 and then fell to 2.6–2.8% in 2018. In 2018, Thailand's trend growth rate and the natural rate of interest had not changed from the 2005 value of 3.6–3.7%.

In Thailand's case, estimated levels of the natural rate from previous studies are different from our results. Zhu (2016) estimated the natural rate of interest at a low level of 0.61% in 2005 and 1.60% in 2014. The International

Monetary Fund (2017) estimated the natural rate of interest for Thailand at 0.1–0.2% in 2015–16. As a number of papers have explored the sensitivity of estimates of natural rate of interest, past studies showed that the path of the natural rate of interest is driven directly by the model assumptions (e.g., Brand et al. 2018). In our model, a one-for-one relationship between the trend growth rate of output and the natural rate of interest is assumed. As the trend growth rate in Thailand, mentioned in the previous subsection, is estimated at 3.7%, the natural rate of interest in our model is estimated at the same level.

In the case of Korea, the decline in the natural rate of interest was sharper than the decline in the trend growth rate. While the trend growth rate in Korea in 2018 was 2.9%, the natural rate of interest is estimated at 0.7%. The results for Korea are consistent with Kim and Park (2013), who found that the country's natural rate of interest fell substantially after the AFC and also after the GFC.

The changes in natural rates of interest are also reported in Table 2. Our main finding is that the movements of the natural rates of interest for the three economies are different in the AFC and GFC periods.

In the period of the AFC, Taiwan's natural rate of interest declined by only 0.5 percentage points from 1995 to 2005. This period also included the dot-com bubble, but the impact of the bubble and its burst on Taiwan's natural rate of interest is considered small. From 1995 to 2005, the declines of the natural rate of interest in Thailand and Korea were 3.4 percentage points and 2.7 percentage points, respectively.

In the GFC period, Taiwan's and Korea's natural rates of interest declined substantially from 2005 to 2018: 1.9 percentage points and 3.4 percentage points, respectively. On the other hand, Thailand's natural rate of interest did not change during the GFC period.

Table 2. Trend Growth and Natural Rate of Interest Estimates

	1995	2005	2018	Change	
	(A)	(B)	(C)	(B) - (A)	(C) - (B)
Trend Growth					
(*g* estimates)					
Taiwan	5.1	4.5	2.8	-0.6	-1.7
Thailand	7.1	3.7	3.7	-3.4	0.0
Korea	6.8	4.8	2.9	-2.0	-1.9
Natural Rate of Interest					
(r^* estimates)					
Taiwan	5.0	4.5	2.6	-0.5	-1.9
Thailand	7.1	3.7	3.6	-3.4	-0.1
Korea	6.8	4.1	0.7	-2.7	-3.4

Source: Author's estimation.

Notes: Estimates are yearly averages and numbers may not sum due to rounding.

4. Concluding Remarks

This paper estimates the natural rates of interest for Taiwan, Thailand, and Korea using the HLW methodology. Following HLW, we summarize the results into four main points. First, we find evidence of time-variation in the natural rates of interest for all three economies. Second, the natural rates of interest in these economies have declined during the past few decades. Third, we focus on the impacts from both the AFC and the GFC. Similar to Kim and Park (2013), we find that Korea's natural rate of interest plummeted in the immediate aftermath of both the AFC and the GFC. Meanwhile, Thailand's natural rate of interest fell substantially only after the AFC, and in Taiwan, it declined sharply only after the GFC. Fourth, the estimates of the natural rate of interest in the three economies are uncertain, similar to HLW's estimates in the US, UK, the Euro Area, and Canada.

The third finding-that the movements of the natural rates of interest for these economies were different after the AFC and the GFC-means that an idiosyncratic factor influenced these natural rates. While we present the hypothesis that both a lower investment/GDP ratio and a higher savings ratio might drive and cause the differences on movements of the natural rate of interest in Asian economies, this paper does not investigate the determinants of the natural rates of interest, which could include demographic changes, inequality, or other global factors. Performing formal statistical analysis between the real interest rate and crises and revealing the determinants of the natural rates of interest for these economies deserve further research.

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Appendices

Appendix I: Data

All variables in this paper are consistent with HLW. For each economy, we use real GDP, inflation, and the short-term nominal interest rate as well as a procedure to compute inflation expectations to calculate the ex ante real short-term interest rate, . The variable refers to the logarithms of real GDP. The inflation measure is the annualized quarterly growth rate of the core consumer price series. We use a four-quarter moving average of past inflation as a proxy for inflation expectations in constructing the ex ante real interest rate. Short-term interest rates are expressed on a 365-day annualized basis.

For GDP in Thailand, to complement the quarterly GDP prior to 1993, we use estimated quarterly GDP data from Abeysinghe and Rajaguru (2004). The

Appendix in Abeysinghe and Rajaguru (2004) uses disaggregation techniques to estimate quarterly real GDP for Thailand dating back to 1976, and we extend Thailand's quarterly GDP data retrospectively with these data.

For short-term rates in Thailand and Korea, we splice the policy rates in each economy with other short-term rates: the interbank lending rate in Thailand and the call rate in Korea.

All non-seasonally adjusted data are seasonally adjusted by X-13 ARIMA.

Table A1. Extracted data.

		Source	Original frequency	Extracted data from	SA/ NSA*
Taiwan					
GDP		National Statistics Republic of China (Taiwan)	Quarterly	1982 Q1	SA
CPI	Core	National Statistics Republic of China (Taiwan)	Monthly	January 1981	NSA
Short-term rate	Policy rate	Central Bank of the Republic of China (Taiwan)	Monthly	January 1982	NSA
Thailand					
GDP		Abeysinghe and Rajaguru (2004)	Quarterly	1976 Q1	NSA
		Office of National Economic and Social Development Board	Quarterly	1993 Q1	NSA
CPI	Core	National Statistical Office of Thailand	Monthly	January 1977	NSA
Short-term rate	Interbank lending rate	Bank of Thailand	Monthly	January 1978	NSA
	Policy rate	Bank of Thailand	Monthly	January 1994	NSA
Korea					
GDP		Statistics Korea	Quarterly	1991 Q1	SA
CPI	Core	Statistics Korea	Monthly	January 1990	NSA
Short-term rate	Call rate	Bank of Korea	Monthly	January 1991	NSA
	Policy rate	Bank of Korea	Monthly	May 1999	NSA

Note: SA; seasonally adjusted

NSA; non seasonally adjusted