Assessing nonlinear dynamics of Central Bank reaction function: the case of Asian Emerging Economies

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ABSTRACT

This paper seeks to produce evidence of a dynamic pattern of Central Bank reaction functions during macroeconomic turbulence and the responsiveness of the monetary policy to demand-type external shocks. In this study, we establish a nonlinear Taylor rule, a nonlinear Nominal Feedback rule and a nonlinear Exchange Rate rule, respectively augmented with a Foreign Exchange Reserves term. In these three models, Central Banks are considered to assign shifting weights to each target variable. We then analyze the reaction to macroeconomic conditions during 2000-2011 of four Asian Emerging Economies, which are China, South Korea, Taiwan and Thailand.

Our findings show that only the People’s Bank of China presents characteristics of a hierarchical nonlinearity and asymmetry of target variables in terms of weighting during the recent crisis. Both the Bank of Korea and the Bank of China (Taiwan) exhibit permanent inflation targeting commitment and a structural output-stimulus monetary policy. There are no concluding results as to the behavior of the Bank of Thailand.

JEL classification: C22; E58; E61; F37

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1. Introduction

The common framework for addressing monetary policy rule is mainly established on the assumption of a linear and symmetric Central Bank reaction function i.e. the coefficients of target variables are considered as being constant and evenly weighted. In other words, one major supposal that governs current monetary policy is that Central Banks tend to treat, symmetrically and with the same magnitude, deviations (either positive or negative) of the target variables from their expected values¹. However, the cogency of such rules, even in the aim of better quantifying Central Banks’ reactions, can be to a very large extent offset by a dearth of realism. The rationale is that the general presumption of the linearity of Central Bank reaction function as well as the symmetry of target variables’ weightings renders inconceivable all short term tradeoffs among policy objectives i.e. transitory prevalence of several target variables upon others².

The conventional wisdom suggests that, under normal circumstances, monetary authorities set up a list of policy objectives ranked in a hierarchical order. Nonetheless, Bernanke and Mishkin (1992) pointed out, in this respect, that, Central Banks may exhibit a « crisis mentality » under specific situations, such as shocks. More precisely, when pressures on one target variable become acute i.e. whose evolution diverges significantly from its preset value, the preestablished policy objectives order and their weightings may be subjected to abrupt modifications. This statement, that we suppose at this stage to be relevant, implies thus one conceptual breakthrough. That is, given the Central Banks’ hypothetical proneness to amend their short run priorities when faced with great economic fluctuations, the posit consisting of steady and even weightings of target variables has ineluctably greater difficulty capturing Central Banks’ time-varying preferences³. In this respect, conventional Central Bank reaction functions appear to be unsatisfactory to be used as theoretical benchmarks in times of significant economic turbulences.

Leading researches in the realm of monetary policy have been essentially centered around two contributions. The first proposal is the McCallum rule (1987). Under this framework, the money supply, as the key policy instrument, fluctuates according to the deviation of the nominal GNP growth rate from its target value, which increases in a specific rate. The second suggestion is the nominal interest rule, outlined by Taylor in 1993. The Taylor rule consists of a linear algebraic interest rate rule intended to fine-tune Central Banks’ key interest rate setting. Monetary authorities adjust the key nominal interest rate when the two underlying policy variables - the inflation and the output gap⁴ - deviate from their target

¹ e.g. Svensson (1997)
² Muscatelli and al. (2002) found numerous breaks in interest rate rules for a sample of Central Banks over the last thirty years; Neumann and Von Hagen (2002) exhibit evolving behaviors of six Central Banks relevant to inflation after adopting inflation targeting regime; Orphanidèes (2004) takes the stance that Central Banks in 1970’s were prone to output stimulus while inflation was generally allowed to grow. In recent years however, they tend to concentrate on inflation control rather than on output gap reduction.
³ Cukierman and Muscatelli (2002), Bec et al. (2002) and Ruge-Murcia (2004) found evidence of asymmetric preferences in an inflation targeting regime. In the line of these contributions, Cukierman and Gerlach (2003) showed that monetary authorities exhibit a higher sensitivity to output gaps, especially in case of negative deviations. In this regard, Nobay and Peel (2003) outlined that, under an inflation targeting regime, Central Banks are hawkish on inflation target overshooting but dovish on inflation undershooting, entailing thus a « deflationary bias ». Peterson (2007) points out the necessity of nonlinear and asymmetric Central Bank reaction functions insofar as several target variables are intrinsically nonlinear processes over the business cycles. For instance, inflation tends to increase more rapidly than it decreases; to the contrary, the output often falls sharply, but recovers smoothly.
⁴ Taylor (1993) drives home the point that, contrary to the proposals of Bryant, Hooper and Mann (1993), policies focusing directly on price level and real output produce better performance than those concentrating on money supply or exchange rate.
value. Despite their difference in terms of policy instruments, both these two policy making formulae purport to provide Central Banks with a binding framework for explicit commitment. Teleologically, the shape of both the Taylor rule and the McCallum rule is elaborated, thus, to be linear. Nevertheless, this is where one conceptual shortcoming mentioned above may lie insofar as neither the Taylor rule nor the McCallum rule is designed in a manner that reflects time-varying preferences of monetary authorities. In this respect, these questions about the « crisis mentality » and the shape of Central Banks’ reaction function appear to be all the more interesting in view of the recent financial crisis, which was accompanied by important economic turbulences.

Our contribution to this discussion can be divided into three points. Firstly, the existing literature investigating nonlinear dynamics of monetary policy rules has mainly centered on developed countries in stark contrast to a relative paucity of relevant studies on the subject of Emerging Economies. We establish to that purpose a list of Asian Emerging Economies presenting a great similarity in terms of economic structure, who are China, South Korea, Taiwan and Thailand. Secondly, the recent financial crisis has given rise to a revival of academic interest in the monetary policy regime of Asian economies. Indeed, as Asian Emerging Economies found their growth on export-oriented activities, they take generally into account an implicit exchange rate objective. Hence, both theoretical and empirical reasons exist to suggest possible discrepancy between self-declared monetary policy regime and the one that they follow in reality. That is, for several Asian economies committed to a self-declared inflation targeting regime, an implicit exchange rate goal with the underlying output objective might receive more attention in practice. This statement gives thus some guidance to possible evidence of time-ordered priorities tradeoffs between output and price stability in case of external demand shocks. Finally, albeit elaborated in an attempt to characterize monetary authorities’ behavior, Central Bank reaction function remains a reduced form of policy formula and might oversimplify monetary authorities’ mindset, a fortiori varying over time. In order to obtain a deeper understanding of Asian Central Banks’ overall concerns and to better capture shifting weightings of different policy objectives, we enlarge baseline equations by incorporating additional explanatory variables.

In view of the above, an additional point of interest, at a methodological level, is to be highlighted. In a number of Asian economies, the desire of policy makers as to domestic financial network completion is concretized by gradual adjustment towards market-based interest-rate setting. As a corollary, it implies that the nominal interest rate constitutes progressively the prevailing policy instrument as well as the impetus of the monetary policy transmission, at the expense of money supply control; all the more that the monetary sovereignty of Asian economies may be blunted by the implicit exchange rate goal.

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6 e.g. Dueker and Fischer’s contribution (1996); Bec and al. (2000); Martin and Milas (2004); Assenmacher-Wesche (2006); Petersen (2007)
7 Clarida, Gali and Gertler (2000)
8 In our sample countries, except the People’s Bank of China (PBC) who reiterates its non-commitment to any form of inflation targeting, as well as the Central Bank of China (Taiwan) who remains committed to both inflation targeting and monetary targeting, the Bank of Korea (BOK) and the Bank of Thailand (BOT) declare officially to follow an inflation targeting regime. Yet, the consideration of exchange rate objective might blunt to a very large extent the effectiveness of the inflation targeting. We then classify two sub groups: De jure inflation targeting Central Banks (BOK and BOT); and No specified regime Central Banks (PBC and BOC).
9 Svensson (2003)
10 Mohanty and Klau (2004) found evidence that, for some Emerging Economies endowed with an implicit exchange rate objective, the key policy interest rate reacts significantly to exchange rate fluctuations. Calvo and Reinhart (2002) go further by pointing out that, for a certain number of Emerging Economies’ Central Banks, greater policy rates responsiveness, rather than greater sterilization magnitude (which involves money supply control), account increasingly for exchange rates stabilization.
Nevertheless, for this group of economies, there are equally grounds to take into account the possibility of using other policy instruments than the interest rate. In this respect, the monetary base still remains a credible choice for at least four reasons. (i) The interest-rate transmission channel in a number of Asian Economies may be relatively inefficient if we take into consideration incipient open market procedures as well as a nascent interbank network. (ii) According to the reverse relationship between bond prices and interest rate, several Asian Central Banks may dither on monetary policy tightening, for fear of foisting fixed-income assets depreciations on national commercial banks, who are the bulk of national sterilization bonds holders. (iii) As the capital account of some Asian Emerging Economies is on the way towards full liberalization, international capital flows constitute one major challenge for Asian countries’ economic stability. Given thus the reserve of a certain number of Asian monetary authorities’ as to an increase in their interest rate for fear of capital influx, we may consider the « fear of tightening » as a cause of a relative inelasticity of interest rate variations. (iv) During 2008-2009, we witnessed a generalized conduct of quantitative easing measures in a great number of Asian Economies. In this respect, given the zero bound constraint, the McCallum-type rule is likely to be more relevant than the Taylor rule.

Besides the money supply, another policy instrument may be equally put forth, which is the exchange rate. Indeed, for a number of Emerging Economies, the exchange rate constitutes an efficient monetary policy instrument, given the fact that (i) the interest rate and money supply transmission channels are still uncompleted (for the reasons mentioned above); and (ii) the fact that it exerts direct effects on target variables. Indeed, on the one hand, given the interconnectedness of the domestic inflation and commodity prices (BIS 2011) in Emerging economies, there are grounds to consider that the exchange rate pass-through may constitute a major transmission channel since it contributes, by means of appreciation, to reach desired inflation level. On the other hand, given the fact that this group of countries founds substantially its growth on export-oriented activities, the exchange rate determines, by the same mechanism, the prices of national export products, and, thus, the output.

In summary, this paper purports to verify, in the first instance, a potential « crisis mentality » of Asian Central Banks during the recent crisis i.e. whether the inflation or the output prevailed, and, in the second instance, to determine whether the Taylor-type rule, the McCallum-type rule or the Exchange rate rule helps the best to capture Asian Central Banks’ behavior. The rest of the paper proceeds as follows: Section 2 assesses the two baseline reaction functions. Section 3 presents nonlinear augmented Taylor rule, Nominal Feedback rule and Exchange Rate rule modeling. Section 4 describes the time series data. Section 5 presents the estimates of the two derived reaction functions and discusses the results. Section 6 concludes.

11 Bhattacharya, Patnaik and Shah (2011)
12 Roubini and Setser (2005); Goldstein and Lardy (2005) found relevant evidence in the case of China.
13 Kaminsky (2005) drives home the fact that international capital inflows are likely to elicit bubbles in Emerging Economies’ asset markets and triggers a loss of competitiveness due to an undesirable appreciation of the domestic currency.
14 Institute of International Finance (2010)
15 Ishi, Stone, Yehoue (2009)
16 Adolfson (2001); Bhattacharya, Patnaik, and Shah (2011)
2. Baseline equations

In the realm of monetary policy steerage, the price stability has emerged over the years as the crucial policy objective. The rationale is that, on the one hand, it fosters a greater and sounder economic growth as well as social well-being improvement\(^{17}\), and on the other hand, it comes within the prerogative of Central Banks\(^{18}\). In accordance with this new intermediate objective, contemporary researches have been centered on the manner of how Central Bankers may conduct the monetary policy within their devolved competencies i.e. operational instruments, in a fashion that reduces prices volatility. These specific prerogatives with which Central Banks are endowed have subsequently given rise to a bifurcation in terms of research: the McCallum rule seeking to eliminate inflation by means of money supply control, and the Taylor rule tending to arbitrate between inflation and output gaps through modifications of key interest rate\(^{19}\).

2.1) The Taylor rule

The Taylor rule purports to describe the evolution of the Fed Funds rates in response to the inflation and output fluctuations over the period 1987-1992. Its original form can be specified as follows,

\[
i_t^* = \bar{r}_t + P^* + \alpha(P_t - P^*) + \beta(Y_t - Y_t^*)
\]  

(1)

where \(i_t^*\), as the policy instrument, indicates the nominal short-term key interest rate level; \(\bar{r}_t\) refers to the real interest rate level; \(P^*\) and \(Y_t^*\) are respectively the target value of inflation and output. The terms \(\alpha\) and \(\beta\) denote the relevant weightings that policy makers assign to each target variable. They are assumed to be evenly weighted according to Taylor; \(\alpha = 0.5, \beta = 0.5\).

The Taylor rule considers that the nominal key interest rate should increase when the observed inflation level exceeds its target value, as well as when the output rises above its designed path, and vice versa. In other words, the Taylor rule allows, at least in its standard form, to strike a mechanical balance between prices control and output stimulus by means of modifying the nominal short term interest rate. In equilibrium, as the inflation and the output gaps tend to be null on average, the nominal interest rate is the sum of equilibrium real interest rate and the inflation.

2.2) The McCallum rule

Another monetary policy rule is the McCallum rule (1984), which specifies a trend growth path for monetary base increasing at a preset rate that reflects the long term average of domestic real output growth. The linear algebraic shape of this rule is as follows,

\[
\Delta \ln b_t = \Delta \ln b_{t-1} + \delta_1(\ln Y^*_t - \ln Y^*_{t-1})
\]  

\(\delta_1 > 0\)

(2)

where \(\Delta\) is the difference operator, \(\ln b_t\) is the log of monetary base (policy instrument) for period \(t\); \(\ln Y_t\) is the log of nominal output growth represented by the nominal GNP, \(\ln Y^*_t\) is the log of growth path value for nominal GNP. The term \(\delta_1\) is a feedback coefficient which

\(^{17}\) Robert Lucas (1996), Martin Feldstein (1999)

\(^{18}\) Mishkin (1999)

\(^{19}\) According to the statement of Taylor, policy makers are continuously confronted with a tradeoff between the volatility of the real sphere (output) and the versatility of the prices, especially in the event of supply shocks.
indicates the amendable responsiveness of money base, in terms of direction and magnitude, to deviations in output growth, \( Y_t \), from its target itinerary.

One of the original contributions of the McCallum rule exposed in eq. (2) consists in the fact that it would adjust mechanically the base money growth rate, \( b_t \), in compliance with the nominal GNP’s augmentation, in a manner that would lead eventually to zero inflation on average\(^{20}\). Consequently, at a functional level, the McCallum rule exerts countercyclical effects in that the instrumental rate decreases, in a contractionary way, when the GNP growth momentum is above its trend or its potential value, and vice versa. Equally noteworthy is the fact that the McCallum’s rule is likely to be more relevant than the Taylor rule in a context of deflation and of a zero bound constraint. Under such circumstances, such as the recent crisis, the money supply may maintain the information flow pertaining to Central Banks’ measures, even if the nominal interest rate reaches its lowest level.

2.3) The Dueker-Fischer rule or the Nominal Feedback rule (NFR)

Outlined by Dueker and Fischer (1996), the nominal feedback rule is an extension of the McCallum rule in that it modifies the baseline McCallum rule by incorporating an inflation targeting variable as well as a nominal exchange rate term, and by applying a Markov switching model. This rule can be specified as follows:

\[
\Delta \ln MB_t = \lambda_0(S_1_t) + \lambda_1 \Delta \ln \left( \frac{MB}{P} \right) + \lambda_2(S_1_t)[\ln P^* - \ln P] + \lambda_3(S_2_t)[\ln e^* - \ln e] + \varepsilon(S_1_t, S_2_t)
\]

\[
\varepsilon(S_1_t, S_2_t) \sim \text{Student}_{t-1}; \quad \text{VAR}[\varepsilon(S_1_t, S_2_t)] = \frac{n}{n-2}\sigma^2(S_3_t)
\]

where \( \ln MB_t \) indicates the log of the monetary base; \( \left( \frac{MB}{P} \right)_{t|t-1} \) denotes the monthly real monetary base demand used to derive the « intended inflation rate » of the month\(^{21}\); \( \ln P^* \) and \( \ln e^* \) are respectively the logs of the prices level and the exchange rate target; \( \ln P \) and \( \ln e \) indicate the logs of the contemporaneous levels of the domestic prices and the exchange rate. At a methodological level, one of the most appealing features of the Dueker-Fischer rule consists in the fact that the Markov switching method permits the modeling of successive stochastic switchings which occur with a degree of probability. In this respect, the Dueker-Fischer rule will be used, conjointly with the Taylor rule, as one of the baseline benchmarks for our model extension. (Section 3.1 contains Markov-switching methodological details)

3. Extended models specification

As stated above, both the McCallum-type rule and the Taylor-type rule assume that (i) the Central Bank reaction pattern ought to be linear, in a concern to serve as a commitment framework; and (ii) Central Banks are supposed to react in an even way to deviations of target variables from their desired values. In this respect, the potential « crisis mentality » of Asian Central Banks that we attempt to outline in this paper can be established on a three-postulate basis. Firstly, against a background of a deflationary crisis, Asian Central Banks may have

\(^{20}\) By means of aligning the base money growth with the real revenue increase, the McCallum rule allows to diminish the inflation. Indeed, the shape of Fisher’s « Quantity Theory of Money » (1911) expressed in terms of growth is as follows, \( m + v = p + q \), where \( m, v, p, q \) are the growth of money supply, money base velocity, prices level and output. Consequently, in light of the relation \( p = m - q + v \), we could posit, considering the downward-sloping trend of the money base velocity thank to technological or institutional changes, that the inflation could be mainly explained by the positive differential between exceeding money supply and the real output growth in the long run, in line with the principle of the McCallum rule.

\(^{21}\) Dueker and Fischer (1996)
been tending to take vigorous measures over the output target, since the latter determines to a large extent the level of domestic growth in the mid/short run\textsuperscript{22}. Secondly, according to the potential « crisis mentality », Asian Central Banks may have been led over the period 2007-2011 not merely to maximize the usually devolved weighting of output, but to « overweigh » the coefficient of the latter. That is, in times of great turbulences, crisis-mentality-endowed Central Banks may be prone to a stronger-than-devolved responsiveness to the prior policy objective – the output stability. Thirdly, in case of a prevalence of the output upon the price stability, Asian Central Banks may have exhibited an « overshooting-prone » mindset. That is, they may have had in mind a « finite temporal horizon » i.e. they concentrated on the short run output stimulus, regardless short to mid run inflationary risks.

In an attempt to verify our assumption, major modifications aiming to mitigate the drawback of the two aforementioned baseline equations appear to be necessary. Thus, the presumptions according to which (i) the weightings\textsuperscript{23} that Asian Central Banks assign to each target variable are linear; as well as (ii) equal importance that policy makers grant to inflation and output, are here relaxed. As a corollary, a two-stage model conception will be sequentially presented. In an effort to exhibit the shape (linear/nonlinear) of Asian Central Bank reaction functions, as well as the evolution of target variables in terms of weighting (symmetric/asymmetric), we firstly apply the Markov-switching method to the baseline Taylor rule, Nominal Feedback rule and to an Exchange rate rule (Section 3.1). Secondly, in order to obtain a deeper understanding of Asian Central Banks’ overall concerns, we modify our Markov-switching type rules by adding additional target variables (Section 3.2).

3.1) Specification of nonlinear reaction functions

A number of nonlinear time series models are available for the conduct of our estimations, which are the Smooth Transition Regression model and the Markov-switching model. However, as Petersen stated in his study (2007), the Smooth Transition Regression model provides explanations for endogenous regimes switching i.e. it allows regression coefficients to change smoothly from one regime to another, whereas the Markov-switching model accounts for exogenous regimes switchings i.e. the regression coefficients are subject to abrupt modifications due to straightforward regimes shifting. Consequently, in an attempt to shed light on a possible « crisis mentality » of Asian Emerging Economies during the recent financial crisis, the Markov-switching model appears to be well suited to that purpose. The models amended by a univariate Markov-switching method in our paper are founded on the basis of the Dueker and Fischer’s model. However, a number of amendments are designed in an effort to better fit the case of Asian Emerging Economies. In regard to the first modification, in order to better put forth the « crisis mentality » i.e. overreaction in terms of weighting over the target variable which is deemed to be in danger, we assume in our model that there exists only one status variable, $S_t$, unlike the Dueker-Fischer model. Indeed, the model of Dueker and Fischer is elaborated in a manner that assigns a binary state variable to each parameter (prices, exchange rate and the error term). As a result, with three binary-state variables ($S_1,S_2,S_3$), the model yields eight possible states.

In this paper, we consider Asian Central Banks’ responsiveness to economic fluctuations as falling into a two-state regime. Our model is specified in a fashion that assumes one common binary-state variable for the whole model ($S_t = 1$ or $S_t = 2$). In other words, there exist only two possible states - the « normal regime » and the « crisis regime » -

\textsuperscript{22} As mentioned above, empirical evidence (e.g. Clarida, Gali and Gertler 2000) suggests that Asian Emerging Economies attach significant importance to export activities, which are highly contingent upon the evolution of external demand.

\textsuperscript{23} The assumed linearity of weightings suggests that the value of each target variable is determined by its lagged value (Brainard 1967, Carmichael 1991).
for each target variable. The rationale of this process is that our explanatory model, albeit simplified, has to be as representative as possible of Asian Central Banks’ mindset; a simplification which is characterized by a pros and cons list of a reasonable clarity. Moreover, even if a greater number of state variables may increase the explanatory strength of the model, its complexity may in contrary imply a relative unintelligibility and jeopardizes its primary quality. Equally noteworthy is the fact that there exist two ways to determine which regime that the state \( S_t = 1 \) and the state \( S_t = 2 \) represent respectively. The first method is to refer to the long run inflation target rate, \( \lambda_0(S_t) \). Indeed, we suppose that there exist two states in our switching model, \( S_t = 1 \) or \( S_t = 2 \). Since \( \lambda_0(S_t) \) is the intended inflation target rate, if \( \lambda_0(S_t = 1) < \lambda_0(S_t = 2) \), we may consider that \( S_t = 1 \) is the « normal regime » (low inflation pressure) and \( S_t = 2 \) is the « crisis regime » (high inflation pressure).

In regard to the second modification, we tend to amend the two baseline equations so as to obtain, structurally speaking, a common and comparable basis. As a corollary, we apply the Markov-switching method to the Taylor-type rule and the Dueker-Fischer rule. In this respect, we modify the baseline Dueker-Fischer rule by incorporating a short run inflation rate target in the place of the exchange rate term, in a manner that resembles the Taylor rule; and we do the same concerning the Exchange rate rule.

**Markov-switching type Taylor rule**

The Taylor-type rule modified by the Markov-switching method can be rewritten as in eq. (4):

\[
i_t = \delta \tilde{r}_t + \lambda_0(S_t) + \lambda_1(S_t)[\ln \tilde{Y} - \ln \tilde{Y}^*_t]_{t-1} + \lambda_2(S_t)[\ln \tilde{P} - \ln \tilde{P}^*_t]_{t-1} + \varepsilon(S_t); \varepsilon(S_t) \sim \text{Normal}(0, h_t)
\]

where \( i_t \) is the key policy interest rate; \( \tilde{r} \) is the real interest rate; \( \ln P_t \) and \( \ln Y_t \) indicate the logs of price and output monthly growth levels; \( \ln P^* \) and \( \ln Y^*_t \) denote the logs of the target price and output levels; \( \lambda_0(S_t) \) refers to the Monetary authorities’ target long-run inflation level; \( \lambda_1 \) and \( \lambda_2 \) are the respective weights (corrective coefficients) of output and inflation deviations of the previous period. \( \lambda_0, \lambda_1 \) and \( \lambda_2 \) are time-varying coefficients with random walk procedure. As Central Banks utilize the gaps between variables’ observed value and variables’ target value in the previous period as an error-correction mechanism, we delay each target variable’s value with one period.

**Markov-switching type Nominal Feedback rule**

The Nominal Feedback rule, analogous to the one used in Dueker and Fischer’s paper (1996), is here modified and can be presented as in eq. (5):

\[
\Delta \ln MB_{t|t-1} = \lambda_0(S1_t) + \lambda_1 \Delta \ln \left(\frac{MB}{P}\right)_{t|t-1} + \lambda_2(S_t)[\ln \tilde{Y} - \ln \tilde{Y}^*_t]_{t-1} + \lambda_3(S_t)[\ln \tilde{P} - \ln \tilde{P}^*_t]_{t-1} + \varepsilon(S_t); \varepsilon(S_t) \sim \text{Normal}(0, h_t)
\]

where \( \ln MB_{t|t-1} \) indicates the log of the seasonally adjusted monetary base; \( \left(\frac{MB}{P}\right)_{t|t-1} \) denotes the monthly real monetary base demand used to derive the « intended inflation rate » of the month \(^{25}\). Other variables remain the same as in the previous Taylor-type equation. In this second scenario, we assume that Asian Central Banks utilize the

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\(^{24}\) In case of equality between the short term target value and the real value of inflation and output, that is, between \( \tilde{Y} \) and \( \tilde{Y}^* \), and \( \tilde{P} \) and \( \tilde{P}^* \), \( \lambda_0(S_t) \) is the differential of \( i_t \) and \( \tilde{r} \). In other words, \( \lambda_0(S_t) \) can be considered, under \( S_t = 1 \) or \( S_t = 2 \), as the long-run inflation growth target.

\(^{25}\) Dueker and Fischer (1996)
monetary base as the policy instrument. For the record, this equation, derived from the baseline Dueker-Fischer rule, is constructed in a manner that resembles the previous Taylor type reaction function. As these two rules are tantamount one to another, structurally speaking, this reconstruction allows to better shed light on the potential tradeoff of Asian Central Banks between the inflation and the output.

**Markov-switching type Exchange rate rule**

As mentioned above, theoretical argument and empirical evidence point out the fact that the exchange rate might constitute a major and independent adjustment variable in a number of Emerging economies, aside from the interest rate and the money supply transmission channels. The Exchange rate rule, modeled on the shape of the two previous rules, can be written as in e. (6):

\[
\Delta \ln \hat{e}_{t|t-1} = \lambda_0(S_t) + \lambda_1(S_t) [\ln Y - \ln Y^*] + \lambda_2(S_t) [\ln P - \ln P^*] + \varepsilon(S_t); \quad (6)
\]

where \(\Delta \ln \hat{e}_{t|t-1}\) is the variation of the exchange rate, calculated on the basis of direct exchange rate against the US dollar\(^{26}\); other variables remain the same as in the previous rules. It is noteworthy that, for the Exchange rate rule, we consider that, contrary to the smoothing pattern that the interest rate might have, the exchange rate is adjusted to target variables in same period, as the impulse of its effects to the real economy is itself lagged.

At a methodological level, the assigned weights of each target variable, ruled by an unobservable state variable, \(S_t\), which indicates the binary state variable subject to two possible states, \(S_t \in \{1, 2\}\). The switching of the state variable exposes random movements by following in this respect a first-order Markov chain. Given the no a-priori assumptions of target priorities in the mindset of Asian Central Banks, the transition probability of the state variable, \(S_t \in \{1, 2\}\), follows in this respect a first-order Markov chain in accordance with the specification of Hamilton’s autoregressive model (1989): \(P[S_t = j|S_{t-1} = i, S_{t-2} = k, \ldots] = P[S_t = j|S_{t-1} = i]\). We define four transition probabilities for the two state-variables: \(P[S_1 = 0|S_{1|t-1} = 0] = p_1\); \(P[S_1 = 1|S_{1|t-1} = 1] = q_1\); \(P[S_2 = 0|S_{2|t-1} = 0] = p_2\); \(P[S_2 = 1|S_{2|t-1} = 1] = q_2\). The error term, \(\varepsilon_t\), follows a i.i.d. Normal distribution with \(n\) degree of freedom, \(n\) as the number of samples. Its probability density function can be written as follows:

\[
f(t) = \frac{\Gamma\left(\frac{v+2}{2}\right)}{\Gamma\left(\frac{v}{2}\right)} \cdot \frac{1}{\nu^{v}} \cdot (1 + \frac{t^{2}}{v})^{-(v+1)/2} ; \quad E(t) = 0, Var(t) = v/(v-2). \]

The maximum log likelihood function is established by:

\[
\log f(Y_t, Y_{t-1}, \ldots, Y_1|Y_0, Y_{-1}, \ldots, Y_{-r+1}) = \sum_{t=r+1}^{T} \log f(Y_t|Y_{t-1}, Y_{t-2}, \ldots, Y_{r+1})
\]

**Evidence of the Crisis Mentality**

Table 1 assesses the responsiveness of policy instruments to the inflation gap and the output gap. It shows expected signs of target variables’ coefficients in our estimations. Under the binding inflation targeting scenario, the expected sign under both regimes (low/high inflationary pressures) of the inflation gap ought to be positive for the Taylor rule; negative for the Nominal Feedback rule; and negative for the Exchange Rate rule. In regard to the output gap, we do not presume the coefficient signs under the normal regime in that the output gap deviation do not imply necessarily supplementary inflationary pressures and the Central Bank do not automatically take it into account at the risk of impeding untimely the output. Under the high inflation regime, however, we consider that the output could constitute an

\(^{26}\) In this case, we may consider that there exists, in our sample countries, exchange rate pegs against the US dollar. The currency pairs in our model are: USD/CNY; USD/WON; USD/TWD; USD/THB.
extra source of inflationary pressures. Therefore, the productive-origin inflation (core inflation) is likely to be integrated into the headline inflation consideration. Under the hypothesis according to which tradeoffs are operated in favor of the output, we consider that this scenario occurs exclusively under the crisis regime (S2 is deemed as the status under which the deviation of output gap is to be acute). In this case, we suppose that the Central Bank concentrates on output stimulus. However, we do not presume its responsiveness to the level of inflation deviation in that the exclusion of the latter may be an evidence of what we consider as to an «overshooting-prone» behavior.

### Table 1

<table>
<thead>
<tr>
<th>Dependant variables</th>
<th>Binding inflation targeting scenario</th>
<th>Output-oriented tradeoff scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lnY &gt; lnY*</td>
<td>lnP &gt; lnP*</td>
</tr>
<tr>
<td>Nominal interest rate</td>
<td>NP</td>
<td>+</td>
</tr>
<tr>
<td>Money base (M0)</td>
<td>NP</td>
<td>-</td>
</tr>
<tr>
<td>Exchange rate</td>
<td>NP</td>
<td>-</td>
</tr>
</tbody>
</table>

NP : not presumed
* : null

### 3.2) Specification of the augmented Markov-switching type models

At this stage, we modify the three aforementioned Markov-switching type reaction functions by adding other «intermediate information variables». As mentioned above, one major characteristic of Monetary Policy rules consists in its clarity i.e. ability to react straightforwardly to economic fluctuations on a basis of a given number of explanatory variables. This implies that Central Bank reaction functions are designed to be representative of the economy in a reduced form. Nevertheless, it is noteworthy that this simplification may undermine to a very large extent the explanatory quality of the reactions functions. Furthermore, Central Banks may attach equal importance in practice to other «intermediate information variables» beside inflation and output. The rationale is that a number of economic aggregates not only provide complementary information as to the two key target variables but also take part in the composition of the latter. As a result, in recent literature, attempts have been made to structurally incorporate supplementary explanatory variables and, thus, to assume the existence of «augmented» reaction functions (e.g. Dueker and Fischer 1996). Accordingly, we integrate, in order to maximize the likelihood of our Markov-switching type Taylor rule, Nominal Feedback rule and Exchange rate rule, the foreign exchange reserves.

As stated above, theoretical and empirical reasons exist to suppose that the exchange rate might constitute the prevailing adjustment variable in a number of Emerging economies for two reasons. In the first instance, the underdeveloped financial network renders probably ineffective interest rate and money supply transmission mechanisms channels. In the second instance, the exchange rate is likely to be more efficient as it exerts direct effect on inflation (by means of influencing international commodities prices) and on output (by means of determining the external competitiveness of national products). This last assertion is all the more convincing that Asian Emerging Economies are proved to be endowed with implicit exchange rate goal. In this respect, an additional interest in verifying this supposal stems from
the fact that it could help to prove the potential « crisis mentality » of Asian Central Banks during the recent crisis in that the exchange rates may have fluctuated in an effort, either to curb inflation, or to shore up export-oriented production.

The above assumption of exchange rate objective leads subsequently to our added explanatory variable, which is the Foreign Exchange Reserves. Despite the preteritions of most Asian Central Banks in this regard, the accumulation of foreign exchange reserves may be considered (BIS 2006), among others, as a sign of an implicit exchange rate objective. In other words, the maintenance of specific exchange rates levels in a number of Asian Emerging Economies yields generally massive sterilization measures. Nevertheless, at an empirical level, one underlying risk relevant to sterilized interventions attracts attention. As the sterilization aims to offset purchased foreign exchange by releasing a quantity of domestic currency – the Funds outstanding for foreign exchange (accompanied by the sale of equal-value domestic bonds issued either by the Central Bank or by the Treasury), this operation may continue on condition that it remains sustainable in view of the monetary sovereignty and of the returns spread level.

That is, on the one hand, the core money supply (independently of the level of the funds outstanding for foreign exchange) must remain under control i.e. the sterilization must not be partial. On the other hand, the spread between the cost of issuing sterilization bonds and the returns on foreign assets should continue to stay profitable to the Central Bank. In substance, besides imported-inflationary risk, Asian Central Banks’ responsiveness to the variations of foreign exchange reserves raises equally the vital issue of both the intensity and the magnitude of the exchange rate depreciation. Thus, the integration of the Foreign Exchange Reserves as explanatory variable shall put the emphasis on the right balance between the necessity of acting on target variables in danger and the constraints that the sterilization foists on Central Banks’ room for maneuver.

In light of foregoing, we add a Foreign Exchange Reserves variation term, which does not depend on our status variable. Our Markov-switching type Taylor rule, Nominal Feedback rule and Exchange rate rule can be rewritten as follows:

### Augmented Markov-switching type Taylor rule

\[
t_t = \delta \bar{r}_t + \lambda_0(S_t) + \lambda_1(S_t)[\ln \bar{Y} - \ln \bar{Y}^*]_{t-1} + \lambda_2(S_t)[\ln \bar{P} - \ln \bar{P}^*]_{t-1} + \lambda_3[\Delta \ln \text{FXRES}]_{t|t-1} + \varepsilon(S_t); \varepsilon(S_t) \sim \text{Normal}(0, \sigma_t)
\]

### Augmented Markov-switching type Nominal feedback rule

\[
\Delta \ln MB_{t|t-1} = \lambda_0(S1_t) + \lambda_1(S_t)\Delta \ln \left(\frac{MB}{P}\right)_{t|t-1} + \lambda_2(S_t)[\ln \bar{Y} - \ln \bar{Y}^*]_{t-1} + \lambda_3(S_t)[\ln \bar{P} - \ln \bar{P}^*]_{t-1} + \lambda_4[\Delta \ln \text{FXRES}]_{t|t-1} + \varepsilon(S_t); \varepsilon(S_t) \sim \text{Normal}(0, \sigma_t)
\]

---

27 Hernandez and Montiel (2001); McKinnon and Schnabl (2004) point out that, most Eastern Asian Emerging Economies pledge to accumulate foreign exchange reserves in the aim of keeping their exchange rate against abrupt appreciation.
28 Prasad (2010) found evidence of an implicit exchange rate objective for China, which results in massive sterilization measures.
29 The purchased foreign exchange reserves are mostly transformed in foreign currency denominated assets, usually the US Treasury bills.
30 Greenwood (2008)
31 We consider that the responsiveness of the policy instruments to the Foreign Exchange Reserves is structural and, thus, independent of switching regimes
Augmented Markov-switching type Exchange rate rule

\[ \Delta \ln e_{t|t-1} = \lambda_0(S_t) + \lambda_1(S_t)[\ln \bar{Y} - \ln \bar{Y}^*]_{t-1} + \lambda_2(S_t)[\ln \bar{P} - \ln \bar{P}^*]_{t-1} + \lambda_3[\Delta \ln FXRES]_{t|t-1} + \varepsilon(S_t); \varepsilon(S_t) \sim Normal(0, h_t) \]  

(9)

4. Data description

The data used in this study is monthly. The sample covers the following periods: January 2000 to December 2011, which corresponds to the period during which the recent financial crisis occurred. However, given the annual basis of the computed inflation growth rate (year-to-year), we delay each value with one period. Hence, the sample really covers the periods from February 2000 to December 2011. The prices level gap and the output gap are measured by means of a Hodrick-Prescott filter, which is given by \( \min \sum_{t=2}^{T}(y_t - T_t)^2 + \lambda t=2T-1[Tt+1-Tt-(Tt-Tt-1)])/2 \). Thus, \( P^* \) and \( Y^* \), are respectively the Hodrick-Prescott trend of \( \bar{P} \) and \( \bar{Y} \). A detailed description of all variables used in this paper can be found in Appendix. All estimations are performed with MATLAB.

5. Estimation results and interpretation

The estimates of the three aforementioned rules described in eq. (7), (8) and (9) are summarized in the Table 2.

5.1) China

Table 2 China\(^{32}\)

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Taylor rule</th>
<th>Nominal feedback rule</th>
<th>Exchange rate rule</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( S_t = 1 )</td>
<td>( S_t = 2 )</td>
<td>( S_t = 1 )</td>
</tr>
<tr>
<td>Switching parameters</td>
<td>( \lambda_0 ) (intended inflation)</td>
<td>( -6.6623 ) (0.00)*</td>
<td>( -0.0008 ) (0.00)*</td>
</tr>
<tr>
<td></td>
<td>( \lambda_1 ) (output gap)</td>
<td>( 3.2868 ) (0.00)*</td>
<td>( 0.1471 ) (0.00)*</td>
</tr>
<tr>
<td></td>
<td>( \lambda_2 ) (inflation gap)</td>
<td>( 23.3406 ) (1.00)</td>
<td>( -23.3576 ) (0.00)*</td>
</tr>
<tr>
<td></td>
<td>Transition Prob. Matrix</td>
<td>( 0.84 )</td>
<td>( 0.12 )</td>
</tr>
<tr>
<td></td>
<td>Duration Regime</td>
<td>( 6.44 )</td>
<td>( 8.06 )</td>
</tr>
<tr>
<td>Non-Switching parameters</td>
<td>( \lambda_3 ) (exchange reserves)</td>
<td>( 65.5805 ) (0.00)*</td>
<td>( 0.0540 ) (0.00)*</td>
</tr>
</tbody>
</table>

***- denotes coefficient significance at the 10 level
** - denotes coefficient significance at the 5 level
* - denotes coefficient significance at the 1 level

\(^{32}\) It is noteworthy, for a better comprehension of subsequent development, that the crisis regime is systematically underlined.
-Taylor rule

Table 2 shows the results from running exercises using an Augmented Markov-switching Taylor rule for China. Firstly, according to the model’s variance, it appears that only the $S_2$ is econometrically significant and that there is no glaring sign of regime shifting. In addition, as $\lambda_0(S_t)$ is the intended inflation target rate, in case $\lambda_0(S_t = 2)$ is greater than $\lambda_0(S_t = 1)$, we may consider that $S_t = 1$ is the « normal regime » (low inflation pressures) and $S_t = 2$ is the « crisis regime » (high inflation pressures) in that the lower (higher) intended inflation target value underlies equally lower (higher) prices level in the economy. In this respect, the findings show that, given the constant term, $\lambda_0$, standing at -6.6623 under $S_1$ and at -0.4615 under $S_2$, $S_2$ could be considered as the crisis regime\(^\text{33}\). Moreover, this statement suggests that, over the sample period, the Chinese economy may have been continuously remaining under one unique status, which is a high inflation target regime.

Secondly, the findings show that: (i) the coefficient of the inflation gap stands at -23.3576 under $S_2$. That is, an increase of 1 percent in the inflation gap of the previous period is likely to yield a decrease of 23.3576 percent in the nominal interest rate (Average Repo rate); (ii) the coefficient of the output gap stands at -3.2836 under $S_2$. That is, an increase of 1 percent in the output gap of the previous period leads to a decrease of 3.2836 percent in the nominal interest rate; (iii) the coefficient of the Foreign Exchange Reserves stands at 65.5805. In other words, an increase of 1 percent in the Foreign Exchange Reserves of the previous period leads to an increase of 65.5805 percent in the nominal interest rate.

In light of foregoing, the nominal interest rate appears to react significantly to the inflation gap and to the output gaps’ deviation but in a counterintuitive way since, instead of rising in order to curb inflationary and overheating pressures, it decreases. Thus, we consider that the estimates of the Taylor rule do not provide at this stage sufficient and coherent information to characterize the People’s Bank of China (PBOC)’s mindset.

-Nominal Feedback rule

According to Table 2, both the two regimes are econometrically significant. As $\lambda_0$ stands at -0.0008 under $S_1$ and at 5.7238 under $S_2$, $S_1$ may be considered as the normal regime, and $S_2$ the crisis regime. The findings show that the duration of $S_1$ is higher than that of $S_2$. Consequently, it can be contended that the Chinese economy has been remaining, for the major part of the sample period, under the normal regime. The results indicate that: (i) the coefficient of the inflation gap stands at -0.1025 under $S_t = 1$ and at 0.1346 under $S_t = 2$. That is, under the normal regime, an increase of 1 percent in the inflation gap of the previous period is supposed to lead to a decrease of 0.1025 percent in the money base supply (M0), whereas, under the crisis regime, an increase of 1 percent in the inflation gap is likely to yield an increase of 0.1346 percent in the money base supply; (ii) the coefficient of the output gap stands at 0.1471 under $S_1$, while it stands at -0.1502 under $S_2$. That is, an increase of 1 percent in the output gap of the previous period underlies an increase of 0.1471 percent in the M0 supply under $S_1$, while an increase of 1 percent in the output gap elicits a decrease of 0.1502 percent in the money base supply under $S_2$; (iii) the coefficient of the Foreign Exchange Reserves stands at 0.0540. In other words, an increase of 1 percent in the Foreign Exchange Reserves of the previous period leads to an increase of 0.0540 percent in the money base supply.

\(^{33}\) For notation convenience, the normal regime and the crisis regime refer respectively to the low inflation regime and the high inflation regime for the rest of the paper.
In view of the above, it is noteworthy that, under both regimes, the inflation gap and the output gap carry contradictory signs. That is, the findings suggest that the monetary policy reacts concomitantly to the inflation gap and to the output gap in an opposite direction. Given the uniqueness of the policy instrument, this interpretation appears to be unsatisfactory. Furthermore, the shifting coefficient signs of the inflation gap and the output gap from one regime to another cast doubt on the validity of any interpretation. In this respect, we verified the data and found that the money base has varied in both direction (upward/downward) in reaction to the inflation gap and the output gap’s augmentation. Thus, the estimates of the Nominal Feedback rule do not provide sufficient information from an economic standpoint.

-Exchange rate rule

Table 2 indicates that both the two regimes are econometrically significant. Since $\lambda_0$ stands at -0.0041 under $S_1$ and at 0 under $S_2$, $S_1$ may be considered as the normal regime. The duration of $S_1$ is higher than that of $S_2$. To summarize, the estimates suggest that the Chinese economy has been staying under the normal regime longer than under the crisis regime. The results show that: (i) the coefficient of the inflation gap stands at -0.0684 under $S_t = 1$ and at 0.0014 under $S_t = 2$. That is, under the normal regime, an increase of 1 percent in the inflation gap of the previous period yields a decrease of 0.0684 percent in the nominal exchange rate (USD/CNY), whereas, under the crisis regime, an increase of 1 percent in the inflation gap underlies an increase of 0.0014 percent in the exchange rate; (ii) the coefficient of the output gap stands at -0.0462 under $S_1$, while it stands at 0.0837 under $S_2$. That is, an increase of 1 percent in the output gap of the previous period leads to decrease of 0.1471 percent in the nominal exchange rate under $S_1$, while an increase of 1 percent in the output gap elicits an increase of 0.0837 percent in the nominal exchange rate under $S_2$; (iii) the coefficient of the Foreign Exchange Reserves stands at 0.0006.

In other words, an increase of 1 percent in the Foreign Exchange Reserves of the previous period leads to a decrease of 0.0006 percent in the nominal exchange rate. In sum, the PBOC exhibits a high responsiveness to both inflation gap and output gap targets’ attainment, by means of currency appreciation under the normal regime, whereas it is prone to currency depreciation under the crisis regime in response to the same variables. In addition, the PBOC appears to react significantly to Foreign Exchange Reserves’ upsurge by means of appreciation.

![Evolution trend of Exchange rate and Commodity prices](image_url)

*Red dotted line refers to the trend curve of the exchange rate USD/CNY; Blue dotted line indicates the trend curve of the Commodity prices*

Source: Author

**Figure 1**
In light of foregoing, three possible interpretations could be put forward. In the first instance, as stated above, there exists strong correlation between the domestic prices level and the international commodity prices in several Asian Emerging Economies (BIS 2011). Thus, there are grounds to consider that the PBOC is generally committed to an inflation targeting under S1 as the Yuan appreciates against US dollar in an attempt to lessen US dollar-denominated commodity prices and, thus, to mitigate imported inflation (Figure 1). In this respect, it is noteworthy that, given the lower responsiveness of the exchange rate to the output gap, the PBOC reacts to a lesser extent to the output target attainment under the normal regime. One interpretation of this slight asymmetry of the two target variables in terms of weighting could be the fact that, given the lesser importance granted to the output gap, Chinese monetary authorities seem to concentrate more efforts on reducing the inflation gap rather than on lessening the output gap. Nevertheless, in absolute terms, the PBOC is likely to pursue a binding inflation targeting under S1 as the weights of both the inflation gap and the output gap remain high.

In the second instance, when the inflationary pressures are to be acute, we notice that the Yuan depreciates against the USD in response to both the inflation gap and to the output gap’s increase. That is, instead of letting the currency appreciation mitigate imported inflation, the PBOC is prone to an accommodative exchange rate policy. Possible explanations can be advanced according to which a high inflation corresponds equally to an important appreciation in real term of the Chinese currency, in view of the Real Exchange Rate. Thus, currency depreciation in this case may be in line with the attempt of shoring up the output by maintaining externally and rapidly the price-competitiveness of national export firms, rendering the domestic prices level adjustment secondary. In this regard, this behavior seems to be close to what we suppose to be an « overshooting-prone » mindset insofar as the exchange rate policy appears to be glaringly output-oriented (0.0837), at the expense of the price stability (0.0014) under the crisis regime. An additional question can be raised here about the reason why the PBOC abides by a binding inflation targeting under the normal regime rather than under the crisis regime. Possible explanation could be the fact that, for the PBOC, it appears to be less costly to combat inflation when the inflationary risks are still at a low level and it strives to impede the economy from falling into the high inflation regime, as shows the transition probability according to which the probability for the Chinese economy to remain under $S1 stands at 97%.

In the third instance, theoretical and empirical reasons exist to suggest that the maintenance of a preset exchange rate level results in massive sterilization measures. That is, Central Bank purchases surplus anchor currencies in an effort to arrest domestic currency appreciation. As stated above, sterilization measures imply structural and important constraints. Once these impediments are deemed by the Central Bank to be unsustainable in terms of monetary sovereignty and of return spread levels, we suppose that the monetary authorities will be led to alleviate the exchange rate commitment. The estimates corroborate this assertion in that the Yuan is tending to appreciate against the USD in response to the upsurge in Foreign Exchange Reserves.

34 In support of this assertion, the significance of the inflation gap (3%) is higher than the output gap (10%).
Figure 2

Figure 2 puts the emphasis on three transitions of the Chinese economy over the sample period. The results suggest that the Chinese economy has had remained under the crisis regime (S2) from February 2000 to February 2005. The PBOC was then committed to a vigorous output-stimulus framework, even in a context of high inflationary pressures (\( \lambda_1 = 0.0837 > \lambda_2 = 0.0014 \)). It shifted to the normal regime (S1) from February 2005 - April 2009. During this period, the PBOC was committed to a relatively binding inflation targeting framework (\( \lambda_2 = -0.0684 > \lambda_1 = -0.00462 \)). From April 2009 to April 2010 (S2), the Chinese economy has had returned to the crisis regime. More precisely, facing generalized deflationary risks, the PBOC has prioritized the output and conducted accommodative exchange rate policy (\( \lambda_1 = 0.0837 > \lambda_2 = 0.0014 \)). And finally, since April 2010, we observe that the PBOC has rendered again the inflation targeting as the prevailing framework. Possible reason of this return could be that the output-stimulus exchange rate policy that we witnessed during the recent crisis has yielded incipient inflationary risks.

In light of foregoing, the observation corroborates our assertions according to which the PBOC has exhibited, during the recent external demand shock, time-ordered priorities shifting between output and price stability. Indeed, this hierarchical tradeoff has occurred twice: (i) During the period of shock in favor of the output (April 2009-April 2010). The PBOC, endowed with a « finite temporal horizon », exhibited an « overshooting-prone » mindset i.e. concentrated on the sole output, regardless potential subsequent imported inflation risks. (ii) During the period of post-crisis (April 2010-November 2011). Once the output stability has been restored, the regime shifted back to the binding inflation targeting framework in an effort to tame headline inflation (both overheating and imported inflationary risks).

To summarize, from an econometric and economic standpoint, the Exchange Rate rule appears to be the most pertinent framework to describe the behavior of the PBOC in comparison with the Taylor rule and the Nominal Feedback rule. Three conclusions can be drawn. That is, (1) the exchange rate pass-through appears to be the prevailing transmission channel for the PBOC’s monetary policy; (2) the PBOC’s reaction function does present hierarchical nonlinear characteristics as well as a « crisis mentality », given the time-varying policy preferences between the price stability (normal regime) and the output stimulus (crisis regime). Equally noteworthy in this respect is the fact that, for the Chinese economy, the regime switching triggers concomitantly a clear-cut Central Bank’s mindset shifting, which implies a different monetary policy stance; (3) the assumption of asymmetric weighting of target variables is to be revised in that, given the mindset shifting, the inflation gap appears to receive more importance under the normal regime, while the output stimulus seems to be the prior objective under the crisis regime.

35 The 66th observation corresponds to this date.
5.2) South Korea

Table 3 Korea

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Taylor rule</th>
<th>Nominal feedback rule</th>
<th>Exchange rate rule</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Switching parameters</strong></td>
<td>$S_t = 1$</td>
<td>$S_t = 2$</td>
<td>$S_t = 1$</td>
</tr>
<tr>
<td>Model’s variance</td>
<td>1.834794 (0.00)*</td>
<td>0.936179 (0.00)*</td>
<td>0.000013 (0.00)*</td>
</tr>
<tr>
<td>$\lambda_0$ (intended inflation)</td>
<td>-12.8748 (0.00)*</td>
<td>3.9193 (0.00)*</td>
<td>0.9952 (0.00)*</td>
</tr>
<tr>
<td>$\lambda_1$ (output gap)</td>
<td>4.5420 (0.00)*</td>
<td>4.2876 (0.00)*</td>
<td>-0.0129 (0.00)*</td>
</tr>
<tr>
<td>$\lambda_2$ (inflation gap)</td>
<td>6.3997 (0.00)*</td>
<td>-3.3948 (0.00)*</td>
<td>-0.2805 (0.00)*</td>
</tr>
<tr>
<td>Transition Prob. Matrix</td>
<td>0.40 0.00</td>
<td>1.00 0.60</td>
<td>0.91 0.24</td>
</tr>
<tr>
<td>Duration Regime</td>
<td>1.68 inf</td>
<td>1.68 inf</td>
<td>11.71 4.08</td>
</tr>
<tr>
<td><strong>Non-Switching parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\lambda_3$ (exchange reserves)</td>
<td>-9.7315 (0.00)*</td>
<td>-0.0255 (0.00)*</td>
<td>-0.2289 (0.10)***</td>
</tr>
</tbody>
</table>

**- denotes coefficient significance at the 10 level
**- denotes coefficient significance at the 5 level
* - denotes coefficient significance at the 1 level

-Taylor rule

Table 3 shows the results from running exercises using an Augmented Markov-switching Taylor rule for South Korea. It indicates that both the two regimes are econometrically significant. Given the fact that $\lambda_0$ stands at -12.8748 under $S1$ and at 3.9193 under $S2$, $S1$ may be considered as the normal regime, and $S2$ the crisis regime. The duration of $S2$ is infinitely higher than that of $S1$. That is, over the sample period, the Korean economy may have been constantly remaining under the crisis regime. The findings show that: (i) the coefficient of the inflation gap stands at -3.3948 under $S_t = 2$. That is, an increase of 1 percent in the inflation gap of the previous period is supposed to lead to a decrease of 3.3948 percent in the nominal interest rate (Overnight Interbank rate); (ii) the coefficient of the output gap stands at 4.2876 under $S_t = 2$. That is, an increase of 1 percent in the output gap of the previous period is likely to elicit an increase of 4.2876 percent in the nominal interest rate; (iii) the coefficient of the Foreign Exchange Reserves stands at -9.7315. In other words, an increase of 1 percent in the Foreign Exchange Reserves of the previous period leads to a decrease of 9.7315 percent in the nominal interest rate.

In view of the above, the responsiveness of the nominal interest rate to the inflation gap and to the output gaps’ deviation appears to carry contradictory sings in a partially counterintuitive way. That is, instead of rising in an attempt to tame high inflationary pressures the nominal interest rate decreases. Moreover, the findings suggest that the nominal interest rate reacts to the inflation gap and to the output gap in an opposite direction. Thus, we consider that the estimates of the Taylor rule appear to be inconsistent and do not provide satisfactory information from an economic standpoint.
-Nominal Feedback rule

According to Table 3, both the two regimes are econometrically significant. As $\lambda_0$ stands at 0.9952 under $S1$ and at -0.4241 under $S2$, $S2$ may be considered as the normal regime, and $S1$ the crisis regime. The findings suggest that the high inflation regime has been the prevailing regime, given the infinite duration of $S1$. Hence, we may consider that the Korea economy has been staying over the sample period exclusively under the crisis regime. The results show that: (i) the coefficient of the inflation gap stands at -0.2805 under $S1$. That is, an increase of 1 percent in the inflation gap of the previous period implies a decrease of 0.2805 percent in the money base supply; (ii) the coefficient of the output gap stands at -0.0129 under $S1$. That is, an increase of 1 percent in the output gap of the previous period underlies a decrease of 0.0129 percent in the M0 supply; (iii) the coefficient of the Foreign Exchange Reserves stands at -0.0255. In other words, an increase of 1 percent in the Foreign Exchange Reserves of the previous period leads to a decrease of 0.0255 percent in the money base supply. In sum, the BOK exhibits a high responsiveness to the inflation gap attainment and to the output gap maintenance to a lesser extent, by diminishing the money base supply under the crisis regime. In addition, the BOK responds significantly to Foreign Exchange Reserves’ upsurge by means of money supply reduction.

In light of foregoing, possible interpretations can be divided into two points. Firstly, we observe that the Bank of Korea (BOK) tends to conduct restrictive money supply policy in response to the inflation gap and the output gaps’ deviations. Furthermore, the BOK appears to attach more importance to inflation target attainment rather than to output gap reduction in that the money base supply exhibits a higher responsiveness to the inflation gap variation ($-0.2805$) than to the output gap deviation ($-0.0129$). This asymmetry in terms of weighting may derive from two considerations. In the first instance, given the structural prevalence of the inflation gap maintenance upon the output, we may consider that the BOK is committed to a binding inflation targeting framework and that there is congruence between the de jure and the de facto monetary policy regime in South Korea. In the second instance, the low sensitivity of the BOK to the output gap deviation may denote a relative “let-it-go” approach, even if the overheating risks are taken into account, as shows the negative and non null sign of the output gap coefficient.

Secondly, as stated above, a preset exchange rate maintenance implies structural foreign currencies purchase and sterilization. In this regard, it is to be noticed that the Republic of Korea operates officially and in practice flexible exchange rate regime. That is, Korean monetary authorities are committed neither to defend permanently any currency peg nor to purchase structurally surplus foreign currencies. However, Higgins and Klitgaard (2004) point out the fact that, for South Korea, the accumulation of Foreign Exchange Reserves is operated in an effort to strengthen its capital account soundness against sudden-stop type risks rather than to defend any exchange rate goal. In view of the above, questions are inevitably raised here about the correlation between the rarefaction of the money supply and the augmentation of Foreign Exchange Reserves. Possible explanation could be the fact that the offset of purchased foreign exchange implies the release of an even quantity of funds outstanding for foreign exchange. As stated above, sterilization measures are feasible as long as it remains sustainable in view of the monetary sovereignty and of the returns spread level.

36 Rajan (2010)
37 The BOK does not exclude, however, exceptional external operations when faced with transitory shocks (e.g. momentary currency peg), as shows its public announcement: “The exchange rate is, in principle, decided by the interplay of supply and demand in the foreign exchange markets. However, the Bank of Korea implements smoothing operations to deal with abrupt swings in the exchange rate caused by temporary imbalances between supply and demand, or radical changes in market sentiment.”
This statement is edifying for the case of Korea that the previous findings indicate as pursuing a binding inflation targeting. That is, beyond a threshold, the diminution of the monetary sovereignty i.e. the money supply becomes contingent on the amount of the funds outstanding for foreign exchange, puts the economy under inflationary pressures, all the more if the sterilization remains partial. Consequently, given the effective inflation targeting to which Korea commits itself, there are grounds to consider that the rarefaction of the money supply in reaction to the Foreign Exchange Reserves denotes the BOK’s desire of currency appreciation and thus its attempt of taming the inflation.

-Exchange rate rule

Table 3 indicates that both the two regimes are econometrically significant. Since $\lambda_0$ stands at -0.0025 under $S_1$ and at 0.0132 under $S_2$, $S_1$ may be considered as the normal regime, and $S_2$ the crisis regime. As the regime duration of $S_1$ is greater than that of $S_2$, we may consider that the Korea economy has been staying over the sample period under the normal regime longer than under the crisis regime. The findings exhibit that: (i) the coefficient of the inflation gap stands at -0.5866 under $S_1$, whereas the target variable reveals to be non significant from an econometric standpoint under $S_2$. That is, under the normal regime, an increase of 1 percent in the inflation gap of the previous period yields a decrease of 0.5866 percent in the exchange rate (USD/WON); (ii) the output gap appears to be non significant econometrically speaking under both $S_1$ and $S_2$; (iii) the coefficient of the Foreign Exchange Reserves stands at -0.2289. That is, an increase of 1 percent in the Foreign Exchange Reserves of the previous period leads to a decrease of 0.2289 percent in the exchange rate.

In light of foregoing, the results put forward two observations. Firstly, under the normal regime, solely the inflation gap and the Foreign Exchange Reserves exert effects on the exchange rate. Secondly, none of our target variables, aside from the Foreign Exchange Reserves, appears to be significant to explain the USD/WON variations. As a corollary, there are grounds to consider that the Exchange Rate Rule does not provide sufficient information as to the BOK’s behavior from an economic standpoint.

To summarize, from both econometric and economic standpoint, the Nominal Feedback rule may be deemed to help the best to characterize the BOK’s behavior in comparison with the Taylor rule and the Exchange Rate rule. Three conclusions can be drawn. That is, (1) the money base supply reveals to be the prevailing instrument of BOK’s monetary policy; (2) there is no glaring sign of hierarchical nonlinear characteristics nor any « crisis mentality », given the absence of regime switching due to a time-consistent inflation targeting mindset of the BOK; (3) the assumption of asymmetric weighting of target variables is outlined in our model in favor of the inflation target attainment, whereas the output gap deviation reveals to be tolerated to a significant extent for South Korea.
5.3) Taiwan

Table 4 Taiwan

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Taylor rule</th>
<th>Nominal feedback rule</th>
<th>Exchange rate rule</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Switching parameters</strong></td>
<td>$S_t = 1$</td>
<td>$S_t = 2$</td>
<td>$S_t = 1$</td>
</tr>
<tr>
<td>Model’s variance</td>
<td>0.752416</td>
<td>0.251257</td>
<td>0.000014</td>
</tr>
<tr>
<td></td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
</tr>
<tr>
<td>$\lambda_0$ (intended inflation)</td>
<td>3.6473</td>
<td>1.1573</td>
<td>0.0010</td>
</tr>
<tr>
<td></td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
</tr>
<tr>
<td>$\lambda_1$ (output gap)</td>
<td>4.3915</td>
<td>1.1336</td>
<td>0.0111</td>
</tr>
<tr>
<td></td>
<td>(0.03)**</td>
<td>(0.03)**</td>
<td>(0.00)*</td>
</tr>
<tr>
<td>$\lambda_2$ (inflation gap)</td>
<td>-31.0630</td>
<td>19.9766</td>
<td>-0.2033</td>
</tr>
<tr>
<td></td>
<td>(0.39)</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
</tr>
<tr>
<td>Transition Prob. Matrix</td>
<td>0.93</td>
<td>0.05</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>0.07</td>
<td>0.95</td>
<td>0.75</td>
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<tr>
<td><strong>Duration Regime</strong></td>
<td>14.92</td>
<td>22.07</td>
<td>inf</td>
</tr>
<tr>
<td></td>
<td>1.33</td>
<td></td>
<td>5.93</td>
</tr>
<tr>
<td></td>
<td>5.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Non-Switching parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\lambda_3$ (exchange reserves)</td>
<td>-9.4612</td>
<td>-0.0212</td>
<td>-0.2705</td>
</tr>
<tr>
<td></td>
<td>(0.06)***</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
</tr>
</tbody>
</table>

***-denotes coefficient significance at the 10 level
**-denotes coefficient significance at the 5 level
*-denotes coefficient significance at the 1 level

-Taylor rule

Table 4 indicates the outcomes from running exercises using an Augmented Markov-switching Taylor rule for Taiwan. According to the estimates, both the two regimes are econometrically significant. Given the fact that $\lambda_0$ stands at 3.6473 under $S1$ and at 1.1573 under $S2$, $S2$ may be deemed to be the normal regime, and $S1$ the crisis regime. In addition, given the fact that the duration of $S2$ is greater than that of $S1$, we may consider that, over the sample period, the Taiwanese economy may have been remaining under the low inflation regime longer than under the high inflation regime. The results indicate that: (i) the inflation gap is econometrically non significant under $S1$, while its coefficient stands at 19.9766 under $S2$. That is, under the normal regime, an increase of 1 percent in the inflation gap of the previous period is likely to underlie an increase of 19.9766 percent in the nominal interest rate (Repo rate); (ii) the coefficient of the output gap stands at 4.3915 under $S1$, whereas it stands at 1.1336 under $S2$. That is, an increase of 1 percent in the output gap of the previous period elicits an increase of 4.3915 percent in the nominal interest rate under the crisis regime, whereas it yields an increase of 1.1336 percent in the nominal interest rate under the normal regime; (iii) the coefficient of the Foreign Exchange Reserves stands at -9.4612. That is, an increase of 1 percent in the Foreign Exchange Reserves of the previous period leads to a decrease of 9.4612 percent in the nominal interest rate. To summarize, under the normal regime, the responsiveness of the Bank of China (Taiwan) appears to be high to the inflation gap maintenance and it reveals to be lesser pertaining to the output deviation. Under the crisis regime, the BOC is likely to react only to the output gap deviation. In addition, the BOC appears to respond significantly to the upsurge of the Foreign Exchange Reserves by means of interest rate hike.
Possible interpretation could be as follows. Given the asymmetry in terms of weighting between the target variables, the Bank of China (Taiwan) appears to attach significant importance to the inflation target attainment under the normal regime, as shows the estimates, while it exhibits a low sensitivity to the output deviation. Theoretical reasons could be that, on the one hand, the BOC is highly committed to the inflation targeting, and, on the other hand, that it tends to safeguard a room for maneuver for the output. In this regard, the output target attainment appears to receive more importance when the inflationary pressures become acute ($S_2 = 1.1336$; $S_1 = 4.3915$). Nevertheless, one observation challenges the validity of our estimates. Indeed, intuitive reasons lack at this stage to explain why the BOC does not take into account the inflation gap as a target variable and concentrates only on output gap maintenance under the crisis regime. To answer this question, we verified the evolution of the Taiwanese economy.

Figure 3 indicates that from February 2000 to May 2002 the Taiwanese economy has generally stayed under the crisis regime. That is, the BOC reacted to the output gap deviation, regardless inflationary risks. From May 2002 to nowadays, the Taiwanese economy has been remaining under the normal regime i.e. the BOC has been committed to vigorous inflation targeting and exhibits relatively loose output gap maintenance ($\lambda_1 1.1336 < \lambda_2 19.9766$). This observation is corroborated by the fact the inflation level has been low in Taiwan since 1994, in comparison with other similar economies (Figure 4). In this respect, the transition probability matrix shows that the probability for the Taiwanese economy to remain under the normal regime stands at 5%.

![Figure 3](image)

**Figure 3**

![Figure 4](image)

* Blue dotted line indicates the trend curve of the inflation in Taiwan

Source: National Statistics, Republic of China (Taiwan)

**Figure 4**
In other words, it is highly probable that the Taiwanese economy, when inflationary risks are low, to fall into a crisis regime. Possible interpretation of this high probability for the economy to fall into S1 could derive from the fact that, as the headline inflation is generally tilted to the downside, the BOC’s monetary policy tends to revolve around, at a lesser strength, the potential core (production-roots) inflation (S1). However, in general terms, as shows Figure 4, the Taiwanese economy has not encountered such circumstances since 2002, despite a brief and sharp regime switching in July 2006.

-Nominal Feedback rule

According to Table 4, both the two regimes are significant. Considering that $\lambda_0$ stands at 0.0010 under S1 and at -7.8698 under S2, S2 may be considered as the normal regime, and S1 the crisis regime. The findings suggest that S1 has been the prevailing regime, given its infinite duration. As a result, we may consider that the Taiwanese economy has been remaining over the sample period totally under the crisis regime. The results show that: (i) the coefficient of the inflation gap stands at -0.2033 under S1. That is, an increase of 1 percent in the inflation gap of the previous period implies a decrease of 0.2033 percent in the M0 supply; (ii) the coefficient of the output gap stands at 0.0111 under S1. That is, an increase of 1 percent in the output gap of the previous period underlies an increase of 0.0111 percent in the money base supply; (iii) the coefficient of the Foreign Exchange Reserves stands at -0.0212. In other words, an increase of 1 percent in the Foreign Exchange Reserves of the previous period leads to a decrease of 0.0212 percent in the money base supply. In sum, the BOC appears to attach importance to attaining the inflation target by conducting restrictive monetary policy, whereas the money supply does not seem to react consistently to the output gap deviation. In addition, the BOC reacts significantly to Foreign Exchange Reserves’ upsurge by means of money supply reduction.

In light of foregoing, we observe that the responsiveness of the BOC to the inflation gap deviation denotes a relatively rigorous inflation targeting commitment. Yet, two remarks are likely to challenge the validity of this model. Firstly, economic justifications lack to account for the positive sign of the output gap coefficient insofar as theoretical reasoning and empirical evidence put forward that monetary authorities are prone to restrictive money supply in reaction to inflationary (overheating) risks. However, it remains inconsistent from an economic standpoint that the BOC conducts accommodative money supply when inflationary pressures are acute. Secondly, given the uniqueness of the monetary policy instrument, the opposite signs of the inflation gap coefficient and the output gap coefficient appear equally to be unintelligible. As a corollary, we consider that the Nominal Feedback rule does not provide at this stage useful and coherent information to characterize the BOC’s behavior.

-Exchange rate rule

Table 4 shows that both the two regimes are econometrically significant. As $\lambda_0$ stands at 0.0039 under S1 and at -0.0008 under S2, S2 may be considered as the normal regime, and S1 the crisis regime. Considering the respective regime duration of S1 and of S2, we may consider that the Taiwanese economy has been almost evenly divided between the two regimes over the sample period. The outcomes of the estimation exhibit that: (i) the inflation gap appears to be non significant under S1, whereas it stands at 0.8680 under S2. That is, under the normal regime, an increase of 1 percent in the inflation gap of the previous period yields an increase of 0.8680 percent in the exchange rate (USD/TWD); (ii) the output gap reveals to be non significant econometrically speaking under S1, while it stands at -0.0370 under S2. That is, under the normal regime, an increase of 1 percent in the output gap of the previous period yields a decrease of 0.0370 percent in the exchange rate; (iii) the coefficient
of the Foreign Exchange Reserves stands at -0.2705. That is, an increase of 1 percent in the Foreign Exchange Reserves of the previous period leads to a decrease of 0.2705 percent in the exchange rate. In view of the above, these findings put forward the fact that the soundness and the intelligibility of the model are to be called into question insofar as, firstly, the coefficient of the inflation gap and that of the output gap carry opposite signs, and secondly, the BOC appears to exclude these two target variables under the crisis regime. Therefore, there are grounds to consider that the Exchange Rate rule does not provide consistent information as to the BOC’s monetary policy.

In light of foregoing, the Taylor rule appears to be the most relevant framework to describe the BOC’s behavior, compared with the Nominal Feedback rule and the Exchange Rate rule. Three observations can be underscored. That is, (1) the key interest rate reveals to be the prevailing transmission channel for the BOC; (2) there are weak signs of nonlinear characteristics (output gap) but the recent financial crisis does not seem to trigger regimes shifting; (3) the findings shore up the assumption of asymmetric weighting of target variables in favor of the inflation target achievement, whereas the output gap maintenance appears to be less imperative for Taiwan. However, there is no glaring sign of any «crisis mentality», given the absence of regime switching during the recent financial crisis (2009-2010), which is majorly explained by the BOC’s consistent inflation targeting mindset and its crawling intermediate objective over the whole sample period.

5.4) Thailand

**Table 5 Thailand**

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>Taylor rule</th>
<th>Nominal feedback rule</th>
<th>Exchange rate rule</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Switching parameters</strong></td>
<td>$S_t = 1$</td>
<td>$S_t = 2$</td>
<td>$S_t = 1$</td>
</tr>
<tr>
<td>Model’s variance</td>
<td>1.190684 (0.25)</td>
<td>1.799980 (0.98)</td>
<td>0.000008 (1.00)</td>
</tr>
<tr>
<td>$\lambda_0$ (intended inflation)</td>
<td>1.5441 (0.04)**</td>
<td>-2.0540 (0.95)</td>
<td>0.0017 (0.00)*</td>
</tr>
<tr>
<td>$\lambda_1$ (output gap)</td>
<td>-0.0736 (0.98)</td>
<td>0.0700 (1.00)</td>
<td>0.0058 (0.22)</td>
</tr>
<tr>
<td>$\lambda_2$ (inflation gap)</td>
<td>40.0532 (0.29)</td>
<td>-40.0492 (0.93)</td>
<td>-0.2132 (1.00)</td>
</tr>
<tr>
<td>Transition Prob. Matrix</td>
<td>0.90</td>
<td>0.11</td>
<td>0.96</td>
</tr>
<tr>
<td>Duration Regime</td>
<td>10.16</td>
<td>8.77</td>
<td>23.49</td>
</tr>
</tbody>
</table>

**Non-Switching parameters**

| $\lambda_3$ (exchange reserves) | 49.3449 (0.66) | 0.0074 (0.20) | -0.1397 (0.02)** |

*** - denotes coefficient significance at the 10 level
** - denotes coefficient significance at the 5 level
* - denotes coefficient significance at the 1 level

**-Taylor rule**

Table 5 exhibits the results from running exercises using an Augmented Markov-switching Taylor rule for Thailand. The outcomes indicate that none of the two regimes is
econometrically significant. In addition, the three target variables reveal equally to be non significant under both regimes. As a corollary, it can be contended that, at this stage, the Taylor rule does not furnish sufficient information as to the monetary policy of the Bank of Thailand.

**-Nominal Feedback rule**

According to Table 5, only the $S_2$ reveals to be econometrically significant. As $\lambda_0$ stands at 0.0017 under $S_1$ and at 0.0051 under $S_2$, $S_1$ may be considered as the normal regime, and $S_2$ the crisis regime. Thus, we may consider that the Thai economy has been remaining entirely under the crisis regime over the sample period. The results show that: (i) the coefficient of the inflation gap stands at -0.2132 under $S_2$. That is, an increase of 1 percent in the inflation gap of the previous period leads to a decrease of 0.2132 percent in the money base supply; (ii) the coefficient of the output gap stands at 0.0476 under $S_2$. That is, an increase of 1 percent in the output gap of the previous period yields an increase of 0.0476 percent in the M0 supply; (iii) the Foreign Exchange Reserves appear to be non significant from an econometric standpoint. In sum, the findings suggest that the BOT is committed to a relatively loose inflation targeting and it appears to lead output-oriented monetary policy. Nevertheless, even if economic grounds exist in support of the observed behavior, one remark mitigates the explanatory strength of the model. That is, the coefficient of the inflation gap and that of the output gap carry opposite signs. Given the fact that consistent justifications lack to account for monetary policy bifurcation, we may consider that the Nominal Feedback rule does not furnish sufficient information at this stage.

**-Exchange rate rule**

Table 5 indicates that both the two regimes are econometrically significant. Since $\lambda_0$ stands at 0.0007 under $S_1$ and at 0.0002 under $S_2$, $S_2$ may be deemed as the normal regime and $S_1$ the crisis regime. Given the fact that the duration of $S_2$ is greater than that of $S_1$, we may consider that the Thai economy has been staying under the normal regime longer than under the crisis regime. The findings show that: (i) the coefficient of the inflation gap stands at 0.5310 under $S_1$, whereas the target variable is non significant under $S_2$. That is, under the crisis regime, an increase of 1 percent in the inflation gap of the previous period yields an increase of 0.5310 percent in the nominal exchange rate (USD/THB); (ii) the coefficient of the output gap stands at -0.0548 under $S_1$, while it reveals to be non significant under $S_2$. That is, an increase of 1 percent in the output gap of the previous period leads to decrease of 0.0548 percent in the nominal exchange rate when inflationary pressures are acute; (iii) the coefficient of the Foreign Exchange Reserves stands at -0.1397. In other words, an increase of 1 percent in the Foreign Exchange Reserves of the previous period leads to a decrease of 0.1397 percent in the nominal exchange rate.

In substance, the above observations suggest that the BOT’s monetary policy reacts to both the inflation gap and the output gap under the crisis regime, while it does not take into account the same target variables under the normal regime. In view of the above, questions are raised about the consistency of the results. Indeed, in the first instance, interpretation lacks to explain why the BOT tends to exclude both the inflation and the output as target variables when inflationary risks are low. In the second instance, under the crisis regime, the BOT responds counterintuitively from an economic standpoint to the inflation gap and to the output gap as it reacts to the inflation gap deviation by means of Baht depreciation and to the output gap via currency appreciation. The reasoning according to which a high inflation corresponds to a currency appreciation, in view of the Real Exchange Rate, and a currency depreciation may be operated in an effort to underpin the output does not hold insofar as the Baht tends to
appreciate in reaction to the output gap. This inconsistency leads us to the third remark, which
is, precisely, the opposite signs of the inflation gap and the output gap under the same regime. Therefore, there are grounds to consider that the Exchange Rate Rule does not provide satisfactory results as to the characterization of the Thai monetary policy.

To summarize, none of our three models appears to fit the genuine BOT’s monetary policy and its mindset from an econometric and economic standpoint.

6. Concluding remarks

This paper investigates nonlinear dynamics of Central Bank reaction function in Asian Emerging Economies. The analysis is conducted on a basis of two hypotheses. Firstly, the Central Bank reaction function is nonlinear and asymmetric when the economy is faced with significant economic turbulences, especially demand-type shocks. This behavior, described as a « crisis mentality » (Bernanke and Mishkin 1992), could have yielded time-ordered policy objectives tradeoffs. Secondly, the real decision-making process can be approximated by preestablished equations. We applied then the augmented Taylor rule, augmented Nominal Feedback rule and augmented Exchange rate rule in this study to four Asian Emerging Economies, which are China, South Korea, Taiwan and Thailand. The outcomes of the estimates are supposed to give guidance to evidence of monetary authorities’ mindset shifting and prevailing policy transmission channel. The estimation of the three rules using a Markov-switching regression model provides interesting results. The modeling finds that:

(i) There is evidence of nonlinear and asymmetric characteristics of the behavior of the People’s Bank of China, which is better captured with an augmented Exchange rate rule. In addition, two results are to be outlined. For China, the regime switching triggered concomitantly a clear-cut Central Bank’s mindset shifting, which implies a different monetary policy direction. That is, the inflation targeting appears to receive more importance under the normal regime, while the output stimulus seems to be the prior objective under the crisis regime. This observation corroborates our hypotheses of Central Bank’s « finite temporal horizon » and « overshooting-prone » mindset during the recent financial turmoil;

(ii) There is no glaring sign of nonlinearity and asymmetry of the behavior of the Bank of Korea, which is better described by an augmented Nominal Feedback rule. For South Korea, the absence of regime switching during the recent financial crisis (2009-2010) can be explained by a time-consistent inflation targeting framework, which corresponds to the de jure monetary regime. The asymmetric weighting of target variables denotes equally a relative « let-it-go » approach as to the output;

(iii) There is weak evidence of nonlinear and asymmetric monetary policy of the Bank of China (Taiwan), which is better characterized by an augmented Taylor rule. For Taiwan, the absence of a « crisis mentality » during the recent crisis may be explained by the BOC’s consistent inflation targeting mindset and its crawling intermediate objective i.e. the BOC acts on the headline inflation under the normal regime, while it concentrates on the core inflation under the crisis regime. The asymmetric weighting of target variables exhibits a high importance granted to the inflation target attainment, whereas the reduction of the output gap deviation appears to be less imperative;

(iv) None of the three aforementioned rules appears to characterize the monetary policy of the Bank of Thailand.

Subsequent researches in the field could proceed by applying this study to a greater number of Central Banks over a longer sample period. One important extension that we intend to proceed with in a future work would be to incorporate supplementary explanatory variables, such as financial indicators, to our three rules with a Smooth Transition Regression model. We believe that such a study could help to obtain a deeper understanding of Asian Central Banks’ mindset.
# APPENDIX

Markov-switching type Taylor rule

<table>
<thead>
<tr>
<th>China</th>
<th>South Korea</th>
</tr>
</thead>
<tbody>
<tr>
<td>( i_t ) Average Repo rate (monthly average)</td>
<td>Overnight interbank rate (monthly average)</td>
</tr>
<tr>
<td>( \hat{r}_t ) Real interest rate (monthly average), which is the difference between the nominal interest rate and the contemporaneous price level</td>
<td>Real interest rate (monthly average), which is the difference between the nominal interest rate and the contemporaneous price level</td>
</tr>
<tr>
<td>( \gamma ) Output, represented by index of production (monthly average)</td>
<td>Output, represented by index of production (monthly average)</td>
</tr>
<tr>
<td>( \tilde{p} ) Inflation, computed as the annual growth rate of change of the Consumer Price Index (YoY)</td>
<td>Inflation, computed as the annual growth rate of change of the Consumer Price Index (YoY)</td>
</tr>
<tr>
<td>( \gamma^r ) Output target value, determined by Hodrick-Prescott filter</td>
<td>Output target value, determined by Hodrick-Prescott filter</td>
</tr>
<tr>
<td>( \tilde{p}^r ) Inflation target value, determined by Hodrick-Prescott filter</td>
<td>Inflation target value, determined by Hodrick-Prescott filter</td>
</tr>
<tr>
<td>( FXRES ) Foreign Exchange Reserves (Central Bank Balance sheet; Foreign Assets; Foreign Exchange Reserves)</td>
<td>Foreign Exchange Reserves (Central Bank Balance sheet; Foreign Assets; Foreign Exchange Reserves)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Taiwan</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td>( i_t ) Repo rate 3M (monthly average)</td>
<td>Bilateral Repo rate (monthly average)</td>
</tr>
<tr>
<td>( \hat{r}_t ) Real interest rate (monthly average), which is the difference between the nominal interest rate and the contemporaneous price level</td>
<td>Real interest rate (monthly average), which is the difference between the nominal interest rate and the contemporaneous price level</td>
</tr>
<tr>
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</table>
### Markov-switching type Nominal Feedback rule

<table>
<thead>
<tr>
<th></th>
<th>China</th>
<th>South Korea</th>
</tr>
</thead>
<tbody>
<tr>
<td>$MB$</td>
<td>Annual growth rate of the monetary aggregate M3</td>
<td>Annual growth rate of the monetary aggregate M3</td>
</tr>
<tr>
<td>$\frac{MB}{r}$</td>
<td>Monthly real monetary base demand</td>
<td>Monthly real monetary base demand</td>
</tr>
<tr>
<td>$\dot{y}$</td>
<td>Output, represented by index of production (monthly average)</td>
<td>Output, represented by index of production (monthly average)</td>
</tr>
<tr>
<td>$\bar{p}$</td>
<td>Inflation, computed as the annual growth rate of change of the Consumer Price Index (YoY)</td>
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</tr>
<tr>
<td>$\bar{y}^*$</td>
<td>Output target value, determined by Hodrick-Prescott filter</td>
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<tr>
<td>$\bar{p}^*$</td>
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<td>$FXRES$</td>
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<tr>
<th></th>
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<td>$MB$</td>
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<tr>
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<td>$\bar{p}^*$</td>
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</tbody>
</table>
### Markov-switching type Exchange Rate rule

<table>
<thead>
<tr>
<th><strong>China</strong></th>
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</tr>
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