Central bank credibility and the expectations channel: Evidence based on a new credibility index

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February 2015

Abstract

This article investigates the relationship between central bank credibility and the volatility of the key monetary policy instrument. Two main contributions are brought forward. First, we propose a time-varying measure of central bank credibility based on the gap between inflation expectations and the official inflation target. While this new index addresses the main limitations of the existing indicators, it also appears more suited to assess the monetary experiences of a large sample of inflation-targeting emerging countries. Second, by means of EGARCH estimations, we formally prove the existence of a negative effect of credibility on the volatility of the short term interest rate. Thus, in line with the expectations channel of monetary policy, the higher the credibility of the central bank, the lower the need to move its instruments in order to efficiently fulfill its objective.

Keywords: Credibility, Inflation targeting, Emerging countries, EGARCH, Expectations.

Code JEL: E43, E52, E58.

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§We are grateful to Claudiu Albulescu, Jarko Fidrmuc, Tomasz Lysiak, Ewa Stanislawska, and participants at the INFER Workshop "Monetary Policy, Asset Prices, and the Real Economy in Central and Eastern Europe" (Timisoara, Romania, 12-13 December 2014). This paper was written while Yannick Lucotte was a visiting researcher at the Economic Institute of the National Bank of Poland (NBP) in Warsaw. He would like to thank the National Bank of Poland for its hospitality and financial support. The views expressed in this article are entirely those of the authors and do not necessarily represent those of the National Bank of Poland. Any remaining errors are ours.

1 Introduction

"*In a word, credibility matters in the theory and it is certainly believed to matter in practice – although empirical evidence on this point is hard to come by because credibility is not easy to measure*" (Blinder (2000, p.1421)). This quotation perfectly sums up the complex issues surrounding the concept of central bank credibility. Credibility is an issue of critical importance in modern central banking (González-Páramo (2007)), and is viewed as a precious asset not to be squandered (Blinder (1998)). Nonetheless, despite the growing interest of policymakers and academics for this concept, no clear consensus emerged on what central bank credibility really means, how it can be established, and especially how it can be measured. Typically, the survey conducted by Blinder (2000) indicates that the definition of credibility is not the same for central bankers and for academics. In particular, the former more closely relate inflation aversion to credibility than the latter[1].

According to Blinder (1998, 2000), such differences in view between practitioners and academics stems from the fact that the former have an other definition of credibility in mind than that formalized within the traditional time-consistency literature originating from Kydland & Prescott (1977) and Barro &Gordon (1983a, 1983b)[2]. Looking back on his experience as a central banker, Blinder (1998) argues that central bankers consider themselves as credible if their announcements are believed by people, even though it is not bound by a rule that tie its hands and may even have an incentive to renege on it. In other words, a monetary authority is said to be credible if "people believe it will do what it says" (Blinder (2000)), i.e. if deeds are expected to match words. This short and intuitive definition is close to that considered by Cukierman & Meltzer (1986) in their theoretical work. They define credibility as the absolute value of the difference between the central bank's planned monetary policy and the private sector's beliefs about these plans. They define in this way the "average credibility of announcements".

On these grounds, in an inflation targeting framework, credibility means that people believe that the central bank has the willingness, but also the ability, to reach the previously announced inflation target. In particular, this means that private sector inflation expectations are anchored on the target and that people do not over-react to target misses. Based on this statement, several scholars have developed measures for assessing the degree of credibility of a central bank. To the best of our knowledge, the first paper that inves-

[1] Nonetheless, partitioners and academics agree with the reasons why credibility is important, and how building it. Similar results are obtained by Waller & de Haan (2004) with an updated version of the questionnaire initiated by Blinder (2000).

[2] See notably Walsh (2010) for an analytical review of this literature.

tigated this issue is Svensson (1993). He compares *ex post* target-consistent real interest rates with market real interest rates on real bonds to assess whether the inflation targeting framework is credible or not in Canada, New Zealand and Sweden[3]. However, such an indirect approach considers credibility as a one/zero variable (credible or not, respectively), while in practice there exists intermediate degrees of credibility (Blinder (1998)). With the increasing availability of survey data on inflation expectations, the next contributions have instead relied on more direct measures of central bank credibility.

Direct credibility measures may be divided into two main categories. The first is based on the Bomfim & Rudebusch (2000) methodology, which consists in assessing the weight attached by the private sector to the inflation target in the formation of their inflation expectations. To this point, if the latter are based on the target, then the central bank is considered as credible. The second category of central bank credibility measures refers to the gap between inflation expectations of the private sector and the inflation target (or the inflation target range). The well-known index of Cecchetti & Krause (2002), who define credibility as an inverse function of this gap, belongs to this category. Such an index has been extended by De Mendonça (2007) and De Mendonça & de Guimarães e Souza (2009), that replace the inflation target point by a target range and consider the possibility of a loss of credibility for negative deviations[4].

The indicators developed by Cecchetti & Krause (2002), De Mendonça (2007), and De Mendonça & de Guimarães e Souza (2009) have two main advantages. They are intuitive and easy to compute. However, they are not discriminating enough. Indeed, they rely on an *ad hoc* parameter for expected inflation, set to 20%, beyond which the credibility of a central bank is considered as being null. Such a threshold is unjustified, regarding the single-digit inflation rate and the decreasing inflation targets in the concerned countries over the last decade. When the target is low, these indicators even lead to improperly underestimate the effect of large positive deviations of inflation expectations from the target on credibility; all the more than the target is far from 20%.

[3]Kupfer (2015) recently used the methodology proposed by Svensson (1993) to assess the monetary policy credibility of the European Central Bank, while Amisano & Tronzano (2010) extended this methodology inside a Bayesian econometric framework.

[4]Another category of measures assumes that the current credibility of a central bank is a self-reinforcing process that can be proxied by past inflation performance. In this view, a central bank is expected to gain additional credibility by reaching its publicly announced target repeatedly, i.e. by having "a history of doing what it says it will do" (Blinder (2000)). Considering this assumption, De Mendonça & de Guimarães e Souza (2009) and Neuenkirch & Tillmann (2014) propose alternative measures of central bank credibility based on the past deviations of inflation from the target. Such backward-looking indicators are particularly relevant for developing countries, for which inflation expectations data are often unavailable.

Against this background, the first purpose of this paper is to propose a new simple time-varying measure of central bank credibility that addresses the main limitation of existing indexes. Because we believe that in practice negative deviations of inflation expectations from the target are less likely to compromise credibility than positive deviations, we provide an asymmetric measure of credibility, based on the linear exponential (LINEX) function. Furthermore, our indicator does not depend on any *ad hoc* threshold. We compute our index for all the emerging countries which adopted an inflation targeting framework, except Ghana for which data on inflation expectations are not available. We then analyze how the credibility of monetary policy has evolved in these economies.

This question of monetary policy credibility is particularly relevant for emerging inflation-targeting countries. A credible central bank is expected to improve the efficiency of monetary policy transmission, through two channels: the expectations channel and the interest rate channel. Indeed, if a central bank is credible, people believe that the announced target will be realized. Agents can infer from the observed and expected inflation rate the future path of interest rates. Monetary policy is then easily transmitted along the yield to maturity curve. Moreover, wage and prices are set accordingly. Disinflation is then less costly. Finally, changes in the policy rates are less likely to be considered as temporary by the banking sector, which is then more prone to pass monetary policy impulses on retail interest rates (Mojon (2001)). At the extreme, the speeches of the governor becomes an instrument *per se*, and is sufficient for governing the stance of monetary policy. It is not necessary to frequently change the level of key interest rates. Consequently, central bank credibility is a self-reinforcing process that emerging economies should seek to strengthen. This is why the second purpose of this paper is to evaluate, in the light on our new indicator, the effect of credibility on interest rate volatility. As far as we know, our study is the first that investigates this issue for a large sample of emerging inflation-targeting countries.

The remainder of the paper is structured as follows. Section 2 provides an overview of the existing measures of central bank credibility. Section 3 presents our new index. Section 4 compares it with previous indicators and analyzes the evolution of central bank credibility in emerging inflation-targeting countries. Section 5 is devoted to the impact of credibility on interest rate volatility. Section 6 concludes.

2 On the existing measures of central bank credibility

Two main types of credibility measures have been developed in the literature. The first refers to the Bomfim & Rudebusch (2000) approach. It consists in assessing the weight the private sector attaches to the inflation target in forming their inflation expectations. More precisely, this approach considers that inflation expectations are determined as a weighted average of the current inflation target and the past inflation rates:

$$\pi^e_{t|T} = \lambda \bar{\pi}_t + (1 - \lambda)\, \tilde{\pi}_{t-q} \tag{1}$$

with $\pi^e_{t|T}$ the inflation expectations of the private sector formed at time t for the period T, $\bar{\pi}_t$ the inflation target, and $\tilde{\pi}_{t-q}$ the average of past inflation rates over the q periods considered ($\tilde{\pi}_{t-q} = \frac{\pi_{t-1} + \ldots \pi_{t-q}}{q}$). The parameter λ ($0 \leq \lambda \leq 1$) measures the degree to which expectations are anchored on the target. The higher λ, the higher the weight attached by the economic agents to the target in forming their expectations, the higher the central bank's credibility. As Bomfim & Rudebusch (2000) argue, with representative agents λ may be interpreted as the subjective probability that an agent attaches to the future achievement of the target. With heterogeneous agents, λ may represent the fraction of the population believing that target will be achieved. However, the Bomfim & Rudebusch (2000) approach has received little coverage in the empirical literature, except the paper of Lysiak, Mackiewicz & Stanisławska (2007) in the case of Poland, and those of Demertzis, Marcellino & Viegi (2009) for some industrialized inflation-targeting countries.

The second type of measures refers to the gap between inflation expectations and the inflation target. It considers any deviations of expectations from the target as a loss of central bank credibility. The index developed by Cecchetti & Krause (2002) belongs to this category. Taking values from 0 (no credibility) to 1 (full credibility), it is defined as follows:

$$CRED_{CK} = \begin{cases} 1 & \text{if } \; \pi^e \leq \bar{\pi}_t \\ 1 - \dfrac{1}{20\% - \bar{\pi}_t} \left[\pi^e - \bar{\pi}_t\right] & \text{if } \; \bar{\pi}_t < \pi^e < 20\% \\ 0 & \text{if } \; \pi^e \geqslant 20\% \end{cases} \tag{2}$$

with $\bar{\pi}_t$ the inflation target pursued by the central bank and π^e the inflation rate expected by the private sector. The central bank is considered fully credible ($CRED_{CK} = 1$) if expected annual inflation is lower than or equal to the inflation target. On the contrary, it is non-credible ($CRED_{CK} = 0$) if expected annual inflation is equal to or higher than 20%.

Between these two limits, the value of the index decreases linearly as expected inflation increases. This index was first extended by De Mendonça (2007), considering that, 1) not only positive, but also negative deviations of inflation expectations from the target can imply a loss of credibility, and 2) in practice the target is not a single value but a range. The following indicator is then suggested by De Mendonça (2007):

$$CRED_{DM} = \begin{cases} 1 & \text{if} \quad \pi^e = \bar{\pi}_t^{mid} \\ 1 - \dfrac{1}{\bar{\pi}_t - \bar{\pi}_t^{mid}} \left[\pi^e - \bar{\pi}_t^{mid}\right] & \text{if} \quad \bar{\pi}_t^{min} < \pi^e < \bar{\pi}_t^{max} \\ 0 & \text{if} \quad \pi^e \geqslant \bar{\pi}_t^{max} \quad \text{or} \quad \pi^e \leqslant \bar{\pi}_t^{min} \end{cases} \tag{3}$$

with π^e the inflation expectations of the private sector, $\bar{\pi}_t^{mid}$ the midpoint inflation target pursued by the central bank, $\bar{\pi}_t^{min}$ and $\bar{\pi}_t^{max}$ the lower and the upper bound of the inflation target range, respectively. Concerning $\bar{\pi}_t$ at the denominator, it corresponds to the lower bound $\bar{\pi}_t^{min}$ if $\pi^e < \bar{\pi}^{mid}$ and to the upper bound $\bar{\pi}_t^{max}$ if $\pi^e > \bar{\pi}_t^{mid}$. As Cecchetti & Krause (2002), the index is defined between 0 (no credibility) to 1 (full credibility). While its maximum (full credibility) is obtained when the expected inflation is exactly equal to the midpoint of the inflation range, the index decreases symmetrically and linearly when expectations deviate from the target point.

However, in focusing on the midpoint, this index is too restrictive, and can therefore lead to misleading conclusions. Full credibility is not only reached when inflation expectations are exactly equal to the midpoint target. One can reasonably consider that it is also the case while private expectations belong to the range. Taking this into consideration, De Mendonça & de Guimarães e Souza (2009) proposed this alternative index:

$$CRED_{DMGS} = \begin{cases} 1 & \text{if} \quad \bar{\pi}^{min} \leqslant \pi^e \leqslant \bar{\pi}^{max} \\ 1 - \dfrac{1}{20\% - \bar{\pi}_t^{max}} \left[\pi^e - \bar{\pi}_t^{max}\right] & \text{if} \quad \bar{\pi}_t^{max} < \pi^e < 20\% \\ 1 - \dfrac{1}{-\bar{\pi}_t^{min}} \left[\pi^e - \bar{\pi}_t^{min}\right] & \text{if} \quad 0 < \pi^e < \bar{\pi}_t^{min} \\ 0 & \text{if} \quad \pi^e \geqslant 20\% \quad \text{or} \quad \pi^e \leqslant 0 \end{cases} \tag{4}$$

with π^e the inflation rate expected by the private sector, $\bar{\pi}_t^{min}$ and $\bar{\pi}_t^{max}$ the lower and the upper bound of the inflation target range, respectively. A central bank is viewed as non-credible ($CRED_{DMGS} = 0$) if expected annual inflation is equal or greater than 20% or lower or equal to 0%, and as fully credible ($CRED_{DMGS} = 1$) if inflation expectations belong to the target range. Between these two limits, the value of the index decreases linearly.

The figure 1 illustrates the profile of $CRED_{CK}$ and $CRED_{DMGS}$, in the case of a single-digit inflation target equal to 2% (with +/- 0.5% point tolerance intervals), and in the case of a double-digit inflation target equal to 14% (with +/- 0.5% point tolerance intervals)[5].

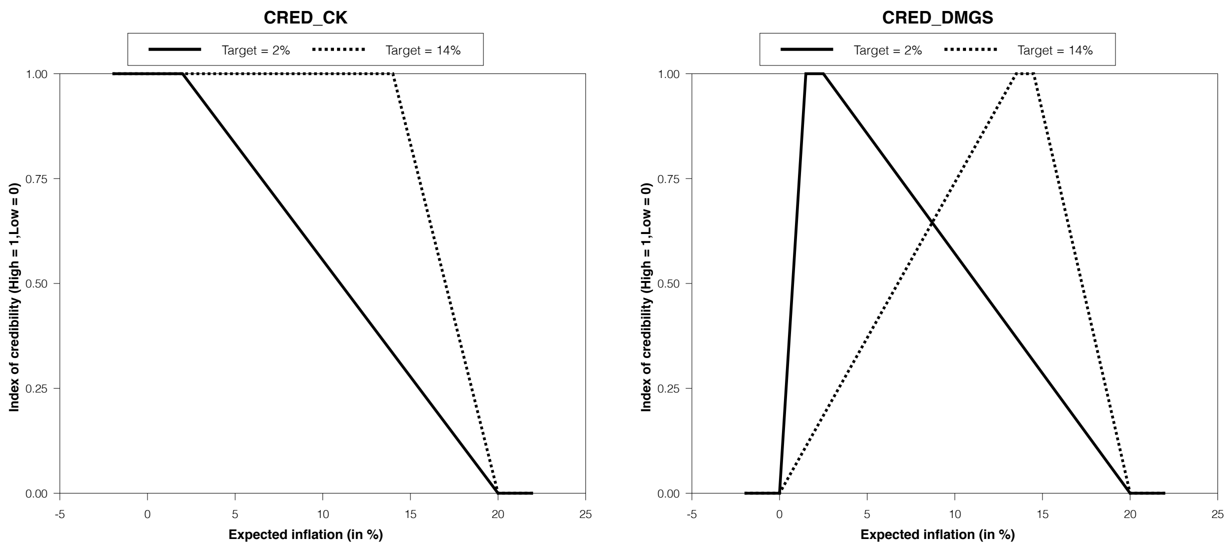

Figure 1: Profile of $CRED_{CK}$ and $CRED_{DMGS}$

As we can see, the profile of these indexes and the marginal loss in credibility largely depends on the level of the inflation target. A positive deviation of inflation expectations from the target is strongly punished in terms of credibility loss if the target is close to the *ad hoc* upper limit of 20%. For example, for a positive deviation of 3% points from the target range, the value of $CRED_{DMGS}$ is equal to 0.45 in the case of a target equal to 14%, and to 0.83 in the case of a target equal to 2%. The $CRED_{CK}$ index is equal to 0.50 and 0.83, respectively. Such a framework is inadequate for assessing the current level of credibility of emerging inflation-targeting central banks, since most of them now pursue relatively low inflation targets. Indeed, in 2014, none of the emerging inflation-targeting countries pursued an inflation target point higher than 5%. Consequently, we propose a new index of central bank credibility, independent of any *ad hoc* upper and/or lower threshold(s). This indicator is described in the next section.

[5]The $CRED_{DM}$ index is not presented here because, as aforementioned, it is certainly too restrictive since it assumes that credibility is null when inflation expectations are outside the target range.

3 A new indicator of central bank credibility

3.1 The rationale for a new indicator

The indicator we suggest is in line with the theoretical considerations of Cukierman & Meltzer (1986), according which credibility can be viewed as the difference between private inflation expectations and the announced policy target. In this respect, it is an extension of the empirical measures suggested by Cecchetti & Krause (2002), De Mendonça (2007) and De Mendonça & de Guimarães e Souza (2009). However, as we have seen, these measures impose an *ad hoc* and undue upper threshold value (20%) for the expected inflation, above which credibility is null.

We consider that an indicator of credibility should fulfill two main properties. First, it should not be based on *ad hoc* upper and/or lower thresholds, but freely converge towards its extreme values. Second, a credibility indicator should not be linear. Indeed, a critical point for developing a credibility index is the following: are negative and positive deviations of expected inflation from the target equivalent in terms of (loss in) credibility? Surely not. The central bank is mandated to maintain the growth rate of prices under control. Positive deviations clearly signal that people do not believe in the ability of the central bank to meet this commitment. Then, the central bank is not entirely credible. Negative deviations also indicate that people believe that actual inflation will not meet the target. However, private agents consider in this case that the monetary authorities can even do better than what is announced in terms of inflation control. And this is rarely perceived as a signal that monetary authorities abandon their objective. On the contrary, people can consider that "*he who can do more can do less*"[6]. As a result, negative deviations are less serious (if they are) than positive deviations. An indicator of central bank credibility should take this asymmetry into account, with positive deviations being more serious in terms credibility loss than negative ones.

We suggest an indicator satisfying this dual challenge, based on the asymmetrical LINEX loss function[7] (partly LINear, partly EXPonential). Noting $\tilde{\pi}^e$ the deviation between expected inflation (π^e) and the target ($\bar{\pi}$), a LINEX function with $\tilde{\pi}^e$ as an argument

[6]Typically, the current and expected inflation rates in the Euro Area have been far below the implicit target of 2%, without questioning the beliefs of the agents on the willingness of the European Central Bank (ECB) to control inflation. On the contrary, this reaffirms that european policymakers are perceived as very attached to their main objective of price stability. Such a situation does not compromise the credibility of the ECB.

[7]See Varian (1974) and Zellner (1986).

is defined such as:

$$f(\tilde{\pi}^e) = exp\left(\phi\left(\tilde{\pi}^e\right)\right) - \phi\left(\tilde{\pi}^e\right) - 1 \tag{5}$$

For $\phi = 1$, $\tilde{\pi}^e > 0$ will be considered as more serious than $\tilde{\pi}^e < 0$ (because the exponential part of the function dominates the linear part when the argument is positive). The figure 2 compares the LINEX function with the usual quadratic one, for $\bar{\pi} = 2\%$, with the horizontal axis corresponding to π^e.

We will show below that an indicator of credibility can be developed on the basis of such a function, with an inverted-U profile between 0 and 1, as usual in the literature. The indicator will precisely be defined in the next subsections, considering two cases, depending whether the target is a single value or a range. Even more, in each case, we will successively assume first that negative deviations induce a credibility loss, and second that they do not imply any credibility loss.

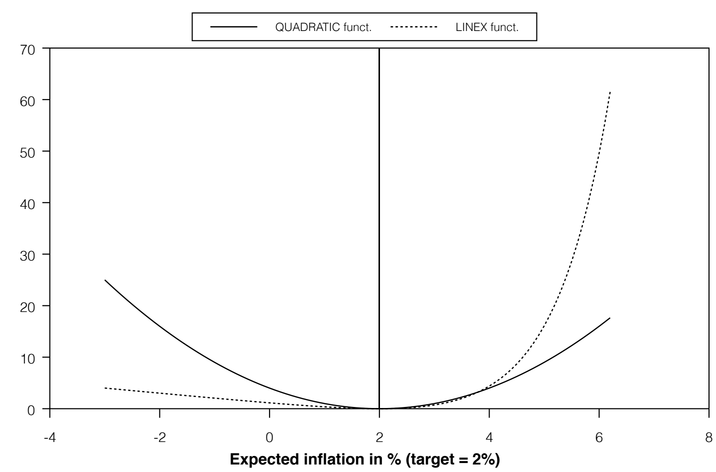

Figure 2: Quadratic *vs* LINEX functions

3.2 The target is a single number

We first considerer that the target is $\bar{\pi}$.

FIRST CASE One considers that $\pi^e < \bar{\pi}$ represents a loss in credibility, even if it is less serious than $\pi^e > \bar{\pi}$. Then, we define a new credibility index as the following inverse *quasi* LINEX function:

$$CRED_{LLR1} = \frac{1}{exp(\tilde{\pi}^e) - \tilde{\pi}^e} \quad \forall\, \pi^e \tag{6}$$

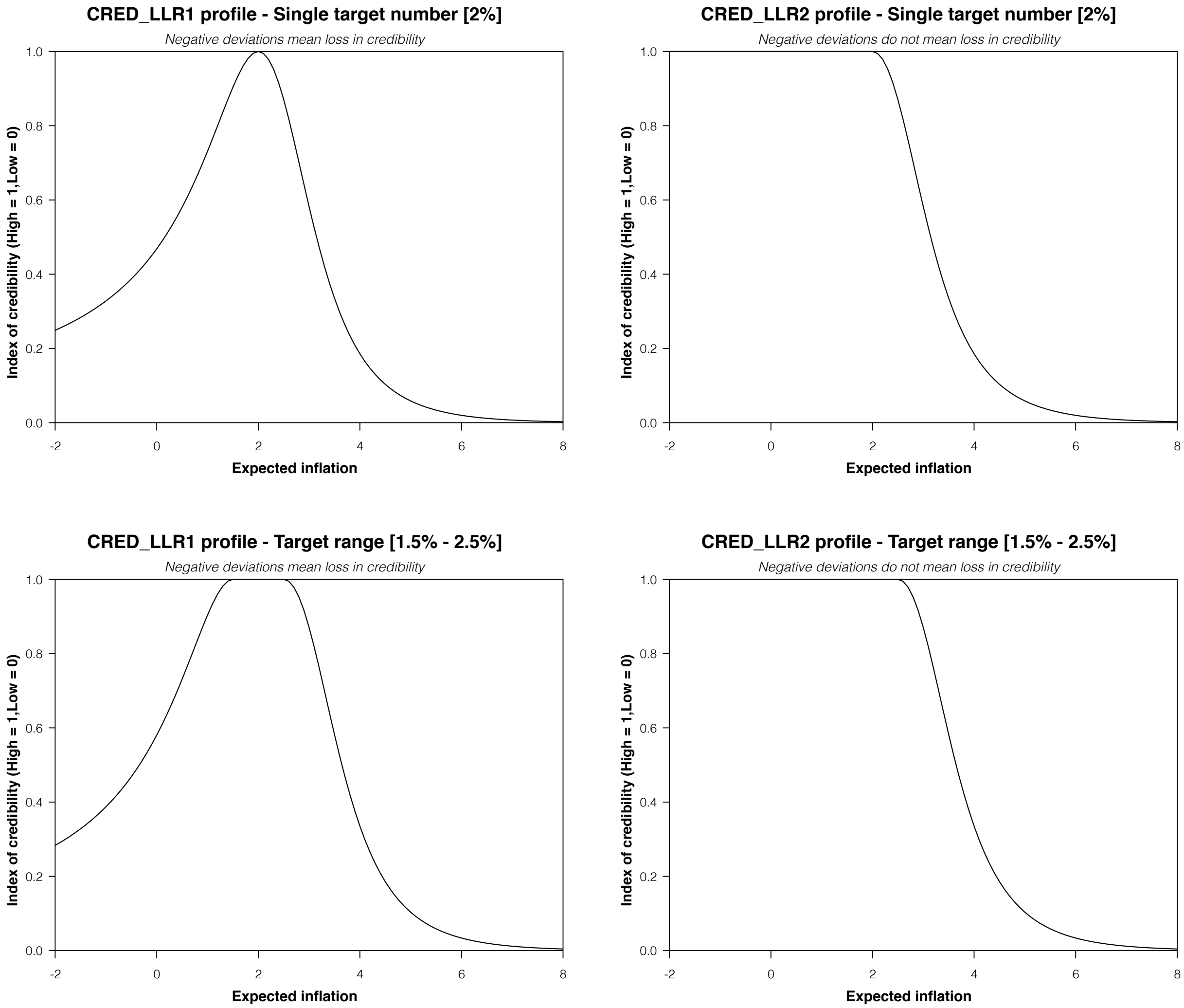

Figure 3: The credibility function as an inverse *quasi* LINEX function ($\bar{\pi} = 2\%$)

As for the existing indicators in the literature, $0 < CRED_{LLR1} < 1$, with 1 for full credibility. At the extreme opposite, $CRED_{LLR1} = 0$ indicates that the corresponding central bank is not credible at all. With such a definition, any reference to a hypothetical upper or lower bound is not required. The upper left panel of the figure 3 gives the profile of this indicator, for $\bar{\pi} = 2\%$, with the horizontal axis representing π^e. As expected, the profile is non-linear. Negative deviations do mean that credibility is compromised, but any positive deviation signals a higher loss in credibility than an equivalent negative one. Moreover, the marginal loss in credibility is decreasing with $\tilde{\pi}^e$. This is an important feature of our indicator. The rationale is the following. Assume that $\bar{\pi} = 2\%$. An expected inflation rate that would grow from 14 to 16% should not coincide with a dramatic loss in credibility, as the latter is already hugely damaged (because of the initial $\pi^e = 14\%$). Quite the opposite, a growing expected inflation rate, say from 2 to 5%, must express a higher marginal loss in credibility. An inverted-U credibility curve, with a higher slope in the neighborhood of the target than at its extremities, is then justified.

SECOND CASE One considers that $\pi^e < \bar{\pi}$ does not mean loss in credibility. This is an extreme interpretation of the "*he who can do more can do less*" hypothesis. Then, our new indicator simply becomes:

$$CRED_{LLR2} = \begin{cases} 1 & \text{for} \quad \pi^e < \bar{\pi} \\ \dfrac{1}{exp(\tilde{\pi}^e) - \tilde{\pi}^e} & \text{for} \quad \pi^e \geqslant \bar{\pi} \end{cases} \tag{7}$$

The profile of this credibility function is represented at the top right panel of the figure 3.

3.3 The target is a range, such that $\bar{\pi} = \left[\bar{\pi}^{min}, \bar{\pi}^{max}\right]$

Again, two cases are to be considered, depending now on whether $\pi_t^e < \bar{\pi}^{min}$ is synonymous with loss in credibility or not.

FIRST CASE $\pi_t^e < \bar{\pi}^{min}$ signals loss in credibility. Then,

$$CRED_{LLR1} = \begin{cases} \dfrac{1}{exp(\pi^e - \bar{\pi}^{min}) - (\pi^e - \bar{\pi}^{min})} & \text{for} \quad \pi^e < \bar{\pi}^{min} \\ 1 & \text{for} \quad \pi^e \in \left[\bar{\pi}^{min}, \bar{\pi}^{max}\right] \\ \dfrac{1}{exp(\pi^e - \bar{\pi}^{max}) - (\pi^e - \bar{\pi}^{max})} & \text{for} \quad \pi^e > \bar{\pi}^{max} \end{cases} \tag{8}$$

The bottom left panel of the figure 3 illustrates this case for a range corresponding to $[1.5\% - 2.5\%]$.

SECOND CASE $\pi^e < \bar{\pi}^{min}$ does not imply loss in credibility. Then,

$$CRED_{LLR2} = \begin{cases} 1 & \text{for} \quad \pi^e \leqslant \bar{\pi}^{max} \\ \dfrac{1}{exp(\pi^e - \bar{\pi}^{max}) - (\pi^e - \bar{\pi}^{max})} & \text{otherwise} \end{cases} \tag{9}$$

The corresponding profile is represented in the bottom right panel of the figure 3.

4 Application to the emerging inflation-targeting countries

$CRED_{LLR1}$ and $CRED_{LLR2}$ are computed for all emerging economies that adopted an inflation targeting framework, except Ghana for which survey data on inflation expectations are not available. This monetary policy strategy is currently led by 18 emerging countries, while Slovakia has abandoned inflation targeting in January 2009 to join the euro area. Our sample is then composed of Brazil, Chile, Colombia, Czech Republic, Guatemala, Hungary, Indonesia, Israel, Mexico, Peru, Philippines, Poland, Romania, Slovakia, South Africa, South Korea, Thailand and Turkey.

4.1 Data and periods

For each country, $CRED_{LLR1}$ and $CRED_{LLR2}$ indexes are computed on a monthly basis, and cover the period between the effective inflation targeting adoption date (if data on inflation expectations are available) and December 2013. The table 1 provides some details concerning inflation targeting adoption dates and data availability.

Concerning private sector inflation expectations, we use the forecast survey dataset provided by Consensus Economics, which gathers professional analysts' forecasts for a large range of macroeconomic variables. Surveyed forecasters are located in their respective country, and are working in the financial sector. Therefore, they have a pretty good idea of how inflation will evolve in the medium-term. Moreover, they are more forward-looking than other categories of the population, such as consumers[8]. Since the forecasts are provided for the current and the next calendar year on a monthly basis, we construct a monthly sample of twelve-month ahead expected inflation by taking the weighted arithmetic average of the mean forecast for the current year and the next year, defined as follows:

$$\pi^e_{t,12m} = \frac{(12-t)\pi_t^{e^{current}} + t\,\pi_t^{e^{next}}}{12} \tag{10}$$

with t the month (with 1 (= January) $\leq t \leq$12 (=December)) at the time of the forecast. Thus, by December, the forecast for the current year is already irrelevant and the forecast for the next year gets full weight (t=12). Most of studies using data of the Consensus

[8]For example, Lysiak et al. (2007) find that consumers and commercial bank analysts form their inflation expectations in a very different way in Poland. While consumers rely heavily on the current inflation target, commercial bank analysts closely follow the announced inflation target. According to Lysiak et al. (2007), this could be explained by the costs of collecting and processing information.

Economics adopt such an approach for constructing twelve-month ahead forecasts (see, e.g., Beck (2001)). Some emerging countries were surveyed only once every two months at the start of the Consensus Economics survey. For Central and Eastern Europe countries, surveys have been conducted each month only since May 2007 (see table 1). Linear interpolation can be applied, but cautiously, given the particularity of the data. Indeed, if the missing observation refers to December or January, the interpolated data will overlap two different years. This is a problem when data aims at measuring the expected evolution of consumer price index over a given year. So, we distinguish two cases. On the one hand, if the missing data refers to December, we consider for this month the observation of November of the same year. Similarly, if the missing data refers to January, we consider for this month the observation of February of the same year. On the other hand, if the missing data does not refer to December nor January, i.e. if the months before and after the missing observations belong to the same year, a linear interpolation is used.

Country	Effective IT start	Target measure	Consensus Economics (Data coverage)	Nb. of obs. (in months)
Brazil	1999M6	Headline Inflation	1990M2 (monthly since 2001M4)	175
Chile	1999M9	Headline Inflation	1993M3 (monthly since 2001M4)	172
Colombia	1999M9	Headline Inflation	1993M3 (monthly since 2001M4)	172
Czech Rep.	1998M1	Headline Inflation since 01/2002	1995M1 (monthly since 2007M5)	192
Guatemala	2005M1	Headline Inflation	2009M1 (monthly since 2009M1)	60
Hungary	2001M6	Headline Inflation	1990M11 (monthly since 2007M5)	151
Indonesia	2005M7	Headline Inflation	1990M11 (monthly since 1990M11)	102
Israel	1997M6	Headline Inflation	1995M1 (monthly since 1995M1)	199
Mexico	2001M1	Headline Inflation	1990M2 (monthly since 2001M4)	156
Peru	2002M1	Headline Inflation	1993M3 (monthly since 2001M4)	144
Philippines	2002M1	Headline Inflation	1994M12 (monthly since 1994M12)	144
Poland	1998M10	Headline Inflation	1990M11 (monthly since 2007M5)	183
Romania	2005M8	Headline Inflation	1995M1 (monthly since 2007M5)	101
Slovakia	2005M1	Headline Inflation*	1995M1 (monthly since 2007M5)	48
South Africa	2000M2	Headline Inflation since 01/2009	1993M6 (monthly since 1993M6)	167
South Korea	2001M1	Headline Inflation since 01/2007	1990M1 (monthly since 1990M1)	156
Thailand	2000M5	Core inflation	1990M11 (monthly since 1990M11)	164
Turkey	2006M1	Headline inflation	1995M1 (monthly since 2007M5)	96

* joined the Eurozone in January 2009.
Source: Roger (2009), Hammond (2012) and Central Banks' website.

Table 1: IT adoption dates, target measures and data coverage

Finally, it is important to note that credibility indexes need to be interpreted with caution for four countries (Czech Republic, South Africa, South Korea, and Thailand). Indeed, as we report in the table 1, they used or have been used a core measure of inflation for their operational target, while inflation expectations published by Consensus Economics deal with headline inflation.

4.2 Overview of the new credibility indicators

Figures 4 to 7 in appendix represent $CRED_{LLR1}$ and $CRED_{LLR2}$ for each country, as well as expected and actual inflation, and inflation targets. We first observe that negative deviations are very rare. $CRED_{LLR2}$ is then very close to $CRED_{LLR1}$. Moreover, we can see a high correlation between actual and expected inflation. The latter rarely overshoots the former. This means that the monetary authorities in the countries we investigate are generally credible. However, episodes of important loss in credibility are possible.

Before comparing our new indicators with the existing ones, the table 2 summarizes the country-by-country evolution of the $CRED_{LLR1}$ index over different sub-periods[9]. In particular, we consider the first 12 and 24 months following the adoption of inflation targeting to assess the initial credibility of the central bank. We also focus on the period between June 2007 and December 2008, characterized by a surge in food and energy prices, and then by a subsequent increase of inflation in most emerging economies[10]. Three main conclusions can be drawn.

First, most of emerging inflation-targeting countries display a relatively high level of central bank credibility over the full period we consider (IT start–2013M12). Indeed, the average value of the $CRED_{LLR1}$ index is equal to 0.89, while the average probability that $CRED_{LLR1}$ exceeds 0.95 is equal to 0.67. South Korea exhibits the highest level of credibility with an index equal to 0.99 on average. Furthermore, as suggested by the fourth column of the table (IT start–2009M12), these good results are not driven by the recent low inflation environment, in the wave of the Great Recession. Our results are consistent with previous empirical studies showing that the adoption of an inflation targeting framework in emerging economies has helped to better anchor private-sector inflation expectations (see, e.g., IMF (2008), Davis (2014)) and to reduce their dispersion (Capistrán & Ramos-Francia (2010)).

[9] As $CRED_{LLR1}$ and $CRED_{LLR2}$ are very close to each other, we only present the characteristics of the former and we will only focus on $CRED_{LLR1}$ in the following sections.

[10] According to Habermeier, Ötker-Robe, Jacome, Giustiniani, Ishi, Vavra, Kişinbay & Vazquez (2009), this inflationary episode was the first significant test for the credibility of the inflation targeting regimes in emerging countries.

	First 12 months	First 24 months	Mean (07M6-08M12)	Mean (IT start - 09M12)	Mean (overall period)	St. Dev. (overall period)	$Prob[LLR1 > 0.95]$ (overall period)	$Prob[LLR1 < 0.5]$ (overall period)	Rank (overall period)
Brazil	1.00	1.00	1.00	0.91	0.94	0.05	0.87	0.06	10
Chile	1.00	1.00	0.83	0.97	0.98	0.01	0.91	0.01	3
Colombia	0.76	0.88	0.90	0.96	0.98	0.01	0.88	0.00	5
Czech Rep.	0.21	0.59	0.78	0.88	0.92	0.04	0.71	0.05	12
Guatemala	-	-	-	-	0.98	0.00	0.82	0.00	2
Hungary	1.00	0.99	0.25	0.66	0.64	0.09	0.19	0.32	18
Indonesia	0.41	0.69	0.55	0.68	0.80	0.09	0.52	0.17	14
Israel	1.00	0.87	1.00	0.97	0.97	0.01	0.87	0.00	6
Mexico	0.91	0.96	0.97	0.98	0.98	0.00	0.85	0.00	4
Peru	1.00	1.00	0.76	0.95	0.97	0.01	0.88	0.03	7
Philippines	0.92	0.89	0.69	0.75	0.83	0.06	0.50	0.16	13
Poland	0.99	0.82	0.97	0.95	0.96	0.01	0.81	0.00	8
Romania	0.75	0.87	0.60	0.76	0.77	0.05	0.32	0.13	15
Slovakia	0.99	0.87	0.47	0.71	0.71	0.06	0.15	0.19	17
South Africa	1.00	1.00	0.66	0.90	0.93	0.03	0.73	0.04	11
South Korea	1.00	1.00	0.97	0.99	0.99	0.00	0.93	0.00	1
Thailand	1.00	1.00	0.81	0.95	0.95	0.01	0.68	0.02	9
Turkey	0.66	0.56	0.38	0.59	0.72	0.10	0.46	0.27	16
Mean	0.86	0.88	0.74	0.86	0.89	0.03	0.67	0.08	
Median	0.99	0.89	0.78	0.91	0.94	0.02	0.77	0.04	

Table 2: Some characteristics of the $CRED_{LLR1}$ index

Second, focusing on the one and two years following the adoption of inflation targeting (columns 1 and 2 of the table 2), it appears that the introduction of this new monetary framework was initially perceived as not very credible (Romania, Turkey), if not non-credible (Czech Republic, Indonesia) by the private sector. Such an initial lack of credibility could be explained by the fact that these countries did not fully satisfy the macroeconomic and institutional preconditions for adopting inflation targeting, such as central bank independence and transparency, fiscal discipline, or exchange rate flexibility. More importantly, the Turkish experience shows that the initial lack of central bank credibility has led to a loss in inflation control and a self-sustaining loss in credibility. In order to stop this vicious circle and to reduce the risk of future overshooting, Turkey decided in June 2008 to revise upward its target. However, as we can see in the figure 8, this revision was insufficient to restore the medium-run credibility of the central bank. The private sector considered this revision as a renouncement of the authorities' commitment to price stability (Habermeier et al. (2009)).

Finally, it appears that the food and energy price shocks in the second half of 2007 and 2008 have not abruptly destroyed the monetary policy credibility of emerging inflation targeting countries. Indeed, while figures 4 to 8 in appendix show that most countries have overshot their targets during this period, the third column of the table 2 (2007 M6-2008 M12) does not highlight a sharply decrease of the $CRED_{LLR1}$ index, except for Hungary. Of course, the size of the increase in inflation expectations and the evolution of the credibility index depend on the severity of inflation shocks. Nonetheless, some countries (Chile, Israel, Mexico, South Africa, and South Korea) succeeded in containing inflation expectations notwithstanding a subsequent increase in actual inflation, above the targets. This demonstrates how much well-established past credibility is important to cope with adverse supply shocks, and to limit second round effects on output. The lower the credibility, the stronger the tightening of monetary policy should be (Alichi & Al. (2009), Neuenkirch & Tillmann (2014)).

4.3 Comparison with the existing indicators

Figures 4 to 7 in appendix allow for comparing $CRED_{LLR1}$ and $CRED_{LLR2}$ to the two existing credibility indicators that constitute a reference so far, namely $CRED_{KM}$ and $CRED_{DMGS}$. Immediately, it appears that the variation amplitude of $CRED_{LLR1}$ and $CRED_{LLR2}$ is higher than those of the existing indicators, inside the [0-1] interval. This is justifiable. Consider for instance the case of Brazil in 2003-2004, when the monetary authorities entirely lost their credibility according to $CRED_{LLR1}$ and $CRED_{LLR2}$. In 2003, the agents unequivocaly (and rightly) expected that the central bank would not meet its commitment. The deviations were important; the expected (actual) inflation rate reached 11% (17%), while the target ceiling was 6.5%. Such a situation encourages the agents to not refer to the target when negotiating their salary or updating their prices, all the more for catching up in wages and prices, as the initial surge in prices was not provided in the previous contracts. Thus, the context of Brazil in 2003-2004, by definition and given the size of deviations, can reasonably be considered as a complete loss in credibility. On the contrary, $CRED_{KM}$ and $CRED_{DMGS}$ did not fall below 0.52 and 0.60, respectively. Given the [0,1] range, the plausibility of their message in terms of credibility is questionable.

The Romanian case also supports our indicators. Indeed, while the monetary authorities failed most of the time to meet the target, and consequently private expectations were often above the target ceiling, $CRED_{KM}$ and $CRED_{DMGS}$ always remain higher than 0.8. At the opposite, $CRED_{LLR1}$ and $CRED_{LLR2}$ appropriately address the deviations, falling for instance to 0.40 in 2006, 0.22 in 2008, 0.40 in 2011 and 0.45 in 2013. They plausibly suggest that the Romanian central bank had suffered from loss in credibility.

Turkey also offers an interesting comparison. From 2006 to 2008, the actual and expected inflation rates always exceeded the target ceiling, up to 4 and 6.5 percentage points, respectively. In these conditions, it is very hard to believe that the Turkish central bank was credible over this period. However, $CRED_{KM}$ and $CRED_{DMGS}$ remained close to 0.75 on average. Once again, on the contrary, $CRED_{LLR1}$ and $CRED_{LLR2}$ duly signal a significant loss in credibility, with values considerably lower than 0.5. Interestingly, while our indicators highlight a full loss in credibility at the end of 2008, Turkey decided to raise the target range, a room for manoeuvre to restore credibility (see, e.g., Habermeier et al. (2009)).

Similarly, the existing indicators do not appropriately address the (sometimes huge) deviations of inflation expectations from the target that typically occurred in South Africa, in Indonesia, in the Philippines and in Hungary, contrary to $CRED_{LLR1}$ and $CRED_{LLR2}$.

5 The impact of credibility on the volatility of monetary policy instrument

We now investigate to what extent central bank credibility – as measured by our new indicator - influences the volatility of the key instrument of monetary policy, namely the short term interest rate. This is an important issue, as a credible central bank is more likely to anchor inflation expectations to its target. In such a case, the central banker does not have to move his key instrument too much for influencing the yield curve in the desired direction. At the extreme, speeches are enough. On the contrary, non-credibility is penalizing in that it implies more volatility of the interest rate, while the variance of the interest rate theoretically enters the micro-founded welfare-based loss function of central banks[11]. Furthermore, the volatility of the monetary policy instrument increases macroeconomic uncertainty and (financial) instability. Thus, we want to test the following hypothesis: a higher (lower) credibility contributes to a lower (higher) volatility of the interest rate.

A similar issue has been adressed by De Mendonça & de Guimarães e Souza (2009) in the case of Brazil. However, they do not explicitly assess the relationship between credibility and interest rate volatility, as they regress the first-difference of the interest rate on the variation of their credibility index, by using Ordinary Least Squares (OLS) estimates. We consider a General Auto-Regressive Conditional Heteroscedastic (GARCH) approach to be more adequate for analyzing the volatility of any variable. We will use such a model to test whether our index of credibility significantly influences the conditional variance of interest rates.

First, it is common to consider interest rate rules, such that the short term interest rate responds to the deviations of the inflation rate towards its target, with a gradual adjustment (see, e.g., Clarida, Gali & Gertler (1998)). Consistently with this, the mean equation of our GARCH specification is a second order autoregressive process[12] augmented with the inflation rate, with a constant that is supposed to represent both the inflation target and the long-run equilibrium interest rate:

$$i_t = c + \rho_1 i_{t-1} + \rho_2 i_{t-2} + \phi \pi_t + \varepsilon_t \tag{11}$$

ε_t represents the innovations of the short term interest rate (free of inflationary shocks) at time t, with a zero mean and time-varying variance noted h_t. More precisely, we suppose that $\varepsilon_t = z_t \sqrt{h_t}$, with z_t a standardized white noise residual.

The time-varying conditional variance of interest rate is supposed to follow an Exponential General Auto-Regressive Conditional Heteroscedastic (EGARCH) process, augmented

[11] See the demonstration of Woodford (2003, Chap. 6).

[12] Considering an autoregressive process higher than first order allows to remove serial correlation of residuals as well.

with the lagged $CRED\_LLR1$ indicator as additional determinant. Its general representation is given by:

$$log\,(h_t) = \alpha_0 + \sum_{i=1}^{q} \alpha_i g(z_{t-i}) + \sum_{i=1}^{p} \beta_i log(h_{t-i}) + \omega CRED\_LLR1_{t-1} \qquad (12)$$

with $g\,(z_{t-i}) = \theta z_{t-i} + \gamma\,(|z_{t-i}| - E|z_{t-i}|)$, where $E|z_{t-i}|$ is conditional to a given density function. While estimating a GARCH(p,q) model requires the parameters α_i and β_i to be positive (since variance cannot be negative), the EGARCH(p,q) model is expressed in terms of log of h_t. Thus the conditional variance will always be positive whatever the sign of the parameters (Nelson (1991)). This is important in our specific case because $CRED\_LLR1$ is expected to have a negative influence on the conditional variance of the interest rate (namely ω is expected to be negative).

The first column of the table 5 in appendix reports the results of excess kurtosis tests for the interest rate data series. The null hypothesis of Normality is only rejected for Colombia, Czech Republic and Mexico. For these three countries, a Student-t distribution with a degree of freedom v (to be estimated) is then preferred to a Normal one, as usual in case of leptokurtic distribution.

The table 5 in appendix also reports the results of no ARCH effect tests. Such a test requires serially uncorrelated ε_t. However, the usual Q tests of no serial correlation relies on an assumption of conditional homoscedasticity. So we used the "robust" Q test suggested by West & Cho (1995). As indicated in the fourth column, the null hypothesis of absence of serial correlation is not rejected at the usual risk levels for every country, even if we can have some doubt for Peru. Finally, the hypothesis of no ARCH effect (for lags = 2, 4 and 6 months) is clearly rejected for most of the countries, except for Hungary, Israël, Slovakia, Thailand and Turkey. For the other countries, the interest rate data series exhibit types of large residuals' clustering that is consistent with a GARCH specification.

Tables 3 and 4 report the results of the estimations of the EGARCH(1,1)-X models[13]. Focusing on the variance equation, the nullity of α_1 and β_1 is rejected for every country, except the nullity of α_1 for Czech Republic and South Korea. So, the current conditional variance of the interest rate is significantly explained by past innovations contained both in $g(.)$ and in the past conditional variance h_{t-1}. This confirms the existence of ARCH effects and supports our econometrical approach. Moreover, according to the test suggested by

[13]Hungary, Israël, Slovakia, Thailand and Turkey are excluded because of the absence of ARCH effects, while Guatemala is not considered because of the lack of short term interest rates data series.

	Brazil	Chile	Colombia	Czech Rep.	Indonesia	Mexico
MEAN EQUATION						
constant	0.063	0.107***	0.017***	-0.022*	0.324***	-0.007
	(0.067)	(0.025)	(0.006)	(0.012)	(0.012)	(0.031)
i_{t-1}	1.802***	1.559***	1.414***	1.267***	0.896***	1.309***
	(0.016)	(0.067)	(0.001)	(0.064)	(0.019)	(0.078)
i_{t-2}	-0.815***	-0.589***	-0.427***	-0.286***	-0.069***	-0.313***
	(0.018)	(0.005)	(0.001)	(0.062)	(0.017)	(0.078)
π_t	0.019**	0.017***	0.009***	0.028***	0.097***	0.006
	(0.009)	(0.005)	(0.001)	(0.006)	(0.003)	(0.008)
VARIANCE EQUATION						
constant	-0.632**	0.354	0.770***	0.028	-2.304***	-0.982*
	(0.278)	(0.396)	(0.001)	(0.432)	(0.264)	(0.524)
$g\left(z_{t-1}\right)$	0.497***	0.661***	-0.291***	2.061	2.287***	0.503**
	(0.114)	(0.104)	(0.001)	(1.394)	(0.203)	(0.239)
h_{t-1}	0.643***	0.949***	0.942***	0.897***	0.865***	1.011***
	(0.013)	(0.015)	(0.001)	(0.039)	(0.050)	(0.009)
$CRED\_LLR1_{t-1}$	-0.729***	-1.043***	-0.788***	-0.564*	0.262	0.607
	(0.260)	(0.385)	(0.001)	(0.313)	(0.375)	(0.525)
Degrees of freedom (a)	-	-	2.92	2.04	-	2.42
GARCH LB test (b)	0.078	0.586	0.035	0.213	0.526	0.999
GARCH McLL test (c)	0.994	0.774	0.750	0.643	0.318	0.999
Number of observations	173	167	170	163	100	132

Notes: Std. errors are in parentheses. *, **, and *** denote significance at the 10%, 5% and 1% level, respectively.
(a) Estimation of the number of degrees of freedom v (in case of Student-t distribution).
(b) P-Value of the Ljung-Box no serial correlation test on the standardized residuals $\varepsilon_t/\sqrt{(h_t)}$.
(c) P-Value of the McLeod-Li no serial correlation test on the squared standardized residuals ε_t^2/h_t.

Table 3: EGARCH-X estimates (1/2)

McLeod & Li (1983), the null hypothesis of no serial correlation for the squared standardized residuals is never rejected at the usual risk levels. This suggests that the variance equation is correctly specified with the orders $q = 1$ and $p = 1$ chosen for the EGARCH.

In the same way, a second-order autoregressive process is found to be appropriate for the mean equation. Indeed, according to the usual Ljung & Box test, the null hypothesis of no serial correlation test for the standardized residuals is never rejected at usual risk levels. Finally, the fact that the estimated degrees of freedom are low (close to but higher than 2) for Colombia, Czech Republic and Mexico validates *ex post* the choice of considering a Student-t distribution.

Despite the very important informational content of the past conditional variance h_{t-1}, we find that the estimated coefficient associated to $CRED_{LLR1}$ is always statistically significant, except for Indonesia and Mexico, and negative. This confirms that central bank credibility decreases the volatility of the key instrument of monetary policy. In that sense, credibility improves the efficiency of monetary policy, notably through the expectations channel. The figure 9 in appendix gives four clear examples of situations in which one can observe obvious surges (decline) in the conditional variance of interest rate h_t following a decrease (increase) in credibility. These examples concern Chile in 2008-2009, the Philippines between 2004 and 2009, South Africa in 2001-2003 and 2007-2010, and South Korea in 2008.

Finally, one can argue that central bank credibility rather evolves according to a sluggish process, in that it can rarely be suddenly increased nor annihilated (see e.g. Blinder (2000)). In this respect, as robustness checks, we have substituted the 6-month moving average of $CRED_{LLR1}$ for its one-lagged value in the variance equation of the EGARCH models. The corresponding results are reported in the tables 6 and 7 in appendix. Overall, they are robust to this alternative specification, even if the estimated coefficient associated to the credibility becomes insignificant for Peru and Poland.

	Peru	Philippines	Poland	Romania	South Africa	South Korea
MEAN EQUATION						
constant	0.286***	-0.044	-0.069	0.077	0.014***	0.032
	(0.003)	(0.030)	(0.059)	(0.148)	(0.001)	(0.028)
i_{t-1}	1.727***	1.305***	0.845***	1.326***	1.573***	1.542***
	(0.001)	(0.001)	(0.009)	(0.072)	(0.001)	(0.004)
i_{t-2}	-0.783***	-0.303***	0.116***	-0.345***	-0.584***	-0.549***
	(0.001)	(0.002)	(0.015)	(0.081)	(0.001)	(0.010)
π_t	-0.019***	0.004	0.077***	0.017	0.013***	-0.001
	(0.001)	(0.007)	(0.007)	(0.019)	(0.001)	(0.006)
VARIANCE EQUATION						
constant	-2.253***	-0.242	-0.097*	-0.255	-0.274	7.659***
	(0.077)	(0.173)	(0.051)	(0.381)	(0.285)	(1.752)
$g(z_{t-1})$	1.517***	0.373***	0.328***	1.062***	0.546***	-0.003
	(0.074)	(0.101)	(0.106)	(0.213)	(0.109)	(0.097)
h_{t-1}	0.538***	0.866***	0.959***	0.567***	0.767***	0.735***
	(0.019)	(0.051)	(0.016)	(0.123)	(0.080)	(0.063)
$CRED1\_LLR_{t-1}$	-0.508***	-0.617***	-0.262***	-1.142**	-0.985***	-9.032***
	(0.078)	(0.202)	(0.049)	(0.573)	(0.302)	(1.997)
Degrees of freedom (a)	-	-	-	-	-	-
GARCH LB test (b)	0.227	0.501	0.119	0.783	0.491	0.688
GARCH McLL test (c)	0.996	0.321	0.682	0.982	0.184	0.557
Number of observations	131	142	181	99	165	154

Notes: Std. errors are in parentheses. *, **, and *** denote significance at the 10%, 5% and 1% level, respectively.
(a) Estimation of the number of degrees of freedom v (in case of Student-t distribution).
(b) P-Value of the Ljung-Box no serial correlation test on the standardized residuals $\varepsilon_t/\sqrt(h_t)$.
(c) P-Value of the McLeod-Li no serial correlation test on the squared standardized residuals ε_t^2/h_t.

Table 4: EGARCH-X estimates (2/2)

6 Concluding remarks

The aim of this article was to provide a simple time-varying metric of central bank credibility. To this end, we suggest a measure of credibility based on the gap between private sector inflation expectations and the inflation target. In contrast to the existing measures, our index introduces two major innovations. First, it is an asymmetric measure of credibility, based on a linear-exponential (LINEX) function. Indeed, one can expect that, in practice, that negative deviations of inflation expectations from the target are less likely to indicate loss in credibility than positive deviations. Second, contrary to the main contributions so far, our measure does not impose any *ad hoc* threshold above which credibility is considered as null.

We then compute our index for all emerging inflation-targeting countries, and compare it to the existing indicators. Our findings suggest a relatively high level of central bank credibility in these countries over the inflation targeting period. Nonetheless, we observe that monetary policy was not necessarily perceived as very credible in the immediate wake of inflation targeting adoption, in particular in Czech Republic, Indonesia, Romania, and Turkey. More importantly, we show that our measure is more suited to assess the monetary experiences of these economies than the existing ones. Especially, our index is better able to discriminate between the periods of low vs high credibility, in a context of rather low inflation targets.

Finally, we empirically investigate the linkage between central bank credibility (measured by our index) and short-term interest rate volatility. An EGARCH model is used to this end. Our results confirm that the level of credibility negatively impacts the variance of interest rate in a large number of countries. This suggests that a credible central bank does not need to frequently change its key instrument to reach the inflation target. Credibility is then expected to improve monetary policy transmission efficiency, particularly through the expectations channel. In terms of policy implications, this means that candidates to an inflation targeting framework need to make institutional reforms that will ensure an initial high level of credibility. Otherwise, an initial weak credibility could lead to higher and self-sustaining volatility in interest rates (as indicated by our GARCH experiments), which in turn would trigger higher macroeconomic instability.

Against this background, an interesting extension would consist in investigating the economic and institutional factors ensuring a minimum level of credibility. Combining the index of credibility we suggest with the literature on the preconditions for adopting inflation targeting would be relevant for such a research. Indeed, the latter highlights some determinants that are likely to play, such as the degree of independence of the central bank, the fiscal context, the exchange rate regime, and the quality of institutions. Revealing the deep factors that set up initial credibility is very important for the emerging countries which are candidates to the inflation targeting framework.

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Appendix

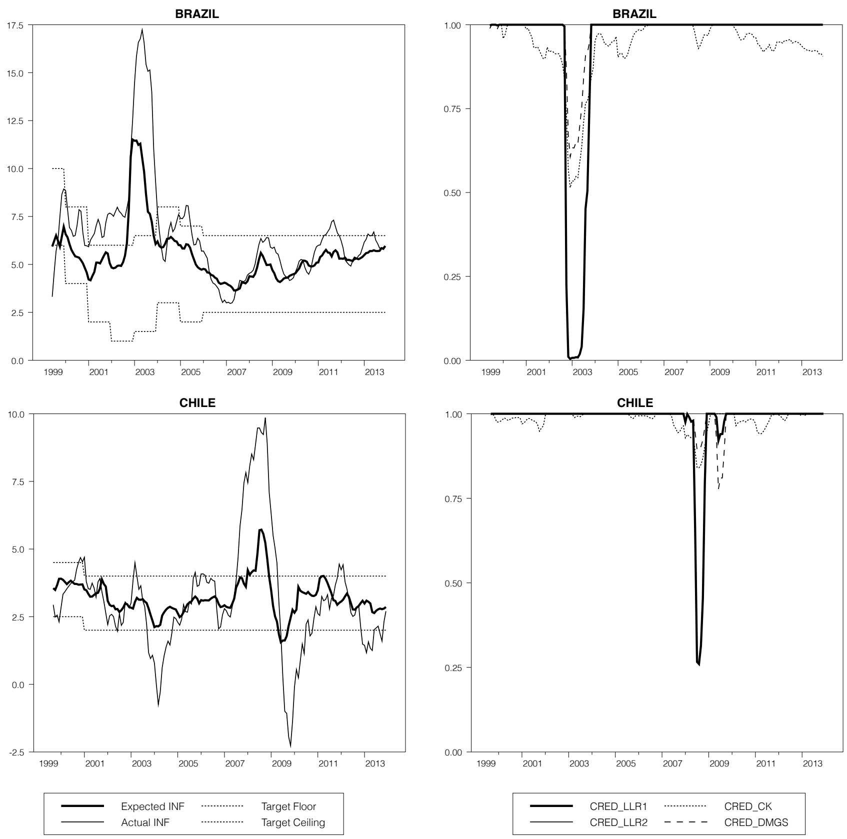

Figure 4: Target range, expected inflation and Credibility Indicators (1/5)

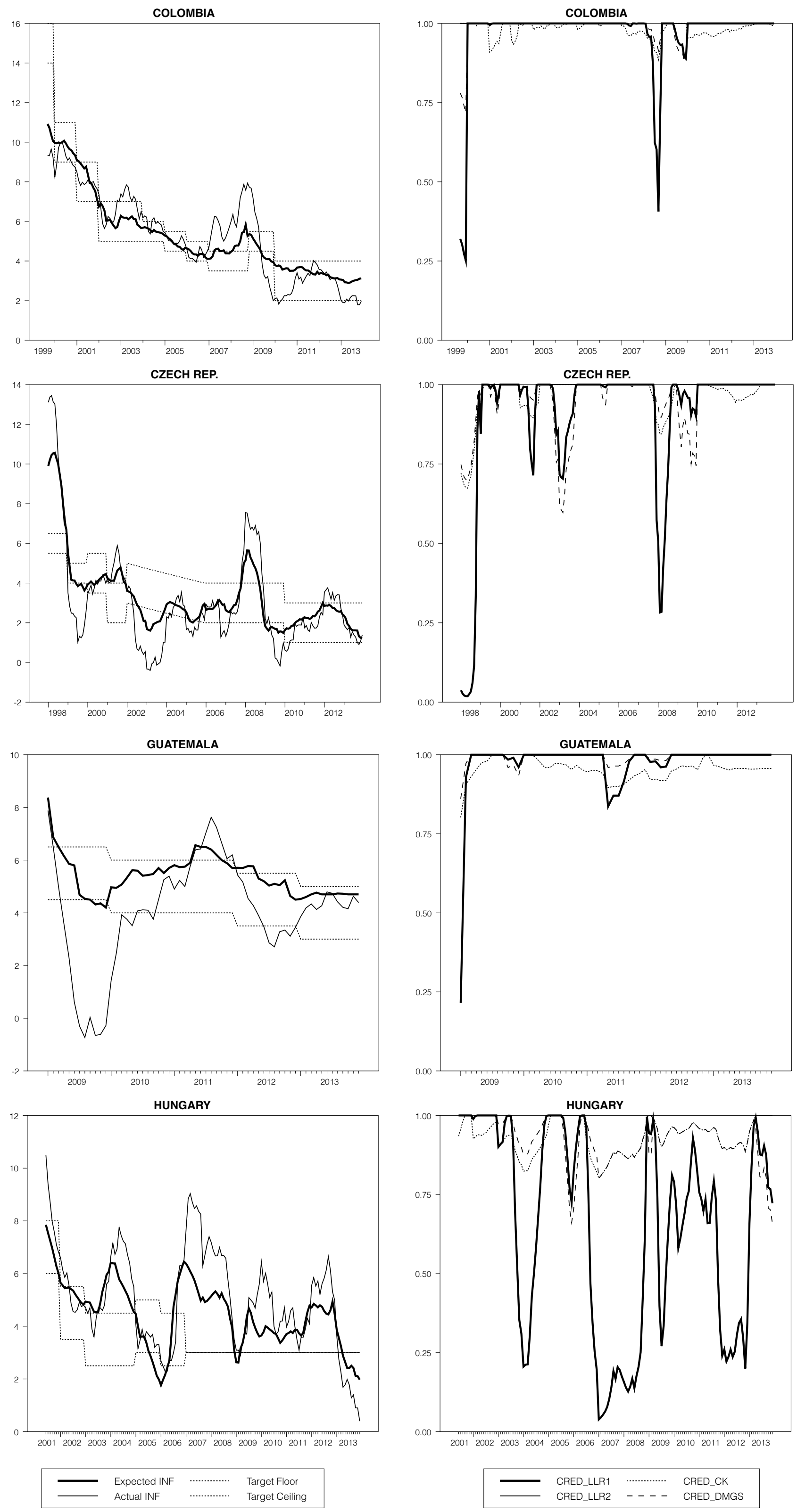

Figure 5: Target range, expected inflation and Credibility Indicators (2/5)

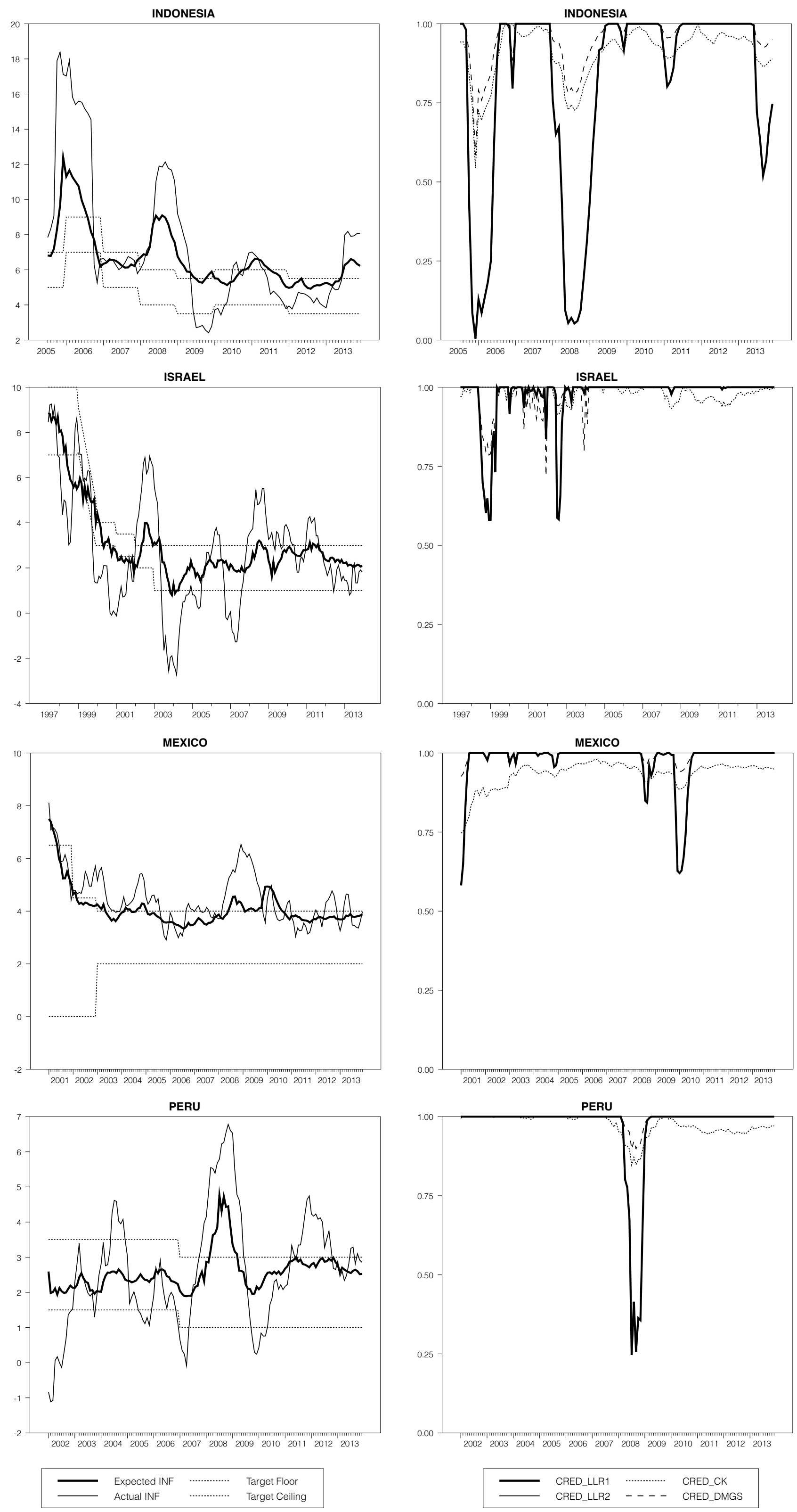

Figure 6: Target range, expected inflation and Credibility Indicators (3/5)

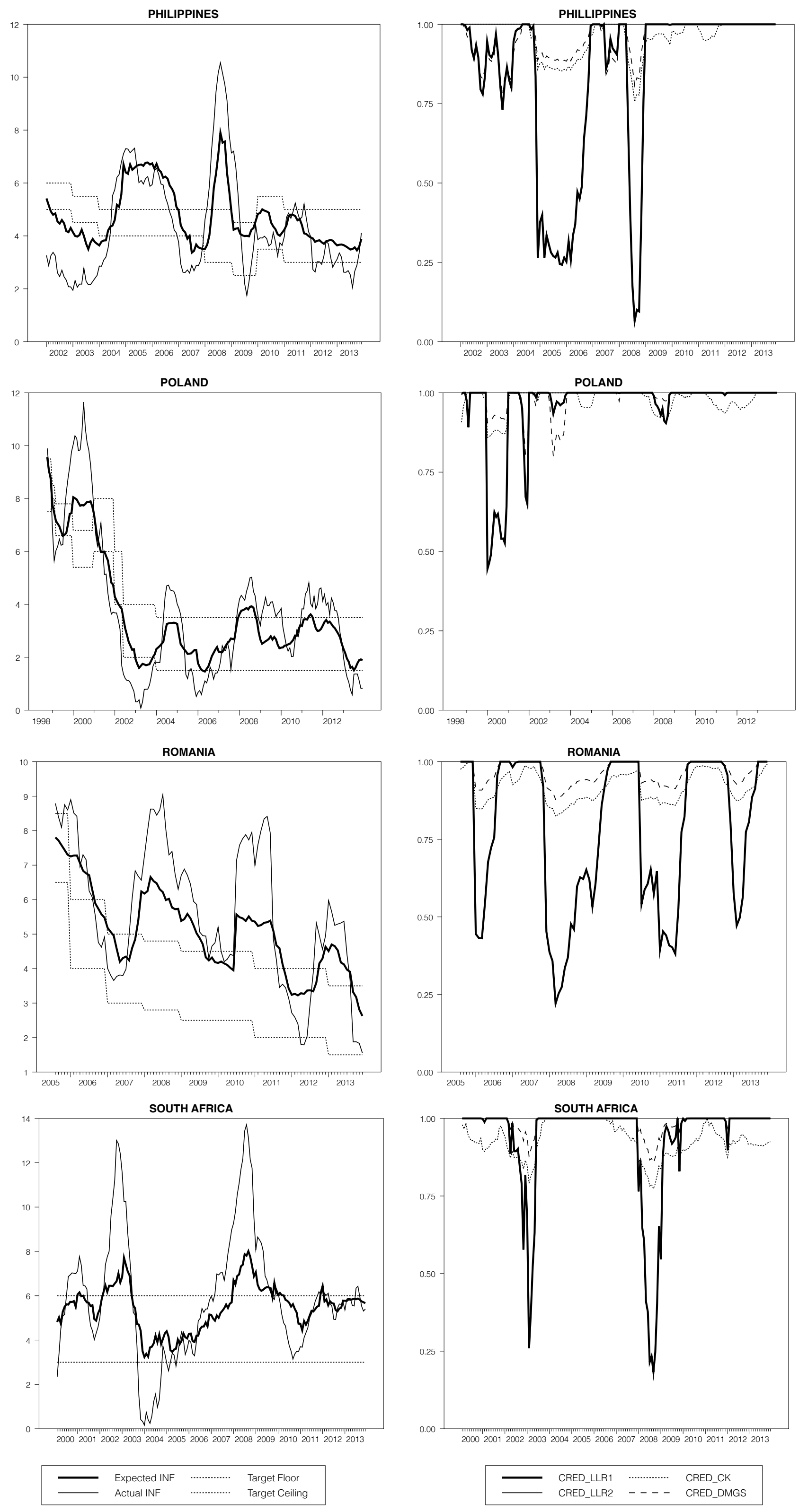

Figure 7: Target range, expected inflation and Credibility Indicators (4/5)

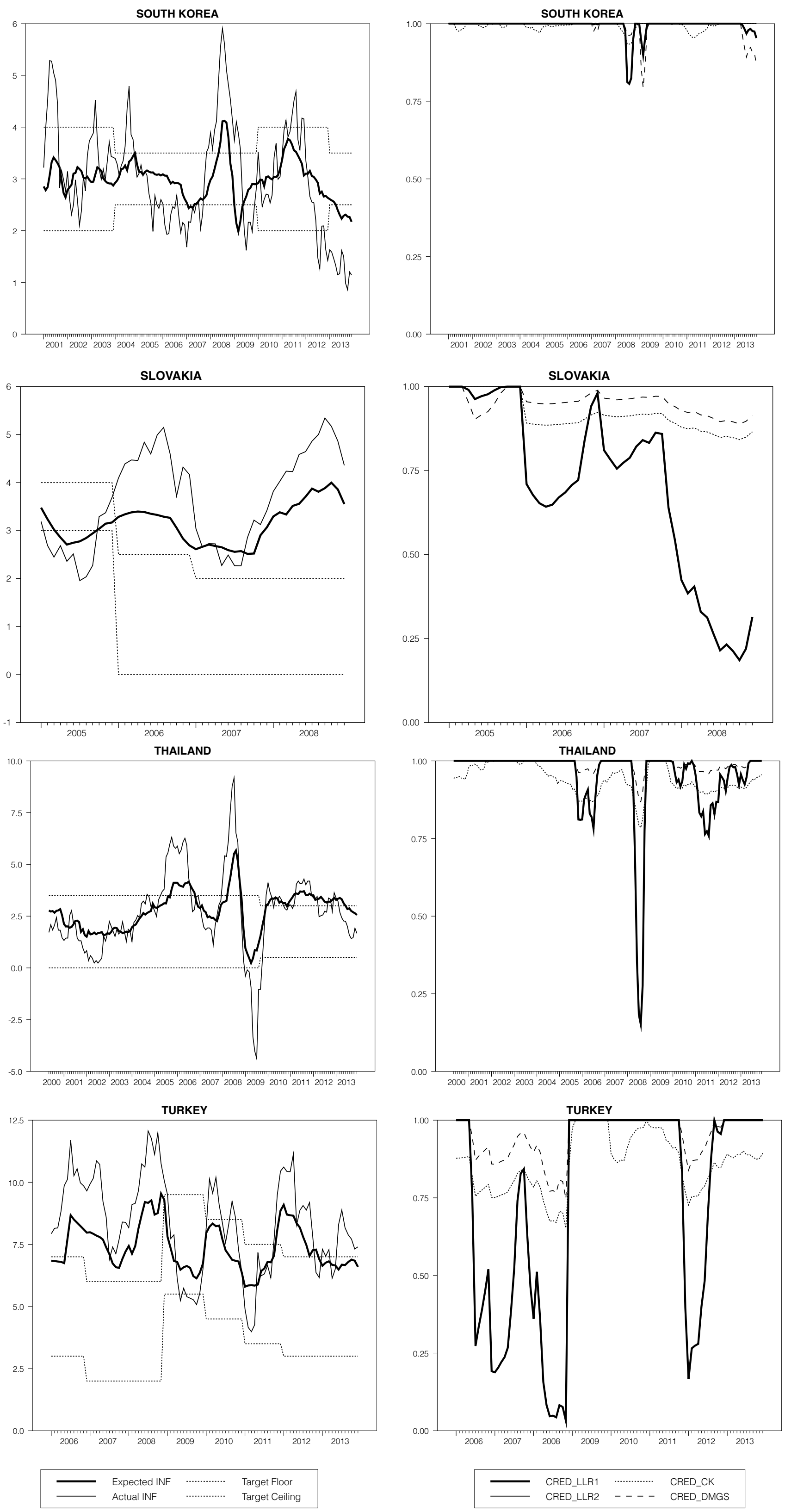

Figure 8: Target range, expected inflation and Credibility Indicators (5/5)

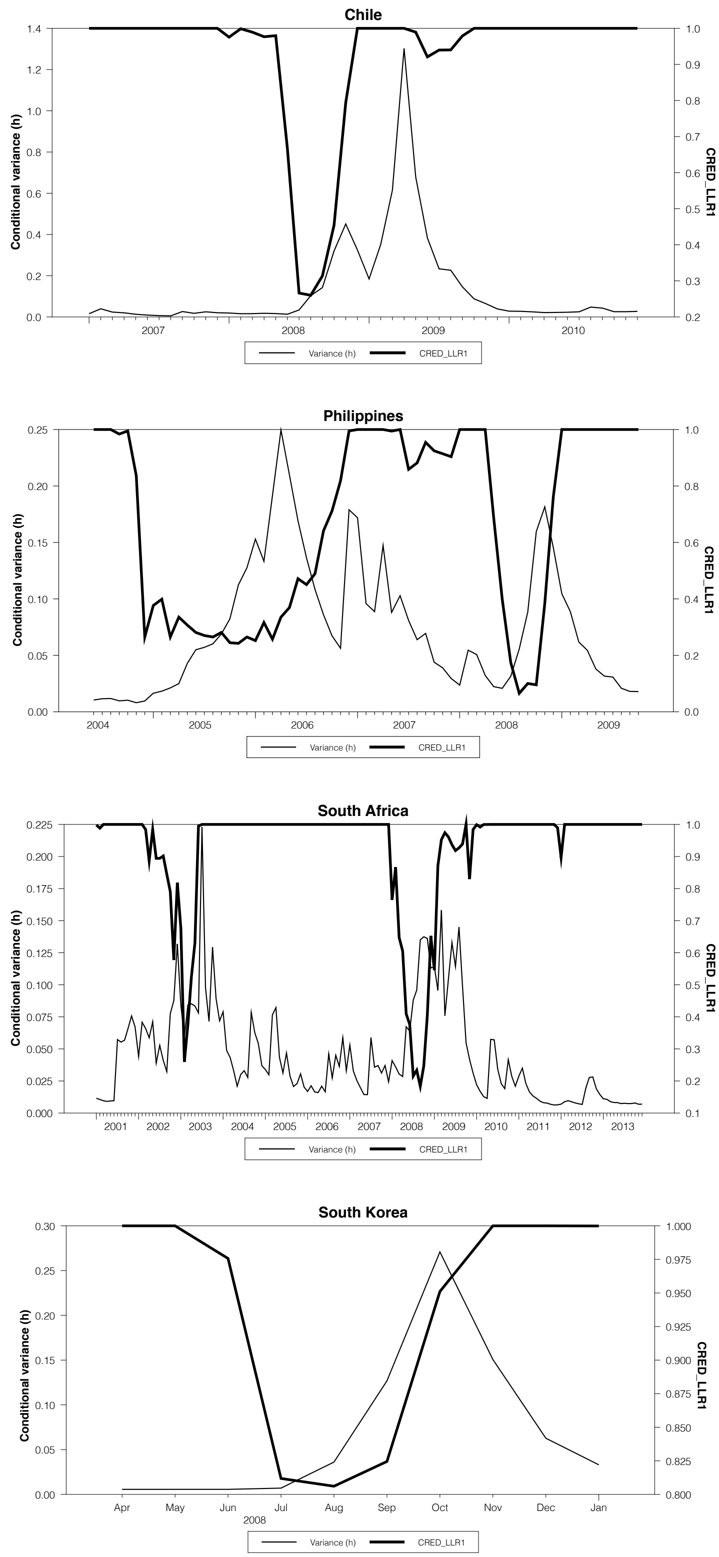

Figure 9: Examples of the negative link between interest rate volatility and credibility

Country	Kurtosis excess on interest rate data series (a)	No serial correlation test on residuals ε_t (b)	No ARCH Effect test on residuals ε_t (c)		
			lags = 2	lags = 4	lags = 6
Brazil	-0.52	0.764	0.022	0.023	0.056
Chile	0.42	0.591	0.000	0.000	0.000
Colombia	0.88*	0.035	0.000	0.017	0.000
Czech Rep.	5.51*	0.918	0.000	0.000	0.000
Hungary	-0.34	0.168	0.951	0.982	0.000
Indonesia	-0.47	0.708	0.000	0.000	0.000
Israel	-0.56	0.846	0.137	0.403	0.096
Mexico	4.32*	0.605	0.006	0.000	0.000
Peru	-0.05	0.001	0.001	0.008	0.035
Philippines	-0.89	0.547	0.056	0.001	0.004
Poland	0.13	0.563	0.000	0.000	0.000
Romania	0.33	0.938	0.025	0.039	0.127
Slovakia	-0.96	0.101	0.233	0.248	0.398
South Africa	-0.95	0.672	0.111	0.002	0.014
South Korea	-1.01	0.965	0.005	0.005	0.021
Thailand	-0.32	0.100	0.115	0.256	0.052
Turkey	-1.60	0.176	0.305	0.596	0.912

(a) $\star$ means rejection of the Normality hypothesis at the 5% level (leptokurtic distribution).

(b) P-value of the West & Cho (1995) test on the residuals ε_t of the mean equation.

(c) P-value of the ARCH test consisting in regressing the square residuals series on its own lags. Under the null, the corresponding R^2 is equal to zero.

Table 5: Properties of the interest rate data series and tests on the mean equation residuals

	Brazil	Chile	Colombia	Czech Rep.	Indonesia	Mexico
MEAN EQUATION						
constant	0.040*	-0.054***	0.003	-0.020	0.272**	-0.010
	(0.021)	(0.005)	(0.029)	(0.014)	(0.111)	(0.029)
i_{t-1}	1.812***	1.558***	1.512***	1.274***	1.138***	1.307***
	(0.001)	(0.001)	(0.059)	(0.073)	(0.020)	(0.004)
i_{t-2}	-0.821***	-0.557***	-0.520***	-0.293***	-0.227***	-0.311***
	(0.001)	(0.002)	(0.061)	(0.071)	(0.023)	(0.001)
π_t	0.005	0.018***	0.010	0.027***	0.027	0.006
	(0.004)	(0.003)	(0.011)	(0.007)	(0.023)	(0.006)
VARIANCE EQUATION						
constant	-0.699***	0.559***	1.499***	-0.239	-1.026***	-1.337**
	(0.100)	(0.017)	(0.126)	(0.367)	(0.331)	(0.598)
$g\left(z_{t-1}\right)$	0.837***	0.602***	1.195***	0.635**	1.036***	1.130
	(0.149)	(0.032)	(0.136)	(0.264)	(0.383)	(0.862)
h_{t-1}	0.156***	0.943***	0.964***	0.863***	0.951***	0.998***
	(0.036)	(0.004)	(0.021)	(0.054)	(0.063)	(0.013)
$CRED\_LLR1\_MA(6)$	-2.378***	-1.207***	-1.604***	-0.729*	0.129	0.976
	(0.093)	(0.017)	(0.140)	(0.451)	(0.202)	(0.622)
Degrees of freedom (a)	-	-	2.01	2.88	-	2.09
GARCH LB test (b)	0.060	0.240	0.004	0.645	0.986	0.556
GARCH McLL test (c)	0.805	0.742	0.980	0.628	0.984	0.154
Number of observations	170	167	167	160	97	130

Notes: Std. errors are in parentheses. *, **, and *** denote significance at the 10%, 5% and 1% level, respectively.
(a) Estimation of the number of degrees of freedom v (in case of Student-t distribution).
(b) P-Value of the Ljung-Box no serial correlation test on the standardized residuals $\varepsilon_t/\sqrt{(h_t)}$.
(c) P-Value of the McLeod-Li no serial correlation test on the squared standardized residuals ε_t^2/h_t.

Table 6: EGARCH-X estimates with the 6-month moving average of $CRED_{LLR1}$ (1/2)

	Peru	Philippines	Poland	Romania	South Africa	South Korea
MEAN EQUATION						
constant	0.131***	-0.048	-0.048	0.180***	-0.036*	0.053***
	(0.026)	(0.033)	(0.077)	(0.038)	(0.021)	(0.001)
i_{t-1}	1.757***	1.253***	0.834***	1.328***	1.499***	1.618***
	(0.051)	(0.003)	(0.037)	(0.005)	(0.001)	(0.001)
i_{t-2}	-0.787***	-0.250***	0.124***	-0.350***	-0.507***	-0.625***
	(0.048)	(0.004)	(0.043)	(0.005)	0.002	(0.001)
π_t	-0.009	0.005	0.074***	0.001	0.015***	-0.007***
	(0.009)	(0.007)	(0.010)	(0.008)	(0.004)	(0.000)
VARIANCE EQUATION						
constant	-6.256***	-0.288	-0.045	-0.057	-0.105	-3.497***
	(1.628)	(0.232)	(0.368)	(0.094)	(0.144)	(0.075)
$g\left(z_{t-1}\right)$	0.915***	0.366***	0.335**	1.090***	0.533***	0.502***
	(0.083)	(0.139)	(0.136)	(0.128)	(0.136)	(0.109)
h_{t-1}	-0.521***	0.825***	0.955***	0.546***	0.630***	-0.566***
	(0.029)	(0.091)	(0.020)	(0.091)	(0.047)	(0.087)
$CRED\_LLR1\_MA(6)$	0.227	-0.727***	-0.333	-1.449***	-1.660***	-4.259***
	(1.698)	(0.256)	(0.326)	(0.147)	(0.319)	(0.381)
Degrees of freedom (a)	-	-	-	-	-	-
GARCH LB test (b)	0.426	0.400	0.110	0.698	0.322	0.435
GARCH McLL test (c)	0.999	0.190	0.705	0.954	0.108	0.004
Number of observations	128	139	178	96	162	151

Notes: Std. errors are in parentheses. *, **, and *** denote significance at the 10%, 5% and 1% level, respectively.

(a) Estimation of the number of degrees of freedom v (in case of Student-t distribution).

(b) P-Value of the Ljung-Box no serial correlation test on the standardized residuals $\varepsilon_t/\sqrt(h_t)$.

(c) P-Value of the McLeod-Li no serial correlation test on the squared standardized residuals ε_t^2/h_t.

Table 7: EGARCH-X estimates with the 6-month moving average of $CRED_{LLR1}$ (2/2)