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Exchange rate as a nominal anchor: is it sustainable? Evidence from the extended Cukierman-Kiguel-Liviatan credibility and reputation model

Abstract: The purpose of this paper is to analyze the sustainability of exchange rate nominal anchor. In order to follow through the process of establishing such an anchor, a model formulated by Cukierman, Kiguel & Liviatan (1992) is extended to capture both commitment and anti-inflationary reputation of monetary authorities. The main finding is that if the assumptions concerning complete information about the future level of exchange rate as well as perfect homogeneity of domestic and foreign government securities are overruled, the exchange rate nominal anchor can be sustained in the short-term. This is especially the case of emerging and developing economies which usually base their anti-inflationary programs on exchange rate nominal anchor, due to lack of domestic monetary policy credibility. However, this policy is biased with a vicious circle: in order to build reputation, a tough commitment concerning exchange rate must be formulated, but fulfilling this commitment is extremely hard due to repeating disturbances, which can be offset only with the use of fiscal policy. In the long-term, as situation of public finances deteriorates, exchange rate nominal anchor is exposed to more and more severe shocks that eventually may lead to its breakdown.
Keywords: commitment, monetary policy, exchange rate, models of credibility and reputation, nominal anchor.
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Introduction

Since the beginning of the seventies, along with the fall of the Bretton Woods system, the long-lasting process of evolution of central banks has begun. Strategies and instruments of monetary policy appeared to be the subject of a deep transformation, as well as its institutional fundamentals. The influence of the qualitative aspects of monetary policy, such as credibility, transparency and accountability, on effectiveness of this policy have become widely discerned (Blackburn & Christensen, 1989; Blinder, 1999; Bofinger, 2001; Friedman, 2002; Kowalak, 2006; Marszałek, 2009; Wojtyna, 1998).

This occurred mainly due to seminal works of Kydland and Prescott (1977), Calvo (1978), as well as Barro and Gordon (1983a, 1983b). According to them, the phenomenon of dynamic inconsistency of economic policy appears due to the fact that decisions of economic agents always precede forthcoming decisions of policymakers. Economic agents formulate their expectations without bothering themselves with official announcements of policymakers, because of awareness that policymakers can always renege on formulated commitments due to the change of the economic circumstances. This poses a problem also for monetary authorities. Even if the central bank is burdened with the task of curbing inflation rate, there is always a proneness to make the sacrifice of price level stability in the name of unemployment reduction. While accepting excessive inflation, monetary authorities can trigger off the fall in real wages, causing employment increase due to the existence of money illusion. Economic agents are aware of this, so they treat monetary policy as incredible. This is the core of the so-called inflation bias, according to which economic agents always expect higher inflation rate than the inflation target of monetary authorities (Kokoszczyński, 2004; Wojtyna, 1998).

Under such circumstances it is extremely hard to lower inflation rate in a permanent manner. Hence, in order to overcome the inflation bias, a rule that binds monetary authorities must be formulated and monetary authorities must have enough willpower to obey this rule. In other words, credibility of monetary policy must be assured. Such credibility exists when economic agents believe that monetary authorities are going to obey monetary policy rule and also that obeying of such a rule is feasible (Drazen & Masson, 1994). It is worth underlining that the credibility is under a great influence of anti-inflationary reputation of the central bank.

The degree of credibility can be increased due to two approaches. The first is to delegate the implementation of anti-inflationary monetary policy to the so-called conservative central banker. Such a conservative central banker uses any available tool in order to prevent the inflation rate growth (Rogoff, 1983). The second approach is to conduct monetary policy according to predefined rules. This leaves monetary authorities no room for discretionary activities, preventing them from breaking the predetermined commitments (Ghosh, Gulde & Wolf, 2002).

In practice, a rigorous realization of these approaches is difficult. Obeying tough rules makes reaction to unpredictable economic disturbances impossible. On the other hand, a conservative central banker has the power to implement discretionary activities, which in turn may affect economic agents' inflationary expectations. In order to avoid these shortcomings, a mixed approach can be implemented, according to which within the framework of a general rule, embodied in the act of the central bank, some discretionary activities of the central bank are acceptable (Bruno, 1991; Kokoszczyński, 2004). Credibility of such a mixed approach lies in the belief of economic agents that monetary authorities are able to maintain a stable price level, and that this goal is in their interest (Houben, 2000).

If an implemented rule is less rigorous, then monetary authorities use the so-called real targets approach. In this situation a central bank is implicitly burdened with the task of maintaining price stability, as well as eliminating extraordinary fluctuations in the level of production and employment. But as restricting the ability of discretionary policy-making arises, approach to monetary policy turns into the nominal anchor one and the price level stability becomes an exclusive target (Corden, 1994, 2002).

In the second approach exchange rate regime plays a key role. Monetary authorities can implement floating exchange rate regime, thus focusing only on stabilizing the price level. An inflation target becomes then a nominal anchor. On the other hand, monetary authorities can also try to stabilize the price level using nominal anchor in the form of exchange rate. If the domestic currency is pegged to a currency of a country with a low inflation track record, then importing anti-inflationary credibility becomes possible, influencing inflationary expectations of economic agents (Bleaney, 2000).

However, "importing" credibility from another country via exchange rate regime is possible only if costs from reneging on such a nominal anchor outweigh the benefits arising from a breach of the commitment. Otherwise economic agents simply do not treat monetary authorities' commitment seriously and monetary policy remains inconsistent. In order to prevent such a phenomenon, costs from a breach of the exchange rate rule should be as high as possible, because this in turn increases credibility of monetary policy. As A.R. Ghosh, Gulde & Wolf (2002, p. 30) aptly put it: 'the harder the peg, the better'. This leaves no choice but to irrevocably fix a domestic currency to a currency of a major trading partner of low inflation rate track record.

The main purpose of this paper is to analyze sustainability of such exchange rate nominal anchor. In order to follow through the process of establishing such an anchor, a Barro-Gordon type credibility and reputation model formulated by Cukierman, Kiguel & Liviatan (1992) is extended in Section 2 to capture both commitment and anti-inflationary reputation of monetary authorities. An important remark here is that the longer the central bank follows a rigorous exchange rate rule, the higher the temptation to break the rule. Then, some light is shed on the prospects of exchange rate nominal anchor and the circumstances, under which such an anchor can be effectively used. Hence, results of the extension of the model in accordance with the second generation currency crisis model are presented in Section 3. Section 4 concludes.

1. The credibility model

According to Cukierman *et al.*, the objective function of monetary authorities is a modified version of Barro-Gordon model:

$$L_R = a\left(\pi - \pi^e\right) - b\frac{\pi^2}{2} - k\left(c + r\right);\ \ a \geq 0 \wedge b,\ \ k > 0 \wedge c,\ \ r \in 0;1 \qquad (1)$$

L_R – the objective function of monetary authorities obeying monetary policy rule; a – relative importance which monetary authorities attach to output gains from surprise inflation as compared with their aversion to inflation; π – actual inflation rate as a result of conducted monetary policy; π^e – inflation rate expected by economic agents; b – relative importance which monetary authorities attach to inflation; k – fixed parameter that determines the size of the cost incurred by monetary authorities when pursued a policy change (for example, when they renege on a commitment c); c – degree of commitment of monetary authorities; r – anti-inflationary reputation of the central bank.

It has to be underlined that in the original model reputation parameter r is not explicitly distinguished. Cukierman, Kiguel & Liviatan (1992) only find out that a 'commitment is more likely to result, when credibility is higher' (p. 10) and that 'a higher reputation is conducive to a stronger commitment' (p. 11). One can also reach a conclusion that anti-inflationary reputation can lower the expected value of surprise inflation ($\pi - \pi^e$); however this remark is not formulated in a clear-cut fashion in original paper.

Obviously, these general insights can hardly be put into question. However, in the original model anti-inflationary reputation is of second-importance character, resulting from systematic fulfilment of commitment. Such a limited approach does not capture a variety of cases in which central banks formulate no explicit commitment, having at the same time relatively high anti-inflationary reputation. In other words, obeying tough commitment is not the one and only way to build anti-inflationary reputation, neither the only precondition to achieve a high level of such reputation. The introduction of a separate r parameter helps to overcome this weakness, allowing the inclusion in the analysis also examples of central banks which follow implicit price stability anchor.

Taking the abovementioned into account, it can be assumed that the $c + r$ sum measures joint effect of commitment and anti-inflationary reputation. This can be treated as a degree of monetary policy credibility. It can also be assumed that the longer monetary authorities fulfil the commitment, the larger is the increase of their anti-inflationary reputation. On the other hand, reneging on a commitment c, apart from negative economic consequences, lowers anti-inflationary reputation of the central bank.

If monetary authorities do not formulate any commitment ($c = 0$), their objective function takes into account the freedom to take discretionary decisions:

$$L_D = a\left(\pi - \pi^e\right) - b\frac{\pi^2}{2} - kr; \;\; a \geq 0 \wedge b > 0 \wedge r \in 0;1 \tag{2}$$

L_D – the objective function of monetary authorities which are not bound by any commitment, the rest as in equation (1).

It has to be underlined that the parameters of the objective functions (1)-(2) are not set simultaneously. First, monetary authorities choose the degree of commitment c. Then parameter a realizes. After this realization economic agents formulate their inflationary expectations π^e. In the end monetary authorities pick the actual rate of inflation π. Hence, if the economy is being struck with a shock, then the value of parameter a increases. If a central bank has strong anti-inflationary reputation, monetary authorities can become more prone to renege on a commitment, triggering surprise inflation off.

Monetary authorities will renege on the commitment if benefits from maintaining $\pi = 0$ are less than benefits from adjusting the inflation rate optimally in view of the realization of a. In the case of creating unexpected surprise inflation $\pi - \pi^e > 0$, it is optimal for monetary authorities to set $\pi = \frac{a}{b}$, as for this value parabolic functions (1)-(2) reach their apex with respect to $\frac{-a}{-2\frac{1}{2}b}$. According to this:

$$a\left(\frac{a}{b} - \pi^e\right) - \frac{b}{2}\frac{a^2}{b^2} - k\left(c + r\right) > -a\pi^e - kr \tag{3}$$

$$a > \sqrt{2bkc} \tag{4}$$

The $a_c = \sqrt{2bkc}$ is the threshold value. If actual realization of a is higher than a_c, monetary authorities certainly break the monetary policy rule and renege on a commitment. Hence:

$$\pi\left(a\right) = \begin{cases} 0 & \text{if } \; a \leq a_c \\ \frac{a}{b} & \text{if } \; a > a_c \end{cases} \tag{5}$$

Economic agents are aware of this. Moreover, only part of the economic agents takes the commitment seriously. Then, the expected inflation rate takes on value:

$$\pi^e(a) = \alpha\pi_R + (1-\alpha)\pi_D \quad \alpha \in 0;1 \tag{6}$$

π_R – zero inflation rate ($\pi_R = 0$), π_D – positive inflation rate, optimal in case of reneging on a commitment ($\pi_D = \frac{a}{b}$), α – parameter that measures economic agents' belief that the fulfilment of the commitment is feasible.

Once again, there is an important difference between the original model and its presented modified version, which has to be underlined. Namely, according to Cukierman *et al.* (1992), parameter is synonymous with credibility of the central bank. Moreover, while reading the original paper, the reader can get an impression that authors treat parameter as equivalent not only to credibility, but to anti-inflationary reputation of the central bank as well. Such a limited approach is not sufficient. As explained in the introduction, the degree of credibility depends on the belief of economic agents that monetary authorities are going to obey monetary policy rule and, at the same time, on the belief that obeying such a rule is feasible. Hence, parameter refers only partially to the credibility of central bank, capturing the second part of the quoted definition. Then, as also pointed out in the introduction to this paper, anti-inflationary reputation is only one of the two pillars of credibility of central bank. The second is the more or less explicit commitment of monetary authorities to follow monetary policy in a such a way as to achieve the predefined targets. So, parameter c as well as r influences central bank credibility. Hence, attracting credibility only to the anti-inflationary reputation of monetary authorities is nothing more but fallacy.

Some agents do not believe that the monetary authorities are determined to live up to commitments. They expect inflation rate $\pi_D = \frac{a}{b}$. Since the proportion of the two groups (*i.e.* 'believers' and 'unbelievers') is given by $\frac{c+r}{2}$, the average expected inflation rate is:

$$\pi^e(a) = \frac{c+r}{2}\left[\alpha\pi_R + (1-\alpha)\pi_D\right] + \left[1 - \left(\frac{c+r}{2}\right)\right]\pi_D = \left[1 - \alpha\left(\frac{c+r}{2}\right)\right]\frac{a}{b} \tag{7}$$

Hence:

$$\pi^e(a) = \begin{cases} \left[1 - \alpha\left(\frac{c+r}{2}\right)\right]\frac{a}{b} & \text{if } \ a \le a_c \\ \frac{a}{b} & \text{if } \ a > a_c \end{cases} \tag{8}$$

Now, if the economy is struck by a negative shock, then the objective function of monetary authorities abiding commitment turns into:

$$L_R(a) = \begin{cases} -\left[1-\alpha\left(\dfrac{c+r}{2}\right)\right]\dfrac{a^2}{b} & \text{if } a \le a_c \\ -\dfrac{a^2}{2b} - k(c+r) & \text{if } a > a_c \end{cases} \tag{9}$$

Hence, the expected value of the objective function $L_R(a)$ equals to:

$$Q_R(c) \equiv EL_R(a) = -\int_0^{a_c}\left[1-\alpha\left(\frac{c+r}{2}\right)\right]\frac{a^2}{b}dF(a) - \int_{a_c}^{\infty}\left(\left[\frac{a^2}{2b}+k(c+r)\right]\right)dF(a) \tag{10}$$

where F is the distribution function of a and from (4) $a_c = \sqrt{2bkc}$.

Assuming the uniform distribution with density K in the interval $\langle 0, a_{max}\rangle$, the objective function can be written as:

$$Q_R(c) = -\frac{1}{a_{\max}}\left[\frac{2-\alpha(c+r)}{2b}\int_0^{a_c} a^2 da + \int_{a_c}^{a_{\max}}\left(\frac{a^2}{2b}+k(c+r)\right)da\right] \tag{11}$$

$$a_{\max}Q(c) = -\left[\frac{1-\alpha(c+r)}{6b}\right]a_c^3 - \frac{1}{6b}a_{\max}{}^3 + k(c+r)(a_c - a_{\max}) \tag{12}$$

The $a_{max}Q(c)$ function does not have a local extreme. The first derivative with respect to c is always negative. Hence the optimal value of c occurs at the boundary of a $\langle 0; 1\rangle$ range. Monetary authorities must pick $c = 0$ or $c = 1$. What follows, if monetary authorities want to increase the monetary policy credibility, they should pick $c = 1$ even if they have strong anti-inflationary reputation ($r \to 1$). This implies that there is a background for the commitment only if:

$$a_{\max}Q(1) - a_{\max}Q(0) > 0 \tag{13}$$

If monetary authorities pick $c = 0$, then a_c equals 0. Taking this into consideration, (13) can be rewritten as:

$$a_{max}Q(1) - a_{max}Q(0) = \left[\frac{\alpha(1+r)-1}{6b}\right]a_c^3 + k\left[a_c(1+r) - a_{max}\right] \tag{14}$$

It follows from (14) that a commitment is less likely to result if anti-inflationary reputation of monetary authorities is low ($r \to 0$), because then $a_c(1 + r) - a_{max} < 0$ and $\alpha(1 + r) - 1 < 0$. Under such circumstances there is no use of picking the commitment, because monetary authorities will be forced to withdraw from it. Of course, inclination to renege increases along with the increase of a_{max}. The higher a_{max}, the more likely $k\left[a_z(1+r) - a_{max}\right] \ll 0$. Obviously, the lack of proneness to shocks induces to pick the commitment $c = 1$, however, in order to create favourable circumstances for abiding monetary policy rule, more than half of economic agents, that do believe that monetary authorities are determined to fulfil their commitment, must also believe that fulfilment of such a commitment is feasible ($\alpha > ½$). The number of this group must be higher, if anti-inflationary reputation parameter r is less than 1. In particular, when r approaches 0, α must approach 1. Otherwise $a_{max}Q(1) - a_{max}Q(0) < 0$.

As follows from (4), if monetary authorities pick $c = 1$, then $a_c = \sqrt{2bkc}$. Then, (14) can be rewritten as:

$$a_{max}Q(1) - a_{max}Q(0) = \left[\frac{\alpha(1+r)-1}{6b}\right](2bk)^{\frac{3}{2}} + k\left[(2bk)^{\frac{3}{2}}(1+r) - a_{max}\right] \tag{15}$$

After an algebraic transformation it can be simplified to:

$$a_{max}Q(1) - a_{max}Q(0) = (2bk)^{\frac{1}{2}}k\left[\frac{\alpha(1+r)+2}{3}\right] - ka_{max} \tag{16}$$

Then, monetary authorities should pick $c = 1$ only if:

$$(2bk)^{\frac{1}{2}}k\left[\frac{\alpha(1+r)+2}{3}\right] - ka_{max} > 0 \tag{17}$$

$$a_{max} < (2bk)^{\frac{1}{2}}\left[\frac{\alpha(1+r)+2}{3}\right] \tag{18}$$

It is worth noticing that the threshold a_{max} value, above which compliance with the undertaking is no longer possible, is the highest when $r = 1$ and $\alpha = 1$. Only then

$a_{max} < \frac{4}{3}\left(2bk\right)^{\frac{1}{2}}$, which means that $a_{max} < \frac{4}{3}a_z$, whereas if $r = 0$ i $\alpha = 1$, $a_{max} < \left(2bk\right)^{\frac{1}{2}}$ and $a_{max} < a_z$. This can be interpreted as follows: if monetary authorities do not have anti-inflationary reputation at all, abiding the commitment is not possible even if all economic agents, that do believe that monetary authorities are determined to fulfil their commitment, also believe that fulfilment of such a commitment is feasible. The problem is that this group is a minority. A major part of economic agents, due to lack of anti-inflationary reputation of monetary authorities, simply disbelieve that these authorities will be having a willpower to obey the predetermined rule.

The conducted analysis allows to examine the effect of a commitment on the level of expected inflation before the realization of a:

$$E_a\left(\pi^e\left(a\right)\right) = \begin{cases} \frac{E(a)}{b}\left[1-\alpha\left(\frac{1+r}{2}\right)\right] = \frac{a_{max}}{2b}\left[1-\alpha\left(\frac{1+r}{2}\right)\right] & \text{if} \quad c=1 \\ \frac{E(a)}{b}\left[1-\frac{\alpha r}{2}\right] = \frac{a_{max}}{2b}\left[1-\frac{\alpha r}{2}\right] & \text{if} \quad c=0 \end{cases} \tag{19}$$

Hence, picking the rigorous commitment $c = 1$ always decreases inflationary expectations by $\frac{\alpha}{2}$ comparing with the lack of commitment. Inflationary expectations of economic agents decrease along with the increase of the number of economic agents that do believe that monetary authorities are determined to fulfil their commitment, and also believe that fulfilment of such a commitment is feasible. It is worth noticing that if $c = 1$, $\alpha = 1$ and $r = 1$, then $\alpha(1 + r) = 2$ and $E_a\left(\pi^e\left(a\right)\right) = 0$. What follows, the expected inflation rate equals zero only if monetary authorities of extremely high anti-inflationary reputation pick the degree of commitment $c = 1$, and all the economic agents, that do believe that monetary authorities are determined to live up to the commitment, also believe that fulfilment of such a commitment is feasible. Such an effect is impossible under discretionary monetary policy, even if monetary authorities have a long anti-inflationary track record, because:

$$E_a\left(\pi^e\left(a\right)\right)_{min} = \frac{E(a)}{2b} = \frac{a_{max}}{4b} \tag{20}$$

A similar calculation with respect to π, yields:

$$a > \sqrt{2bkc}E_a\left(\pi\left(a\right)\right) = \begin{cases} \frac{E(a)}{b}\left[\frac{1}{2}-\frac{r}{2}\right] = \frac{a_{max}}{2b}\left[\frac{1}{2}-\frac{r}{2}\right] & \text{if} \quad c=1 \\ \frac{E(a)}{b}\left[1-\frac{r}{2}\right] = \frac{a_{max}}{2b}\left[1-\frac{r}{2}\right] & \text{if} \quad c=0 \end{cases} \tag{21}$$

One can notice that the degree of anti-inflationary reputation influences the expected value before the realization of a. If monetary authorities of strong anti-inflationary reputation pick $c = 1$, then $E_a\left(\pi\left(a\right)\right)=0$. On the other hand, if the degree of such reputation approaches zero, then $E_a\left(\pi\left(a\right)\right)=\frac{a_{\max}}{4b}$. It is worth underlining that even if anti-inflationary reputation is strong, the expected value of the actual inflation rate is equal to:

$$E_a\left(\pi\left(a\right)\right)_{\min}=\frac{E(a)}{b}=\frac{a_{\max}}{4b} \tag{22}$$

Hence, monetary authorities are always more prone to achieve a lower inflation rate, if they follow rigorous commitment. This proneness can be strengthened by a high degree of anti-inflationary reputation. Moreover, if $z = 1$, $r = 1$, $\alpha = 1$ then the expected value of the actual inflation rate and the inflation rate expected by economic agents (both before realization of a) have the same, zero value.

Equations (19) and (21) can be used in order to evaluate the influence of the commitment $c = 1$ on the expected degree of surprise inflation before realization of a:

$$E_a\left(\pi\left(a\right)-\pi^e\left(a\right)\right)=\begin{cases}\frac{E(a)}{2b}\left[\left(1+r\right)\left(\alpha-1\right)\right] & \text{if}\quad c=1\\ \frac{E(a)}{2b}\left[\left(\alpha-1\right)r\right] & \text{if}\quad c=0\end{cases} \tag{23}$$

Hence, if monetary authorities pick rigorous commitment $c = 1$, then the expected surprise inflation before realization of a is smaller than under zero commitment. The difference equals to $\alpha - 1$.

Now, some light should be shed on a rigorous ($c = 1$) commitment itself. According to Stone and Bhundia (2004), only exchange rate in the form of hard peg can provide a strong nominal anchor by limiting monetary policy autonomy. From this perspective $\pi > 0$, means the rate of devaluation of the domestic currency. When monetary authorities fulfil the commitment then $\pi = 0$, so there is no devaluation during the analyzed period. However, exchange rate commitment can be broken as monetary policy optimal in the period t can become suboptimal in the period $t + 1$. Then surprise devaluation can be generated ($\pi - \pi^e > 0$) in order to create stimulus to output and employment growth.

The conducted analysis reveals that monetary authorities should formulate only rigorous commitments or should not formulate them at all. Only corner solutions maximize the objective function of monetary authorities. However, such an approach is a static, short-term one. In practice, setting the parameters of the objective function occurs in a dynamic way, as figure 1 depicts.

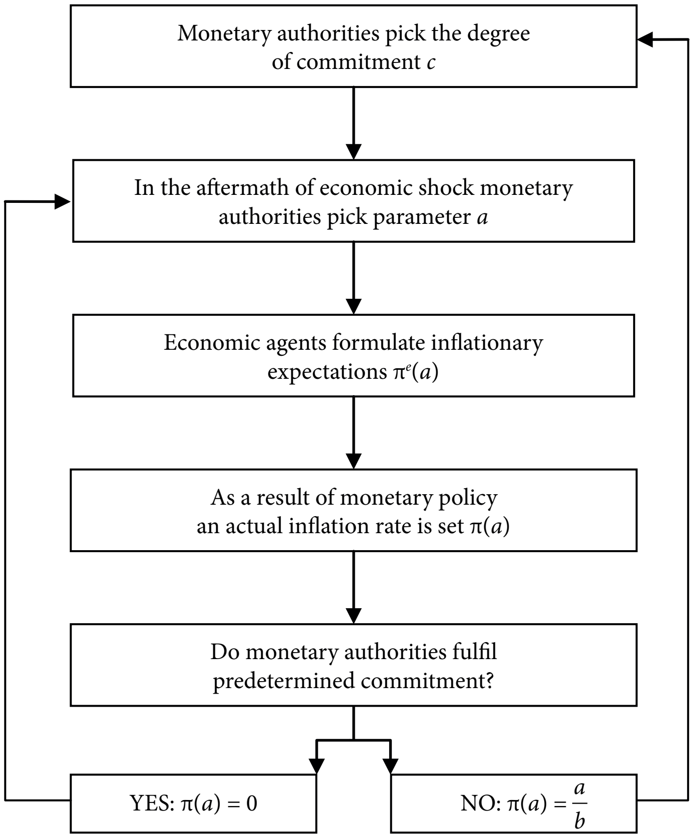

Figure 1. Algorithm of setting parameters of the objective function

Obviously, picking $c = 1$ does not solve all the problems related to the inflation bias. This phenomenon can be eliminated only in the short-term. In the long-term it still exists, limiting the monetary policy credibility, as rational economic agents are conscious of inability of abiding the rigorous commitment indefinitely. Hence, in practice always a part of them does not believe that monetary authorities are determined to fulfil their commitment $\left(\frac{c+r}{2}<1\right)$. Moreover, even these agents that trust monetary authorities, usually estimate the feasibility of the commitment's fulfilment as less than 100 % ($\alpha < 1$). This in turn lowers the central bank's credibility.

As it was noticed, a systematic fulfilment of the rigorous commitment strengthens anti-inflationary reputation of monetary authorities and increases the number of economic agents that do believe that monetary authorities are determined to abide the commitment and believe that fulfilment of such a commitment is feasible.

However, as comes from equation (1), abiding tough rule while anti-inflationary reputation is growing makes reneging on this rule more costly. Hence, the temptation to renege on the rigorous commitment occurs, being stronger, the longer is the period during which the commitment is obeyed, as economic disturbances become more and more devastating for the domestic economy, increasing the value of *a*. It appears then that the rigorous commitment can be hardly fulfilled in the long term. However, this does not mean that monetary authorities completely refrain from formulating any commitments as such an attitude could lower their anti-inflationary reputation. Hence, mixed and suboptimal approaches to monetary policy can turn out to be quite stable. This can also be a result of interactions between monetary and fiscal policies.

Namely, the presented model takes into account solely the behaviour of monetary authorities, completely ignoring the fiscal side of the story. But when monetary authorities follow a rigorous rule and stabilize exchange rate, then fiscal authorities are burdened with offsetting negative results of economic shocks. Hence fiscal policy is of great importance for the monetary policy's credibility and must become subordinate to the fulfilment of the exchange rate commitment (Corden 2002). Establishing and maintaining such subordination is not an easy task, especially if monetary authorities pick an extremely rigorous exchange rate commitment, because of proneness of fiscal authorities to generate positive impulses in order to achieve real goals such as the growth of output or employment. This is due to the fact that under exchange rate commitment inflationary pressure resulting from fiscal stimulus appears after some time, as fixing or pegging the exchange rate makes inflationary expectations of economic agents more sticky (Canzonieri, Cumby & Diba, 2001; De la Torre *et al.*, 2003; Duttagupta & Tolosa, 2006; Tornell & Velasco, 1995).

2. Extension of the model and its implications

As follows from the preceding section, monetary policy based on any rigorous anchor cannot be fully credible. This refers also to exchange rate nominal anchor. Keeping a stable exchange rate can become extremely hard; hence monetary authorities always implicitly admit that reneging on this commitment is possible. According to Obstfeld and Rogoff (1995, p. 77–78), most central banks have access to sufficient foreign exchange resources to beat down a speculative attack of any magnitude, but only provided they are willing to subordinate all the other goals of monetary policy. This is just like squaring the circle. There is no way to make a peg fully credible (Larrain & Velasco, 2001).

In the countries where the exchange rate is used as a nominal anchor in disinflation programs, this is often the case. In such cases the transition to price stability is usually accompanied by large capital inflows. Economic agents borrow to finance consumption for fear that the lowering of the inflation rate is only temporary phenomenon. Banks finance a growing credit activity by borrowing offshore, as it is cheaper due to a lower interest rate. Domestic interest rates must remain high, in order to support exchange rate. The currency peg limits exchange risk. Thus, consumption is lending-based and quite fast turns into a current-account deficit. Balance of payments becomes dependent on the continued inflow of foreign capital. If that inflow dries up for any reason, being accompanied by speculative attacks on the official peg due to increasing doubts about the permanence of the stabilization program, an exchange rate crisis will burst (Bird, 1998; Eichengreen, 1998; Tavlas, 2000).

The last decade of the twentieth century witnessed a number of currency crises of similar fashion. One strand of literature, related to the second generation currency crises models, attempted to explain the roots of crises concentrating on self-fulfilling speculative attacks. As opposed to the key assumption of first generation models, that domestic macroeconomic policy is fundamentally at odds with exchange rate peg, causing speculative attacks and a constant drain of reserves, proponents of the second generation models take into account that a speculative attack can succeed even if monetary and fiscal policies are consistent with the peg. In other words, a speculative attack can become a self-fulfilling prophecy if it increases costs of abiding the peg. As follows from Section II, monetary authorities always renege on exchange rate commitment, if costs of the peg exceed costs from its abandonment. Economic agents know that monetary authorities can renege on the commitment under such circumstances and that anti-inflationary programs based on the exchange rate nominal anchor always include the so-called escape clause (Gandolfo, 2004; Sarno & Taylor, 2009).

In order to shed some light on the pattern of a speculative attack of self-fulfilling type, the model presented in the preceding section can be used. Assuming that purchasing power parity and uncovered interest parity (perfect foresight form) hold, equation (8) can be treated as equation of the average expected devaluation rate:

$$d^e(a) = \begin{cases} \left[1-\alpha\left(\frac{c+r}{2}\right)\right]d_D & \text{if } a \le a_c \\ d_D & \text{if } a > a_c \end{cases} \tag{24}$$

$d^e(a)$ – average devaluation rate expected by economic agents; d_D – positive devaluation rate, optimal in case of reneging on a commitment $\left(d_D = \frac{a}{b}\right)$, the rest – the same is in equations (1) and (6).

Taking into account that parameter a takes on values from the range $\langle 0; a_{max} \rangle$ and the shock is uniformly distributed, average devaluation rate expected by economic agents turns into:

$$d^e(a) = P\{a > a_c\} d^e(a | a > a_c) + P\{a \le a_c\} d^e(a | a \le a_c)$$

$$d^e(a) = \frac{a_{\max} - a_c}{a_{\max}} d_D + \frac{a_c}{a_{\max}} \left[1 - \alpha\left(\frac{c+r}{2}\right)\right] d_D \tag{25}$$

Similarly, equation (5) can be modified, yielding an average actual devaluation rate:

$$d(a) = \frac{a_{\max} - a_c}{a_{\max}} d_D + \frac{a_c}{a_{\max}} 0 = \frac{a_{\max} - a_c}{a_{\max}} d_D \tag{26}$$

Taking equations (25)-(26), a relation of average devaluation rate expected by economic agents $d^e(a)$ to average devaluation rate $d(a)$ can be established:

$$\frac{d^e(a)}{d(a)} = \frac{a_{\max} - a_c \alpha\left(\frac{z+r}{2}\right)}{a_{\max} - a_c} \tag{27}$$

As follows from (4) the threshold value of a_c equals to:

$$a_c \equiv \max\left\{\min\left\{\sqrt{2bkc}, a_{\max}\right\}, 0\right\} \tag{28}$$

Hence, if $a_z < a_{\max}$, then $d^e(a) = d(a) = 0$ if and only if 1) monetary authorities of high degree of anti-inflationary reputation follow rigorous exchange rate commitment, 2) all economic agents believe that monetary authorities are determined to abide the commitment, and also believe that fulfilment of such a commitment is feasible $\left(\alpha\left(\frac{z+r}{2}\right) = 1\right)$. If just one of these conditions is not met, then . It is worth noticing that along with the fall of the belief of economic agents in the feasibility of fulfilment of the exchange rate commitment, $\frac{d^e(a)}{d(a)}$ increases. In extreme case, when α approaches zero, then:

$$\lim_{\alpha \to 0}\left(\frac{d^e(a)}{d(a)}\right) = \frac{a_{\max}}{a_{\max} - a_c} \tag{29}$$

In such a case, the formulation of the commitment makes no sense, because economic agents do not believe that the predefined target can be met. This means that $c = 0$ and $a_z = 0$. This yields:

$$\lim_{\alpha \to 0}\left(\frac{d^e(a)}{d(a)}\right)=\frac{a_{\max}}{a_{\max}}=1 \tag{30}$$

This implies that under the circumstances of rational expectations of economic agents and complete information, the exchange rate anchor is not sustainable. As it was noticed in the preceding section, even if all economic agents do believe that monetary authorities are determined to abide the exchange rate commitment, a part of them always judge such a fulfilment as infeasible ($\alpha < 1$). Hence, rational economic agents always expect positive devaluation rate that exceeds actual devaluation rate. Figure 2 explains consequences of such attitude.

If $c, r, \alpha = 1$, then $d^e(a), d(a) = 0$, which reflects point **A** (0;0). Then $d^e(a)$ and $d(a)$ remain at zero level as long as economic agents believe that monetary authorities

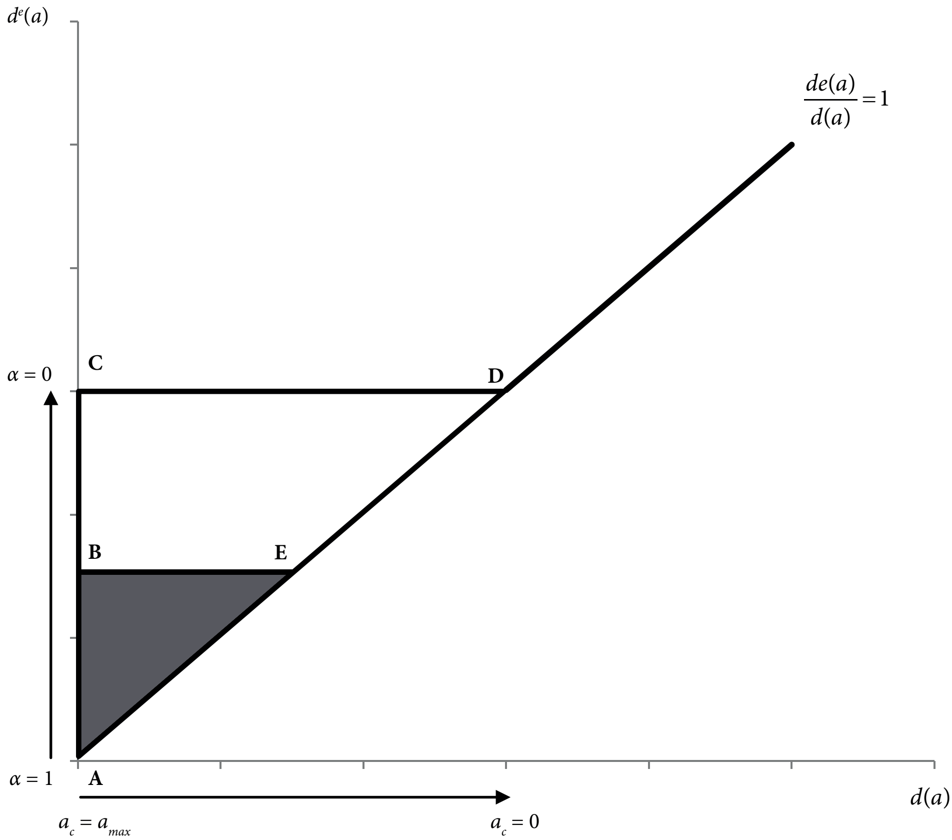

Figure 2. Average devaluation rate expected by economic agents and average actual devaluation rate

have powers and are able to stabilize an exchange rate. If this belief is undermined, for example due to change in economic agents' attitude towards conducted monetary policy, and it is not restored quickly, then a move towards another point inside the triangle **ACD** is going to be observed. The direction of this move depends on the depth of the fall in the α value as well as on the difference between $a_{\max}$ and a_c. It can be noticed, however, that in any point inside the **ACD** triangle $\frac{d^e(a)}{d(a)} > 1$. Hence, a background for a speculative attack appears, causing the values of α and a_z to fall. As a consequence, another move towards section **CD** must occur. This in turn induces monetary authorities to renege on exchange rate commitment. If so, $c = 0$ and $a_z = 0$. This means a final shift to point **D** ($a_{\max}$; $a_{\max}$), where $d^e(a) = d(a)$ once again, and expectations of rational economic agents are coherent with discretionary monetary policy: economic agents expect a high devaluation rate, which follows indeed.

What is worth underlining is that a speculative attack is going to occur faster, when a joint strength of undertaken exchange rate commitment and anti-inflationary reputation of monetary authorities is less than 2. For example, if $c + r = 1$ (which means, for instance, that monetary authorities of weak anti-inflationary reputation are burdened with rigorous commitment concerning exchange rate), then $\alpha = 1$ and $a_{\max} \approx a_z$ result in $d^e\left(a\right) \approx \frac{a_{\max}}{2}$ and $d(a) \approx 0$. The point that is consistent with the $\frac{d^e(a)}{d(a)}$ relation is nearby **B** $\left(0; \frac{a_{\max}}{2}\right)$. Next, economic agents are going to test determination of monetary authorities. If official foreign interventions appear to be insufficient in order to sustain anti-inflationary reputation, then devaluation expectations increase, resulting in shift from **B**, at first to another point inside **BCDE** trapezium, and finally to point **D** ($a_{\max}$; $a_{\max}$), in which monetary authorities finally renege on exchange rate commitment.

The conducted research is based on two crucial assumptions, apart from rational expectations of economic agents. These assumptions concern complete information about the future level of exchange rate and perfect homogeneity of domestic and foreign government securities, which appear to be the main component of investors' portfolios. However, these very assumptions can be overruled, using the Flood-Marion (1998) model of self-fulfilling risk predictions.

According to its modification which was implemented for the analysis in this article, under the circumstances of uncertainty and imperfect homogeneity of domestic and financial markets, reflected in different risk premium, uncovered interest parity holds, if:

$$i = i^* + d^e\left(a\right)\theta\frac{db}{eb^*} \tag{31}$$

i – domestic interest rate; i^* – foreign interest rate; $d^e(a)$ – average devaluation rate expected by economic agents; θ – risk premium; d – positive constant factor; b – a worldwide private holdings of domestic government securities; eb^* – a worldwide private holdings of foreign government securities expressed in domestic-currency terms.

Risk premium from equation (31) summarizes how the desired asset holdings are influenced by tastes towards risk and uncertainty about returns:

$$\theta = g\left(\frac{d^e(a)}{d(a)}\right) \tag{32}$$

The risk premium depends on coherence between $d^e(a)$ and $d(a)$ and on measure of risk aversion g. This means that in the world of certainty, where $\frac{d^e(a)}{d(a)} = 1$ and relative risk neutrality $g = 1$ (which means that relation of risk aversion towards domestic government securities is the same as average risk aversion towards foreign ones), the risk premium is of no influence on difference between domestic and foreign interest rate.

Hence, if complete information about exchange rate and perfect homogeneity of domestic and foreign securities hold, uncovered interest parity yields:

$$i - i^* = d^e(a) = \frac{a_{\max} - a_c}{a_{\max}} d_D + \frac{a_c}{a_{\max}}\left[1 - \alpha\left(\frac{c+r}{2}\right)\right] d_D \tag{33}$$

If these conditions are not met, equation (33) turns into:

$$i - i^* = d^e(a)\theta\frac{db}{eb^*} = \theta\frac{db}{eb^*} d_D\left[\frac{a_{\max} - a_c}{a_{\max}} + \frac{a_c}{a_{\max}}\left[1 - \alpha\left(\frac{c+r}{2}\right)\right]\right] \tag{34}$$

Hence:

$$\frac{d^e(a)\theta\frac{db}{eb^*}}{d(a)} = \frac{\theta\frac{db}{eb^*}\left[a_{\max} - a_c\alpha\left(\frac{c+r}{2}\right)\right]}{a_{\max} - a_c} \tag{35}$$

This implies that if $\theta\frac{db}{eb^*} < 1$, then $\frac{d^e(a)\theta\frac{db}{eb^*}}{d(a)} < \frac{d^e(a)}{d(a)}$. What follows is that when risk aversion towards domestic government securities is significantly lower than an average risk aversion towards foreign ones ($\theta < 1$) and the issue of domestic government bonds is significantly lower than abroad ($cb \leq eb^*$), then exchange rate nominal anchor is sustainable. It can be sustained even if monetary authorities do not have a high degree of anti-inflationary reputation. If average devaluation rate expected by economic agents, corrected by the $\theta \frac{cb}{eb^*}$ factor equals average actual devaluation rate, exchange rate nominal anchor is stable. A point that depicts this relation belongs to **AD** section, near point **A**. This means that even a narrow band of acceptable fluctuations does not undermine credibility of exchange rate nominal anchor. On the other hand, if preferences of economic agents concerning domestic securities change, for example, due to fall of creditability of the government, causing increase in risk aversion, then risk premium is going to grow rapidly. This in turn upsets the $\frac{d^e(a)\theta \frac{cb}{eb^*}}{d(a)}$ relation, causing its increase above unity. As a consequence, investors are starting to get rid of domestic securities, rebalancing their portfolios in favour of foreign securities. This can trigger a speculative attack off.

As follows from equations (33) and (35), if the securities issue is excessive, exchange rate nominal anchor can be difficult to maintain, because adjustments in economic agents' portfolios bring about a drain of reserves of official foreign assets. What is worth underlining, a speculative attack can occur without deterioration of macroeconomic fundamentals. For the outburst of such an attack the change of preferences for domestic and foreign securities is enough. Then, in order to hold uncovered interest rate parity, the domestic interest rate must increase. In order to prevent this, a fiscal expansion can be introduced, but this, in turn, makes stabilization of exchange rate more difficult and may cause a speculative attack, resulting in a shift to point **D**.

Concluding remarks

The main finding of this paper is that under assumption of rationality of economic agents, complete information concerning the future exchange rate level and perfect substitution of domestic government securities for foreign ones, exchange rate nominal anchor is not sustainable. Economic agents expect a higher devaluation rate than the average actual devaluation rate. Sooner or later, this must bring about a speculative attack, resulting in reneging on exchange rate commitment. This creates favourable conditions for a self-fulfilling speculative attack that results not from worsening of macroeconomic fundamentals, but due to lack of monetary policy credibility. A perfect credibility under exchange rate nominal anchor can never be achieved, as dynamic inconsistency of monetary policy and inflation bias cannot be eliminated.

The situation changes, however, if the assumptions concerning complete information about the future level of the exchange rate as well as perfect homogeneity of domestic and foreign government securities are overruled. Under such circumstances, exchange rate as a nominal anchor can be used, if: 1) economic agents' risk aversion towards domestic government securities is significantly lower than an average risk aversion towards foreign ones; 2) economic agents do expect a lower devaluation rate than the actual devaluation rate in the future; 3) the domestic government bonds issue is significantly lower than abroad. It is enough to fulfil one of these requirements, but meeting them jointly increases odds in favour of keeping a stable exchange rate.

It has to be noticed, however, that such requirements can hardly be met by emerging and developing economies, which usually base their anti-inflationary programs on exchange rate nominal anchor, due to lack of domestic monetary policy credibility. It may seem paradoxical then that the countries which really need to import credibility of monetary policy via exchange rate have the biggest problems with sustainability of such an anchor due to lack of anti-inflationary reputation. This really looks like a vicious circle: in order to build reputation, a tough exchange rate commitment must be formulated, but abiding this commitment is extremely hard due to lack of reputation. On the other hand, exchange rate nominal anchor can be effectively used by monetary authorities who actually do not need such an anchor, because they are already credible.

This leads to the final conclusion that an exchange rate nominal anchor can be sustained only in the short-term. In the long-term, as the situation of public finances deteriorates, the exchange rate nominal anchor is exposed to more and more severe shocks that eventually may lead to its breakdown.

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