

Applying the Signalling Theory for Monetary Policy: The Case of Brazil

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ABSTRACT: The aim of this article is to relate the trinomial credibility-reputation-transparency with the signalling theory applied to monetary policy of inflation targets by building a model of signalling on monetary policy. In this model, it is considered that transparency is the signal issued by the central bank for the public with the purpose of revealing its type. The main results show that the central bank of the opportunistic type has no incentive to be transparent and the committed type is in a better situation under separating equilibrium in relation to the pooling equilibrium. In addition, the separating equilibrium is multiple, and the situations of low or high transparency generate pooling equilibria, which supports the idea of an intermediate level of transparency. While highlighting the role of the public in determining the level of transparency, this paper met that it is not reasonable to compare levels of optimal transparency between central banks due to differences between the public of different countries. Empirically, through the event study methodology, it was found that for the Brazilian economy occurred a reduction of the predictability of decisions of the central bank and thus an increase of asymmetric information in the analysis period.

KEY WORDS: transparency, signalling, central bank.

RESUMO: O objetivo deste artigo é relacionar a credibilidade trinomial-reputação-transparência com a teoria de sinalização aplicada à política monetária de metas de inflação realizada através da construção de um modelo de sinalização na política monetária. Neste modelo, considera-se que a transparência é o sinal emitido pelo banco central para o público com o objetivo de revelar seu tipo. Os principais resultados mostram que o banco central do tipo oportunista não tem qualquer incentivo para ser transparente e o tipo que cumpre o prometido está em uma situação melhor sob equilíbrio separador em relação ao equilíbrio agregador. Além disso, o equilíbrio separador é múltiplo, e as situações de baixa ou alta transparência geram equilíbrios agregadores, o que apoia a ideia de um nível intermediário de transparência. Ao destacar o papel do público na determinação do nível de transparência, é verificado que não é razoável comparar níveis de transparência ótimos entre bancos centrais, devido às diferenças entre o público de diferentes países. Empiricamente, através da metodologia de estudo do evento, foi encontrado que para a economia brasileira ocorreu uma redução da previsibilidade das decisões do banco central e, portanto, um aumento de informação assimétrica no período de análise.

Palavras-chave: transparência, sinalização, banco central.

JEL: E58, D82, E52.

Área 5: Macroeconomia Aplicada

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1. Introduction

The purpose of this article is to relate the trinomial credibility-reputation-transparency with the signalling theory applied to monetary policy by constructing a model that uses transparency as a signal sent by the monetary authority for the public.

The role of credibility, reputation and transparency, referenced as trinomial, emerged in the literature on monetary policy from the discussion of "rules versus discretion". Second Cukierman and Meltzer (1986), credibility can be defined as the absolute value of the difference between the plan of policymakers and public beliefs about these plans, i.e. the difference between what the public expects to be accomplished with what was planned. The credibility of policymakers is relevant because it increases the effectiveness of monetary policy in several theoretical models. For example, the Barro and Gordon (1983a; 1983b) model considers that a higher level of credibility allows the policymaker reduce inflation at a lower cost and still suggests that the use of transparency can be beneficial.

Transparency may refer to the activities carried out by the central bank in terms of dissemination of information, being such as the degree to which the information is available (LASTRA, 2001) or may refer to the understanding of the public in relation to the monetary authority's policy decisions (WINKLER, 2000). However, other definitions are presented in the theoretical literature, and this influences the conclusions about the usefulness of transparency, as he approached Posen (2003).

Additionally, the reputation is related to the confidence gained by the monetary authority after a period of observations about his actions and commitment to the policies adopted. So, the reputation can be acquired, retained or even destroyed over time. As Geraats (2001), the opacity of the economic forecasts damages the reputation of a strong central bank that presents itself inside out to inflation.

Credibility, reputation and transparency are closely related. Issing (2001) presents the idea that credibility and transparency contribute to the effectiveness of monetary policy. Following this, a high degree of transparency and responsibility in making monetary policy strengthen the legitimacy of the central bank, which supports the public belief about the commitment to price stability, contributing to the increased credibility. In other words, transparency increases the credibility of monetary policy and contributes to building the reputation. On the whole, transparency, in the language of the theory of contracts, can be used as a sign to show what the intentions/preferences, or what is the type of central bank.

Empirically, the 1998's study with 94 central banks held by Fry (2000) showed that 74% of central banks consider transparency a vital component or very important for its monetary policy. Additionally, Blinder (2000) conducted a survey of 88 central banks and also concludes that transparency is considered very important factor not only to establish the credibility, but also to keep it.

The signalling theory addressed initially by Spence (1973) proposed a way to solve the problem of information asymmetry by a signal sent from the more informed for, the less informed. With a focus on the labour market, the author referred to above found that the employer can't recognize the productivity of the employee before hiring him, which may cause the adverse selection problem discussed by Akerlof (1970) to stipulate an average remuneration. In order to solve the problem, education can be used as a signal on the part of the worker to reveal what's its type, high or low productivity, and thus solve the problem informative.

Applied to monetary policy, the problem of information asymmetry is present in the relationship between the central bank and the public. In this case, the central bank has more information about the performance of the economy than the public beyond this power to assume two distinct types: type I (weak) – that would be the central bank with an opportunistic behaviour, assumes more commitments not meets and; type II (strong) – that would be the central bank that complies with what has been agreed. The

information about the central bank's type is restricted to itself, and the public only observes their actions over time, damaging their expectations that lead to affect the entire economy.

Thus, as a hypothesis, it is interesting to the central bank show their type, adopting, in this case, transparency as a sign to reveal to the public what type it is. The use of transparency makes the public assign a level of credibility the political decisions of policymakers, which contributes to the effectiveness of monetary policy. Over time, it is possible that the central bank raises or keeps its reputation. This paper will adopt the central bank monetary policy as inflation targeting regime. Stylized facts were presented by Dincer and Eichengreen (2007) and Geraats (2009) by which it found that: increased the dissemination of information, especially about political decisions and macroeconomic analysis; transparency presented greater expansion in central banks to adopt inflation targeting; countries with high inflation in the 1990 presented a higher increase of transparency of monetary policy; countries with greater transparency have tended to experience lower inflation after periods.

This work contributes to the theoretical literature on transparency and the effectiveness of monetary policy having as differential signalling theory's approach to rescuing aspects of the seminal work by Spence (1973). In addition, deals with the discussion on an optimal level of transparency. The article is divided as follows: in addition to this introduction, section two presents a review of the literature on the role of transparency, credibility and reputation of the monetary authority and the policy adopted and also about the literature of signalling theory applied to monetary policy; section three presents a model of signalling that uses the ideas of trinomial transparency-credibility-reputation applied to monetary policy of inflation targets; section four discusses the issue of equilibrium and the optimal level of transparency; section five uses the event study methodology to answer about the behaviour of the Central Bank of Brazil; and section six, finally, presents the conclusions.

2. Literature Review

In the economic literature on monetary policy known as "rules versus discretion" arose also the debate on the role of reputation, credibility and transparency of the central bank associated with their political actions. Fellner (1979) presented for the first time the issue of credibility. After this, there are the works of Kydland and Preston (1977) and Barro and Gordon (1983a; 1983b) with developments in credibility and reputation of the monetary authority. Blinder (1999) states that many economists agree with the employability of transparency on the part of the central bank in the conduct of monetary policy; the main argument is that the presence of transparency makes the private sector to be more informed, allowing it makes better decisions. Thus, the effectiveness of monetary policy is related to the ability of the public to anticipate the actions of the central bank.

However, as shown in the study of Demertzis and Hallett (2007), there are other opinions such as the idea that the best would be an incomplete transparency associated with the central bank's reputation. So it would not be necessary to disclose a large number of information given to the public would provide a high degree of credibility to the central bank. In addition, there is a discussion that must impose restrictions on transparency due to operational issues, one should enhance the credibility of the central bank (EIJFFINGER; HOEBERICHTS, 2002) and emphasize the difference between information that is necessary for the public to know of those that are necessary to understand (ISSING, 1999). Another point of discussion is that there is a conflict between the need for transparency and the ability to control, indicating that a high degree of transparency brings a cost to the monetary authority.

In summary, it is observed that discussing the degree of transparency, its positive relationship with the credibility, the elevation of the ability to control the central bank coupled with a high degree of transparency and even his relationship with the efficiency of monetary policy. Moreover, the transparency

factor has been used increasingly by policymakers and it's no different in the decisions of the central bank monetary policy. Many authors agree on the importance of transparency to the conduct of monetary policy although there is no consensus on the optimal level of transparency (CUKIERMAN, 2001; EIJJFINGER; GERAATS, 2002). Furthermore, it cannot be denied that transparency reduces the uncertainties of the agents.

The model presented by Svensson (1999) shows the influence of transparency on the effectiveness of monetary policy. It was considered transparency in relation to an explicit target employment and has, as a result, more responsible central bank's posture and unable to commit opportunism. In another article, Svensson (2003) addressed on transparency in relation to an inflation target of defending the use of a control error, or an interval between the targets to reveal the preferences of the central bank.

Jensen (2000) addressed that the announcement of the inflation target serves as a way to demonstrate the commitment of the central bank, which suggests the positive relationship between transparency and credibility. The author above also focuses on the question of the existence of private information, that if this doesn't exist, greater transparency does not affect the credibility of the monetary authority, which emphasizes the need for an informational asymmetry problem for use of transparency.

The belief that the information must be clear in order for monetary policy to be more effective is in agreement with the argument that the reduction of asymmetric information benefits all parties involved. The information being passed clearly is a way to reduce the problem of asymmetric information. It is possible to interpret the transparency as a central bank signal to the public, with the aim of revealing its type.

Geraats (2002) presented five types of transparency: politics, related to the existing clarity central bank objectives; economic, related to economic information used in political decisions, procedures, related to the decision-making process, monetary policy, related to the orientation of monetary policy; and operational, related to the effects of the implementation of monetary policy. Given that one can understand transparency in different ways, adopts what Eijfing and Geraats (2002) point as features of a transparent monetary authority, being: owning a numerical target for monetary policy; disclose an inflation report explaining what are the effects that are expected when monetary policy changed; disclose the inflation forecast; and, lastly, to assess the effects of past policies.

The question arose to reduce the asymmetric information between the central bank and the public, in order to work for the public provides for better monetary policy actions. In addressing Demertzis and Hallett (2007), the absence of transparency, is an imperfect transparency related to priorities and objectives or to information conditioned, targets or shocks, distorts the public's expectations about inflation. The study of Morris and Shin (2000) showed that the publication of information by the central bank influences the control of inflation expectations. In the presence of uncertainties, transparency of public is reduced and improved choices, so that bad decisions or forecast errors are not related to informational problems, unless the passed information does not show quality.

Regarding the literature on informational problem that exists between public and central bank, Cukierman and Liviatan (1991) presented a set of signalling on monetary policy. The authors used the idea that the public can't distinguish what the central bank's type is, may be a strong type, who keeps what was agreed or weak type, with opportunistic behaviour. Only the central bank itself knows what kind. The main conclusion is that the unreliable policymaker should adopt a posture of accommodation of inflationary expectations. The role of reputation for stabilization programs was highlighted to exemplify the policymaker's behaviour influences the success of policies.

Walsh (2000) extends the model proposed by Cukierman and Liviatan (1991) including forward looking expectations in a model with contracts of short-term and long-term wages considering a function of Lucas and the effects on the great choice of inflation. The conclusion about the accommodation policy

expectations also is present and with forward looking expectations the central bank of weak type is forced to postpone inflationary surprises in addition to contributing to the reduction of inflationary bias.

The monetary policy adopted by the government, according to Svensson (1998) points out that transparency is part of the characteristics of the scheme in which inflationary targets and provides explicit inflation target, says with a degree of transparency and accountability.

3. Model of Signalling on Monetary Policy

The articles of Spence (1973, 1974) showed how agents can market use signs to solve the problem of adverse selection at the moment when the employer wishes to distinguish candidates, according to their qualification. Applying the necessary changes, the model proposed by Spence shows plausible to represent the context of monetary policy signals. All the ideas presented in this section and the next are based heavily on an article by Spence (1973).

The public is unaware of the characteristics of the central bank or the president of the same before the decision making on monetary policy being followed and throughout this for maintenance of monetary policy. This information is only available to the public after the policies actions have been taken and persecuted, then the public will be able to define what central bank's type is, it can be the kind that fulfils its promise or not. However, the period of learning by the public regarding the central bank's type is harmful to the economy since the information is not perfect.

The problem of asymmetric information arises from the situation that only the central bank or the president even know its real type in such a way that the absence of this information to the public cause distortions in time to form its expectations about important variables of the economy, particularly inflation and expectations of future interest rates.

In the case of monetary policy of inflation target, it is considered that the public wishes to know whether the central bank will follow the established inflationary target or not. Thus, a mechanism is required to convey the information about its type, reducing the informational problem. It can be done using a sign to reveal to the public their true type, represented here as transparency. It should be noted that the signal must be an observable characteristic that can be manipulated by individuals (SPENCE, 1973).

Consider the following assumptions: (i) there is the interaction of two groups in the economy, the central bank and the public; (ii) the monetary policy adopted by the government is based on the inflationary targets; (iii) the central bank may take of distinct types, type I - weak, which does not meet the proposed target, i.e. has an opportunistic behaviour, and type II, which seeks to follow the targets, thus has an opportunistic behaviour; (iv) the public attaches to a level of central bank credibility; (v) the public knows the probabilities of the central bank's type.

The public assesses the transparency (y) in order to find out what the central bank's type is. If this is not being transparent enough, the public classifies as belonging to the type I - weak; on the other hand, if the transparency is effective, in order to disclose the number of sufficient information to demonstrate a commitment to the inflationary target, the central bank is seen as being of type II - strong.

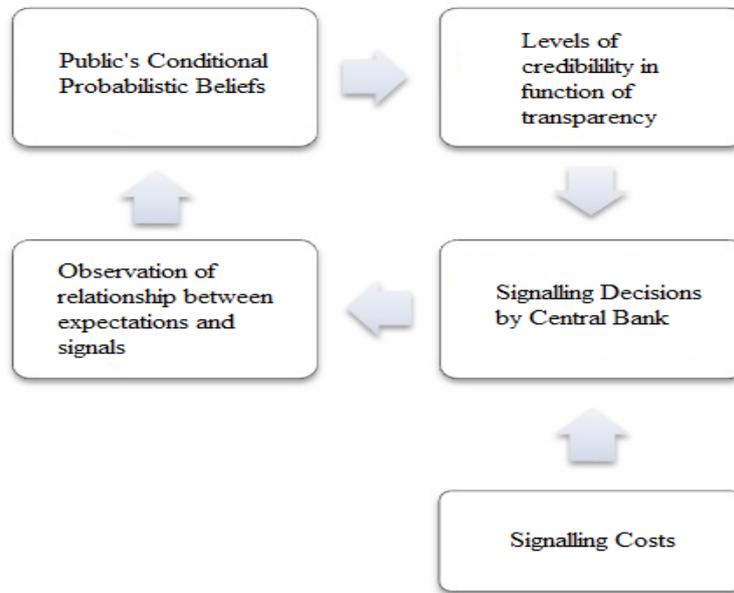
It is considered that transparency is available to the central bank, however; there are cost associated with it and this cost are different depending on the type that the monetary authority takes over. The central bank of weak type has a function of cost of greater transparency, given by $C_I(y) = y$, while the central bank of strong type has a function of cost transparency given by $C_{II}(y) = y/2$. Under the hypothesis that when the central bank assumes a posture not opportunistic, the cost of being transparent is smaller than when this takes an opportunistic posture. Additionally, it is proposed that the central bank get a level of

credibility (index) equal to 1 when type is weak, and equal to 2 when is strong. Furthermore, it is considered that the public knows that the probability q of the central bank is the type weak, and $1 - q$, it is the strong type. Briefly, we have:

Type of central bank	Levels of credibility	Probabilities	Cost of transparency
Type I - Weak	1	q	y
Type II - Strong	2	$1-q$	$y/2$

With the goal of finding market equilibrium, it is assumed that there is a set of probabilistic beliefs of the public which are confirmed by the feedback mechanism, as illustrated in Figure 1.

Figure 1: Process feedback loop of public's beliefs



Source: Adapted from Spence (1973)

This feedback process represented by Figure 1 shows that in a given period, the public to form their probabilistic beliefs tells the level of credibility that is assigned to the central bank, which in turn leads to this organ to decide on the level of transparency to be adopted, and that this decision depends on the cost of signal that varies according to their type. After the central bank taking its decision, the public observes the new level of transparency and form its opinion on the central bank and then correct, if necessary, their beliefs. In the event of amendment, the process begins again. It can be considered that periods in a row without changing their beliefs collaborates for the maintenance or increase in reputation of the monetary authority.

In this way it is determined the level of transparency that can identify the central bank's type, i.e. a level of separating transparency, denoted here as y^* . If the transparency level issued by the central bank (y) is less than y^* , has that kind the central bank is weak. If the transparency level issued is greater than y^* , this is a strong type. This conclusion can be represented as follows:

$$Decision\ rule = \begin{cases} y < y^*, central\ bank\ of\ weak\ type \\ y > y^*, central\ bank\ of\ strong\ type \end{cases}$$

It is assumed that levels of credibility $W(y)$ are given by:

$$W(y) = \begin{cases} 1, & \text{if the central bank is of weak type} \\ 2, & \text{if the central bank is of strong type} \end{cases}$$

Given the levels of credibility established by public transparency level for each used by the central bank, this will decide the optimal level of transparency that maximizes its interests taking into account that the greater the transparency, the greater the level of credibility. However, costs are higher as it grows the transparency. In simplified form, the maximization can be represented by:

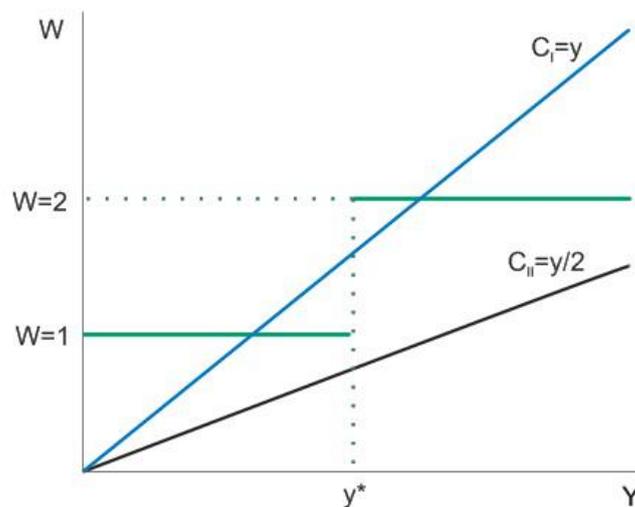
$$\max_y [W(y) - C(y)]$$

Thereby, using the approach of games, the first decision is taken by the central bank, which chooses its level of transparency and has a level of credibility in information that he was being classified for each y in addition to information, transparency, costs that are seen as a disincentive to transparency.

With the maximization of their interests, it is observed that the central bank will choose to set $y = 0$ if it is weak, and type $y = y^*$ if it is strong type. Following this, if the probabilistic beliefs are confirmed, the public can find out what behaviour is having the central bank, when choosing the y^* delimiting the level of transparency that distinguishes between the two types, obtaining a separating equilibrium. If the central bank is a strong type, and it is expected that this organization seeks to be of this type to achieve better results in their policies, y^* becomes the transparency level.

Figure 2 graphically represents the separating equilibrium, which represent the cost functions, signalling levels of credibility and the transparency level determined by the public (y^*); it can find the equilibrium. If the central bank is the weak type, the signalling cost outweighs the benefit of signal, i.e. the gain (level of credibility minus the cost of signal) to the weak type, which has a cost function of signal represented by C_I , when does not signal is I , since the level of credibility is I and the signalling cost are null. However, when the sign is y^* , the gain shall be $2 - y^*$, because the level of credibility is 2 and the cost C_I valued at y^* is y^* . As $2 - y^*$ is less than I , the weak kind does not signal ($y = 0$).

Figure 2: Separating Equilibrium



Similarly, if the central bank's type is strong, the signalling cost is less than the benefit to the sign. In other words, $2 - y/2$ which is the gain if signal is greater than I (in case it does not gain signal). Thus, its decision will be to signal the level y^* .

4. Separating and Pooling Equilibrium and the Optimal Level of Transparency

In summary, the resulting equilibrium will be a separating equilibrium if the Central Bank behaviour types (weak and strong) are clearly identified so that the public can distinguish them. Thus, the equilibrium is also known as signalling equilibrium. Otherwise, it is called the pooling equilibrium.

As has been seen, the separating equilibrium arises when the central bank has no incentives to change their decisions in relation to the level of transparency that it issued taking into account the costs of transparency and the levels of credibility that the public would establish. On the other hand, the public has its probabilistic beliefs confirmed.

Therefore, the signalling equilibrium is also a Nash equilibrium, since each agent of the signalling game chooses a strategy characterized by the best response to the strategy of the other agent.

Once the choice of y^* points a range in the domain of y , there is an infinite number of possible equilibria for the values of y^* , i.e., the equilibrium is not unique. However, the different equilibria can be classified based on the Pareto criterion. In the previous model, it was considered that the central bank of the weak type will not signal due $2 - y^*$ is less than 1 , i.e. $y^* > 1$. For the central bank of strong type, the decision to signal derived from relationship of $2 - y^*/2$ greater than 1 , i.e. $y^* < 2$. These two self-selectable constraints must be met for the establishment of separating equilibrium (SPENCE, 1973). So it can also be used to sort the multiple equilibria.

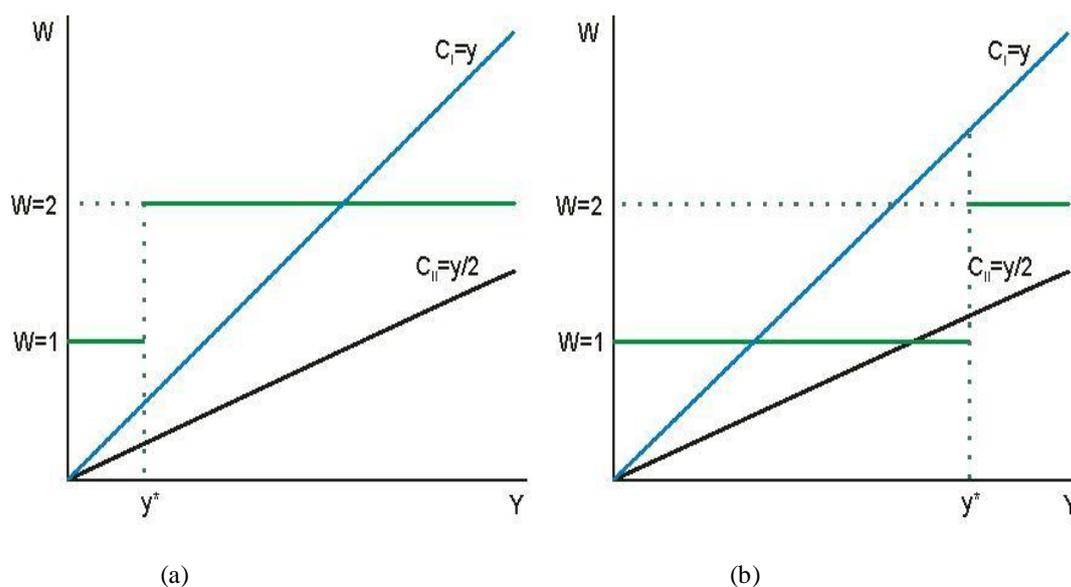
As y^* approaches 2 , the situation for the central bank of strong type worsening since raises signalling cost, with a weak type is not affected by this amendment. Thus, the equilibrium in $y^* = 1$ would produce a separating equilibrium with Pareto-efficient outcome, since, in this case, the signalling cost are in a minimum possible level still separating the two types of the central bank. However, without information asymmetry, the solution found is Pareto dominant to all separating equilibria.

There are two conditions necessary to ensure that the transparency of the central bank create a separating equilibrium: (i) incentive compatibility condition, the central bank that has opportunistic behaviour, being of type weak, will not have incentives to be more transparent; (ii) individual rationality condition, the central bank of strong type is, in fact, better off on separating equilibrium than in a pooling equilibrium.

If the conditions are met for the separating equilibrium, the choice of the central bank in relation to the level of transparency to be adopted will indicate what its type is, being solved the problem of information asymmetry.

As shown earlier, the transparency level great y^* is between 1 and 2 being the closer of 2 worst the situation of strong type and around the 1 has a Pareto-efficient equilibrium. However, there is debate whether there are situations in which the public to stipulate y^* does not generate a separating equilibrium, being, therefore, a pooling equilibrium.

Figure 3: Pooling equilibrium with low and high degree of transparency



It can happen the case where y^* is stipulated in relatively low level, represented in Figure 3 (a). In this case, for the weak, the increase to the signal is higher than that earned if does not signal ($2 - y^* > 1$), so that in this case the weak type pass to signal. According to the same previous results, in this situation of low level of y^* , will still be better for the strong type signals ($2 - y^*/2 > 1$). It is observed that the two types end up signalling generating a pooling equilibrium.

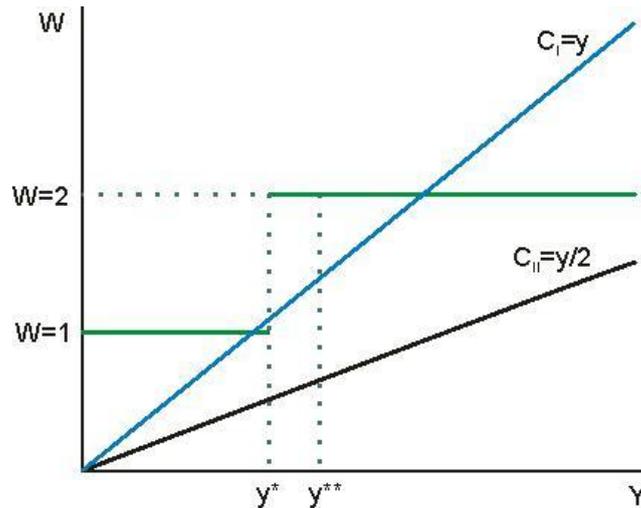
This is a situation in which there is a sign not informative, i.e. transparency at very low level is not able to reveal the central bank's type. It is a situation that the public is not better if the sign does not have been issued.

Assuming the otherwise, it will be analyse the very high level of transparency case (Figure 3 (b)). For the central bank of the weak type, the gain if it does not signal outweighs the gain to the signal ($2 - y^* < 1$), therefore, its decision will not signal ($y = 0$). In the same way, the situation is not different from the separating equilibrium. However, to the central bank of strong type, the high level of y^* causes raise signalling costs in such a way that the gain when it does not signal exceeds the signalling gain ($2 - y^*/2 < 1$), deciding ultimately non-signal. In summary, when both types decide the same, in this case, no signal, it becomes pooling equilibrium, not informative signal.

The separating equilibrium and the pooling equilibrium are not unique. There are infinite points that generate separating equilibrium. However, these are not equivalent as seen in the classification of equilibria. On the whole, one cannot assert that the solution with symmetric information is Pareto dominant in relation to the pooling equilibrium, since, in both cases, the situation of weak type is just as good and strong type is worse under the pooling equilibrium.

In summary, given the multiplicity of separating equilibrium, it can discuss what occurs when two levels of transparency, for example, can distinguish the central bank's type. In other words, it want to know if occurs transition from one equilibrium to another. Figure 4 presents two levels of transparency. Under the level y^* , is the minimization of the costs of the two types, however, did not consider $y^* = 1$ for making the central bank weak type is indifferent between signal or no signal, eliminating this possibility, the point represented on y^* in Figure 4 is considered Pareto-dominant to all other separating equilibria.

Figure 4: Optimal level of transparency



Below y^* , the result would be a pooling equilibrium, but under y^* , the equilibrium is separator and if the level of transparency was y^{**} , the equilibrium would also be separator. However, in the case of y^{**} have a larger signalling cost for the central bank of strong type and generate the same level of credibility ascribed to the public. If two situations produce the same results in terms of credibility, it is reasonable to believe that, at some point, the public would experience a level y^* that create more efficient results. Alternatively, include in this situation the role of reputation, possible since the time was added in the analysis, which could make a public review down the transparency level required of the monetary authority. This shows that, over time, the public can change y^* always seeking efficient results reaching an optimum level y^* .

5. Econometric Aspects

To get the impact of disclosure of the target of basic interest rate (Selic) on the term structure of interest rates, uses the event study methodology as proposed by Hardy (1998) and Haldane and Read (2000). Typically used in the area of Economics and finance, the study of events is widely used to perform tests of market efficiency. As Kloecker (1995), the method focuses on the date of announcement of an event or an irregularity of the return of the shares, that deviation irregularity of stock returns of ex ante returns that are not conditional to the event.

In this methodology, to measure an impact of a particular event, it must use high-frequency data so that the signal-to-noise ratio is maximized, since other communicated or facts can also change asset prices when it has interest. So, the window will be between the period of market closure of the day prior to the disclosure of the new basic rate of interest and the closing of the business day after the day of the disclosure of the Selic target.

From the hypothesis of interest-rate expectations, which is based on the condition that no arbitrage along the curve of interest rates, which explains the influence of changes in the target of market interest rate, the term structure:

$$R_t = \frac{1}{2}(r_t + E_t r_{t+1}) + \varepsilon_t \quad (1)$$

where R_t is the interest rate for two periods, r_t is the interest rate for one period, $E_t r_{t+1}$ is the current expectation of interest rate in the following period and ε_t is a risk premium.

The equation (1) shows the relationship between the rate of interest on a long-term basis and effective interest rates and expected short-term. Generalizing to a rate of just a period and the long-term rate of n periods:

$$R_t = \frac{1}{n} \left(\sum_{i=0}^n E_t r_{t+i} \right) + \varepsilon_t \quad (2)$$

Given the hypothesis of rational expectations:

$$E_t r_{t+1} = r_{t+1} + \eta_{t+1} \quad (3)$$

where η_{t+1} is a white noise i.i.d. with null mean.

Thus, the equation (2) considering the equation (3) can be rewritten as follows:

$$\frac{1}{n} \left(\sum_{i=0}^n E_t r_{t+i} \right) = \frac{1}{n} \left(\sum_{i=0}^n r_{t+i} + \eta_{t+i} \right) = \frac{1}{n} \left(\sum_{i=0}^n r_{t+i} \right) = R_t - \varepsilon_t \quad (4)$$

By subtracting r_t both sides of the equation (4):

$$\frac{1}{n} \left(\sum_{i=0}^n E_t r_{t+i} \right) - r_t = \alpha + \beta (R_t - r_t) \quad (5)$$

where it assumes constant $\alpha = -\varepsilon_t$.

Finally, equation (5) can be rewritten in a way that expresses the variation on the term structure of interest rates and also changing the current basic interest rate, as Hardy (1998) features:

$$\Delta \ln(R_t) = c_1 + c_2 \Delta \ln(Meta_t) + \varepsilon_t \quad (6)$$

where $\Delta \ln(R_t)$ is the change of the logarithm of the swap pre-DI interest rate a.a., $\Delta \ln(Meta_t)$ is the change of the logarithm in the target of basic interest rate Selic and c_2 is the coefficient that represents the surprise to the average interest rate.

When estimating the coefficient c_2 , is a hypothesis testing, where under the null hypothesis ($c_2 = 0$) agents are able to anticipate the change in the target, that is, there is no surprise. If the null hypothesis is rejected, if $c_2 \neq 0$, concluding by the presence of the surprise effect. Associating the informational problem, the rejection of the null hypothesis leads to the conclusion of the presence of information asymmetry, being the Central Bank adopts a more opportunist and, otherwise, the rejection not conclude by the absence of informational problem.

Comparing the magnitude of the coefficients in different sample intervals, could be observed as the predictability of decisions of the central bank behaved over time. According to the theory of contracts, find $c_2 = 0$ means that the signalling is effective and that the existing of asymmetric information is reduced; otherwise, there is evidence that the problem is not resolved with the signal sent by the central bank. It can be said, therefore, that given the transparency feature, already present at the central bank, the public should not suffer significant surprises, which leads to believe that the central bank's posture is more opportunistic, i.e. is not so quick to follow its commitments.

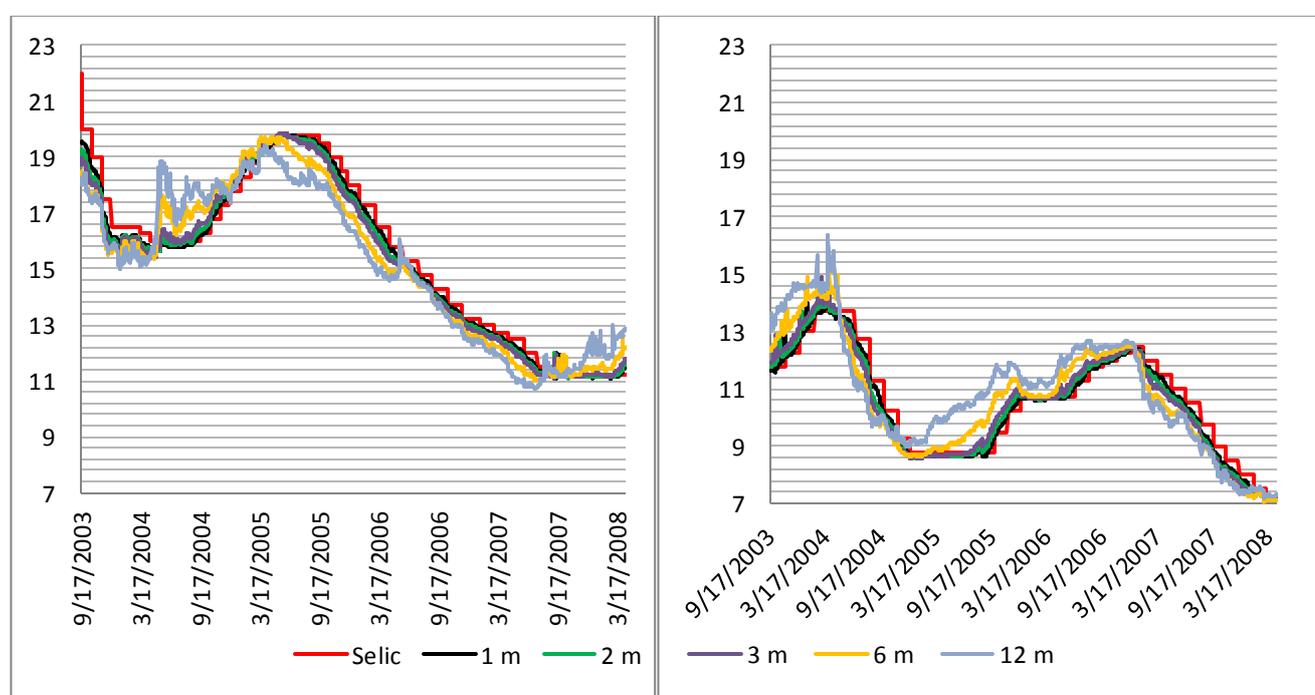
The estimation of equation (6) by least squares will be held for four time intervals, each with a particular goal: (a) 4 days before the decision until the day after the announcement, assesses how far in advance the market can anticipate the disclosure of the prime rate; (b) 1 day before the decision, evaluates whether there is anticipation on the day of the disclosure; (c) 1 day after the decision, assesses the impact of

disclosure on the next day, and (d) 4 days before the announcement until 5 days after the decision, evaluates whether there is adjustment days before and after the announcement.

5.1 Estimation and Analysis of the Results

It was used to accomplish the estimation daily data from Brazil of the period between September 17, 2003 to December 20, 2012. Deciding to start on this date given the modifications imposed by circular n° 3204 of the Central Bank of Brazil, which changed the schedule of disclosure of the Selic rate target, passing to be disclosed after the market closes and no more during the operation. The series employed were the target of Selic interest rate set by the Copom (Committee of monetary police) – Central Bank of Brazil, annualized, and the series of reference rate of swaps DI pre-fixed disclosed daily by Bovespa BM&F, times annualized in the 1, 2, 3, 6 and 12 months. Figure 3 presents the development of the term structure of interest rates for the period studied and the trajectory of the Selic's target.

Figure 5: Historical of the term Structure of interest rates in Brazil and Target Selic in the period between 9/17/2003 to 12/20/2012 (% p.a.)



Source: BM&F Bovespa (2013) and Banco Central do Brasil (2013).

Through observation of the figure (5), a realizes that the interest rate for 12 months has differentiated behaviour in relation to the term interest rates lower. In certain periods, the interest rate for 12 months is below short-term rates such as the period from 2003 to mid-2004, the years of 2005 and 2006 and in some periods of 2007 and 2011. This may indicate that there is a public expectation that the central bank is late in loosening of its monetary policy.

In the analysed period, the Copom meetings occurred 84 times, in 60 of them, there have been changes, 22 of which have increased the interest rate target and 48 times there were reduction of the Selic interest rate. In 14 meetings the target was kept constant. The changes of the Selic and its different trends over time can also be visualized in figure (5). The sample was divided into two periods: period I – between September 17, 2003 and April 16, 2008 and period II – between April 17, 2008 and December 20, 2012. The choice of date is related to the end of a long period of downward Selic target, which is considered as

a relevant change of politics until then adopted. In the period I occurred 47 Copom meetings (pre-crisis period) and in period II occurred 37 meetings (American crisis period; the Brazilian recovery and the first three years of Government Dilma, period in which the change occurred in the Central Bank presidency, when Tombini took office in place of Meireles, who was the President in force throughout the period of analysis). The table 2 presents the results obtained from estimations of equation (6) for the first and second period.

For the period I, it was found that the predictive power in general decreases the longer the time to maturity, i.e. there is a reduction of the short rate prediction for the long rates. To observe the change of $t - 4$ to $t + 1$, the period referred to in the four days before the decision and one day after, it was concluded that there is a surprise until 3 months with the change ranging from 0.07 to 0.14. Already in relation to the change the day before the decision ($t - 1$ to t), i.e. the first day of meeting of Copom, practically there is no surprise and the parameter c_2 presented meaningful only to the expiration of one month. No surprise the day after the announcement of the Selic and, considering the total adjustment to changing $t - 4$ to $t + 5$, much of the change occurs until a day after the announcement, approximately 60% (0.14 vs. 0.22), and 27% of the adjustment occurs in $t - 4$ to $t - 1$, whereas 1 month of maturity.

For the period II, the results show that the predictive power decreases the short-term interest rates for the long-term interest rates, a result similar to that achieved in the study of the period I. Likewise that previously, there is a surprise until the three months in changing $t - 4$ to $t + 1$ and the effect is descending reducing of 0.16 to 0.10. Compared to the day before the announcement, both for the expiration of a month as for the expiration of two months, the results found that the parameter c_2 is statistically significant at 1%. Unlike the period I, in which only the maturity of 1 month showed surprise, period II also showed a surprise at the maturity of two months. As early as the day after the announcement, the same result was obtained, and there was no surprise to none of the interest rates. The same occurred to change $t - 4$ to $t + 5$, where the surprise result occurred in up to six months. Considering only the maturity of 1 month, 72% of the adjustment occurred between $t - 4$ to $t + 1$, being approximately 45% before the announcement ($t - 4$ to $t - 1$). With respect to magnitudes of surprises, although the report periods rates next, it was observed an increase of effects in the period. The changes of $t - 4$ to $t + 1$ in the period that ranged from 0.07 to 0.14 in period II are presented ranging from 0.10 to 0.16. The latter result indicates that there has been a reduction of the predictability of decisions of the Central Bank of Brazil.

Table 2: Results of Estimates of the Effect of Changes of the Selic Rate Target on Pre DI Swap Interest Rates

Period I												
Maturity	Changes t-4 to t+1			Changes t-1 to t			Changes t to t+1			Changes t-4 to t+5		
	c ₂	p-value	R ²	c ₂	p-value	R ²	c ₂	p-value	R ²	c ₂	p-value	R ²
1 month	0.1436	0.0000***	0.4671	0.0361	0.0031***	0.1820	0.0545	0.2815	0.0269	0.2274	0.0014***	0.2126
	<i>There is surprise</i>			<i>There is surprise</i>			<i>There is not surprise</i>			<i>There is surprise</i>		
2 months	0.1069	0.0000***	0.3216	0.0147	0.2444	0.0307	0.0449	0.3931	0.0170	0.1842	0.049**	0.0871
	<i>There is surprise</i>			<i>There is not surprise</i>			<i>There is not surprise</i>			<i>There is surprise</i>		
3 months	0.0701	0.0103**	0.1404	0.0137	0.3025	0.0241	0.0659	0.2653	0.0288	0.1705	0.0698*	0.0744
	<i>There is surprise</i>			<i>There is not surprise</i>			<i>There is not surprise</i>			<i>There is surprise</i>		
6 months	0.0225	0.5463	0.0083	-0.0186	0.3212	0.0224	0.0945	0.1981	0.0382	0.1977	0.047**	0.0887
	<i>There is not surprise</i>			<i>There is not surprise</i>			<i>There is not surprise</i>			<i>There is surprise</i>		
12 months	0.0212	0.7153	0.0031	-0.0229	0.3696	0.0183	0.0786	0.2453	0.0313	0.1650	0.1207	0.0551
	<i>There is not surprise</i>			<i>There is not surprise</i>			<i>There is not surprise</i>			<i>There is not surprise</i>		
Period II												
Maturity	Changes t-4 to t+1			Changes t-1 to t			Changes t to t+1			Changes t-4 to t+5		
	c ₂	p-value	R ²	c ₂	p-value	R ²	c ₂	p-value	R ²	c ₂	p-value	R ²
1 month	0.1605	0.0001***	0.3837	0.0498	0.0003***	0.3297	0.0102	0.6935	0.0046	0.2191	0.0007***	0.2912
	<i>There is surprise</i>			<i>There is surprise</i>			<i>There is not surprise</i>			<i>There is surprise</i>		
2 months	0.1188	0.0046***	0.2129	0.0352	0.0027***	0.2356	0.0118	0.6777	0.0051	0.2224	0.0054***	0.2065
	<i>There is surprise</i>			<i>There is surprise</i>			<i>There is not surprise</i>			<i>There is surprise</i>		
3 months	0.0993	0.0528*	0.1059	0.0224	0.4513	0.0168	0.0036	0.9117	0.0004	0.1613	0.0275**	0.1350
	<i>There is surprise</i>			<i>There is not surprise</i>			<i>There is not surprise</i>			<i>There is surprise</i>		
6 months	0.0658	0.2074	0.0463	0.0181	0.2695	0.0357	0.0133	0.7450	0.0032	0.1454	0.0865*	0.0840
	<i>There is not surprise</i>			<i>There is not surprise</i>			<i>There is not surprise</i>			<i>There is surprise</i>		
12 months	0.0185	0.7692	0.0026	-0.0044	0.8478	0.0011	-0.0016	0.9700	0.0000	0.1086	0.2232	0.0433
	<i>There is not surprise</i>			<i>There is not surprise</i>			<i>There is not surprise</i>			<i>There is not surprise</i>		

Note: ***Significant at 1%, **Significant at 5%, *Significant at 10%.

Source: Elaborated by the author.

The results converge with the studies already carried out for the Brazilian economy. Tabata and Tabak (2004) found that, through the introduction of the regime of inflationary targets in 1999, there was a reduction of the effects surprises in monetary policy on the curve of interest, being that the results obtained were associated with the change in the exchange rate regime and the increased transparency of monetary policy.

Nunes, Holland and Silva (2011) analysed for Brazil in two different periods: January 2000 to August 2003 and September 2003 to July 2008. Comparing the two periods, it concluded that the effects have been reduced and surprise that the predictive power increased. Thus, the results indicated that the expectations of agents are more aligned to the monetary policy adopted by the government. These authors met, in the present work, the same results qualitatively that Nunes, Holand and Silva (2011), in the sample period which coincides, with the exception of the parameters of change of t to $t + 1$, which performed statistically non-significant for any maturity, unlike found in Nunes, Holland and Silva (2011), in which there was statistical significance for up to three months.

6. Conclusion

With the goal of relating the trinomial credibility-reputation-transparency with the signalling theory applied to monetary policy of inflationary targets, this work presented a model of signalling on monetary policy based on Spence (1973) in which transparency is used as a sign for the central bank to the public in order to show its type.

The constructed model assumed two distinct types for the central bank, weak type that has opportunistic behaviour and strong type that has commitment to the policy established, against a backdrop of monetary policy of inflation targets in which the public has uncertainties regarding the central bank with respect to the establishment of stipulated target or not. The information asymmetry that exists between the central bank and the public affects the expectations of the last which can affect the economy; the monetary authority uses transparency to reveal to the public what type. However, the central bank takes into account the signalling cost, i.e. the cost of being transparent, which can be seen in the literature as the cost of control, and this cost for the central bank of weak type is larger compared to the signalling cost of the strong type. Furthermore, the central bank tries to maximize its interests considering the level of credibility that is assigned by the public.

The equilibrium arises from the situation in which the public has its probabilistic beliefs informing the central bank the level of credibility on the basis of transparency by establishing a level of transparency (y^*) in what is believed to be able to recognize the central bank's type. With this information, the monetary authority decides what level of transparency maximizes its interests taking into account the signalling cost; this decision is seen by the public that concludes about the central bank's type or revises its probabilistic beliefs.

The main results of the model are: a) a weak central bank's type has no incentives to be transparent and the strong type this in a better situation under separating equilibrium in a pooling equilibrium; b) separating equilibrium is a Nash equilibrium and is not

unique, however, these can be classified according to the Pareto criterion; c) conditions of low or high transparency generate polling equilibria, which implies that the ideal situation is a middle or intermediate and transparency; d) between different levels of transparencies able to identify the type of central bank, reputation can be used so that the level of transparency is reduced to such a level that shows a lower signalling cost.

Thus, it can infer from the model that the optimal transparency level originates of the relationship between the central bank and the public, highlighting the role that the latter has, because it is the public that establishes what level of transparency that he believes to be able to recognize the type of central bank. Three points stand out about it. First, these beliefs can be changed over time, conditions such as changes of government or the presidency of the central bank, short-term factors and even the reputation may cause the revision of public beliefs about the inflationary target keeping. Second, by highlighting the role of the public in this relationship, it is not reasonable to compare optimal transparency levels between central banks, since public are distinct and that the beliefs are different. Third, both the results with a low degree of transparency and high transparency do not produce results capable of distinguishing the type of central bank. Therefore, a low transparency and even high transparency are not desirable, defends an intermediate transparency.

Evaluating the signalling mechanism in monetary policy through the impact of changes in the Selic interest rate on the term structure of interest rates, represented through the pre-DI swap interest rates, it was possible to examine the predictability of monetary policy decisions by comparing two periods and so obtain the conclusions about the presence of information asymmetry. It was worked with the idea that the signalling is exercised by the Central Bank through their actions of transparency, as the release of the inflation report, the announcement of the Selic target, the disclosure of the minutes of meetings of the Copom, among others, being these actions seen as signals issued by the central bank to reveal their type. If the agents are able to adjust their expectations without surprises, the signs emitted being believable, the problem of information asymmetry minimized and the central bank's posture is not opportunistic; otherwise, the presence of surprise features informational problem persistence that left unsolved by the signs held by the central bank, given that its posture tends to be opportunistic.

Empirically, sought to assess whether a change has occurred in the predictability of decisions of the Central Bank due to change of scenario in recent years, given the occurrence of some events, such as the American crisis of 2008, beginning of Dilma's government and the change of presidency of the Central Bank of Brazil. Thus, the sample is divided into two periods: period I between September 17, 2003 and April 16, 2008 and period II – between April 17, 2008 and December 20, 2012. The results showed that: (i) in general, the predictive power decreases in interest rates for short long rates in both periods; (ii) there is surprise for rates up to 3 months in the two periods, which barely existed in surprise first day of meeting, which begins to occur in period II; (iii) the effect of surprises that ranged from 0.07 to 0.14 in the period I to vary between 0.10 to 0.16 in the period II, which shows the increase of the result. However, it is not so big – what is attributed to learning by the agents of the Central Bank's actions which cause the effects are reduced, though upon a backdrop of increased volatility due to the crisis of 2008 which causes increase in surprise. It was closed, by empirical evidence, that there was a reduction in the predictability of decisions of the Central Bank and that it possessed a posture closer to the weak type considered in the theoretical model, resulting in increasing information asymmetry in recent years. It should be noted that if

the behaviour remains the same for the following periods can compromise the credibility of the central bank with public requesting higher levels of transparency and still affect the reputation of the Central Bank of Brazil damaging monetary policy and consequently the level of production, investment, credit, exchange, stock market and several other economic variables.

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