Explicit inflation targets and central bank independence: friends or foes?

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Abstract   The paper studies the relationship between two institutional innovations in monetary policy of the past few decades: central bank independence (*CBI*) and explicit inflation targeting (*EIT*). The aim is to make inferences about the optimal institutional design of monetary policy, and the right sequencing of policy reform. Our reduced-form model unifies several approaches in the literature, and offers three novel institutional findings (that we square with existing empirical evidence). First, *instrument-CBI* is a *complement* to *EIT*, whereas *goal-CBI* acts as a *strategic substitute* for *EIT* in ensuring low inflation and policy credibility. Second, out of these two 'commitment technologies,' *EIT* is shown to be socially superior to *goal-CBI*. Third and controversially, countries that first implement *goal-CBI* are then less likely to adopt the desirable *EIT* regime. This is because independent central bankers may have less need to do so (their independence partly substitutes for *EIT*), as well as less willingness to do so (due to a higher degree of accountability associated with a transparently legislated target). Our analysis therefore implies that developing and emerging market countries should go down the New Zealand route—legislate *EIT* together with *instrument-CBI*, but stay clear of *goal-CBI*. Unfortunately, many transition countries have followed the opposite Fed/Bundesbank route, which we show may have adverse welfare consequences through several channels.

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… critics have asked that Mr Greenspan and his colleagues give us a clearer
sense of what their objectives really are. We are happy to leave them alone to
do their jobs; we just want to understand some of the details of what that job
is. Would it really do that much harm to the policymaking process if the Fed
were to announce a medium-term numerical inflation objective? Cecchetti
(2003)

1 Introduction

The past three decades have seen a clear trend towards independent monetary
policymaking from increasingly transparent and accountable central banks.
However, there have been significant variations across countries. Most obviously,
some countries have explicitly committed to numerical inflation targets whereas
others have not. This paper's attempts to (i) understand the reasons for this trend and
its differences; (ii) draw some conclusions about the desirability of central bank
independence (*CBI*), explicit inflation targeting (*EIT*), transparency (*TR*) and
accountability (*AC*); and (iii) based on those results, to identify the most effective
institutional setting and timing of policy reform in a transforming country.

While the effects of *CBI* and *EIT* have been examined in detail,[1] the relationship
between them has received little attention.[2] Our analysis will show, however, that
this relationship contains valuable information in determining their desirability as
institutional arrangements. Specifically, it challenges the conventional belief that
CBI is unreservedly beneficial—pointing to an important distinction between
instrument-CBI and *goal-CBI* first elaborated by Debelle and Fischer (1994).

In order to examine the *CBI-EIT* relationship, we proxy the 'degree' of *EIT* by
the regime's key features—*TR* and *AC*. These two institutional features are highly
positively correlated since transparency is necessary to implement an accountability
measure, and both are essential ingredients of *EIT* (see e.g. Bernanke et al. 1999).

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[1] On *CBI* see McCallum (1995), Fuhrer (1997), Posen (1998), Forder (1998a), Jordan (1999), Lippi
(1999), and Hayo and Hefeker (2002). On the theory of *EIT* see Bernanke et al. (1999, 2002), Bernanke
(2003), Cecchetti (2003), McCallum (2003), Goodfriend (2003), Kohn (2003), Friedman (2004), Mishkin
(2004), and the papers in Bernanke and Woodford (2005). On the empirics of *EIT* see the references in
Sect. 4.

[2] This is perhaps unsurprising—countries are commonly viewed as either inflation targeters or non-
targeters, so there is not enough variation in the *EIT* variable to perform empirical testing. The papers that
have attempted to test the effects of *EIT* using a dummy for *EIT*, e.g. Ball and Sheridan (2003), have been
criticized precisely on this point: Gertler (2003). This is because many countries pursue an inflation target
implicitly—including the US, see Goodfriend (2003), or the Bundesbank and the Swiss National Bank in
the 1980s, see Bernanke et al. (1999).
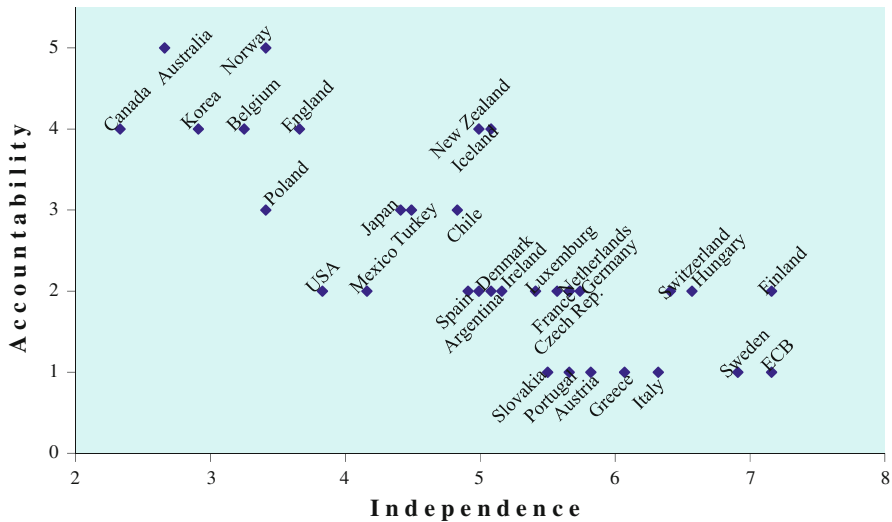
Fig. 1 *Source* Sousa (2002), see "Appendices 2–6" for details on the criteria, countries, and scores. The correlation coefficient is −0.78 ($t = −6.94$)

We survey the existing literature and data on the *CBI-TR* and *CBI-AC* relationships below from which two conflicting streams of literature emerge. Specifically, one stream predicts a positive and the other a negative *CBI-EIT* relationship.

It is the conventional view that *TR* and *AC* should go hand in hand with *CBI* to be consistent with democracy (for a widely cited example see King 1998), and avoid a 'democratic deficit'. This is even more important in transition economies in which various democratic checks and balances may not be fully in place. An early contribution by Geraats (2001) presents additional 'political economy' arguments for a *positive CBI-TR* relationship motivated by empirical findings of Chortareas et al. (2002) and Fry et al. (2000). Also, historical evidence shows that *EIT* was often adopted as a way of enhancing *CBI*, see e.g. Singleton et al. (2007).

By contrast, the seminal work of Cukierman and Meltzer (1986) postulated a weakly *negative CBI-TR* relationship based on 'constructive ambiguity'. In line with this Briault et al. (1997) observe that '… transparency has been pursued most actively by central banks with **little** independence…' (emphasis added). Their paper, and those of de Haan et al. (1999) and Sousa (2002), present evidence that *CBI* and *AC* may be *negatively* related in practice (see Fig. 1 for an example).[3]

As is apparent, most of the *EIT* countries in Fig. 1 are located in the top left hand corner and feature relatively low *CBI*. The existence of these two conflicting streams of results implies that the link between *CBI* on one hand, and *EIT*, *TR*, *AC* on the other, is not straightforward. One of this paper's goals is to reconcile them, both theoretically and empirically, and derive some policy recommendations.

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[3] Out of the three papers we depict the latter due to the largest sample. This finding can be viewed as robust as it has been found in variety of studies using differently constructed indices for different countries and different periods.

On the empirical front we perform an analysis of the available indices in Sect. 4. It shows that *instrument-CBI* is *positively* related to *TR* (*economic-TR* in particular)—which is consistent with the first group of results cited above. Nevertheless, it also shows that *goal-CBI* is *negatively* related to *goal-TR* and *AC* as the second stream predicts. This implies that the two sets of results may not be in contradiction—they simply relate to different aspects of the institutional arrangements.

On the theoretical front, we construct a simple reduced-form model that incorporates a number of institutional concepts: in addition to *goal-CBI*, *goal-TR*, *AC* and *EIT*, it also incorporates regime overriding, reputation, credibility, and monitoring. The analysis implies that *instrument-CBI* complements *EIT* (it is one of the regime's prerequisites; a 'friend'), whereas *goal-CBI* acts as a strategic substitute ('foe') to *EIT*. This 'equal but opposite' distinction between *instrument-CBI* and *goal-CBI* by Debelle and Fischer (1994) turns out to be crucial.[4] Since the complementarity of *CBI* and *EIT* is less controversial and has received more attention in the literature, our paper focuses on modelling the substitutability of the two (consistent with Fig. 1) and its policy implications for transition countries.

In summary, we show that both *goal-CBI* and *EIT* are partially substitutable 'commitment devices'. While each works through a different channel—the former through the Rogoff (1985) conservatism channel and the latter through the Walsh (1995) incentive contract channel—they both reduce a potential inflation bias, and hence improve the policy's credibility. This is the relatively standard part of our results.

What is less standard is the fact that *EIT* is found to be superior to *goal-CBI* for several reasons.[5] First, it eliminates the possible democratic deficit in Fig. 1 through enhancing *AC*. Second, it is robust to the degree of *goal-CBI*, i.e. it delivers credibility even under a non-conservative policymaker. Put differently, credibility is 'institutionalized' by *EIT*—tied up with the legislated regime, not with an individual, and is therefore not at stake if a particular conservative Governor departs. Third, *EIT* reduces the monitoring cost of the public by enhancing *goal-TR*. This is because under the *EIT* regime the government's overriding of (interference with) monetary policy is easily detectable (sustained deviations from the legislated target are visible), which results in public's cheaper monitoring (updating information about the government's type). Fourth and finally, because of that, *EIT* makes it more likely that the public monitors, and hence reduces the government's incentive to interfere and override the central bank. This in turn increases monetary policy's credibility and steady-state output. One of the implications of these results is that an important advantage of *EIT* is the improvement of the central bank's ability to communicate with the public.[6]

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[4] To document this claim from a different angle, the correlation between *instrument-CBI* and *goal-CBI* among the 22 transition countries in Fry et al. (2000) is −0.34.

[5] To demonstrate, the survey by Blinder (2000) shows that *CBI* (without the goal vs. instrument distinction) is still perceived by central bankers and academics as the most important institutional feature of monetary policy in terms of achieving credibility.

[6] The emphasis is however not so much on the details (providing information about shocks and forecasts which has been the focus of most of the literature) but in clarifying what the policy goals are. The need for this sort of communication is reflected in Cecchetti's (2003) plea in the introduction. The fact that there may be room for improvement is implied by e.g. Goodfriend (2003) who describes the 'don't ask, don't tell' situation in the US of the early 2000s: 'Congress doesn't ask the Fed whether it places a priority on low inflation, and the Fed does not say whether it has such priority'.

Arguably the most controversial part of our results, and the one directly relevant to reforming countries, is the model's prediction that if the government grants a high degree of *goal-CBI*, then the appointed central banker is less likely to adopt *EIT*. First, he will have less need to use the Walsh channel as credibility of low inflation is delivered through the substitute Rogoff channel. Second, he may have less willingness to do so if he is averse to the possibility of punishment/criticism attached to an *EIT*. Put differently, in line with the principal/agent literature, the policymaker will prefer to minimize its own *AC*, other things equal. The fact that *AC* can only be enhanced by *goal-TR* implies, in accordance with the findings of the second stream of literature and Fig. 1, that both *goal-TR* and *AC* will be negatively related to *goal-CBI*.

These results have strong implications for the optimal institutional design, and sequencing of its reform. They argue for *EIT* (which includes *goal-TR*, *AC*, and *instrument-CBI*), but against the simpler *goal-CBI* regime usually following the 'just do it' approach. As evident in Fig. 1, some transition countries have however followed the latter route and made their central bankers very independent without the appropriate accountability measures, which may have led to inferior outcomes.

2 The model

To make the analysis more instructive, while also incorporating a number of institutional variables at the same time, we choose to use the simplest setting in which the institutional insights can be shown analytically. In this we follow Blanchard (2008) who calls for 'the re-legalization of shortcuts and of simple models.' Our analysis should therefore be interpreted as a demonstration of the various relationships at play, not necessarily as the most realistic depiction of the economy and behaviour. Nevertheless, it will become apparent that since all our institutional assumptions are in line with the existing literature, our insights are not model specific and would likely hold more generally in a richer model.

Since our interest lies in the effect of institutional design on monetary policy (in democratic countries) we will adopt a long-term perspective and focus on the steady-state outcomes of the game. This will be reflected in three respects. First, the Phillips curve describing the supply side of the economy will be deterministic and disregard (zero mean) cost-push shocks. Second, the demand side of the economy (IS curve) will be ignored, and inflation treated directly as the instrument of monetary policy. Third, the policymakers' preference for output stabilization will be assumed out only focusing on the level of their output target.[7]

Let us sketch the mechanics of the model. Unlike the government who has an over-ambitious (above-potential) output target for political economy reasons (for example under aging populations), the central banker responsibly targets potential output. Which of these two policymakers, and to what extent is in charge of setting monetary policy is determined by the degree of *goal-CBI*. We further assume that

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[7] An earlier version of the paper featured these aspects but as the contribution was marginal they have been left out.

both policymakers dislike AC—because of punishments implied by an optimal linear incentive contract as in Walsh (1995) and Svensson (1997b); and, to a lesser extent due to their accountability aversion. Because the incentive contract can only be implemented if policy goals are transparent (e.g. Bernanke et al. 1999; Mishkin 2004), AC is postulated as an increasing function of *goal-TR*.

There are two types of government following Backus and Driffill (1985): weak and strong. The weak (impatient) type has a temptation to temporarily override (suppress) the institutional regime and force its own preferred policy setting. Overriding may lead to an output gain through surprise inflation, but it deteriorates the government's reputation (for being strong) and hence future monetary policy outcomes. For that reason a strong (patient) government is not tempted to override the central bank. The problem is that the public cannot observe the government's type in real time and correctly predict the government's interference in monetary policy, unless it 'monitors'—that is, unless it pays a fee for a signal that reveals the government's type. We model the public as 'economically rational' (in the spirit of Feige and Pearce 1976), i.e. it chooses whether or not to obtain the signal based on cost-benefit calculations.

The three players will be denoted as follows: the public, p, the government, g, and the central bank, b. They are rational, have common information, and know their opponents to be rational. The economy is summarized by a simple Phillips curve

$$\pi_t = \omega x_t + \pi_t^e \tag{1}$$

where π is inflation, π^e is expected inflation, x is the output gap (difference between current and potential output), and t denotes discrete time. The players' single period utility functions are the following

$$u_t^i = \lambda^i x_t - (\pi_t - \bar{\pi})^2 - a_t AC_t \tag{2}$$

$$u_t^p = -(\pi_t - \pi_t^e)^2 - m_t M_t \tag{3}$$

where $i = \{g,b\}$, $\bar{\pi}$ is the socially optimal average inflation target (whether or not it is made explicit will be endogenized below), $AC \geq 0$ denotes accountability, $M \in \{0, 1\}$ denotes the degree of the public's monitoring, $\lambda \geq 0$ is (the reciprocal of) conservatism, and $a \geq 0$, $m \geq 0$ denote the magnitude of accountability and monitoring costs respectively. The government's and central banker's preferences differ in the level of the output gap target, as in Faust and Svensson (2001). As the authors do, we assume that the central banker is 'responsible,' $\lambda^b = 0$, but that the government is ambitious $\lambda^g > 0$.[8] Finally, the government's discount factor is δ_g, where we will depict two levels: $\delta_g = 1$ will be called patient, and $\delta_g = 0$ impatient.[9]

The intuition behind the players' preferences is standard; but there are two additions. First, we allow for the possibility that the policymakers are averse to accountability. Second, the public's utility function expresses 'economically

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[8] For the responsible/ambitious terminology see e.g. Faust and Svensson (2001). Government's ambition may be due to re-election attempts in the presence of naïve voters, lobby groups, unions etc; and/or due to the drivers of long-term fiscal stress such as unaffordable welfare/health/pension schemes in the presence of an aging population, high debt, or liabilities implied by public guarantees for financial institutions.

[9] We will abstract from discounting of the central bank and the public for parsimony without affecting our conclusions.

rational expectations,' in which their monitoring (information updating) decision is the result of a cost-benefit analysis performed by the agents.[10]

2.1 Institutional features

In this section and the next, we introduce the various concepts used in our framework. We prefer to give formal definitions to avoid ambiguity.

Definition 1   Central bank *goal-independence*, $CBI \in [0, 1]$, refers to the capacity of the central bank to set and pursue its own objectives (targets).

Following Hughes Hallett and Weymark (2005) *CBI* is assumed to be an index. In order to better express who actually sets monetary policy in practice, the two players can be merged into one called '*monetary policymaker*,' denoted m. His preferences are assumed to be an average of the two players' objectives weighted by *CBI*, $u_t^m = CBIu_t^b + (1 - CBI)u_t^g$, from which it follows that

$$u_t^m = \lambda^g (1 - CBI)x_t - (\pi_t - \bar{\pi})^2 - a_t AC_t \qquad (4)$$

As a justification, it has long been argued that monetary and fiscal policies are interconnected in that they both affect the same variables, see for example the unpleasant monetarist arithmetic of Sargent and Wallace (1981), and the Fiscal Theory of the Price Level of Leeper (1991). This is especially relevant in an era of fiscal stress as currently faced by most advanced countries.

Definition 2   *Goal-transparency*, $TR \geq 0$, refers to the degree of explicitness with which long-run monetary policy objectives (targets) are stated in the central bank statutes or related legislation.

This definition is in line with Geraats (2002).[11] It will become apparent that this aspect of 'legality' makes *goal-TR* substantially different from a policy announcement—because of its effect on *AC* and monitoring.

Definition 3   *Accountability*, $AC \geq 0$, refers to the monetary policymaker's punishability (by the public) for deviating from the long-run monetary policy objectives.

In most settings the central banker is accountable to the government, and the government is subject to periodic re-election by the public and to scrutiny by parliament and the press. Our definition therefore combines the two.

Aversion to *AC* is determined by the following incentive scheme of Walsh (1995), in which the contract is linear for modelling purposes (as in Svensson 1997a).

$$a_t = \gamma(\pi_t - \bar{\pi}) + \kappa \qquad (5)$$

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[10] This is in line with models of 'rational inattention' (Sims 2003; Reis 2006). We could also incorporate public's inflation aversion, but follow Backus and Driffill (1985) and disregard it to keep the intuition comparable to standard rational expectations.

[11] In Geraats (2002) *goal-TR* (referred to as 'political' transparency) has three elements, namely 'formal objectives', 'quantitative targets', and 'institutional arrangements'. All three are officially grounded in the legal framework of monetary policy (the Central Bank Act, the Statutes etc).

where γ is a '*punishment aversion*,' defined as $\gamma > 0$ for $\pi_t \geq 0$ and $\gamma = 0$ otherwise.[12] The constant term, $\kappa \geq 0$, denotes the policymaker's '*punishability aversion*' as such—the threat of punishment itself, as opposed to the size of actual punishment for deviating from the long-run target. This is in the spirit of Milton Friedman who argued that: 'By far and away the two most important variables in the central banker's loss function are avoiding accountability on the one hand and achieving public prestige on the other' (quoted in Fischer 1990). In other words, punishability may be a constraint on the policymaker, effectively limiting his or her policy choices (similarly to the intuition of Faust and Svensson 2001, 2002).

With regards to achievability of *AC*, the literature argues that it can only be secured through *goal-TR*: e.g. Debelle (1997), Svensson (1999), Eijffinger et al. (2000), or Geraats (2002). This is because the optimal incentive contract can only be put in place if the policymaker's targets are clearly specified, implying $\frac{\partial AC}{\partial TR} > 0$, $\forall TR \geq 0$. For the purposes of illustration, we use a specific functional form

$$AC_t = \tau TR_t \tag{6}$$

The fact that *EIT* is interpreted as a monetary policy regime with a high degree of *goal-TR* and *AC* implies that these three concepts are a single object in our analysis.[13]

2.2 Government types, reputation, regime overriding and monitoring

In this section we elaborate on the uncertainty present in the game. We find it realistic to model overriding as a temporary interference with the existing institutional arrangements rather than as a dismissal of the central banker or abandoning the *EIT*, neither of which have been observed in practice.

Definition 4   *Overriding* in period t, $R_t = 1$, refers to the government's temporary suppression of the institutional arrangements and setting inflation itself, i.e. $CBI_t = 0 = AC_t(TR_t)$.

Following the work on reputation by Backus and Driffill (1985), we assume that there are two types of government, strong and weak, $T \in \{S, W\}$. Unlike in their paper, our government types differ in their discounting of the future.

Definition 5   The *strong* type of the government, g^S, is patient, whereas the *weak* type, g^W, is impatient.

This implies $\delta_g^S = 1 > \delta_g^W = 0$. We denote the fixed probability of g^S by $\theta \in [0, 1]$. While we assume that the public knows the incentives of each

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[12] Assuming no punishment for deflation is a technical assumption without loss of generality as neither player has an incentive to choose negative inflation levels in our model.

[13] The literature has often treated *AC* and *goal-TR* as synonymous, as they go hand in hand in the real world (Svensson 1999; Mishkin 2004). While this is justified for modelling purposes it may have undesirable consequences: indices of these institutional features include criteria that refer to the other variable. Therefore, we prefer to postulate them separately. Further, it should be noted that real world *EIT* has a number of additional features other than *AC* and *goal-TR*. Nevertheless, as these two pivotal features most affect the incentives of the policymakers and steady-state outcomes, we focus on them.

government type, the public does not know that fixed is constant, and can only *directly* observe the type with a one-period lag, i.e. g_{t-1}^T at t. Therefore, in every period the public makes an assessment of g_t^T before setting inflation expectations.

Definition 6   The government's *reputation*, $\theta_t^e \in [0, 1]$, refers to the probability perceived by the public that the government is strong (patient) in period t, $g_t^T = g^S$.

The cases of $\theta_t^e = 1$ and $\theta_t^e < 1$ will be called *perfect* and *imperfect* reputation respectively. Past realizations of g^T according to which the public updates θ_t^e are assumed to be costlessly available. If the public updates its beliefs according to Bayes rule each overriding decision leads to a 'punishment' by the public: a reduction in reputation, θ_{t+1}^e, increasing expectations π_{t+1}^e, and consequently decreasing output x_{t+1}, all these commonly lasting for a number of periods. We will keep the focus on the institutional relationships and leave the evolution of θ_t^e unmodeled here. Instead, we will follow Barro and Gordon (1983) and assume a grim trigger strategy scenario, under which overriding leads to the loss of the government's reputation forever. Such a strong punishment mechanism implies that patient governments are never tempted to override: $R_t^*(g^S) = 0$, $\forall t, M$.

Importantly, we assume that the public is *not* constrained to the past realizations, but has the option of monitoring in each period.

Definition 7   *Monitoring*, $M = 1$, refers to the public's acquiring real-time information about the government's type.

Specifically, $M_t = 1$ will denote the purchase of a 100% informative signal of g_t^T before the actions in period t are made (whereas in the case of no-monitoring, $M_t = 0$, the public's prior information does not change).[14] In either case we find it realistic to assume that the government can observe the value of M_t in period t prior making a move.

Monitoring costs in the literature are conventionally defined as a function of two variables: (i) the degree of informativeness of the signal, and (ii) the degree of difficulty of obtaining that signal. Therefore, we postulate the monitoring cost as a decreasing function of *goal-TR*

$$m_t = \frac{\mu}{1 + TR_t} \tag{7}$$

where $\mu > 0$ is the maximal monitoring cost that occurs under fully opaque objectives.

Definition 8   Monetary policy *credibility*, $C \leq 0$, refers to the degree with which the public expects the optimal long-run inflation level (target) to be achieved.

We follow Faust and Svensson (2001) who postulate

$$C_t = -\left| \bar{\pi} - \pi_t^e \right| \tag{8}$$

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[14] Arguably, in young democracies the effectiveness of the public's monitoring may only be improving over time. This could be modelled by obtaining a noisy signal rather than a fully informative one, but we will not pursue this avenue.

Intuitively, the further long-run expectations are from the (implicit or explicit) inflation target the lower is the credibility; i.e. $C_t = 0$ is the case of *perfect* credibility and if $C_t < 0$ the policy *lacks* credibility.

2.3 Timing and versions of the game

We will consider two versions of the game. We will distinguish a *pre-EIT* era (game G) in which *goal-TR* and *AC* are *not* available, and *post-EIT* era (game G^{EIT}) in which they can be implemented. This will explicitly incorporate an important feature of the real world that the *EIT* regime is institutionally more demanding than *CBI*. In particular, there exist a number of prerequisites that need to be satisfied before the *EIT* regime can be successfully adopted, such as absence of fiscal dominance, absence of exchange rate peg, sound infrastructure (developed capital markets), good forecasting and inflation control, *instrument-CBI* etc (for more see Masson et al. 1997; Blejer et al. 2002).

In the *pre-EIT* era we will consider both the case in which *CBI* is exogenous, and the case in which it is selected by the government of the day. In the *post-EIT* era *goal-TR* and *AC* can be optimally chosen by the monetary policymaker, taking the degree of *CBI* as given. The exogeneity of *CBI* reflects the fact that this feature may be outside the government's control.[15]

The actions that happen in every period $t \geq 1$ are equivalent for both versions of the game and can be summarized as follows (Fig. 2 presents the extensive form).

1. The public updates θ_t^e by observing g_{t-1}^T.
2. There is a move of nature—realization of the government's type, $T_t \in \{S, W\}$, as a random draw given θ.
3. Unable to observe g_t^T the public chooses from the monitoring set, $M_t \in \{0, 1\}$.
4. Observing M_t the government chooses whether to override/interfere, $R_t \in \{0, 1\}$.
5. Inflation, π_t, is then set (through the interest rate) by either the monetary policymaker (in the case of $R_t = 0$) or the government (if $R_t = 1$).
6. Unable to observe π_t, and either able to observe g_t^T (if $M_t = 1$) or unable to observe g_t^T (if $M_t = 0$), the public forms inflation expectations π_t^e (note that the $M_t = 0$ case is reflected in Fig. 2 by the larger information set).
7. The pay-offs of period t are realized.

This is the full description of G with exogenous *CBI*. In G with endogenous *CBI* we assume that at the beginning of the game, in period $t = 0$, the government chooses *goal-CBI* from the set $CBI = [0,1]$, which can be observed by all players. In game G^{EIT} there is a different (one-off) observable move in $t = 0$: the monetary policymaker chooses the degree of *goal-TR* from the set $TR \in [0, \infty)$, taking *CBI* as given.[16]

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[15] There is a growing literature on 'inflation culture' that shows that the degree of *goal-CBI* is driven by various long-run factors, for example the public's attitudes towards inflation and/or inequality: see Posen (1995), Hayo (1998), and de Jong (2002), and cannot be changed readily.

[16] Since these are one-off decisions we will drop the time subscript on *CBI*, *TR*, and *AC* (except in an overriding situation).
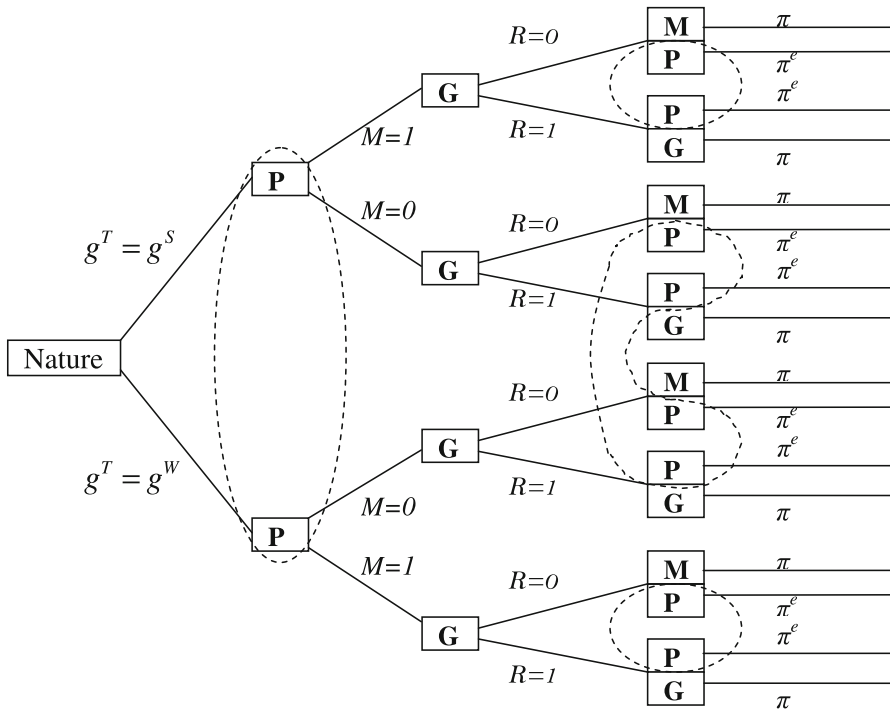
Fig. 2 The extensive form of the stage game of G with exogenous CBI

3 Results

3.1 Game G

Our first two propositions relate to the public's monitoring—indentifying its effect and then the conditions under which it occurs.

Proposition 1 *If the public monitors, the institutional regime is never overridden, potential output always obtains in the steady state, and the two types of government are observationally equivalent.*

Proof We need to show that if $M_t = 1$ then $R_t^* = 0$ and $x_t^* = 0$, $\forall CBI, g_t^T$ (where an asterisk will denote an equilibrium level throughout). Solving backwards, substitute all relevant information into (3)–(4), realizing that $R_t = 1$ leads to $CBI_t = 0$. Differentiating with respect to the inflation rate and rearranging yields the time-consistent level in the steady-state

$$\pi_t^* = \bar{\pi} + \frac{\lambda^g}{2\omega}[1 - CBI(1 - R_t)] \qquad (9)$$

Note that with the exception of the $CBI = 1$, $R_t = 0$ case, (9) implies $\pi_t^* > \bar{\pi}$, which is the influential time-inconsistency and inflation bias result of Kydland and Prescott

(1977) and Barro and Gordon (1983). We relegate the rest of the proof to "Appendix 1".   □

Intuitively, the public's monitoring discourages even a weak government from overriding the regime as it eliminates the possibility of an inflation surprise induced output gain. As such, policy credibility is increased and so is steady-state output as a consequence. An interesting implication is the fact that under monitoring the realized monetary policy outcomes may be insufficient to reveal the type of the government, as both types produce identical outcomes.

To keep our focus on the institutional design of monetary policy, we will not examine in detail what happens under no-monitoring, $M_t = 0$. It is however straightforward to show that: (1) The weak/impatient type of government always overrides the central banker, $R(g^W)^* = 1$. Therefore, (2) the policy lacks credibility, $C_t^* < 0$, even if the central banker is fully independent and the government is never weak, $CBI = \theta = 1$. (3) Deterioration in the government's reputation leads to a decrease in the monetary policy's credibility. (4) As a consequence, the economy never operates at potential output in the steady-state regardless of the government's type, $x_t^* \neq 0$, $\forall g_t^T, \theta_t^e \in [0, 1)$. We will continue by focusing on the monitoring case, $M_t = 1$.

Proposition 2   *The public will monitor if and only if: (i) the government's reputation is imperfect, and (ii) there exists some institutional arrangement that could be overridden, and (iii) the monitoring cost is sufficiently small.*

Proof For the public to find it optimal to monitor it is required that $u_t^p(M_t = 0) \leq u_t^p(M_t = 1)$. Substituting all of the above results into (3) yields

$$\theta_t^e \left[-\frac{\lambda^g}{2\omega}(1 - \theta_t^e)CBI \right] + (1 - \theta_t^e)\left(\frac{\lambda^g}{2\omega}\theta_t^e CBI \right) - \frac{\lambda^g}{2\omega}(1 - \theta_t^e CBI)$$
$$\leq -\mu - \frac{\lambda^g}{2\omega}(1 - CBI) \tag{10}$$

which can be simplified into

$$\bar{m} = \bar{\mu} \leq \frac{\lambda^g}{2\omega}(1 - \theta_t^e)CBI \tag{11}$$

This implies that if $\theta_t^e < 1$ (condition i), $CBI > 0$ (condition ii), and $0 < m(\mu) \leq \bar{m}(\bar{\mu})$ (condition iii) then $M_t^* = 1$ for all g_t^T.   □

The intuition of the result is as follows. The public is 'economically rational,' and hence its monitoring decision is based on cost-benefit considerations. If the cost of monitoring is sufficiently small relative to the probability of overriding (given the government's reputation), and relative to the magnitude of the subsequent inflation surprise (given by the government's ambition and the degree of *CBI*), the public will find it optimal to monitor. Put differently, its tradeoff is resolved in favour of minimizing the expectation error by costly (but not too costly) monitoring. This will discourage the weak government type from interfering with the institutional setting and pressuring the central bank. Optimally low inflation then becomes time-consistent and credible.

As it is reasonable to suppose that all conditions of Proposition 2 generally hold, we will impose them throughout the rest of the paper: $\theta_t^e < 1$, $\forall t$ and $m(\mu) \leq \bar{m}(\bar{\mu})$.[17] This allows us to focus on the relationships between the institutional features, since we know that the public will then always monitor ($M_t^* = 1$, $\forall t$ from Proposition 2) and the regime will therefore never be overridden ($R_t^* = 0$, $\forall t$ from Proposition 1).

Proposition 3   *In the pre-EIT era goal-CBI (i) reduces steady-state inflation and (ii) improves credibility. Therefore, the government finds it optimal to grant full goal-independence to the central banker.*

Proof   The effect of *CBI* on inflation follows by inspection of (9). Its effect on credibility can be seen by substituting (9) and (19) into (8), which yields

$$C_t = -\left| -\frac{\lambda^g}{2\omega}\left[1 - CBI(1 - R_t^e)\right]\right| \tag{12}$$

and shows that C_t is increasing in *CBI*. Moving backwards, the government takes the above into account. Using $M_t^* = 1$, $R_t^* = (R_t^e)^* = 0$, substituting (9) and (19) into (2) and differentiating with respect to *goal-CBI* yields

$$\frac{\partial u^g}{\partial CBI} = \frac{\lambda^g}{2\omega} > 0 \tag{13}$$

which implies $CBI^* = 1$.   □

These results are in the spirit of Rogoff (1985), and in line with some empirical findings discussed in Sect. 5. It is interesting to relate the first claim to the qualification of McCallum (1995) who argued that a higher degree of *CBI* may not work if an overriding threat exists. Our analysis implies that this threat may impact inflation and credibility differently. In particular, while *CBI* reduces inflation only if the regime is not overridden, *CBI* improves credibility even if it is overridden: C_t in (12) is increasing in *CBI* for all R_t.

In terms of the second claim, due to the welfare improving effects of *CBI* the government is willing to formally distant itself from the monetary policy process—in the spirit of Tinbergen (1954).

3.2 Game G^{EIT}

This version allows for the possibility of the monetary policymaker choosing the degree of *goal-TR*, i.e. how explicit policy goals will be, treating *CBI* as given. We believe it to be realistic, as in the real world this decision has been made the government, the central bank, or jointly by both institutions (whereby the higher the

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[17] In terms of the small monitoring cost assumption, $m(\mu) \leq \bar{m}(\bar{\mu})$, obtaining information has arguably become much more affordable in the era of internet and far reaching media. Alternatively, unlike the inflation and output gap costs that are borne by every member of the society the monitoring cost may be shared. Once the signal is 'purchased' by one individual it may be passed onto others with little additional cost. In terms of the imperfect reputation assumption, $\theta^e < 1$, can best be supported by the length of time that was needed for central banks to re-establish their credibility in the 1980s and 1990s, after the inflationary excesses of the 1970s. Section 5 has more discussion of this.

CBI the more input into the decision the central bank has). The following proposition reports the effect of *EIT* on monetary policy outcomes.

Proposition 4 *EIT with transparent and accountable goals weakly: (i) reduces steady-state inflation and (ii) improves credibility.*

Proof Denoting all post-*EIT* variables by a hat, and using the fact that Propositions 1–2 hold in G^{EIT}, the time-consistent steady-state inflation level is[18]

$$\hat{\pi}_t^* = \bar{\pi} + \frac{\lambda^g}{2\omega}(1 - CBI) - \frac{\gamma\tau TR}{2}, \quad \forall \hat{\pi}_t^* \geq \bar{\pi}, \quad \text{otherwise} \quad \hat{\pi}_t^* = \bar{\pi} \qquad (14)$$

which, when combined with $(\hat{\pi}_t^e)^* = \hat{\pi}_t^*$ and $C_t = -\left|\bar{\pi} - \pi_t^e\right|$, proves the claims. □

The intuition is similar to that of Proposition 3—the difference is that *EIT* works through a different commitment channel, the Walsh incentive contract. We show below that this is in line with a number of empirical findings.

The following proposition examines the decision of the monetary policymaker to make his goals more explicit. It entails a tradeoff between improving policy outcomes (reported in the previous proposition), and the potential punishment and punishability costs attached to it.

Proposition 5 *(i) Under a sufficiently small punishability aversion, $\kappa < \bar{\kappa}$, goal-TR and AC are both positive but decreasing in CBI (as well as in γ, ω, τ, and increasing in λ). In such a case, equilibrium steady-state inflation is on target regardless of CBI, i.e. $\hat{\pi}_t^* = \bar{\pi}, \forall CBI$. (ii)In contrast, under $\kappa \geq \bar{\kappa}$, the goals of monetary policy remain opaque and unaccounted for, $\widehat{AC}^* = \widehat{TR}^* = 0$, and equilibrium steady-state inflation deviates from the target for all CBI < 1.*

Proof Substitute (14) into (4) together with (5) and all other relevant information derived in the above proofs, differentiate with respect to *goal-TR*, set equal to zero and rearrange to obtain

$$TR = \frac{2\kappa}{\gamma^2\tau} \qquad (15)$$

From the fact that the second derivative is positive it follows that such *goal-TR* level minimizes the policymaker's utility. This, combined with the fact that his utility is a parabola, implies a corner solution. Depending on the punishability aversion κ, the optimal degree of *goal-TR* is either zero or the highest level that still reduces inflation, which is, using (14)

$$\widehat{TR}^* = \frac{\lambda^g(1 - CBI)}{\tau\gamma\omega} \quad \text{and} \quad \widehat{AC}^* = \frac{\lambda^g(1 - CBI)}{\gamma\omega} \qquad (16)$$

Specifically, from the fact that the parabola is symmetric it follows that the threshold level is, using (14) and (15),

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[18] The appropriate threshold monitoring cost, $\bar{\mu}$, is now lower due to the inflation reducing effect of *goal-TR*, but the derivation of (11) implies that a sufficiently low positive level exists.

$$\bar{\kappa} = \frac{\lambda^g \gamma (1 - CBI)}{4\omega} \qquad (17)$$

If $\kappa < \bar{\kappa}$ then the minimum utility level from (15) is closer to zero, and hence the equilibrium levels of *goal-TR* and *AC* are those in (16). In contrast, if $\kappa \geq \bar{\kappa}$ then $\widehat{AC}^* = \widehat{TR}^* = 0$. Substituting these levels into (14) yields the claimed $\hat{\pi}_t^* > \bar{\pi}$ for all $CBI < 1$ and completes the proof. □

Intuitively, the resolution of the policymakers' tradeoff depends on the cost of deviating from optimal macroeconomic outcomes relative to their accountability aversion. If they are highly averse, they will sacrifice the outcomes in order to avoid a greater level of public scrutiny and a potential punishment for wrongdoing or policy errors. The next proposition summarizes the welfare findings of the paper, in light of the above reported results, and provides the basis for our policy recommendations.

Proposition 6   *(i) EIT featuring transparent and accountable goals increases social welfare. (ii) Goal-independence granted to the central banker prior to adopting EIT reduces social welfare.*

Proof   Noting that, $\forall t$, $\hat{x}_t^* = 0$, we need to substitute (7) into (3) and differentiate with respect to *goal-TR* and *CBI* (using (16) as a constraint in the latter case). Setting equal to zero and rearranging yields

$$\frac{\partial \hat{u}^p}{\partial TR} = \frac{\mu}{(1 + TR)^2} > 0 \quad \text{and} \quad \frac{\partial \hat{u}^p}{\partial CBI} = - \frac{\frac{\mu \lambda^g}{\tau \gamma \omega}}{\left[1 + \frac{\lambda^g (1 - CBI)}{\tau \gamma \omega}\right]^2} < 0 \qquad (18)$$

The fact that the public's marginal utility with respect to *TR* and *AC* is positive, whereas with respect to *CBI* is negative, proves the proposition. □

Intuitively, *CBI* granted in the pre-*EIT* era becomes socially undesirable in the post-*EIT* era as a *goal*-independent banker is less likely to commit to a transparent inflation target.[19] This has been shown above to have several adverse consequences: (i) a higher monitoring cost for the public, (ii) a decreased likelihood of monitoring, (iii) an increased likelihood of regime overriding, (iv) larger magnitude of the output gap (in expectation), (v) a higher probability of a democratic deficit (the disutility of which is not modelled here, but is potentially important, especially in countries without a strong history of democracy and sound institutions).

4 Some observations of the empirical evidence

Our analysis has a number of testable implications. Since our attention has been on the institutional features of monetary policy, and since the results of Propositions

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[19] As possible examples, one can think of the Federal Reserve, the Bundesbank, and the Swiss National Bank.

1–2 do not significantly deviate from conventional wisdom, we will focus on the remaining findings.[20]

4.1 Effect of *CBI* (Proposition 3)

The commitment effect on inflation and credibility is in line with empirical findings of Grilli et al. (1991), Cukierman et al. (1992), Alesina and Summers (1993), Eijffinger and Schaling (1993), Briault et al. (1997), and Eijffinger et al. (1998).[21] Furthermore, our analysis points to a possible explanation for the puzzling empirical results of Posen (1998), who found *CBI* to be associated with *higher* sacrifice ratios. It suggests that controlling for the endogenously driven *EIT* may be crucial—it may not have been higher *CBI* that increased the sacrifice ratios, it may have been the lower *TR* and *AC* that did so.

4.2 Optimal delegation (Proposition 3)

By the mid-1980s, prior to the 'invention' of *EIT*, some countries have established *goal*-independence of their central bankers, whereas others have not. The existence of the former group (with US, Germany, and Switzerland being the prime examples) is consistent with the result about the government's incentive to grant *CBI* in the pre-*EIT* world. The existence of the latter group (e.g New Zealand, Canada, and the UK) provides some evidence for the claim that *goal-CBI* is often beyond the government's immediate control since it is determined by some long-term factors (e.g. Posen 1995; Hayo 1998; de Jong 2002).

4.3 Effects of *EIT*, *goal-TR* and *AC* (Proposition 4)

Due to the relationship between *EIT* and *CBI*, our analysis implies that empirical findings crucially depend of the choice of the sample—in terms of countries, the time frame, dates over which some variables are averaged, and the way *CBI* (and what type of *CBI*) is controlled for. This substitutability is likely to explain the contradictory findings of the literature: Wu (2004) and Hyvonen (2004) find inflation targeting to reduce inflation whereas Ball and Sheridan (2003) and Willard (2006) do not—all using the sample of industrial countries. It is however unsurprising that the effect of *EIT* will be small and/or insignificant in these countries—*EIT* was only adopted from 1990, by which time most industrial countries had disinflated.

This however in no way shows that *EIT* does not matter. The regime may still, in line with Proposition 5, have the effect of both keeping inflation low and reducing higher inflation. This is clearly confirmed if emerging and developing countries are

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[20] The undesirable effect of imperfect reputation and/or lacking credibility on policy outcomes and their positive relationship seem uncontroversial, similarly to the gradual reduction of monitoring costs. The effect of the public's monitoring on the government's overriding incentives is intuitive.

[21] It should be noted that valid concerns have been expressed over some of these findings and approaches, see Forder (2000). The mixed evidence of the effect of CBI in the post-EIT era found by e.g. Fuhrer (1997), combined with strong evidence of positive CBI effects in the pre-EIT era, is consistent with our findings. It can be explained by the substitutability of goal-CBI and EIT derived in our model.

included—see e.g. Corbo et al. (2001). Many of these countries have even used *EIT* as a disinflation device. In line with this, Debelle (1997) finds inflation targeting to increase the policy's credibility. Further, our results agree with the theoretical finding in Eijffinger et al. (2000) and the empirical result by Chortareas et al. (2002) who show transparency to lower the average rate of inflation. Also, this is consistent with Demertzis and Hughes Hallett (2007) who show average inflation to be unaffected by transparency in the absence of accountability in industrial countries. Likewise, accountability appears to reduce inflation in theory (Walsh 1995; Svensson 1997b; Schaling and Nolan 1998) as well as in practice (Briault et al. 1997).[22]

4.4 Relationship of *EIT*, *goal-TR* and *AC* with *goal-CBI* (Proposition 5)

Briault et al. (1997) was the first paper to present evidence that *goal-CBI* and *AC* are *negatively* related. Later work, using differently constructed indices for different countries and periods, have confirmed this, de Haan et al. (1999) and Sousa (2002) showed in Fig. 1. This is also consistent with the empirical relationship of *goal-TR* and *goal-CBI* sketched out in Fig. 3.

Furthermore, it is supported using the large sample in Fry et al. (2000) in which the correlation between *goal-CBI* (denoted as item A.5:2) and *goal-TR* (item A.4:3) is −0.24 among industrial countries. As discussed in the introduction, the *goal-CBI* versus *instrument-CBI* distinction is of crucial importance. This can be seen if we use the same sample and index, Fry et al. (2000) in which the correlation between *instrument-CBI* (item A.5:3) and economic-*TR* (item A.7) in industrial countries is positive, namely 0.38. This is in contrast with the findings of Figs. 1 and 3 and lends support to the hypothesis of Geraats (2001) that implies complementarity of *instrument-CBI* and *EIT*.

4.5 Inflation in the post-*EIT* world (Proposition 5)

Industrial countries have had low inflation rates for some time now. This is predicted by the model—these countries meet all the prerequisites of *EIT* discussed in Sect. 2.3, and the punishability aversion of their policymakers is arguably close to zero. In contrast, the position of (many) emerging and developing countries seems different because all of the prerequisites for adopting *EIT* have not been met. As a result (i) a smaller proportion of these countries have adopted *EIT*, (ii) they have, on average, less economic-*TR* (which may indicate the quality of forecasting and inflation control), and (iii) they still have, on average, higher levels of inflation and inflation variability.[23]

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[22] For completeness, let us mention that in addition to the long-run effects of *EIT* the literature has identified a number of short-run stabilization effects of *EIT*. These regard primarily the anchoring effect, e.g. Levin et al. (2004), Kuttner and Posen (1999), Gürkaynak et al. (2005), or Libich (2008), and the effect on the volatility of nominal interest rates, e.g. Siklos (2004), Neumann and von Hagen (2002), or Eijffinger and Geraats (2004).

[23] In terms of (ii), Fry et al. (2000) show that out of the maximum rating of 10, average *economic-TR* scores for industrial, emerging and developing countries are 6.9, 5.7, and 5.1 respectively. Nevertheless, the data from transition and developing countries, using this index, support all the main conclusions of our analysis. First, *EIT* (*TR* and *AC*) are found to reduce inflation. Second, the negative correlation between *goal-CBI* and *AC* procedures is present in both groups.
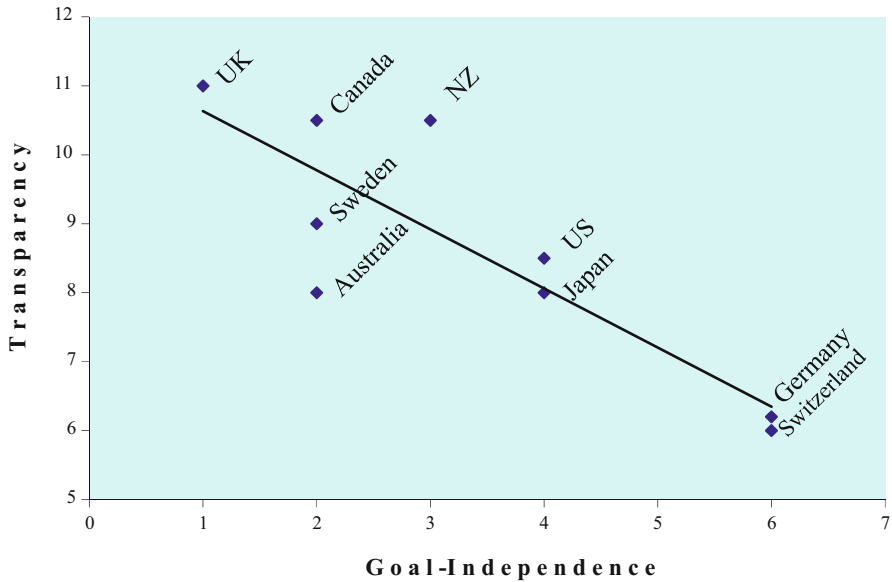
Fig. 3 *Source* Goal-TR is from Eijffinger and Geraats (2006) for year 1998, goal-CBI from Briault et al. (1997). The correlation coefficient equals −0.86 (t = −4.46). See "Appendices 2–6" for details on the criteria, scores, and a discussion of the Bundesbank's 1998 goal-TR score

4.6 Social welfare (Proposition 6)

The superiority of *EIT* from a welfare point of view is very hard to verify empirically—but the popularity of *EIT* and the fact that no country has ever abandoned the regime provide indirect evidence. Nevertheless, our conclusion on the inferiority of *goal-CBI* is supported by recent work—notably papers by Eggertsson and Le Borgne (2003), Hughes Hallett and Weymark (2004), Forder (1998b), and several by Lars Svensson—that cast doubt on the wide-spread belief about the unreserved desirability of *CBI*. These papers, like ours, imply that while *instrument-CBI* is desirable, *goal-CBI* is not.

5 Summary and conclusions

The paper attempts to make inferences about the socially optimal institutional design of monetary policy, and sequencing of central banking reform. While the past three decades have witnessed a general trend towards central bank independence (*CBI*), transparency (*TR*), accountability (*AC*), and explicit inflation targeting (*EIT*), there have been striking differences across countries. We propose a simple model in which we formally incorporate all these institutional features, as well as related concepts such as overriding, reputation, credibility and monitoring.

We show that the distinction between *instrument-CBI* and *goal-CBI* elaborated by Debelle and Fischer (1994) is crucial. This is because *instrument-CBI* is found to *complement EIT* (it is one of the regime's prerequisite, i.e. a 'friend'), but *goal-CBI* is found to act as a *strategic substitute* to *EIT* and hence may be a 'foe' to the regime. Our analysis demonstrates why this can be a problem.

First, both *goal-CBI* and *EIT* are shown to reduce inflation and enhance credibility. Second, *EIT* is shown to be socially superior for four reasons: (i) *EIT* reduces the financial sector's monitoring cost through its *goal-TR*—as argued in Faust and Svensson (2001) and Imperato (2002). (ii) Because of that, *EIT* makes it more likely that the private sector monitors and hence it reduces the probability of the regime being overridden. (iii) *EIT* eliminates the democratic deficit, the situation of an independent central banker without a high degree of accountability, see Briault et al. (1997). (iv) *EIT*'s incentive structure delivers a low-inflation-high-credibility outcome independently of the central banker's degree of conservatism or independence. It is therefore politically robust.

There is another potential reason (that we do not model explicitly) related to the global financial crisis. A number of economists such as Greg Mankiw or Jim Hamilton have argued that a numerical inflation target would be beneficial to reduce the threat of deflation, as well as help the Fed's 'exit strategy'. As Mishkin (2010) argues: 'Providing a firm anchor for long-run inflation expectations would make the threat of deflation less likely. But a firm anchor would also give the Fed flexibility to respond to the weakness of the economy—because it would help ensure that any new moves to quantitative easing would not be misinterpreted as signalling a shift in the central bank's long-run inflation goal, making an upward surge in inflation expectations less likely too.' Similarly, Walsh (2009) believes that: '…the ability to deal with demand shocks and financial crises can be enhanced by a commitment to an explicit target.'

The implication of these results is that one advantage of *EIT* is an improvement of the central bank's communication with the public and financial markets. This is not so much by explaining in detail what the bank is doing; but in clarifying what it is trying to do (reaffirming its objectives) and hence what the private sector might reasonably expect from policy in the future. This is in line with the plea of Cecchetti (2003) quoted in the introduction, and is consistent with the arguments in Hughes Hallett et al. (2008) who show formally that communication in this sense is necessary if policymakers are to shift or anchor expectations. But it differs from the existing ideas on communication which have focussed on cheap talk, publishing private information about shocks and forecasts, and issues of unanimity (or otherwise) in the monetary policy committee.

As a third and final step the model shows that *EIT* may be disliked by the policymakers because the associated *AC* increases the risk of scrutiny/criticism/dismissal. Therefore, *goal*-independent central bankers may be less likely to explicitly commit. Such potential animosity between *goal-CBI* and *EIT* has important implications for optimal design of monetary policy. The analysis suggests that *EIT* should be implemented (which includes *goal-TR*, *AC*, and *instrument-CBI*), but *goal-CBI* should be avoided. Unfortunately, many transition and developing

economies have followed the Fed scenario and appointed *goal*-independent central bankers before *EIT* was fully established. This may have led to opaque objectives and a democratic deficit, combined with inferior macroeconomic outcomes. While we do not observe the counter-factual, our analysis implies that the timing of institutional reform generally matters.

The analysis however implies two caveats to the above conclusions. First, the beneficial effects of *EIT* occur under many—but not all—circumstances. For example, the inflation target must be specified as a long-run objective, i.e. one that only needs to be achieved on average, not every point in time (which would unduly reduce the central bank's flexibility to stabilize the real economy). As another example, the model shows that increases in *goal-TR* and *AC* only improve outcomes up to a point, after which further increases lead to no change in steady-state inflation and credibility. This is consistent with Acemoglu et al. (2008) who show that the effect of an institutional reform crucially depends on the political context in which it is implemented.

Second, the paper has not given an overall evaluation of *EIT*. More research is required to provide a complete welfare assessment of *EIT*, especially in light of the global financial crisis, and the need to potentially respond to a broader measure of inflation than just consumer prices. But regardless of the exact specification of the inflation target, our analysis suggests that it should be made explicit to deliver the desirable effects credibility, reputational, and monitoring consequences.

Appendix 1: Proof of Proposition 1

As overriding is not observable the public forms an expectation of it, R_t^e, and sets inflation expectations rationally based on (9)

$$(\pi_t^e)^* = \bar{\pi} + \frac{\lambda^g}{2\omega}\left[1 - CBI(1 - R_t^e)\right] \tag{19}$$

Moving forward let us examine the overriding choice. Under $M_t = 1$ the public knows the true g_t^T, i.e. has full information about the opponents' preferences and can thus perfectly anticipate overriding, $(R_t^e)^* = R_t$. Using this constraint with (2), (9) and (19) yields

$$\frac{\partial u^{g^W}}{\partial R} = -\frac{\lambda^g CBI}{2\omega}\left[1 - CBI(1 - R_t)\right] < 0 \tag{20}$$

This implies that $R_t^* = 0, \forall g^T$. The public therefore sets $(R_t^e)^* = 0$ in (19), leading to $x_t^* = 0$ from (1).   □

Appendix 2: *CBI* index (Sousa 2002)

Criteria	Points
Personal independence	
1. Appointment of the central bank board members	1.00
2. Mandate duration of more than half of the central bank board members	1.00
3. Policymaker (or other fiscal branches representatives) participation at central bank meetings, where monetary decisions are taken	1.00
Political independence	
4. Ultimate responsibility and authority on monetary policy decisions	1.00
5. Price stability	1.00
6. Banking supervision	1.00
7. Monetary policy instruments	1.00
Economic and financial independence	
8. Policymaker financing	1.00
9. Ownership of the central bank's (equity) capital	1.00

Appendix 3: *AC* index (Sousa 2002)

Criteria and methodology of this index is adopted from de Haan et al. (1999). We only use the 'final responsibility' component that we believe best proxies the degree of *EIT*.

Criteria	Points
Final responsibility	
1. Is the central bank subject of monitoring by Parliament?	1.00
2. Has the policymaker (or Parliament) the right to give instruction?	1.00
3. Is there some kind of review in the procedure to apply the override mechanism?	1.00
4. Has central bank possibility for an appeal in case of an instruction?	1.00
5. Can the central bank law be changed by a simple majority in Parliament?	1.00
6. Is past performance a ground for dismissal of a central bank governor?	1.00

Appendix 4: *Goal-CBI* index (Briault et al. 1997)

1. Whether the statutes of the central bank make it independent of the government	2.00
2. Whether more than half the appointments to the central bank board are made independently of the government	2.00
3. Whether there are government officials on the board	2.00
4. Whether the central bank does in practice set its own goals (for example, monetary or inflation targets).	2.00

Appendix 5: *TR* index (Eijffinger and Geraats 2006)

1. Political	
(a) Formal objectives	1.00
(b) Quantitative targets	1.00
(c) Institutional arrangements	1.00
2. Economic	
(a) Economic data	1.00
(b) Policy models	1.00
(c) Central bank forecasts	1.00
3. Procedural	
(a) Explicit strategy	1.00
(b) Minutes	1.00
(c) Voting records	1.00
4. Policy	
(a) Prompt announcement	1.00
(b) Policy explanation	1.00
(c) Policy inclination	1.00
5. Operational	
(a) Control errors	1.00
(b) Transmission disturbances	1.00
(c) Evaluation policy outcome	1.00

Appendix 6: Evaluation table

Index	Country	CBI Sousa (2002)[a]				AC Sousa (2002)[a]	TR Eijffinger and Geraats (2006) for 1998						Goal-CBI Briault et al. (1997)
		Personal	Political	Economic and financial	Total[b]	Final responsibility	Political	Economic	Procedural	Policy	Operational	Total	Total
1	Argentina	1.25	2.83	1.00	5.08	2							
2	Australia	0.50	2.16	0.00	2.66	5	3	1	1	1.5	1.5	8	2
3	Austria	1.66	3.16	1.00	5.82	1							
4	Belgium	1.75	1.50	0.00	3.25	4							
5	Canada	0.50	1.83	0.00	2.33	4	3	2.5	1	2	2	10.5	2
6	Chile	2.00	1.83	1.00	4.83	3							
7	Czech Republic	1.58	3.16	1.00	5.74	2							
8	Denmark	2.16	2.83	0.00	4.99	2							
9	EMU—ECB	2.50	3.66	1.00	7.16	1							
10	England	1.00	2.66	0.00	3.66	4	3	1.5	3	1.5	2	11	1
11	Finland	2.50	3.66	1.00	7.16	2							
12	France	1.50	3.16	1.00	5.66	2							
13	Germany	1.50	3.16	1.00	5.66	2	1[c]	1[c]	1[c]	2[c]	1[c]	6[c]	6
14	Greece	1.91	3.16	1.00	6.07	1							
15	Hungary	1.91	3.66	1.00	6.57	2							
16	Iceland	1.75	3.33	0.00	5.08	4							
17	Ireland	1.00	3.16	1.00	5.16	2							
18	Italy	2.16	3.16	1.00	6.32	1							
19	Japan	0.75	3.66	0.00	4.41	3	1.5	1	2	1.5	2	8	4

Appendix 6 continued

Index	Country	CBI Sousa (2002)[a]				AC Sousa (2002)[a]	TR Eijffinger and Geraats (2006) for 1998						Goal-CBI Briault et al. (1997)
		Personal	Political	Economic and financial	Total[b]	Final responsibility	Political	Economic	Procedural	Policy	Operational	Total	Total
20	Korea	0.75	2.16	0.00	2.91	4							
21	Luxemburg	1.25	3.16	1.00	5.41	2							
22	Mexico	1.83	2.33	0.00	4.16	2							
23	Netherlands	2.41	3.16	0.00	5.57	2							
24	New Zealand	1.83	2.16	1.00	4.99	4	3	2.5	3	1	1	10.5	3
25	Norway	1.58	1.83	0.00	3.41	5							
26	Poland	1.25	2.16	0.00	3.41	3							
27	Portugal	1.50	3.16	1.00	5.66	1							
28	Slovakia	1.00	3.50	1.00	5.50	1							
29	Spain	0.75	3.16	1.00	4.91	2							
30	Sweden	2.75	3.16	1.00	6.91	1	2	1.5	2	1.5	2	9	2
31	Switzerland	2.08	3.33	1.00	6.41	2	1	1	1	2	1	6	6
32	Turkey	1.66	2.83	0.00	4.49	3							
33	USA	2.00	1.83	0.00	3.83	2	1	2.5	2	1.5	1.5	8.5	4

[a] Assessment is based on situation in January 2002

[b] Excludes aspect 9 due to missing observations

[c] Eijffinger and Geraats (2006) do not provide a value for the Bundesbank for the year 1998. The literature agrees that Bundesbank's practices were very similar to the Swiss National Bank's (see e.g. Bernanke et al. 1999) and we indeed find all the two countries' criteria scores to coincide. This is further supported by the fact that in Sousa (2002) and Fry et al. (2000) the scores of the two central banks are equal (in the latter index in terms of goal-TR)

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