Independent Utility Regulators: Lessons from Monetary Policy

Revised version August 2003

Paul Levine
University of Surrey & London Business School

Francesc Trillas
Universitat Autonoma de Barcelona and London Business School

Jon Stern
London Business School & NERA
Independent Utility Regulators: Lessons from Monetary Policy

Paul Levine
University of Surrey and London Business School

Jon Stern,
London Business School and NERA

Francesc Trillas
Universitat Autonoma de Barcelona and London Business School

August 21, 2003

Abstract

This paper explores the similarity and differences between the credibility problem of monetary policy and the under-investment problem of price regulation. In both cases reputational solutions are possible provided that the policymaker is sufficiently far-sighted. But even if regulators are far-sighted, this solution to the investment problem is undermined if capital depreciates slowly. Flexible commitment rules are difficult to monitor and sustain as reputational equilibria. These considerations make the Rogoff-delegation solution to the regulatory commitment problem especially attractive. The paper concludes with a short discussion that links these theoretical considerations to the empirical literature on utility regulatory regimes.

JEL Classification: C72, E61, L51

Keywords: Monetary policy, credibility, regulation, under-investment, delegation.
### Contents

1 Introduction  

2 Rules and Delegation in the Conduct of Monetary Policy  
   2.1 Commitment, The Time-Inconsistency Problem and Discretion  
   2.2 Solutions to the Credibility Problem  
      2.2.1 Reputational Equilibria  
      2.2.2 Rogoff Delegation to an Independent Central Bank  

3 Price Regulation and the Under-investment Problem  
   3.1 The Model  
   3.2 Commitment, The Hold-up Problem and Discretion  
   3.3 Solutions to the Hold-up Problem  
      3.3.1 Reputational Equilibria  
      3.3.2 Rogoff-Delegation to an Independent Regulator  

4 Empirical Evidence  

5 Conclusions
1 Introduction

Over the last 10-20 years, there has been an enormous increase in the number of countries (a) delegating monetary policy to independent central banks and (b) establishing separate regulatory agencies for utility service industries - typically with telecommunications as the pathfinder. This joint development has taken place not just in the EU and other European and OECD countries, but also in many middle income countries (particularly in Latin America) and increasingly in other developing countries, including some low income countries in Asia and Africa.

The growth of these institutions has given rise to a sizeable number of academic and informal discussion both of the central bank independence (its key characteristics, governance issues and its impact) and of regulatory agencies (their key features including independence and governance). However, to date, there has been little discussion of the common relationship between the two developments. This is somewhat surprising since the prime motive force behind the two developments is very similar. Indeed, one of the main purposes of this paper is precisely to demonstrate the similarities in the underlying economic problem in each case and to show the common relationship between the adopted responses. In particular we show that in both cases reputational solutions to the time inconsistency problem are available provided that the policymaker is sufficiently far-sighted. But even if regulators are far-sighted, a solution to the regulatory investment problem is undermined if capital depreciates slowly. The hold-up problem in regulation turns out to be more serious than the inflation bias problem in monetary policy in that the reputational equilibrium is far more difficult to sustain.

For independent central banks, there has been a lot of empirical work which suggests that independent central banks - and particularly independent central banks with good governance arrangements (and practices) - are associated with better macro-economic outcomes, for example on inflation and exchange rate volatility. As yet, there is relatively little literature that has formally tested the impact of independent utility regulation and governance arrangements on utility service outcomes. This is, at least in part, because of the difficulties in specifying common desirability in outcomes (for example, on utility

\[1\] See International Telecommunications Union (2002)

\[2\] An informal discussion of the policy issues is to be found in Stern and Trillas (2001).
service price movements) across a large number of countries. Nevertheless, the empirical literature on the effects of various independent central bank governance arrangements on macro-economic outcomes provides a strong starting point for evaluating the impact of telecoms and other utility service regulators.

It is useful to distinguish between three types of problems facing central banks, regulators and other public authorities: (i) the credibility of commitment; (ii) asymmetric information in relation to the private sector; (iii) departures from social welfare maximization arising, for example, from electoral pressures or capture by special interest groups. In this paper we focus almost exclusively on the first of these problems and we assume that the policymaker in question is benevolent and shares information with the private sector (and vice-versa). Although we do not formalize games with asymmetric information and political economy considerations, we conjecture that introducing them would reinforce our argument in favour of a form of delegation that we call ‘as if’ Rogoff delegation.

The plan of the rest of the paper is as follows. Section 2 presents the theoretical rationale behind central bank independence. Section 3 parallels section 2 and presents the theoretical rationale behind the establishment of independent regulatory agencies for utility services. Section 4 discusses the empirical literature on independent central banks and regulatory agencies. Section 5 concludes the paper.

2 Rules and Delegation in the Conduct of Monetary Policy

2.1 Commitment, The Time-Inconsistency Problem and Discretion

Following the seminal article by Barro and Gordon (1983) the credibility problem involving the conduct of monetary policy is usually formalised in the literature in terms of a game between the private sector and the monetary authority. The elements of this game are as follows. The private sector consists of consumers, firms and wage setters. There are large numbers of these agents so the private sector is atomistic and does not act strategically. Their behaviour is completely described by an expectations-augmented Phillips Curve

\[ l_t = \bar{l} + \xi[\pi - E_{t-1}(\pi_t)] - \epsilon_t \]  

(1)

\footnote{In relation to asymmetric information, Geraats (2001) provides a comprehensive review of the theoretical literature on the benefits or otherwise of central bank transparency.}

\footnote{But see al-Nowaihi and Levine (1998), for a recent treatment of political monetary cycles.}
where $l_t$ denotes employment in period $t$ expressed in logarithms, $\bar{l}$ is the equilibrium or ‘natural’ level of employment, $\pi_t$ is the inflation rate, $E_t(\cdot)$ denotes rational expectations at time $t$ and $\epsilon_t$ is a supply shock, independently distributed over time with zero mean.

In this game, the move of the monetary authority is the inflation rate set in each period. The monetary authority prefers full-employment to unemployment and zero inflation to positive or negative inflation. If $n$ is the full-employment level (still in logarithms and assuming a fixed individual supply of labour by households) then the equilibrium unemployment rate (the ‘natural rate’ or ‘NAIRU’) is approximately $n - \bar{l} = u$, say. In employment-inflation space the bliss point of the monetary authority is then $(n, 0)$. These preferences are summarized by the single-period social welfare loss function

$$W_t = b(l_t - n)^2 + \pi^2$$

For the simple, essentially static model of the economy assumed, optimal rules must take the form of a constant deterministic component plus a stochastic shock-contingent component. These rules depend on whether the policymaker can commit, or she exercises discretion and engages in period-by-period optimization. The standard results in these two cases are respectively:

$$\pi_t = \frac{b\xi}{1 + b\xi^2} \epsilon_t = \pi^C(\epsilon_t)$$
$$\pi_t = b\xi u + \frac{b\xi}{1 + b\xi^2} \epsilon_t = \pi^D(\epsilon_t)$$

Thus the optimal inflation rule with commitment, $\pi^C(\epsilon_t)$ consists of zero average inflation plus a shock-contingent component which sees inflation raised (i.e., monetary policy relaxed) in the face of a negative supply shock. The discretionary policy, $\pi^D(\epsilon_t)$, can be implemented as a rule with the same state-continent component as the ex ante optimal rule. The difference is now that it includes a non-zero average inflation or inflationary bias equal to $b\xi u$ which renders the rule time-consistent. The credibility or ‘time-inconsistency’ problem, first raised by Kydland and Prescott (1977), can be stated simply as how to eliminate the inflationary bias whilst retaining the flexibility to deal with exogenous shocks.

---

5 Of course monetary authorities do not in fact ‘set’ inflation; but we can think of them as having intermediate inflation targets which they successfully achieve using the usual array of actual monetary instruments (the money supply, short-term interest rates, reserve ratios etc). What is important is that the actual targets are credible in the sense to be described below.
2.2 Solutions to the Credibility Problem

2.2.1 Reputational Equilibria

Suppose now that there are two types of policymaker, a ‘strong’ type who likes to commit and perceives substantial costs from reneging on any such commitment, and a ‘weak’ type who optimizes in an opportunistic fashion on a period-by-period basis. In a Nash equilibrium of the single-shot game, given the realization of the shock, a strong type pursues the commitment rule (3) with expected inflation at zero and a weak type pursues the discretionary policy (4) with non-zero expected inflation. With uncertainty about the type of policymaker, the game is now one of incomplete information and we examine the possibility that, in repetitions of the one-shot game, the commitment rule (3) can be sustained as a Perfect Bayesian Equilibrium.\(^6\)

In this repeated game, using (1) and (2), at time \(t\) the policymaker minimizes an expected intertemporal loss function given by

\[
\Omega_0 = E_0 \left[ \sum_{t=0}^{\infty} \beta^t W_t = \sum_{t=0}^{\infty} \beta^t \{ b[\xi(\pi_t - \pi^e_t) - \epsilon_t - u] + \pi^2_t \} \right]
\]  

(5)

where \(\beta\) is a discount factor. Let \(\rho_t\) the probability assigned by the private sector to the event that the policymaker is of the strong type. We can regard \(\rho_t\) as a measure of reputation. Suppose that the weak type acts as weak with probability \(q_t\) but mimics a strong type with probability \(1 - q_t\). For a strong type prior to the shock, \(\pi^e_t = 0\) whilst for a weak type \(\pi^e_t = b\xi u\). Hence private sector expectations of inflation, given \(\rho_t\) and \(q_t\) are

\[
\pi^e_t = \rho \times 0 + (1 - \rho_t)q_t(q_t b\xi u + (1 - q_t) \times 0) = (1 - \rho_t)q_t b\xi u \tag{6}
\]

Now consider the following strategy profile.

1. A strong type follows the commitment rule (3).

2. In period \(t\) a weak type acts as strong and follows the commitment rule with probability \(1 - q_t\), if it has acted strong \((q_t = 0)\) in all previous periods. Otherwise it has revealed its type and must pursue (4). \(^6\)

\(^6\)This analysis is essentially a generalization of the deterministic treatment of Barro (1986) to a stochastic environment.
3. At the beginning of period 0 the private sector chooses its prior $\rho_0 > 0$. In period $t$ the private sector receives the `signal’ consisting of inflation set by the policymaker. At the end of the period it updates the probability $\rho_t$, using Bayes rule, and then forms expectations of the next period’s inflation using (6).

In principle there are three types of equilibria to these games. If both strong and weak governments send the same message (i.e. play zero inflation) we have a *pooling equilibrium*. If they send different messages this gives a *separating equilibrium*. If one or more players randomises with a mixed strategy we have a *hybrid equilibrium*. Thus in the above game, $q_t = 0$ gives a pooling equilibrium, $q_t = 1$ a separating equilibrium and $0 < q_t < 1$ a hybrid equilibrium. If $q_t = 0$ *is a Perfect Bayesian Equilibrium to this game, we have solved the credibility problem*. Then the weak government always mimics the strong government and follows the commitment rule (3). Average zero inflation and optimal stabilization can then be sustained even by a weak government.

As with repeated games under complete information it is sufficient to show that given these beliefs by the private sector there is no incentive for a weak government to ever deviate from acting strong. The no deviation condition is derived as follows. Let $\bar{\pi} = b\xi u$ be the inflationary bias. At time $t$ given expectations $\pi_t^e = (\pi^C)^e = 0$, the one-period gain in the interval $[t, t+1]$ from deviating, or *temptation*, is given by:

$$b[\xi(\pi^D(\epsilon_t) - (\pi^C)^e) - \epsilon_t - u]^2 + \pi^D(\epsilon_t)^2] - b[\xi(\pi^C(\epsilon_t) - (\pi^C)^e) - \epsilon_t - u]^2 + \pi^C(\epsilon_t)^2]$$

From time $t+1$ onwards, given the strategy profile the loss from deviating or the *punishment* is given by

$$E_0 \left[ \sum_{\tau=t+1}^{\infty} \beta^{\tau-t} b\{\xi(\pi^D(\epsilon_\tau) - (\pi^D)^e) - \epsilon_\tau - u]^2 + \pi^D(\epsilon_\tau)^2] - b[\xi(\pi^C(\epsilon_\tau) - (\pi^C)^e) - \epsilon_\tau - u]^2 + \pi^C(\epsilon_\tau)^2] \right]$$

The no-deviation condition for a pooling equilibrium is then that punishment must exceed temptation. Substituting for the rules from (3) and (4) after some manipulation we arrive at the condition

$$\epsilon_t < \frac{u(1 + b\xi^2)}{2} \left[ \frac{2\beta - 1}{1 - \beta} + b\xi^2 \right]$$

For bounded shocks within the interval $[-v, v]$ a sufficient condition for a pooling PBE is...
therefore
\[ \frac{v}{u} < \frac{2\beta - 1}{1 - \beta} \]  

(8)

Result (8) can be used to assess the feasibility of a solution to the credibility problem of monetary policy by reputational effects. For small shocks \((v \simeq 0)\), this condition implies that \(\beta > \frac{1}{2}\) is sufficient to sustain a reputational solution. How large do shocks need to be to overturn this result? Consider an annual time interval (i.e., the inflation target is set annually). Suppose that the monetary authority is benevolent and adopts the same rate of discount as the private sector. A plausible value for this rate is \(r = 5\%\) per annum. Then \(\beta = \frac{1}{1+r} = 0.95\) and the condition becomes \(\frac{v}{u} < 180\) i.e., the shock (as a proportion of GDP) must not exceed \(180\times\) the unemployment rate, not a stringent one. One must conclude that for a benevolent monetary authority with a rate of discount the same as that of the private sector, then for any conceivable upper bound on the shock, there exists a unique pooling PBE to this game and the credibility problem has been solved.

By contrast this analysis shows that a non-benevolent monetary authority with \(\beta\) far less than unity because, for instance, of its short-term electoral priorities would find it difficult to credibly follow an optimal commitment rule. This provides one rational for independent central banks: by depoliticizing monetary policy and delegating control to an independent authority which, free of electoral pressures can take a long-term view, it is then possible for the optimal but time-inconsistent rule to be credibly pursued as a reputational equilibrium.\(^7\)

Originally monetary growth rules were seen as the most likely way of handling the macroeconomic time inconsistency problem. However, rules are difficult to apply strictly and their performance has been increasingly disappointing. One possible reason suggested by our analysis is government short-termism and difficulties associated with establishing genuinely independent central banks. Another possible reason is that optimal commitment rules are likely to be complex and difficult to monitor, a feature that is essential for the possibility of a reputational equilibrium. Even in our simple set-up where the only source of uncertainty is the exogenous supply shock \(\epsilon_t\), if the central bank had private

\(^7\)We have examined games with an infinite time horizon. For finite time horizons the PBE is more complicated. Then a weak government always deviates to high inflation in the last period and reveals its type. In the periods just before the last period it will randomise and at the beginning of the game it mimics a tough government and plays zero inflation with probability one (see Barro (1986)).
information regarding the shock then it can disguise a deviation from the rule in the form of an upward adjustment to the inflation rule as a legitimate response to a large negative supply shock consistent with no deviation. This problem becomes more serious if we allow for other forms of uncertainty, the most obvious of which is model uncertainty associated with the slope of the Phillips Curve and consequently the parameter $\xi_t$, which now becomes a stochastic time series. The ex ante optimal commitment rule (3) is a feedback on current observations or estimates of the supply shock $\epsilon_t$. In general optimal rules under uncertainty do not have this convenient ‘certainty equivalence’ property and depend on higher moments of the distribution describing the stochastic parameters. To design a commitment rule with stochastic $\xi_t$ and $\epsilon_t$, the policymaker needs to know the joint distribution of $\xi_t$ and $\epsilon_t$. In a more realistic model of the transmission mechanism between inflation and output, more potential model uncertainty emerges. In practice then optimal commitment rules are exceedingly difficult to design and even more so to monitor. Inevitably it is impossible to incorporate every aspect of model uncertainty so any rule must be sub-optimal. This feature of optimal rules has been understood by macro-economists for some time and attention has focused on ‘simple’ sub-optimal but easily monitored feedback rules, such as the Taylor Rule, which feed back on a limited number of easily observed macro-economic variables, typically output and inflation.\(^8\)

### 2.2.2 Rogoff Delegation to an Independent Central Bank

The alternative and, increasingly, the preferred solution to the macroeconomic time inconsistency problem has been for governments to delegate the operation of monetary policy to a goal-independent central bank (CB) with powers of discretion. In the context of our model goal-independence means that the CB sets and perfectly achieves its own inflation rate in accordance with its own welfare loss function. The theoretical case for such a policy has been set out by Rogoff (1985) among others. Rogoff proposed a second-best solution to the credibility problem involving a trade-off between low average inflation and effective monetary stabilization policy. The solution is to delegate monetary policy to an independent central bank with an appointed board chosen to be ‘conservative’, in the sense that they assign a higher priority to low inflation than that of the representative government.

An optimal choice of conservatism will then see bankers appointed who deliver low average inflation, but who are not so over-conservative as to prevent monetary stabilization.

The details of the delegation equilibrium are as follows: suppose that both the government and the appointed bankers have preferences represented by the welfare loss function of the form (2), but with a different weight on employment. For the government a weight $b = b_m$ is adopted representing the preferences of the median voter. The point of delegation is that the bankers have different preferences, $b \neq b_m$. One would expect bankers to be naturally conservative in which case their weight on employment $b$ is less than $b_m$. Some bankers are more conservative than others and, in principle, by asking potential appointees how much higher inflation is worth sacrificing for a 1% reduction in unemployment, the government can employ a CB executive with a particular degree of conservatism. In what follows we assume the government does this in such a way as to minimise its own welfare loss function. The CB subsequently pursues a discretionary policy corresponding to its own preferences. In choosing the degree of independence of the CB or the type of banker the government then minimizes $E_0[W_t]$ with respect to $b$ where

$$W_t = b_m(l_t - n)^2 + \pi_t^2 = b_m[\xi(\pi_t^D(\epsilon_t) - \pi_t^e) - \epsilon_t - u]^2 + \pi_t^2$$

and $\pi_t^D(\epsilon_t)$ is given by (4). Then $E_0[W_t] = (b_m + b^2 \xi^2) \left[ u^2 + \frac{\sigma^2}{(1 + b\xi^2)^2} \right]$. The first order condition is

$$bu^2 + \sigma^2 \frac{(b - b_m)}{(1 + b\xi^2)^3} = 0$$

Since the first term on the left-hand-side of (10) is positive, the second term must be negative; i.e., $b < b_m$ so that the optimally chosen banker is conservative. It is also apparent that $b > 0$, so that the optimal conservative banker does not completely eliminate the inflationary bias but, instead, achieves a compromise of a lower inflation rate than the representative banker and the retention of some degree of stabilization policy.

The great advantage of delegation is that, in contrast with commitment rules of either the optimal or sub-optimal variety, the CB retains discretionary powers and can base monetary policy on the latest forecasts and information available. To explore this further,

---

9The first-order condition (10) is a quartic in $b$ so there may be more than one choice of conservatism satisfying this equation. In fact it is straightforward to show that there is only one positive solution to (10).
suppose now we allow $\xi$ and $u$ to vary over time. Given expectations of inflation on the part of the private sector the CB can in each period adopt an inflation rate

$$\pi_t = \frac{b\xi_t}{1 + b\xi_t^2}(u_t + \xi_tE_{t-1}[\pi_t] + \epsilon_t)$$

(11)

based on their best current estimates of $\xi_t$, $u_t$ and $\epsilon_t$. Optimal delegation described above in the first-stage of the delegation game still requires knowledge of the joint distribution of all parameters describing the model. It must also take into account rational expectations formed using (11) which now incorporates uncertainty in parameters $\xi_t$ and $u_t$. Delegation will inevitably be sub-optimal (i.e., worse in welfare terms than the ex ante optimal commitment rule) even if the right CB types can be found.

One practical problem with this approach is that the government has to find a central banker with the right weight $b$. However, for a typical OECD country one can think of the monetary framework in two ways: as literal or ‘as if’ Rogoff Delegation. In the case of literal delegation a goal-independent CB evolves towards optimally chosen conservative bankers. This may possibly involve reputation-building where reputation for independence is established over time. In the case of ‘as if’ Rogoff an independent CB that has a duty to act in a conservative way (e.g. via obligations set out in the relevant law). One may think of the CB as ‘goal-dependent’, in the sense that its objectives (in the form of utility defined over outcomes) are given to it by policymakers. However, the CB has the legal right to set the instruments under its control in a discretionary manner, using all available current information. The US Federal reserve with its emphasis on the personality of its head corresponds more to literal Rogoff-delegation and the European Central Bank (ECB) is a good example of ‘as if’ delegation. The Bank of England (BoE) is goal-dependent, in the more sense that it has imposed inflation targets which can be revised by government. Then the UK monetary policy could be seen as a form of ‘as if’ Rogoff delegation.

In a uncertain world where the economic environment is constantly changing one might expect either of these forms of policy regime to outperform any fixed rule that forbids discretion. In addition ‘as if’ Rogoff delegation might be expected to be superior to pure Rogoff delegation since the policy depends less on whether the predicted performance of monetary policy decision-makers is optimally conservative. With ‘as if’ Rogoff delegation where the desired trade-off between low inflation and flexibility is given to the office-holder
as a duty that they must fulfil, the choice of monetary policy decision-maker can be made purely on the basis of technical and other ability and not on ability plus a prediction of whether the chosen person is (and will remain) optimally conservative.

To summarise then the choice of approach to the credibility problem is then between the second-best alternatives of commitment to a sub-optimal commitment rule either fixed and based only on information on the economy available at the time the rule is announced, or state-contingent but in a very limited and transparent way, or delegation to an independent CB who follows a sub-optimal discretionary policy based on all the latest information on the economy.

3 Price Regulation and the Under-investment Problem

For utility services like telecoms there is a classic time inconsistency problem analogous to the inflationary bias problem in monetary policy: these services require large volumes of investment which, once installed become ‘sunk assets’ in the sense that most or all of them cannot be removed and used elsewhere or sold on second-hand markets at their original cost. In consequence, private investors are at risk of opportunistic behaviour by Governments, particularly over prices, once the investments have been installed; and awareness by private investors of this regulatory risk drives up the required rate of return and the cost of capital. The latter dramatically reduces investment as has been seen in many countries (see Levy and Spiller, 1996).

In order to examine this under-investment or ‘hold-up’ problem, we set out below a simple model of the regulatory pricing problem for private sector utility services such as telecoms.\footnote{The basic model is close to that in Salant and Woroch (1992), but our treatment of the regulation game parallels the monetary game above, rather than the trigger-strategy game of those authors. We discuss these differences further at the end of section 3.3.1.} We will show that there exists a close parallel between the inflation bias in the conduct of monetary policy and a high price bias arising from the under-investment problem in utility regulation. We then proceed to examine and contrast the counterparts, in regulation, to the reputational and delegation solutions to the credibility problem proposed for monetary policy.
3.1 The Model

Our main point can be made by confining ourselves to a deterministic model with perfect foresight.\footnote{However, later we do discuss the effect of a stochastic element in the model on the reputational equilibrium.} Then our comparison is with the monetary model with small shocks where a discount factor $\beta > 0.5$ is sufficient to sustain a reputational equilibrium. Consider at time $t$ a firm making investments $\{i_\tau, \tau = t, t + 1, t + 2, \cdots\}$ over an infinite time horizon. Its capital stock $K_\tau$ evolves according to

$$K_{\tau+1} = (1 - \delta)K_\tau + i_\tau; \tau = t, t + 1, t + 2, \cdots$$  \hspace{1cm} (12)

where $\delta$ is the depreciation rate. In period $\tau$, the firm produces a quantity $q_\tau$ of a homogeneous good at total cost

$$C_\tau = k - f(K_\tau) + cq_\tau$$  \hspace{1cm} (13)

where $c$ is the marginal cost, $k - f(K_\tau)$ is the fixed cost where $f(0) = 0$. Thus the purpose of the capital in this set-up is to lower fixed costs. We make standard assumptions: $f' > 0, f'' < 0$ and $f'(0) = \infty$. The good is sold at a regulated price $p_\tau$ and $q_\tau = D(p_\tau)$ is the demand curve. Choosing the price of one unit of capital as the numeraire, the firm’s profit in period $\tau$ is given by

$$U_\tau = (p_\tau - c)q_\tau - k + f(K_\tau) - i_\tau = U(p_\tau, K_\tau, i_\tau)$$  \hspace{1cm} (14)

Now suppose that the firm plan investment at $t = 0$ at which time $K_0 = 0$. Then given expectations of regulated prices $E_0\{p_\tau\}, \tau \geq 1$ and given the current regulated price $p_0$, the firm chooses investments to maximize

$$E_0 \left[ \sum_{\tau=0}^{\infty} \beta_\tau U(p_\tau, K_\tau, i_\tau) \right]$$  \hspace{1cm} (15)

where $\beta_f \in (0, 1)$ is the discount factor of the firm, subject to (12) and a participation constraint

$$E_0 \left[ \sum_{\tau=0}^{\infty} \beta_\tau U(p_\tau, K_\tau, i_\tau) \right] \geq i_0$$  \hspace{1cm} (16)

The solution to this optimization problem is standard: in the absence of any adjustment costs, the firm invests immediately to achieve its optimal level of stock $i_0 = K = K^*$ given
by equating the marginal product of capital with the cost of capital; i.e.,

\[ f'(K^*) = r_f + \delta \quad (17) \]

where the firm’s discount rate \( r_f \) is defined by \( \beta_f = \frac{1}{1 + r_f} \). Thereafter for \( \tau \geq 1 \), constant investment \( i = i_1 = i_2 = \ldots = \delta K^* \) is made to compensate for depreciation. In what follows we impose on \( f(\cdot) \) the property \( k > f(K^*) > (r + \delta)K^* = f'(K^*)K^* \) so fixed costs are always positive and the marginal product of capital \( f'(K^*) \) is less than the average product \( \frac{f(K^*)}{K^*} \) at \( K = K^* \).

The set-up is completed by specifying the price-setting authority’s intertemporal social welfare function at time \( t \) as

\[ \Omega_t = \sum_{\tau=t}^{\infty} \beta^{\tau-t} [S(p_\tau) + \alpha_m U_\tau] \quad (18) \]

where \( S(p_\tau) \) is the net consumer surplus given by

\[ S(p_\tau) = \int_{p_\tau}^{\infty} D(p') dp' \quad (19) \]

and \( \alpha_m \) is the weight on rent that reflects the preferences of the median voter. For a utilitarian policymaker, \( \alpha_m = 1 \) and we, in general, assume that \( 0 \leq \alpha_m \leq 1 \).

### 3.2 Commitment, The Hold-up Problem and Discretion

We can now formulate the commitment price rule that will induce the firm to invest \( K = K^* \). First we assume that in period \( t = 0 \) the regulated price is such that \( (p_0 - c)D(p_0) = k \).\(^ {13} \) Then with optimal investment by the firm, its participation constraint becomes

\[ E_0 \left[ \sum_{\tau=1}^{\infty} \beta_{\tau} U(p_\tau, K^*, \delta K^*) \right] \geq K^* \quad (20) \]

With the weight on rent \( 0 \leq \alpha_m \leq 1 \), single period welfare \( S(p_\tau) + \alpha_m U_\tau \) increases as the price falls towards the marginal cost and therefore the firm’s participation constraint must bind. From (20) using \( \sum_{\tau=1}^{\infty} \beta_{\tau} = \frac{\beta_f}{1 - \beta_f} = \frac{1}{r_f} \), a steady state commitment price, \( p^C \) say, must satisfy

\[ (p^C - c)D(p^C) = k - f(K^*) + (r_f + \delta)K^* \quad (21) \]

\(^ {12} \)The weight \( \alpha_m \) denotes the preferences of the median voter. Although consumers own shares in the regulated firm, if the distribution of shares is concentrated among high income consumers then \( \alpha_m < 1 \).

\(^ {13} \)As we shall see, this turns out to be the price with regulatory discretion.
Thus the commitment price allows just sufficient revenue to the firm to cover variable plus fixed costs, plus the cost of capital at a rate $r_f + \delta$.

Whilst (20) is the ex ante participation constraint at time $t = 0$, once investment has been sunk at time $t \geq 1$ the ex post participation constraint becomes

$$E_t \left[ \sum_{\tau=t}^{\infty} \beta_f^{-t} U(p, K^*, \delta K^*) \right] = \frac{1}{\beta_f} E_t \left[ \sum_{\tau=t}^{\infty} \beta_f^{\tau-t+1} U(p, K^*, \delta K^*) \right] \geq sK^*$$

where $s < 1$ is the scrap value of one unit of capital. It follows that since $\beta_f s < s < 1$, the ex post participation constraint is relaxed compared with the ex ante constraint. This is the source of the hold-up problem.

Recognizing this incentive to renege on the commitment price at time $t = 1$, at time $t = 0$ the firm will anticipate that the ex ante participation constraint (20) will not be satisfied and will make an optimal decision not to invest. Hence without some mechanism to enforce commitment, the equilibrium with regulatory discretion will be a no-investment outcome with $K_t = i_t = 0$ and a discretion price $p = p^D$ given by

$$(p^D - c)D(p^D) = k - f(K^*) + (\beta_f sr_f + \delta)K^*$$

The fact that $p^R < p^C$ can be shown formally as follows. Let $\eta(p) = \frac{p D'(p)}{D(p)}$ be the price elasticity. Then differentiating the left-hand-side of (23) and (21) we have that

$$\frac{d}{dp} [(p - c)D(p)] = D(p) \left[ 1 - \left( \frac{p-c}{p} \right) \eta(p) \right] > 0$$

since $L = \frac{p-c}{c}$, the Lerner index, must be below its monopoly level $\frac{1}{\eta}$. It follows that the left-hand-side of (23) and (21) are increasing in price. It must follow from $\beta_f s < 1$ that $p^R < p^C$.

Recognizing this incentive to renege on the commitment price at time $t \geq 1$, at time $t = 0$ the firm will anticipate that the ex ante participation constraint (20) will not be satisfied and will make an optimal decision not to invest. Hence without some mechanism to enforce commitment, the equilibrium with regulatory discretion will be a no-investment outcome with $K_t = i_t = 0$ and a discretion price $p = p^D$ given by

$$(p^D - c)D(p^D) = k$$

Then using the property $f(K^*) > (r + \delta)K^*$, it follows that $p^D > p^C$. Thus paradoxically the consumer loses out as a result of the opportunistic behaviour of the regulator who is not able to commit. Because of the opportunity to renege and lower the price to $p^R < p^C$, the equilibrium that results sees no investment and a regulated price under discretion $p^D > p^C$. This is analogous to the monetary policy case where because of the incentive to
renege on zero inflation and raise output by engaging in surprise inflation, the public ends up in a discretionary equilibrium with high inflation and output still at its equilibrium level. However as we shall see, the hold-up problem turns out to be more serious than the inflation bias problem in monetary policy in that the reputational equilibrium is far more difficult to sustain.

3.3 Solutions to the Hold-up Problem

3.3.1 Reputational Equilibria

The game theoretic aspects of this game are very similar to the monetary policy game. Again we first consider the possibility of sustaining optimal investment as a reputational equilibrium in which a weak price-setting authority (government or regulator) mimics a strong type who likes to commit. We consider the strategy profile:

1. A strong authority follows the commitment price rule (21).

2. In period t a weak authority acts as a strong one and follows the commitment rule with probability \(1 - q_t\), if it has acted strong \((q_t = 0)\) in all previous periods. Otherwise it has revealed its type and must follow a discretionary policy starting from optimal investment. This is derived below.

3. At the beginning of period let \(\rho_t\) be the probability the firm assigns to the authority being strong. At time \(t = 0\), the firm has a prior \(\rho_0 > 0\). In period \(t\) the firm receives the ‘signal’ consisting of the regulated price set by the authority and uses Bayes rule to form expectations of the next period’s regulated price.

In an infinite-time horizon game \(q_t = 0\) is a Perfect Bayesian pooling equilibrium provided the welfare, following deviation, is less than that if the commitment rule is pursued. In order to examine this condition we first need to derive the discretionary policy after deviating from the commitment path. To solve this infinite time-horizon problem we first consider a finite time horizon with terminal date \(T\) and then let \(T \to \infty\). Suppose that the agency deviates from the commitment path at time \(t\) where \(K_t = K^*\), the optimal stock of capital. Investment ceases on deviation and capital stock declines according to

\[
K_{t+1} = (1 - \delta)K_t; \quad \tau \geq t, \quad K_t = K^* \tag{26}
\]
Then at time $T > t$, the ex post participation constraint (22) must bind and implies a discretionary regulated price given by

$$U(p_T, K_T, 0) = (p_T - c)D(p_T) - k + f(K_T) = sK_T$$

(27)

where, from (26), $K_T = (1 - \delta)^{T-t}K^*$. Proceeding by backward induction at time $T-1$

$$U(p_{T-1}, K_{T-1}, 0) = (p_{T-1} - c)D(p_{T-1}) - k + f(K_{T-1}) = sK_{T-1} - s\beta K_T = s[1 - \beta f(1 - \delta)]K_{T-1}$$

(28)

and at time $\tau \in [t, T]$

$$U(p_{\tau}, K_{\tau}, 0) = (p_{\tau} - c)D(p_{\tau}) - k + f(K_{\tau}) = s[1 - \beta(1 - \delta)]K_{\tau} = s[1 - \beta f(1 - \delta)](1 - \delta)^{\tau-t}K^*$$

(29)

Note that

$$\sum_{\tau=t}^{\infty} \beta^{\tau-t}U(p_{\tau}, K_{\tau}, 0) = \sum_{\tau=t}^{\infty} [1 - \beta f(1 - \delta)][\beta f(1 - \delta)]^{\tau-t}sK_t = sK_t = sK^*$$

(30)

so this profile satisfies the ex post participation constraint (22).

Let the solution to (29), $p_D^\tau(K^*)$, be the discretionary deviation price at time $\tau \geq t$ following a deviation at time $t$ from a commitment path with capital stock at $K^*$. Then what we previously denoted by $p_D$, the discretionary price in the absence of investment, becomes $p_D^\tau(0)$. The profile of this path for the regulated price is as follows: at $\tau = t$, the time of deviation, $p_D^\tau(K^*) < p^C$ and there are welfare gains to consumers. From $\tau > t$, capital stock declines and the regulated price rises. Eventually, at time $\tau = t + n$ periods say, the regulated price following deviation rises above the original commitment price and the consumer begins to lose out.

For the infinite time-horizon game we are considering, let $T \rightarrow \infty$. Then the no-deviation condition becomes

$$\sum_{\tau=t}^{\infty} \beta^{\tau-t}[S(p^C) + \alpha_nU(p^C, K^*, \delta K^*)] > \sum_{\tau=t}^{\infty} \beta^{\tau-t}[S(p_D^\tau) + \alpha U(p_D^\tau, (1 - \delta)^{\tau-t}K^*, 0)]$$

(31)

We can express this in terms of ‘temptation’ and ‘punishment’ as we did before in the monetary policy game. Temptation lasts for $n$ periods during which $p_D^\tau(K^*) < p^C$. Thereafter as capital stock depreciates further and $p_D^\tau(K^*) > p^C$, punishment sets in and (31)

\footnote{Using $\sum_{\tau=t}^{\infty} x^{\tau-t} = \frac{1}{1-x}$ for $|x| < 1$.}
can be written as

\[
\sum_{\tau=t}^{t+n} \beta^{\tau-t} [S(p^D_\tau) - S(p^C) + \alpha_m [U(p^D_\tau, (1 - \delta)^{\tau-t} K^*, 0) - U(p^C, K^*, \delta K^*)]]
\]

\[
< \sum_{\tau=t+n+1}^{\infty} \beta^{\tau-t} [S(p^C_\tau) - S(p^D) + \alpha_m [U(p^C, K^*, \delta K^*) - U(p^D_\tau, (1 - \delta)^{\tau-t} K^*, 0)]
\]

(32)

The left-hand-side of (32) is the temptation over \( n \) periods during which \( p^D_\tau(K_\tau) < p^C \).

The right-hand-side is the punishment over the remaining periods for which \( p^D_\tau(K_\tau) > p^C \).

An important difference between the reputational equilibria in monetary and regulation policy is now apparent. Unless capital stock depreciates completely within a period, temptation in the regulation game lasts for more than one period and, indeed, if depreciation is at a low rate it can last for very many periods. By contrast in monetary policy game we saw that temptation only lasts for a single period. It follows that for the regulation game

\textit{unless depreciation is rapid a pooling Perfect Bayesian Equilibrium may not exist, even for }\beta\textit{ close to unity, ruling out a reputational solution to the hold-up problem in regulation.}

Figures 1 to 6 illustrate this result. Figure 1 shows the profile of the discretionary deviation price, \( p^D_\tau \) following deviation at time \( t = 0 \).\textsuperscript{15} Immediately following deviation the regulated price following deviation drops from its commitment level of around \( p^C = 1.106 \) to \( p^D(0) = 1.054 \). Then investment ceases, but as the capital stock only depreciates gradually (at 5% per year in figures 1 to 3) the price remains below the commitment level for around 23 years in this simulation. This is the temptation period. Thereafter in the punishment period the deviation discretionary price rises above the original commitment price and approaches a long-run level of around \( p^D(\infty) = 1.162 \). The deviation condition that punishment exceeds temptation only holds for \( \beta > 0.87 \) if the regulator is utilitarian (with \( \alpha_m = 1 \)) and for \( \beta > 0.97 \) if the regulator only cares about consumer surplus (\( \alpha_m = 0 \)). Figure 3 shows the single-period rent of the firm falling from \( U^C \) under commitment to \( U^D \) under discretion following a deviation.

Figures 4 to 6 repeat this exercise for a higher depreciation rate, \( \delta = 0.2 \). Then the temptation period decreases to around 6 years and the deviation condition holds for \( \beta > 0.87 \) if the regulator is utilitarian and for \( \beta > 0.84 \) if the regulator only cares about

\textsuperscript{15}The following functional forms are adopted: \( D(p) = Ap^{-\gamma} \), \( f(K) = K^\gamma \) and parameter values are \( \gamma = 0.55, \eta = 2, A = 20, c = 1, k = 3, r = 0.05 \) and \( s = 0.5 \). In figures 1 to 3, \( \delta = 0.05 \); in figures 4 to 6, \( \delta = 0.2 \).
consumer surplus. An interesting feature of this simulation is that whereas before, with δ = 0.05, a utilitarian regulator (α_m = 1) had a lower incentive to renege than one only concerned with consumers (α_m = 0), with δ = 0.2, this is now reversed for all values of β below around 0.92. The reason for this can be seen by comparing the discretionary rents in the two cases, figures 3 and 6. For the high depreciation case, the discretionary policy involves a higher long-run price to compensate for the higher replacement investment and discretionary policy sees the immediate reneging price at a level where discretionary rent is actually higher than commitment rent. This enters into the utility of the utilitarian but not the pro-consumer regulator and thereby increases the temptation in this case for all but high values of the discount rate β.

These results contrast with the sufficient (and not even necessary) condition, β > 0.5 for a monetary authority to be able to sustain the optimal policy as a reputational equilibrium when shocks are very small. Thus we have illustrated the result that a reputational solution to the hold-up problem is much more difficult that for monetary policy.

There are very few previous studies that analyze to what extent is regulation sustainable in the presence of sunk investments, without additional institutional restraints. Newbery (1999, chapter 2), and Salant and Woroch (1992) present two other infinite horizon games of regulation that examine this issue, and hence are related to our paper. These two infinite horizon models allow the regulator (who basically represents the consumers) and a regulated firm to alleviate the under-investment problem by sustaining a cooperative equilibrium in which the firm invests and the regulator sets a price that allows for the recovery of sunk investment costs. The structure of these games is based on the same kind of Folk Theorems that are used to explain collusion between oligopolists. This same structure, in which there is complete information, was used by Barro and Gordon (1983) to find conditions under which the inflation bias could be alleviated in an infinite horizon monetary policy game.

16 A stochastic element can be easily introduced into the regulation game as for the monetary game and this will further undermine the prospect of a reputational equilibrium. For example suppose that the scrap value of a unit of capital s is replaced with \( s_t = s - \zeta_t \) at time t. Then as for the supply shock in the monetary game, a high realization of \( \zeta_t \) will relax the ex post participation constraint of the firm further and increase the temptation of the regulator to renege on the commitment price.
Figure 1: Commitment Price ($p^C$) and Discretionary Deviation Price Following Deviation at Time 0. ($p^D$): $\delta = 0.05$

Figure 2: The No-Deviation Condition (Punishment $>$ Temptation) as the Regulator’s Discount Factor, $\beta$, Increases: $\delta = 0.05$
Figure 3: Commitment Rent ($U^C$) and Discretionary Deviation Rent Following deviation at Time 0. ($U^D$): $\delta = 0.05$

Figure 4: Commitment Price ($p^C$) and Discretionary Deviation Price Following deviation at Time 0. ($p^D$): $\delta = 0.2$
Figure 5: The No-Deviation Condition (Punishment > Temptation) as the Regulator's Discount Factor, $\beta$, Increases: $\delta = 0.2$

Figure 6: Commitment Rent ($U^C$) and Discretionary Deviation Rent Following Deviation at Time 0. ($U^D$): $\delta = 0.2$
One of the problems of these infinite horizon games with complete information based in the Folk Theorem is that the cooperative equilibrium is just one of many possible equilibria. In fact, the no-investment/no-recovery outcome remains a possible solution, and forms the conflict point of the game. If coordination is possible, parties would coordinate on the efficient outcome. But then the equilibrium is not ‘renegotiation-proof’ and this questions the credibility of trigger-strategy equilibria, even though they are subgame perfect. Barro (1986) presents a reputational model of monetary policy, where the private sector is uncertain about the monetary authority type, that avoids this problem. In this context, reputation for commitment can be sustained under certain conditions, which may alleviate the inflation bias. The relationship of our model to Newbery and Salant/Woroch is the same as between Barro (1986) and Barro and Gordon (1983). We introduce incomplete information about the type of regulator, which allows for a reputational equilibrium to be sustained under some conditions. Apart from the theoretical problems of trigger-strategy equilibria alluded to, given that there are few doubts that sustaining the reputation of the regulators is an important ingredient in the modern institutions that govern the economy, we believe that truly reputational games are a preferable way of modelling price regulation.

Our basic model differs from Newbery in two important respects: first we allow for variable demand, whereas in his model demand is inelastic (it varies with two possible states of nature, but it does not vary with price). This implies a crucial difference between his results and ours when the profits of the firm have the same weight in the regulator’s objective function than the consumers’ surplus. When demand is inelastic, allocative efficiency plays no role, so that with a weight of one for profits in the objective function, productive efficiency may be achieved by covering the sunk investments costs. However if, as in our model, demand is elastic, when the weight of profits and consumers’ surplus is the same, allocative efficiency calls for price equal to marginal cost, which does not cover the fixed costs, and hence the firm loses the incentive to invest. A second difference between

---

17 See al-Nowaihi and Levine (1994) who, in the context of the monetary policy game, argue for a refinement they term ‘chisel-proofness’ to resolve this difficulty. It should be noted that the renegotiation-proof equilibria used in repeated games differ from the concept used in the contract literature. They do not necessarily involve contracts or even negotiation, but should be interpreted as allowing players to recoordinate their expectations of strategies. For this reason the term ‘recoordination-proof’ equilibria is often used instead.
our model and Newbery (1999, chapter 2) is that we fully incorporate depreciation as an explicit variable of our set-up. Although Newberry acknowledges the role played by depreciation, he just mentions that depreciation costs can be interpreted as part of the cost of capital. He rightly argues that the size of the capital costs depends on the capital intensity of production and also on the length of the period over which capital depreciates and needs to be replaced or augmented: “If this period is long, then the regulator gains a considerable advantage for consumers before having to incur the replacement costs, but if short, then the benefits of reneging are transient, but the costs go on forever.” He thus reaches the conclusion that high rates of depreciation or obsolescence help sustain the regulatory compact, and this is one of the reasons why “privatizing telecoms is therefore likely to be easier than privatizing electricity.” We develop this insight further in our model, by making depreciation an explicit and fundamental ingredient of our set-up, and a key issue in the comparison between monetary policy and utilities regulation.

The explicit treatment given to depreciation is a common feature of our model and Salant and Woroch (1992), although ours is a reputational model where the firm is uncertain about the regulatory type, and we emphasize the comparison with monetary policy. They do not make the point that problems with sustaining the cooperative equilibrium can be solved by delegation. Finally, investment enters the profits of the regulated firm in a generic way in their setting, whereas in our model we make explicit the role of investment as reducing fixed costs.

3.3.2 Rogoff-Delegation to an Independent Regulator

In the model as it stands there is under-investment unless the government is able to commit to a price rule before investment is made that guarantees a sufficient return to the firm. The practical implementation problems with this rule are similar to those of the monetary rule: more complex and realistic models of the firm with time-varying stochastic fixed costs $k_t$ and marginal costs $c_t$ will lead to non-certainty equivalence and rules which depend on second moments and the joint distribution of $c_t$ and $k_t$. Revisions of the rule will be indistinguishable from reneging unless the basis for these revisions are completely transparent. For instance the firm may have private information regarding costs. Then any commitment mechanism in place will lack credibility and the firm may still under-invest.
If the main purpose of independent central banks is to eliminate the temptation to engage in surprise inflation, the main purpose of independent regulatory agencies is to solve the hold-up problem and eliminate the temptation to engage in a surprise cut in the regulated price, thereby supporting investment. As set out above, the underlying rationale for an independent utilities regulator and an independent central bank is extremely similar. This suggests that there may well be similarities between the proposed ways of creating an institution which can establish and maintain a credible reputation for making and keeping commitments in a way that governments find extremely difficult to do. Surprisingly, however, there has been relatively little written on the Rogoff-delegation approach in regulation.\footnote{Rogooff-delegation has been proposed in the environmental regulation context by Spulber and Besanko (1992). Where firms have private information, Levine and Rickman (2001) examine the role of delegation as a means of ameliorating both the ‘ratchet-effect’ associated with incentive contracts and the hold-up problem.}

We now turn to the formalisation of the delegation game in regulation. The timing of events is as follows:

1. At time $t = 0$, the government delegates price regulation to an independent regulator with preferences

$$\Omega_t = \sum_{\tau=t}^{\infty} \beta^{\tau-t} [S(p_\tau) + \alpha U_\tau]$$

where $\alpha > \alpha_m$ measures the extent to which the regulator is pro-industry.

2. At time $t=0$, the firm chooses its investment plan $i_\tau; \tau \geq 0$.

3. In every period $t > 0$, the regulator chooses the regulated price to maximize $\Omega_t$ subject to the ex post participation constraint

Again we first consider a finite time horizon with terminal date $T$. Solving by backward induction for a perfect equilibrium, at stage time $T$ the independent regulator solves the problem:

Given $K_T$ and $i_T$ maximize w.r.t $p_T$ 

$$[S(p_T) + \alpha U_T(p_T, K_T, i_T)]$$

subject to $U_T(p_T, K_T, i_T) = (p_T - c)D(p_T) - k + f(K_T) - i_T \geq sK_T$.
Figure 7: The Lerner Price, $p^L$, as $\alpha$ increases compared with the Commitment Price $p^C$.

The solution to this problem is standard and takes the form of the Lerner price given by

$$p^L = \frac{c\alpha\eta}{\alpha(\eta - 1) + 1} = p^L(\alpha)$$

(35)

if the second-period participation constraint does not bind. This happens when $\alpha$ is sufficiently large. Then as $\alpha$ rises it reaches a point where

$$p^L(\alpha) = p^C$$

(36)

and the regulator is sufficiently pro-firm that even with discretion it chooses a price at the commitment level that offers the firm a return on its initial capital investment. Solving for stage 2 the firm then invests at the optimal level $i_0 = K^*; i_\tau = \delta K^*; \tau \geq 1$ and the hold-up problem has been solved. Figure 7 illustrates this result.

As with monetary policy, the great advantage of Rogoff-delegation is that it allows full discretion for the regulator to engage in period-by-period optimization (where a period can be considered as the interval between price reviews) based on all information available at the time the price decision is made. In the context of our model a sufficiently pro-firm regulator can implement the Lerner price $p^L_2$ based on the latest estimates of $c$ and $\eta$. Note that this does not imply a form of cost-plus regulation even though prices can be
updated for each price review using all the latest information about market conditions, technology etc. Once the regulated price is announced, firms that manage to reduce costs below those average industry costs anticipated by the regulator will generate a surplus and therefore have every incentive to improve efficiency.

To summarize, as for the case of monetary policy, the choice of approach to the credibility problem in utility regulation is between *commitment to a price rule* (21) or *Rogoff-delegation to a literally conservative regulator* or, in our preferred interpretation, ‘as if’ *Rogoff delegation* to an independent regulator who has a duty to behave in a conservative way and follows a sub-optimal discretionary policy based on the latest information on the industry.\textsuperscript{19} The commitment rule (21) can be made contingent on current estimates of parameters, but the same objections raised for monetary policy apply, namely that revisions may be difficult for the private sector to distinguish from opportunistic behaviour. Simple, but sub-optimal approximations to the optimal rule may overcome this problem. However the previous sub-section has shown that any regulatory commitment price rule, simple or optimal, is inherently difficult to sustain as a reputational equilibrium.

The view that regulatory agencies should operate by simple rules and have no (or minimal) discretion is particularly associated with Spiller (see for example Guasch and Spiller, 1999) and it is developed in a framework where the emphasis is on the need for regulatory stability to achieve successful privatisation. In the context of Latin America and in many developing countries, Spiller argues that the essential is to create effective governance arrangements. These must be tailored to the institutional capacity of the country and it is more important than the content of regulation. Hence, it is argued that countries with limited institutional capacity should carry out regulation by simple, minimum discretion or, if possible, by reliance by the regulatory agency on contract enforcement. The problem is that the proposed solution is very inflexible and seems to create significant problems beyond the short run as post-privatisation conflicts in Chile and other Latin American countries have shown.\textsuperscript{20}

\begin{itemize}
  \item \textsuperscript{19}In the electricity industry, recent appraisals of actual regulatory reforms point out that regulatory governance arrangements based on rigid rules were not robust to unforeseen contingencies. (See Joskow (2001) for the case of California).
  \item \textsuperscript{20}See Fischer and Galetovic (2000) on problems derived from rigidity in Chilean electricity and Abdala (1999) on post-privatisation conflicts in Argentinian telecommunications.
\end{itemize}
In public utilities regulation in OECD countries, it is common that the government establishes the policy to be followed (for example, a policy to expand broadband, or a policy to promote certain fuels in energy) and the regulator acts in a discretionary fashion to set a previously defined set of instruments using all available current information. Indeed critics of UK regulatory processes regularly maintain that regulators have too much discretion. Primary legislation usually prescribes that the regulator has to guarantee the financial viability of regulated firms. In this sense, regulators such as the British are goal-dependent, required to behave in a conservative way and therefore constitute an example of our ‘as if’ Rogoff-delegation.

4 Empirical Evidence

There is a very large literature on the economic impact of central bank independence. The general consensus is that countries which assign monetary policy to an independent central bank have lower and less variable rates of inflation. There is less evidence that countries with independent central banks have higher employment levels or that they have less variance - i.e., that they avoid ‘boom and bust’. If countries with independent central banks have less variable inflation, their real interest rates should be lower and this should encourage investment and increase the rate of growth for a long period if not in perpetuity. But again, there is less conclusive evidence on this.

In addition, Fracasso, Genberg and Wyplosz (2003) have demonstrated for inflation-targeting central banks how superior informational transparency in inflation reports is associated with smaller interest rate surprises. Better information - particularly more clearly written inflation reports - are associated with better outcomes and appears to provide a stronger basis for independent CBs to pursue a bounded and accountable discretionary monetary policy while retaining their credibility. Other studies discussed in Geraats (2002) support the positive impact of informational transparency on financial markets (e.g., the response of market interest rates to changes in the official rate) and, to a lesser extent, on macro-economic outcomes.

For utility regulators, the corresponding literature is small but there are now some studies that are beginning to demonstrate positive results of having a regulatory agency,

---

21Excellent surveys are to be found in Eißinger and De Haan (1996) and Berger et al (2000).
particularly for telecommunications. In general, the focus has been on the role of regulators in stimulating private investment (typically proxied by the number of mainlines or mainlines per 100 inhabitants). The data for telecoms is better and there is more experience with telecom regulation than for other utilities. In addition, the availability of reasonable time-series data for telecoms on a sizeable number of countries allows the estimation of static and dynamic panel data models. It remains to be seen whether the results for telecommunications regulation will generalise to other utility industries.

The focus on developing country private investment in telecom and similar industries is appropriate and corresponds to the concerns of this paper. There is no question that these countries have considerable unsatisfied demand and that they face major difficulties in inducing sufficient investment to meet the capacity needs - at least at an acceptable cost of capital. Hence, the role of the regulator is crucial in providing the credibility that will support the necessary investment flows.

None of the studies yet done have data on regulatory processes or practice; the only regulatory data that exists is for the legal framework. That is most unfortunate given, firstly, the findings for independent CBs in developing countries; and, secondly, the findings that regulatory practice is typically worse than the quality of the legal framework. It means that coefficient estimates on the regulatory variable are likely to be downward biased because of an errors-in-variables problem. In addition, it can be very difficult to establish the impact of regulation per se since the law that establishes the regulator is frequently the same one that provides for competition and/or privatisation (or it is enacted close in time to laws on these other factors).

In spite of these difficulties, Wallsten (2002) finds that installing a regulatory agency separate from the relevant Ministry before privatisation is positively and significantly associated with several indicators of investment - mainline numbers, mainlines per capita, telecom investment (data primarily on investment by the incumbent operator) and number of mobile subscribers. This findings relate to a sample of 185 developed and developing countries. Wallsten also found that, for the 33 countries which had partially or wholly privatised their incumbent telephone company, having a regulator in place before privatisation was positively and significantly associated with the implied privatisation sales

\[ \text{See Stern and Holder (1999), table 2, p 46.} \]
Wallsten’s regulatory variable was a simple time-dated dummy on whether or not a regulator had been enacted in the law. The same is true of the regulatory variable in the study of 86 non-OECD countries by Fink, Mattoo and Rathindran (2003). This study concentrates on the sequencing of privatisation and competition rather than regulation but finds that the existence of an independent regulatory agency significantly augments the (positive) effect on mainline penetration of competition and privatisation, although not significant on mainline penetration itself.

Probably the most relevant studies for this paper are Gutierrez (2003) and Gual and Trillas (2003). Gutierrez (2003) estimates the effect of a 7-item index of regulatory governance on mainline density and efficiency for 22 Latin American and Caribbean countries. He finds that both the index and the three main sub-components have a positive and significant effect (at the 1% level) on mainline penetration, controlling for competition and privatisation. This holds for static and dynamic models and the estimated coefficients are robust to corrections for potential endogeneity. The same results held in general for a sample of 12 lower income Latin American and Caribbean countries although the estimated coefficients were smaller in size.

Gual and Trillas (2003) present two indices that measure the degree of independence of telecommunications regulatory agencies in 37 countries, in the spirit of the empirical literature on Central Bank independence. One of the indices is constructed by just adding up eleven original variables (such as appointment and reporting rules, funding sources, responsibility over key policy variables, etc.), and the other is constructed using principal components techniques and thus taking advantage of the correlation between the original variables. These two indices are highly correlated. They use these indices to study the determinants of regulator independence. They find that evidence that regulator independence (once its endogeneity is taken into account through instrumental variables) has a positive and weakly significant impact on network penetration, using International Telecommunications Union data. However, since most of the regulatory agencies in these data sets were created in the late nineties, there are still too few data points to claim that this evidence is conclusive.

There have been some papers covering other industries, particularly for Latin Amer-
ica. For instance, Guasch Laffont and Straub (2002) find that the probability of major renegotiation of infrastructure concession contracts (primarily in water and for roads) is significantly reduced if there is an independent regulatory agency. Clearly the relevant literature on testing whether (and, if so, how and why) utility regulatory agencies help alleviate the time inconsistency problems associated with private investment are as yet in their infancy relative to the independent CB literature. Nevertheless, some studies are now emerging which report similar results to those for independent CBs. A major task is to include evidence on regulatory procedures and practices eg the percentage of regulatory agency commissioners (or office heads) whose tenure is ended prematurely.

The evidence is beginning to show that independent regulatory agencies can allow the flexibility to enable regulatory agencies to provide bounded and accountable discretion with which to respond to changes in conditions while maintaining a reputation for credibility and thereby promoting investment. As with independent CBs, it is not always an easy task and by no means all countries succeed. However, the evidence suggests that a number of countries, particularly developing countries, are beginning to reap the benefits.

5 Conclusions

Our argument may be summarised as follows:

1. Both in central banking and regulation a reputational equilibrium (i.e. a pooling Perfect Bayesian Equilibrium) will not exist if the policymaker is short-sighted. This provides one rationale for delegation to independent agencies free of short-term electoral pressures.

2. Even with long-sighted regulators, a solution to the hold-up problem in the form of a reputational equilibrium is undermined if capital depreciates slowly.

3. These reputational equilibrium require the existence of a type of policymaker who can, or likes to commit.

4. Flexibility makes commitment rules difficult to monitor for deviation. This undermines reputational equilibria further unless they take the form of simple but sub-optimal rules.
5. These considerations suggest we may need alternative solutions to the credibility problem, especially for regulation. We propose ‘as if’ Rogoff-delegation to a relatively pro-industry as one such alternative.

Of course, there are significant differences between the tasks faced by independent central banks and independent regulatory agencies. The most important is that regulation (at least in some network industries such as telecommunications) is inherently about the monitoring and enforcement of the behaviour of commercial (and potentially competing) companies according to licence conditions or equivalent obligations. Monetary policy is not primarily concerned with the regulation of banks. In consequence, regulation must operate within a general competition framework and may in time be replaced - at least in some countries - by general ex post competition policy. A further crucial issue is that the history of telecom and other utility service regulatory agencies is very limited, particularly outside the US. In contrast, a significant number of countries still have very clear memories of hyper-inflation and the damage it causes. For many other countries there is a greater understanding of the need to maintain a low inflation rate through the relationship between monetary stability, low inflation and a good economic growth performance.

The theoretical arguments and the central bank literature suggest strong potential benefits from well-founded regulatory arrangements with proper and transparent procedures that will support limited and accountable discretion. The next task is to define and estimate the benefits, in practice, in the field of utility regulation.

References


