
When can an Independent Central Bank offer lower Inflation at no Cost? A Political Economy Analysis

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Abstract: An Independent Central Bank is often associated with being able to achieve low inflation and greater output stability than government run policies. In this paper we examine whether, and under what circumstances, an independent Central Bank can achieve both these targets with only one policy instrument at its disposal. This turns out to be possible in some special cases, or sometimes for limited periods of time, but not in general. It is an outcome which arises when increasingly conservative policies reduce the 2 target, 1 instrument conflicts, rather than from the suppression of any political cycle.

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1. INTRODUCTION

Conventional theory has it that delegating monetary policy to an independent Central Bank will deliver lower rates of inflation than alternative regimes. This happens because Central Bank independence removes the temptation for governments to follow time inconsistent policies, either in an attempt to achieve output growth and employment above the natural rates, or for the sake of short term political advantage. The private sector, knowing that these temptations have been removed, would then revise their inflationary expectations downwards and hence their price and wage demands accordingly.

However, one of the most remarkable results in this literature is the claim that this lower inflation can be achieved at no cost in terms of output fluctuations. Not all models of Central Bank independence have this property. For example Rogoff's (1985) model does not. But the model of Alesina and Gatti (1995) does,¹ and it has been offered as an explanation of the empirical evidence which shows that low inflation can be obtained at no cost. For example Cukierman (1996) finds negative correlations between inflation rates and the degree of independence of OECD Central Banks; while Alesina and Summers (1993) and Eijfinger et al (1998) show that there is no discernible relation between the variability of output and that degree of independence. The explanation offered by Alesina and Gatti is that Central Bank independence eliminates the effect of electoral uncertainty on the cycle.² Moreover, any lags in counter-cyclical policies could easily have the effect of exaggerating rather than dampening that cycle. Removing those two elements by delegating monetary policy to an authority not subject to electoral or cyclical concerns would clearly reduce the variability of output while reducing inflation. However, what this analysis does not cover is the possibility that increased attention to inflation control may, in itself, increase the natural variability of the economic part of the cycle and hence overall output variability. *A priori* one cannot tell which way the trade-off will go and the Alesina-Gatti model does not say.

¹ See also the model in Alesina (1989)

What is missing from this analysis is a clear statement of whether, and under what conditions, an independent Central Bank will actually deliver lower inflation at no cost – generally, not at all, or only in special cases – and whether the suppression of the political cycle in economic policies is strong enough to deliver this result. Policy makers need to know that before they come to rely on the Bank’s independence. Campillo and Miron (1997), Posen (1998) and Forder (1998), for example, all point out that low inflation in the OECD area cannot be accounted for by institutional arrangements alone; other factors, such as fiscal policy, are also needed. Indeed, Melitz (1997) finds that monetary and fiscal policies tend to be used together to achieve inflation and output targets. So the explanation of the empirical evidence may simply be that a second instrument has been used. Certainly, theoretical analysis shows that the traditional results can be turned on their head once a second instrument – say fiscal policy, or structural reform and labour market policies - is brought into play³; and also when governments are subject to electoral pressures (Demertzis et al, 1999). Likewise Cukierman and Lippi (1999) and Guzzo and Velasco (1999) point out that Central Bank independence does not maximise Social Welfare; and that that result may influence wage bargaining - and hence the inflation and output outcomes.

It is not clear from the available evidence therefore, whether independent Central Banks do actually deliver lower inflation and at no extra cost. However, given that other policies and other policy makers could influence the outcomes, it is necessary to examine this question using the delegation model on its own terms. That will allow the Central Bank to pursue a proper “commitment solution” - uninterrupted by the actions of others with different priorities, but taking into account the fact that political changes would affect the private sector behaviour which must condition the Bank’s actions. We therefore study the inflation and output outcomes that would follow from such commitment solutions.

² Posen (1998) however, finds little systematic evidence of this in practice, even among the non-German countries with dependent Central Banks (see also Mangano 1998).

³ A point first made by Blackburn and Christensen (1989).

2. THE MODEL

In line with the standard literature, our world is described by a Lucas supply function (Rogoff 1985, Alesina and Gatti 1995). The level of output is positively affected by unexpected inflation and random supply shocks ε , with zero mean and finite variance:

$$y_t = \pi_t - \pi_t^e + \varepsilon_t \quad \varepsilon \rightarrow N(0, \sigma_\varepsilon^2) \quad (1)$$

The timing is such that shocks occur after the private sector has negotiated the wages to which authorities need to react. A given government optimises the following loss function in terms of inflation and output

$$\min_{\pi} L = \frac{1}{2} [(\pi_t)^2 + \beta(y_t - k)^2] \quad (2)$$

where the last term, $(y_t - k)$, shows the source of an expansionary bias built in the objective function. The government intends to achieve a level of output $k > 0$ that is higher than the natural rate. It does so in order to overcome the distortionary effects of taxation and public expenditure made for social reasons. This is the classic formulation given by Persson and Tabellini (1990).

Parameter β is the weight given to the output objective, and demonstrates the government's relative priorities with respect to the two objectives. Substituting (1) in (2), minimising the loss function with respect to π and solving for rational expectations yields:

$$\pi = \beta k - \frac{\beta}{(1 + \beta)} \varepsilon, \text{ and} \quad (3)$$

$$\pi^e = \beta k. \quad (4)$$

Substituting (3) and (4) into (1) gives

$$y = \frac{1}{(1 + \beta)} \varepsilon \text{ and } \text{Var}(y) = \left(\frac{1}{1 + \beta} \right)^2 \sigma_\varepsilon^2 \quad (5)$$

Consequently, if inflation is delegated to a body primarily concerned with reducing inflation, and described by preferences $b < \beta$, the results are unambiguous: inflation is

reduced but at the expense of greater output variability⁴. This is the result presented by Rogoff (1985).

2.1 Political Uncertainty

Alesina and Gatti (1995) however, reverse this result by using a model in which different political parties come into play. The timing now requires that wage negotiations are undertaken before elections. This automatically introduces electoral uncertainty which biases the private sector's inflationary expectations and, given the model, destabilises output. More specifically, there are now two sources of output instability; the first is exogenous supply shocks as before, but the second arises from the uncertainty of which party will rule after the elections. Hence by removing monetary policy from political control, the argument goes, that part of the variance in output which is due to electoral uncertainty is removed and output variability falls as a result (provided the impact of supply shocks does not get larger). The other source of output instability however, is still there. The probability of getting an inflation averse, as opposed to an instability averse, government will therefore be the crucial variable for determining the outcomes.

The model is as follows: there are two parties D and R (Democrats and Republicans) which each optimise their own objective functions when in power: i.e.:

$$L^D = \frac{1}{2}[\pi^2 + b^D (y_t - k)^2] \text{ and}$$

$$L^R = \frac{1}{2}[\pi^2 + b^R (y_t - k)^2] \text{ where } 0 < b^R < b^D.$$

These parameter values imply that party D cares more about output stabilisation, whereas party R cares more about inflation. Party D is expected to win the elections with probability P and party R with probability 1-P. Wages are negotiated first, then one of the two parties gets elected, and finally a shock ε occurs to which the governing party has to react. The timing is crucial because risk-averse wage

⁴ Since $E(\pi) = \beta k > bk$ and $\text{Var}(y) = \left(\frac{1}{1+\beta}\right)^2 \sigma_\varepsilon^2 < \text{Var}(y) = \left(\frac{1}{1+b}\right)^2 \sigma_\varepsilon^2$.

negotiators are negatively affected by the uncertainty of the electoral outcome and would therefore try to cover themselves in advance.

Anticipated inflation and output variability are now different to the case where a government is already in place. The *ex ante* rules applied by the two parties are:

$$\pi^D = \frac{b^D(1+b^R)}{(1+b^D) - P(b^D - b^R)} k - \frac{b^D}{1+b^D} \varepsilon \quad (6)$$

$$\pi^R = \frac{b^R(1+b^D)}{(1+b^D) - P(b^D - b^R)} k - \frac{b^R}{1+b^R} \varepsilon \quad (7)$$

for inflation, and

$$y^D = \frac{(1-P)(b^D - b^R)}{(1+b^D) - P(b^D - b^R)} k - \frac{1}{1+b^D} \varepsilon \quad (8)$$

$$y^R = \frac{P(b^D - b^R)}{(1+b^D) - P(b^D - b^R)} k - \frac{1}{1+b^R} \varepsilon \quad (9)$$

for output. From (8) and (9) we get an expression for output variability

$$\text{var}(y) = \frac{P(1-P)(b^D - b^R)k^2}{[(1+b^D) - P(b^D - b^R)]^2} + \frac{P}{(1+b^D)^2} + \frac{(1-P)}{(1+b^R)^2} \sigma_\varepsilon^2 \quad (10)$$

To discover if delegating monetary policy to an independent and conservative body produces lower inflation **and** lower output variability we have to compare what is achieved with an independent Central Bank, i.e.

$$E(\pi_1) = \hat{b}k \quad (11)^5$$

$$\text{Var}(y_1) = \frac{1}{(1+\hat{b})^2} \sigma_\varepsilon^2 \quad (12)$$

with what can be achieved without an independent Central Bank, i.e:

$$E(\pi_{NI}) = \frac{b^R(1+b^D) + P(b^D - b^R)}{(1+b^D) - P(b^D - b^R)} k, \text{ and} \quad (13)$$

$$\text{Var}(y_{NI}) = \frac{P(1-P)(b^D - b^R)k^2}{[(1+b^D) - P(b^D - b^R)]^2} + \frac{P}{(1+b^D)^2} + \frac{(1-P)}{(1+b^R)^2} \sigma_\varepsilon^2 \quad (14)$$

If Central Bank independence is to come at no extra cost, then we must have $E\pi_{NI} > E\pi_I$ and $V(y_{NI}) \geq V(y_I)$ respectively.

3. WHEN IS PRICE STABILITY ACHIEVED AT NO EXTRA COST?

We now compare (11) to (13), and (12) to (14), across the whole spectrum of probabilities to show how changing perceptions about the electoral outcome can have an impact on the effectiveness of the Central Bank's policies - even when the latter are set independently. We start by looking first at the outcomes when there is no uncertainty, and then when the electoral outcome is unknown.

3.1 Electoral Certainty

1. Assume the following ordering of preferences: $\hat{b} < b^R < b^D$. There are three possible cases in which electoral outcomes are known in advance:

A. $P=0$

$$\begin{aligned} E(\pi_I) = \hat{b}k &< E(\pi_{NI}) = b^Rk && \text{but} \\ \text{Var}(y_I) = \frac{1}{(1 + \hat{b})^2} \sigma_\varepsilon^2 &> \text{Var}(y_{NI}) = \frac{1}{(1 + b^R)^2} \sigma_\varepsilon^2 \end{aligned}$$

B. $P=1$

$$\begin{aligned} E(\pi_I) = \hat{b}k &< E(\pi_{NI}) = b^Dk && \text{but} \\ \text{Var}(y_I) = \frac{1}{(1 + \hat{b})^2} \sigma_\varepsilon^2 &> \text{Var}(y_{NI}) = \frac{1}{(1 + b^D)^2} \sigma_\varepsilon^2 \end{aligned}$$

C. $\hat{b} < b^R = b^D = b$

$$\begin{aligned} E(\pi_I) = \hat{b}k &< E(\pi_{NI}) = bk \\ \text{Var}(y_I) = \frac{1}{(1 + \hat{b})^2} \sigma_\varepsilon^2 &> \text{Var}(y_{NI}) = \frac{1}{(1 + b)^2} \sigma_\varepsilon^2 \end{aligned}$$

⁵ \hat{b} is the degree of the Central Bank's conservativeness.

An ultra-conservative⁶ central bank will therefore, always achieve lower inflation - but never lower output variability.

2. Suppose now that the Central Bank's preferences are between those of the two parties, i.e.: $b^R < \hat{b} < b^D$. The same three cases now imply:

A. $P=0$

$$\begin{aligned} E(\pi_I) = \hat{b}k &> E(\pi_{NI}) = b^R k && \text{but} \\ \text{Var}(y_I) = \frac{1}{(1 + \hat{b})^2} \sigma_\varepsilon^2 &< \text{Var}_{(NI)} = \frac{1}{(1 + b^R)^2} \sigma_\varepsilon^2 \end{aligned}$$

B. $P=1$

$$\begin{aligned} E(\pi_I) = \hat{b}k &< E(\pi_{NI}) = b^D k && \text{but} \\ \text{Var}(y_I) = \frac{1}{(1 + \hat{b})^2} \sigma_\varepsilon^2 &> \text{Var}_{(NI)} = \frac{1}{(1 + b^D)^2} \sigma_\varepsilon^2 \end{aligned}$$

C. $b^R = b^D = b < \hat{b}$

$$\begin{aligned} E(\pi_I) = \hat{b}k &> E(\pi_{NI}) = bk \\ \text{Var}(y_I) = \frac{1}{(1 + \hat{b})^2} \sigma_\varepsilon^2 &< \text{Var}_{(NI)} = \frac{1}{(1 + b)^2} \sigma_\varepsilon^2 \end{aligned}$$

In this case, an independent Central Bank still achieves one of its targets but never both. The target which it does achieve, depends on which party wins the elections. If the more conservative Republicans are elected, an independent Central Bank will produce lower output variability, but higher inflation rates than a government managed Central Bank. That is because the independent Central Bank's preferences are more liberal (inflation permissive) than the elected government would have chosen for itself.

By contrast, if it is the Democrats that are elected, an independent Central Bank would produce lower inflation but higher output variability - this time because the Bank's priorities are more conservative (inflation-averse) than the elected government would have chosen for itself⁷.

⁶ i.e. more inflation-averse than anyone in this economy would vote for.

⁷ Obviously the same logic will also apply to the case where both parties have the same inflation preferences (but less than \hat{b}), as case C above demonstrates. But this

The upshot here is that, given electoral certainty, an independent Central Bank can never produce lower inflation at no cost. Either such a bank will achieve lower inflation but higher output variability - if the Central Bank is more conservative than the government - or it will produce higher inflation but lower output variability if the Central Bank is more liberal than the government.

3.2 Electoral Uncertainty

The traditional analysis of an independent Central Bank relies on the fact that wage negotiations take place before the electoral outcome is known - or equivalently before the exact monetary stance, and hence inflationary pressures, are known. We therefore introduce that uncertainty directly, using (11), (12) and (13), (14) when $0 < P < 1$ and $b^R < b^D$, in the conventional manner.

In fact (11) and (13) imply an independent Central Bank will always generate lower average inflation rates, if $E(\pi_I) < E(\pi_{NI})$:

$$\text{i.e. if } \hat{b}k < \frac{b^R(1+b^D)+P(b^D-b^R)}{(1+b^D)-P(b^D-b^R)} \quad (15)$$

$$\text{or } \frac{(b^R-\hat{b})(1+b^D)+P(1+\hat{b})(b^D-b^R)}{(1+b^D)-P(b^D-b^R)} > 0 \quad (16)$$

Now that is unambiguously true if $\hat{b} \leq b^R \leq b^D$ since $0 < P < 1$. But it is not so obviously true if $b^R < \hat{b} < b^D$. Indeed an independent Central Bank will generate higher average inflation if (16) is negative:

$$\text{i.e. if } (\hat{b}-b^R)(1+b^D) > P(1+\hat{b})(b^D-b^R),$$

is a less interesting case because it is unlikely that any economy would voluntarily accept a more inflation prone Central Bank than the electorate would vote for.

$$\text{or when } P < P^C = \frac{(\hat{b} - b^R)(1 + b^D)}{(1 + \hat{b})(b^D - b^R)} \quad (17)$$

This result means that a dependent Central Bank will generate lower inflation if the probability of a Democrat government being elected is relatively low (lower than a critical value P^C); or an independent Central Bank will do so when that probability is relatively high (greater than P^C), assuming that $b^R < \hat{b} < b^D$ in both cases. That is as expected. Hence, the Alesina and Gatti assertion that there always exists a range of values for \hat{b} between b^R and b^D , for which an Independent Central Bank produces lower inflation, is correct. The crucial point however, is that inflation performance is linked not only to the preference parameters but also to probability P as well. It is entirely possible therefore, for P to fall below the critical value P^C at certain times and hence remove the benefits of an independent central bank. The only thing policy authorities can do to prevent that is to insist on a very conservative policy stance: i.e. that $\hat{b} \leq b^R$. But that may increase the variability of output at the same time.

To summarise, an independent Central Bank will only generate lower inflation rates, in general, if $R(P) = E(\pi_{NI}) - E(\pi_I)$ is positive. That requires P to be greater than P^C . The problem here is that those who have to design institutional structures cannot know that the value of P will never fall below P^C – even if they can be sure that their Central Bank will stick faithfully to a pre-committed anti-inflation path – unless they always choose a Central Bank that is more conservative than every possible government ($\hat{b} \leq b^R$). But if they do that, the regime will not allow social welfare to be maximised (Guzzo and Velasco, 1999) with the result that the voting public will inevitably choose governments designed to get closer to that social welfare maximum (Demertzis *et al*, 1999a)⁸. That could take the form of b^D increasing or of b^R increasing towards b^D , both of which increase P^C . But it could equally well happen when $P^C=0$, because governments are more often than not, judged on more than just their inflation records such as public expenditure policies, social and job protection schemes, civil justice, foreign or defence policies etc. This automatically reduces the relevance of inflation performance as a criterion for elections.

⁸ See Figure 1 and Section 3 of that paper.

4. OUTPUT FLUCTUATIONS WITH ELECTORAL UNCERTAINTY

We now turn to the problem of whether an independent Central Bank would generate higher output variability than a non-independent Central Bank. To answer that question, we define a function $Q(P) = V(y_{NI}) - V(y_I)$ which shows that output variability is higher with a dependent Central Bank whenever $Q(P)$ is positive. Conversely, output fluctuations will be higher with an independent Central Bank when $Q(P) \leq 0$. This therefore, matches the inflation comparison function ($R(P)$ as defined in section 3.2), and we can again look for critical values of P at which the independent Central bank will start to deliver higher output fluctuations. In particular, the independent Central Bank will only be “doing better” than its dependent counterparts on both criteria, if $Q(P)$ and $R(P)$ are both simultaneously positive. Figure 1 illustrates the point. The next step is to determine the conditions under which that can happen.

4.1 Determining when Output Fluctuations are lower with Central Bank Independence

From (12) and (14), we can see that an independent Central Bank will deliver higher output variability if $Q(P) > 0$

$$\text{i.e.} \quad \frac{1}{(1 + \hat{b})^2} \leq \frac{P(1 - P)(b^D - b^R)g^2}{[1 + b^D - P(b^D - b^R)]^2} + \frac{P}{(1 + b^D)^2} + \frac{1 - P}{(1 + b^R)^2} \quad (18)$$

where $g^2 = k^2 / \sigma^2$ is the political “signal to noise” ratio, measuring the strength of policy commitments relative to the size of the typical output disturbance.

To facilitate the algebra, let $x = 1 + b^D$, $y = 1 + b^R$ and $z = (1 + \hat{b})$. That implies $b^D - b^R = x - y$, and that $y < z < x$ if $\hat{b} > b^R$, but $z \leq y$ otherwise. In that case, (18) becomes

$$\frac{1}{z^2} \leq \frac{P(1-P)(x-y)^2 g^2}{[x-P(x-y)]^2} + \frac{P}{x^2} + \frac{1-P}{y^2} \quad (19)$$

We can now express $Q(P) = V(y_{NI}) - V(y_1)$ in the following polynomial form:

$$Q(P) = A_1 P^3 + A_2 P^2 + A_3 P + A_4 \quad (20)$$

where

$$A_1 = (x-y)^2 \left[\frac{1}{x^2} - \frac{1}{y^2} \right]$$

$$A_2 = (x-y)^2 \left[\frac{z^2 - y^2}{y^2 z^2} - g^2 + \frac{2x(x+y)}{x^2 y^2} \right]$$

$$A_3 = (x-y) \left[\frac{2x}{z^2} - \frac{2x}{y^2} - \frac{(x+y)}{y^2} + (x-y) g^2 \right]$$

$$A_4 = x^2 \left[\frac{z^2 - y^2}{y^2 z^2} \right] \geq 0$$

The sign of A_4 depends on the temporary assumption that $y \leq z < x$; for if $z < y$ (i.e. $\hat{b} < b^R$) it would be negative. We shall return to the latter possibility ($z \leq y$) in cases II and III below. For now we take $y < z$.

Notice also that the signs of A_2 and A_3 depend on the size of g , the political “signal to noise” ratio. If g is large, A_2 is negative and A_3 positive. That is the case where the policy makers have ambitious targets for output and employment. But if g is small, they can only have very modest ambitions beyond simply stabilising output shocks. In that case, $A_2 > 0$ and $A_3 < 0$.

Now we are in a position to determine if there are values of \hat{b} , g and P for which the inequality $Q(P) \geq 0$ in (20) is satisfied. If so, an independent Central Bank will generate lower output variability at those values. We proceed as follows:

- We first attempt to establish that $Q(P)=0$ has at most one root in the interval $0 \leq P \leq 1$, given arbitrary choices for $\hat{b} < b^D$ and g . For if there is only one root, P^0 say, and $Q(0)$ is positive, then there is always the possibility of a free lunch for an

independent Central Bank– i.e. lower inflation and lower output fluctuations - if $P^0 > P^C$. But that result is only available so long as P falls in the interval (P^C, P^0) . Below P^C or above P^0 the dependent Central Bank will be doing better, with respect to inflation in the first case and with output stability in the second (figure a).

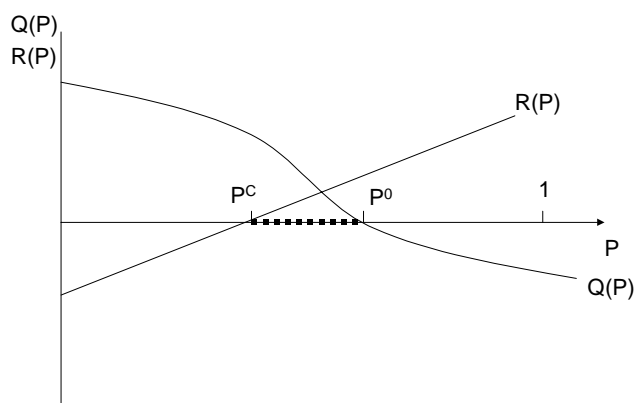


Figure a

- Conversely, if $Q(P)=0$ has no roots in the interval $0 \leq P \leq 1$, while $Q(0) > 0$, then the free lunch result will hold for the interval $P \in (P^C, 1)$, (figure b).

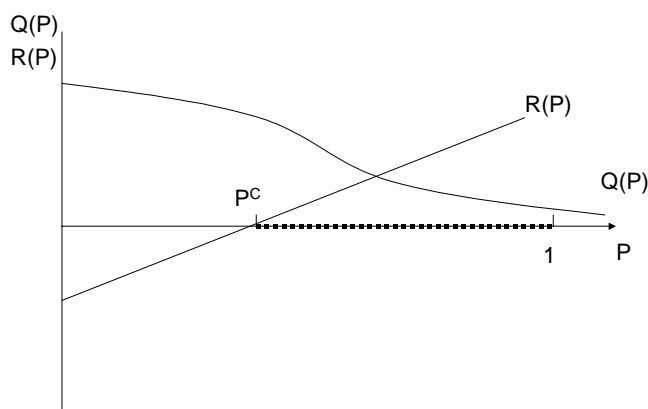


Figure b

- If on the other hand, $Q(0)$ is negative⁹ and $Q(P)=0$ has only one root in the

⁹ Clearly, if $Q(0)=0$, then a positive or negative first derivative $Q'(P)$ will be the determining conditions – rather than the sign of $Q(0)$.

interval $0 \leq P \leq 1$, then a free lunch is only available if P falls in the interval $(P^c, 1)$ or $(P^0, 1)$ – whichever is the smaller (figures c and c').

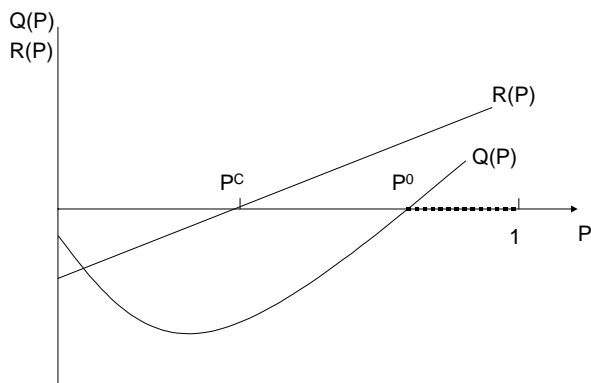


Figure c

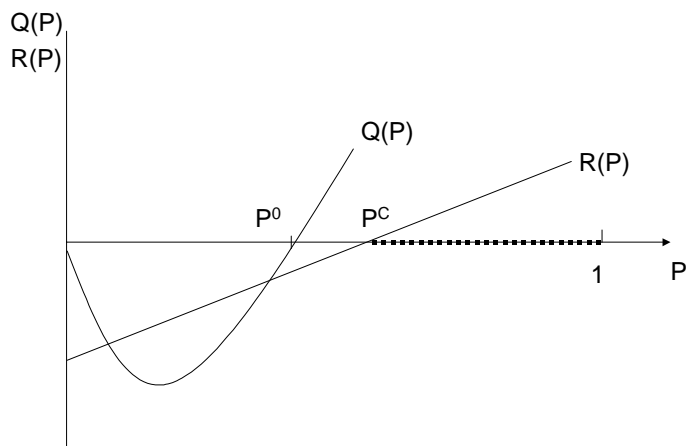


Figure c'

- Finally, if there are no roots (while $Q(0)$ remains negative), then there is no free lunch at all (figure d).

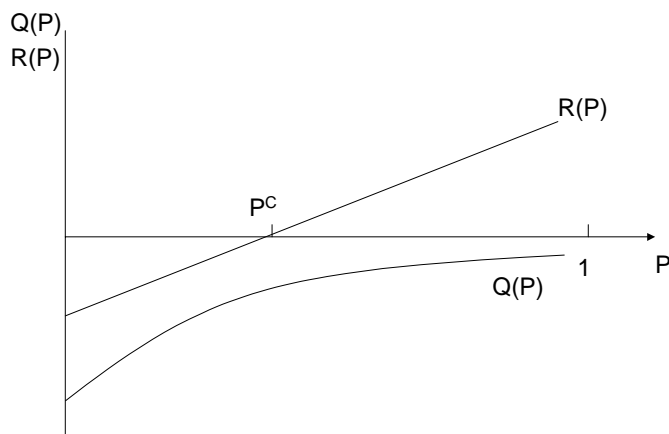


Figure d

To determine the number of roots to $Q(P)=0$ in any interval, we use the following theorem:

Theorem 1 (Budan-Fourier): If a and b ($a < b$) are not roots of the polynomial $p(x)$, of degree n , then the number of real roots lying between a and b is equal to the number sign changes lost when the sequence of derivatives

$$p(x), p'(x), p''(x), \dots, p^{(n)}(x) \quad (21)$$

is evaluated first at $x=a$ and then at $x=b$, or less than that by an even number (Demidovich and Maron, 1973, pp 176/7).

Corollary: If the number of sign changes lost is exactly one, then there is exactly one real root in the interval (a,b) .

However, given the ambiguity in the signs of A_2 and A_3 , the sequences of derivatives will evidently have to be evaluated for small and large values of g separately. Similarly it is also convenient to evaluate them separately for $b^R < \hat{b}$, $\hat{b} = b^R$ and $\hat{b} > b^R$, given the ambiguity in the sign of A_4 .

Case I: $b^R < \hat{b} < b^D$. This case implies a moderately conservative central bank. The derivative sequence of $Q(P)$ as implied by (21), is:

$$Q'(P) = 3A_1 P^2 + 2A_2 P + A_3$$

$$Q''(P) = 6A_1 P + 2A_2 \quad \text{and,}$$

$$Q'''(P) = 6A_1$$

Evaluating these derivatives at $P=0$ and at $P=1$, when g is very small and then sufficiently large, yields the sign pattern reported in table 1:

Table 1: The sign pattern for theorem 1, when $\hat{b} > b^R$

	Small g		Large g	
	at P=0	at P=1	at P=0	at P=1
Q(p)	+ve ^{b)}	-ve ^{d)}	+ve ^{b)}	-ve ^{d)}
Q'(p)	-ve	+ve	+ve	-ve
Q''(p)	+ve	+ve ^{a)}	-ve	-ve
Q'''(p)	-ve ^{c)}	-ve ^{c)}	-ve ^{c)}	-ve ^{c)}
No. of sign changes	3	2	1	0

Notes:

- a) subject to an upper bound to the value of b^D or a lower bound on \hat{b} . However, these bounds don't matter since a change of sign in this position would not alter the number of sign changes, or sign changes lost.
- b) independent of the value of g.
- c) independent of the values of either g or \hat{b} .
- d) independent of the value of g, but subject to an upper bound on the value of \hat{b} which is strictly larger than b^R . That upper bound is a complicated function of b^D and b^R . It is the value of \hat{b} which solves $y^4 (z^2 - x^2) + x^4 (1 - z^2)(y^2 - z^2) = 0$. That value clearly lies somewhere between b^R and b^D since $z=y$ leaves this expression negative (as in the table) and $z=x$ leaves it positive, given that $z \geq 1$ and $y < z \leq x$. The text and the table therefore refer to the "moderately conservative" case with \hat{b} below that bound. If we took a more liberal case, with \hat{b} between that bound and b^D , the final two figures in the last row of table 1 would be 1 and 1 - implying two (or possibly zero) roots in the interval $[0, 1]$ if g is small, and none in that interval if g is large.

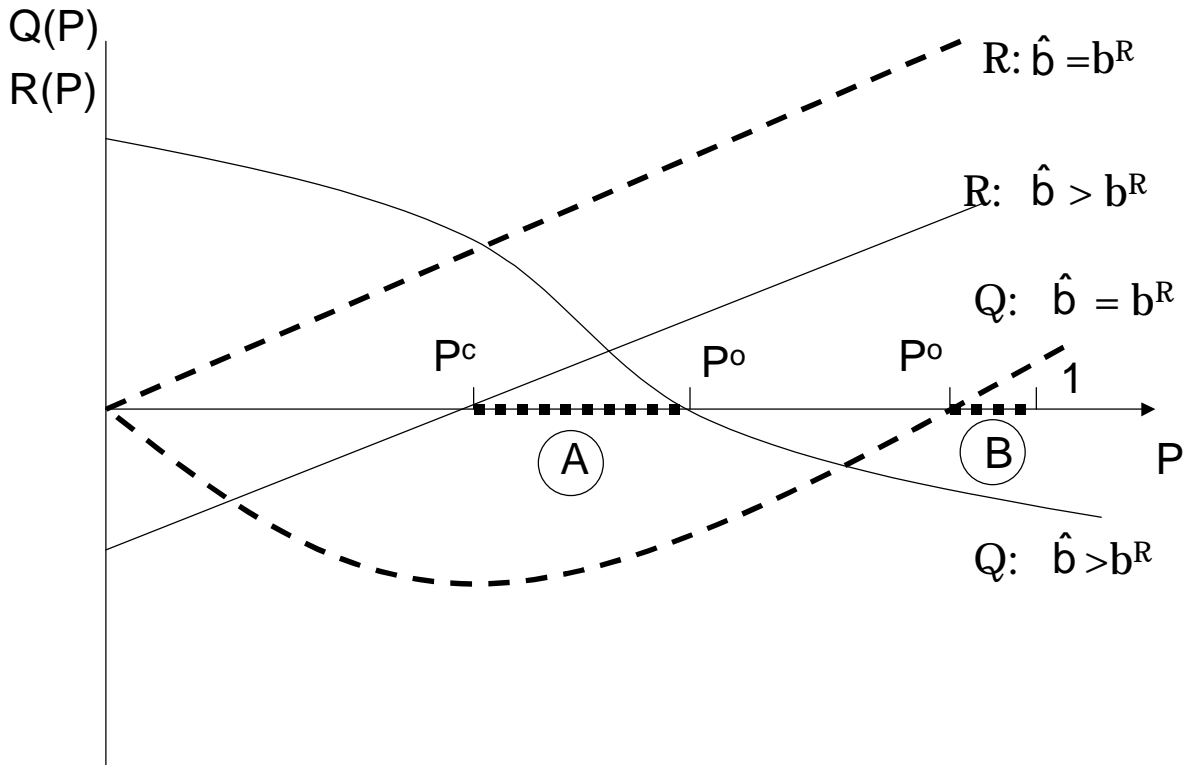


Figure 1: The Free Lunch Intervals when $\hat{b} \geq b^R$ and g is small; A: when $\hat{b} > b^R$, B: when $\hat{b} = b^R$. The independent Central Bank delivers better results when $Q(P)$ and $R(P)$ are positive since $Q(P) = V(y_{NI}) - V(y_i)$ and $R(P) = E\pi_{NI} - E\pi_i$.

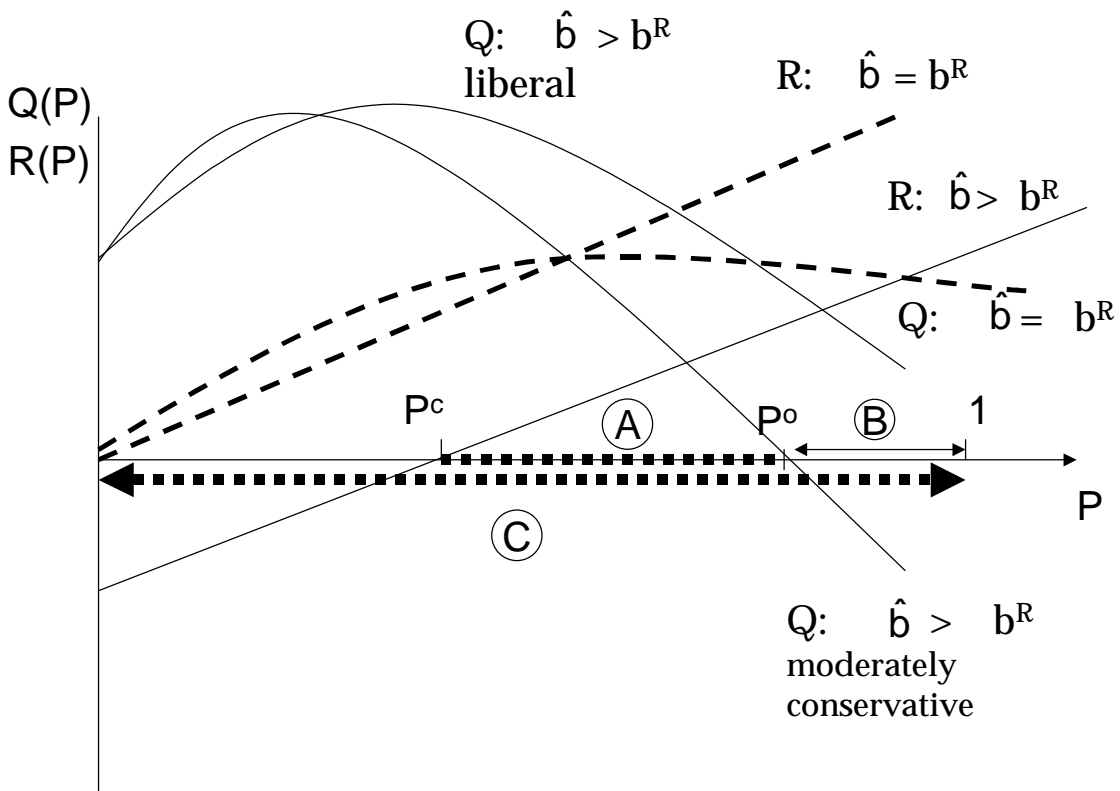


Figure 2: as for figure 1, but larger values of g . A: the Free Lunch Interval with a Moderately Conservative Central Bank; B: its extension when the Bank is Liberal; and C: its alternative when the Central Bank is more conservative.

Commentary: Table 1 therefore shows that in the moderately conservative case there is exactly one root to $Q(P)=0$ and that $Q(0)>0$ holds, irrespective of whether g is small or large¹⁰. That follows from theorem 1. Thus $V(y_I)<V(y_{NI})$ holds for small values of P , and $V(y_I)>V(y_{NI})$ for larger values¹¹; and there is just one cross-over point P^0 . Hence a “free lunch” becomes possible if $P^0>P^C$. But beyond the interval (P^C, P^0) , if it exists, an independent Central Bank will generate longer output fluctuations whenever it would generate lower inflation rates. Conversely, it would generate smaller output fluctuations where it would yield higher inflation rates.

Case II: $\hat{b}=b^R$. The Bank adopts a strongly conservative stance. The analysis has to be adapted since now $A_4=0$ and $Q(0)=0$. That means $P=0$ is a root. For the remaining interval

$$\hat{Q}(P)=A_1 P^2 + A_2 P + A_3 \quad P \neq 0$$

with derivatives $\hat{Q}'(P)=2A_1 P + A_2$ and $\hat{Q}''(P) = 2A_1$.

For that interval we get table 2 to replace table 1:

Table 2: The sign pattern for theorem 1, when $\hat{b} = b^R$

	Small g		Large g	
	at $p \leq 0$	at $p=1$	at $p \leq 0$	at $p=1$
$\hat{Q}(p)$	-ve	+ve	+ve	+ve
$\hat{Q}'(p)$	+ve	+ve	+ve	-ve
$\hat{Q}''(p)$	-ve	-ve	-ve	-ve
No. of sign changes	2	1	1	1

Consequently there is exactly one root beyond $P=0$ if g is small, but none if g is large. However the values of $Q(P)$ itself have to be recovered from (20). We have $Q(0)=0$ whatever the value of g , and $Q(1)>0$ likewise. That means an independent Central Bank gives lower inflation and lower output fluctuations for larger P values if g is

¹⁰ Evidently $P=0$ is not a root of $Q(P)=0$ in this case, nor in general is $P=1$. Theorem 1 can therefore be applied directly. For the one particular value of \hat{b} that implies $Q(1)=0$, see note d) in table 1, we can take a value of P arbitrarily close to (but smaller than) 1 and get exactly the same result.

¹¹ See also Demertzis (1999).

small. And it will do so for all P values if g is large. (See figures 1 and 2).

Case III: $\hat{b} < b^R$. The Bank adopts an ultra-conservative position. What happens in this case obviously depends on how far \hat{b} is set below the reference value b^R . If it is only a small amount, then by continuity the sign pattern won't change from table 1 except in row 1 where $\hat{b} = b^R$ produced zero entries when $P=0$, and reversed signs when $P=1$. Since $\left. \frac{\partial A_4}{\partial \hat{b}} \right|_{\hat{b} = b^R} > 0$ all z, and if $d\hat{b}$ is sufficiently small, we get table 3 from table 1; and from $Q(0)=0$ and $Q(1)>0$ in the $\hat{b} = b^R$ case.

Table 3: The sign pattern for theorem 1, when $\hat{b} < b^R$

	Small g		Large g	
	at p=0	at p=1	at p=0	at p=1
Q(p)	-ve	+ve	-ve	+ve
Q'(p)	-ve	+ve	+ve	+ve
Q''(p)	+ve	+ve	-ve	-ve
Q'''(p)	-ve	-ve	-ve	-ve
No. of sign changes	2	1	2	1

This implies a single root in $Q(P)=0$; and again $Q(0)<0$ whatever the value of g. It also implies lower inflation and smaller output fluctuations with an independent Central Bank - but only for larger values of P.

4.2 Summary: When Does a Free Lunch Interval Exist?

(a) A guaranteed free lunch in all circumstances? From (17), we must have $\hat{b} = b^R$ and a large value for g, for this to be true; and also $Q(0)\geq 0$ and $Q(1)>0$. Note that a small value of g is no good since then one root exists for $Q(P)=0$ and small values of P won't allow a free lunch: see table 2 below. Notice also that a small value of $\hat{b} > b^R$ might nearly do it since P^C would be small. But then $Q(1)<0$, so that output fluctuations would still be larger for large values of P and an independent Central Bank.

(b) No free lunch ever. This happens if $P^C \geq P^0$: see below, equation (22), for

conditions where that can happen. It could also happen where $Q(0) \leq 0$ and $Q(1) < 0$, but we have found no cases of that.

- (c) A limited free lunch zone is available for limited periods of time only if $P \in (P^C, P^0)$ and $P^0 > P^C$. The key questions then, are how large is that zone; and whether it can be expanded by the policy makers?

For case (b), recall that (15) and (17) imply that $R(P) = E(\pi_{NI}) - E(\pi_I)$ is an upward sloping function of P such that $R(P) = 0$ at $P = P^C$; but $R(P) < 0$ for $P < P^C$. Moreover $P^C = 0$ and $R(0) = 0$ if $\hat{b} = b^R$. To determine now exactly when a limited free lunch can exist, recall $Q(P) = V(y_{NI}) - V(y_I)$ will have one root between $P = 0$ and $P = 1$ at most, and that $Q(0) > 0$, if $\hat{b} > b^R$. Similarly (20) implies $Q(0) = 0$ if $\hat{b} = b^R$. But if $Q(P^C) > 0$ in either case, then we have at least a limited free lunch interval. Using (20), we get

$$Q(P^C) = (z-y)^2 x^2 \left[\frac{(z-y)(x+y)}{xz} + \frac{(z-y)^2}{z^2} + \frac{2(x+y)}{x} \right] + \frac{(z-y)x}{z} + y - \frac{(z-y)x}{z} g + \frac{(z-y)x}{y^2 z} \left[\frac{2x(z^2 - y^2)}{z^2} - (z+y) + \frac{(z+y)x}{z} \right] \quad (22)$$

Hence $Q(P^C) = 0$ if $z = y$. There is no free lunch interval if $\hat{b} = b^R$ therefore. More generally, $Q(P^C) > 0$ is guaranteed so long as g is large enough and $\hat{b} > b^R$, since the middle term of (22) is positive. But, if g is small ($g \approx 0$) and $\hat{b} > b^R$, (22) can easily imply $Q(P^C) < 0$. For example $b^R = 0$ and $b^D = \hat{b} \geq 0.8$ will do it. That is not a very liberal regime. Similarly $b^R = 0$, $\hat{b} = \frac{1}{2}(b^D + 1) - 1$ and $b^D \geq 4$ will do it. That is a little more liberal.

4.3 Can we extend the Free Lunch Zone?

There is no guarantee that a free lunch interval exists in the moderately conservative or liberal cases, or even in the very conservative case if g is rather small. However, if such an interval does exist, the policy makers could extend it either by decreasing \hat{b} if $\partial Q(P^C) / \partial \hat{b} < 0$, since (16) implies $\partial R(P) / \partial \hat{b} < 0$; or alternatively by increasing

g , since $R(P)$ is invariant to g . The latter option is always open. The former option turns on the sign of (23):

$$\begin{aligned}
\frac{\partial Q(P^C)}{\partial z} = & -\frac{Q(P^C)}{z} - \frac{(z-y)^2 x^2}{y^2 z^2} \left[\frac{(z-y)(x+y)}{xz} + \frac{(z-y)^2}{z^2} + \frac{2(x+y)}{x} \right] \\
& + \frac{x}{z} + y - \frac{(z-y)x}{z} g + \frac{x}{y^2 z} \left[\frac{2x(z^2 - y^2)}{z^2} - (x+y) + \frac{(z+y)x}{z} \right] \\
& + \frac{(z-y)^2 x^2}{y^2 z^2} \left[\frac{(x+y)}{xz} + \frac{(z-y)(x+y)}{xz^2} \right] + \frac{(z-y)x}{y^2 z} \left[\frac{4xz}{z^2} + \frac{4x(z^2 - y^2)}{z} \right] \\
& + \frac{x}{z} - \frac{(z+y)x}{z^2} + \frac{(z-y)x}{z} - \frac{(z-y)x}{z^2} g
\end{aligned} \tag{23}$$

It is straight forward to check that $\partial Q(P^C) / \partial \hat{b}$ is positive if g is large; but that it is negative if g is small and $x < z^2 / (z-1)$, assuming that (22) has yielded $Q(P^C) > 0$ in the first place.

These two results therefore, imply that trying to increase the free lunch interval by decreasing \hat{b} when g is large, will trigger a conflict between lower inflation and smaller output fluctuations. However, when g is small and $x < z^2 / (z-1)$ - which means that b^D must be no more than $2 + \hat{b}$ if the Central Bank is relatively liberal, but is effectively unlimited if it is very conservative - decreasing \hat{b} will indeed increase that interval. However it remains a limited interval, and could only exist if (22) is positive.

5. NUMERICAL EXAMPLES

Our analysis shows that the only sure way to get low inflation at no cost, is to appoint a very conservative Central Bank, with $\hat{b} = b^R$, in the countries where g takes a large value. It is of course possible to get something of the same result under other conditions, but then not for all circumstances and only for limited periods of time.

It is interesting to note that Alesina and Gatti's own example falls into the latter category. They consider a world with $b^R=0$, $b^D=3$ and $\hat{b}=0.5$; $P=0.5$ and $k^2=\sigma^2=1$. That yields $P^C=0.444$, $A_1=-6.75$, $A_2=18.504$, $A_3=-19.333$, $A_4=8.889$ and $P^0 > 1$.

Consequently the low inflation at no cost result will hold no more than half the time (for $P > .444$; see figure 3).

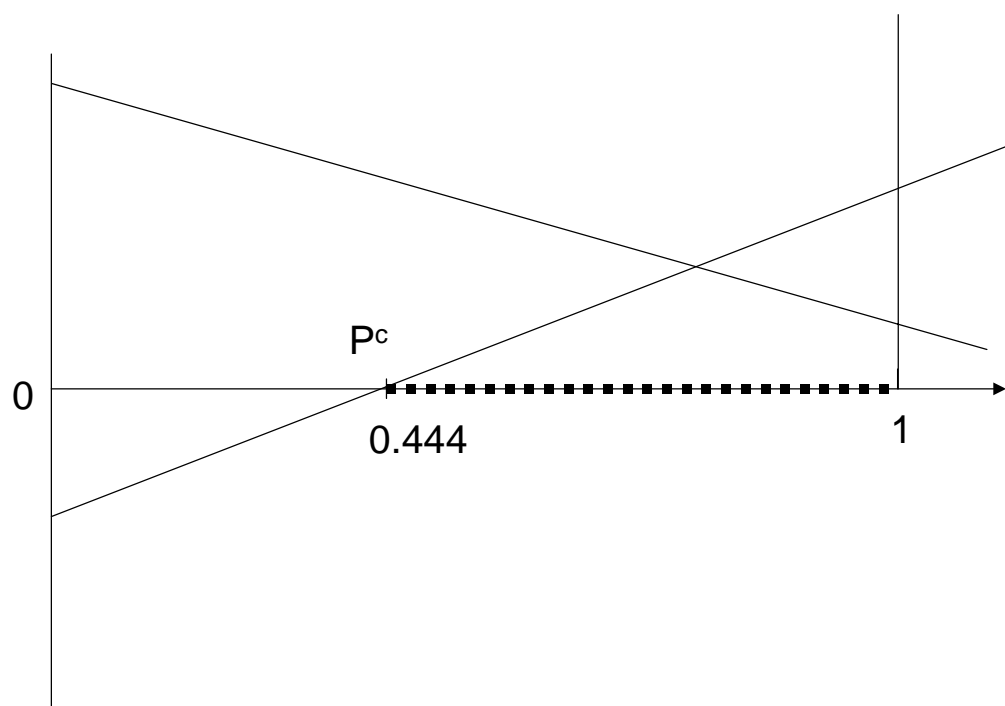


Figure 3: The Alesina-Gatti Example

In fact this is a case with a relatively small g value, since $A_2 > 0$; and also a relatively liberal Central Bank since \hat{b} exceeds the upper bound of note d) in table 1. Hence a relatively liberal Central Bank could, in this case, produce lower inflation when the Democrats have a better chance of winning elections than the Republicans. But it would not do so when the Republicans are more likely to win.

More generally it would be interesting to check if the countries which have more conservative Central Banks and stronger policy commitments actually do lie below the average in inflation and output variability in practice for their degree of independence. And conversely, that the others lie above the regression line. We have sketched those outcomes in Figure 4. Unfortunately measuring \hat{b} and g with any degree of objectivity is not going to be possible in practice, and we have not attempted to do so.

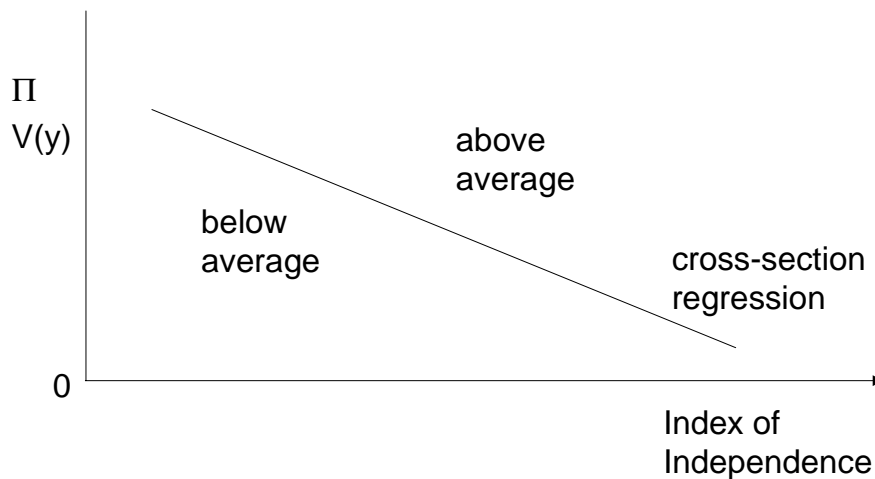


Figure 4: Identifying the conservative Central Banks with strong commitments to Stabilisation.

6. CONCLUSIONS

No Central Bank, however independent, can promise to deliver lower inflation at no cost all of the time. It is only possible to do so if the bank is very conservative, ($\hat{b} = b^R$) and the “political signal to noise” ratio, g , is sufficiently large. That may seem an improbable combination. More likely are the conditions under which there is no free lunch at all ($P^c \geq P^o$). Between these two polar cases, lower inflation for no cost is possible; but only in certain circumstances or for limited periods of time.

Second, the possibility of low inflation at no cost appears to have very little to do with the elimination of the political cycle. The elimination of the that cycle is neither sufficient to guarantee low inflation at no cost; nor is it necessary to prevent the opposite (i.e. higher inflation and/or output fluctuations). Instead the low inflation at no cost result depends on having both the right degree of conservatism and sufficiently ambitious (or distorted) output targets, when the Central Bank is independent. But the same outcome can also be obtained with a dependent Central Bank and suitable values for those same parameters. Thus an independent Central Bank may be able to reduce the political part of the cycle – in the worst case the cycle will be constrained to what b^R will allow. But it cannot reduce or eliminate an economy’s overall cycle at no cost, except in special cases. This is the important

lesson in our results since we are concerned with the existence and amplitude of the economy's cycle, rather than its source.

The intuition behind a possible free lunch therefore, has to depend on a weakening rather than the elimination of the economy's natural cycle. Any restriction like $\hat{b} \leq b^R$ will lower the inflation bias by more under independence because the more liberal elements in society, represented by b^D , are no longer expected to play any effective role in determining inflation. There could however, still be a cycle; but that cycle will be smaller than before since, under an independent Central Bank, it will be restricted by the lower value of b^R . In other words, we get closer to a single target, single instrument world- even if the temptation to switch policies is not entirely eliminated.

In the same way, a large value of k relative to σ_ε would normally lead to larger policy switches as the quadratic term in output failures would dominate when b^D was in office - the equilibrium value of y being zero, not k . A conservative independent Central Bank would then find it more acceptable to stay a roughly constant distance away from an unattainable k - than it would have done if k were smaller or \hat{b} larger in relation to σ_ε , or if b^D were let back into the game.

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