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Independence Day for the "Old Lady": A Natural Experiment on the Implications of Central Bank Independence

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ABSTRACT

Central bank independence is widely thought be a *sine qua non* of a credible commitment to price stability. The surprise decision by the UK government to grant operational independence to the Bank of England in 1997 affords us a natural experiment with which to gauge the impact on the yield curve from the adoption of central bank independence. We document the extent to which the decision to grant independence was 'news' and illustrate that the reduction in medium and long term nominal interest rates was some 50 basis points, which we show to be consistent with a sharp increase in policymaker's aversion to inflation deviations from target. We suggest therefore central bank independence represents one of the clearest signals available to elected politicians about their preferences on the control of inflation.

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There has been an enormous and influential research effort over the past two decades devoted to understanding the case for the adoption of central bank independence. Much of this research has passed into received economic wisdom about the appropriate formulation of monetary policy. Following Finn Kydland and Edward Prescott (1977) and the subsequent work by Robert Barro and David Gordon (1983), it became clear that the absence of a credible commitment by the monetary authorities to price stability would induce a positive (and costly) bias to equilibrium inflation outcomes.[1] An independent central bank with a credible commitment to price stability was widely thought to be the way to establish such credibility. This key debate was particularly instrumental in the UK. It provided the stimulus for a series of reforms to the monetary constitution of the UK in the 1990s, following exit from the ERM in 1992, and culminated with the granting of operational independence for the Bank of England in 1997.

Despite overwhelming theoretical evidence, the empirical evidence of the impact of operational central bank independence has been limited, offering at best qualified support for the benefits of such a framework.[2] We are fortunate therefore that the incoming Labour government in the UK in 1997 decided to make a surprise announcement about the creation of operational independence for the Bank of England on its fifth day of office. Although a decision to reform some aspects of the monetary constitution was expected, the crucial and final step of operational independence for the Bank of England was a complete surprise to the financial markets on the morning of May 6 1997. We should further note that the announcement did neither entail any reduction in the central target for inflation nor any change in the measure of inflation. It involved a number of

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[1] The literature is too large to do justice to in a short note such as this and we suggest the reader follows the debate in Carl Walsh (1998).
[2] The touchstone for this literature was Alberto Alesina and Lawrence Summer's (1993) finding of a negative association between the extent of central bank independence and low inflation but of no significant relationship with output growth.

procedural changes, which we outline below, with the main force of the policy initiative being that of operational independence.[3] Ben Bernanke (2003) has recently argued that "(t)he maintenance of price stability -- and equally important, the development by the central bank of a strong reputation for and commitment to it - …serves to anchor the private sector's expectations of future inflation" and it is this impact of the announcement that we wish to assess.

In this paper, we are able to evaluate the implications, in terms of nominal interest rates, from the announcement of central bank independence *per se*. Section 1 outlines the key result from a recent paper by Tore Ellingsen and Ulf Söderström (2001) which gives us the framework for examining the UK's natural experiment with a model that builds a term structure of interest rates into Lars Svensson's (1997) widely used model of aggregate supply and demand. Section 2 outlines the available documentary evidence on the decision to grant operational independence in May 1997, and shows that the decision was a surprise and thus the change in interest rates on the trading day represent a measure of the implications resulting from the adoption of credible central bank independence. Section 3 presents the response of the market in terms of the yields on UK government bonds, where we find clear evidence that the nominal yields fell dramatically on the announcement of central bank independence. Section 4 infers the move in central bank preferences in favour of inflation stabilization that would be consistent with the predictions of the Svensson-Ellingsen-Söderström model and finds a close match with the actual shift in longer tem interest rates observed on the Bank of England's 'Independence Day'. Section 5 offers a short conclusion.

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[3] Short term policy rates were also raised by 25Bp on 'Independence Day' but this move was widely expected and led to little or no movement in the short end of the yield curve see Figure 2. For example, April 1997 Goldman Sachs *UK Economics Analyst* reported that "we expect a base rate rise of at least 25 basis points at the May 7 monetary meeting" and Paribas *Economic Research* produced a forecast, April 7

I. Modeling the Yield Curve

How should the term structure of interest rates respond to monetary policy news? Specifically, how should the financial markets treat the decision by a government to adopt operational independence for a central bank in pursuit of a stated monetary objective? In a recent contribution Ellingsen and Söderström (2001) note that the literature has offered competing answers to that question. Some have argued that the yield curve ought to respond symmetrically, with long term interest rates moving in the same direction as short term interest rates. Others contend that long rates ought to respond in the opposite direction to short rates.

Ellingsen and Söderström reconcile these views arguing that what is key is whether the 'shock' driving the change in monetary policy is to the structural relations of the economy or whether shocks to the preferences of the monetary policymaker have occurred. Clearly, we can treat the move to operational independence as a clear signal that the preferences of the monetary policy maker had shifted decisively against inflation and should *mutatis mutandis* have clear implications for the rest of the yield curve. They adopt an influential model developed by Lars Svensson (1997, 1999)[4], in which shocks to inflation and output are persistent, and in which monetary policy operates with a lag. Policy authorities assess economic outcomes, and formulate policy plans, with reference to a quadratic criterion in output and inflation.

Broadly speaking, they show that if monetary policy changes are well understood by the private sector then both ends of the yield curve will move in the same direction. So, for

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1997, in which not only base rates were expected to rise 25Bp immediately after the election but also where the term structure of interest rates, as a result, shifted upwards by 25-50Bp.

[4] Laurence Ball (1999) also presents a similar model.

instance, following a tightening of the monetary stance the rise in the yield curve at the short end will be mirrored by a rise at the long end (and at all points in between). In the case of an inflation averse central bank the change at the short end is likely to be greater than the change at the long end. This same pattern of symmetric responses at the short and long end is also present when the central bank has private information on the shocks hitting the economy. In this case a rise in short rates informs agents about the future path of monetary policy.

However the presence of asymmetric information *vis a vis* the preferences of the central bank may lead to an asymmetric response at opposite ends of the curve. A tightening of monetary policy may reveal information about the preferences of the policymaker. If this is a perceived permanent change to inflation aversion then the policymaker will enact a relatively sharp tightening in the monetary stance in the short run, enabling interest rates to return to base more quickly and consequently long rates actually fall. In this case, it was not the tightening *per se* that indicated a change in preferences but an explicit announcement that the operation of policy would be undertaken by an independent central bank.

As Ellingsen and Söderström argue, testing the predictions of their model is not straightforward as "it is necessary to classify changes in monetary policy according to whether they reflect unanticipated changes in policy preferences or in economic developments" (p. 1603). However, on May 6 1997, shortly after the new Labour Government took office, the Bank of England was granted operational independence with respect to monetary policy. What is more, as we document more fully below, this policy initiative took commentators by surprise. We go on to argue therefore that the UK data

appear to be an important place to test the second prediction of the Svensson-Ellingsen-Söderström (SES) model.

II.   The Decision to Grant Independence

Following exit from the European Exchange Rate Mechanism on September 16 1992, the UK monetary authorities had adopted a target for inflation of 1-4% in October 1992 for the Parliament of 1992-7. The inflation rate was to be measured by the Retail Price Index excluding mortgage interest payments, so-called RPIX. The Chancellor of the Exchequer pursued this inflation target in conjunction with advice offered by the Governor (and other senior officials) of the Bank of England at a monthly meeting. This new post-1992 regime was accompanied by initiating the publication of an Inflation Report and minutes of monthly Governor-Chancellor meetings. The central expectation for the markets following the election of a Labour government on May 1 1997 was that this system of Central Bank advice and Treasury action would continue unchanged.[5]

But on May 6 1997, a mere four days after taking office, the incoming Labour government, with its first policy initiative, announced that the Bank of England would be granted operational independence for monetary policy. Furthermore they charged a newly created Monetary Policy Committee (MPC) with meeting the same central inflation target. In his letter to the Governor, Chancellor Brown writes: "[o]perational decisions on interest rate policy will be made by a new Monetary Policy Committee

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[5] To be clear, it was the announcement of central bank independence (CBI) on that day which was a surprise. For example, a previous Chancellor, Nigel Lawson, had made calls for formal independence and under the Maastricht Treaty the terms of joining any future European Monetary Union would involve CBI. There was much widespread opinion in the UK of the need for CBI, see, for example, Roll (1993) but adoption of CBI was not expected immediately after the election.

comprising the Governor, the Deputy Governors and six members". Additionally, the government adopted an explicit and symmetric target for RPIX inflation of 2.5%, from which any deviation of 1% would require an open letter of explanation from the Governor to the Chancellor. We stress that there was no downward shift in the central inflation target to be pursued by the monetary authorities.[6]

The decision to grant independence on that day was a surprise to the markets, HM Treasury, and to the Bank of England itself. In fact, the Chancellor's decision to grant operational independence was only openly discussed with incoming Prime Minister Blair on polling day itself, May 1 1997.[7] The Labour Party's Business Manifesto published on April 11 1997 had proposed the following reform to the Bank of England, which falls well short of operational independence:

"We propose a new monetary policy committee to decide on the advice which the Bank of England should give to the Chancellor."[8]

In the week following the announcement, the Economist Newspaper actually complained that the reform was not signaled in the Labour Party manifesto and was not debated or discussed as a serious policy initiative.[9] This decision "surprised everybody, including the Bank of England and the Treasury".[10] Certainly, in subsequent interviews the officials at the Bank of England have admitted both market and personal surprise at the announcement. Howard Davies (2000), then Deputy Governor at the Bank of England,

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[6] This is crucial as otherwise falling nominal bond yields could be attributed to falling (long run) inflation expectations via the Fisher effect.

[7] Andrew Rawnsley (2000), a widely respected political commentator in the UK, uses private interviews to establish this element of the surprise, page 3 and 31. Note that May 5 1997 was a 'Bank' Holiday Monday and so the decision was delayed to the Tuesday by this Public Holiday.

[8] Quoted by Denzil Davies (Labour) M.P. in Hansard on November 11 1997, Column 737.

[9] Economist, May 10 1997, page 13.

admitted in an interview that the announcement was "[t]o the market's surprise". Governor Sir Eddie George also admitted in an interview that he was not expecting immediate operational independence and drew a link to the likely impact on longer-term interest rates:

"…I was very surprised by the timing – the decision to move [on independence] immediately on taking office…the markets believed that the politicians would not let go of the decisions on implementation of monetary policy. And this was damaging. It meant that inflation expectations did not adjust to the extent that they might have done to the decline in actual inflation. The impact on expectations is shown by the fact that bond yields dropped 50 basis points on the announcement by the incoming government in May 1997."[11]

To sum up, the decision to grant operational independence to the Bank of England was not incorporated in central market expectations of interest rates at the close of business trading on May 2 1997 and we can therefore treat the close of business trading prices of those interest rates on May 6 1997 as indicating the impact of central bank independence.

III.   Market Interest Rates

In this section we examine three sets of market interest rates and their responses to the news of Independence on May 6 1997. Figure 1 shows the response of the three-month sterling interest rate futures at quarterly intervals until the longest dated contract at

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[10]   William Keegan (2001) *The Observer*, June 17 2001.
[11]   Central Banking Publications Limited, March 25 2002, page 22.

twenty-two months out. Figures 2 and 3 depict the response of the forward government yield curve, at horizons up to five years and then out to twenty-five years.[12]

Table 1 simply picks a small number of the representative nominal rates and quantifies the magnitude of the interest rate response. At longer term horizons we note a substantial response, measured either from the previous trading day on May 2 1997 or from two days previously on May 1 1997. The response of 10-year instantaneous forwards is illustrative. The basis point change from the closing date of the election or from the closing date of the new government's first day in office, suggests a fall in yields of some 50-60 basis points: that represented a shock in the region of several standard deviations of the typical daily change.

Short sterling contracts are market forecasts of a short-term interest rate closely related to the policy rate.[13] We note that the response of expected rates increases with horizon. This is consistent with the view that inflation from at least one year out is most likely to be affected by current monetary policy. Up to that horizon inflation is in some measure pre-determined and hence monetary policy responses should not be as sensitive to the change in preferences that central bank independence entails. This hypothesis is corroborated by the rate response of short-term interest rates. As we examine longer term interest rates, where preferences are increasingly likely to impact on interest rates, we find in each a significant decrease in interest rates. The value of central bank independence looks clear – it can significantly reduce medium and long nominal rates for both government and private sector liabilities.

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[12]   Note as May 2 1997 was a Friday and the following Monday was a Public Holiday, May 6 1997 was the next trading day. The corporate sector's commercial rates followed a very similar pattern and are available on request.

IV.   The Implications of Independence Day

The Svensson-Ellingsen-Söderström (SES) model is based on two equations in deviation form:

(1) $\pi_{t+1} = \pi_t + \alpha y_t + \varepsilon_{t+1}$

(2) $y_{t+1} = \beta y_t - \gamma(i_t - \pi_t) + \eta_{t+1}$,

where π_t is the deviation at time t of the inflation rate from its long run equilibrium level, y_t is the percentage deviation in real output from equilibrium, i_t is the deviation of the nominal short (policy) interest rate from its long-run equilibrium level and ε_t and η_t are both identically and independently distributed shocks. Equation (1) is a simple aggregate supply relationship employing an accelerationist Phillips curve, where the change in inflation is a function of the previous period's deviation in output and an aggregate supply shock. The aggregate demand relationship, equation (2), represents the deviation in output as a function of its own lag and (the deviation in) the *ex-post* real interest rate and a demand shock. At each point in time it is assumed the monetary authority selects the nominal short interest rate in order to minimize a standard inter-temporal loss function:

(3) $\Psi_t = E_t \sum_{s=0}^{\infty} \delta^s L(\pi_{t+s}, y_{t+s})$,

where δ is a constant discount factor and λ, the monetary authority's preference parameter, is the weight placed upon output stabilization relative to inflation stabilization in a standard period loss function,

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[13]   Since March 1997 the instrument of monetary policy in the UK has been a two week repo rate.

(4) $\qquad L(\pi_t, y_t) = \frac{1}{2}\pi_t^2 + \frac{1}{2}\lambda y_t^2$.

The bank is assumed to minimize its loss function subject to a constraint found by taking expectations of equation (1). We make use of the following Lagrangian formulation:[14]

(5) $\qquad L = E_t \sum_{s=0}^{\infty} \delta^{s+1} \left\{ \left(\frac{1}{2}\pi_t^2 + \frac{1}{2}\lambda y_t^2 \right) + \phi_{t+1} \left(\pi_{t+2} - \pi_{t+1} - \alpha y_{t+1} \right) \right\}$.

First order conditions are given by,

(6) $\qquad \delta \pi_{t+2|t} + (1-\delta)\phi_{t+2|t} = 0$

(7) $\qquad \lambda y_{t+1|t} - \alpha \phi_{t+1|t} = 0$

(8) $\qquad \pi_{t+2|t} - \pi_{t+1|t} - \alpha y_{t+1|t} = 0$

We exploit the trade off in the loss function and posit that the optimal expected output gap is negatively related the expected deviation in inflation two periods ahead,

(9) $\qquad y_{t+1|t} = -k\pi_{t+2|t}$

We shall solve for k in a moment[15]. Substituting for the expected output gap in equation (7), using equation (8) and putting the resulting expression into equation (6) yields,

(10) $\qquad \left(1 - \frac{\lambda k}{\alpha \delta} \right) \pi_{t+2|t} = \phi_{t+2|t}$

If we then lead equations (7), (8) and (9) forward one period, then a small amount of algebra yields,

(11) $\qquad \phi_{t+2|t} = - \left(\frac{\lambda k}{\alpha(1+\alpha k)} \right) \pi_{t+2|t}$

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[14] Svensson (1997, 1999) and Ellingsen and Söderström (2001) make use of dynamic programming to uncover the optimality conditions.

[15] Note that this is analogous to the 'guess and verify' approach to finding the value function. See Svensson (1997, 1999) and Ellingsen and Söderström (2001) for further details.

Equation (11) may then be substituted into equation (10) in order to derive the following

unique and positive expression for k,

(12) $$k = \frac{1}{2\alpha\lambda}\left\{\left[\alpha^2\delta - \lambda(1-\delta)\right] + \sqrt{\left[\alpha^2\delta + \lambda(1-\delta)\right]^2 + 4\lambda\alpha^2\delta^2}\right\}$$

We then substitute equation (9) into equation (2) and take expectations of the resulting

expression to get,

(13) $$i_t - \pi_t = \frac{\beta}{\gamma}y_t + \frac{k}{\gamma}\pi_{t+2|t}$$

and then put equations (1) and (2) into equation (9). Taking expectations of the resulting

expression results in,

(14) $$i_t = (1+A)\pi_t + By_t$$

where

$$A = \frac{k}{\gamma(1+\alpha k)} \quad \text{and} \quad B = \frac{\beta}{\gamma} + \alpha A$$

That is, the optimal rule used by the central bank may be represented by an optimal

Taylor rule.

Leading the optimal Taylor rule (6) and taking expectations gives

(12) $$i_{t+s|t} = (1+A_t)\pi_{t+s|t} + B_t y_{t+s|t}$$

That is the expected forward rate is simply the expected Taylor rule at each point in the

future. Ellingsen and Söderström then show that by leading and taking expectations of

equations (1) and (2) and using them in equation (12) it is possible to write the expected

forward rate (under certainty equivalence) as:

(13) $$i_{t+s|t} = [1+A_t(1-\gamma B_t)][1-\alpha\gamma A_t]^{s-1}(\pi_t + \alpha y_t),$$

where $i_{t+s|t}$ is the expected interest rate s periods ahead, and A_t and B_t are functions of the

parameters of equations (1), (2), (3) and (4).[16]

Our estimation strategy is to generate the yield curve pre and post-Independence

Day using equation (5), which most closely replicates the observed change in nominal

rates outlined in Section 3 and infer the implied change in preferences, λ. The first step

is to estimate the set of parameter values (α, β, γ) as well as obtain values for the

inflation and output shocks at the time. Armed with estimates of the structural model

from equations (1) and (2), we then calculate a value for the policy preference

parameter, λ both before and after operational independence that minimizes the

difference between the change in the forward yield curve predicted by our model and the

change in the forward yield curve observed in the real world data.[17]

We obtain parameter values $\alpha, \beta,$ and γ by estimating equations (1) and (2) using

full information maximum likelihood (FIML). Our estimates were made on data of both

annual and quarterly frequency, for a number of different samples and making use of a

number of different definitions of the variables included in equations (1) and (2).[18] The

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[16] See Ellingsen and Söderström (2001) for a fuller derivation of this result.
[17] Related work includes Cecchetti *et al*, (2002), who make use of an SVAR model to generate an optimal
interest rate series that minimizes a standard loss function. This series is then use to extract an estimate of
the policy preference parameter for a number of European economies. Robertson and Symons (1994, 1997)
make use of government index linked debt to extract an estimate of the *ex-ante* real short interest rate and
examine how it is influenced by changes in UK monetary policy.
[18] More specifically our FIML estimates are calculated using annual data covering the period from 1950 to
1996, and quarterly data covering the periods 1980:1 to 1997:1 and from 1993:1 to 1997:1. Our output
variable is the percentage difference between actual real GDP and potential real GDP where potential real
GDP is calculated by fitting a quadratic trend through the appropriate sample of data. For sub-samples
based on 1993:1 to 1997:1, potential GDP is calculated using 1980:1 to 1997:1 sample. We also
experimented with percentage growth as the output variable. We assume equilibrium inflation to be the
then Bank of England target rate of 2.5% and the equilibrium nominal short interest rate to be the
appropriate sample mean. In other specifications we experimented by allowing equilibrium inflation to be
a centred five year moving average of actual inflation and the equilibrium nominal short interest rate to be
equal to this value plus a constant term, where the constant is from a regression of the nominal interest rate
on the inflation rate over the appropriate sample period. Inflation is measured as the (annualized) change in
the RPIX (from 1976 onwards) and the RPI (before 1976). Our interest rate variable is the appropriate
monetary policy instrument (base rate), which was the Bank Rate until October 1972, the Minimum
Lending Rate from October 1972 until March 1981, the Minimum Band 1 Lending Rate thereafter until
March 1997 and the two week Repo Rate since. Since the regression equations are in 'quasi' – deviation

upper panel of Table 2 presents the estimated parameter values. We also assume that both inflation and output were both expected to be above target in the absence of policy action.[19]

In order to illustrate this methodology we will initially select the parameter values of $\alpha = 0.1$[20], $\beta = 0.1, \gamma = 1.0$[21] and $\delta = 1/1.04$, with the supplementary assumption that the economy faced an inflation and output overshoot of 1.0%. We may then select values of the Bank of England's preference parameter for output over inflation stabilization both before (λ_1) and after (λ_2) operational independence. We calculate a nominal forward rate curve before and after operational independence and compare this generated change with the observed change in the nominal forward rate curve. Values for λ_1 and λ_2 are chosen by minimizing the root mean squared error (RMSE) statistic for the difference in the change between the two sets of curves.

For this particular combination of parameters and deviations on 'Independence Day', the RMSE is minimized when $\lambda_1 = 10.3$ and $\lambda_2 = 0.6$ (see Figure 4). This implies a large proportionate fall in λ when the Bank of England was granted operational independence, and is consistent with the predictions of the SES model. The observed fall in yields is consistent with a surprise fall in the policy preference parameter, which in turn causes the expected future interest rate to fall, as markets expect inflation to return to equilibrium more quickly. This finding is robust for any reasonable value of the Phillips curve slope, α. Figure 5 plots the change in λ (as a percentage of its initial value) against α, and suggests the magnitude of the change decreases in α. Note also, we find that as

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form, we also included a constant term in some specifications. Further details of the estimates are available on request.
[19] The 1997 IMF Article IV pointed to the main risk in the UK economy was that 'too-rapid growth based on the momentum of domestic demand could rekindle inflation' see
http://www.imf.org/external/np/sec/pn/1997/pn9734.htm
[20] This value corresponds to that found by Glenn D Rudebusch and Lars E. O. Svensson, 1999, and is close in spirit to the micro-founded value used by Julio J. Rotemberg and Michael Woodford, 1997.
[21] These values are suggested by Laurence Ball, 1999 for a small open economy.

the value of α rises (after a minimum of 0.04), so does the value of the RMSE statistic (see Figure 6) and we find that the log likelihood is also maximized when α implies a relatively inelastic inflation response to output and so we best explain the observed shift in the yield curve with a relatively inelastic Phillips curve slope. The intuition follows from the impact of a demand shock (Equation 2), which will lead to changes in both the output and inflation deviation variables in the same direction. The monetary authority's response, in terms of interest rates, will have a weaker impact on expected future inflation (Equation 1) the lower is α (the flatter is the Phillips curve). Thus expected future short rates will mean revert relatively less quickly causing the difference in the simulated forward rate curves, before and after operational independence, to diminish less quickly and resemble more the real world data, and hence improve the fit of the SES model.

The upper panel of Table 2 presents our parameter estimates and the lower panel the results of using these estimates to calculate the implied change in central bank preferences. From these estimates we infer λ_1 and λ_2, which generate the closest fit to the observed shift in the yield curve on Independence Day. We therefore apply the parameter values to our simulations. For each model and set of parameters we find clear evidence that $\lambda_1 > \lambda_2$ (i.e., that $\Delta\lambda / \lambda_1 < 0$) so that the shift in the yield curve was consistent with a sharp perceived fall in the relative weight the monetary authorities placed on inflation relative to output following the announcement of central bank independence. In effect, we find that, providing our parameter estimates are acceptable and that the UK economy needed higher interest rates in order to stabilize output and inflation, the substantial shift downwards in the interest rates associated with longer term liabilities can be attributed to a sharp fall in the extent to which the monetary authorities valued output deviations from equilibrium as opposed to inflation deviations from target.

V.   Conclusion

The arguments for central bank independence represent a key contribution of economic science to the formulation of monetary policy. Ellingsen and Söderström (2001) provide us with a framework for understanding why the audacious stroke of the UK's new government in 1997 so profoundly affected nominal interest rates. Our results suggest the granting of operational independence for the Bank of England allowed policymakers to signal, in the clearest form available to them, that there was a significant increase in the policy losses associated with inflation instability. The empirical evidence for the benefits of central bank independence is thus clarified: long-term interest rates will fall.

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TABLE 1   RESPONSE OF MARKET INTEREST RATES TO INDEPENDENCE DAY.

| Yield Curve	1-day change	2-day change	Standard deviation
September 1997	-6 B.p.	-5 B.p.	6 B.p.
June 1998	-14 B.p.	-9 B.p.	6 B.p.
December 1998	-20 B.p.	-17 B.p.	6 B.p.
5 year nominal forward	-34 B.p.	- 34 B.p.	7 B.p.
10 year nominal forward	-51 B.p.	-62 B.p.	7 B.p.
15 year nominal forward	-59 B.p.	-62 B.p.	7 B.p.
20 year nominal forward	-59 B.p.	-49 B.p.	7 B.p.
5 year benchmark:			
7% 2002	- 18 B.p.	- 22 B.p.	6 B.p.
10 year benchmark:			
7 ¼% 2007	-29 B.p.	-33 B.p.	6 B.p.

Notes: We show the change on implied interest rates three-month sterling futures, the fitted forward curve and on benchmark bond redemption yields on one-trading day i.e. either side of the decision on independence and the two-day change, which includes the first day of trading following the election of the incoming Labour government. The standard deviation represents that of daily changes in the calendar year.

**TABLE 2**   **PARAMETER ESTIMATES.**

	Model		
	a	b	c
α	0.24	0.28	0.29
β	0.61	0.67	0.60
γ	0.14	0.05	0.05
Frequency	quarterly	annual	quarterly
Sample	93:1 – 97:1	50 - 96	80:1 – 97:1
ML	-5.86	-209.36	-291.56
$\overline{R}_1^2$	0.22	0.61	0.48
$\overline{R}_2^2$	0.80	0.17	0.35
DW_1	1.04	1.92	0.42
DW_2	1.04	1.97	0.28
λ_1	8.5	6.1	4.8
λ_2	1.0	1.7	1.6
$\Delta\lambda / \lambda_1$	-0.88	-0.72	-0.67
RMSE	17.01	16.47	21.67

Notes: The parameters were estimated by FIML, using annual and quarterly data. Models a-c are estimates of the Equations (1) and (2) from the text. We assume equilibrium inflation is the target rate of 2.5 percent and that the equilibrium level of the nominal short interest rate is the relevant sample mean. In the quarterly models output is measured as a deviation from potential output and in c output is measured as percentage growth. Summary statistics of the regressions are also presented: ML represents the maximized likelihood value, $\overline{R}_1^2$ and DW_1 and $\overline{R}_2^2$ and DW_2 are the adjusted R^2 and Durbin-Watson statistics from estimation of Equations (1) and (2) respectively. λ_1 and λ_2 are the weights placed upon output stabilization relative to inflation stabilization by the monetary authorities before and after operational independence. For given output and inflation innovations, values for λ_1, λ_2, and $\Delta\lambda / \lambda_1$ are found by minimizing the difference, as measured by Root Mean Squared Error (RMSE) statistic, in basis points, between the change in the actual nominal forward yield curve and that predicted by the model. We assume an initial deviation in both inflation and output of 0.8 percent.
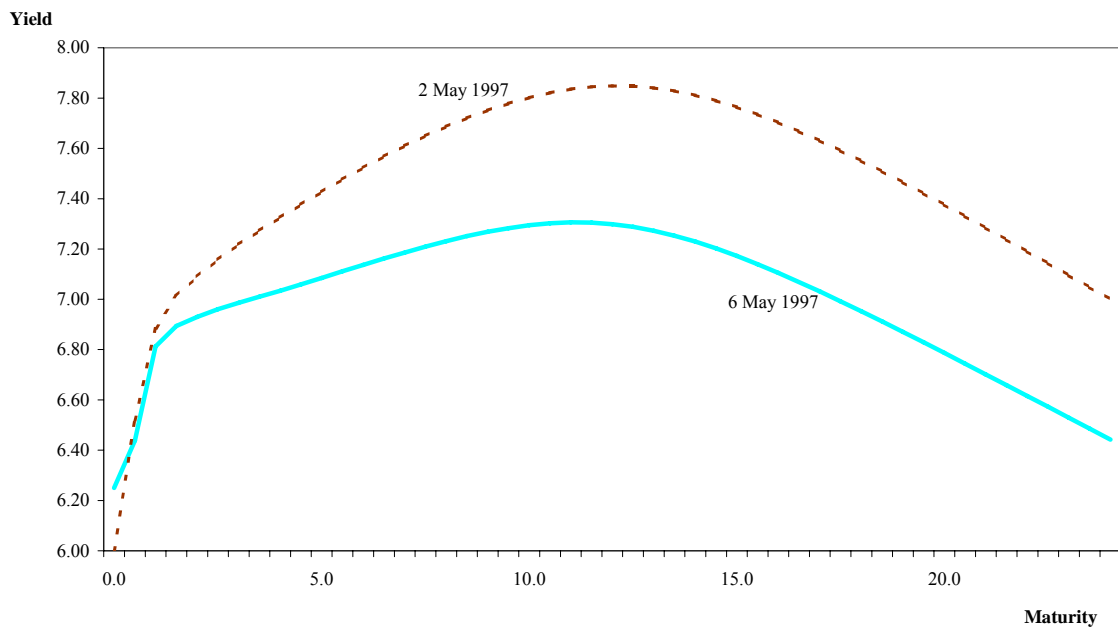
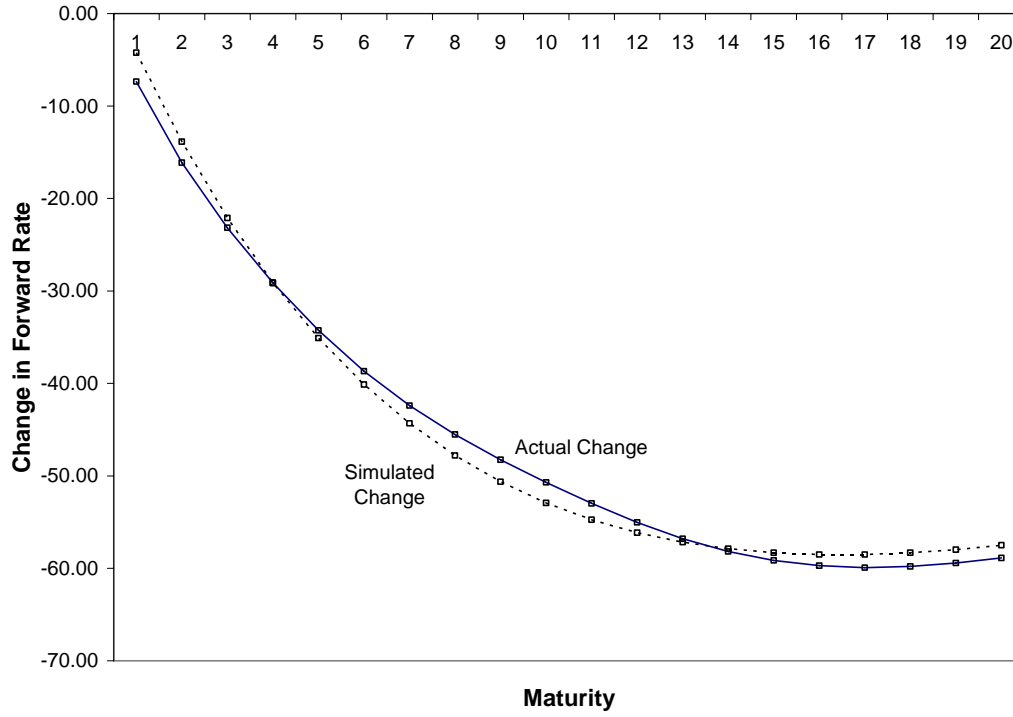**Figure 1: UK Three Month Sterling Futures**
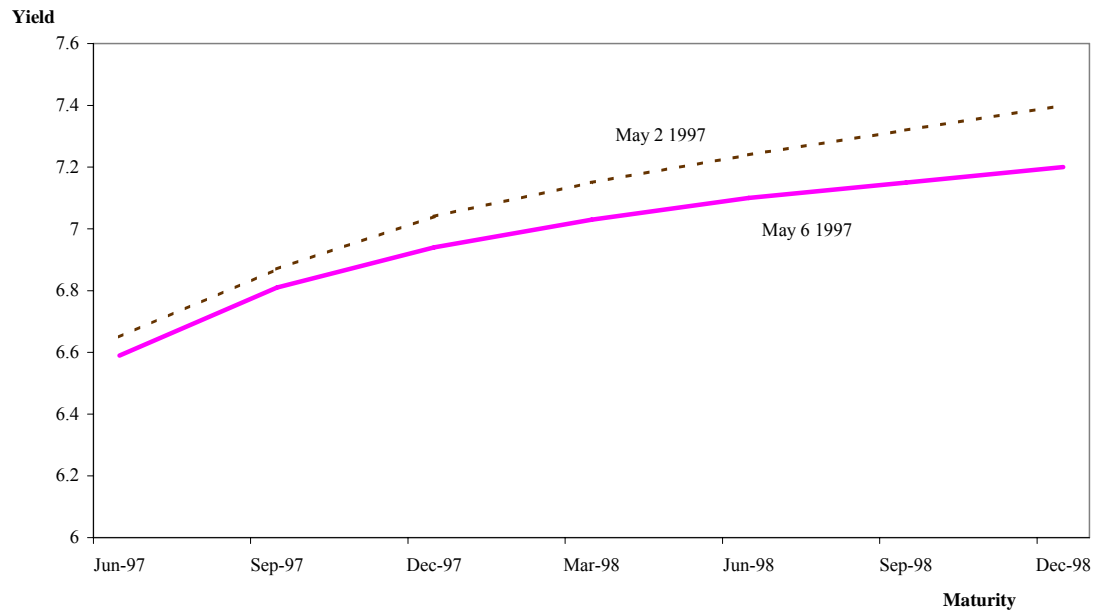
Figure 2: UK Nominal Forward Curve - Short End
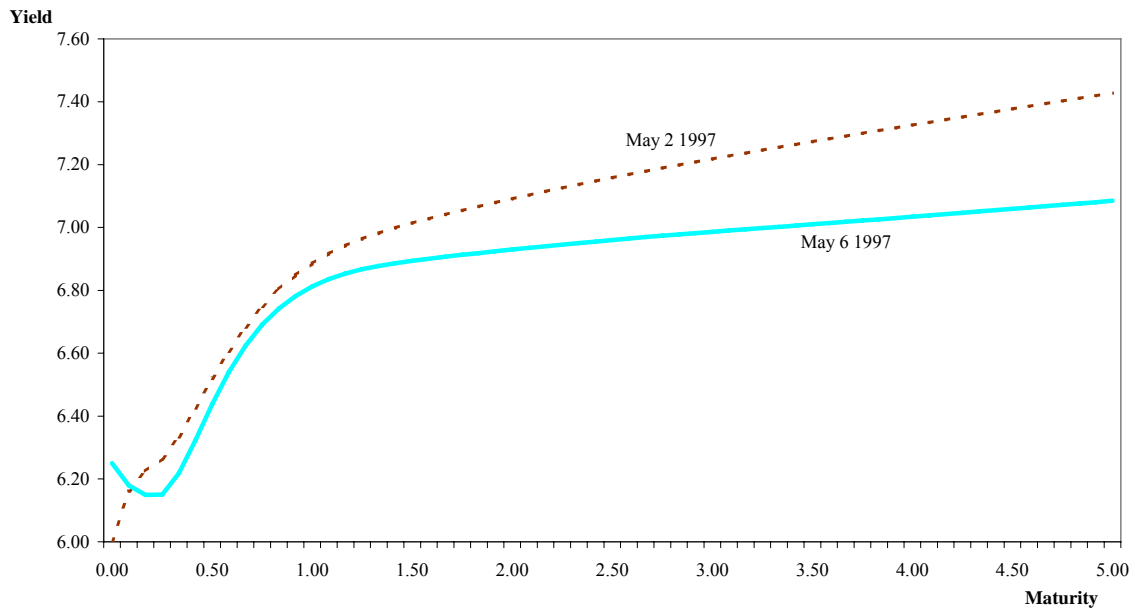
**Figure 3: UK Nominal Forward Curve**

Figure 4: Actual and simulated change in UK nominal forward rates

Notes: We assume $\alpha = 0.1, \beta = 0.9, \gamma = 1.0, \delta = 1/1.04$ and the inflation and output innovations are equal to 1.0 percent. This results in a minimized RMSE of 1.63 basis points, $\lambda_1 = 10.3$, $\lambda_2 = 0.6$ and a proportionate fall in λ of 0.94. The change in the forward rate is measured in basis points.
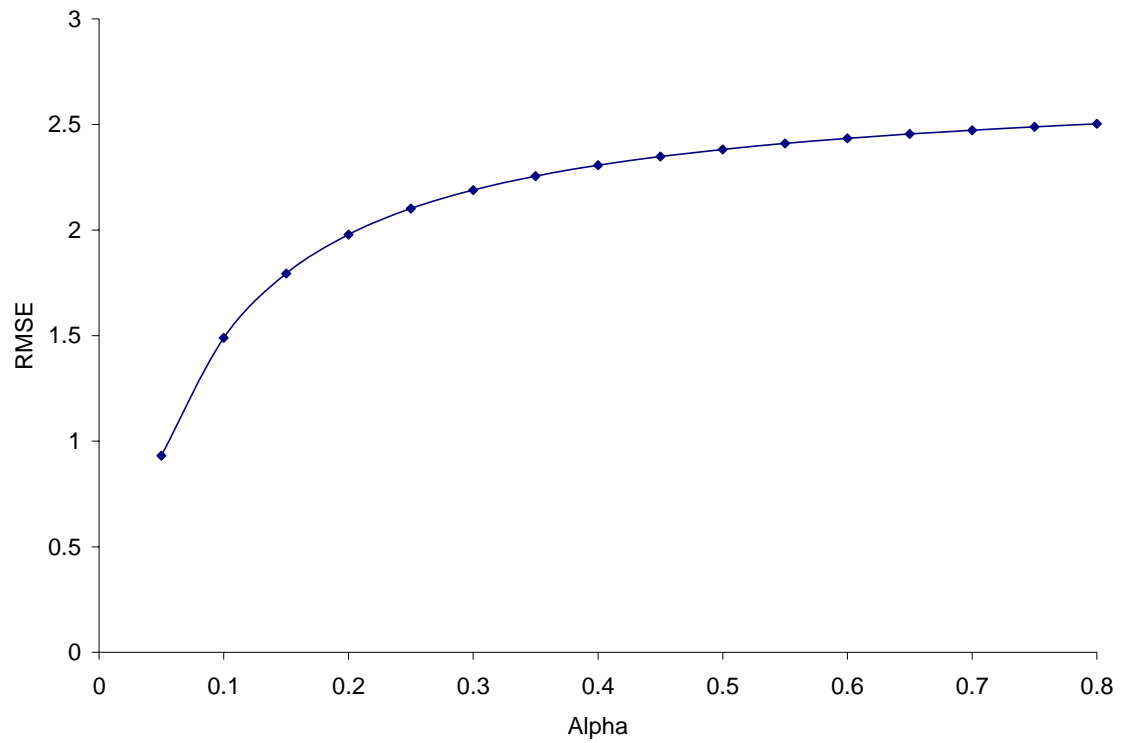
Figure 5: Response of the percentage change in lambda to a change in α
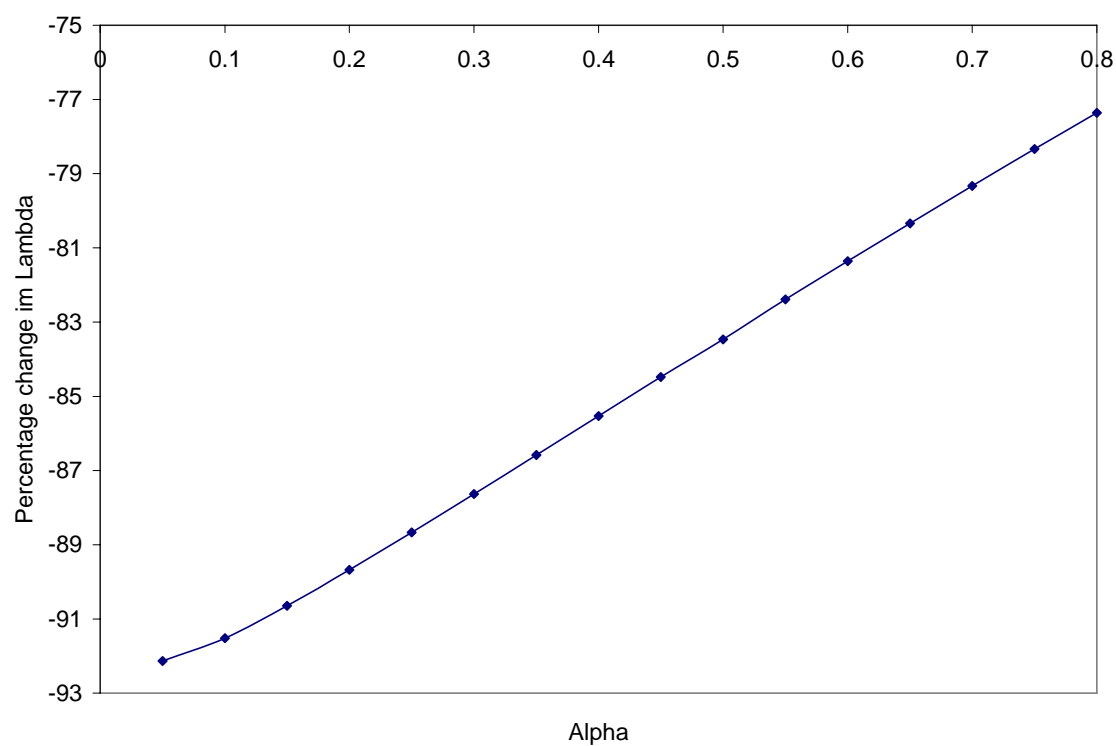

Notes: We assume $\beta = 0.9, \gamma = 1.0, \delta = 1/1.04$ and the inflation and output innovations are equal to 1.0 percent. The diagram suggests a negative relationship between the slope of the Phillips curve and the magnitude of the percentage fall in the policy preference parameter on 'Independence Day'.

Figure 6: Response of RMSE to a change in α

Notes: We assume $\beta = 0.9, \gamma = 1.0, \delta = 1/1.04$ and the inflation and output innovations are equal to 1.0 percent. The diagram suggests the RMSE (measured in basis points) of the best fitting SES model increases with the slope of the Phillips curve.

Figure 7: Response of the maximized likelihood value to a change in α
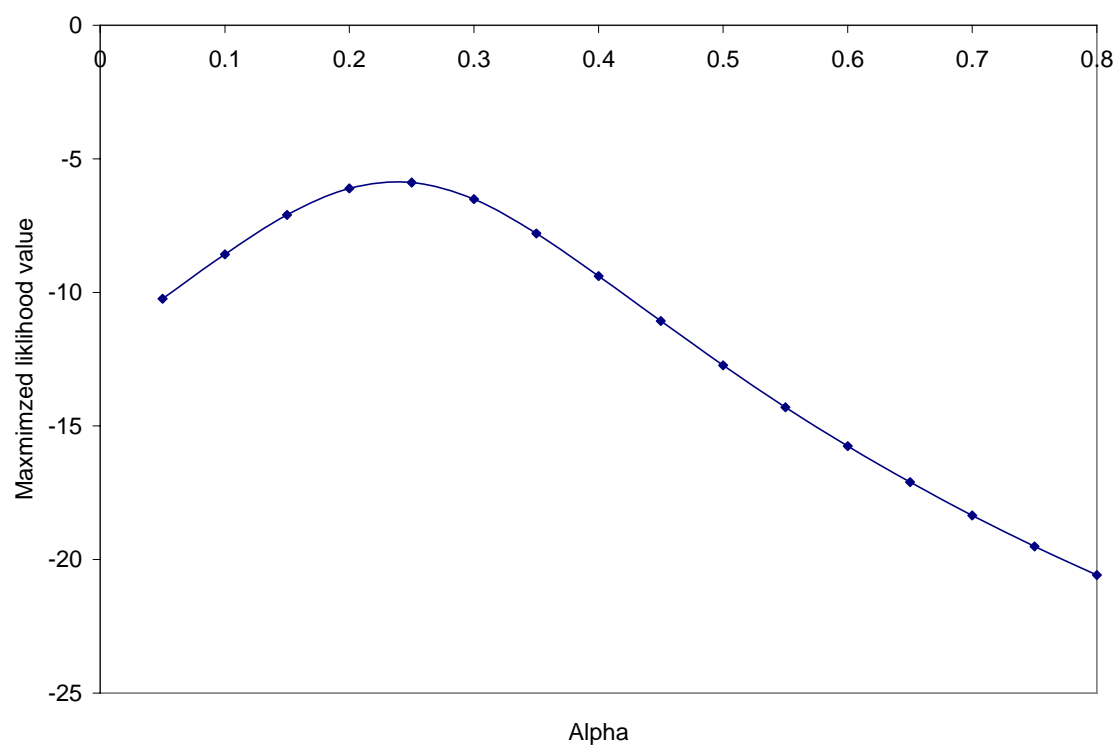
Notes: The maximized likelihood value is found from model a in Table 2 above. We allow α to vary, but fix the other parameters and the deviation from equilibrium in inflation and output.

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