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ABSTRACT

UK Phillips Curves and Monetary Policy*

This Paper documents some stylized facts on evolving UK Phillips curves and shows how these differ from their US versions. We interpret UK Phillips curve dynamics in a positive theory of monetary policy – how policy-maker attitudes on the Phillips curve have evolved since the 1950s – rather than, more traditionally, as interaction between exogenous demand and supply disturbances. Combining this framework with reasoned conjectures on how policy-makers' beliefs have changed helps explain some features of the evolving UK Phillips curve. We suggest that correlations suggesting an extreme favourable unemployment/inflation trade-off might indicate not something to be exploited but instead only policy-makers' correctly acknowledging that no trade-off exists.

JEL Classification: C22, C23, E31, E32
Keywords: beliefs, inflation, natural rate hypothesis, stability

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NON-TECHNICAL SUMMARY

Forty years ago, AW Phillips plotted nominal wage inflation against unemployment in the United Kingdom and remarked on their tight and stable negative relation over the previous century. This marked the birth of the Phillips curve.

Twenty years after Phillips's Paper, Robert Lucas and Thomas Sargent set the simultaneously high inflation and unemployment of the 1970s, evident across practically all developed economies, against a Phillips curve backdrop and decried the 'econometric failure on a grand scale'. This followed a sequence of papers during the 1970s that had called into question the econometric and theoretical basis of the Phillips curve and hence its usefulness for public policy purposes.

Yet a further twenty years on, the Phillips curve seems to have once more resumed a central place in macroeconomic analysis. Careful econometric studies in the US have detected a stable and persisting correlation between wage inflation and unemployment at business cycle frequencies. At least in the US, a Phillips curve persists in the data and, reflecting this, the Phillips curve continues to be the centrepiece of many modern-day macroeconomic models.

These three generations of academic thinking have been mirrored in the evolution of monetary policy-making in the UK, albeit with a lag. Over the post-war period, the design of monetary frameworks in the UK has been heavily influenced by changing intellectual perspectives on the Phillips curve. Of particular significance were the empirical regularities, exploitable or otherwise, which the Phillips curve was, at different times, believed to embody. A post-war history of UK monetary policy is, in essence, a post-war history of the Phillips curve.

During the 1950s and 1960s in the UK, the Phillips curve was believed to present policy-makers with a simple menu of long-run inflation/unemployment choices. The policy-makers' job was simple: to position the economy at a preferred inflation/unemployment point on this apparently unchanging Phillips curve technical frontier. This approach, which was heavily influenced by the empirical regularity first unearthed by Phillips, dominated UK policy behaviour right up to the beginning of the 1970s.

The 1970s marked the first turning point. The sharp rise in world-wide inflation in the early 1970s and its continuation in the UK through much of the 1980s, destroyed the previous policy consensus. Inflation expectations, once dislodged, meant that the empirical regularities evident in Phillips's work

became a ‘moveable feast’. Those lessons, first made explicit in the work of Milton Friedman and Edmund Phelps and subsequently Robert Lucas, implied that monetary policy was largely ineffective for influencing anything other than the economy’s nominal side, certainly over medium-term horizons. Attempts to exploit even temporary Phillips curve trade-offs resulted in those trade-offs disappearing. More seriously, attempting to exploit the Phillips curve risked pushing the economy towards ever higher inflation.

This message was digested by UK policy-makers from the early 1970s onwards. By the mid-1970s, frameworks for monetary policy set out to target explicitly nominal magnitudes: different measures of the money supply (with varying degrees of emphasis between 1976–86); the exchange rate (implicitly in 1987–8 and explicitly in 1990–2); and since 1992, the inflation rate itself. Over the period since then, inflation in the UK has roughly speaking been on a downward path.

During the 1990s, as UK inflation has fallen to its lowest levels since the 1960s, there has been a further, subtle shift in monetary policy emphasis. Once again, this view seems to be rooted in a particular view of the Phillips curve. This new policy approach seems to be grounded in two propositions. First, following inflation disturbances, short-run inflation/output trade-offs can be exploited to smooth output as inflation is directed back to target. Second, the scope for exercising this counter-cyclical flexibility in the face of inflationary shocks is greater when inflation expectations are anchored close to target. Acting in this way, monetary policy would aim to stabilize the real side of the economy over the business cycle, while at the same time adhering to a medium-term inflation target. This approach is founded on a stable short-run Phillips curve, at least over the business cycle.

What does empirical evidence reveal about the evolving pattern of Phillips curve (ir)regularities in the UK? And how do these compare with empirical patterns in the US? The data we consider are annual data on unemployment and wage inflation over the period 1856–1997. This sample extends Phillips’s original sample by 45 years: 5 years before, and 40 years after. We need a long run of data to be able to detect some of the regime-shifts in monetary policy thinking and behaviour discussed above.

The data are analysed in two ways. First, we filter the data to pick out its business cycle components before plotting unemployment against wage inflation. Similar exercises to this have been conducted in the US on post-war data. They have found evidence of a strong negative unemployment/inflation relation at business cycle frequencies. Post-war UK data reveal a different pattern, however. At business cycle frequencies, there is no evidence of a Phillips curve. Indeed, the UK Phillips curve appears almost vertical on filtered post-war data.

Second, we simply plot unconditional graphs of unemployment against wage inflation, in the spirit of Phillips's original work. This too reveals some interesting patterns. On post-war US data, there is then no evidence of a Phillips curve relation. The exact opposite is again true in the UK, however. Although the distribution of inflation/unemployment outcomes varies over time, over a sample back to 1856 there is clear evidence of a Phillips curve relation. Within this, it is possible to identify three distinct episodes. Over Phillips's original sample, a negative relationship is clearly evident. Over the period 1949–79, this relation disappears and the Phillips curve appears as almost vertical. Finally, over the period since 1980, there is evidence of a negative unemployment/inflation relation having re-emerged. Indeed, over this period the UK Phillips curve is practically horizontal.

How do we make sense of these stylized facts? What explains the changing nature of the unemployment/inflation relation in the UK over time? And how do we account for the different empirical Phillips curve patterns in the UK and the US? We develop an analytical model to try and understand these empirical patterns. The analytical framework focuses on the interaction between policy-makers' beliefs about how the economy operates and the private sector's response to the policy-makers' actions and beliefs. Observed correlation between unemployment and inflation derive endogenously from this public-private sector interaction. As policy-makers' beliefs about the economy change, so too will the observed Phillips curve correlation, as policy-maker and private sector behaviour adapt.

The model we use is similar in many respects to Clarida, Gali and Gertler. It comprises aggregate demand and aggregate supply relationships, which describe the behaviour of aggregate output and aggregate inflation in the economy. Both decision rules are subject to shocks, labelled respectively demand and productivity (supply) disturbances. Aggregate demand depends negatively on the real interest rate: the policy lever of the monetary authorities. The aggregate supply relation is vertical in the long run, monetary policy is long-run neutral, but there is a potential short-run relation between aggregate output and inflation in the model: there are potential short-run non-neutralities.

Monetary policy-makers face an intertemporal optimization problem of minimizing squared deviations of output from trend and inflation from target. This objective function appears to describe well the preferences of monetary policy-makers, for example, in the US (under the Humphrey-Hawkins Act), the UK (under the Bank of England Act) and the Euro-area (under the terms of the Maastricht Treaty). Policy-makers choose a decision rule for short-term interest rates, which depends on the outcomes for observable macroeoconomic variables.

To begin with, we assume that in choosing their decision rule policy-makers have correct beliefs about the structure of the economy: they are perfectly informed. In particular, they are assumed to understand that monetary policy is neutral with respect to the real side of the economy in the long-run, but that over the short-run there may be important non-neutralities at work.

The equilibrium of the model is derived from the behavioural interaction between policy-makers and the private sector. This interaction gives rise to a reduced-form distribution of inflation and output outcomes, or Phillips curve. In the model, when perfectly informed policy-makers optimize in conducting monetary policy, this reduced-form distribution implies a wrongly sloped or horizontal Phillips curve relationship. Why is this?

It derives from the authorities' optimizing response to demand and supply shocks. In an optimizing setting, demand shocks are fully offset by the authorities' interest rate rule. This is possible because output and inflation are shifted in the same direction by demand shocks. They therefore pose no dilemma for a policy-maker seeking to stabilize inflation relative to target and output relative to trend. In particular, monetary policy will tighten sharply to offset positive demand shocks, which push inflation and output above their equilibrium values; and, conversely, will loosen sharply to offset the effects of negative demand shocks, which push inflation and output below equilibrium. The aggressiveness of policy in response to demand shocks means that their effects on the economy can be neutralized completely.

Supply shocks pose greater problems for the policy-maker. They push inflation and output in opposite directions relative to their equilibrium values. Monetary policy cannot therefore fully offset the effects of these shocks, as aiming to push inflation back to target would risk pushing output further away from trend, or vice-versa. It is the authorities' inability to neutralize fully the effects of supply shocks on both output and inflation that gives rise to the wrongly-sloped Phillips curve in the equilibrium of the model.

A horizontal Phillips curve results when the short-run aggregate supply is very inelastic, that is, when monetary policy is neutral with respect to the real side, not just in the medium term but in the short run as well. When the underlying aggregate supply curve is vertical in both the long and short run, and policy-makers recognize this, the optimizing policy response is to damp the effects of supply shocks on inflation while allowing output to be buffeted around by these shocks, about which policy-makers can do nothing. It is this behaviour that gives rise to the horizontal Phillips curve, with inflation anchored at target by monetary policy and output driven by productivity shocks.

These results have important normative implications for the conduct of monetary policy. A misguided policy-maker could observe a horizontal

unconditional Phillips curve and conclude that this provided considerable scope for counter-cyclical monetary policy. In fact, the horizontal Phillips curve derives precisely from the absence of any true Phillips curve trade-off, in both the long and the short run.

This is similar to the warning issued to policy-makers by Robert Lucas back in the 1970s. That warning was about misguidedly attempting to exploit observed short-run Phillips curve trade-offs, because attempts to do so would themselves cause the trade-off to worsen and ultimately disappear. Here the warning is slightly different: That policy-makers may draw precisely the wrong conclusion about the probable efficacy of their counter-cyclical actions by making inferences from reduced-form output/inflation correlation. The reason is simple: these correlations are partly the result of policy-makers' actions and preferences, not an inviolable technical frontier.

These analytical results are also useful in helping to explain the stylized facts about reduced-form output/unemployment correlation in the UK. Over the period since 1980, the Phillips curve relationship in the UK is roughly horizontal. One interpretation is that this is a reflection of better-informed policy-making on the part of the UK monetary authorities. In particular, it is consistent with policy-makers having recognized the pervasiveness of monetary non-neutralities, not only over the long run but potentially over the shorter run too and optimally recallibrating monetary policy in response to this information. So a standard analytical framework can be used to provide one interpretation of Phillips curve correlation in the UK over the period since 1980. But as it stands, it cannot account for Phillips curve correlation over earlier periods in the UK. For example, what accounts for the original Phillips curve correlation, which existed right up to the 1960s? And how do we explain the Phillips curve then vanishing and the simultaneous increase in inflation in the 1970s?

One potential explanation is to be found in the changing beliefs of UK policy-makers. So far we have assumed that the authorities are perfectly informed about the structure of the economy and in particular about the nature of the aggregate supply curve. This is inconsistent with our historical reading of the behaviour of monetary policy-makers in the UK. At different times in the past, policy-makers have held quite different views about the nature of the aggregate supply curve. Could the actions of misinformed policy-makers, acting on those misguided beliefs, generate different inflation/output correlation, which are better aligned with historical patterns?

We consider three types of misguided beliefs on the part of the policy-maker; all of them regarding the nature of the aggregate supply curve. In the first case, we assume that the authorities misguidedly disbelieve long-run neutrality. In the second case, we assume that policy-makers believe there is

a short-run output/inflation trade-off, when in fact no short-run trade-off exists (both the short- and long-run aggregate supply curve is vertical). In the third case, the policy-maker mistakenly takes the short-run output/inflation trade-off to be stable, when in fact it shifts each period as the policy-maker tries to exploit the short-run relationship, as in the 'surprise' aggregate supply curve of Robert Lucas.

All three of these cases deliver a conventional, negative relationship between inflation and unemployment. In the case of mistaken beliefs about long-run neutrality, this results from the policy-maker being too expansionary in the face of supply shocks. So for example, negative productivity shocks cause the policy-maker to pursue expansionary policies, raising output at the expense of the upward impetus to inflation, thereby generating a positive correlation between the output and inflation, or a conventionally-sloped Phillips curve. A similar logic applies to the other two cases. In both, policy-makers believe they have the capacity to conduct counter-cyclical policy more effectively than is in fact the case. So the Phillips curve correlation evident in earlier periods can plausibly be explained by the different beliefs of policy-makers about the aggregate supply curve that then prevailed.

The model does less well in accounting for the high and runaway inflation of the 1970s. In the model, misperceptions about the long-run Phillips curve deliver a negative inflation bias in equilibrium. Though the nominal interest rate is lower than is optimal in this case, this lower nominal rate is matched exactly by lower inflation expectations. Alternative frameworks would therefore be needed to account for inflationary behaviour in the 1970: perhaps models where there is no nominal anchor for monetary policy at all, or where the authorities aim systematically to inflict inflationary surprises on the public.

We think of the exercise as a partial success. Using a standard model of monetary policy, but allowing policy-makers to be misguided about the nature of the economy, it is possible to reproduce some salient facts about UK Phillips curves. Published statements by UK central bankers were used to determine the nature of these misperceptions. Over Phillips's original sample, and over the period since the 1980s, the model appears to give some useful insights. The model fails, however, to provide a clean explanation of the 1960s and in particular the 1970s in terms of average inflation performance.

Finally, we conclude with a policy warning. In this model, perfectly informed policy-makers are capable of generating a horizontal Phillips curve. Indeed, this is exactly what is observed in UK data from 1980. Importantly, however, this does not mean that an exploitable Phillips curve trade-off exists. In fact, the opposite is true: such a relation emerges precisely when there is no trade-off, in either the long or short-run and the authorities appropriately acknowledge that fact when setting monetary policy.

1 INTRODUCTION

Forty years ago, A. W. Phillips [11] plotted nominal wage inflation against unemployment in the UK, and thereby highlighted a tight and stable relation over the preceding century. When broadly similar relationships were found for other countries, the Phillips curve became integral to macroeconomic policy.

The 1970s, however, saw for many countries inflation and unemployment rise simultaneously, contrary to Phillips-curve predictions. This, put with forceful theoretical and econometric critique (Lucas and Sargent [9]) of its use, drove the Phillips curve into academic disrepute.

In the last decade, yet another turnaround has occurred, with the Phillips curve once more re-assuming a central place in macroeconomic analysis.

These three generations of academic thinking, we believe, have been mirrored in UK monetary policy-making, albeit with a lag. During the 1950s and 1960s, the Phillips curve was believed to present policymakers with a menu of inflation/unemployment choices.[1] By contrast, from the mid 1970s, the sequence of UK monetary policy frameworks sought to target nominal variables, implicitly accepting the absence of a long-run tradeoff. Inflation targeting is an instance and a natural outgrowth of such views.

More recently, two supplementary principles appear to be guiding monetary policy decisions: first, that short-run inflation tradeoffs can be exploited to smooth output as inflation tends back towards target; and, second, that opportunity for this is greater whenever credible policy has anchored inflation expectations close to the long-run target.

Section 2 of this paper documents this set of evolving academic and policymaker views. Against this backdrop, we describe in Section 3 Phillips curve regularities and instabilities in the UK over the last 140 years. We find these Phillips curve dynamics differ importantly

[1] Although important qualifications appeared in the original text, this was the view many took from Samuelson and Solow [13]. See Sargent [14].

from those in the US. The differences matter because the UK experience contradicts a simple story that many macroeconomists might tell about the US—that the Phillips curve broke down as a long-run relation due to high inflation in the 1970s, but that it has continued as a stable feature of business cycles throughout.

We then provide in section 4 a theoretical framework that attempts to explain the observed pattern of UK Phillips curve dynamics. Our model focuses on the interaction between policymaker's beliefs about the economy and the private sector's response to policymaker action and beliefs. We show in section 5 that the model reproduces a major feature of UK monetary history, namely that the last twenty years of inflation and unemployment experience are consistent with Phillips's original sample. In the model, optimizing and perfectly-informed policymakers result in a near-horizontal *observed* Phillips curve with "favorable" tradeoffs, even though the true underlying Phillips curve—that relevant for policy calculations—is vertical. Since the true underlying relation is vertical, attempting to exploit the apparently flat Phillips curve that is observed would reduce welfare. Section 6 concludes with a brief summary.

2 The changing views of UK monetary policymakers

Rightly or wrongly, policymakers viewed the first incarnation of the Phillips curve as an invariant technical frontier in inflation and unemployment. It made no sense to operate within the frontier, while on it, there was a clear tradeoff. Leigh-Pemberton [7], former Governor of the Bank of England, summarised this view retrospectively as follows:

> *The failure of policy in the early post-war period was to assume that it was possible to reduce unemployment by accepting some upward pressure on the price level.* [...] *Governments, it seemed, could choose at which point on this "Phillips curve" to operate.*

The empirical regularity in this original Phillips curve guided UK policy choices right up to the beginning of the 1970s.

The sharp rise in worldwide inflation in the early 1970s and its continuation in the UK through much of the 1980s destroyed the earlier policy consensus. Inflation expectations, once dislodged, meant that the empirical regularities evident in Phillips's work became a moveable feast. Those lessons, made explicit in first Friedman [2] and Phelps [10] and subsequently Lucas [8] and Sargent and Wallace [15], implied monetary policy was ineffective for anything beyond the economy's nominal side. Attempts to exploit even temporary Phillips curve tradeoffs risked deteriorating those tradeoffs and taking the economy to ever higher inflation.

This message was digested by UK policymakers from the early 1970s onwards. By the mid-1970s frameworks for monetary policy set out to target explicitly nominal magnitudes: different measures of the money supply (with varying degrees of emphasis during 1976–1986); the exchange rate (implicitly in 1987–1988 and then explicitly in 1990–1992); and since 1992 the inflation rate itself.

From the mid-1970s the theoretically-predicted vertical long-run Phillips curve has, to an increasing degree, guided thinking on UK monetary policy. Current Bank of England Governor George [3] has expressed it as follows:

> *Progressively over the last 20 years or so, it came to be recognised that there is in fact no tradeoff—except in the short-term—between growth and [price] stability, and the emphasis of macroeconomic policy has shifted to maintaining [price] stability in the medium to longer term.*

During the 1990s, as UK inflation fell to its lowest levels since the 1960s, there has been a further, subtle shift in policy emphasis. Again, it seems to be rooted in a particular view of the Phillips curve.

We see two key features in this new policy stance. First, following inflation disturbances, short-run inflation-output tradeoffs can be exploited to smooth output as inflation tends back to target. In the words of Bank of England Deputy Governor King [5]:

> *Faced with supply shocks, central banks have a choice. They can either try to bring inflation back to the target level as soon as possible, possibly exacerbating the initial impact of the shock on output. Or they can accommodate the inflationary consequences of the supply shock in the short run, bringing inflation back to the target level more slowly and reducing the impact on output. Hence, in the short run, there is a trade-off between inflation and output.*

Second, the scope for exercising such flexibility in the face of shocks is greater when inflation expectations are close to target and the nominal side hence anchored, as has been the case recently in the UK. Again, quoting King [4]:

> *In the early stages of transition to price-stability, it pays not to accommodate as much of the inflation shock as would be optimal once expectations have adjusted to price stability. A central bank that is embarking on the road to price-stability cannot afford to engage in as much flexibility in monetary policy as can a central bank which has established a track record for a commitment to price stability.*

These two features underly the increasing focus in the UK on stabilising, over the business cycle, the real side of the economy while, at the same time, adhering to a medium-term inflation target. The approach is founded on the empirical regularity of a stable short-run Phillips curve over business cycles: The greater the dependence on the short-run Phillips curve regularity, the greater the degree of output accommodation and policy flexibility in response to disturbances.

This approach to exploiting the short-run Phillips curve carries a risk, however, related to an earlier one on exploiting long-run Phillips curves tradeoffs (Lucas [8], Sargent [14]). As we show below, perfectly-informed, optimizing policymakers can end up generating a horizontal observed Phillips curve, even when the true Phillips curve is vertical. Any attempts by policymakers to exploit that apparently favourable

trade-off will be welfare-depleting. This further confirms the view that the Phillips curve is built on shifting sands, as UK policymakers found to their cost in the 1970s. As the Bank of England Deputy Governor King [5] observed, this general message applies in both the short and long run:

> *It is important for any central bank to realise the limitations to its ability to engage in countercyclical policy.* [...] *The [Bank of England's] Monetary Policy Committee is under no illusion that it can abolish the business cycle.* [...] *It cannot fine-tune output, and it would be a mistake to do so.*

Our paper underscores this important message.

3 THE EVOLVING UK PHILLIPS CURVE

Fig. 1 graphs the Phillips curve, extending Phillips's original sample of annual observations 5 years before and 40 years after.[2] The symbols denoted 'a' represent observations from Phillips's sample, up through 1957; those denoted 'b' are data since then. Perhaps the most striking feature in this figure is the apparent systematic breakdown of the Phillips curve over the last 50 years. The 'b' points drift northeasterly.

Time series plots of the same data, in Fig. 2, temper this conclusion. Except for the period 1949–1979, wage inflation and unemployment have moved contemporaneously in lockstep, as Phillips

[2] We take the Phillips curve to be a property of a bivariate joint distribution in wage (or price) inflation and unemployment, and nothing more. In this interpretation, a projection of inflation on unemployment makes as much sense as one of unemployment on inflation. When one of these relations breaks down, so does the other. Our definition also leaves out conditioning on auxiliary knowledge about the economy—serial correlation, special one-time allowances, information on putative structural breaks, and so on. Conditioning on those factors is doubtless useful for a whole range of issues; but it takes us away from the Phillips curve.

originally hypothesized. After 1980 the negative comovement between inflation and unemployment—as in the approximately 90 years from 1856—appears to have re-emerged.

This apparent re-assertion of the Phillips curve leads us to focus on the most recent developments. Fig. 3 shows the Phillips curve for *monthly* data from July 1948 through June 1998. For the time being, we can ignore the difference between points labelled 'a' and 'b'. In this new sample, a few outlier points stretch northeasterly and southwesterly, but the bulk of the distribution lies along the conventional slope of the original Phillips curve.[3]

In one interpretation, this suggests a useful comparison with what some might view as a comparable re-emergence of the US Phillips curve. The analyses of King and Watson [6] and Sargent [14] showed that while the Phillips curve is not directly observable in US data, appropriate business-cycle filtering reveals the usual strong, stable negative relation. For comparison, Fig. 4 reproduces that US business-cycles analysis.[4] However, when redone on UK data, Fig. 5 shows no comparable relation.

What then is the post War UK Phillips curve suggested by Fig. 3? Turning back to that figure, notice now the 'a' and 'b' designations. The strong, stable negative relation in Fig. 3 turns out to be due entirely to the mixing of two differently-behaved subsamples. The early subperiod, July 1948 through December 1979, yields a scatter of 'a' points that cluster vertically, and at low measured unemployment values. The later subperiod, January 1980 on, by contrast, yields a scatter of 'b' points that—apart from outliers—cluster horizontally,

[3] We switch to price rather than wage inflation here, but the change is inessential. It merely aids our comparison with the US business-cycle Phillips curve.

[4] We have used here an exact frequency-domain procedure, concentrating on periodicities between 5 and 8 years. Our experimenting with US and UK data showed this bandwidth interval to be most revealing. That, coupled with the difference in econometric method, is why we display these findings, rather than the frequency intervals used by King and Watson [6] and Sargent [14].

and at higher measured unemployment values. Simple inspection shows this subsample behavior is absent in US data.

For convenience, we end this section by listing our principal empirical conclusions.

1. Since Phillips's 1861–1957 study, the UK has seen increased variation ranges in inflation and unemployment. Inflation and unemployment have both been higher than suggested by the earlier joint distribution
2. From King and Watson [6] and Sargent [14], we know a Phillips curve is not directly apparent in US postwar data; only concentrating on business-cycle dynamics is there revealed a strong, stable negative relation between inflation and unemployment. The exact opposite, however, holds for the UK. Fifty years of UK postwar data show an obvious Phillips curve. In the UK, concentrating on business-cycle dynamics removes the Phillips curve: the latter becomes practically vertical
3. It is revealing to consider two subsamples of these fifty years of postwar data. The UK, up through 1980, has its Phillips curve practically vertical; after 1980, the Phillips curve is practically horizontal (with a conventional slope). The mass of post-1980 points are also ones with lower inflation and higher unemployment than pre-1980. Both these facts have contributed to the Phillips curve post-war re-emergence, even though relative to Phillips's original curve, the post-war observations overall might have only indicated a north-easterly (higher inflation, higher unemployment) breakdown.
4. US data show no similar subsample regularity.

4 A BASIC PHILLIPS CURVE MODEL

The core of our model is, in essence, identical to that in Clarida, Gali, and Gertler [1] and Svensson [16]. Thus, we use this section primarily to introduce notation, and to emphasize where our departures have been.

4.1 The private sector

Assume an economy of the form:

$$Y_t = -\gamma \left[I_t - E_t \boldsymbol{\pi}_{t+1} \right] + \phi E_t Y_{t+1} + G_t, \tag{1}$$

$$\boldsymbol{\pi}_t = \lambda_t Y_t + \theta E_t \boldsymbol{\pi}_{t+1} - \lambda_t A_t. \tag{2}$$

Real output Y_t can be taken to be the negative of the unemployment rate or output growth or output fluctuations about a (possibly time-varying) underlying trend. Inflation $\boldsymbol{\pi}_t$ and the nominal interest rate I_t are measured in the same units. The terms G and A are, respectively, demand and productivity disturbances.[5]

Equation (2) is naturally referred to as *aggregate supply* or an *AS* curve. It might also be called a "Phillips curve", although in this paper we reserve that term for the sense in which we used it in section 3. Equation (1) describes how, given expectations and demand disturbances, the real side of the economy Y varies with real interest rates: thus, (1) can be viewed as an *IS* curve.

Both private sector and monetary authorities share a common information set Ω_t that, at time t, includes the history

$$\left\{ (G_{t-s}, A_{t-s}) : s \geq 0 \right\}.$$

We assume that

$$\forall \Omega_t \qquad \lim_{k \to \infty} E \left[A_{t+k} | \Omega_t \right] = 0 \text{ a.s.}, \tag{3}$$

i.e., the productivity disturbance, far enough ahead, is expected to be zero.

[5] Clarida, Gali, and Gertler [1] distinguish productivity and cost disturbances, with productivity appearing in their definition of Y as fluctuations about a productivity-driven trend, and their cost disturbances as $-\lambda A$ in our notation. In their framework productivity never enters model (1)–(2) explicitly, and thus never affects discussion of the Phillips curve in $(\boldsymbol{\pi}, Y)$. Given the focus in our paper we have chosen instead to call A productivity and to ignore disturbances in the underlying trend altogether.

Coefficients γ, ϕ, and θ are positive, with $\phi,\ \theta \leq 1$. For each t, the term $\lambda_t > 0$ is the slope of an aggregate supply schedule. Whether λ_t turns out also to be (up to a sign change) the slope of the observable Phillips curve depends. We assume the sequence $\{\lambda_t : t \geq 0\}$ is deterministic. When $\theta = 1$, equations (1)–(2) describe an economy whose real side $\{Y_t : \ t \geq 0\}$ is neutral with respect to permanent shifts in

$$\{I_t,\ \boldsymbol{\pi}_t,\ E_t\boldsymbol{\pi}_{t+1} :\ t \geq 0\},$$

regardless of λ. We will maintain this $\theta = 1$ restriction in almost all the calculations below—the significant exception is when we consider monetary authorities mistakenly disbelieving long-run neutrality. For convenience, then, we will carry along θ in the calculations, even though it will be set to unity in what we take to be reasonable situations.[6]

That λ evolves will be critical for our analysis below. It also differentiates our work from most of the literature using this class of models. We have chosen in (2) to scale the productivity disturbance A by λ_t. Since A has mean zero, this simply specifies a form of heteroskedasticity. Such a setting allows us to avoid uninteresting degeneracies below when we let λ_t evolve in particular ways.

4.2 The monetary authorities

Assume the monetary authorities have discount factor $\beta \in (0, 1)$, and solve

$$\max_{\{I_{t+j} \in \Omega_{t+j}\}_{j \geq 0}} -E\left[\sum_{j=0}^{\infty} \beta^j Loss(\boldsymbol{\pi}_{t+j}, Y_{t+j}) \mid \Omega_t\right] \tag{4}$$

subject to (1)–(2), with current-period loss function

$$Loss\left(\boldsymbol{\pi}_t, Y_t\right) = \frac{1}{2}\left[(\boldsymbol{\pi}_t - \boldsymbol{\pi}^*)^2 + \omega Y_t^2\right], \quad \omega \geq 0. \tag{5}$$

[6] In Clarida, Gali, and Gertler [1], θ is a subjective discount factor, and therefore is routinely taken to be strictly less than 1.

The policy-maker seeks to stabilize inflation about the target rate $\boldsymbol{\pi}^*$ simultaneously with stabilizing the real side about its natural rate, normalized at zero. Typically, $\boldsymbol{\pi}^*$ is set to be zero. In this paper, however, different biases result depending on the target $\boldsymbol{\pi}^*$, so we make it explicit. We take $\boldsymbol{\pi}^*$ to be non-negative in general.

Coefficient ω describes the relative weights placed on the different inflation and output objectives. The policy-maker seeks a decision rule for setting interest rates as a function of observable variables.

4.3 Equilibrium

We assume the monetary authorities do not attempt to manipulate expectations, although they realize that in equilibrium, expectations will be rational.[7] An *equilibrium* is a process

$$\{(I_t, \boldsymbol{\pi}_t, Y_t) : t \geq 0\}$$

satisfying equations (1)–(2), with I_t a policy function solving (4)–(5).

The value function for (4) satisfies the Bellman equation:

$$V_t(\Omega_t) = \max_{I_t \in \Omega_t} \left[-Loss(\boldsymbol{\pi}_t, Y_t) \ + \beta E \left(V_{t+1}(\Omega_{t+1}) \mid \Omega_t \right) \right]. \tag{6}$$

A necessary first-order condition for (6) is

$$\boldsymbol{\pi}_t - \boldsymbol{\pi}^* = -\frac{\omega}{\lambda_t} Y_t. \tag{7}$$

Using (7) in the *IS* equation (1) gives a rule for policy-makers:

$$I_t - E_t \boldsymbol{\pi}_{t+1} = \gamma^{-1} G_t + \frac{1}{\omega\gamma} \left[\lambda_t (\boldsymbol{\pi}_t - \boldsymbol{\pi}^*) \right. \\ \left. - \phi \lambda_{t+1} E_t (\boldsymbol{\pi}_{t+1} - \boldsymbol{\pi}^*) \right]. \tag{8}$$

Nominal interest rates should peg expected real interest rates, but otherwise increase to offset the impact of demand disturbances and relatively high *current* inflation.

[7] In the taxonomy in Sargent [14], we seek a Nash (rather than a Ramsey) equilibrium in the game (1)–(5) between monetary authorities and private agents.

Inflation and expected inflation are, of course, endogenous, so that equation (8) is not a policy function for problem (6). To obtain the closed-form decision rule, begin by rewriting AS equation (2) as

$$\boldsymbol{\pi}_t - \boldsymbol{\pi}^* = -(1-\theta)\boldsymbol{\pi}^* - \lambda_t A_t + \lambda_t Y_t + \theta\left[E_t\boldsymbol{\pi}_{t+1} - \boldsymbol{\pi}^*\right],$$

and plug in the first-order condition (7) to give

$$\begin{aligned}\boldsymbol{\pi}_t - \boldsymbol{\pi}^* = &-\left(1+\frac{\lambda_t^2}{\omega}\right)^{-1}\left(\lambda_t A_t + (1-\theta)\boldsymbol{\pi}^*\right)\\ &+\left(1+\frac{\lambda_t^2}{\omega}\right)^{-1}\theta\left[E_t\boldsymbol{\pi}_{t+1} - \boldsymbol{\pi}^*\right].\end{aligned}$$

Recursively substitute on the right for $\boldsymbol{\pi}_{t+j} - \boldsymbol{\pi}^*$, $j \geq 1$, and apply the law of iterated expectations to yield

$$\boldsymbol{\pi}_t - \boldsymbol{\pi}^* = -\sum_{j=0}^{\infty}\theta^j\prod_{l=0}^{j}\left(1+\frac{\lambda_{t+l}^2}{\omega}\right)^{-1}\left(\lambda_{t+j}E_tA_{t+j} + (1-\theta)\boldsymbol{\pi}^*\right). \tag{9}$$

Inflation deviates from its target rate according to a present discounted value in current and expected future productivity disturbances and a near-constant term. This last term depends on the target inflation rate itself and on the forward-looking coefficient θ, vanishing when θ equals 1. Demand disturbances G do not affect inflation as they have been exactly offset by the nominal interest rate I in (8), and therefore in equilibrium.

In equilibrium, an external observer sees neither a conventional nor vertical Phillips curve. Instead, the unconditional distribution in $(\boldsymbol{\pi}, Y)$ is restricted by the first-order condition[8] (7). Thus when

[8] Strictly, of course, (7) implies the joint distribution is singular conditional on λ, but we do not emphasize this interpretation. Similarly, we do not take literally that the interest rate rule (8) exactly offsets demand disturbances G, and therefore the latter have zero impact on inflation (9). We say merely that whatever impact there

the monetary authorities credibly optimize and the economy follows equations (1)–(2), Phillips curves are positive-sloped. The reduced form in $(\boldsymbol{\pi}, Y)$—its unconditional distribution—depends not on interaction between demand (1) and supply (2). Instead, that unconditional distribution depends on the conduct of monetary policy (7). This feature holds in many models where monetary policy is deliberate and inflation targeting occurs, in particular in Clarida, Gali, and Gertler [1] and Svensson [16].

Below we will study situations where, by contrast, conventional-sloped or vertical or horizontal Phillips curves can emerge. For a first intuition on how this might happen, notice that the observed Phillips curve tends to horizontal as $\lambda_t \uparrow \infty$. Using (9) in (7), if the $\lambda_{t+j} A_{t+j}$ sequence diverges no faster than λ_{t+j} (if A were stationary, say) then

$$\begin{aligned} Y_t &= -\frac{\lambda_t}{\omega} \times (\boldsymbol{\pi}_t - \boldsymbol{\pi}^*) \\ &= -\frac{\lambda_t}{\omega} \times O_p(\lambda_t^{-1}) = O_p(\lambda_t) \times O_p(\lambda_t^{-1}) \\ &= O_p(1) \quad \text{while } \boldsymbol{\pi}_t - \boldsymbol{\pi}^* = O_p(\lambda_t^{-1}) \end{aligned} \tag{10}$$

(using the big O, little o notation from econometrics, e.g., White [17]). Thus, for large λ_t, the real side Y_t always has probability order of variation larger than that for inflation. Indeed directly from AS equation (2), in the limit as $\lambda_t \to \infty$, we have

$$Y_t = A_t \quad \text{and} \quad \boldsymbol{\pi}_t = \boldsymbol{\pi}^* \text{ a.s.},$$

so that the Phillips curve always appears horizontal, despite there being no tradeoff between inflation and the real side of the economy, in the long or short run.

This last result is usefully compared with earlier ones on Phillips curve instability. Lucas [8] showed that when monetary authorities, misguidedly, attempt to exploit an observed short-run Phillips curve

might be, it is small. Thus, the singularity of the joint distribution is read only to say that the distribution should not have a graph too different from that in (7).

tradeoff, then that tradeoff worsens, and, in the limit, a vertical long-run Phillips curve manifests also in the short-run. Equation (10), by contrast, asserts that as the (short-run) aggregate-supply tradeoff worsens, and the monetary authorities act optimally, the Phillips curve observations emerge as horizontal.

5 POLICYMAKER BELIEFS AND THE PHILLIPS CURVE

Section 4.3 assumed the monetary authorities are not just benevolent, but also have accurate beliefs about the structure of the economy. In this section, we allow those beliefs to be incorrect, and assume the private sector takes this into account. The goal is to see if we can match our reading of the beliefs of UK monetary authorities (section 2) with the empirical evidence (section 3) on the evolving UK Phillips curve.

We concentrate on three questions: First, what beliefs and policy actions account for the original Phillips curve? Second, after the discovery of the Phillips curve, what beliefs and policy actions explain its vanishing and the simultaneous increase in inflation? Finally, after widespread recognition of long-run neutrality and the importance of inflation expectations, why did the Phillips curve re-emerge in its extreme (relative to historical norm) horizontal form?

To address these, we will alternatively allow λ to evolve in particular ways, and the monetary authorities to believe values for θ or λ that are inconsistent with values implied by time-series generated in the model. We do not explain why λ evolves; we simply take it to do so exogenously. We do not allow the monetary authorities to learn; they stubbornly refuse to change their perceptions. The exercise we undertake here might best be viewed as analogous to that in, for instance, Rogoff [12], where central bankers can simply disagree. Sargent [14] analyzes models where the authorities learn over time.

In all cases below, equilibrium is, again, a process

$$\{(I_t, \boldsymbol{\pi}_t, Y_t) : t \geq 0\}$$

satisfying equations (1)–(2), with I_t solving the appropriate modification of (4)–(5). In general, the first-order condition (7) will no longer hold. This provides a clue into the results to follow. On the right side of (7), output Y can always be arbitrarily driven by both supply-side A and demand-side G disturbances. But as long as the first-order condition (7) holds, the negative (unconventional) correlation between $\boldsymbol{\pi}$ and Y necessarily obtains. In this class of models, therefore, it is only by appropriately violating the optimizing first-order condition (7) that a conventional Phillips curve can emerge.

But while there is only a unique way to be correct in beliefs, there are many different ways in which the policymaker can be misguided. In our analysis below, in what one might consider the natural case that results in a conventional Phillips curve, inflation turns out to have a *negative* bias, not a positive one. Therefore, this class of models has difficulty explaining runaway high inflation due entirely to misled but benevolent monetary authorities.

5.1 The Phillips sample, 1861–1957

Three cases are natural to consider, and all will produce a conventional Phillips curve:

1. The authorities misguidedly disbelieve long-run neutrality (i.e., in truth $\theta = 1$, but the authorities act as if $\theta < 1$).
2. The authorities believe the AS curve to be stable, $\lambda_{t+1} = \lambda_t = \lambda < \infty$, when, in fact, $1/\lambda = 0$, as in Lucas [8]. They do, however, correctly understand long-run neutrality $\theta = 1$.
3. The authorities understand long-run neutrality, but although the AS curve shifts from under them, each period they shed historical observations, and stubbornly think λ to be stable thereafter.

These cases share the feature that reality is "more neutral"—either in the long run (case 1.) or short (cases 2. and 3.) than the authorities believe. We will see that case 1. will generate under-responsive inflation, overly-variable output, and a long-run negative bias in inflation.

By contrast, cases 2. and 3. will show excessively volatile inflation relative to the optimal but no systematic bias.

Recall from section 4 that the policy function in I is obtained by substituting (9) into (8). When the authorities are misguided, they continue to do this. They know (8), up to possibly incorrect parameter values; they plug in their guess for equilibrium expectations (9), again with their possibly mistaken parameter values.

In case 1., take for simplicity $\lambda(t) = \lambda$ finite. Then, substituting (9) into (8), the policy function is

$$\begin{aligned} I_t = {} & \boldsymbol{\pi}^* + \gamma^{-1} G_t \\ & - \frac{\lambda}{\theta} \sum_{j=1}^{\infty} \left(\frac{\theta}{1 + \lambda^2/\omega} \right)^j E_t A_{t+j} \\ & - \left(\frac{\lambda^2}{\omega\gamma} \right) \left(1 + \lambda^2/\omega \right)^{-1} \left[A_t + \left(1 - \frac{1 + \lambda^2/\omega}{\theta} \phi \right) \right. \\ & \qquad \left. \times \sum_{j=1}^{\infty} \left(\frac{\theta}{1 + \lambda^2/\omega} \right)^j E_t A_{t+j} \right] \\ & - \left(\frac{1 - \theta}{1 + \lambda^2/\omega - \theta} \right) \left[1 + (1 - \phi) \frac{\lambda}{\omega\gamma} \right] \boldsymbol{\pi}^*. \end{aligned} \tag{11}$$

Equation (11) might appear complicated, but its key feature is that it applies for arbitrary θ. In particular, the correct optimal policy is (11) with θ set to 1. The last term then shows an important difference of the misguided policy from optimal: When λ/ω is small and $\boldsymbol{\pi}^*$ is positive, the view that $\theta < 1$ induces a *downwards* bias in the nominal interest rate I_t. This matches the conclusions from the Friedman [2]–Phelps [10] accelerationist analysis—what Sargent [14] calls "the triumph of natural rate theory". Monetary policy is overly and systematically expansionary.

Further insight can be gleaned if we assume that productivity A is a first-order Markov sequence relative to Ω,

$$E\left(A_{t+j} | \Omega_t \right) = \rho^j A_t, \quad 0 \leq \rho < 1. \tag{12}$$

Indexing the policy functions in (11) in the natural way by θ, the misguided policy departs from the optimal one by

$$\begin{aligned} I_{\theta,t} - I_{1,t} = &-\lambda\rho\left[1+\frac{\lambda}{\omega\gamma}(\rho^{-1}-\phi)\right] \\ &\times\left\{\left(1+\lambda^2/\omega-\theta\rho\right)^{-1}-\left(1+\lambda^2/\omega-\rho\right)^{-1}\right\}A_t \\ &-\left(\frac{1-\theta}{1+\lambda^2/\omega-\theta}\right)\left[1-(1-\phi)\frac{\lambda}{\omega\gamma}\right]\boldsymbol{\pi}^*. \end{aligned} \tag{13}$$

The coefficient on A_t is positive. Thus compared to optimal the misguided policy responds *too little* to productivity disturbances. Policy is in the short term insufficiently aggressive in its response to A, while in the long run it is systematically too expansionary. An erroneous view about the long run ($\theta < 1$) therefore has implications also on behavior in the short term.

To examine implications for the Phillips curve, substitute (11) into IS (1) and combine with AS (2)—being careful to distinguish the monetary authorities (inaccurate) expectations from the private sector's (correct) ones. Under the first-order Markov assumption (12), the method of undetermined coefficients gives

$$\begin{aligned} \boldsymbol{\pi}_t - \boldsymbol{\pi}^* = &\frac{-\lambda}{1+\lambda^2/\omega-\theta\rho}\left[1+\frac{(1-\phi\rho)(1-\theta)\rho}{(1-\phi\rho)(1-\rho)-\lambda\gamma\rho}\right]\times A_t \\ &-\frac{(1-\theta)\left[1+(1-\phi)(\lambda/\omega\gamma)\right]}{1+\lambda^2/\omega-\theta}\times\boldsymbol{\pi}^* \end{aligned} \tag{14}$$

and

$$\begin{aligned} Y_t = &\left[1+\lambda^2/\omega-\theta\rho\right]^{-1} \\ &\times\left[\lambda^2/\omega+\frac{\lambda\gamma\rho^2}{\lambda\gamma\rho-(1-\phi\rho)(1-\rho)}(1-\theta)\right]A_t. \end{aligned} \tag{15}$$

As $\theta\uparrow 1$, solutions (14) and (15) converge to the correct ones with

$$\begin{aligned} \boldsymbol{\pi}_t - \boldsymbol{\pi}^* &= \frac{-\lambda}{1+\lambda^2/\omega-\rho}A_t \\ Y_t &= \frac{\lambda^2/\omega}{1+\lambda^2/\omega-\rho}A_t \end{aligned}$$

Relative to these, the actual outcomes (14) and (15) show, first, a *downwards* bias in inflation for $\boldsymbol{\pi}^*$ positive, and no bias on real side fluctuations; and, second, inappropriate responses to the productivity disturbances A_t.

For γ sufficiently large—real interest rates have a strong effect on the economy—inflation does not rise enough in response to a negative productivity disturbance (the A_t coefficient in (14) is smaller in magnitude than optimal) while the real side (15) over-reacts and becomes too variable. Further, the correlation between $\boldsymbol{\pi}_t$ and Y_t switches from negative to positive. Thus, while a credible optimizing policy-maker results in a perverse positively-sloped Phillips curve, one who is sufficiently powerful (γ large enough) and incorrectly disbelieves the natural rate hypothesis can lead to Phillips curves having their conventional slope.[9]

Turn now to case 2., where the monetary authorities correctly take on board long-run neutrality $\theta = 1$, but assume $\lambda < \infty$ even though, in reality, λ is infinite.

As before, substitute (9) into (8) to obtain (11). Use $\theta = 1$, and now index the resulting policy functions by alternative values of λ.

[9] An interesting finding here is that equilibrium inflation (14) shows a systematic downwards bias. Standard reasoning might have suggested instead that a systematically lower interest rate setting would produce, as in Friedman-Phelps, runaway inflation. Two features in the current model prevent this. First, the nominal anchor for inflation implicit in the authorities' objective function (5) rules out such paths in equilibrium, even when the authorities are misguided in their neutrality beliefs. Given this, the second feature is long-run neutrality with $\theta = 1$: A constant real interest rate together with a lower nominal interest implies a lower equilibrium inflation rate.

Misguided (finite λ) policy departs from the optimal by:

$$\begin{aligned} I_{\lambda,t} - I_{\infty,t} = & -\lambda \sum_{j=1}^{\infty} \left(1+\lambda^2/\omega\right)^{-j} E_t A_{t+j} \\ & + \frac{\lambda}{\omega\gamma} \left[\left(\frac{-\lambda}{1+\lambda^2/\omega} \right) \left[A_t + \sum_{j=1}^{\infty} \left(1+\lambda^2/\omega\right)^{-j} E_t A_{t+j} \right] \right. \\ & \qquad \left. + \phi\lambda \sum_{j=1}^{\infty} \left(1+\lambda^2/\omega\right)^{-j} E_t A_{t+j} \right] \\ & + \gamma^{-1} \left[A_t - \phi E_t A_{t+1} \right]. \end{aligned} \tag{16}$$

For explicit expressions, again assume the first-order Markov case (12). Then (16) becomes

$$\begin{aligned} & I_{\lambda,t} - I_{\infty,t} \\ & \quad = \frac{-\lambda}{1+\lambda^2/\omega} \left[\frac{\lambda}{\omega\gamma} A_t + \left(1 - \frac{\lambda}{\omega\gamma}\phi \right) \rho A_t \right] + \gamma^{-1}(1-\rho\phi) A_t \\ & \quad = \left(\frac{-\lambda}{1+\lambda^2/\omega-\rho} \right) \rho A_t + \gamma^{-1}(1-\phi\rho) \left(1 - \frac{\lambda^2/\omega}{1+\lambda^2/\omega-\rho} \right) A_t \\ & \quad = \left(\frac{1}{1+\lambda^2/\omega-\rho} \right) \left[-\lambda\rho + \gamma^{-1}(1-\phi\rho)(1-\rho) \right] A_t \end{aligned}$$

Relative to the optimal policy, the small-λ policy-maker under-reacts to productivity disturbances. In equilibrium since, in truth, $\lambda^{-1} = 0$ we have $Y_t = A_t$. Combining the correct $I_{\infty,t}$ with the *IS* equation (1) then gives

$$E_t(\boldsymbol{\pi}_{t+1} - \boldsymbol{\pi}^*) = \left(\frac{1}{1+\lambda^2/\omega-\rho} \right) \left[-\lambda\rho + \gamma^{-1}(1-\phi\rho)(1-\rho) \right] A_t. \tag{17}$$

Strictly, current inflation is undetermined even though its future expectation follows (17). But using the minimum mean-square princi-

ple, equation (17) implies a preferred version of $\boldsymbol{\pi}_t$ satisfying

$$\boldsymbol{\pi}_t - \boldsymbol{\pi}^* = \left(\frac{1}{1+\lambda^2/\omega-\rho}\right)\left[-\lambda\rho+\gamma^{-1}(1-\phi\rho)(1-\rho)\right]\rho^{-1}A_t. \tag{18}$$

For λ small, (18) shows that inflation fluctuates around target $\boldsymbol{\pi}^*$, and varies positively with productivity A. By contrast, at the optimal policy $I_{\infty,t}$, inflation is always pegged at $\boldsymbol{\pi}^*$. Disagreement on λ—the slope of the short-run supply schedule—therefore can generate a conventional-sloped Phillips curve.

Finally, given the way we have worked out case 2., case 3. is basically the same, only adding in subscripts for λ. Each period the misguided policymaker acts as if λ_t is fixed, and so uses $I_{\lambda_t,t}$ in (16). The optimal policy, by contrast, is 'between' $I_{\lambda_t,t}$ and $I_{\infty,t}$. This too then, as in case 2., generates a conventional-sloped Phillips curve.

5.2 The vanishing Phillips curve, 1958–1979

As we have already suggested, none of 1. through 3. in the previous section yields an easy interpretation of the runaway inflation that the UK experienced through the 1960s and 1970s.

If we maintain the assumption that economic agents saw through what the monetary authorities were doing, then the errors that the latter made—in trying to run monetary policy systematically as if the economy was not long-run neutral—*cannot* explain those historical observations. Something else must have been happening.

One natural possibility is that the monetary authorities might have had no inflation target at all, or one that was high. Another possibility is that the monetary authorities at that time did not, in fact, run monetary policy systematically. They might have tried to surprise economic agents—as in the accelerationist natural-rate theory—or they might have increased policy variability. In this interpretation, their actions were inconsistent with their own underlying beliefs about the economy.

5.3 The extreme re-emergent (horizontal) Phillips curve, 1980–

By contrast with our model's difficulties with the 1958–1979 period of runaway inflation, the re-emergent extreme Phillips curve over the last twenty years falls out neatly.

Since 1979 UK policymakers have progressively acknowledged the pervasiveness of monetary neutralities, even as those neutralities in reality have become more entrenched ($\theta = 1$ and $\lambda_t \uparrow \infty$). In our interpretation, policymakers have become more informed and more credible. We think, therefore, that the dicussion at the end of section 2 and the analysis surrounding equation (10) in 4 have become increasingly cogent. That model produces exactly a horizontal Phillips curve.

This, however, is not a Phillips curve with favorable tradeoffs to be exploited. Instead, such a Phillips curve emerges precisely when there is, in fact, no such underlying tradeoff, and policymakers correctly acknowledge that.

6 Summary and conclusions

The UK Phillips curve differs from the US one. In the US, the most compelling empirical analysis suggests two conclusions: One, the Phillips curve as a long-run relation broke down due to high inflation in the 1970s. Two, it has, however, continued as an abiding feature in US business cycles throughout. In the UK, by contrast, the Phillips curve has, over time, disappeared and then re-emerged, mirroring—in our analysis—the evolving beliefs guiding UK monetary policy.

This paper has attempted to interpret this evolving Phillips curve over the last 140 years as resulting from the interaction between evolving policymaker beliefs and the private sector's response to those beliefs. Doubtless other factors mattered, but we chose to see how far a simple story like this could take us.

We think of the exercise as a partial success. Using what is now

a fairly standard model of optimal monetary policy, but allowing policymakers to be misguided about the nature of the economy, we were able to reproduce some salient facts about UK Phillips curves. We took published statements by UK central bankers as our guide on how policymakers were misguided. The model gives—in our view—useful insights over Phillips's original sample and since the 1980s. The model fails, however, to provide a clean explanation of UK runaway inflation over the 1960s and 1970s.

Applied to UK monetary history since 1980 the model predicts a horizontal Phillips curve. This is, indeed, exactly what is observed ("horizontal" is relative to historical norms). However, this does not mean a Phillips curve, with favorable tradeoffs, is there to be exploited. The opposite is true: such a relation emerges precisely when there is no tradeoff, and the monetary authorities appropriately acknowledge that fact.

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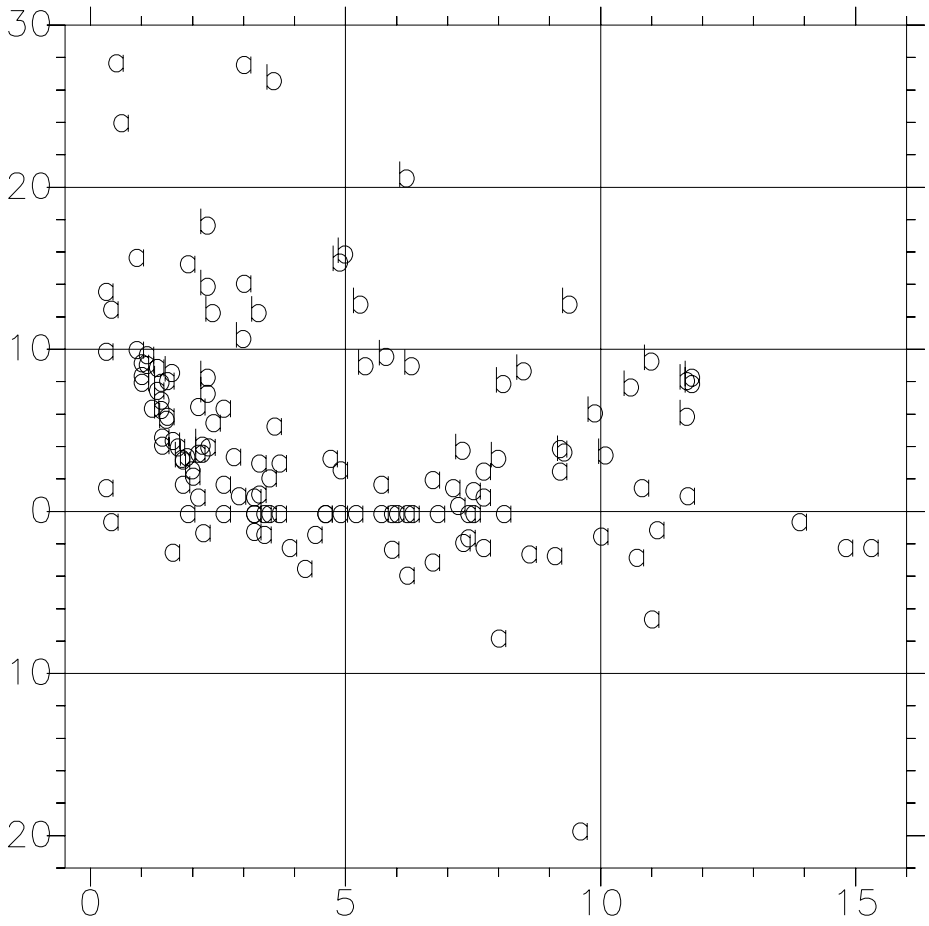


Vertical axis: Nominal wage inflation (% per year);
Horizontal: Unemployment (%)

Fig. 1: Wage inflation and unemployment, UK 1856–1997 (Annual) The original Phillips sample covered 1861–1957; we have augmented the data over 1856–1860 and 1958–1997. The graph depicts the early sample 1856–1957 by "a"; the last forty years, "b". The curve appears to have drifted northeasterly.

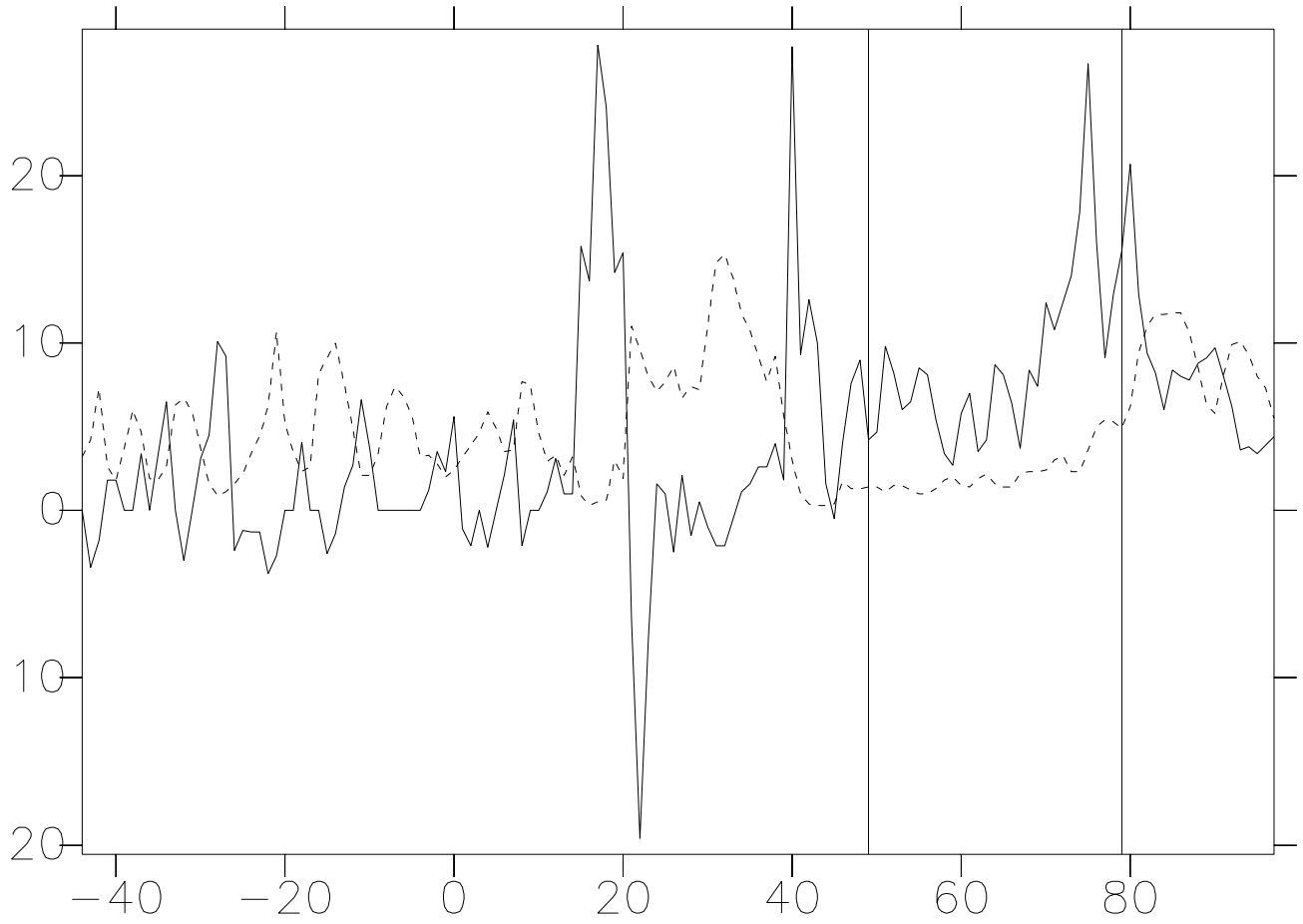
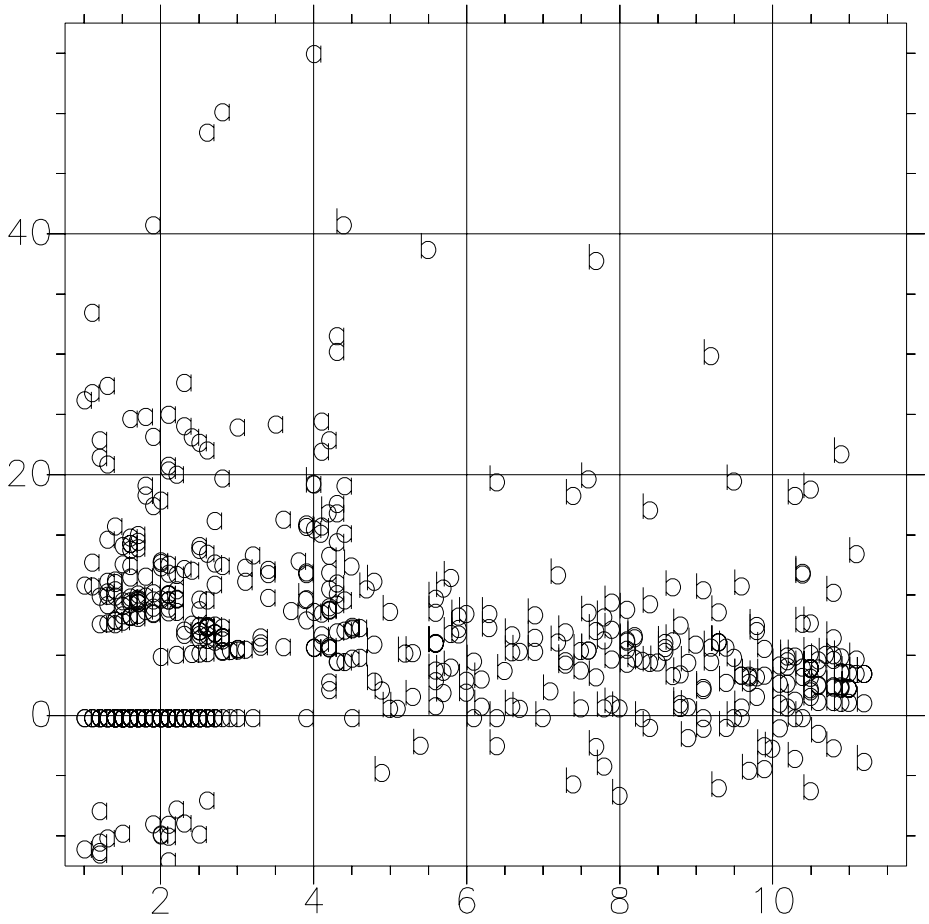
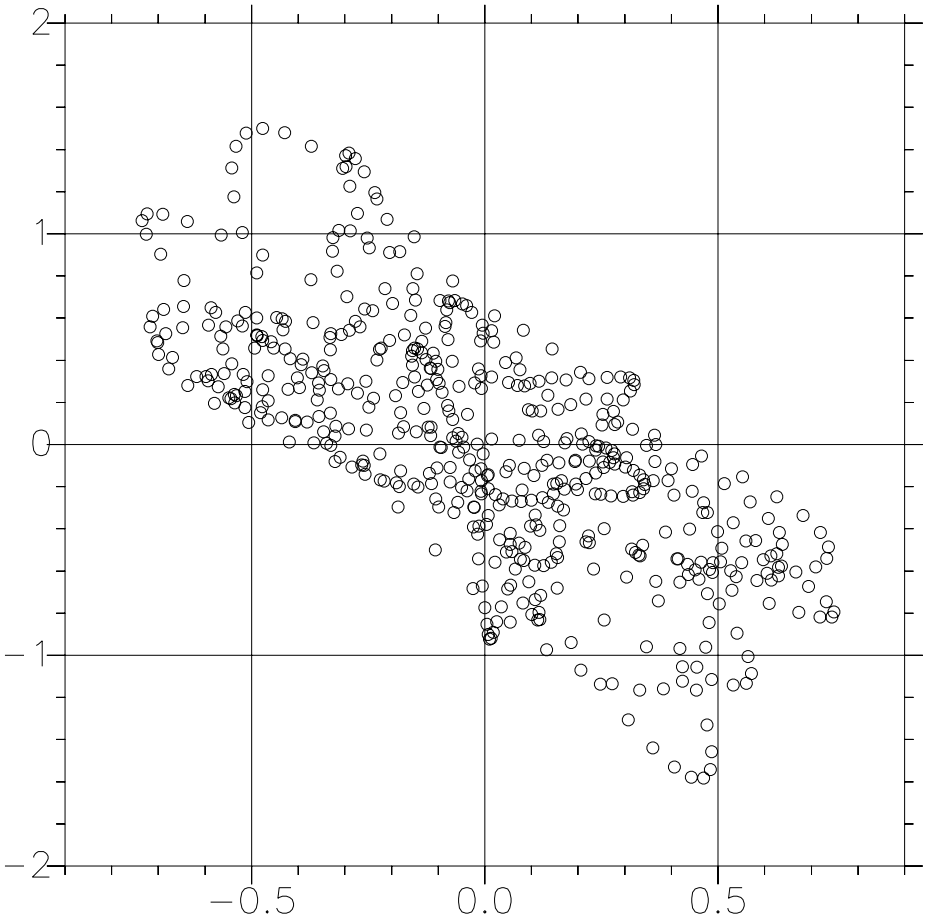


Fig. 2: Wage inflation and unemployment, 1856–1997 (Annual) Time-series plot shows wage inflation (solid) and unemployment (dashed). The horizontal axis denotes years relative to 1900; the two vertical lines indicate 1949 and 1979.



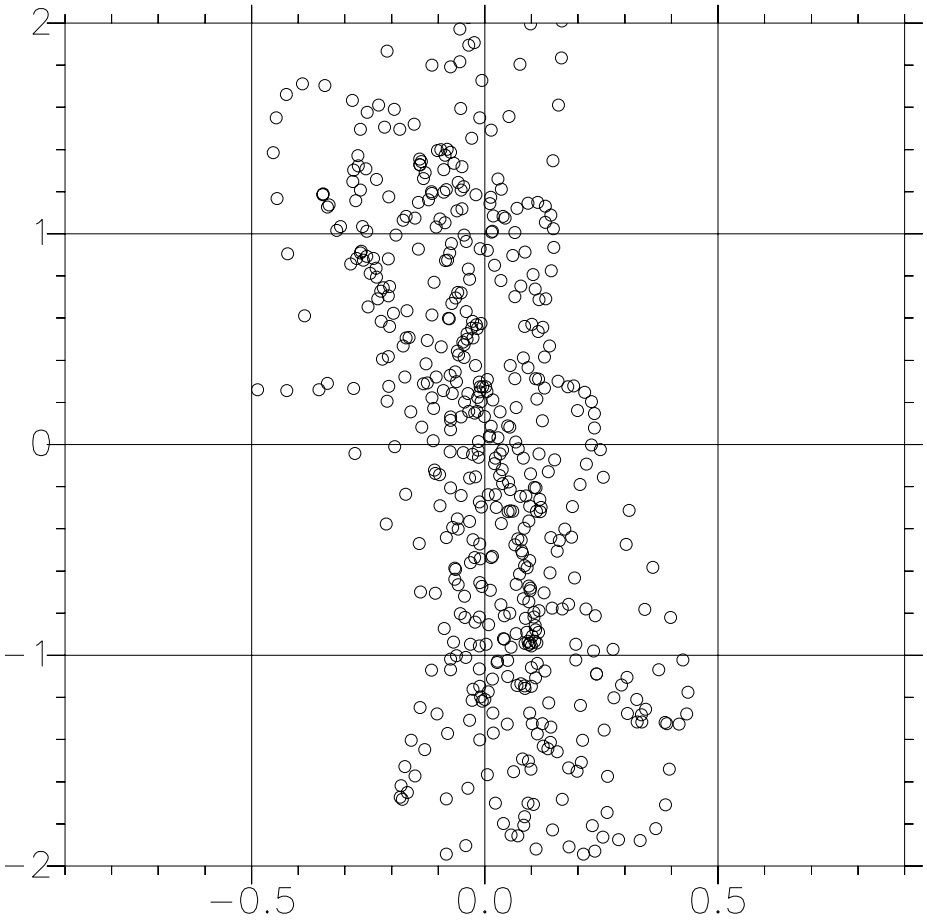
Vertical axis: RPIX inflation (% per year);
Horizontal: Unemployment (%)

Fig. 3: RPIX inflation and unemployment, UK 1948:07–1998:06 (Monthly) Scatter plot shows annualized percentage growth in RPIX and the claimant count as a percentage of the labor force. Points denoted "a" are for 1948:07 through 1979:12; those denoted "b", 1980:01 through 1998:06.



Vertical axis: US CPI Inflation (% per year);
Horizontal: US Unemployment (%)

Fig. 4: Price inflation and unemployment, US business-cycle components, 1954:01–1997:07 (Monthly) Scatter plot shows business-cycle components (5–8 year periodicities) in comparable US data.



Vertical axis: RPIX inflation (% per year);
Horizontal: Unemployment (%)

Fig. 5: RPIX inflation and unemployment, UK business-cycle components, 1948:07–1994:06 (Monthly) Scatter plot shows business-cycle components (5–8 year periodicities) in the series in Fig. 3. Axes are scaled to match Fig. 4. (The last four years were dropped to reduce endpoint effects.)