U.K. Monetary Regimes and Macroeconomic Stylised Facts*

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Abstract

We exploit the marked changes intervened in U.K. monetary arrangements since the metallic standards era to investigate continuity and changes across monetary regimes in key macroeconomic stylised facts in the United Kingdom. Our main findings may be summarised as follows.

(1) Historically, inflation persistence appears to have been the *exception*, rather than the rule, with inflation estimated to have been highly persistent only during the period between the floating of the pound, in June 1972, and the introduction of inflation targeting, in October 1992. Under inflation targeting, inflation is estimated to have been slightly negatively serially correlated based on all the price indices we consider.

(2) We document a remarkable stability across regimes in the correlation between inflation and the rates of growth of both narrow and broad monetary aggregates at the very low frequencies, some instability at higher frequencies.

(3) The post-1992 inflation targeting regime appears to have been characterised, to date, by the most stable macroeconomic environment in recorded U.K. history, with the standard deviations of the business-cycle components of real GDP, national accounts aggregates, and inflation measures having systematically been lower than for any previous regime/period.

(4) The Phillips correlation appears to have been the flattest under the Gold Standard, the steepest between 1972 and 1992. In line with Ball, Mankiw, and Romer (1988), evidence points towards a positive correlation, both across regimes and over time, between mean inflation and the steepness of the Phillips correlation.

(5) The real wage was markedly counter-cyclical during the interwar era, while it has been, so far, strongly pro-cyclical under inflation targeting.

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1 Introduction

Over the course of the last few centuries the United Kingdom experienced dramatic changes in its monetary arrangements, from the *de facto* silver standard prevailing until 1717 up to the post-October 1992 inflation targeting regime. Such a marked variation in monetary regimes makes the United Kingdom an ideal 'laboratory' for macroeconomic analysis, as it provides the natural experiments that might help to discriminate those stylised facts that, historically, have been reasonably invariant across regimes—and might therefore be thought of as reflecting the workings of the 'deep structure' of the economy—from those facts that, on the contrary, exhibited variation across regimes, and might therefore reflect the impact of the monetary rule. Based on a unique dataset (detailed in section 3 below) in this paper we use both time- and frequency-domain techniques to characterise continuity and changes across monetary regimes in key macroeconomic stylised facts in the United Kingdom since the metallic standards era. Our main findings may be summarised as follows.

First, historically, inflation persistence appears to have been the *exception*, rather than the rule, with inflation estimated to have been very highly persistent only during the period between the floating of the pound, in June 1972, and the introduction of inflation targeting, in October 1992. Under inflation targeting inflation is estimated to have been slightly negatively serially correlated (although not significantly different from white noise) based on all the price indices we consider. In line with a recent, and growing, literature—see in particular Cogley and Sargent (2002) and Cogley and Sargent (2003)—and in contrast with the 'traditional' position of, e.g., Fuhrer and Moore (1995), our results provide therefore compelling evidence that high inflation persistence is *not* an intrinsic, structural feature of the economy, and strongly suggest, instead, that the extent of inflation persistence may crucially depend on the monetary regime in place. Our results also clearly contradict Mishkin's (1992) explanation for time-variation in the extent of the Fisher effect—based on the notion that inflation and interest rates are cointegrated—while they are largely, although not entirely, compatible with Barsky's (1987) position, stressing the link between inflation persistence, its extent of forecastability, and the presence or absence of a Fisher effect as captured by Fama (1976) regressions.

Second, we document a remarkable stability across regimes in the correlation between inflation and the rates of growth of both narrow and broad monetary aggregates at the very low frequencies, with the exception of base money growth under the current inflation targeting regime, for which the correlation clearly appears to have been, so far, negative. Our results, in particular, clearly suggest that a key finding in Rolnick and Weber (1997), a stronger correlation between inflation and the rates of growth of monetary aggregates under fiat standards than under commodity standards, may find its origin in their exclusive focus on the raw data (in other words, in their failure to distinguish between the different frequency components of the data). As we show, under the Gold standard the correlation between inflation and money growth at the very low frequencies had been remarkably high both for base money (0.94) and for M3 (0.97). We also document some instability in the money growth-inflation correlation at higher frequencies. For example, the contemporaneous correlation between inflation and M4 growth at the business-cycle frequencies turned from negative to positive over the second half of the 1980s, so that, within this frequency band, inflation and M4 growth move, today, closely in synch.

Third, the post-1992 inflation targeting regime appears to have been characterised, to date, by the most stable macroeconomic environment in recorded U.K. history, with the volatilities of the business-cycle components of real GDP, national accounts aggregates, and inflation measures having been, post-1992, systematically lower than for any of the pre-1992 monetary regimes/historical periods, often—as in the case of inflation and real GDP—markedly so. Although, it ought to be stressed, the interpretation of such reduced-form, purely statistical evidence is clearly debatable, overall our results provide what we would define as 'strong circumstantial evidence' on the good macroeconomic performance of the current U.K. monetary framework when seen from a historical perspective. By contrast, and not surprisingly, the interwar period appears to have been, by far, the most turbulent in recorded history.

Fourth, the Phillips correlation between unemployment and inflation at the business-cycle frequencies appears to have been the flattest under the Gold Standard, the steepest between 1972 and 1992. Under inflation targeting the correlation has exhibited, so far, the greatest extent of stability in recorded history, as measured by the dispersion of the observations around the least-absolute deviations (LAD) regression line. In line with Ball, Mankiw, and Romer (1988), evidence points towards a positive correlation—both across monetary regimes and over time (especially over the post-WWII era)—between mean inflation and the steepness of the Phillips correlation.

Finally, the real wage was markedly counter-cyclical during the interwar period, while it has been, so far, pro-cyclical under inflation targeting. As for other regimes/periods it displayed some evidence of pro-cyclicality under Bretton Woods, but no consistent pattern either between 1972 and 1992 or under the gold standard, turning for example from pro-cyclical during the years between 1855 and 1865, to counter-cyclical over the following decade.

The papers most closely related to the present work are Backus and Kehoe (1992), Bergman, Bordo, and Jonung (1998), Basu and Taylor (1999), and Bordo and Schwartz (1999).[1] Based largely on linear filtering techniques, these papers produce business-cycle stylised facts for several countries since the second half of the XIX century.[2] There are, however, several differences between these papers and the

[1] See also Sheffrin (1988), who reports standard deviations of the rate of growth of U.K. real GNP for three sub-periods, 1871-1914 (0.024), 1922-1939 (0.031), and 1951-1984 (0.022).

[2] Based on HP-filtering, Blackburn and Ravn (1992) document a series of business-cycle regularities for the post-WWII U.K. along the lines of Hodrick and Prescott (1997) and Kydland and Prescott (1990). However, first, their sample period, 1956:1-1990:1, ends well before the introduction of inflation targeting; and second, they do not split their sample around the time of either the collapse of Bretton Woods, in August 1971, or of the floating of the pound, in June 1972, so that

present work. At a general level, first, to the very best of our knowledge, the vast majority of the series in our dataset—which we either recovered from original, hard-copy sources, or we downloaded from the *NBER Historical Database* on the web (see section 3)—have never been analysed before. Second, while all the four previously mentioned papers exclusively analyse annual data, in order to obtain more precise results we also analyse, whenever possible, quarterly or monthly data. This is especially important for the interwar period and the inflation targeting regime, for which the comparatively short length of the sub-samples may cast doubts on the reliability of results based on annual data. Third, we focus exclusively on the United Kingdom, so that the breakdown of the overall sample period exactly reflects the evolution of U.K. monetary arrangements over the last several hundred years (see section 2).

Entering into details, Backus and Kehoe (1992) investigate business-cycle fluctuations for a sample of ten countries, dividing the overall sample period into pre-WWI, interwar, and post-WWII sub-periods. They filter the data based on the Hodrick-Prescott filter—setting however λ=100, instead of the optimal value of 6.25 subsequently suggested by Ravn and Uhlig (2002)—and focus on the amplitude of output fluctuations, and on the co-movements of expenditure components, price levels, inflation rates, and monetary aggregates with real GDP/GNP. As for inflation persistence, they only report the first autocorrelation of inflation rates.

Bergman, Bordo, and Jonung (1998) analyse data for thirteen countries on real GDP/GNP, national accounts aggregates, the money stock, and consumer prices, filtering the data via the Baxter and King (1999) filter, and dividing the overall sample period into four regimes/periods: the Gold Standard (up to 1914), the interwar period (1919-1939), Bretton Woods (1945-1971), and the period of floating (post-1971). Both for money and prices, they look at filtered log levels, instead of rates of growth. They focus on the amplitude of business-cycle fluctuations, the co-movements of other variables with real GDP/GNP, relative volatilities, and international co-movements. One problem with their dataset is that they use, as a measure of real GNP, Feinstein's (1972) expenditure-based estimate[3] which, as stressed by Backus and Kehoe (1992), and as we briefly discuss in section 3, should reasonably be regarded as inferior to the one we use, Feinstein's 'compromise estimate'.

Basu and Taylor (1999) analyse data on output, prices, real wages, exchange rates, total consumption (public plus private), investment and the current account for fifteen countries since 1850 or later, dividing the overall sample by monetary regime as Bergman, Bordo, and Jonung (1998), and filtering the data via the Baxter-King filter. They report results on the volatility and persistence of filtered series—in other words, they look at the persistence (as measured by the first autocorrelation) of filtered log prices, instead of inflation persistence—and on their co-movement with output.

no investigation of the changing nature of U.K. business-cycle fluctuations across regimes/periods is performed.

[3]See Feinstein (1972, Table 2).

Bordo and Schwartz (1999) analyse annual data for five countries, dividing the overall sample by monetary regime as in the previous two papers. They only analyse raw data, and report simple means and standard deviations by regime/period. Results for inflation persistence are based on AR(1)'s estimated via simple OLS, while persistence in the price level is measured via the Cochrane (1988) variance ratio estimator. Given the short length of most regimes/periods, however, results based on the variance ratio estimator—which, it is important to stress, is designed to capture *long-run* properties of a series—are probably of limited reliability.

The paper is organised as follows. The next section presents a brief chronology of U.K. monetary arrangements from the second half of the XVII century up to the current inflation targeting regime. Section 3 describes our dataset. In section 4 we illustrate and discuss empirical evidence on inflation persistence, the Fisher effect, the correlation between inflation and the rates of growth of both narrow and broad monetary aggregates within several frequency bands, the amplitude of business-cycle fluctuations, the Phillips correlation between inflation and unemployment at the business-cycle frequencies, and the cyclicality of the real wage. Section 5 discusses several implications of our findings for macroeconomic theory and modelling. Section 6 concludes.

2 A Brief History of U.K. Monetary Regimes

Our dataset starts in 1661, five years before the Great Fire of London, when the United Kingdom was operating under a *de facto* silver standard and without a central bank. The *Bank of England* was created on July 27, 1694[4] and was given a partial monopoly on banknote issue in England and Wales via the acts of Parliament of 1708 and 1709, which made it unlawful for companies or partnerships of more than six persons to set up banks and issue banknotes.[5] The *de facto* silver standard prevailed until 1717, when the United Kingdom accidentally switched to a *de facto* gold standard due to a mistake of the then Master of the Mint, Sir Isaac Newton, in fixing the official parity between gold and silver (the switch was therefore due to the operation of Gresham's law). The *de facto* gold standard prevailed until the wars with France of the late XVIII century, when, on February 26, 1797, the government relieved the *Bank of England* from its legal obligation of converting notes into gold

[4] The creation of the *Bank of England* was due to the strained financial position of the English Crown. When King William III and Queen Mary II ascended to the throne, in 1688, the state of public finances was dire, and the system of money and credit was in disarray. William Paterson, a prominent businessman, proposed a loan of £1,200,000 to the Government: in return for the loan, the subscribers would be incorporated as the 'Governor and Company of the Bank of England'. The money was raised in a few weeks, and the Royal Charter was sealed on July 27, 1694. The Bank of England opened for business with 17 clerks and 2 gatekeepers.

[5] In 1844, the *Bank Charter Act*—under which no new banks of issue could be established, and existing banks were barred from expanding their issue—allowed the *Bank of England* to gradually achieve full monopoly on note issue.

on demand. The 'suspension period'—during which the gold standard was legally established with the Coinage Act of July 1816, after the end of the Napoleonic wars—lasted until May 1, 1821, when convertibility was restored at the prewar parity. The *de jure* gold standard then prevailed until August 6, 1914, when at the outbreak of World War I gold convertibiliy was again suspended.

During the WWI period, the price level increased by 107.7% between July 1914 and July 1919,[6] compared with the 64.2% increase between 1797 and the peak year, 1813, at the time of the Napoleonic wars.[7] After a sharp deflation at the very beginning of the 1920s,[8] during which the price level[9] fell by 36.5% from the peak of November 1920 to November 1923, the Conservative government led by Stanley Baldwin, within which Winston Churchill was serving as the Chancellor of the Exchequer, restored the gold standard at the prewar parity on April 28, 1925.[10] The dramatic economic contraction of 1930-1931, and a run on sterling, led however the United Kingdom to finally abandon gold parity on September 21, 1931.[11] During the period following its abandonement of the Gold Standard, the United Kingdom became the centre of the so-called 'sterling area', which in 1933 comprised the countries of the British Empire (with the exception of Canada and Newfoundland), most of the Scandinavian and Baltic countries, and a few other countries (the sterling area lost all its European members soon after the start of WWII).

The aftermath of WWII saw two major changes in U.K. monetary arrangements. First, nationalisation of the *Bank of England*, with ownership of the Bank being transferred to the Treasury on March 1, 1946. Second, on December 18, 1946, the beginning of Bretton Woods, with the declaration of the par values *vis-a-vis* the U.S. dollar on the part of 32 member countries. Full convertibility of sterling, at the rate of $4.03 to the pound, was introduced on July 15, 1947 in accord with Clause 8 of the Anglo-American Loan Agreement of December 1945, but was abandoned a few weeks later, on August 20, 1947, due to massive capital outflows. Full external convertibility of sterling then had to wait until December 27, 1958, generally regarded as the starting date of the fully functioning Bretton Woods regime.[12] The period until the collapse of Bretton Woods then saw another devaluation of sterling on November 19, 1967, from $2.80 to $2.40. After President Nixon's closing of the 'gold window',

[6] Based on the seasonally unadjusted monthly retail price index from Capie and Webber (1985)—see section 3.

[7] Based on the Schumpeter (1938) index for prices of consumer goods—see section 3.

[8] On the interwar period see Eichengreen (1992).

[9] Based, again, on the same Capie-Webber monthly seasonally unadjusted retail price index.

[10] For a scathing critique of the decision to restore gold convertibility at the prewar parity, see Keynes (1925).

[11] Between November 1929 and August 1931 the *Economist*'s index of business activity fell from 1,135 to 980 (-13.7% over a period of 21 months), while the percentage of insured workers unemployed increased from 10.6% to 21.4% (both series are seasonally adjusted). For an extensive account of this episode see Cairncross and Eichengreen (2003).

[12] On September 18, 1949 sterling devalued from $4.03 to $2.80. Sterling's devaluation was followed by analogous devaluation by about 30 other countries.

on August 15, 1971, the parity with the dollar was temporarily increased to \$2.60571 at the Smithsonian Agreement of December 17-18, 1971, being finally abandoned on June 23, 1972.

The period between June 23, 1972 and the introduction of inflation targeting, on October 8, 1992, was characterised by a succession of different monetary arrangements and measures. After June 23, 1972, U.K. membership of the 'snake'—a system of currency bands created by the six founding members of the European Economic Community, and also comprising the United Kingdom, Denmark, and Ireland—lasted only six weeks, after which the United Kingdom resorted to a fully floating rate. Following sterling's exit from the snake, monetary targets, first contemplated in the letter of intent with the IMF signed by the U.K. government following the 1967 devaluation, received renewed attention, but it was not until Margaret Thatcher that they acquired prominence, in the form of targets for sterling M3 growth.[13] As stressed however by Cairncross and Eichengreen (2003), pp. xxv-xxvi,

> [h]ow to formulate monetary policy in these circumstances was never clear. Not only did British policymakers lack the constraint imposed by an exchange rate commitment, but they failed to develop another reliable means of orientation. Sterling M3 turned out to be unworkable: controlling it was too difficult, the link to inflation was too loose. Narrow money (M0) worked no better [...].[14]

Exchange rate volatility only compounded the problems associated with monetary targeting, thus laying the ground for the United Kingdom's entry into the exchange rate mechanism (ERM) of the European Monetary System.[15]

The United Kingdom joined the ERM on October 8, 1990 at a parity of DM 2.95 per pound, and suspended ERM membership on 'Black Wednesday', September 16, 1992, following a massive wave of currency speculation. Three weeks after suspension of EMS membership, on October 8, 1992, the Conservative government led by John Major established the first direct inflation target, as a range of 1-4% for annual RPIX[16] inflation. On June 14, 1995, the Chancellor modified the inflation target for annual RPIX inflation to 2.5% or less. On May 6, 1997, five days after Labour's election victory, the new Chancellor of the Exchequer, Gordon Brown, granted the Bank of England operational independence, and announced the creation of the Monetary Policy Committee (henceforth, MPC), which first met on June 5.[17] On June 12, the

[13] The U.K. government first committed itself to targets for domestic credit expansion in the letter of intent with the IMF of December 1976, at the time of the negotiations on the repayment of the \$5 billion loan the United Kingdom obtained from the Group of Ten industrialised countries in June 1976.

[14] For a discussion of the overshooting of the sterling M3 targets, see for example Sargent (1983).

[15] Before joining the ERM, the United Kingdom informally 'shadowed' the Deutsche mark between March 1987 and March 1988.

[16] 'Retail prices index, all items excluding mortgage interest payments'.

[17] A key characteristic of the new U.K. monetary framework is that MPC members are held individually accountable by Parliament for the votes they cast (individual MPC members' votes are indeed published). As stressed by the Bank's Director of Markets and MPC member, Paul Tucker,

Chancellor outlined the remit for the MPC as a symmetrical target of 2.5% for annual RPIX inflation. A system of accountability was also established, according to which fluctuations in RPIX annual inflation in excess of $\pm 1\%$ around the target should be explained by the Governor in an open letter to the Chancellor, in which appropriate measures designed to put inflation back on target should also be detailed. The most recent period has seen only a minor change, the switch to an inflation target of 2% for annual CPI inflation. Announced by the Chancellor on December 10, 2003, the switch took effect in January 2004.

Based on the previous discussion, in what follows we consider the following monetary regimes/historical periods:

- *de facto* silver standard: from the beginning of our sample up until 1717.
- *De facto* gold standard: from 1718 up until the beginning of the suspension period, on February 26, 1797.
- *De jure* gold standard: from May 1, 1821 up to the beginning of the second suspension period, on August 6, 1914.
- Interwar period: from the constitution of the Irish Free State as a British dominion, on December 6, 1921, to the United Kingdom's declaration of war on Germany, on September 3, 1939.
- Bretton Woods regime: from December 18, 1946 up to the floating of the pound *vis-a-vis* the U.S. dollar, on June 23, 1972.
- From June 23, 1972 to the introduction of inflation targeting, on 8 October 1992.
- Inflation targeting regime: from 8 October 1992 to the present.

Several issues deserve further discussion. First, as for the starting date of the interwar period, the precise date of the separation of Southern Ireland's 26 counties from the rest of the then United Kingdom is not entirely uncontroversial. In 1920 the British Parliament passed an act establishing separate Parliaments for Southern and Northern Ireland. The act was accepted by the six Northern counties, which elected a parliament on May 24, 1921, but was ignored by the 26 Southern counties. On December 6, 1921, Great Britain and Ireland signed an 'articles of agreement for a treaty' according to which Ireland accepted dominion status, subject to the right of Northern Ireland to opt out. The treaty was signed on January 7, 1922. The opt-out right was exercised, and the border between the Irish free state (comprising the 26 counties) and the six counties of Northern Ireland was fixed in December 1925,

during a recent *Inflation Report* press conference, this 'provides an incredibly powerful incentive for each individual MPC member to get it right'.

which could therefore reasonably be regarded as an alternative starting date. The key motivation for starting the interwar period in December 1921 is for reasons of homogeneity, as for several of our series—for example, those from Friedman and Schwartz (1982)—the original source explicitly states that Northern Ireland is included up to 1921, and excluded thereafter.

Second, as the previous exposition makes clear, the precise starting date of the United Kingdom's full membership of the Bretton Woods regime is not entirely clear-cut. In particular, an alternative starting date could be conceived, December 27, 1958, when the Bretton Woods regime began functioning fully and properly.

Finally, although the period between the floating of the pound and the introduction of inflation targeting was by no means perfecty internally homogeneous, we have decided to treat it as a single period mainly for two reasons. First, the short length of several of the sub-periods would prevent us from making reasonably robust statements. (Exactly for the same reason we treat the interwar period as a unique 'regime', in spite of the several, previously documented changes intervened during those years.) Second, breaking it down into sub-periods would not be not entirely uncontroversial—this is especially true for the period of monetary targeting, which did not have a clear-cut beginning and a clear-cut end.

3 The Data

Here follows a detailed description of our dataset.

Annual series The Elisabeth Schumpeter price indices for consumer and producer goods, available for the periods 1661-1823 and respectively 1661-1801, are from Table 4 of Schumpeter (1938). The composite consumer price index and the series for the purchasing power of the pound, both available for the period 1750-2003, are from the *Office for National Statistics* (henceforth, ONS)—see O'Donoghue, Goulding, and Allen (2004)—while a series for the wholesale price index for the period 1851-1988, is from Table H1 of Mitchell (1992). Real national accounts components and their deflators are from the ONS starting from 1948. Before that, we consider two different sets of estimates. The first set is based on National Accounts' Tables 5 and 6 of Mitchell (1988), containing estimates for GNP, consumption, government expenditure and investment since 1830 at current and, respectively, constant prices; and on Tables 3 and 5 of Feinstein (1972), containing estimates for exports and imports of goods and services since 1870, again at current and, respectively, constant prices. National accounts components' deflators are computed as the ratio between the respective series at current and constant prices. For real national accounts components we then consider a second set of estimates, based on Table 7 of Feinstein (1972), containing index numbers for consumption, government expenditure, investment, and exports and imports of goods and services since 1870 at constant market prices; and on Table 6 of Feinstein (1972), containing a 'compromise' real GDP estimate starting in 1855 based on three alternative, independent estimates of real output, based on income, expenditure and respectively production data. As stressed by Backus and Kehoe (1992, p. 868),

[s]ince the three estimates draw on different sources, their measurement errors should be imperfectly correlated, and the compromise estimate should be more accurate than any of the individual series'.[18]

Following Backus and Kehoe (1992), in what follows we take the second set of estimates as our benchmark for real quantities, although we will report and discuss results based on the first set of estimates every time there are significant discrepancies. For real output, we also consider a third estimate, the 'compromise estimate' of GDP from Table 2 of Greasley (1989). As we briefly mention, for example, in Table 2 (note *a*), results based on this series are however nearly identical to those based on Feinstein's 'compromise estimate'. Sectoral outputs for transports and communications, and for distributions and other services, are from National Accounts' Table 8 of Mitchell (1988) until 1948, and from the ONS after that. Output in industry is from Crafts and Mills (1994) from 1700 to 1913, from National Accounts' Table 8 of Mitchell (1988) for the period 1921-1948, and from the ONS after 1948. Output in manufacturing is from Table 51 of Feinstein (1972) from 1855 to 1948, and from the ONS after that. (With the exception of output in manufacturing, the years 1914-1920 and 1939-1945 are missing for all sectoral output indicators.) Civilian and overall employment, and the rate of unemployment, are from Table 57 of Feinstein (1972), and are all available for the period 1855-1965. A real wages' series for the period 1750-1913 is from Crafts and Mills (1994). A series for nominal wages is from Table 1 of Greasley (1989). A series for the three-month bills rate, available for the period 1871-1975, is from Table 4.9 of Friedman and Schwartz (1982). Two series for Gurney's rate for first-class three-months bills and for the three months' bank bills rate, available for the the periods 1824-1856 and respectively 1845-1938, are from Financial Institutions' Table 15 of Mitchell (1988).[19] A series for the yield on consols, available for the period 1756-1980, is from Financial Institutions' Table 13 of Mitchell (1988). A series for an approximate yield on 3 per cent funds, available for the period 1743–1801 is from table 9 of Ashton (1959). An M3 series available for the period 1871-1969 is from Table I.1(3) of Capie and Webber (1985).

Quarterly series National accounts aggregates and their respective deflators are from the ONS. For all series the sample period is 1955:1-2004:1. Sectoral output indicators are from the ONS. The sample period is 1948:1-2004:1 for all indicators except all industries' output, which starts in 1955:1. An employment series from the ONS is available for the period 1978:2-2004:1. The two series for the monetary base are from Capie and Webber (1985) and, respectively, from the *Bank of England* database.

[18]Largely because of the well-known problems plaguing U.S. historical data discussed by Romer (1986) and Romer (1989), Backus and Kehoe (1992) stress the (most likely) greater reliability of European series. On this, see also Sheffrin (1988).

[19]Between 1911 and 1938, the series for the three months' bank bills rate is computed as the average of the maximum and minimum reported in Mitchell (1988).

The sample periods are 1870:1-1982:4 and 1969:3-2004:1 respectively. A series for M4 from the *Bank of England* database is available for the period 1963:2-2004:1. The long rate ('Long-dated (20 years) par yield, per cent per annum'), average earnings in the whole economy, and a series for the compensation of employees are from the ONS. The sample periods are 1963:1-2004:1, 1963:1-2004:1, and, respectively, 1955:1-2004:1.

Monthly series A series for the 3-month bank bill rate (rate on prime bills, end of month figures), available for the period January 1870:1-December 1982, is from Table III.(10), column V of Capie and Webber (1985). An index of wholesale prices of domestic and imported commodities available for the period January 1790-December 1850 is from Table 39 of Gayer, Rostow, and Schwartz (1953). A series for the rate of unemployment based on the claimant count, available for the period July 1948-June 2004, is from the ONS. A seasonally unadjusted series for the rate of unemployment among insured workers, available for the period January 1920-December 1939, is from Table 4.4 of Capie and Collins (1983). A seasonally unadjusted series for the Board of Trade wholesale price index, available for the period January 1919-December 1939, is from Table 2.1 of Capie and Collins (1983). A seasonally unadjusted series for the retail price index available for the period July 1914-December 1982 is from Table III.(11) of Capie and Webber (1985). The *Economist*'s seasonally adjusted index of business activity, available for the period January 1920-December 1938 is from Table 3.1 of Capie and Collins (1983). Two series for the market rate of interest on best three-month and six-month bills (quoted at an annual rate), both available for the period January 1919-December 1939, are from Tables 7.1 and 7.3 of Capie and Collins (1983). Three series for the interbank 3-, 6-, and 12-month interest rates[20], available for the period January 1979-June 2004, are from the *Bank of England* database. A seasonally unadjusted series for the retail price index from the ONS (series code is CDKO) is available for the period June 1947-June 2004. A series for real average weekly wages for the period January 1925-December 1939 has been constructed by deflating the series for nominal average weekly wages from Table 4.2 of Capie and Collins (1983) by the Capie and Webber (1985) retail price index. A monthly, seasonally unadjusted series for the CPI, available for the period January 1975-August 2004, is from the ONS. Finally, a series for the wholesale price index from the NBER historical database (series code: 04053) is available from January 1885 to May 1951.

When needed, unemployment rate series, and the *Economist*'s business activity index for the interwar era, have been converted to the quarterly frequency by taking averages within the quarter. All other series have been converted by keeping the last observation from each quarter.

[20] All figures are end-of-month,and have been computed as the simple averages between the LIBID and LIBOR rates.

4 Monetary Regimes and Macroeconomic Facts

Figure 1 shows the logarithm of the U.K. price level and U.K. inflation since the times of the Great Fire of London (1666), while Table 1 reports average values for inflation rates, interest rates, and for the rates of growth of monetary aggregates by monetary regime/historical period. With the single exception of the 'suspension period' between 1797 and 1821, the pre-WWI era exhibited a remarkable stability in the average level of prices, with (e.g.) the Elisabeth Schumpeter index for the prices of consumer goods *decreasing* slightly from 109 in 1661 to 104.92 in 1823 (–3.74% overall, over a period of 162 years), and the ONS' composite price index slightly increasing from 9.5 in 1823 to 9.8 in 1913 (+3.2% overall, over a period of 90 years). As the first three columns of Table 1 show, under metallic standards—either *de jure* or *de facto*, and based on either gold or silver—average inflation rates based on any price index had invariably been remarkably low, in several cases having been negative. The post-WWII era, by contrast, has seen the price level literally take off, with increases between 1947 and 2003 ranging from 2,313% based on the RPI, to 2,423.2% based on the GDP deflator. The 1972-1992 period was characterised by the highest average inflation rates, interest rates, and rates of monetary growth in recorded history, while the interwar era exhibited the lowest inflation rates and rates of monetary growth, with average inflation having systematically been negative based on all of the price indices we consider. The inflation targeting regime, by constrast, does not stand out in any particular way: as we will see in section 4.4, the unique, distinctive characteristic of this regime is indeed a different one: a remarkably low volatility of business-cycle fluctuations for most of the series. But let's start our analysis from a topic currently at the top of the macroeconomic research agenda: inflation persistence.

4.1 Inflation persistence

Inflation persistence has been, over the last decade, one of the most intensely investigated topics in the field of macroeconomics. If, as argued by, e.g., Fuhrer and Moore (1995),[21] high inflation persistence is an *intrinsic*, structural characteristic of industrial economies, then a DSGE model's ability to replicate it is indeed a crucial test of adequacy. In recent years, however, several papers—see in particular Cogley and Sargent (2002) and Cogley and Sargent (2003)—have produced empirical evidence at odds with the notion of inflation as an intrinsically persistent process, strongly suggesting instead that, at least in the United States, high inflation persistence may have been 'chronologically concentrated' (so to speak) around the time of the Great Inflation of the 1970s.[22]

[21] An earlier paper, influential in establishing the conventional wisdom notion of inflation as a highly persistent process, was Nelson and Plosser (1982).

[22] See also Klein (1975), Barsky (1987), Alogouskoufis and Smith (1991), Evans and Wachtel (1993), and Levin and Piger (2003).

It is important to stress that, at a very general level, the notion that inflation may be intrinsically persistent should be seen, at the very least, with suspicion, for the simple reason that, on strictly conceptual grounds, the stochastic properties of inflation cannot possibly be thought of as being independent of the underlying monetary regime. A price-level targeting regime, for example, would make the price level (trend) stationary, thus causing inflation to be perfectly negatively serially correlated. By the same token, as a simple matter of logic it is hard to believe that inflation may be highly persistent under an inflation-targeting regime in which the central bank pre-emptively and aggressively fights any deviation of inflation from target. The adoption, since the end of the 1980s, of inflation-targeting regimes in several developed and emerging economies raises therefore doubts on the notion that, today, inflation may be, in these countries, very highly persistent.

Table 2 reports, for the inflation series in our dataset, parametric measures of persistence based on univariate AR(p) representations by monetary regime/historical period.[23] For each inflation series we estimate via OLS the following AR(p) model[24]

$$\pi_t = \mu + \phi_1 \pi_{t-1} + \phi_2 \pi_{t-2} + ... + \phi_p \pi_{t-p} + u_t \tag{1}$$

selecting the lag order based on the Schwartz information criterion,[25] for a maximum possible number of lags P=6. For each series, the table reports the median-unbiased estimate of our preferred measure of persistence—which, following Andrews and Chen (1994), we take it to be the sum of the autoregressive coefficients[26]—computed via the Hansen (1999) 'grid bootstrap' procedure, together with the 90%-coverage confidence interval. Specifically, following Hansen (1999, section III.A) we recast (1) into the augmented Dickey-Fuller form

$$\pi_t = \mu + \rho \pi_{t-1} + \gamma_1 \Delta \pi_{t-1} + ... + \Delta \gamma_{p-1} \pi_{t-(p-1)} + u_t \tag{2}$$

—where ρ is defined as the sum of the AR coefficients in (1)—and we simulate the sampling distribution of the t-statistic t=($\hat{\rho}$-ρ)/$\hat{S}(\hat{\rho})$, where $\hat{\rho}$ is the OLS estimate of ρ, and $\hat{S}(\hat{\rho})$ is its estimated standard error, over a grid of possible values [$\hat{\rho}$-3$\hat{S}(\hat{\rho})$; $\hat{\rho}$+3$\hat{S}(\hat{\rho})$], with step increments equal to 0.01. For each of the possible values in the grid, we consider 1000 replications. Both the median-unbiased estimates of ρ

[23] Given the short length of the inflation-targeting and interwar sub-periods, for either sub-period we only report results based on quarterly data.

[24] In the case of the quarterly wholesale price index from the *NBER* historical database, of the retail price index, and of the CPI, which are all seasonally unadjusted, we augment (1) with three seasonal dummies.

[25] Specifically, the lag order has been chosen based on the model estimated over the full sample.

[26] As shown by Andrews and Chen (1994), the sum of the autoregressive coefficients maps one-to-one into two alternative measures of persistence, the cumulative impulse-response function to a one-time innovation and the spectrum at the frequency zero. Andrews and Chen (1994) also contain an extensive discussion of why an alternative measure favored, e.g., by Stock (1991), the largest autoregressive root, may provide a misleading indication of the true extent of persistence of the series depending on the specific values taken by the other autoregressive roots.

and the 90% confidence intervals reported in Table 2 are based on the bootstrapped distribution of the t-statistic.

As Table 2 clearly shows, historically, high inflation persistence appears to have been the *exception*, rather than the rule, with inflation estimated to have been very highly persistent only during the period between the floating of the pound, in June 1972, and the introduction of inflation targeting, in October 1992. Specifically,

- the inflation targeting regime exhibits some mildly *negative* serial correlation based on either the retail price index, the CPI, or the GDP deflator.[27] In all cases, the null of white noise cannot be rejected at the 90% level, and in all cases the upper limit of the 90% confidence interval is well below one.

- In stark contrast with the current regime, the period between 1972 and 1992 exhibits very high persistence based on each single series, with point estimates of ρ ranging from 0.79 to 0.96, and upper limits of 90% confidence intervals ranging between 1.03 and 1.05.

- Persistence appears as entirely absent under metallic standards, either *de facto* or *de jure*, and based on either gold or silver.[28] The *de facto* gold standard, in particular, displays a mild, although not statistically significant, negative serial correlation based on all three inflation series, while results for the *de facto* silver standard and the *de jure* gold standard are, under this respect, not consistent across series.

- Intriguingly, the turbulent interwar period only displays a mildly positive serial correlation, and for both inflation series the null of a unit root can be clearly rejected.

- Bretton Woods displays some evidence of serial correlation, with point estimates of ρ ranging from 0.21 to 0.56, and two cases in which it is not possible to reject the null of a unit root, but the evidence is clearly nowhere nearly as strong and consistent as that for the 1972-1992 period.[29]

These results provide the strongest possible refutation of the notion that inflation is *intrinsically* persistent, while they are compatible with the alternative notions that (a) inflation persistence is historically determined, and (b) the extent of persistence

[27] This is consistent with the notion that the current monetary regime contains, *de facto*, a slight component of mean-reversion in the price level.

[28] One *caveat* is that the likely presence of measurement error in old (log) price series automatically introduces negative serial correlation in their first differences, thus biasing downwards persistence estimates. Unfortunately, it is not clear at all how to even gauge an idea of the likely extent of such an effect.

[29] Our results for the post-WWII era are consistent with Cogley, Morozov, and Sargent (2003) who, based on a Bayesian random-coefficients VAR with stochastic volatility, detect evidence of a broadly hump-shaped pattern in U.K. RPI inflation persistence since the beginning of the 1960s.

found in the data crucially depends on the monetary regime in place over the sample period. In particular, the fact that persistence appears to have been entirely absent under both metallic standards and the current inflation targeting regime—monetary arrangements providing strong nominal anchors—while it has only appeared during the period between June 1972 and October 1992, characterised initially by the complete lack of any nominal anchor, and subsequently by shifting and, arguably, only partially credible monetary arrangements, provides strong *prima facie* evidence in favor of the notion that the strength and credibility of the nominal anchor of the system is the key underlying determinant of inflation persistence.[30] The immediate implication for macroeconomic modelling is that, contrary to the traditional Fuhrer-Moore position, the ability to generate high inflation persistence is *not* a crucial test of adequacy for a macroeconomic model. Rather than needing theories capable of generating very high inflation persistence, what we need is theories/explanations of why persistence has been entirely absent during specific historical periods, while it has only appeared during other periods.

We now turn to an issue closely related to inflation persistence: the Fisher effect.

4.2 The Fisher effect

Despite being one of the cornerstones of monetary economics, evidence in favor of the Fisher effect is entirely absent from the pre-Bretton-Woods era, and it only appears after about 1960[31]. As stressed for example by Mishkin (1992), in the U.S. evidence *pro*-Fisher has essentially disappeared after the 1970s. Currently, there are two leading explanations for such a puzzling time-variation in the extent of the Fisher effect.[32] In both of them, inflation persistence plays a crucial role, although for completely different reasons.

A first explanation, put forward by Mishkin in a series of papers,[33] is based on the notion that inflation and nominal interest rates are cointegrated. During certain historical periods they share strong stochastic trends, thus making the Fisher effect apparent. Over different periods, on the other hand, the stochastic trends they have in common are much more subdued, thus causing the Fisher effect to disappear. The fact that, as we have shown in the previous section, a unit root in inflation can

[30] For a conceptually related position, see Levin and Piger (2003).

[31] See Ibrahim and Williams (1978), Barthold and Dougan (1986), and especially Barsky (1987). Lack of evidence in favor of the Fisher effect was stressed by Irving Fisher himself, who, in the *Theory of Interest*, proposed an explanation based on the notion that agents form inflation expectations based on a long distributed lag of past inflation. In the end, however, Fisher himself was dissatisfied with his own theory—see Fisher (1930).

[32] Here we rule out the Friedman and Schwartz (1976) explanation—based on the notion that economic agents only gradually 'learned their Fisher'—on purely logical grounds. The partial disappearance of a Fisher effect in recent years documented in Mishkin (1992) and, for the U.K., in the present paragraph, would indeed imply that, over the last two decades, economic agents have somehow 'unlearned their Fisher', which appears implausible to us.

[33] See in particular Mishkin (1992),

be strongly rejected for all regimes/periods except between 1972 and 1992, provides decisive evidence against Mishkin's hypothesis, for the simple reason that, for two series to be cointegrated, they first have to be individually I(1).

A second explanation—due to, e.g., Barthold and Dougan (1986), and especially Barsky (1987)—attributes changes in the Fisher effect to changes in inflation forecastability. To take an extreme example, if inflation were completely unforecastable in the R^2 sense, Fama (1976)-type regressions would fail to uncover evidence *pro*-Fisher even in a world in which the Fisher effect held *ex-ante* by assumption/construction. The evidence produced in the previous section of changes in U.K. inflation persistence over the sample period—which, as stressed, e.g., by Barsky (1987), imply corresponding changes in the extent of its forecastability—leads us to expect to find a strong Fisher effect in U.K. data only between 1972 and 1992, the single period in U.K. history in which inflation had indeed been very highly persistent.

Table 3 reports results from Fama (1976) regressions by regime/period of the *ex-post* inflation rate prevailing between months t and $t+k$ on a constant and on the nominal rate prevailing over the same period,

$$\pi_{t+k} = \alpha + \beta r_{t,t+k} + u_{t+k} \tag{3}$$

where the notation is obvious. The use of overlapping data—i.e., of data for which the interest rate and inflation rate horizon is longer than the one-month sampling frequency—automatically induces serial correlation in the error term, which we tackle *via* the Andrews (1991) heteroskedasticity and autocorrelation-consistent covariance matrix estimator.[34] Finally, given that none of the price series we use is seasonally adjusted, we augment (3) with monthly seasonal dummies.

The rationale behind Fama (1976) regressions is that, under rational expectations, and assuming the Fisher hypothesis to be true, the nominal interest rate prevailing over a specific time period should contain information on the inflation rate which will prevail over the same period. In particular, assuming the *ex-ante* real interest rate to be constant (an assumption which, needless to say, is very much at odds with the recent macroeconomics literature) the estimate of β in (3) should not be significantly different from one, thus implying that movements in expected inflation translate one-to-one into movements in nominal interest rates.

Results in Table 3 are largely—although not entirely—compatible with the Barthold and Dougan-Barsky hypothesis. As expected, estimates of β have been extremely low, and not significantly different from zero, under the inflation targeting and Bretton Woods regimes, and markedly higher, and not significantly different from one, between 1972 and 1992. Evidence for the interwar period appears at first sight puzzling, with *negative* estimates of β for both the 3- and the 6-month maturities, although in neither case they are significantly different from zero at conventional levels. In order to correctly interpret such a result, however, it is important to keep in mind the

[34] Qualitatively similar results based on the Newey and West (1987) covariance matrix estimator are available upon request.

sheer peculiarity of those years. In particular, first, inflation had been negative for a significant portion of the interwar period (based on the ONS' annual composite price index, for example, for ten years out of seventeen). Second, for a non-negligible portion of that period—specifically, between the second half of 1934 and the second half of 1938—nominal rates had been essentially flat below one.[35] It should therefore come as no surprise that results from Fama regressions produce such disconcerting results for the interwar era. Results for the *de facto* Gold Standard are instead truly quite puzzling. As we discussed in section 4.1, all estimates of ρ for that period, ranging between -0.21 and 0.17, clearly point towards the essential white noiseness of inflation under that regime, thus implying, by the Barthold-Dougan-Barsky argument, that estimates of β in Fama regressions should be essentially zero. By contrast, our evidence—although admittedly very limited, and especially imprecise, to the point that the null of β=0 cannot be rejected at conventional levels—suggests the *possible* presence of a Fisher effect during a period in which the univariate properties of inflation suggest its near-unforecastability.[36] Due to the imprecision of the estimate, however, such a result should necessarily be regarded as purely tentative.

4.3 Money growth and inflation

In the spirit of Lucas (1980b) and Christiano and Fitzgerald (2003), in this section we investigate the evolution across regimes of the correlation between inflation and the rates of growth of both narrow and broad monetary aggregates within three frequency bands, comprising components with periodicities beyond 30 years, between 8 and 30 years, and between 6 quarters and 8 years (traditionally regarded as the business-cycle ones). The approximated band-pass filter we use is the one recently proposed by Christiano and Fitzgerald (2003). Figures 2 to 5 show, for inflation and for the rates of growth of base money, M3, and M4, both the raw series and the three just-mentioned components, while Table 4 reports cross-correlations by regime/period for both the raw and the filtered data. Two main findings stand out. First, a striking stability in the correlation between inflation and the rates of growth of all monetary aggregates at the frequencies beyond 30 years. Second, some instability at higher frequencies. Specifically,

- the components of inflation and money growth beyond 30 years have been systematically and very strongly positively correlated across *all* regimes.[37] This

[35] In particular, the 3-month rate had stayed between 0.3 and 0.9% with the sole exception of December 1936, when it was equal to 1.1%, while the 6-month rate had been between 0.4 and 0.9% (all figures are annualised).

[36] One possible explanation along the lines of Barsky and Delong (1991) is that the univariate time series properties of inflation under the Gold Standard underestimated the true extent of inflation forecastability, in that gold production obviously had forecasting power for inflation under that regime.

[37] It is however important to remember that components beyond 30 years are, quite inevitably, comparatively less precisely estimate than components associated with higher frequencies.

has held for both narrow and broad monetary aggregates, with the single exception of base money under the current regime, for which the correlation has clearly been, so far, negative (-0.73). Although we do not offer any explanation for such a puzzling finding, we exclude that the result may be a fluke due to an endpoint problem with the band-pass filter: as panel (a) of figure 2 and Table 4 clearly show, the result is there, although weaker, even in the raw data.

- The same holds for the frequency band between 8 and 30 years, with the exception of M4, for which the correlation does not exhibit any clear-cut pattern; of M3 under Bretton Woods, for which the correlation turns negative, compared to the previous years; and of base money around WWII and its immediate aftermath, when M0 growth markedly overshot, and then undershot, inflation. This last episode, however, lends itself to a simple explanation, namely the price controls in place around WWII, so that base money first markedly expanded, and then contracted, only partially affecting, in either case, the rate of inflation.

- At the business-cycle frequencies instability has been especially marked in the case of M4 over the post-WWII era—with the business-cycle components of RPI inflation and M4 growth having been contemporanou *negatively* correlated until the end of the 1980s, and having been instead markedly *positively* correlated since then—less so for M3, with the correlation turning from mildly positive before WWII to mildly negative under Bretton Woods.

How to interpret such a marked stability across regimes in the correlation between money growth and inflation at very low frequencies? As stressed by Svensson[38] the precise *meaning* to be attributed to the correlation between money growth and inflation crucially depends on the nature of the underlying monetary regime. In the extreme case of a pure monetary targeting regime in which the central bank perfectly controls the money supply, for example, money growth would be exogenous, while inflation would endogenously adjust to it. Under these circumstances, we could legitimately say that 'money growth causes inflation'. Under a pure inflation targeting regime in which the central bank perfectly controls inflation, on the other hand, the opposite would be true: inflation would now be exogenous, while money growth would endogenously adjust to it *via* an equilibrium condition on the money market. Under these circumstances, it would be legitimate to argue that 'inflation causes money growth'. In general, however, 'money growth and inflation are both endogenous variables and there is no clear direction of causality',[39] so that the correlations illustrated in figures 2-5 should be regarded as *purely reduced-form*,[40] without any clear-cut

[38] See, e.g, Svensson (2003).

[39] Svensson (2003, p. 1064).

[40] A conceptually related point is that, as it is well known, Whiteman (1984) and McCallum (1984), in their criticism of Lucas (1980b) forcefully demonstrated how results based on frequency-domain techniques do not have, in general, clear-cut implications for quantity-theoretic propositions, i.e.

causality running from one variable to the other—with the exception of the inflation targeting regime, under which inflation should be largely regarded as exogenous.[41] However, the fact that the correlations between the very low-frequency components of inflation and of the rates of growth of several monetary aggregates have remained so remarkably stable over long periods of time, comprising markedly different monetary arrangements (with the only exception, so far, of base money growth under inflation targeting), suggest such correlations to find their origin in deep features of the economy—in other words, to be 'hardwired' into the model in ways that make them largely independent of the underlying monetary regime. Especially interesting is, in our view, the strong correlation between the low-frequency components of inflation and the rates of growth of M0 and M3 under the Gold Standard (see panels b of figures 2 and 4), clearly suggesting that a key finding in Rolnick and Weber (1997),

> '[...] under fiat standards, the growth rates of various monetary aggregates are more highly correlated with inflation [..] than under commodity standards',[42]

may find its origin in their exclusive focus on the raw data (in other words, in their failure to distinguish between the different frequency components of the data). As Table 4 shows, under the Gold standard the correlation at the very low frequencies had been remarkably high both for base money (0.94) and for M3 (0.97).

4.4 The amplitude of business-cycle fluctuations

'You've never had it so good'
—Harold Macmillan

Table 5 reports the standard deviations of the band-pass filtered business-cycle components for the series in our dataset. The approximated band-pass filter we use is, again, the Christiano-Fitzgerald (2003) one. Following established conventions in business-cycle analysis[43], we define the business-cycle frequency band as the one containing all the components of a series with a frequency of oscillation between 6 quarters and 8 years.

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implications whose validity is independent of a specific structural model, and of a specific policy rule in place. On the contrary, the values taken by both the band spectrum regression estimator implicitly used by Lucas, and the cross-correlations considered here, depend in general *both* on the structure of the model, *and* on the underlying policy rule.

[41] Under the Gold standard, on the other hand, money growth, being linked to the evolution of the stock of gold, was partly exogenous and partly endogenous, the former component reflecting exogenous influences on gold production (e.g., the invention of the cyanide process in the second half of the XIX century), the latter originating from the self-correcting mechanism intrinsic to metallic standards—see, e.g., Fisher (1922) and Barro (1979)—with a negative shock to the price level giving rise to both an increase in extraction activity, and a switch of base metal from non-monetary to monetary uses.

[42] See Rolnick and Weber (1997, p. 1308)

[43] See for example King and Watson (1996), Baxter and King (1999), Stock and Watson (1999), and Christiano and Fitzgerald (2003).

Several facts are readily apparent from the table. In particular, first, based on annual data, the volatilities of the business-cycle components of the logarithms of real GDP and of *all* national accounts aggregates have been, post-1992, systematically lower than during any of the previous monetary regimes/historical periods, in several cases markedly so. The volatility of the cyclical component of log real GDP, for example, has been equal to 68.3% and 51.1% of what it was under Bretton Woods and, respectively, during the 1972-1992 period, while the figure for the interwar period is a striking 32.0%, thus confirming, once again, the well-known, remarkable instability of the interwar era when seen from a historical perspective. Interestingly, the volatility associated with the *de jure* gold standard regime, at 1.71%,[44] although twice as large as that associated with the inflation targeting regime, is very close to that prevailing during the 1972-1992 period (1.68%). It is important to stress, once again, the high quality of U.K. XIX century real GDP data—as we mentioned in the previous section, the Feinstein (1972) 'compromise estimate' we use is based on three independent estimates based on income, expenditure and respectively production data—so that these results should be regarded as reliable. Our results paint a different picture from that found in the related studies mentioned in the introduction,[45] with a period of extreme turbulence (the interwar years), one of remarkable stability (the inflation targeting regime), and three periods 'in-between', with the volatility of the gold standard era and that of the 1972-1992 period being essentially the same. Based on quarterly post-WWII data, the inflation targeting regime appears, once again, as the most stable by far for both real GDP and all national accounts aggregates, with the single exception of government expenditure, for which the lowest volatility pertains to the Bretton Woods regime. (There is no need to stress, however, how for no reason we should expect the volatility of public expenditure to bear any systematic relationship with the prevailing monetary regime.)

A near-identical picture emerges for inflation measures.[46] First, the inflation targeting regime appears to have been been characterised, to date, by the lowest volatility ever for *all* the inflation measures we consider, with the obvious exceptions of the Schumpeter price indices and of the wholesale price index, which do not extend up to the current regime. Second, the fall in volatility under the current regime, compared with the pre-1992 regimes/historical periods, has been most of the times extremely marked. Focusing on annual GDP deflator inflation, for example, the volatility of its business-cycle component post-1992 has been equal to 44.4% and 20.4% of what it was under Bretton Woods and, respectively, during the 1972-1992 period, while the

[44] As we stress in note *a* to Table 2, based on Greasley's (1989) GDP estimates volatility for the *de jure* gold standard period increases only marginally to 1.77%.

[45] Backus and Kehoe (1992) report the following standard deviations for the HP-filtered logarithm of real GNP by sub-period: prewar, 2.12%; interwar, 3.47%; postwar, 1.62%. Bergman, Bordo, and Jonung (1998), based on the Baxter-King filter, obtain the following results by sub-period: 1876-1913, 2.0%; 1920-1938, 2.9%; 1948-1972, 1.1%; 1973-1995, 1.7%.

[46] Results for the filtered logarithms of price indices are qualitatively the same as those for inflation measures, and are not reported here, but are available upon request.

corresponding figures for the ONS' composite CPI are 76.5% and respectively 37.3% (figures based on the inverse of the purchasing power of the pound are very close to those based on the composite CPI). The volatility of inflation fluctuations under the gold standard was 4.3 times that corresponding to the current regime based on the GDP deflator, and 4.2 times based on the composite CPI. Intriguingly, the corresponding figures for the interwar period are 1.23 and 1.19, thus pointing towards a less-than-dramatic decrease in volatility under the current regime, compared with the interwar era. Figures for the *de facto* gold standard and the *de facto* silver standard, ranging from 6.47 to 9.28, point towards a remarkable volatility of inflation fluctuations under those regimes. These figures, however, are likely to overstate the authentic extent of volatility reduction over the most recent era for two reasons. First, it can reasonably be assumed that old price data are subject to a sizeable measurement error, the older the data the more so. This automatically exaggerates the authentic extent of volatility reduction in the most recent era. Second, the composition both of overall output, and of the average consumption basket in previous historical periods was markedly 'skewed'—compared with today's figures—towards agricultural goods, whose prices are markedly more volatile than industrial goods' prices. Again, this would exaggerate the authentic extent of volatility reduction over the most recent era. Results based on quarterly RPI inflation, available from 1914:4, confirm the previously discussed pattern, with the volatility of the cyclical component of inflation under the current regime having been equal, so far, to 31.3%, 48.7%, and 31.7% of what it was during the interwar years, under Bretton Woods, and respectively between 1972 and 1992.

Figure 6 shows scatterplots of the standard deviations of the business-cycle components of the logarithm of real GDP and of two alternative inflation measures, based on the composite CPI (annual data), and on the RPI (quarterly data). Although based on an extremely limited number of observations, the correlation clearly appears to be positive based on quarterly data, while based on annual data it appears to be positive if we exclude the interwar era, which might be regarded as anomalous. Most sticky-price (sticky-wage) DSGE models currently used in monetary policy analysis imply a trade-off between inflation and output volatility[47], in the sense that, *ceteris paribus*, a monetary policy aimed at reducing the unconditional volatility of inflation necessarily implies an increase in the unconditional volatility of output. The exception is represented by the early sticky-price models of, e.g., Goodfriend and King (1997) and King and Wolman (1999), where, due to the simplicity of the model's structure, there was no trade-off between inflation and output gap's stabilisation. The results reported in figure 6 suggest several possible alternative—and non mutually exclusive—interpretations. A first possibility is that the trade-off between inflation and output gap volatility is indeed there, but that, historically, changes in the variance of the structural shocks—including monetary policy shocks—have accounted for a dominant fraction of the changes in the volatilities of inflation and output across

[47] See, e.g., the analysis in Erceg, Henderson, and Levin (2000).

monetary regimes. A second possibility is instead that, in line with Goodfriend and King (1997) and King and Wolman (1999), there is no trade-off between inflation and output gap volatility. Although a possibility from a conceptual point of view, such an explanation appears to us as less-than-appealing simply because the very same frictions giving rise to the trade-off appear to be necessary in order to allow DSGE models to successfully replicate the dynamics found in the data.[48]

Turning to results for other indicators,

- both industrial output and output in the manufacturing sector display an overall pattern broadly resembling the one we previously discussed for real GDP and national accounts components, with the volatility associated with the inflation targeting regime having been, by far, the lowest in recorded history, and with marked volatility reductions compared with previous regimes/periods. Transport and communications' output, on the other hand, appears to have been the most cyclically stable under Bretton Woods, while results for distribution and other services do not exhibit any clear-cut pattern, with quarterly data suggesting the lowest volatility post-1992, and annual data, quite surprisingly, indicating the interwar era as the most stable ever.

- Concerning monetary aggregates, first, quarterly post-WWII M4 data point towards significant volatility reductions post-1992 compared with the previous two regimes/periods, by 40.4% and respectively 22.3%. As for base money, the volatility post-1992 ranges between 22.8% and 58.3% of what it was under previous regimes/periods.

- Results for interest rates, first, consistently suggest the 1972-1992 period to have been characterised by the largest volatility in recorded history. Second, post-WWII quarterly data on either short or long rates clearly suggest, again, the current regime to have been characterised by the lowest volatility of the post-WWII era. Third, both the annual long rate series, and the quarterly series for the three-month bank bills rate, clearly indicate the lowest volatility to have been associated with the *de jure* gold standard.[49]

- Not surprisingly, results for the rate of growth of nominal earnings closely mimic those for inflation measures, with the volatility under inflation targeting being 26.4% and 17.6% of what it was under Bretton Woods, and respectively between 1972 and 1992. The figure for the interwar period, being based on the Capie and Collins (1983) series for average weekly wages, is strictly speaking not fully

[48] On this see, e.g., Smets and Wouters (2003a), Smets and Wouters (2003b), and Christiano, Eichenbaum, and Evans (2004).

[49] It is important to stress how, different from most other series, interest rates do not suffer from either measurement error problems, or changes in the nature/composition of the object which is being measured (a one-year interest rate today is essentially the same as a one-year interest rate two hundred years ago), so that these comparisons are probably the most reliable in the entire paper.

comparable with the post-WWII data, but taken at face value suggests volatility under inflation targeting to have been less than half that for the interwar years. Results for the rate of unemployment consistently suggest the greatest extent of stability to have been associated with the Bretton Woods years, although, based on quarterly data, the difference with the current regime is comparatively small.

4.5 The Phillips correlation

In the spirit of Lucas (1973), and especially Ball, Mankiw, and Romer (1988), this section presents evidence on the Phillips trade-off between the cyclical components of inflation and unemployment, both across monetary regimes and over time. The idea, once again, is to exploit the dramatic variation intervened in U.K. monetary arrangements since the metallic standards era as the 'natural experiment' capable of identifying a set of stylised facts that any reasonable macroeconomic model should replicate. Panels (a) to (e) of figure 7 show scatterplots of business-cycle components of unemployment and inflation by monetary regime/historical period together with LAD regression lines, while Table 6 reports standard deviations of LAD regression residuals by regime/period. Several findings stand out. In particular,

- the inflation targeting regime appears to have been characterised, to date, by the most stable (although not the flattest) unemployment-inflation trade-off in recorded history, with all the observations tightly clustered around the regression line, and a standard deviation of regression residuals between 25.3% and 38.8% of what it had been under previous regimes/periods.

- In stark contrast—again—with the current regime, the period between June 1972 and October 1992 was characterised by both the steepest, and the most unstable trade-off in recorded history, with a slope of the LAD regression line equal to -2.33 and a standard deviation of regression residuals between 1.13 and 3.96 times what it has been under other regimes/periods.

- Not surprisingly, maybe—given the intrinsic tendency of metallic standards to stabilise the price level[50]—the Gold Standard was characterised by the flattest trade-off ever, although this came at the price of remarkably large fluctuations in the cyclical component of unemployment (see Table 5). A qualitatively similar experience characterised the interwar period, with a slope of the regression line equal to -0.90, and a similarly large volatility of unemployment fluctuations.

What explains historical changes in the slope of the U.K. Phillips correlation? Although providing an explanation is beyond the scope of this paper, in line with the cross-country evidence in Ball, Mankiw, and Romer (1988), the U.K. experience

[50] On this see, e.g., Barro (1982).

seem to clearly point towards a positive correlation—both across regimes and over time (especially over the post-WWII era)—between mean inflation and the slope of the Phillips correlation, with an increase in mean inflation being associated with an increase in the slope of the LAD regression line. Panel (f) of figure 7 shows a scatterplot of mean inflation and the negative of the LAD regression line across regimes/periods. Although admittedly based on just five observations, evidence clearly suggests a positive correlation between mean inflation and the negative of the slope of the LAD regression line. Figure 8 presents analogous evidence, based on monthly data for rolling 10-year samples,[51] for both the interwar era and the post-WWII period. Evidence of a positive correlation is clear for the latter period, much less so for the former. As stressed by Ball, Mankiw, and Romer (1988), such a stylised fact provides an important litmus test for discriminating between alternative theories/models of the Phillips trade-off, clearly falsifying (e.g.) 'Lucas' islands'-type explanations of the trade-off, and favoring instead New Keynesian theories emphasising the link between mean inflation, the frequency of price/wage adjustments, and the steepness of the trade-off.

4.6 The cyclicality of real wages

In the second chapter of the *General Theory*,[52] Keynes thus speculated on the relationship between changes in money (i.e., nominal) and changes in real wages.

> [I]n the case of changes in the general level of wages, it will be found, I think, that the change in real wages associated with a change in money-wages, so far from being usually in the same direction, is almost always in the opposite direction. [...] This is because, in the short period, falling money-wages and rising real wages are each, for independent reasons, likely to accompany decreasing employment; [...].

In this passage, Keynes made two conjectures: (1) changes in real and in nominal wages are systematically *negatively correlated*; and (2) real wages are *counter-cyclical*. As is well-known, the first conjecture was refuted by (among others) Dunlop (1938) and Tarshis (1939). Conventional wisdom[53] holds that Dunlop and Tarshis also refuted Keynes' second conjecture, on the counter-cyclicality of real wages. Before discussing our results, it is therefore worth spending a few words setting the record straight: while Dunlop and Tarshis convincingly refuted Keynes' first conjecture, a careful reading of their papers clearly shows that *in no way they ever came close to refuting Keynes' conjecture on the counter-cyclicality of real wages*. On the contrary, the Postscript in Tarshis (1939)[54] contains the following passage.

[51] The negative of the slope of the LAD regression line is plotted in correspondence with the mid-point of the 10-year rolling window.

[52] See Keynes (1936), page 10.

[53] See, for example, Sargent (1987), chapter XVIII.

[54] See Tarshis (1939, p. 154). It is important to remember that Tarshis' study was based on U.S. data.

Further analysis of the material, undertaken after this note had been set up in proof, brought to light certain results relevant to this enquiry. [...] If changes in man-hours [the cyclical indicator considered by Tarshis] are related to changes in 'real hourly wages, uncorrected', [the 'corrected' series Tarshis considered in the previous part of the paper controlled for 'changes in the cost of living that were due to changes in the prices of agricultural products', so 'uncorrected' here means just raw] *a rather high negative association is to be found.* For the period of 75 months, considered above, the coefficient of association is -0.64, and with the exclusion of changes of two-tenths of one per cent. [*sic*] or less, the coefficient stands at -0.75. That is to say, *changes in real hourly wages are in general opposite in direction from changes in man-hours of work.* (emphasis added)

Keynes (1939) was well aware of this: after acknowledging (page 34) that, in the light of the results reported by Dunlop and Tarshis, his first conjecture 'needs to be reconsidered', he stressed however (page 35) that in the *General Theory* he was

[...] dealing with the reaction of real wages to changes in output, and had in mind situations where changes in real and money wages were a reflection of changes in the level of employment caused by changes in effective demand'.

Further, on page 42 he points out that

[...] in the *postscriptum* to his note, Mr. Tarshis explains that whilst real wages tend to move in the same direction as money wages, they move in the opposite direction, though only slightly, to the level of output as measured by man-hours of employment; from which it appears that Mr. Tarshis's final result is in conformity with my original assumption.

Let us now turn to our results. Figure 9 plots band-pass filtered business-cycle components of real wages and of two alternative indicators of real economic activity—real GDP for the Gold Standard and the post-WWII era, and minus the rate of unemployment[55] for the interwar period—by monetary regime/historical period since the second half of the XIX century, while figure 10 shows cross-correlations at leads and lags between the same components plotted in figure 9. Several findings stand out. First, the striking counter-cyclicality of real wages during the interwar period, which, together with the previously mentioned results for the U.S. reported in Tarshis's (1939) *Postscript*, dramatically confirms the correctness of Keynes' conjecture for the interwar era. Second, the clear pro-cyclicality of real wages under the current inflation targeting regime. Although providing a structural interpretation of such reduced-form evidence is beyond the scope of the present work, we can't resist offering an intriguing conjecture. As it is well-known—see, e.g., Goodfriend and King (1997)—a policy designed to stabilise the price level causes a sticky-price DSGE model to mimic the behaviour of its real business-cycle underlying deep structure. Since real

[55] Specifically, the series for 'percentage of insured workers unemployed' from Table 4.5 of Capie and Collins (1983). Qualitatively similar results based on an alternative real activity indicator, the *Economist*'s index of business activity, are available upon request. The key reason why we have preferred to use the rate of unemployment as a cyclical indicator is that the *Economist*'s index exhibits an 'extreme' behavior in 1926, collapsing from 106 in April to 44.5 *in the following month*, slowly recovering up to 102 in December.

wage pro-cyclicality is a key property of real business cycle models, we tentatively conjecture that real-wage pro-cyclicality post-1992 may find its origin in the fact that the policy of price stability pursued under the current regime may be causing the U.K. economy to behave like its real real business cycle underlying core.

Other regimes/periods do not exhibit any clear-cut cyclical pattern, with the possible exception of Bretton Woods, for which the cross-correlation reported in Figure 10 seems to indicate some evidence of pro-cyclicality (such a pattern, however, appears less apparent based on the simple inspection of the filtered series in figure 9). The lack of an obvious cyclical pattern is especially clear for the Gold Standard period. Based on either Feinstein's 'compromise' GDP estimate, or on the alternative Greasley measure, the cross-correlation function oscillates between -0.26 and 0.22, while a simple visual inspection clearly shows how the cyclical component of real wages was strongly positively correlated with the cyclical component of Feinstein's 'compromise' GDP estimate between, roughly, 1855 and 1865, was negatively correlated between 1870 and 1880 and between 1895 and 1905, and did not exhibit any pattern over the remaining years. Finally, for the 1972-1992 period, too, both the cross-correlation and a simple visual inspection, points towards the absence of any clear-cut pattern.[56]

What are the implications of these findings—in particular, of the marked variation in real wage cyclicality over the sample period—for macroeconomic theory and modelling? While the negative implications—a clear falsification of (classes of) models, like the standard RBC one, predicting uniformly pro-cyclical real wages—are obvious, the positive implications are not clear-cut. One theory recently suggested by Huang, Liu, and Phaneuf (2004) to explain the switch, documented for the United States, from a mild real wage counter-cyclicality during the interwar era to a mild pro-cyclicality after WWII, is based on the interaction between nominal wage and price rigidities and an evolving input-output structure of the economy, with an increase over time in the extent of goods' processing. As they show, for plausible calibrations such a story is capable of replicating the change over time in the cyclical pattern of real wages seen in the data. While Huang *et al.*'s theory appears a useful

[56] Previous results in the literature are mixed. For the U.S., based on the Hodrick-Prescott filter, Kydland and Prescott (1990) show that average hourly real compensation in the U.S. business sector had behaved in a 'reasonably strong pro-cyclical manner' over the period 1954-1989, with a peak in the cross-correlation function of 0.42 and a lead of 2 quarters over GNP. Much weaker pro-cyclicality is reported by Stock and Watson (1999) based on the Baxter-King filter, while Stock and Watson (1999), based again on the Baxter-King filter, do not detect any clear evidence of either pro- or counter-cyclicality.

As for the U.K., the only study we are aware of for the post-WWII era is Blackburn and Ravn (1992), which reports evidence of mild pro-cyclicality over the period 1956:1-1990:1, with a peak in the cross-correlation function of 0.24 at lag zero. There are however several differences between Blackburn and Ravn (1992) and the present work, in particular their use of the Hodrick-Prescott filter, of a different nominal wage indicator (nominal wage rate for manufacturing workers), the fact that they do not break their sample period further, and especially the fact that their sample does not include the period of stronger pro-cyclicality.

starting point, the previously documented pattern for the United Kingdom over the last several decades—in particular, the weak pro-cyclicality under Bretton Woods, the near-a-cyclicality between 1972 and 1992, and the strong pro-cyclicality under inflation targeting—points towards a possible role for shocks and especially monetary policy.

5 Conclusions

The Lucas research program—as articulated in Lucas (1977) and Lucas (1980a)—is based on the notion of, first, establishing a set of macroeconomic 'stylised facts' in the most neutral and a-theoretical way possible, and then building fully-specified artificial economies capable of replicating them. A key problem in the practical implementation of the Lucas program is that, because of the Lucas (1976) critique, it is logically impossible, based on data generated by a single, internally stable policy regime, to disentangle those facts which largely reflect the impact of the regime prevailing over the sample period from those which, on the contrary, are reasonably invariant to changes in the policy regime, reflecting instead the workings of the deep structure of the economy. In this paper we have treated the dramatic variation in monetary regimes intervened in the United Kingdom since the metallic standard era as a set of 'natural experiments', allowing us a preliminary attempt at disentangling these two sets of facts. Only one stylised fact—the high correlation between inflation and the rates of growth of both narrow and broad monetary aggregates at the very low frequencies—has emerged as remarkably invariant to changes in the policy regime and, as such, should be replicated by any reasonable macroeconomic model. All the other facts we have investigated, on the other hand, exhibited a sometimes marked variation across monetary regimes. In particular,

- high inflation persistence, regarded for some time as a robust, established fact, clearly appears to have been, historically, the exception, rather than the rule, with inflation estimated to have been very highly persistent only during the period between the floating of the pound, in June 1972, and the introduction of inflation targeting, in October 1992. Interestingly, under inflation targeting inflation is estimated to have been, so far, slightly negatively serially correlated based on all the price indices we consider. While these findings clearly refute the notion that inflation is intrinsically persistent, they are compatible with the alternative position that the extent of inflation persistence crucially depends on the strength and credibity of the nominal anchor of the system.

- In contrast to the high stability exhibited at the very low frequencies, the correlation between inflation and the rates of growth of monetary aggregates has exhibited a sometimes marked variation at higher frequencies. This is particularly evident in the case of M4 at the business-cycle frequencies, whose contemporaneous correlation with inflation has turned from negative to positive over the second half of the 1980s.

- The Phillips correlation between unemployment and inflation at the business-cycle frequencies appears to have been the flattest under the Gold Standard, the steepest between 1972 and 1992. In line with Ball, Mankiw, and Romer (1988), evidence points towards the existence of a positive correlation—both across monetary regimes and over time (especially over the post-WWII era)—between mean inflation and the slope of the Phillips correlation, which is compatible with New Keynesian theories emphasising the link between mean inflation and the frequency of price adjustments.

- The real wage was markedly counter-cyclical during the interwar period, while it has been, so far, pro-cyclical under inflation targeting. As for other regimes/periods it displayed some evidence of pro-cyclicality under Bretton Woods, but no consistent pattern either between 1972 and 1992 or under the gold standard, turning for example from pro-cyclical during the years between 1855 and 1865, to counter-cyclical over the following decade. While these findings clearly falsify models/theories, like the standard RBC one, predicting uniformly pro-cyclical real wages, they do not naturally point towards cleat-cut alternatives. In particular, the weak pro-cyclicality under Bretton Woods, the essential a-cyclicality between 1972 and 1992, and the strong pro-cyclicality under inflation targeting suggest a possible role for shocks and especially monetary policy.

As for possible directions for future research, it would be interesting to exploit another set of 'natural experiments'—the adoption, since the end of the 1980s-beginning of the 1990s, of inflation targeting regimes on the part of several advanced countries—to compare key macroeconomic stylised facts before and after the adoption of the new regime. In particular, if our conjecture that inflation persistence crucially depends on the strength and credibility of the nominal anchor of the system is correct, we should expect to find high persistence during the period between the collapse of Bretton Woods and the introduction of inflation targeting, but much lower persistence since then.

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Table 1 Average inflation, money growth, and interest rates by monetary regime/historical period

	De facto silver standard	*De facto* gold standard		*De jure* gold standard		Interwar period		Bretton Woods		Bretton Woods to inflation targeting		Inflation targeting	
	A	A	Q	A	Q	A	Q	A	Q	A	Q	A	Q
	Inflation rates based on:												
E. Schumpeter price indices for:													
consumer goods	−0.27*	0.69	–	–	–	–	–	–	–	–	–	–	–
producer goods	−0.13*	0.66	–	–	–	–	–	–	–	–	–	–	–
GDP deflator	–	–	–	0.04	–	−0.83*	–	4.53	4.42	9.83	9.87	2.58	2.54*
ONS's composite CPI	–	1.63		−0.05	–	−1.03*	–	4.47	–	9.72	–	2.48	–
Inverse of purchasing power of the pound	–	1.31	–	−0.33	–	−1.07*	–	4.22	–	8.63	–	2.40	–
Wholesale price index	–			0.23	0.77	−1.41*	−1.17*	4.00	–	–	–		–
Retail price index[a]	–	–	–	–	–	–	−0.94*	–	4.39	–	9.79	–	2.56
	Rates of growth of monetary aggregates:												
M0[b]	–	–	–	1.05	1.77	0.91*	1.09*	3.67	3.74	–	7.60	–	6.82
Money stock[b]	–	–	–	2.04	–	1.21*	–	3.74	–	–	–	–	–
M3 (*Capie-Webber*)	–	–	–	1.78	–	1.26*	0.79*	3.17	3.06	–	–	–	–
M4 (*Bank of England*)	–	–	–	–	–	–	–	–	10.50	–	13.86	–	7.48*
	Interest rates:												
Long rates[c]	3.65[d]	3.95	–	3.16*	–	3.96	–	5.44	7.38	–	11.67	–	6.19*
3-month bank bills	–			2.91	2.79	2.53	2.47*	4.21	4.24	–	11.50	–	–
ONS interbank rate	–			–	–	–	–	–	7.55	–	11.61	–	5.65*

[a] Interwar period from Capie and Webber (1985), after that from ONS. [b] Annual data from Friedman and Schwartz (1982); quarterly data: *de jure* gold standard to Bretton Woods, from Capie and Webber (1985), after that from *Bank of England.* [c] Annual: yield on consols; quarterly: ONS's 20-year par yield. [d] Approximate yield on 3% funds from Ashton (1959).
* indicates the lowest entry in each row. A = annual; Q = quarterly.

Table 2 Inflation persistence: Hansen (1999) 'grid-bootstrap' median-unbiased estimates of ρ, and 90% confidence intervals

	De facto silver standard	*De facto* gold standard	*De jure* gold standard	Interwar period	Bretton Woods	Bretton Woods to inflation targeting	Inflation targeting
	Annual series:						
E. Schumpeter price indices for:							
consumer goods	-0.31 [-0.71; 0.11]	-0.24 [-0.61; 0.14]	–	–	–	–	–
producer goods	0.19 [-0.04; 0.41]	-0.22 [-0.41; -0.03]	–	–	–	–	–
GDP deflator	–	–	0.05 [-0.13; 0.22]	–	0.51 [0.15; 0.93]	0.79 [0.44; 1.04]	–
ONS's composite CPI	–	-0.17 [-0.62; 0.29]	-0.21 [-0.45; 0.02]	–	0.56 [0.19; 1.02]	0.91 [0.53; 1.04]	–
Inverse of purchasing power of the pound	–	–	–	–	0.56 [0.16; 1.01]	0.96 [0.54; 1.05]	–
Wholesale price index	–	–	0.17 [-0.05; 0.39]	–	0.21 [-0.15; 0.53]		–
	Quarterly series:						
Wholesale price index from NBER database	–	–	0.14 [-0.02; 0.30]	0.24 [0.05; 0.46]	–	–	–
Retail price index[a]	–	–	–	0.37 [-0.05; 0.80]	0.56 [0.33; 0.83]	0.91 [0.72; 1.03]	-0.05 [-0.57; 0.49]
Consumer price index						0.93 [0.89; 0.98]	-0.12 [-0.51; 0.24]
GDP deflator	–	–	–	–	0.44 [0.07; 0.83]	0.88 [0.70; 1.04]	-0.19 [-0.70; 0.35]

[a] For the interwar period, retail price index from Capie and Webber (1985). After that, from ONS.
Lag order chosen based on SIC. For technical details, see section 4.2.

Table 3 The Fisher effect: estimated Fama regressions by monetary regime/historical period

De facto *gold standard (1885:1-1914:7)*			
Maturity:	3-month		
$\hat{\alpha}$	-2.12 (2.68)		
$\hat{\beta}$	0.77 (0.73)		
Interwar period (1922:1-1939:7)			
Maturity:	3-month	6-month	
$\hat{\alpha}$	-6.67 (1.63)	-6.81 (1.85)	
$\hat{\beta}$	-0.44 (0.37)	-0.65 (0.37)	
Bretton Woods (1947:6-1972:5)			
Maturity:	3-month		
$\hat{\alpha}$	1.87 (1.58)		
$\hat{\beta}$	0.03 (0.32)		
Bretton Woods to inflation targeting (1979:1-1992:9)			
Maturity:	3-month	6-month	12-month
$\hat{\alpha}$	-8.49 (2.66)	-4.44 (2.24)	-2.42 (1.56)
$\hat{\beta}$	1.23 (0.27)	1.09 (0.24)	0.80 (0.17)
Inflation targeting (1992:10-2004:6)			
Maturity:	3-month	6-month	12-month
$\hat{\alpha}$	0.76 (1.22)	1.20 (0.85)	2.50 (0.21)
$\hat{\beta}$	0.06 (0.18)	0.06 (0.12)	0.01 (0.05)

Standard errors (in parentheses) are based on the Andrews (1991) HAC covariance matrix estimator. *Inflation* Gold standard: based on the wholesale price index from the NBER database. Interwar period: based on the RPI from Capie and Webber (1985). After that, based on the RPI from the ONS. *Interest rates* Gold standard and Bretton Woods, from Capie and Webber (1985). Interwar period, from Capie and Collins (1983). After Bretton Woods, from the *Bank of England* database.

Table 4 The correlation between money growth and inflation

	Raw series, correlations between π_t and Δm_t lagged: 2 years	1 year	Contemporanous correlations: between raw series	between components: beyond 30 years	between 8 and 30 years	between 1.5 and 8 years
	M0 growth and composite CPI inflation (annual)					
Gold standard	0.07	0.51	-0.04	0.94	0.76	-0.46
Interwar period	0.06	0.35	0.64	0.75	0.69	0.00
Bretton Woods	-0.11	0.05	-0.03	0.92	-0.12	-0.05
1972-1992	0.69	0.80	0.69	0.99	0.90	-0.15
	M0 growth and RPI inflation (quarterly)					
1972-1992	0.43	0.37	0.38	0.99	0.90	-0.13
Inflation targeting	-0.27	0.01	-0.16	-0.73	0.64	-0.43
	M3 growth and composite CPI inflation (annual)					
Gold standard	0.00	0.40	0.34	0.97	0.81	0.16
Interwar period	0.12	0.34	0.64	0.61	0.81	0.10
Bretton Woods	-0.10	0.15	-0.14	0.99	0.23	-0.13
	M4 growth and RPI inflation (quarterly)					
Bretton Woods	-0.14	0.02	0.17	1.00	0.23	-0.30
1972-1992	0.20	0.06	0.00	0.97	-0.05	-0.24
Inflation targeting	-0.12	-0.09	0.21	0.93	0.72	0.64

Both the annual composite CPI and the quarterly CPI are from the ONS. The annual M0 series is from Capie and Webber (1985) and *Bank of England*. The annual series for the money stock is from Friedman and Schwartz (1982). The annual M3 series is from Capie and Webber (1985). The quarterly M4 series is from the *Bank of England*.

Table 5 Standard deviations of business-cycle components by monetary regime/historical period

	De facto silver standard	*De facto* gold standard		*De jure* gold standard		Interwar period		Bretton Woods		Bretton Woods to inflation targeting		Inflation targeting	
	A	A	Q	A	Q	A	Q	A	Q	A	Q	A	Q
	Logarithms of real national accounts components:												
GDP	–	–	–	1.71[a]	–	2.69	–	1.28	1.20	1.68	1.54	0.86*	0.73*
Consumption	–	–	–	1.32	–	1.03	–	1.31	1.26	1.90	1.80	0.95*	0.72*
Government expenditure	–	–	–	4.81	–	3.06	–	2.51[b]	1.49	1.25	0.86*	0.73*	0.90
Investment	–	–	–	6.22	–	5.78	–	3.19	2.68	3.95	3.72	2.19*	1.82*
Exports	–	–	–	3.37	–	7.36	–	4.51	2.18	2.86	2.36	2.13*	2.02*
Imports	–	–	–	3.06	–	3.78	–	3.85	2.80	4.03	4.17	1.18*	0.93*
	Inflation rates based on:												
E. Schumpeter price indices for:													
consumer goods	9.28	7.41	–	–	–	–	–	–	–	–	–	–	–
producer goods	7.17	7.20	–	–	–	–	–	–	–	–	–	–	–
GDP deflator	–	–	–	3.81	–	1.26	–	1.98	1.68	4.30	4.22	0.88*	1.13*
ONS's composite CPI	–	6.74	–	6.14	–	1.73	–	1.89	–	3.88	–	1.45*	–
Inverse of purchasing power of the pound	–	6.47	–	5.97	–	1.51	–	1.72	–	2.98	–	1.19*	–
Wholesale price index	–	–	–	5.71*	6.09*	6.86	10.25	11.90	–	12.81	–	–	–
Retail price index[c]	–	–	–	–	–	–	4.15	–	2.66	–	4.10	–	1.30*

[a] Based on the Greasley (1989) real GDP estimate, the standard deviation for the Gold Standard is 1.77.
[b] Starts in 1948, due to the presence of two obvious outliers in 1946-47. [c] For the interwar period, retail price index from Capie and Webber (1985). After that, from ONS. * indicates the lowest entry in each row. A = annual; Q = quarterly.

Table 5 (cont.) Standard deviations of business-cycle components by monetary regime/historical period

	De facto silver standard	*De facto* gold standard	*De jure* gold standard		Interwar period		Bretton Woods		Bretton Woods to inflation targeting		Inflation targeting	
	A	A	A	Q	A	Q	A	Q	A	Q	A	Q
	Logarithms of sectoral output indicators in the non-agriculture sector:											
All industries	8.45	3.04	3.99	–	4.73	–	1.43	1.20	1.62	1.46	0.89*	0.72*
Manufacturing	–	–	3.92	–	3.79	–	2.96	2.83	3.21	3.11	1.58*	1.48*
Transport, communications	–	–	2.34	–	3.37	–	1.37*	1.28*	2.09	2.05	1.71	1.50
Distribution, other services	–	–	1.00	–	0.79*	–	1.85	1.72	2.79	2.66	1.30	1.03*
	Rates of growth of monetary aggregates:											
M0[a]	–	–	2.55	6.02	2.28*	4.29	3.07	2.77	–	2.36	–	1.38*
M3 (*Capie-Webber*)	–	–	1.88*	–	3.78	4.57	2.23	2.28*	–	–	–	–
M4 (*Bank of England*)	–	–	–	–	–	–	–	3.56	–	2.73	–	2.12*
	Interest rates:											
Long rates[b]	0.22[c]	0.28	0.12*	–	0.14	–	0.37	0.70	1.33	1.08	–	0.68*
Three-month bank bills	–	–	0.59*	0.62*	0.84	0.74	0.79	1.00	2.48	2.43	–	–
ONS's interbank rate	–	–	–	–	–	–	–	1.98	–	2.04	–	0.92*
	Additional indicators:											
Nominal earnings (rate of growth)[d]	–	–	–	–	–	1.64	–	2.95	–	4.44	–	0.78*
Unemployment rate[e]	–	–	1.75	–	1.31	1.78	0.25*	0.41*	–	0.72	–	0.46
Logarithm of employment	–	–	1.59	–	0.81	–	0.54*	–	–	1.07	–	0.42*

[a] Annual data from Friedman and Schwartz (1982); quarterly data: *de jure* gold standard to Bretton Woods, Capie and Webber (1985), after that from *Bank of England.* [c] Annual: yield on consols; quarterly: ONS's 20-year par yield.
[c] Approximate yield on 3% funds from Ashton (1959). [d] Interwar period: average weekly wages' index from Capie and Collins (1983). After that, average earnings in the whole economy from the ONS.
[e] Quarterly data: for the interwar period, unemployment rate among insured workers from Capie and Collins (1983). After that, unemployment rate based on claimant count from the ONS.

Table 6 The Phillips correlation: standard deviations of LAD regression residuals by regime/period

Gold standard (1855-1913)	Interwar period (Jan 1922-Aug 1939)	Bretton Woods (Jul 1948-May 1972)	Jun 1972-Sep 1992	Inflation targeting (Oct 1992-Jun 2004)
2.602	3.270	2.410	3.699	0.935

(From LAD regression of cyclical inflation on cyclical unemployment and a constant.)

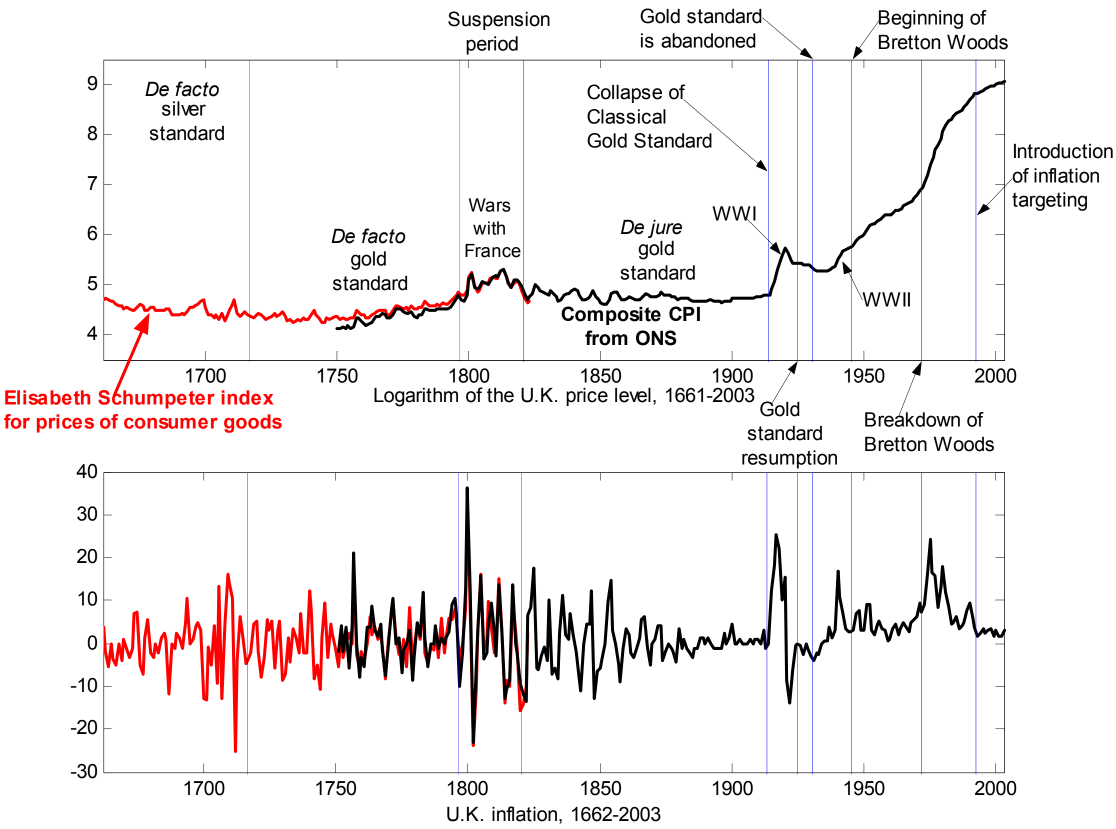

Figure 1: Logarithm of the U.K. price level, 1661-2003, and U.K. inflation, 1662-2003

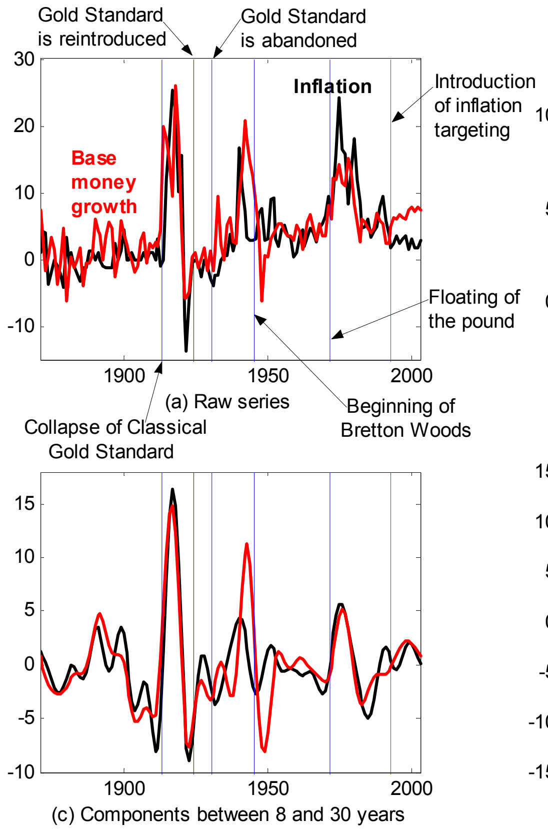

Figure 2: Inflation and base money growth, annual data, 1870-2003 (inflation is based on the ONS's composite price index; base money is from Capie and Webber, 1985, until 1970, and from the *Bank of England* after that)

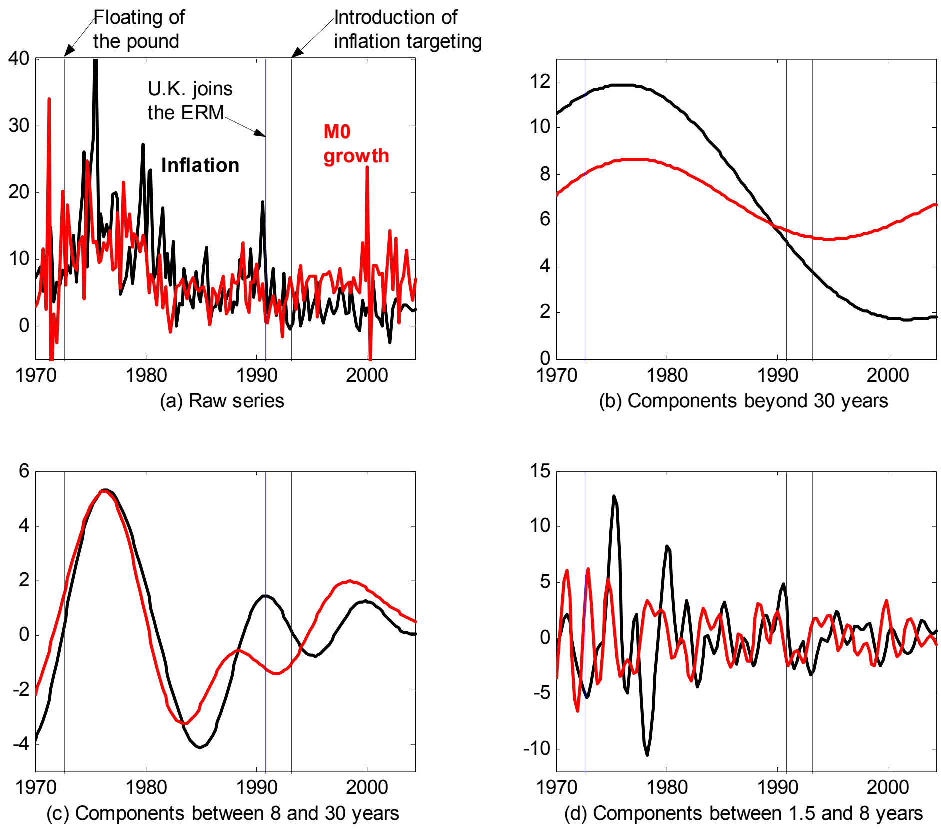

Figure 3: Inflation and M0 growth, quarterly data, 1969:3-2004:1 (inflation is based on the retail price index; M0 is from the *Bank of England* database)

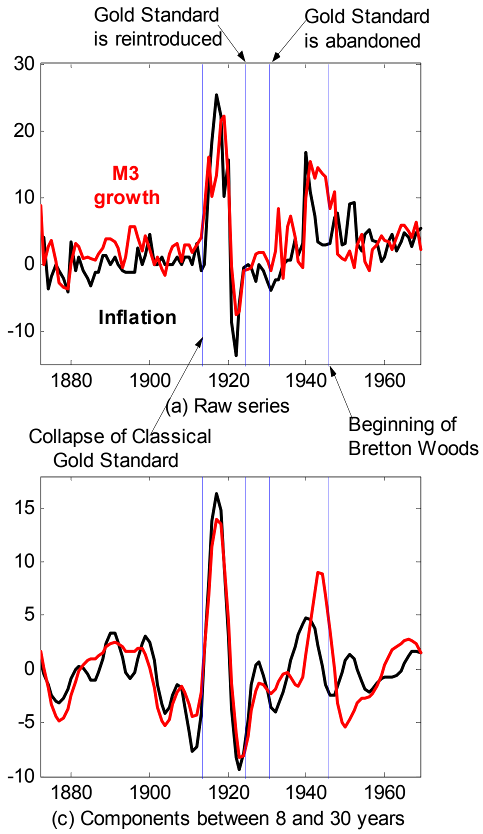

Figure 4: Inflation and M3 growth, annual data, 1871-1969 (inflation is based on the ONS's composite price index; M3 is from Capie and Webber, 1985)

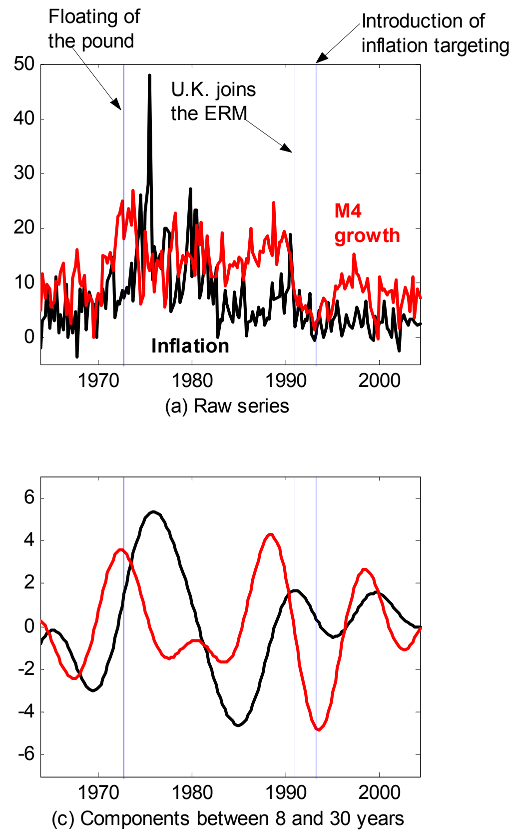

Figure 5: Inflation and M4 growth, quarterly data, 1963:3-2004:1 (inflation is based on the retail price index; M4 is from the *Bank of England* database)

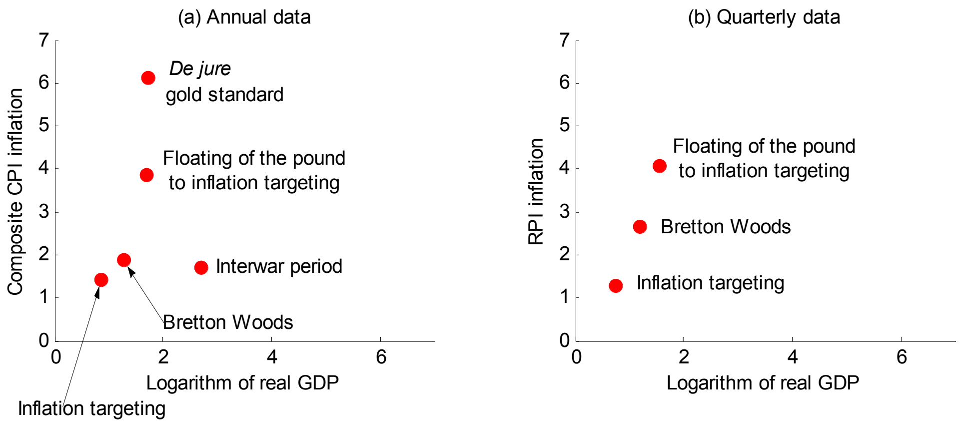

Figure 6: Standard deviations of business-cycle components of log real GDP and inflation by monetary regime

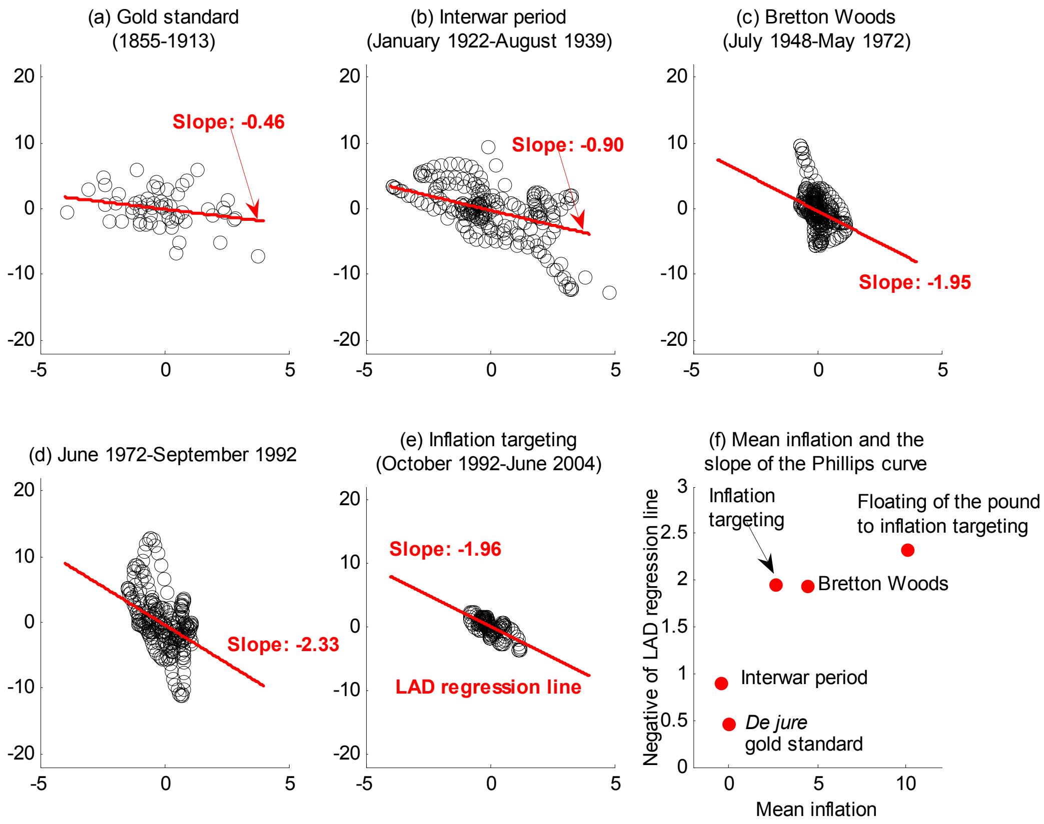

Figure 7: The U.K. Phillips correlation across monetary regimes, 1855-2004

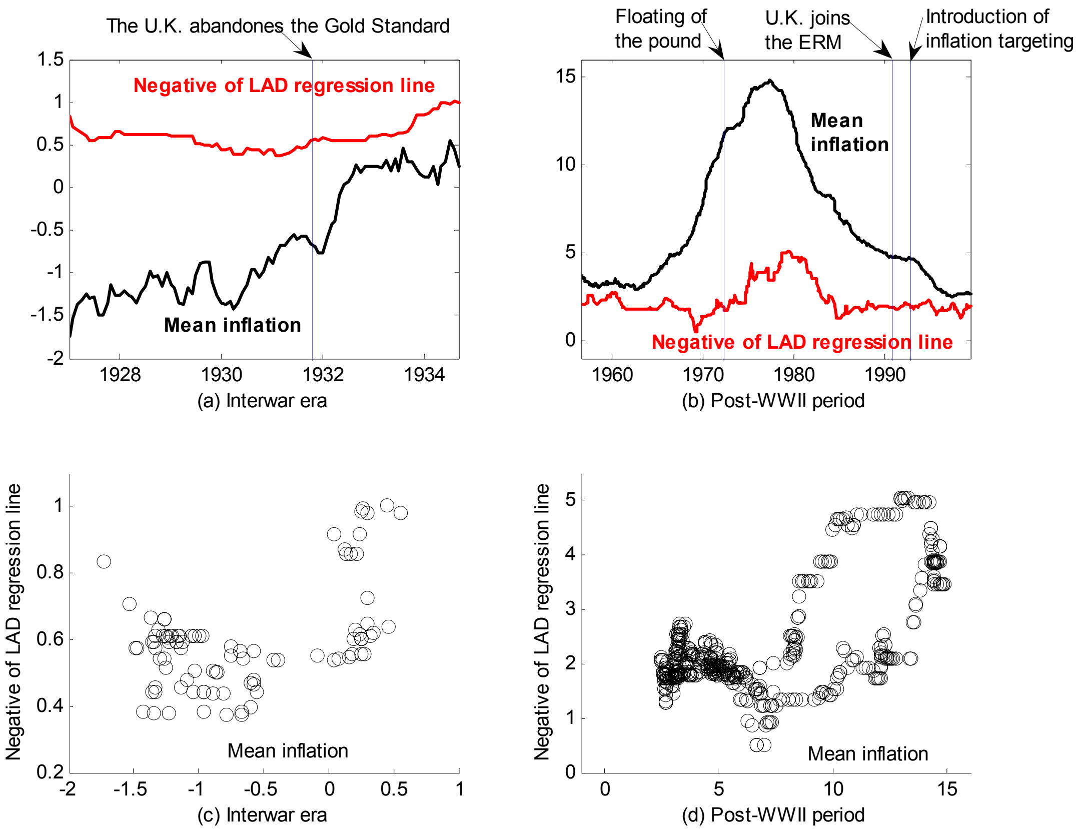

Figure 8: The U.K. Phillips correlation in the XX century, rolling 10-year samples

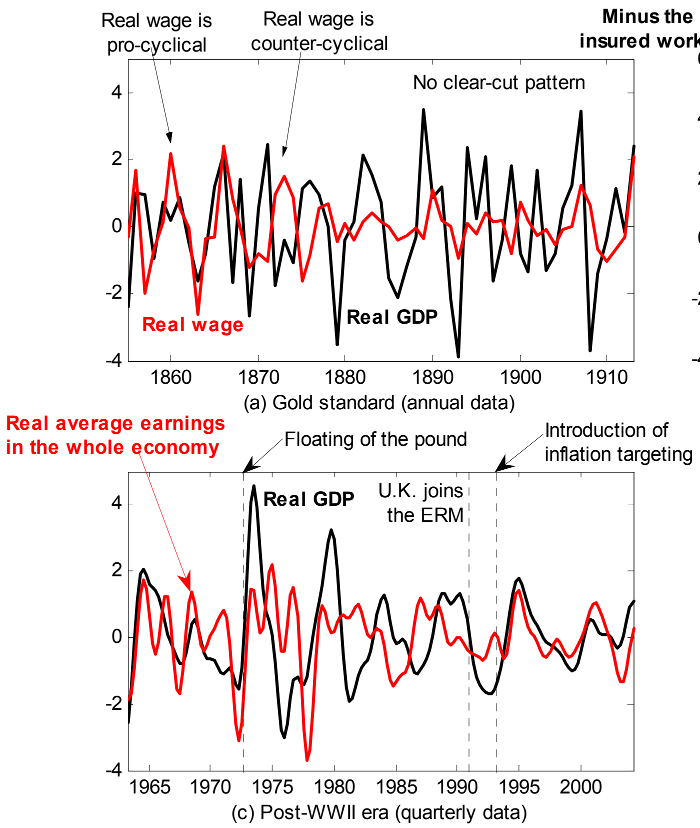

Figure 9: The cyclicality of real wages: band-pass filtered cyclical components by monetary regime/historical period

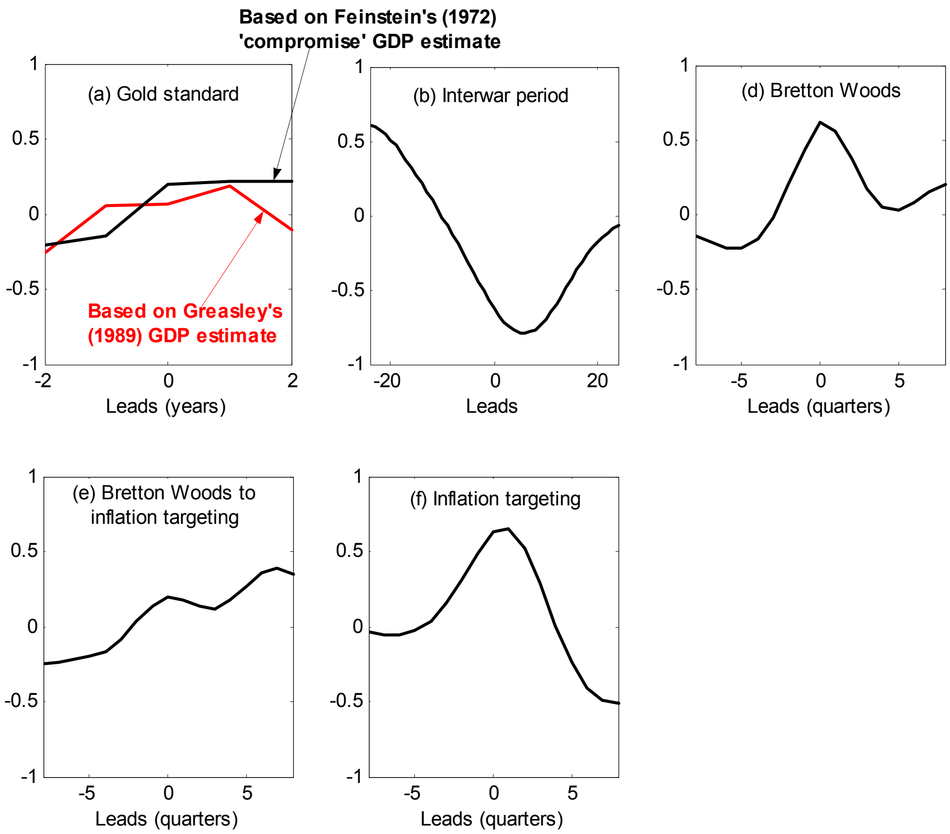

Figure 10: The cyclicality of real wages: cross-correlations between band-pass filtered cyclical components by monetary regime/historical period