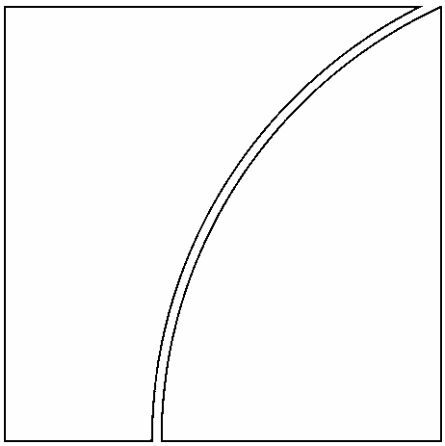

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Back to the future? Assessing the deflation record

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Abstract

The rhetoric of deflation has become more prevalent in policy circles and in the press despite the fact that deflation has been a rare phenomenon in modern fiat currency economies. To better understand the nature of deflation, this paper looks back to a period when deflation was a regular feature of the economic environment, across both time and a wide set of countries. One feature of the deflation record stands clear. During the 19th century and early 20th century, deflation was not generally associated with persistent and deep economic malaise. Most periods of deflation also appear to have been largely unanticipated, with interest rates rarely approaching their zero lower bound. One notable exception to this typical pattern was the Great Depression of the early 1930s, the event that nowadays colours current general perceptions of what deflationary episodes might look like. At the risk of oversimplification, one way to think about this broad sweep of history is that deflations come in three basic types: the good, the bad and the ugly. The paper then jumps forward in time, seeking to draw lessons from the past about the possibility of future episodes of deflation and their characteristics. In doing so, it pays particular attention to the similarities and differences in the monetary and financial regimes prevailing now and in the past. While great care should be taken in any such exercise, the paper concludes that certain features of the past can help to shed some light on the policy challenges that policymakers might face in the future.

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Introduction[1]

The behaviour of aggregate price movements has often been at the centre of policy decisions and economic research. For most of the past several decades, the concerns largely surrounded inflation, not deflation, for obvious reasons. In recent years, the focus has shifted somewhat from inflation towards deflation, seemingly for less obvious reasons. To be sure, the fact that some countries have recently been experiencing deflation, notably Japan, has reawakened concerns. And in Japan, the apparently entrenched nature of deflation and its association with sluggish economic activity have conjured up parallels with the Great Depression. At the same time, deflation – defined here simply as a decline in the aggregate price level of currently produced goods and services – has so far largely been confined to parts of Asia.

Should policymakers be concerned about deflation? What might be the prospect of future episodes of deflationary pressure and their likely characteristics? And should deflation per se be the source of serious concern? Part of the problem in answering these questions is that deflation has been rare in recent history, leaving the observer without obvious benchmarks. Moreover, the academic analysis of deflation, while no doubt extensive, has so far been rather dispersed and has focused disproportionately on individual countries or specific periods, notably the Great Depression. What follows makes a first step in the direction of filling in this gap in the literature. It does so by taking a sweeping view of the historical record and trying to draw some preliminary lessons for today on the basis of a cross-country data set put together from a variety of sources.

In the first section we document a set of stylised facts about deflation both across countries and across time. We also consider briefly the extent to which deflations in the past were anticipated or unanticipated. In the second section we lay out a typology of deflation, based on the costs in terms of output that might be expected to be associated with different episodes of deflation. In the third section we explore in more detail the link between deflation and economic activity and, on the basis of the limited data available, we seek to distinguish between the various types of deflation that did take place. This section also explores the cross-country historical incidence of the zero lower bound (ZLB), as a factor that might have made deflations more costly. In the fourth section we attempt to derive the implications of the preceding analysis for the prospect and characteristics of future deflationary episodes. In the conclusions, we note some policy challenges posed by deflation and raise some questions that deserve further research.

A number of stylised facts emerge from the historical analysis. First, and most obviously, in recent years the incidence of declines in the aggregate price of goods and services has risen. In large part, the greater frequency reflects the success of many countries in achieving low inflation, in some cases in an environment of stronger productivity growth. Second, existing evidence would appear to suggest that during the gold standard and interwar years the onset, and typically the subsequent unfolding, of deflation were largely unanticipated. Third, cross-country evidence confirms the fact that the ZLB was reached only rarely in the past. Fourth, the historical record does not suggest that a mild deflation is always more harmful than a mild inflation. In fact, in many respects the experience of the Great Depression in the interwar years stands out as rather exceptional in terms of the large output losses. Typically, the episodes of deflation before the interwar years were rather benign in terms of such losses. This suggests that, at least if it remains mild, it is not so much deflation per se that is the problem as the set of economic circumstances against which deflation takes hold. Finally, admittedly based only on a couple of case studies owing to the limited availability of data, the evidence indicates that booms and busts in credit and asset prices have accompanied some of the deflationary episodes associated with significant costs for the real economy. Together with more recent evidence about the

[1] This is a revised version of the paper originally prepared for the conference "Macroeconomics of Low Inflation and the Prospects for Global Deflation" sponsored by the Lowe Institute of Political Economy, 25-26 April 2003. The authors would like to thank Jeffery Amato, Palle Andersen, Joseph Bisignano, Michael Bordo, Guy Debelle, Barry Eichengreen, David Laidler, Pierre Siklos, Bill White and two anonymous referees for helpful discussions and comments as well as the participants at the Lowe Institute conference and seminar participants at the Hong Kong Monetary Authority. For assistance with data, we would like to thank Patrick D'Arcy, Piet Eichholtz, Karsten Gerdrup, Boris Hofmann, Christopher Kent and Herrala Risto, and are particularly indebted to Barry and Michael for granting access to their cross-country data set. We also thank Henri Bernard and Les Skoczylas for expert assistance in setting up and analysing the data set. The views expressed are those of the authors and not necessarily those of the Bank for International Settlements.

implications of such booms and busts, this finding suggests that they may help to identify one type of costly deflation.

Of course, the historical record can only tell us so much about the possibility and characteristics of any future episodes of deflation. Not least, a corrective lens needs to take into account similarities and differences between the current monetary regime and those ruling during previous episodes of deflation. For instance, we argue that the current degree of monetary policy activism as compared with the very passive policies followed under the Gold Standard may increase the incidence of the ZLB being reached. Similarly, we note that, because of better information, expectations may now react more quickly to deflation than they did in the 19th century, unless the authorities succeed in credibly anchoring them tightly around their inflation objectives. Moreover, to the extent that financial factors are viewed as important, the lessons of the historical record also depend on similarities and differences in the financial regime, notably as reflected in the degree of financial liberalisation. Here, in our view, the similarities deserve greater attention than the apparent differences, as might otherwise be inferred from the degree of market sophistication.

From this perspective, two different views can be held about the future possibility and characteristics of deflationary episodes (Borio et al (2003)). A more orthodox view would see the current environment as a natural continuation of that prevailing during the inflation years, and hence tend to downplay the prospects of future deflationary episodes. Given the natural inflationary tendencies of fiat currency regimes, as now successfully moderated by central bank policies, and low but positive inflation rates pursued by the monetary authorities, only unusually large unexpected shocks could drive inflation into the negative territory. By contrast, a less orthodox view would attach somewhat greater weight to the similarities between the current environment and that prevailing in the era when episodes of falling prices were more common. In doing so, it would also highlight the potential role played by financial imbalances, notably in the form of overindebtedness and asset price booms and busts, as drivers of economic fluctuations. As a result, it would tend to see a somewhat greater possibility of one type of episode of falling prices typically associated with costs for the real economy.

Deflation and inflation: looking back over the past

While episodes of deflation have been rare recently, they were much more commonplace in the 19th century and early 20th century. Thus, in what follows we cast our gaze far back and document the behaviour of prices by focusing on the frequency, severity, duration, persistence and cross-country correlations of deflation since the 19th century. We also make some inferences about the behaviour of inflation expectations by drawing on other work.

An obvious caveat with this type of analysis relates to data limitations. We use standard data series for a variety of countries going back as far as possible. These data, of course, are subject to questions regarding their accuracy and reliability. Given these possible drawbacks, we have tried to focus on common features of the data that appear to be robust, realising that we may be passing over some interesting but more speculative hypotheses of interest.

In what follows, “deflation” is defined simply and neutrally as a “decline in the aggregate price level of goods and services”. We consider a variety of price indices and deliberately do not arbitrarily require a minimum cutoff period of time of price declines, although we do examine duration carefully. The intention is to strip as far as possible the term “deflation” of its negative connotations and to let the facts speak.

Inflation rates

Inflation rates generally rose from the early 19th century to the late 1970s, punctuated at times by such events as wars and hyperinflations. However, since the early 1980s, there has been a noticeable trend towards lower inflation (Table 1).

The reduction in the mean level of inflation as well as the variance of inflation in the past two decades largely reflects a sea change in thinking at central banks. The strong intellectual, political and economic consensus to fight inflation culminated in institutional reforms stressing greater operational independence of central banks and greater emphasis on inflation objectives.[2]

Frequency of deflation

The frequency of deflation has largely followed the pattern of the mean inflation rates. Beyond that, the picture varies somewhat across decades, countries and with the indices used.

The upper panel of Table 2 shows that deflation was more commonplace in the 19th century than in the 20th century. The highest frequency corresponds to the 1880-1913 subperiod, when the incidence of deflation was even higher than in the 1914-49 subperiod. At the same time, the data used for this inference are only annual, relate exclusively to CPI indices and, because they go so far back in history, cover only a limited set of countries. As a result, these data may obscure shorter deflationary episodes and hence not provide the full picture.

The middle panel partly overcomes these drawbacks by focusing on quarterly deflation frequencies across many more countries and based on a variety of price indices, albeit only since 1960. It shows that the frequency of CPI declines in this broader set of countries is higher and that it is highest when deflation is measured with the wholesale price index.

What about the possibility of an upward bias in the CPI owing to measurement problems? This issue is addressed in the bottom panel. While the size of the mismeasurement is still an open question, recent research suggests that 1% is a reasonable estimate (see, eg, Wynne and Rodriguez-Palenzuela (2004) and Lebow and Rudd (2003)). Calculated on this basis, the near-deflation frequencies have been quite high recently. This of course helps to explain the heightened awareness of deflation in recent years.

Amplitude of deflation

The amplitude of deflation has fallen significantly over time (Table 3). Somewhat surprisingly, the median size of deflation during the pre-1880 period was actually higher than during the 1914-49 period, which also includes the Great Depression. Despite the decline in the median, the extremes in deflation were greater in the 1914-49 period. This reflects to some extent attempts by a variety of countries to deflate in order to rejoin the gold standard at the pre-World War I parities and the impact of the Great Depression. As expected, the severity of deflation in the past 30 years has been well below that in the earlier period.[3]

Duration of deflation

The duration of deflation has also declined somewhat over the past two centuries, at least until recently (Table 4). Rather strikingly, in the selected countries experiencing deflation, the median duration of deflation has typically been no longer than two years, with the maximum at around six years. In the pre-World War I period, this is indicative of the limited persistence in the inflation process (see below). The multiyear deflations of late represent a return to price behaviour that was not uncommon in the distant past. In fact, the recent experience in Japan exhibits a comparatively long duration by historical standards.

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[2] See, for example, Borio et al (2003) for a more detailed analysis.

[3] As a minor historical note, the median deflation for the United Kingdom from 1271 and Germany from 1501 was roughly 5 1/2%, confirming the secular trend toward more modest deflations.

Persistence of the inflation process

Another characterisation of inflation behaviour across countries and across time is the degree of persistence of inflation rate changes. By degree of persistence we mean the extent to which one-off "shocks" to the inflation rate tend to be embedded in subsequent inflation rates as opposed to dissipate over time, with inflation reverting to its previous path. Interesting differences emerge across time.

The unit root tests on annual data confirm the general view that price dynamics in the 19th and early 20th centuries did not exhibit the persistence in the changes of inflation rates that would be consistent with a unit root (Table 5). The rejection of the unit root hypothesis for such a wide range of countries suggests how powerful the gold standard was in constraining inflation.

In contrast, in the latter part of the 20th century it is not possible to reject the unit root hypothesis for inflation rates at conventional confidence levels. It is somewhat surprising that at first sight the more recent period does not provide strong evidence to reject the unit root hypothesis in the light of the considerable progress that central banks from around the world have made at reining in inflation. Strong statistical conclusions, however, are subject to qualification because of the well known limited power of the unit root tests in small samples (Lee and Wu (2001)).[4]

Confirming this limitation, the results based on quarterly data provide evidence that inflation has indeed again become more mean-reverting over time as central banks have put greater emphasis on fostering an environment of low, stable inflation (second panel of Table 5). This has brought the inflation process closer to the one that prevailed in the distant past. Of additional interest are the unit root tests using the log levels of the price index (third panel). One seemingly surprising finding is the fair number of rejections of the unit root tests in levels (with a trend specification). This suggests that some central banks were able to keep the average inflation rate relatively stable (also see Siklos (2002)). While this is a plausible outcome given an inflation targeting framework, it is not preordained because most inflation targeting regimes are designed to allow for drift in the price level.[5]

Estimates of the first-order autoregressive coefficient of the inflation process provide some insight into the increased degree of persistence in changes in inflation, an aspect about which unit root tests are silent (Table 6).[6] In general, inflation persistence peaked in the 1970-89 period and has subsequently declined, quite sharply in some cases, again reverting to patterns closer to those prevailing in the distant past. Not surprisingly, evidence of the largest declines was found in those countries adopting inflation targeting regimes, such as Canada, New Zealand and the United Kingdom. Along with the experience of the gold standard and its aftermath, this evidence highlights the importance that monetary regimes play in determining inflation persistence.[7]

Cross-country correlation of changes in the price level

An issue that has been highlighted in recent years is the possibility that deflation might be "exported" from one country to another. The conventional view is that in a regime of flexible exchange rates there is no compelling reason for this to be true. Inflation differentials between countries should generally be reflected in an appreciation of the exchange rate in the low-inflation (or deflation) country relative to

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[4] Another important consideration is the possibility of asymmetric inflation adjustments when rates are low. For example, Enders and Siklos (2001) explore the low power of standard unit root tests in the presence of asymmetric adjustments. This statistical problem may be particularly important for countries with significant downward nominal rigidities. Resolving the issue, however, is left for future research.

[5] This possibility is consistent with the average inflation targeting regime discussed in King (1999). Another possible interpretation is that the supply and demand shocks over the past decade have been largely symmetric, thereby producing stationary behaviour of the inflation rate.

[6] The first-order autoregressive coefficient is, of course, not the only way to measure persistence. Spectral methods such as those used by Cogley and Sargent (2001) provide another possible benchmark with which to measure persistence. Their approach would account for the effect of higher-order autoregressive and moving average components. Despite the differences in methods, the empirical results are largely consistent.

[7] This is not to say that changing monetary regimes are the only important factor. See Burdekin and Siklos (1999) for a discussion of other factors that may account for the changing persistence, such as the impact of wars and oil price shocks.

that of the high-inflation country. To gain some insight into this possibility, we examine the contemporaneous cross-country correlations in inflation rates (Table 7).

Surprisingly, perhaps, the results indicate that the correlation in inflation rates was much lower in the heyday of the gold standard period than in the post-Bretton Woods period. In 1880-1913 the cross-correlation of inflation was less than 0.5, albeit somewhat above the pre-1880 period and somewhat lower than in the 1920-38 period. In contrast, the correlation in the post-Bretton Woods period is generally above 0.7%.

There may be several reasons for this. First, it is possible that common shocks are more prevalent now than in the past or that the progress of global economic integration has been significant. However, the degree of economic integration prevailing in the gold standard period, at least as regards financial integration, was higher than that prevailing in much of the postwar period.[8] Second, it is also possible that the noise in inflation rates was sufficiently large in the past to limit the ability to arbitrage differences away. For instance, recent research on international price differentials finds that arbitrage across national borders is not as easy as textbook treatments would suggest (Engel and Rogers (1996)).

More fundamentally, however, the explanation may lie in the nature of the monetary policy regime. Admittedly, the gold standard was explicitly designed as a fixed exchange rate system which, all else the same, would suggest a high correlation of inflation rates. Likewise, the current flexible system, all else the same, would suggest the opposite. However, the de facto rules of the game during the gold standard may not have been as strict as some have believed, in part owing to the role of moral suasion and other means to restrict capital flows in some countries (Eichengreen (1992)).[9] And in the post World War II period, "independent" domestic monetary policies may have been more synchronised than generally assumed. This may in part have resulted from common responses to common shocks reflecting shared policy strategies or objectives. The general run-up in inflation during the 1970s following the oil shocks was arguably a case in point. But the link may also be more indirect. Developments in the core country (or countries) in the system can spread elsewhere, as other monetary authorities react to their unwelcome side effects. For instance, attempts to resist a rapid real appreciation of the currency owing to a loose monetary stance in the core country may be a key mechanism (McKinnon (1993)). If the exchange rate system did not preordain the correlations in inflation, the effective rules of the game may have.[10]

Inflation and deflation expectations

To what extent have inflation and deflation rates been anticipated or unanticipated? And how has this varied over time? These questions take us away somewhat from the realm of stylised facts to that of interpretations. An answer, however, serves as a useful background for some of the subsequent analysis about the costs of deflation and its likely dynamics in the future.

Admittedly, data limitations make it hard to provide an answer to these questions. In particular, there are no reliable surveys for the distant past. Nor was the art of forecasting developed to the point of providing a separate source of information, as nowadays. Even so, some tentative conclusions can be reached based on evidence for specific subperiods and from the more general behaviour of interest rates.

There is considerable evidence from the United States suggesting that the Great Depression was largely unanticipated. Hamilton (1992), for example, based on evidence culled from commodity price futures, convincingly argues that the onset of the Depression was unexpected and that, even as the

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[8] On the issue of common shocks, see Bordo and Helbling (2003). Greater openness has been documented in Bordo et al (1999), Mussa (2000), Bordo and Eichengreen (2002) and Bordo and Helbling (2003). For a somewhat different view, see Obstfeld and Taylor (2003).

[9] For example, Scammell (1965) and Eichengreen (1985) point out that moral suasion rather than active interest rate movements played an important role in providing incentives for gold flows during the gold standard period, at least in some countries.

[10] The evidence in Table 5 also supports this view. The rejections and non-rejections of the unit root tests show a fair amount of correlation across countries. Panel unit root tests along the lines of Lee and Wu (2001) could cast additional light on the hypothesis. In addition, he finds evidence that there is broad mean reversion since 1957 in most G10 countries.

deflation became entrenched, inflation expectations continued to be overly optimistic. Klug et al (2002), looking at internal forecasts from railroad shippers at the time, find evidence that the depth and duration of deflation were not forecast. Temin (1976) reaches a similar conclusion, based on an analysis of forecasts made at the time and other reports from the day. Cooper (1982) draws an analogous inference.[11]

In addition, there is some indirect evidence, based on the behaviour of nominal and real interest rates, suggesting that the expectation formation mechanism has changed considerably between the gold standard period and the postwar, inflation era. Specifically, there has been considerable work arguing that expectations of inflation became much more accurate in the postwar period, as reflected in more rapid adjustments of nominal rates to inflation (the Fisher effect). This stylised fact regarding the relationship between nominal rates and inflation is confirmed by the behaviour of the correlation between these two variables across a number of countries (Table 8). This correlation was nearly zero in the period 1863-1913, but rose to generally around 70% during 1960-2001. By contrast, the correlation that was stronger in the previous period was that between the nominal interest rate and the *price level*, the so-called Gibson paradox (not shown).

If, as notably argued by Fisher (1930) and Friedman and Schwartz (1982), sluggish adjustments in expectations to inflation and deflation during the prewar period can explain these patterns, what could in turn account for the sluggishness in those adjustments? Perhaps the best explanation combines the nature of "information technology" with that of the monetary regime prevailing at the time.[12]

In the pre-World War I period economic agents had limited real-time information about inflation and a limited understanding of its measurement. For one, reliable aggregate price data were generally not at hand.[13] To be sure, certain goods prices would have been published regularly, such as those of traded goods and commodities. However, information about broad sets of consumer prices was harder to come by. And even if such real-time information had been widely available, it is unclear that the notion of an aggregate price index was sufficiently well developed for it to be of much use. The theories of Lowe, Laspeyeres, Jevons and others were only in their infancy at the time.[14] Moreover, the United Kingdom did not publish aggregate indices until 1914 and the United States not until 1919 (Cooper (1982)).[15]

In addition, no doubt the difference in the degree of sluggishness in the formation of inflation expectations is broadly consistent with the nature of the inflation processes and underlying monetary regimes in the two historical phases. As noted earlier, changes in inflation tended to be less persistent under the gold standard than during much of the inflation era. Consequently, the costs of expectational errors would have been lower in the earlier period, and expectations that approximated more closely the unconditional mean of inflation would have been more justifiable.[16]

This complementary explanation could be tied even more closely to the nature of the informal monetary policy rules. Under the gold standard, short-term rates were set to be kept broadly stable

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[11] For a dissenting voice, see Cecchetti (1992).

[12] This is not to say that all deflations were largely unexpected, of course. For instance, those that took place following wars and the resumption of convertibility were much more likely to be anticipated by economic agents (eg Klein (1975)).

[13] Wicksell and Keynes offered an alternative explanation based on the productivity of physical capital. Higher productivity would lead to higher demand for loanable funds and interest rates. Expansion of credit would ultimately lead to higher prices and hence a correlation between price levels and nominal interest rates. Friedman and Schwartz (1982), however, noted that there was little evidence of a positive correlation of the real interest rate and the price level.

[14] Laidler (2003) points out that Jevons (1875) had been discussing indexation for credit market contracts and Marshall in 1887 had recommended a proposal to index labour markets to a suitable price index. These ideas got "nowhere in practice."

[15] Finally, it is unclear that the theoretical relationship between inflation expectations and nominal interest rates was sufficiently appreciated. After all, Fisher's papers on the topic were not published until the early 20th century. Wicksell in the late 19th century appears to have published some results consistent with the Fisher effect, but these ideas were largely missing in his later work on the natural rate of interest (Wicksell 1907). More recently, Barsky and DeLong (1991) and Barsky and Summers (1988) have argued that there was considerable information about gold flows that, in theory, should have helped investors and savers to improve their ability to predict future inflation. The lack of evidence that they did may suggest that uncertainty about the underlying model of nominal interest rate determination may have effectively interfered with rational agents' ability to refine their conditional estimates of inflation.

[16] See Ball (2000) for a similar discussion.

around historical levels unless the convertibility constraint came under pressure owing to an internal or external drain (manifested in declining gold reserves), in which case they were raised. In particular, policy interest rates were unresponsive to period-by-period inflation or deflation per se, and responded to them only to the extent that the convertibility constraint was threatened.[17] And this constraint would more naturally be called into question only after *cumulative changes in the price level* in relation to the gold stock. As a result, it was not unreasonable for the private sector to expect both short-term and long-term rates to be, in turn, rather insensitive to period-by-period inflation developments and to be more closely tied to the price level.[18] Moreover, as long as the monetary regime was sufficient to guarantee a reasonable degree of stationarity in inflation over long horizons - given the evolution of the external gold constraint and financial innovations that allowed the system to economise on it - the sluggish responsiveness of expectations would tend to be validated. By contrast, in the postwar period, after an initial phase in which the authorities kept interest rates rather stable, if not fixed, they started to set them more explicitly and deliberately in response to inflation developments, establishing a clear positive correlation between the two. Under the new conditions, a closer link of inflation expectations - as derived from market interest rates - to period-by-period inflation would only be natural.

Types of deflation: the good, the bad and the ugly?

The stylised facts highlighted so far tell us little about the extent to which deflation should raise concerns for policymakers. This depends on how the costs of deflation compare with those of inflation. Aside from arbitrary redistributions of income, which might be thought to be undesirable in themselves, the answer in turn largely hinges on the costs that episodes of deflation might imply for economic activity. Such costs might arise either because deflation directly *causes* them or because deflation may be a *symptom* of concomitant developments that bring them about. A number of possibilities spring to mind, suggesting that the link between deflation and economic activity may well vary over time, depending on circumstances.

Just as with inflation, one channel through which deflation can undermine economic activity is by jamming the *information* content of price signals. Deflation can cloud the distinction between changes in absolute and relative prices or, indeed, between changes in real and nominal magnitudes. Reasoning by analogy with experience with inflation, such costs may well be minor at relatively mild deflation rates, but could rise considerably at higher rates.[19]

Informational channels aside, the main mechanisms through which deflation can undermine economic activity operate through various kinds of *nominal rigidities.* The three most notable examples include nominal wage rigidities, debt burdens and the ZLB for interest rates.

Given downward wage rigidity, deflation would tend to reduce profitability, raise unemployment and lower equilibrium aggregate demand and supply. For instance, the role of nominal wage rigidity in deepening the Great Depression has received considerable attention (eg Bernanke and Carey (1996)).[20] More recently, Akerlof et al (1996) have argued that, as inflation approaches zero downward nominal wage rigidities can interfere with efficient economic adjustments in labour markets, prolonging and deepening economic contractions, which can ultimately feed deflationary forces. Even so, there is still some controversy over the macroeconomic significance of such rigidities, as questioned for the

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[17] And, even then, monetary authorities often used moral suasion and other means to effectively constrain interest rate movements. This is not to downplay the importance of credit rationing, especially in the case of the United Kingdom, as a means to deal with pressure on gold reserves (Eichengreen (1992)).

[18] Here, of course, we treat long-term rates as weighted averages of expected short-term rates.

[19] See, for instance, the evidence in Barro (1995).

[20] It could also be argued that excessive nominal wage flexibility could be a problem too, at least to the extent that it could further cut aggregate demand by shifting income distribution away from wage earners and by affecting their income expectations adversely, especially in the presence of money illusion. This channel has not been examined in recent years, given the empirical evidence suggesting a negative relationship, both in the time series and across countries, between output weakness and real wages during the Great Depression, as noted in the text.

United States by Lebow et al (1999) for the recent period and by Hanes and James (2001) for the prewar era.

Debt deflation can sap real economic activity by increasing the cost of servicing outstanding nominal debt obligations and, in the limit, contributing to bankruptcies.[21] The consequent deterioration in the financial condition of borrowers can increase the pressure to cut spending so as to adjust balance sheets, can undermine the quality of lenders' balance sheets and can make access to external funding harder.[22] These costs would be exacerbated if the very viability of financial intermediaries became impaired, leading to a broader banking crisis.[23] While, because of data limitations, debt deflation is difficult to measure, some authors have interpreted the evidence of the operation of credit constraints during the Great Depression as well as other findings as consistent with the relevance of this channel (eg Bernanke (1983) and Bernanke and James (1991)).

The ZLB arguably represents one of the most daunting challenges for monetary policymakers in a deflationary environment. Since interest rates on riskless assets cannot fall below zero, as cash guarantees a zero nominal return, once the lower bound is reached (ex ante) real rates vary *exclusively* as a result of inflationary or deflationary expectations. If expectations of deflation become entrenched, the monetary authority could lose control over short-term real rates, and hence over its ability to stimulate the economy through this channel. Likewise, the effectiveness of quantitative easing as a substitute for lower real rates is uncertain.[24] Under these conditions, it is even possible to imagine a situation in which the economy would be stuck in a deflation trap. In this case, the equilibrium real interest rate would be lower than that determined by deflation expectations, thereby leading to a further strengthening of the deflationary forces which would in turn raise the real rate of interest further, thus triggering a deflation spiral (eg Reifschneider and Williams (2000)). Other things equal, the lower the potential growth rate of an economy, the lower the equilibrium real rate and hence the higher the likelihood of falling into such a trap.[25]

In fact, expectations play a subtle role in determining the costs of deflation. On the one hand, the real interest rate channel is operative as long as deflation is *expected*. On the other hand, the debt deflation and, to a lesser extent, the wage rigidity channels work if deflation is *unexpected*. More precisely, they operate as long as the assumption made about the rate of change in prices at the time contracts are entered is different from its subsequent realisation during the period over which contract terms cannot be altered. This also means that, paradoxically, deflation can operate through *both types of channels simultaneously*. For example, the investment decisions of a firm may be held back both by

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[21] More generally, though, this mechanism arises whenever the rate of inflation falls short of that implicit in the interest rate at which the debt was contracted, assuming that the debt was at fixed rates. This also means that unexpected *disinflation* can have a similar effect.

[22] Irving Fisher (1933) offers the debt deflation hypothesis to explain why the Great Depression was so different from previous cycles.

[23] Deflation can also have a negative impact on banks' profitability through the so-called "endowment effect". Simply put, if a fraction of deposits does not pay interest (or is insensitive to changing nominal lending rates), a given disinflation would tend to reduce bank profits in a low-inflation environment. To illustrate this, assume a percentage point disinflation at a time when the deposit rate is at or near zero. In this situation, the decline in the nominal lending rate could not be matched by a decline in the rate paid to depositors. Hence, bank revenues would fall to a commensurate extent. See Fung et al (2003) and Fukao (2003).

[24] See, for example, Wolman (1998), McCallum (2000) and Reifschneider and Williams (2000)). Put differently, money demand becomes sufficiently elastic at a zero interest rate to generate a liquidity trap. Note also that the floor for interest rates on default-free instruments would normally be above zero, because of the presence of market (interest rate) risk, depending on their duration. More generally, of course, perfect substitutability with respect to government securities does not imply perfect substitutability with respect to other assets, such as equity, real estate or foreign exchange. Changes in the supply of money in relation to those assets, as long as not offset by opposite changes in the supply of perfectly substitutable government securities, could still have an impact on the corresponding relative yields and hence expenditures (Tobin (1969) and Meltzer (1999)). Kimura et al (2002) develop a means to assess the effect of the Bank of Japan's policy of quantitative easing. See also, for example Goodfriend (2000), Buiter and Panigirtzoglou (2002) and Fukao (2003) for means to overcome the ZLB constraint by implementing a Gesell tax on money or using so-called "helicopter drops" of money, by which what is really meant is government deficits financed by money creation. See BIS (2003), Chapter IV, for a discussion of various alternative policies and of their potential effectiveness, ranging from attempts to influence relative yields to fixing the price of the corresponding assets. Key issues raised in this context include the required size of the operations and their consequences for international relations, the implied degree of effective nationalisation of the economy and exit strategies.

[25] In a standard golden rule model of growth, the growth rate and the equilibrium real interest rate are highly correlated.

the (unexpected) debt deflation on its outstanding long-term debt and by the high perceived ex ante real rates associated with expected future price declines.

Deflation and economic activity: lessons and a typology

This discussion points to three related conclusions, useful for what follows.

First, the effects of deflation are likely to be "non-linear", in the sense that they should be expected to vary more than proportionately with its intensity. In particular, they depend on certain constraints becoming binding, such as downward nominal wage inflexibility and the zero lower bound constraint. In turn, the extent to which they become binding will depend on factors such as the underlying productivity growth of the economy and, more generally, its underlying strength and flexibility.

Second, quite apart from reverse causation, part of the weakness in economic activity observed during periods of deflation may clearly arise from deflation itself, but if the deflation rate remains mild, much may result from developments for which, at best, deflation acts as a symptom. For example, given historical ranges of fluctuation, asset price busts arguably can have a considerably larger effect on balance sheets, and hence financing constraints and/or the willingness to spend, than deflation itself, especially if accompanied by widespread banking distress (Borio and Lowe (2002a), Goodhart and Hofmann (2003), Bordo and Jeanne (2002)).[26] As also noted by various observers, it is hard to see how the mild deflation experienced in Japan over the last few years could be the *primary* reason for output stagnation, at least once compared with the major asset price deflation experienced by the economy (Okina and Shiratsuka (2003), Koo (2003), Ahearne et al (2002)).[27] This does not imply that deflation should not be avoided, far from it. In fact, even from this perspective, in a deflationary environment nominal asset price declines are more likely so that, as argued, balance sheet problems are harder to resolve. It does, however, make the appropriate degree of concern dependent on a broader set of factors and puts a premium on understanding what set of conditions are associated with, and ideally give advanced warning of, the more disruptive forms of deflation.

Finally, and as a corollary, there is in fact no reason to expect that deflations should *necessarily* be associated with economic weakness. This is the reason why observers have sometimes classified deflations into different types, depending on the context in which they take place (eg Bordo et al (2002) and Selgin (1997)). "Good" deflations would be those reflecting productivity improvements against the background of underlying or secular restraints on the growth of nominal demand.[28] These might occur alongside higher growth, buoyant asset prices and a healthy rate of expansion of monetary and credit aggregates, reflecting the fact that lower prices would not impair profitability and cash flows. "Good", or perhaps better "benign", deflations might also be those transitory and mild declines in the aggregate price level linked to normal cyclical downturns in a low-inflation environment. The costs of such episodes would not be clearly distinguishable from those of similarly sized positive deviations of inflation from "price stability" objectives.[29] "Bad" deflations would be those where the specific nominal rigidities played an important role in undermining economic activity or else where other concomitant developments resulted in serious economic weakness. The recent example of

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[26] Other such factors would include large demand shocks arising from the private sector or from policy, such as large swings in confidence (ie animal spirits) and badly judged policy moves.

[27] For a different view, see Fukao (2003), who argues that the decline in asset prices itself reflects to a considerable extent actual and expected price declines. While such a link should be present, it would presumably take expectations of secular deflation for it to be of major quantitative significance compared with other factors normally affecting the variation in asset prices.

[28] In a sense, this is the basis for Friedman's (1969) optimum-quantity-of-money prescription for an economy with fully flexible prices, which calls for deflation at a rate equal to the real interest rate (ie nominal interest rates equal to zero). This conclusion is based on the view that fully anticipated deflation has no additional costs.

[29] This, of course, begs the question of whether deflation at the rate of underlying productivity growth might not be a reasonable objective, as suggested by, for example, Selgin (1997). This would amount to stabilising wages rather than prices. Conceptually, the answer to this question depends, inter alia, on the relative downward rigidity of wages and prices (eg Keynes (1936)), the potential information function played by wages and prices in the economy and, last but not least, concerns with the ZLB. Concerns with the ZLB would unambiguously favour a price stability objective. As discussed further below, as suggested by signs such as the recent upward adjustment to the inflation target range of the Reserve Bank of New Zealand and the controversy surrounding the lower bound of the ECB's effective range, for the foreseeable future desired inflation rates will likely be low but positive numbers.

Japan could fall under this category. Extending such a terminology further, "ugly" deflations could best be thought of as those where deflationary forces conspired with the asymmetries to create a *spiral* of self-reinforcing disruptions, in a context in which the self-equilibrating mechanisms of the economy failed to work satisfactorily.[30] The Great Depression of the interwar years could be considered a case in point.

The costs of deflation: the historical record

Laying out the configuration of direct and indirect linkages between deflation and economic activity is relatively simple, but exploring their empirical significance is a daunting task. The paucity of historical data makes this extremely hard. For example, key variables such as productivity, unemployment, indebtedness and property prices are either not available at all or else restricted to a handful of countries for limited, typically the less distant, periods. As a result, in what follows we simply begin to explore in a more systematic way some of the more straightforward empirical regularities.

The message from simple bivariate and multivariate relationships

As a first step, we investigate the simple bivariate relationship between economic activity and deflation at relatively lower frequencies. To do so, we identify local peaks and troughs in the price level in the following way. First, candidate peaks are obtained by locating peaks in a five-year moving average of the CPI; then, the final peaks are estimated choosing the highest value of the unsmoothed series in a five-year window around the candidate peak. The estimated peaks for selected countries are found in Table 9. Note that there is a loose tendency for peaks to coincide.

When the data set is partitioned this way, a first, rather striking, stylised fact that seems to emerge is that history is replete with examples of what might be classified as "good" or at least "benign" deflations. Graph 4 shows that in the 19th and early 20th centuries, most deflations were of the good or benign type, in the sense that output remained broadly on track despite the decline in aggregate prices.[31] This is not simply an artefact of averaging. Looking at the deflationary experiences in the United States, the United Kingdom and France as well as in three periphery countries for which we have very long time series for CPI, nearly every episode of deflation was accompanied by rising output (Graph 5). In addition, asset prices generally rose during such periods. There were, of course, exceptions to this rule. The Great Depression in the interwar years is the most notable one.[32] While the growth rate, on average, slowed a modest (and statistically insignificant) amount during most deflation periods in the sample, the much larger decline in the 1925-39 period is statistically significant (Table 10). And unlike the more benign episodes of deflation, the Great Depression was preceded by a large equity price boom and comparatively high growth rates of output (Graph 4).

A somewhat richer historical perspective on the cross-correlations of deflation with other macroeconomic variables confirms the large difference between deflations pre-1913 and those in the interwar period (Table 11). In particular, during the 1882-1913 period, declines in the CPI were generally associated with output growth, short-term interest rates above the ZLB, positive nominal wage growth and to some extent rising equity prices. Second, some of the deflations were associated with periods of banking and currency crises and some were not. In the interwar period, the nature of deflation was quite different. Deflation was associated with much more dire economic conditions, especially in 1930-33. Output, wages and equity prices fell. In subsequent decades, the deflations

[30] A further conclusion is that there is much that can be learned by comparing the costs of *deflation* in the pre-World War II period with those of *disinflation* in the subsequent historical phase. This results from the fact that some of the costs arise from mistakes in forecasting inflation rates, regardless of their level. However, we leave this line of enquiry to future research, focusing in what follows on deflation episodes only.

[31] See also BIS (1999) and (2003), Chapter IV.

[32] In addition, the post World War I period exhibited a significant downshift in economic activity in several countries that coincided with the downward pressures on prices, largely owing to efforts to reestablish the pre-war gold standard.

were too rare to be able to draw any broad conclusions. Comparable statistics for the inflation years are also provided.

In order to get a sense of which factors were most closely associated, in a statistical sense, with the output costs of deflation, a cross-country regression analysis was performed. Here, the sample is limited to the set of G10 countries.[33] In this cross-country framework the output costs are defined as the change in the growth rate of output during the five-year period before the CPI peak, $\dot{y}_{pre}$, minus the growth rate of output during the five-year period after the peak, $\dot{y}_{post}$. The differencing removes any constant country-specific effects that might be present. The right-hand variables are the change from the pre-peak period to the post-peak period in the growth rate of CPI, real money, equity prices and real wages, and an indicator measure of banking and currency crises. The cross-country regression model is

$$\dot{y}_{pre} - \dot{y}_{post} = \beta_0 + \beta_\pi \Delta\pi_i + \beta_m \Delta(\Delta \log m/p_i) + \beta_{ep} \Delta(\Delta \log \textit{equity price}_i) + \beta_w \Delta(\Delta \log w/p_i) + \beta_c \textit{crises}_i + \varepsilon \quad (1)$$

The bivariate results (between output and inflation) are consistent with the view that the destabilising potential of price changes is likely to be non-linear (Zarnowitz (1992)), rising disproportionately with the intensity of deflation. In the pre-1914 period, the decline in inflation is correlated positively with a deceleration in output (ie a positive coefficient in the first column of the table) but the result is statistically insignificant. In contrast, in the larger sample which includes observations from the interwar period, which are dominated by the largest deflations, the correlation becomes stronger and statistically significant. This might suggest that larger deflations are associated with proportionately larger output adjustments. Even when conditioning on a variety of other economic variables, the size of the correlation is roughly two to three times that in the pre-1914 period. Further research into these differences is clearly warranted.

Other statistical regularities are evident from the multivariate regressions (Table 12). As measured, the change in real money growth provides the most statistically reliable correlation with the deceleration in output growth in both sample periods. On the one hand, this finding may suggest that monetary developments caused both deflation and output costs in a way consistent with textbook monetarist hypotheses (Friedman and Schwartz (1982)). On the other hand, money may simply be responding passively to other economic developments such as credit cycles (Kiyotaki and Moore (1997)), real business cycles (Plosser (1988)) or other factors that also affect output growth. In either case, the role of money or possibly some broader aggregate such as credit may be an important part of the deflation story. In contrast, the predictive power of equity prices was generally insignificant in both samples. Real wage growth in the larger sample suggests that real wage developments in the inter-war period, especially during the Great Depression, added significantly to output costs. Another interpretation can be inferred from the robustness of the coefficient on the change in inflation, implying that the inflation variable may be picking up a nonwage channel, such as debt deflation.[34] In addition, the crises indicators appear to pick up limited information above and beyond that contained in inflation and real money growth.[35]

[33] The G10 countries are Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States.

[34] Such a non-wage channel, although weak, was not found in Bernanke and Carey (1996). Their empirical setup and data, however, were quite different from those in this paper. Bordo et al (2000) also find evidence supporting the view that wage stickiness was an important feature of output dynamics during the Great Depression.

[35] The limited statistical evidence does not necessarily indicate that crises were unrelated with the causes, and possibly the symptoms, of deflation. During the historical period, it is quite possible that various factors, particularly the monetary one, served as the channels through which crises affected the economy. See Bordo (1986) for a more detailed discussion.

Credit-asset price booms and busts

In the light of these results, it is worth investigating further the relationship between the nature of deflation, on the one hand, and credit and asset price booms and busts, on the other. Indeed, recent empirical evidence has documented in detail that credit and asset price booms since the 1980s have been harbingers of financial strains, economic weakness and disinflationary pressures over horizons of three to five years ahead (Borio and Lowe (2002a), (2002b), and (2003a)). Does this relationship hold during the gold standard period too? If so, and given relatively low and not very persistent inflation rates at the time, such signals could have been harbingers of one of the less benign forms of deflation.

Lack of data on credit and asset prices make a systematic evaluation of this hypothesis impossible at this stage. Even so, it is possible to illustrate the relationship, albeit just tentatively, based on two cases or "event studies" for which data on credit as well as real estate prices are in fact available. Of the two, only one – for the United States in the interwar years – belongs to the Great Depression; the other – for Australia in the late 1880s-early 1890s – is drawn from a period for which the previous evidence suggests that, on balance, deflationary episodes were relatively benign. This could help distinguish the role of credit and asset price booms from that of falling prices of goods and services per se.

The picture that emerges from these two episodes is broadly consistent with the hypothesis (Graph 6). First, banking crises did occur in the two cases following price peaks, with a lag of at least a couple of years. In the United States and Australia the crises took place in 1930-31 and 1893, respectively, while the peaks in the price level occurred in 1926 and 1891. Second, in both cases deflation was associated with considerable output losses, measured as before over the two five-year windows centred around the price peak. In this sense, deflation was of the "bad" kind, as defined above. At the same time, the timing of the output weakness was more closely associated with the financial distress than deflation per se. In fact, in both countries prices started turning down while the economy was still booming. Finally, both episodes were preceded by a significant increase in the ratio of credit to GDP and asset price booms that turned into busts. The large swings in property prices are especially noteworthy, as is their association with economic weakness. [36]

The zero lower bound constraint

The previous analysis also noted that the ZLB could potentially be a serious factor undermining economic activity. The recent experience in Japan has highlighted its disruptive potential. But how far has it been so in practice through history? As a first go at answering this question, it may be useful to explore to what extent the ZLB seems to have been binding in the first place (see also Graphs 1 and 2).

Given the paucity of data available, we assess the effective constraint of the ZLB by a low rate that is not literally zero. As noted by English (2000), for instance, the US call money rate at 1% is consistent with a short-term Treasury rate close to the ZLB. More generally, this type of upward bias may exist for some of the short-term interest rate and discount rate series used here. Thus, reporting the frequency of annual interest rate observations less than 0.5, 1.0 and 1.5% may provide a more robust assessment of the relevance of the ZLB, at least for the more distant dates for which data availability is a problem.

Using these benchmarks, the historical record suggests that the ZLB was binding only rarely, with the relevant observations being largely confined to the interwar years (Table 13 and Graph 1).[37] The

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[36] For much more detailed analyses of these three episodes consistent with this perspective, see: for Australia, Kent and D'Arcy (2001) and Kent and Fisher (2000), and for the United States, Eichengreen and Mitchener (2003). Note that in the case of the Great Depression in the United States, the argument is simply that the nature of the boom helps to explain the characteristics of the contraction and the nature of the problems that the authorities subsequently faced. This view is still consistent with a major role played by inadequate policy responses in exacerbating the contraction as the economy tanked and generalised financial strains emerged. See, for instance, Bordo (2003) for comments on Eichengreen and Mitchener (2003) and his emphasis on major policy failures. For an analysis similar to the one put forward here but applied to banking crises in Norway and based on more partial data, see Gerdrup (2003).

[37] A similar picture of the ZLB would result from looking at discount rates or long-term interest rates.

percentage of observations of near-zero interest rates during the past 200 years has been tiny. In particular, for the (mainly core) countries for which data are available, there were only rare episodes where the constraint might have been binding before the interwar years, consistent with the apparently mostly "good" or at least "benign" nature of deflations during that historical phase. Likewise, while some instances seem to emerge for the period 1950-69, this is arguably an artefact of the use of the higher thresholds for a period for which the data are, in fact, more reliable. By contrast, the binding nature of the constraint in Japan recently is quite real. We return below to the question of how this evidence should be interpreted when assessing the likelihood of the ZLB constraint being binding in future.

Assessing the prospect of deflation in the current low-inflation environment

What does the previous analysis tell us about the possibility of future deflationary episodes and their characteristics? Drawing potential lessons is necessarily a more speculative exercise, and depends crucially on the lens used to identify them.

It goes without saying that economies nowadays differ markedly from those when deflationary episodes were more common. For instance, the structure of production is substantially different, as the size of the agricultural sector was much larger and that of the service sector much smaller at the time. Inter alia, this would have made the economy more vulnerable to supply-side "shocks" arising in the agricultural sector and, correspondingly, made the CPI index more volatile.[38] Likewise, the government sector was much smaller then, reducing the scope for built-in stabilisers to work.

In what follows, however, we focus exclusively on the aspects most closely tied to the previous analysis. In so doing, we pay particular attention to the implications of the evolving nature of monetary and financial policy regimes. Despite the necessary caveats and limitations of the analysis, some useful clues can be highlighted.

Deflations: often unexpected, not always costly

First of all, and least contentiously, the historical record suggests that the likelihood of an economy slipping into deflation from a low-inflation environment should not be underestimated. After all, low inflation environments increase the risk of deflation because they reduce the threshold for the size of demand and supply "shocks" that can push an economy into deflation.

Moreover, the record also suggests that the onset of deflation is typically unexpected. Admittedly, for the reasons suggested before, given the better information available compared with the prewar historical phase, economic agents are now in a better position to forecast more accurately inflationary and deflationary pressures, as the record does seem to indicate. Even so, recent experience has been no exception to the typical historical pattern. The current deflationary episode in Asia was largely an unexpected outcome associated with weaker than expected economic activity (Table 14).[39]

At the same time, the historical record also suggests that mild deflations need not necessarily be that costly. Moreover, it has not been uncommon to see periods of persistent price declines alongside relatively rapid growth. Such "good" deflations are perhaps best regarded as a reflection of improvements on the supply potential of the economy. Stronger productivity growth following technological improvements or structural policies is a key such mechanism. Some observers have argued that the recent experience in China may be classified as such a case. As a result, the extent to which any future deflationary episodes, were they to materialise, should raise policy concerns would depend very much on the nature of the corresponding deflationary pressures and the broader economic context in which they took place.

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[38] On this, see Ho and McCauley (2003), who discuss this issue in detail in the context of comparisons of emerging market economies and industrial countries today.

[39] For a detailed analysis of the recent experience with deflation in Asia, see Fung et al (2003). For an alternative view emphasising the role of real exchange adjustments, see Gerlach and Peng (2003).

Aspects of the monetary regime: expectations, the ZLB and exchange rates

Moving further into the realm of interpretation, if properly filtered the findings of the paper can also help to cast light on the likely role of expectations, the ZLB in future and the global exchange rate regime. These implications are all intimately connected with the nature of the monetary regime. Consider each in turn.

Changes in the way expectations of price dynamics are formed compared with the prewar era can play a subtle role in the dynamics of deflation. The greater the sensitivity of inflation expectations to prevailing inflation, the greater the contractionary effect of deflation on real output associated with the (ex ante) real interest channel and with the weight of falling prices on contracts whose terms cannot be adjusted in the light of anticipated price declines, such as debt at fixed rates.[40] Judging from the post-war inflationary period alone, one would infer that the faster adjustment in expectations compared with the gold standard period could make deflations more damaging going forward, all else equal. This would indeed be so at least to the extent that faster adjustment resulted purely from the better "information" technology available nowadays. However, matters are more nuanced once the relevance of the evolving monetary regime is taken into account. In particular, we have seen that there are signs that inflation has become more mean-reverting since the 1990s. Moreover, there is also evidence that expectations appear to be better anchored around inflation objectives.[41] In both of these respects, the monetary regime and associated expectation formation mechanisms have come to resemble more closely those in the gold standard period. What remains to be seen is how robust the anchoring of expectations is, and whether it would survive a period of persistent, even if mild, deflation. This puts a premium on the credibility of the monetary anchor and, more generally, on that of the overall policy framework.

In addition, there are reasons to believe that the ZLB may be more of an issue than a superficial reading of the historical record might suggest. One reason is the "technologically" higher speed in the adjustment of expectations of price changes. For a *given* monetary regime, this would tend to put greater downward pressure on market rates as deflation emerged. Another reason is that in the current regime monetary policy is more activist than in the past.

Table 15 is meant to provide a hypothetical, admittedly very crude and partial, yardstick to get a sense about how an activist monetary policy, couched in terms of an interest rule, would have increased the frequency of hitting the ZLB in the past. This is done on the basis of a conventional Taylor rule specification, relating the policy rate to past inflation and deviations of output from potential.

The results show a significant increase in the frequency with which the policy rate hits the ZLB compared with the historical record. While the actual frequency of hits on the bound in the 1881-1913 period is zero for many of the countries and small for the others, the frequency jumps significantly in the counterfactual experiment, and the increase is especially large in the 1918-69 period.

Of course, this exercise is subject to obvious limitations. In particular, it can be objected that a more activist monetary policy could limit the risk of hitting the ZLB in the first place, by resulting in more benign paths for output and inflation. The more aggressive or pre-emptive monetary easing followed by the Federal Reserve in the recent slowdown was precisely designed to fend off potential deflationary pressures, and hence to act as a kind of insurance device.[42]

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[40] The impact of the debt deflation channel is discussed below. As regards the wage channel, to the extent that wage rigidities depend on slow adjustments in expectations, as opposed to broader sociological factors, the real wage channel would be less important. Sociological factors or other institutional norms, however, may be quite important, and could offset this effect (eg Bewley (1995)). For example, despite persistent and sizeable deflation, wages in a flexible economy such as Hong Kong SAR have exhibited significant downward rigidities recently. There is not much evidence about the degree of downward wage flexibility nowadays compared with that in the interwar years or in the pre-World War I period. Qualitatively, it is possible to say that the labour market reforms since the late 1980s should have improved wage flexibility relative to the Great Inflationary phase. But this says little about comparative wage flexibility across broad historical phases. This aspect, therefore, is not explicitly discussed in the text, which focuses on the relevance of the monetary and financial regimes.

[41] See the analysis and references in Borio et al (2003).

[42] See, in particular, the discussion and references in Borio et al (2003). An alternative, in principle more satisfactory, thought experiment would have been to estimate the fundamental supply, demand and policy "shocks" consistent with a fully articulated macroeconomic model over the time for which the behaviour of the policy rate is simulated. The shocks could then be used to simulate a model with a standard policy reaction function such as a Taylor-type rule (see, for example Orphanides and Wieland (1998)). Instead, the interest rate from the counterfactual experiment in the text can be thought of

On balance, however, the qualitative results do not seem that unreasonable, as can be inferred from the frequency with which policy rates have approached or reached the ZLB in the most recent period. In addition to the United States, the recent Japanese experience is a clear illustration of this simple point, with policy rates having reached zero in the late 1990s. In Switzerland, too, interest rates at the time of writing are very close to the ZLB, with a policy rate at a mere 0.25%, without deflation actually emerging or output contracting drastically.[43]

The point is *not* that an activist policy should be seen as a problem per se. As noted, such a policy can be justified as part of a pre-emptive strategy to avoid "bad" or ugly" deflations. Rather, the point is that the historical evidence should not be superficially read as suggesting that the ZLB is unlikely to be a constraint in the future. In turn, this puts a premium on seeking to limit any negative effects on confidence and hence expectations that reaching the ZLB could have.

The exchange regime can play a crucial role in the transmission of deflation pressures across currency areas. The role of the gold standard in spreading the Great Depression has been amply documented.[44] By analogy, nowadays countries with tight exchange rate arrangements can be immediately exposed to deflation pressures coming from abroad or, conversely, may forfeit a useful tool to escape from domestically induced pressures, subject to the obvious caveat of capital controls and other impediments to price arbitrage. The recent experience of the currency board in Hong Kong SAR is a clear case in point. In contrast, the flexible exchange rate regimes in New Zealand and Australia have been a factor allowing their inflation rates to remain near the upper end of the inflation targeting bands despite the deflationary forces in the Asian region. At the same time, the insulation properties of flexible exchange rate regimes should not be overstated, as revealed by the previous finding of a high correlation of inflation rates in the postwar flexible exchange rate era. Moreover, the risk of competitive depreciations would likely be higher were a global deflationary environment to materialise.

Beyond the monetary regime: two views

Making further inferences about the characteristics of future potential deflation episodes requires going beyond the implications of the monetary regime, and conjecturing about its interaction with the financial regime. In this way, we can form a fuller view about the nature of the current economic landscape by comparison with that in which previous episodes of deflation took place. As argued in detail elsewhere (Borio et al (2003), Borio and White (2004)), two intentionally stylised views can be seen to capture the spectrum of possible perspectives.

The more orthodox view would see the current environment as a natural continuation of the one prevailing in the inflation years. And it would tend to regard the dynamics of the economy as primarily driven by a sequence of exogenous shocks, whose effects would have relatively short persistence on economic activity. As a result, this view would probably tend to play down the possibility of further deflationary episodes in the absence of large negative shocks to demand and output. If anything, it would see the bias in a fiat money regime as being systematically towards inflation, albeit at present effectively restrained by the safeguards put in place in the monetary regime.

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as the short-term rate that a monetary authority following a Taylor-type rule would set on a *period-to-period basis* in response to the inflation and output conditions prevailing at the time of the response. Of course, if the nominal interest rate from the rule had actually been used, then the time paths for inflation and output would have been different. The alternative, more ambitious modelling approach relies on the assumption that the model estimated is indeed an accurate description of the economy and that the relationships estimated are invariant with respect to the policy rule. These, too, are rather heroic assumptions.

[43] Moreover, in other respects the procedure used in Table 16 to calibrate the Taylor rule may in fact *underestimate* the frequency with which the ZLB would have been binding. There are two possible reasons for this. First, the sensitivity parameters on the inflation and output gaps assumed here may be too low, as suggested by results in Taylor (1999). Second, the calibration of the "equilibrium" real interest rate based on the ex post real interest rate may have biased upwards the counterfactual policy rate during periods in the past when the ZLB was binding, such as during the Great Depression.

[44] See, for example Eichengreen (1992) and Eichengreen and Sachs (1995), and even Fisher (1933). See also Temin (1989) and (1993) and Bernard and Bisignano (2002).

The less orthodox view would rather emphasise the elements of discontinuity between the current environment and that prevailing in the inflationary years and would highlight the importance of changes in the financial regime, particularly in the form of financial liberalisation.[45] In addition, rather than seeing the economy as driven by short-lived exogenous shocks, it would assign greater weight to lower-frequency dynamic endogenous processes, notably those associated with financial factors. In particular, it would stress that a liberalised environment can increase the likelihood of the occasional cumulative build-up of financial imbalances and of the associated distortions in the real economy, even in periods of low and comparatively stable inflation. And it would highlight the potentially disruptive consequences of their subsequent unwinding. This view would tend to see excessively rapid credit growth and booming asset prices, especially if accompanied by heavy capital accumulation, as possible harbingers of contractionary pressures down the road, possibly exacerbated by financial strains.[46] Starting from a low initial level of inflation, weakness in economic activity and the likely headwinds faced by monetary policy could thus increase the risk of tipping the economy into an unwelcome period of disinflation or even falling prices. As a result, such a view would attach somewhat greater weight to the possibility of future episodes of falling prices than its counterpart, while at the same time emphasising the negative effects of asset price deflation per se.

From this less orthodox perspective, to varying degrees the recent experiences of several countries around the globe would be seen as consistent with the greater importance of financial factors in economic fluctuations. The clearest examples are those of Japan and East Asian countries, which saw economic fluctuations not dissimilar from the stylised ones just described followed by disinflationary or even deflationary pressures. In these cases, inflationary pressures typically remained rather benign during the preceding booms. Apart from obvious differences, some such elements could also be discerned in the more recent global equity market boom and subsequent bust, which in some countries was also accompanied by rapid credit expansion and heavy capital accumulation, including in the United States.[47]

Importantly, this view would highlight the similarities in the arrangements in the monetary and financial regimes with those prevailing in the gold standard era. For beyond obvious other differences, it was then that we last saw the conjunction of liberalised financial markets with a monetary regime that was seen as delivering a good measure of price stability. Indeed, the resemblance would seem to be especially close to the first phase of the interwar period. This period had seen successful attempts to re-establish monetary stability in a number of European countries as well as experimentation in how to conduct monetary policy in the context of price stability but a weakened exogenous anchor on credit expansion. In particular, in the United States, given the country's excess gold reserves, monetary policy was not constrained by the availability of gold *during the boom years*.

From this perspective, the role of indebtedness in the economy becomes crucial. For in addition to the effect of deflation on debt burdens, the extent of leverage in the system affects its loss absorption capacity, as critically influenced by the decline in asset prices.[48]

The available evidence is ambiguous in this respect. Overall, debt-to-GDP ratios have tended to increase substantially following financial liberalisation and the decline in inflation.[49] On the one hand, in part this reflects an equilibrium phenomenon and a long-term rise in the underlying value of the assets held against such debt. On the other hand, this also makes the economies somewhat more vulnerable to asset and general price deflation. Comparing current levels of debt with those prevailing

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[45] For a further elaboration of this view, see for example, Borio and Crockett (2000), Borio and Lowe (2002a), Crockett (2003) and Borio and White (2004).

[46] For empirical evidence on this link, see Borio and Lowe (2002a), (2002b) and (2003a).

[47] This view would also pay particular attention to housing price booms experienced by several countries in the current cycle, even as the economies slowed down. For the role played by real estate prices in economic fluctuations and deflations, see Goodhart and Hofmann (2003). For the role of housing prices in the current cycle, see BIS (2003), IMF (2003), Borio and McGuire (2004), Tsatsaronis and Zhu (2004) and Debelle (2004).

[48] Importantly, however, in contrast to the gold standard period, nowadays the loss absorption capacity of the system has been strengthened by the establishment of prudential frameworks; on this, see Borio and Lowe (2002a) and (2002b) as well as the references therein.

[49] See Borio and Lowe (2002a) and Borio and White (2004).

in the interwar years or the gold standard phase is hard because of lack of data and changes in the degree of financial deepening as well as in other financial characteristics. [50,51]

Conclusions

This paper has tried to document stylised facts about deflation from a broad historical perspective across a large group of countries and to draw some informed conjectures about the prospects and characteristics of potential deflationary episodes in the future. Rather than summarising the various findings and repeating the main conclusions, already anticipated in the introduction, it may be worth reflecting here on some policy implications and on open questions left for future research.

The new environment of low inflation suggests that careful thought should be given to how best to address the issue of deflation in current monetary policy frameworks. Importantly, the historical record strongly suggests that many deflationary episodes have been rather benign. Not all, however, have been so. Moreover, in such less benign cases the effectiveness of the monetary policy levers can be less certain, at least if the zero lower bound on interest rates becomes a binding constraint. And uncertainties also surround the transitional response of economies as they migrated into a deflationary episode - an exceptional event by postwar standards.

This puts a premium on understanding what configuration of factors tends to herald the risk of the emergence of the disruptive forms of deflation, and on exploring how monetary policy strategies and tactics could be adjusted to address it. Such a deeper understanding would help to strike a delicate balance between the risk of indiscriminate overreaction, on the one hand, and of insufficient pre-emptiveness, on the other.[52] Thought could also be given to the effectiveness of alternative measures to exit deflation, depending on its characteristics. In the case of the less benign forms of deflation, these measures would likely call for closer coordination with fiscal and, in some circumstances, prudential authorities.

At the same time, much more analytical and empirical research is necessary into the genesis, dynamics and costs of deflation. Improving the available historical data would be an important first step. As discussed in the paper, statistical gaps prevent a proper analysis of past deflationary episodes. Some gaps are understandable, given the limitations of even recent data, such as those relating to real estate prices. Other gaps, however, are far less justifiable; those concerning historical credit and debt statistics are obvious cases in point. Addressing these statistical gaps deserves closer attention than received so far.

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[50] Even so, the available figures for a handful of countries would seem to suggest that private debt-to-GDP ratios, after their postwar lows, have recovered to levels similar to, or higher than, those that prevailed then. It would appear that in this respect, too, the current economic landscape is coming to resemble more closely that prevailing in the prewar period.

[51] For instance, as concerns the impact of general price, as opposed to asset price, deflation, the sensitivity of the duration of the liabilities to price developments is also important. Evidence here, too, is very sparse. Arguably, however, on balance the legacy of high inflation in the 1970s and part of the 1980s has resulted in a higher percentage of debt liabilities at adjustable interest rates and shorter maturities, limiting the risk of unexpected deflation being associated with unexpectedly large servicing costs. On empirical evidence on these points, see Borio (1997).

[52] The range of possible policy responses is rather broad. For instance, to the extent that financial imbalances are seen as potentially heralding economic weakness and, starting from very low-inflation levels, higher unwelcome disinflationary risks, it could include longer policy horizons, greater attention to the balance of risks and asymmetric costs in devising interest rate responses and a more deliberate focus on the build-up of financial imbalances at the strategic level of policy (eg Borio et al (2003), Borio and Lowe (2003b), Bean (2003) and Borio and White (2004)). But more generally, regardless of the specific cause of the less benign forms of deflation, adjustments to the inflation objectives themselves or to the interest rate strategies in terms of the timing and size of interest rate moves can also be considered. The communication of policy to the public is also key. Some of these issues are discussed in more detail in BIS (2003).

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Table 1

Cross-country inflation statistics, average inflation rates

	1801–79	1880–1913	1914–49	1950–69	1970–89	1990–2002
United States						
CPI	0.5	1.0	2.7	2.2	6.3	2.9
Wholesale	0.3	0.2	3.2	1.6	5.7	1.6
GDP deflator	–3.2	0.6	2.9	2.5	5.7	2.2
Japan						
CPI	…	2.5	24.0	4.2	5.8	0.8
Wholesale	3.7	2.4	27.7	3.2	3.6	–0.8
GDP deflator	…	4.3	33.8	6.8	5.2	–0.0
Germany						
CPI	1.3	0.9	617 M	1.8	3.9	2.4
Wholesale	–0.2	0.7	3.3	1.4	3.8	0.9
GDP deflator	…	0.4	293 M	3.2	4.3	2.1
France						
CPI	0.5	0.2	16.6	4.8	8.1	1.8
Wholesale	…	1.2	16.4	4.5	7.3	0.1
GDP deflator	…	0.4	16.0	5.7	8.2	1.6
United Kingdom						
CPI	–0.0	–0.2	2.7	3.6	10.0	3.3
Wholesale	–0.6	0.3	3.6	3.7	9.9	2.6
GDP deflator	0.1	0.3	3.6	4.0	10.2	3.3
Italy						
CPI	1.0	0.2	27.7	3.2	11.9	3.8
Wholesale	…	1.4	24.6	1.5	11.3	2.7
GDP deflator	…	–0.1	20.0	4.3	12.7	4.0
Canada						
CPI	…	0.7	2.2	2.5	6.9	2.3
Wholesale	1.0	0.8	3.1	1.6	6.9	2.0
GDP deflator	…	0.8	2.7	3.0	7.1	1.7
Australia						
CPI	–0.9	0.5	2.6	4.8	9.1	2.8
Wholesale	…	1.1	3.8	3.4	8.8	2.2
GDP deflator	…	0.7	3.2	4.5	9.3	2.1
Netherlands						
CPI	…	–0.2	3.2	3.9	4.9	2.7
Wholesale	…	1.3	3.8	2.1	3.4	1.1
GDP deflator	…	0.5	3.6	4.5	5.4	2.6
Belgium						
CPI	0.5	0.0	11.0	2.2	6.0	2.2
Wholesale	…	…	7.8	1.8	5.0	1.1
GDP deflator	…	…	11.1	2.2	5.5	2.1
Sweden						
CPI	…	0.4	3.2	4.1	8.3	3.0
Wholesale	…	…	…	2.2	8.5	2.0
GDP deflator	…	1.3	3.7	4.3	8.4	2.5

Table 1 (cont)

Cross-country inflation statistics, average inflation rates

	1801–79	1880–1913	1914–49	1950–69	1970–89	1990–2002
Denmark						
CPI	–1.5	0.4	4.1	4.6	8.1	2.2
Wholesale	–6.1	0.3	5.3	2.7	5.7	–1.8
GDP deflator	…	0.2	4.1	4.4	7.9	2.1
Norway						
CPI	0.6	0.9	3.5	4.3	8.4	2.4
Wholesale	…	0.1	3.6	3.8	7.3	1.3
GDP deflator	…	0.8	2.8	3.8	8.6	2.3
Ireland						
CPI	…	…	2.1	4.1	11.0	2.9
Wholesale	…	…	4.9	3.5	10.1	1.5
GDP deflator	…	…	…	5.0	11.0	3.8
Average						
CPI[1]	0.2	0.6	8.1	3.6	7.8	2.5
Wholesale	–0.3	0.9	8.5	2.7	6.9	1.2
GDP deflator[1]	–1.6	0.9	9.0	4.2	7.8	2.3

Notes: M denotes million. The starting years for the CPI measure are as follows: United States 1821, Japan 1881, Germany 1502, France 1841, United Kingdom 1272, Italy 1862, Canada 1881, Australia 1862, Netherlands 1881, Belgium 1836, Sweden 1881, Denmark 1816, Norway 1836, Ireland 1923. See appendix for starting years for the wholesale price index and the GDP deflator.

[1] Excluding Germany from 1914 to 1949.

Table 2

Deflation frequency, annual, 1801-2002

	1801–79	1880–1913	1914–49	1950–69	1970–89	1990–2002
United States	31.3	23.5	30.6	5.0		38.5
Japan	…	29.4	27.8	10.0		
Germany	28.8	29.4	11.1	10.0	5.0	
France	35.0	26.5	22.2	10.0		
Italy	7.5	32.4	25.0			
United Kingdom	51.3	44.1	33.3			
Canada	7.5	23.5	25.0	5.0		
Belgium	23.8	44.1	25.0	15.0		7.7
Sweden	20.0	44.1	30.6			
Denmark	38.8	41.2	25.0	5.0		
Australia	13.8	44.1	22.2	5.0		
Norway	25.0	35.3	36.1			
Netherlands	2.5	32.4	36.1	10.0	5.0	
Ireland	…	…	25.0	5.0		

Deflation frequency, quarterly, 1960-2002[1]

	1960–69	1970–79	1980–89	1990–99	1999–2001	2002
Headline inflation	6.6	1.2	2.5	3.8	15.4	18.5
GDP deflator[2]	5.1	1.4	1.9	6.6	22.9	17.6
Core inflation[3]	0	0	0.2	3.5	8.3	6.7
Services less housing[4]	3.4	0.8	0.3	2.7	11.5	7.3
Wholesale inflation[5]	11.5	5.1	17.6	25.0	24.7	57.6

Note: Simple average of the following economies: Argentina, Belgium, Brazil, Canada, Chile, China, Colombia, euro area, France, Germany, Hong Kong SAR, Indonesia, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, Peru, Singapore, Sweden, Switzerland, United Kingdom, United States, Taiwan (China), Thailand and Venezuela.

[1] Defined as percentage of cases of falling prices in the corresponding price index. [2] Excluding Argentina, Chile, China, Colombia, Peru, Singapore and Venezuela. [3] Excluding Argentina, Brazil, Chile, China, Colombia, Hong Kong SAR, Indonesia, Malaysia, Peru, Singapore, Taiwan (China) and Venezuela. [4] Excluding Argentina, Chile, China, Colombia, Hong Kong SAR, Malaysia, Peru, Singapore, Taiwan (China), Thailand and Venezuela. [5] Excluding China and Hong Kong SAR.

Near-deflation (less than 1%) frequency, quarterly, 1960-2002[1]

	1960–69	1970–79	1980–89	1990–99	1999–2001	2002
Headline inflation	13.4	2.9	7.3	11.7	28.7	29.6
GDP deflator[2]	8.7	2.0	4.8	15.2	36.7	33.3
Core inflation[3]	3.5	1.5	2.5	13.3	33.3	17.8
Services less housing[4]	4.0	1.3	2.2	10.9	30.4	12.2
Wholesale inflation[5]	27.4	7.6	23.2	3.6	35.1	68.2

See footnote in middle panel.

Table 3

Amplitude of deflation

	1801–79	1880–1913	1914–49	1950–69	1970–89	1990–2002
United States						
Median	–4.1	0.0	–2.3	–0.3		
Minimum	0.0	0.0	0.0	–0.3		
Maximum	–15.5	–3.9	–10.8	–0.3		
Japan						
Median	…	–4.0	–8.2	–0.8		–0.7
Minimum	…	–2.2	–1.6	–0.7		–0.1
Maximum	…	–6.8	–18.7	–0.9		–0.9
Germany						
Median	–5.2	–1.3	–7.4	–4.0	–0.1	
Minimum	0.0	0.0	–0.1	–1.8	–0.1	
Maximum	–33.8	–4.0	–9.6	–6.2	–0.1	
France						
Median	0.0	0.0	–9.7	–0.7		
Minimum	0.0	0.0	–0.4	–0.2		
Maximum	–3.9	–2.3	–23.8	–1.1		
United Kingdom						
Median	–5.5	–2.1	–1.7	0.0		
Minimum	–0.1	0.0	0.0	0.0		
Maximum	–23.0	–9.4	–27.5	0.0		
Italy						
Median	–2.1	–0.9	–3.4			
Minimum	0.0	0.0	0.0			
Maximum	–14.4	–6.0	–19.1			
Canada						
Median	…	–2.2	–4.3	–1.0		
Minimum	…	0.0	–0.6	–1.0		
Maximum	…	–12.5	–12.0	–1.0		
Australia						
Median	–2.3	–2.9	–3.5	–0.2		
Minimum	–0.3	0.0	–0.6	–0.2		
Maximum	–9.7	–8.9	–9.9	–0.2		
Netherlands						
Median	…	–1.1	–2.5	–0.8	–0.6	
Minimum	…	0.0	0.0	0.0	–0.6	
Maximum	…	–10.8	–14.1	–1.9	–0.6	
Belgium						
Median	–3.7	–2.4	–4.4	–0.5		
Minimum	0.0	0.0	0.0	–0.3		
Maximum	–14.1	–12.4	–12.4	–0.9		
Sweden						
Median	…	–2.2	–1.9			–0.3
Minimum	…	0.0	0.0			–0.3
Maximum	…	–5.3	–19.5			–0.3
Denmark						
Median	–3.8	–2.5	–3.0	–0.4		
Minimum	0.0	0.0	0.0	0.0		
Maximum	–37.5	–5.7	–12.2	–0.8		

Table 3 (cont)

Amplitude of deflation

	1801–79	1880–1913	1914–49	1950–69	1970–89	1990–2002
Norway						
Median	–3.1	–1.8	–4.5			
Minimum	0.0	0.0	–0.5			
Maximum	–10.4	–5.9	–19.6			
Ireland						
Median	…	…	–2.3	–1.7		
Minimum	…	…	0.0	–1.7		
Maximum	…	…	–6.1	–1.7		
All countries						
Median	–3.7	–2.1	–3.4	–0.7	–0.4	–0.5

Note: The starting years for the CPI measure are as follows: United States 1821, Japan 1881, Germany 1502, France 1841, United Kingdom 1272, Italy 1862, Canada 1881, Australia 1862, Netherlands 1881, Belgium 1836, Sweden 1881, Denmark 1816, Norway 1836, Ireland 1923.

The annual median deflation for Germany and the United Kingdom prior to 1801 was –5.5 and –5.6 years respectively.

Table 4

Duration of annual CPI deflation

	1801–79	1880–1913	1914–49	1950–69	1970–89	1990–2002
United States						
Median	1	2	2	1		
Minimum	1	1	1	1		
Maximum	6	7	7	1		
Japan						
Median	…	2	3	1		3
Minimum	…	1	2	1		1
Maximum	…	3	3	1		4
Germany						
Median	2	2	4	1	1	
Minimum	1	1	4	1	1	
Maximum	4	6	4	1	1	
France						
Median	3	2	2	2		
Minimum	1	1	1	2		
Maximum	6	5	2	2		
United Kingdom						
Median	3	2	2	1		
Minimum	1	1	1	1		
Maximum	5	3	9	1		
Italy						
Median	2	2	1			
Minimum	1	1	1			
Maximum	4	9	5			
Canada						
Median	…	1	1	1		
Minimum	…	1	1	1		
Maximum	…	6	4	1		
Australia						
Median	3	2	1	1		
Minimum	1	1	1	1		
Maximum	5	4	4	1		
Netherlands						
Median	…	2	2	1	1	
Minimum	…	1	1	1	1	
Maximum	…	8	5	1	1	
Belgium						
Median	2	2	2	1		
Minimum	1	1	1	1		
Maximum	4	6	6	1		
Sweden						
Median	…	2	3			1
Minimum	…	1	2			1
Maximum	…	6	6			1
Denmark						
Median	2	3	1	1		
Minimum	1	1	1	1		
Maximum	3	7	7	1		

Table 4 (cont)

Duration of annual CPI deflation

	1801–79	1880–1913	1914–49	1950–69	1970–89	1990–2002
Norway						
Median	3	2	2			
Minimum	1	1	1			
Maximum	5	5	9			
Ireland						
Median	…	…	1	1		
Minimum	…	…	1	1		
Maximum	…	…	4	1		
Median statistics						
Maximum	**7**	**3**	**4**	**2**	**1**	**3**
Average	**3**	**2**	**2**	**1**	**1**	**2**
Percentage of countries	100.0	100.0	100.0	85.7	28.6	14.3

Note: The starting years for the CPI measure are as follows: United States 1821, Japan 1881, Germany 1502, France 1841, United Kingdom 1272, Italy 1862, Canada 1881, Australia 1862, Netherlands 1881, Belgium 1836, Sweden 1881, Denmark 1816, Norway 1836, Ireland 1923.

The median duration was two years for both Germany and the United Kingdom prior to 1801.

Table 5

Unit root tests for annual CPI

	1801–80	1881–1913	1918–39	1945–69	1970–89	1990–2001
United States	R*** (1823-80)	R*	R*	R***	R*	NR
Japan	…	R** (1883-1913)	R**	R**	NR	NR
Germany	R***	R**	R**	R**	R*	NR
France	R*** (1843-80)	R***	R*	NR	NR	NR
United Kingdom	R***	R***	R*	R**	NR	NR
Italy	R** (1864-80)	R**	NR	R***	NR	NR
Canada	…	R*** (1883-1913)	R*	R**	NR	NR
Argentina	…	R** (1887-1913)	R**	R**	NR	R***
Australia	R** (1864-80)	R***	R**	NR	NR	R*
Belgium	R*** (1838-80)	R***	R*	NR	R*	NR
Brazil	…	R* (1883-1913)	NR	NR	NR	NR
Chile	…	R*** (1883-1913)	R***	NR	R**	NR
Colombia	…	…	NR (1926-39)	R***	NR	NR
Denmark	R*** (1818-80)	R**	NR	R***	NR	R***
Finland	…	R*** (1883-1913)	R*	NR	R*	NR
India	…	…	NR (1924-39)	R**	R***	NR
Ireland	…	…	NR (1925-39)	R***	NR	NR
Mexico	…	R* (1903-1913)	R**	R**	NR	NR
Netherlands	…	R** (1883-1913)	NR	R**	NR	NR
New Zealand	…	…	NR (1918-39)	R*	R*	NR
Norway	R*** (1838-80)	NR	R***	R**	R**	R*
Peru	…	…	NR (1918-39)	NR	NR	NR
Spain	…	R** (1883-1913)	R*	R**	NR	NR
Sweden	…	R** (1883-1913)	NR	R***	NR	NR
Venezuela	…	…	R* (1918-39)	NR	R*	NR

Note: Augmented Dickey-Fuller unit root tests on annual percentage changes in CPI, using a constant and a one-period lag. NR means the unit root hypothesis cannot be rejected; R***, R** and R* mean the hypothesis can be rejected with a probability of 99, 95 and 90% respectively.

Table 5 (cont)

Unit root tests for quarterly CPI

	Growth rate	Log levels	Additional log level tests	
	1990:1–2001:4	1990:1–2001:4		
United States	R**	R**	R**	90:3-01:4
Japan	R***	NR		
Germany	R***	NR		
France	R***	NR	NR	92:1-01:4
United Kingdom	R**	R***	NR	92:1-01:4
Italy	R***	NR	NR	92:1-01:4
Canada	R**	R**	R**	90:3-01:4
Argentina	R***	R***		
Australia	R*	NR		
Belgium	R***	NR		
Brazil	R**	NR		
Chile	R***	R***		
China	NR	NR		
Colombia	R***	NR		
Denmark	R***	NR		
Finland	R***	R**	NR	93:1-01:4
Hong Kong SAR	R**	NR		
India	R***	NR		
Indonesia	NR	NR		
Ireland	R*	NR		
Mexico	R**	NR		
Netherlands	R***	NR		
New Zealand	R**	NR		
Norway	R***	R*		
Peru	R**	R***		
Singapore	R**	NR		
Spain	R**	NR	NR	93:1-01:4
Sweden	R**	R***		
Switzerland	R**	R**	NR	94:1-01:4
Thailand	R*	NR		
Venezuela	NR	NR		

Table 6

Inflation persistence, evidence from an autoregressive model

	1800–80	1881–1913	1918–39	1945–69	1970–89	1992–2001
United States	0.201 (1.55)	0.383 (2.353)	0.573 (3.69)	0.476 (2.568)	0.703 (4.158)	0.274 (1.164)
Japan	...	0.285 (1.63)	0.666 (4.273)	0.713 (4.851)	0.665 (3.698)	0.538 (2.677)
Germany	0.191 (1.727)	0.418 (2.621)	–0.048 (–0.213)	–0.002 (–0.008)	0.800 (5.887)	0.735 (3.59)
France	0.168 (1.039)	–0.045 (–0.251)	0.123 (0.58)	0.778 (5.93)	0.854 (6.209)	0.518 (2.616)
United Kingdom	0.265 (2.481)	–0.241 (–1.386)	0.029 (0.13)	0.199 (0.954)	0.677 (3.998)	0.08 (0.352)
Italy	0.054 (0.214)	0.116 (0.678)	0.262 (1.362)	0.194 (11.237)	0.788 (6.08)	0.688 (3.886)
Canada	...	0.06 (0.335)	0.44 (2.622)	0.408 (2.164)	0.788 (5.484)	–0.048 (–0.267)
Argentina	...	0.109 (0.574)	0.052 (0.246)	0.106 (0.514)	1.082 (1.401)	0.145 (8.675)
Australia	0.047 (0.188)	0.056 (0.31)	0.297 (1.39)	0.521 (2.977)	0.638 (4.044)	0.281 (0.76)
Belgium	0.096 (0.634)	0.117 (0.653)	0.386 (2.006)	0.581 (3.99)	0.785 (5.255)	0.399 (1.464)
Brazil	...	0.405 (2.44)	0.567 (3.107)	0.764 (5.794)	0.381 (1.081)	0.59 (2.003)
Chile	...	0.042 (0.23)	0.075 (0.336)	0.539 (3.121)	0.794 (5.494)	0.706 (13.645)
Colombia	...	...	–0.169 (–0.618)	–0.174 (–0.853)	0.532 (2.892)	0.876 (5.318)
Denmark	0.156 (1.231)	0.253 (1.53)	0.362 (1.701)	0.345 (1.789)	0.690 (4.269)	0.295 (0.881)
Finland	...	0.455 (2.863)	0.266 (1.312)	0.063 (0.304)	0.765 (5.752)	0.46 (2.102)
India	...	...	0.113 (0.418)	0.104 (0.531)	0.227 (1.025)	0.255 (0.763)
Ireland	...	...	0.181 (0.567)	0.181 (0.864)	0.834 (5.893)	0.396 (1.028)
Mexico	...	–0.062 (–0.254)	0.091 (0.43)	0.092 (0.444)	0.699 (4.304)	0.417 (1.213)
Netherlands	...	0.064 (0.348)	0.491 (2.537)	0.251 (1.263)	0.857 (6.406)	0.603 (1.259)
New Zealand	...	...	0.326 (1.561)	0.337 (1.731)	0.445 (2.166)	0.079 (0.222)
Norway	0.21 (1.384)	0.445 (3.011)	0.273 (1.734)	0.401 (2.126)	0.210 (0.973)	0.016 (0.051)
Peru	...	...	0.572 (3.549)	0.114 (0.545)	0.762 (4.917)	0.17 (5.802)
Spain	...	–0.047 (–0.26)	0.523 (2.653)	0.392 (2.006)	0.805 (7.070)	0.73 (4.174)
Sweden	...	0.41 (2.476)	0.676 (4.736)	0.168 (0.825)	0.522 (2.999)	0.196 (1.181)
Venezuela	...	...	0.28 (1.282)	0.111 (0.626)	0.735 (2.619)	0.605 (1.909)

Note: The coefficient is the AR estimate from the regression equation $\pi_t = \mu_0 + \mu_1 \pi_{t-1} + \mu_3 \textit{time trend} + \varepsilon_t$. The t-statistics are in parentheses.

Table 7

Annual inflation correlation

1801–1979	UK	US	DE	FR	IT	BE	CA	NL	SE
United Kingdom	1.00								
United States	0.22	1.00							
Germany	0.29	0.24	1.00						
France	0.29	0.15	–0.05	1.00					
Italy	0.55	–0.16	0.40	0.26	1.00				
Belgium	0.63	0.09	0.46	0.26	0.52	1.00			
Canada	0.67	0.36	0.24	0.24	0.69	0.50	1.00		
Netherlands	0.79	–0.12	0.78	0.43	0.86	0.53	0.52	1.00	
Sweden	0.37	0.07	0.41	0.09	0.49	0.59	0.33	0.62	1.00

1880–1913	UK	US	JP	DE	FR	IT	BE	CA	NL	SE	CH
United Kingdom	1.0										
United States	0.3	1.0									
Japan	0.3	0.2	1.0								
Germany	0.4	0.5	0.4	1.0							
France	0.3	0.1	–0.2	0.3	1.0						
Italy	0.1	0.1	0.5	0.4	0.2	1.0					
Belgium	0.5	0.3	0.2	0.5	0.3	0.2	1.0				
Canada	0.3	0.5	0.4	0.3	–0.0	0.2	0.4	1.0			
Netherlands	0.4	0.2	0.1	0.4	0.2	0.2	0.3	0.2	1.0		
Sweden	0.4	0.4	0.4	0.7	0.1	0.3	0.3	0.4	0.4	1.0	
Switzerland	0.5	0.4	0.4	0.7	0.2	0.5	0.5	0.4	0.5	0.5	1.0

1920–38	UK	US	JP	DE	FR	IT	BE	CA	NL	SE	CH
United Kingdom	1.0										
United States	0.8	1.0									
Japan	0.4	0.2	1.0								
Germany	0.0	0.1	0.2	1.0							
France	0.7	0.8	0.2	0.2	1.0						
Italy	0.4	0.6	0.1	–0.1	0.6	1.0					
Belgium	0.6	0.7	0.1	0.2	0.7	0.3	1.0				
Canada	0.8	1.0	0.3	0.0	0.8	0.5	0.7	1.0			
Netherlands	0.9	0.7	0.6	0.1	0.6	0.3	0.7	0.8	1.0		
Sweden	0.5	0.5	0.4	–0.3	0.4	0.1	0.3	0.6	0.6	1.0	
Switzerland	0.7	0.6	0.5	0.4	0.5	–0.1	0.6	0.6	0.8	0.5	1.0

Table 7 (cont)

Annual inflation correlation

1950–73	UK	US	JP	DE	FR	IT	BE	CA	NL	SE	CH
United Kingdom	1.0										
United States	0.5	1.0									
Japan	0.3	0.6	1.0								
Germany	0.6	0.6	0.5	1.0							
France	0.1	0.4	–0.0	0.2	1.0						
Italy	0.5	0.4	0.5	0.5	0.3	1.0					
Belgium	0.5	0.8	0.6	0.8	0.2	0.6	1.0				
Canada	0.4	0.9	0.5	0.6	0.5	0.5	0.9	1.0			
Netherlands	0.4	0.4	0.1	0.1	–0.0	0.5	0.5	0.5	1.0		
Sweden	0.5	0.7	0.5	0.7	0.5	0.5	0.7	0.7	0.1	1.0	
Switzerland	0.7	0.6	0.6	0.9	0.2	0.6	0.8	0.6	0.3	0.6	1.0
1973–2002	**UK**	**US**	**JP**	**DE**	**FR**	**IT**	**BE**	**CA**	**NL**	**SE**	**CH**
United Kingdom	1.0										
United States	0.8	1.0									
Japan	0.8	0.7	1.0								
Germany	0.7	0.7	0.7	1.0							
France	0.8	0.9	0.7	0.8	1.0						
Italy	0.9	0.9	0.7	0.8	1.0	1.0					
Belgium	0.8	0.7	0.8	0.8	0.9	0.9	1.0				
Canada	0.8	0.9	0.7	0.7	0.9	0.9	0.8	1.0			
Netherlands	0.8	0.7	0.8	0.8	0.8	0.8	0.9	0.7	1.0		
Sweden	0.8	0.8	0.6	0.7	0.8	0.9	0.7	0.9	0.6	1.0	
Switzerland	0.6	0.6	0.7	0.8	0.6	0.6	0.7	0.7	0.6	0.6	1.0

Note: BE = Belgium; CA = Canada; CH = Switzerland; DE = Germany; FR = France; GB = United Kingdom; IT = Italy; JP = Japan; NL = Netherlands; SE = Sweden; US = United States. Source: National data.

Table 8

Simple correlation of annual short-term interest rate and inflation

	1863–1913	1960–2001
Finland	0.0	0.7
France	0.2	0.7
Germany	0.1	0.7
Netherlands	0.1	0.3
Norway	–0.2	0.6
Sweden	0.0	0.7
United Kingdom	0.2	0.6
United States	0.1	0.8

Note: Includes all countries with data availability for the earlier period. Because of data limitations, the discount rate is used for Finland, the Netherlands, Norway and Sweden.

Table 9

Price level peak dates for selective countries

	1830s	1840s	1850s	1860s	1870s	1880s	1890s	1900s	1910s	1920s
United States	1837	1847	1857	1866		1881	1891			1920 1926
United Kingdom		1840 1847		1860	1873		1891			1920
Germany	1831	1847	1855		1874	1881	1891			1928
France					1871 1877	1884		1902		1930
Canada	…	…	…	…	1872	1882 1889				1920 1929
Italy	…	…	…		1874		1891			1926
Japan	…	…	…	…	…					1920
Belgium		1842 1847	1856	1862	1873		1891	1901		1929
Sweden		1842 1847	1857	1862	1874		1891			1920
Denmark	1831 1836	1847	1856	1867	1874		1891	1902		1920
Norway			1856		1874	1882	1891	1900		1920

Note: The notation "…" indicates no data; empty cells indicate no price peak in the decade.

Table 10

Difference between output growth before and after CPI peaks, G10 countries

	Mean (μ)	Standard error (σ)	t-statistic[1]	Number of observations
1820–2001	0.4	0.4	0.9	50
1820–1914	0.3	1.1	0.3	37
1925–39[2]	6.2	1.6	3.6	5

[1] The t-statistic is for the test H_0: $\mu_{pre} = \mu_{post}$ at the 5% significance level, where μ is the difference between the average growth rate in the pre-peak five-year period and the post-peak five-year period, and σ is the standard error of μ. [2] The five observations correspond to the United States (1926), France (1930), Italy (1926), Canada (1929) and Germany (1928).

Table 11

Deflation in perspective

	Deflation periods						
	Consumer prices	Output	S-T interest rates	Nominal wages	Equity prices	Crisis	Years of inflation
	Average annual percentage growth						
	1882–1913						
United States	–2.4	2.6	2.7	1.1	–5.7	1	6
Japan	–5.5	2.6	2.2	…	…	0	5
Germany	–2.0	4.1	2.5	0.9	4.0	0	8
France	–1.0	2.1	2.0	1.1	–3.4	0	2
Italy	–2.0	1.0	…	2.3	–2.1	1	7
United Kingdom	–3.6	1.0	2.3	1.3	4.6	1	10
Canada	–4.6	1.1	…	…	…	0	3
Belgium	–4.2	1.6	2.3	…	…	0	8
Sweden	–2.8	2.1	…	1.4	37.9	0	12
Denmark	–3.5	2.8	…	1.8	…	1	10
Average	–3.2	2.1	2.3	1.4	5.9		7
	1923–39						
United States	–4.2	–3.5	2.5	–2.1	–6.1	1	8
Japan	–8.5	1.0	2.1	–1.4	–5.8	1	6
Germany	–6.1	–6.2	5.8	–8.5	–18.3	1	4
France	–9.9	–4.0	2.0	–1.4	–11.2	0	4
Italy	–5.4	–0.7	…	–4.1	–5.0	1	5
United Kingdom	–3.0	1.3	3.5	–1.7	–3.8	0	7
Canada	–6.1	–8.5	…	–3.7	–11.3	0	4
Belgium	–4.7	–0.5	2.5	…	–8.2	2	6
Sweden	–3.0	2.8	…	–0.5	–5.3	1	8
Denmark	–5.5	2.7	…	–1.4	–3.5	1	6
Average	–5.6	–1.6	3.1	–2.8	–7.8		6
	of which 1923–39 excluding 1930–33						
United States	–1.6	1.2	3.0	1.4	6.7	0	4
Japan	–7.3	0.4	2.3	1.0	–2.6	1	4
Germany	–0.1	–4.2	6.9	3.1	–22.5	0	1
France	–8.0	–1.8	2.6	–1.5	–9.1	0	2
Italy	–6.6	0.0	…	–3.6	9.1	0	1
United Kingdom	–1.4	3.5	4.1	–1.9	2.7	0	4
Canada							
Belgium	–3.6	1.3	2.1	na	8.6	1	2
Sweden	–3.2	5.9	…	0.0	4.3	0	4
Denmark	–6.0	2.2	…	–2.6	2.0	0	4
Average	–4.2	1.0	3.5	–0.5	–0.1		3

Table 11 (cont)

Deflation in perspective

	Deflation periods						
	Consumer prices	**Output**	**S-T interest rates**	**Nominal wages**	**Equity prices**	**Crisis**	**Years of inflation**
	Average annual percentage growth						
	1951–70						
France	–0.7	3.9	3.8	3.6	40.0	0	2
	1971–95						
None							
	1996–2002						
Japan	–0.7	0.7	0.2	0.1	–2.9	0	4

[1] Deflation defined as at least two consecutive years of price decreases. [2] 1886–1913. [3] 1926–39. [4] 1926–29 and 1934–39. [5] 1901–13 for equity prices.

Table 11 (cont)

Deflation in perspective

	Inflation periods						
	Consumer prices	**Output**	**S-T interest rates**	**Nominal wages**	**Equity prices**	**Crisis**	**Years of inflation**
	Average annual percentage growth						
	1882–1913						
United States	1.5	3.8	3.8	1.7	3.4	2	26
Japan	4.0	2.7	2.5	…	…	2	27
Germany	1.7	2.6	3.4	2.5	0.6	1	24
France	0.2	1.7	2.5	0.7	0.9	3	30
Italy	0.9	2.1	…	1.5	–4.1	2	25
United Kingdom	1.3	2.2	3.0	0.9	–0.9	0	22
Canada	1.1	4.7	…	2.7	…	0	29
Belgium	1.6	2.1	3.0	…	2.3	0	24
Sweden	2.2	3.3	…	3.2	12.3	2	20
Denmark	1.8	3.1	…	2.8	…	1	22
Average	1.6	2.8	3.0	2.0	2.1		25
	1923–39						
United States	1.8	7.4	3.1	5.4	14.9	0	9
Japan	6.3	5.8	1.8	0.8	12.2	0	11
Germany	1.5	8.8	3.9	5.6	17.2	0	10
France	12.0	4.1	3.4	9.3	11.9	1	13
Italy	3.8	3.7	…	2.1	10.0	1	12
United Kingdom	2.0	2.9	1.7	1.3	4.1	0	10
Canada	0.6	6.6	0.7	1.9	10.6	1	13
Belgium	9.9	2.7	3.8	…	3.1	2	11
Sweden	1.5	4.3	…	2.6	13.2	0	9
Denmark	3.6	3.2	…	1.3	5.3	0	11
Average	4.3	5.0	2.6	3.4	10.2		11
	of which 1923–39 excluding 1930–33						
United States	1.8	7.4	3.1	5.4	14.9	0	9
Japan	6.6	6.5	1.7	0.4	3.9	0	9
Germany	1.4	8.3	3.9	6.1	18.1	0	9
France	13.5	4.4	3.7	10.4	17.1	0	11
Italy	3.8	3.7	…	2.1	10.0	1	12
United Kingdom	2.2	3.1	1.8	1.6	1.5	0	9
Canada	0.6	6.6	0.7	1.9	10.6	1	13
Belgium	9.9	2.7	3.8	…	3.1	2	11
Sweden	1.5	4.3	…	2.6	13.2	0	9
Denmark	3.8	3.9	…	1.5	3.5	0	9
Average	4.5	5.1	2.7	3.6	9.6		10

Table 11 (cont)

Deflation in perspective

	Inflation periods						
	Consumer prices	**Output**	**S-T interest rates**	**Nominal wages**	**Equity prices**	**Crisis**	**Years of inflation**
	Average annual percentage growth						
	1951–70						
United States	2.4	3.8	4.4	4.3	8.5	0	20
Japan	4.6	9.6	6.5	10.8	18.0	0	20
Germany	2.2	5.6	4.5	…	15.0	0	20
France	5.3	5.5	4.8	10.0	10.0	0	18
Italy	3.2	5.7	6.2	6.4	8.5	0	20
United Kingdom	3.7	2.8	5.0	6.8	8.0	0	20
Canada	2.5	4.9	3.5	5.2	6.9	0	20
Belgium	2.5	4.1	3.4	5.9	5.8	0	20
Sweden	4.4	4.0	5.9	8.5	6.7	0	20
Denmark	4.5	4.0	…	8.5	3.6	0	20
Average	3.5	5.0	4.9	7.4	9.1		20
	1971–95						
United States	5.7	3.1	7.8	5.6	8.5	3	25
Japan	4.7	3.7	5.8	7.2	10.6	1	25
Germany	3.8	2.4	6.8	6.2	6.3	0	25
France	6.9	2.5	9.5	9.2	9.6	1	25
Italy	10.6	2.6	12.6	12.8	12.1	2	25
United Kingdom	8.8	2.2	10.7	11.0	11.9	3	25
Canada	6.1	3.1	8.9	–0.2	7.4	2	25
Belgium	5.3	2.5	8.9	7.5	6.7	0	25
Sweden	7.6	1.7	9.6	7.9	17.4	1	25
Denmark	6.7	2.1	11.0	9.3	12.0	2	25
Average	6.6	2.6	9.2	7.6	10.2		25
	1996–2002						
United States	2.4	3.2	4.8	3.3	10.7	0	7
Japan	0.8	1.4	0.6	1.0	–4.1	0	3
Germany	1.5	1.4	3.4	2.6	8.6	0	7
France	1.4	2.4	3.6	3.2	13.1	0	7
Italy	2.5	1.6	5.1	2.6	14.2	0	7
United Kingdom	2.4	2.5	5.8	…	5.3	0	7
Canada	1.9	3.5	4.1	10.5	8.5	0	7
Belgium	1.8	2.1	3.4	2.6	9.9	0	7
Sweden	1.0	2.3	4.4	4.8	22.0	0	7
Denmark	2.3	2.4	4.0	…	15.6	0	7
Average	1.8	2.3	3.9	3.8	10.4		7

Sources: B R Mitchell, *International Historical Statistics 1750-1993*; US Department of Commerce, Bureau of the Census, *Historical Statistics of the US*, 1975.

Table 12

Cross-country regressions

Dependent variable: difference in output growth pre- and post-CPI peak; based on G10 countries' data*

	Pre-1914 period						
Constant	–.06 (.46)	.63 (.81)	–.06 (.97)	.95 (.89)	–.19 (.68)	.32 (1.12)	.74 (1.00)
$\Delta\pi$	.10 (.09)	.01 (.27)	.17 (.29)	.05 (.30)	.16 (.12)	.08 (.33)	.00 (.29)
$\Delta(\Delta \log m/p)$		.28 (.06)	.30 (.07)	.26 (.07)		.29 (.07)	.29 (.07)
$\Delta(\Delta \log$ *equity price*$)$				-.06 (.04)			
$\Delta(\Delta \log w/p)$					.02 (.06)		
Bank crises (pre-peak)			1.08 (.88)				
Twin crises (pre-peak)[1]						.38 (.90)	
Crises (post-peak)[2]							–.17 (.74)
$\bar{R}^2$	.01	.63	.60	.61	–.02	.60	.60
No of observations	37	13	13	8	17	13	13
	Full sample (excluding peaks in 1919-20)						
Constant	.16 (.60)	1.03 (.98)	1.23 (1.08)	1.12 (1.22)	-.30 (.66)	.90 (1.03)	.57 (1.33)
$\Delta\pi$	.18 (.09)	.26 (.14)	.17 (.16)	.15 (.18)	.28 (.09)	.20 (.19)	–.17 (.08)
$\Delta(\Delta \log m/p)$		.35 (.14)	.33 (.14)	.34 (.15)	.33 (.10)	.34 (.14)	.16 (.13)
$\Delta(\Delta \log$ *equity price*$)$			–.03 (.08)	–.03 (.08)			
$\Delta(\Delta \log w/p)$ [3]					-.23 (.13)		
Bank crises (pre-peak)				.45 (1.68)			
Twin crises (pre-peak)						.76 (1.35)	
Crises (post-peak)[4]							3.06 (1.44)
$\bar{R}^2$	.06	.25	.28	.17	.63	.22	.32
No of observations	43	19	11	11	9	19	25

Cross-country regression model

$$\Delta(\Delta \log y_i) = \beta_0 + \beta_\pi \Delta\pi_i + \beta_m \Delta(\Delta \log m/p_i) + \beta_{ep} \Delta(\Delta \log \textit{equity price}_i) + \beta_w \Delta(\Delta \log w/p_i) + \beta_c \textit{crises}_i + \varepsilon_i$$

where the variables are changes in the five-year growth rates of output, prices, real money, equity prices, and real wages before and after the peak in CPI for the respective countries. The crises variable is 1 if a crisis occurred in the post-peak period. Standard errors are in parentheses.

* The G10 countries are Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States.

[1] The indicator variable for crises is 0 if no crises, 1 if either a banking or a currency crisis and 2 if twin crises. [2] The indicator variable for crises is 0 if no crises and 1 if a banking, a currency crisis or both. [3] The sample was adjusted to eliminate two outliers. [4] See definition for note 2. This column includes peaks in 1919-20. Excluding the peaks causes the estimate to fall to 1.79 with a standard error of 1.67.

Table 13

Approaching the zero lower bound for short-term interest rates, observations per period

	<1880	1880–1913	1914–49	1950–69	1970–89	1990–2002
United States						
<1.5%	○	1	15	○	○	○
<1.0%	○	○	2	○	○	○
<0.5%	○	○	○	○	○	○
Japan						
<1.5%	…	2	6	○	○	8
<1.0%	…	○	○	○	○	7
<0.5%	…	○	○	○	○	4
Germany						
<1.5%	○	○	○	○	○	○
<1.0%	○	○	○	○	○	○
<0.5%	○	○	○	○	○	○
France						
<1.5%	○	○	2	○	○	○
<1.0%	○	○	○	○	○	○
<0.5%	○	○	○	○	○	○
Italy						
<1.5%	…	…	…	○	○	○
<1.0%	…	…	…	○	○	○
<0.5%	…	…	…	○	○	○
United Kingdom						
<1.5%	○	2	17	2	○	○
<1.0%	○	1	11	2	○	○
<0.5%	○	○	○	○	○	○
Canada						
<1.5%	…	…	14	4	○	○
<1.0%	…	…	14	2	○	○
<0.5%	…	…	7	○	○	○
Belgium						
<1.5%	…	○	7	7	○	○
<1.0%	…	○	○	○	○	○
<0.5%	…	○	○	○	○	○
Sweden						
<1.5%	…	…	…	○	○	○
<1.0%	…	…	…	○	○	○
<0.5%	…	…	…	○	○	○
Denmark						
<1.5%	…	…	…	…	○	○
<1.0%	…	…	…	…	○	○
<0.5%	…	…	…	…	○	○

Table 13 (cont)

Approaching the zero lower bound, observations per period

	<1880	1880–1913	1914–49	1950–69	1970–89	1990–2002
Australia						
<1.5%	…	…	…	○	○	○
<1.0%	…	…	…	○	○	○
<0.5%	…	…	…	○	○	○
Norway						
<1.5%	…	…	…	…	○	○
<1.0%	…	…	…	…	○	○
<0.5%	…	…	…	…	○	○
Netherlands						
<1.5%	…	…	13	6	○	○
<1.0%	…	…	5	3	○	○
<0.5%	…	…	2	○	○	○
Ireland						
<1.5%	…	…	…	…	○	○
<1.0%	…	…	…	…	○	○
<0.5%	…	…	…	…	○	○

Note: The symbol ○ signifies 0 observations of the interest being below the threshold.

Table 14

Inflation and output developments in Asia in 2002, in percentages

	Inflation			Output growth		Exchange rate[4]
	Actual[1]	Forecast[2]	Forecast error	Actual[3]	Forecast error	
Countries experiencing deflation	–0.5	1.5	–1.9	4.2	–1.2	
China	–0.1	2.5	–2.6	7.9	–0.2	0.0
Hong Kong SAR	–4.3	2.5	–6.8	1.9	–2.9	0.0
Japan	–0.9	0.0	–0.9	–0.3	–2.2[5]	2.3
Singapore	–0.2	2.0	–2.2	2.6	–3.9	0.7
Countries with inflation less than anticipated	2.8	4.8	–2.0	4.8	–1.1	
India	3.6	5.8	–2.2	5.1	–1.5	2.2
Malaysia	1.6	2.9	–1.3	4.1	–2.3	0.0
Philippines	2.5	5.6	–3.1	3.9	0.2	4.5
Taiwan, China	0.6	1.8	–1.2	3.3	–2.4	4.1
Thailand	1.2	2.6	–1.4	4.6	0.2	1.2
Countries with inflation higher than anticipated	6.6	4.2	2.4	4.2	–0.3	
Australia	3.2	2.3	0.9	3.7	0.1	–0.6
Indonesia	10.5	6.2	4.3	3.4	–0.9	–2.8
New Zealand	2.6	2.0	0.6	4.0	1.0	–6.0
Korea	3.5	2.7	0.8	5.9	0.1	–2.2
Other G7 countries	2.2	2.1	0.1	1.8	–1.4	

Note: Country groupings are weighted by 1995 GDP at PPP exchange rates.

[1] Yearly percentage change to November 2002 (third quarter 2002 for Australia and New Zealand, August for India, September for Hong Kong SAR, October for Japan and Singapore). [2] January 2001 forecast for 2002. [3] Estimated in December 2002. [4] January 2001 to November 2002. Exchange rates are in units per US dollar: a negative number indicates an appreciation against the US dollar. [5] Part of the revision is likely due to the changes in the national accounts methodology.

Sources: National data; Consensus Economics Inc; BIS calculations.

Table 15

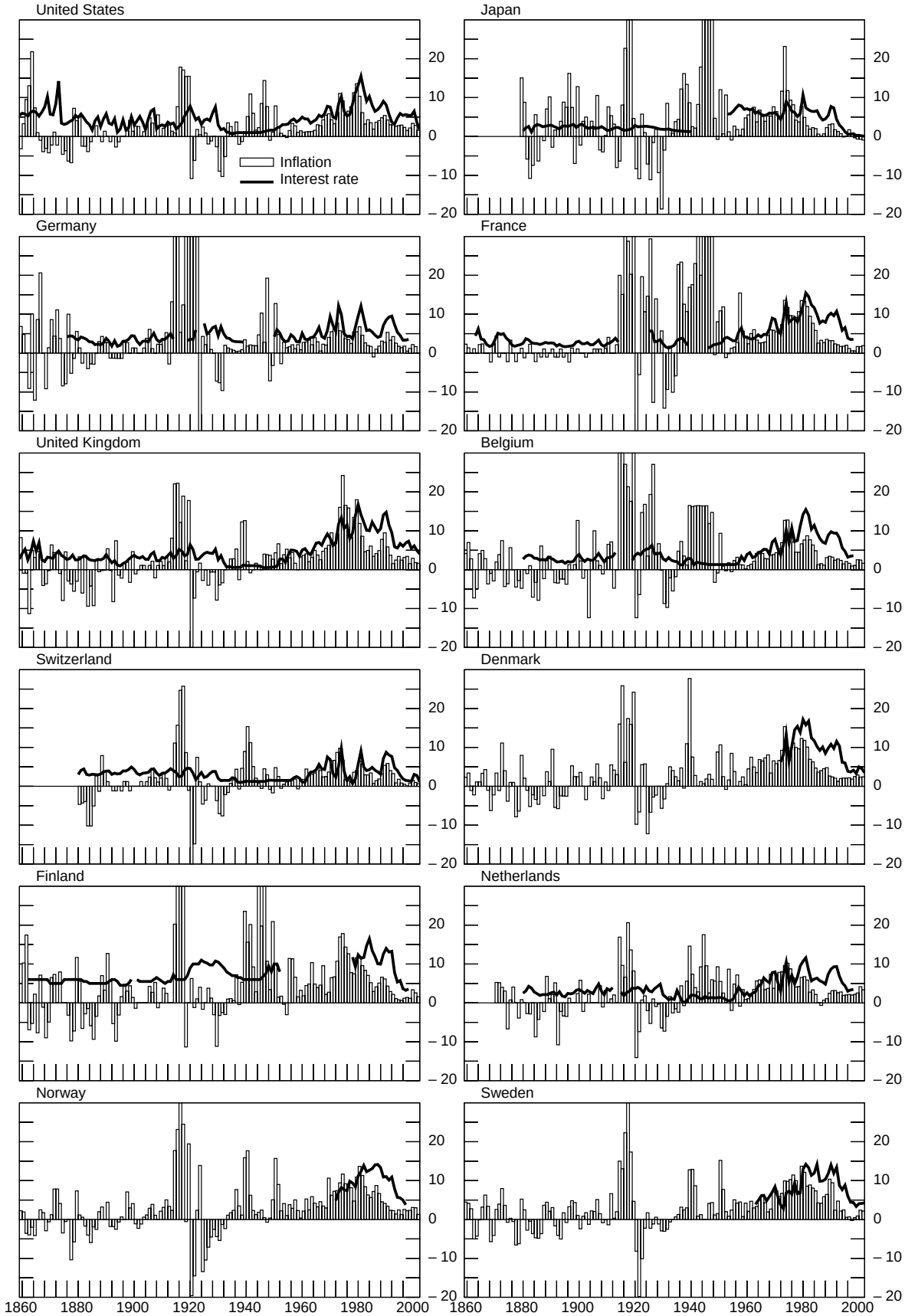
Zero lower bound and activist monetary policy: a counterfactual exercise

	1881–1913	1918–39	1945–69	1970–2000
United States	0	27	16	0
Japan	20	41	0	0
Germany	0	0	0	0
France	0	33	13	0
United Kingdom	9	18	20	0
Belgium	4	33	24	0
Australia	18	23	48	0
Netherlands	8	12	20	0
Finland	9	36	37	0
Switzerland	0	23	20	0

Notes: A standard Taylor-type rule is used for each country and each period. The equilibrium real interest rate is estimated as the ex post rate for each period. The inflation rate is the annual CPI rate and the desired inflation rate is taken to be a 10-year moving average of the actual inflation rate. The output gap is estimated by using a Hodrick-Prescott filter on real GDP (with a smoothing weight of 100). The coefficients on the output and inflation gaps are both 0.5.

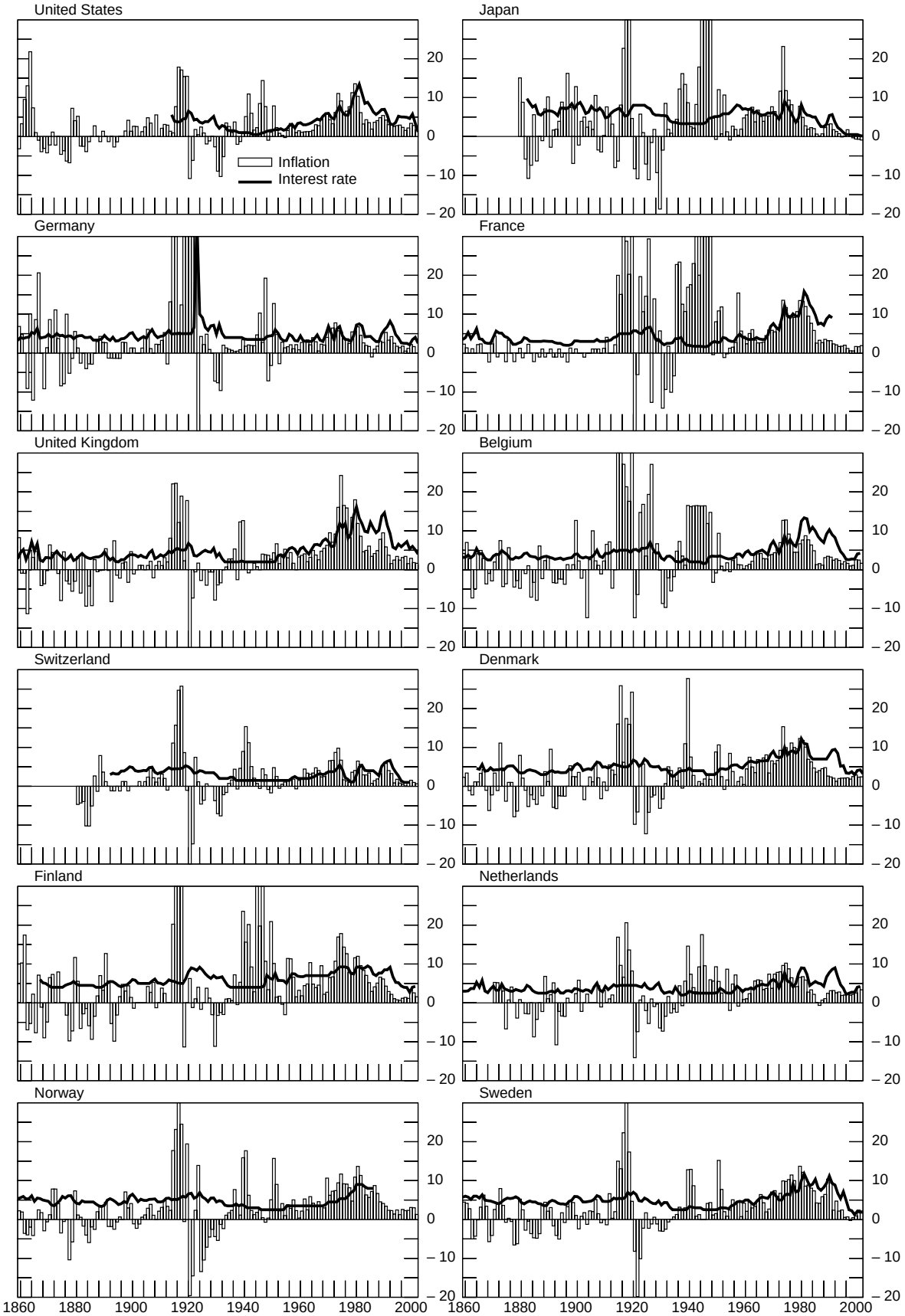
Graph 1

Price inflation and short-term interest rate



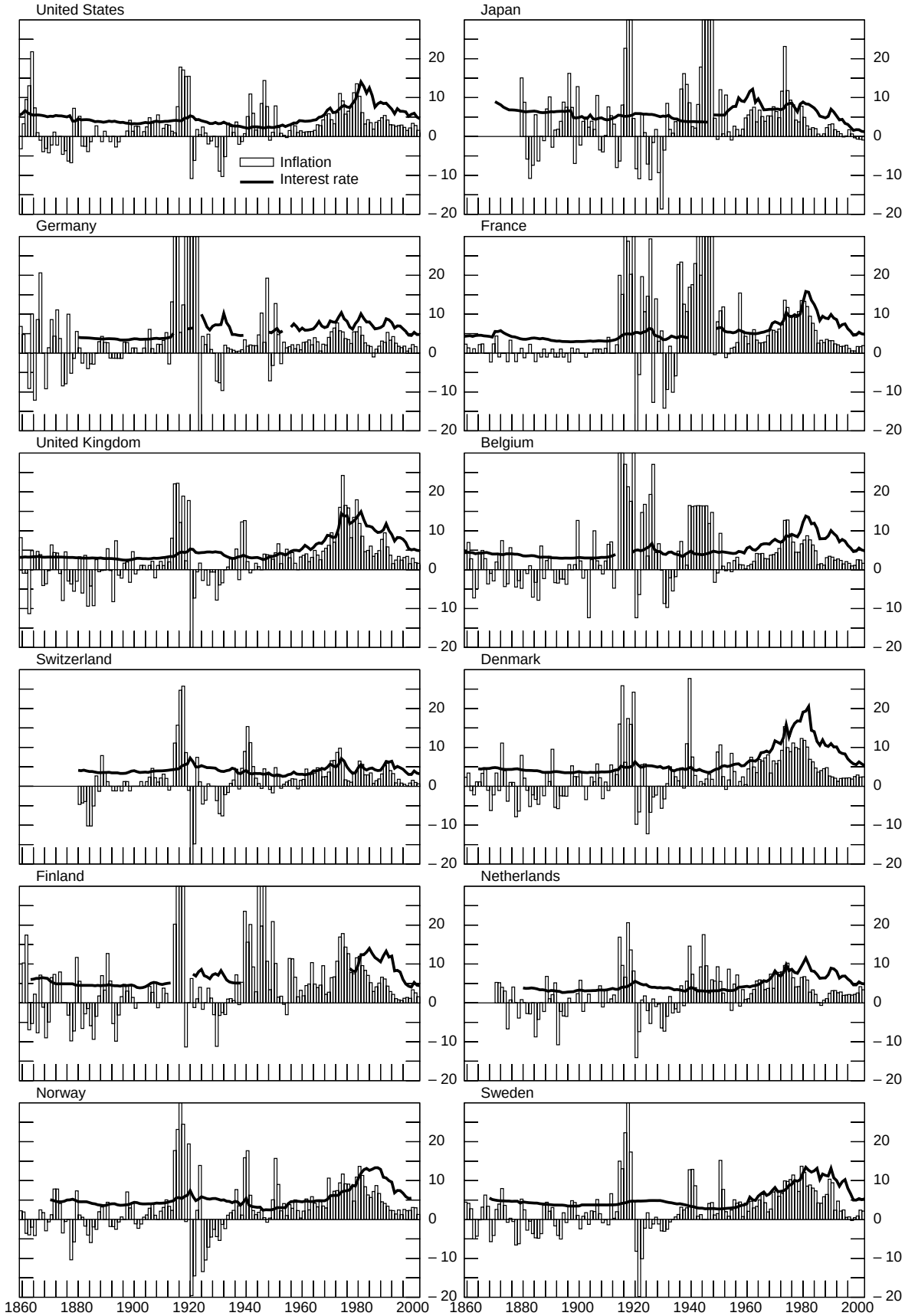
Graph 2

Price inflation and discount rate



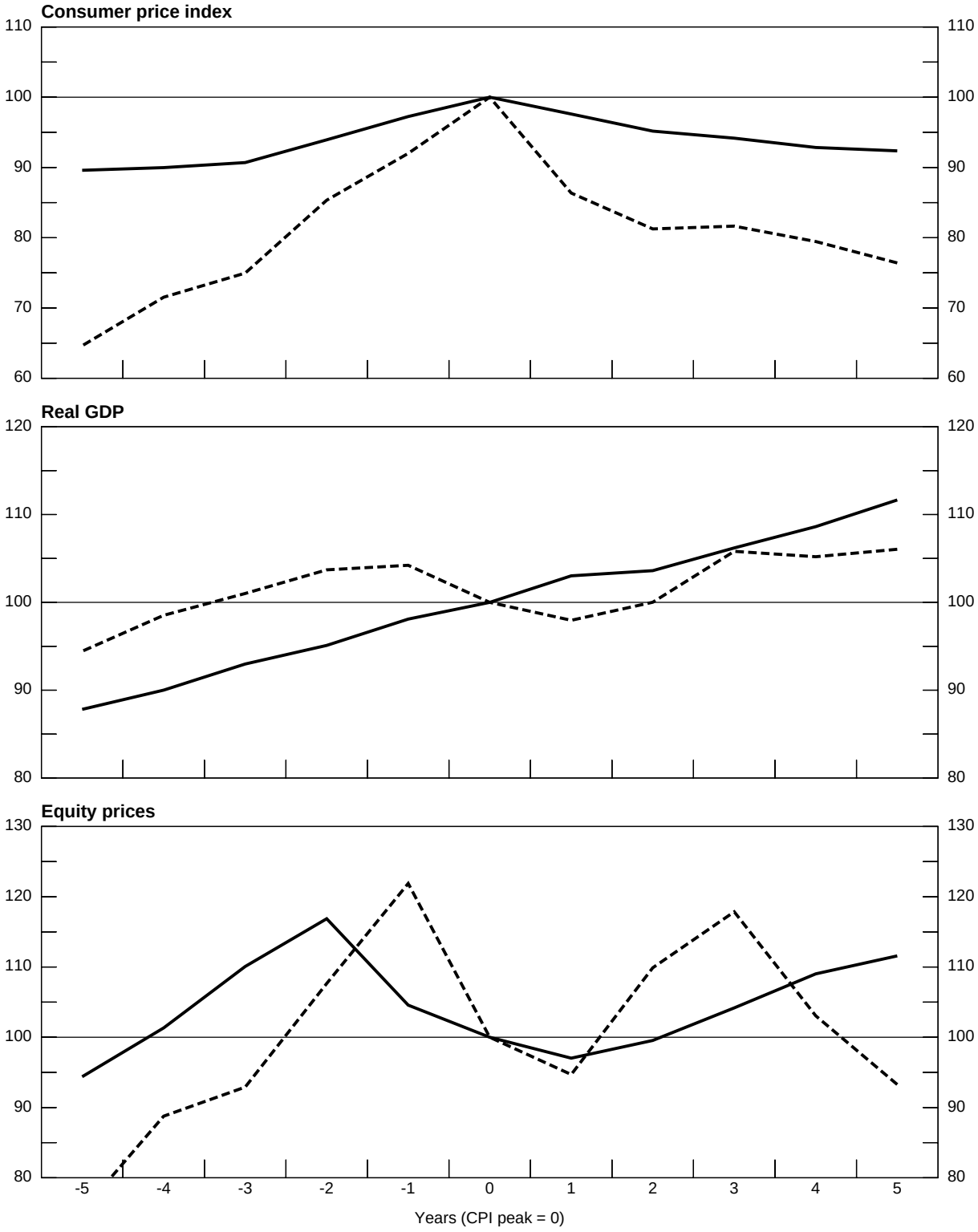
Graph 3

Price inflation and long-term interest rate



Graph 4

Dynamics of deflation, output and equity prices

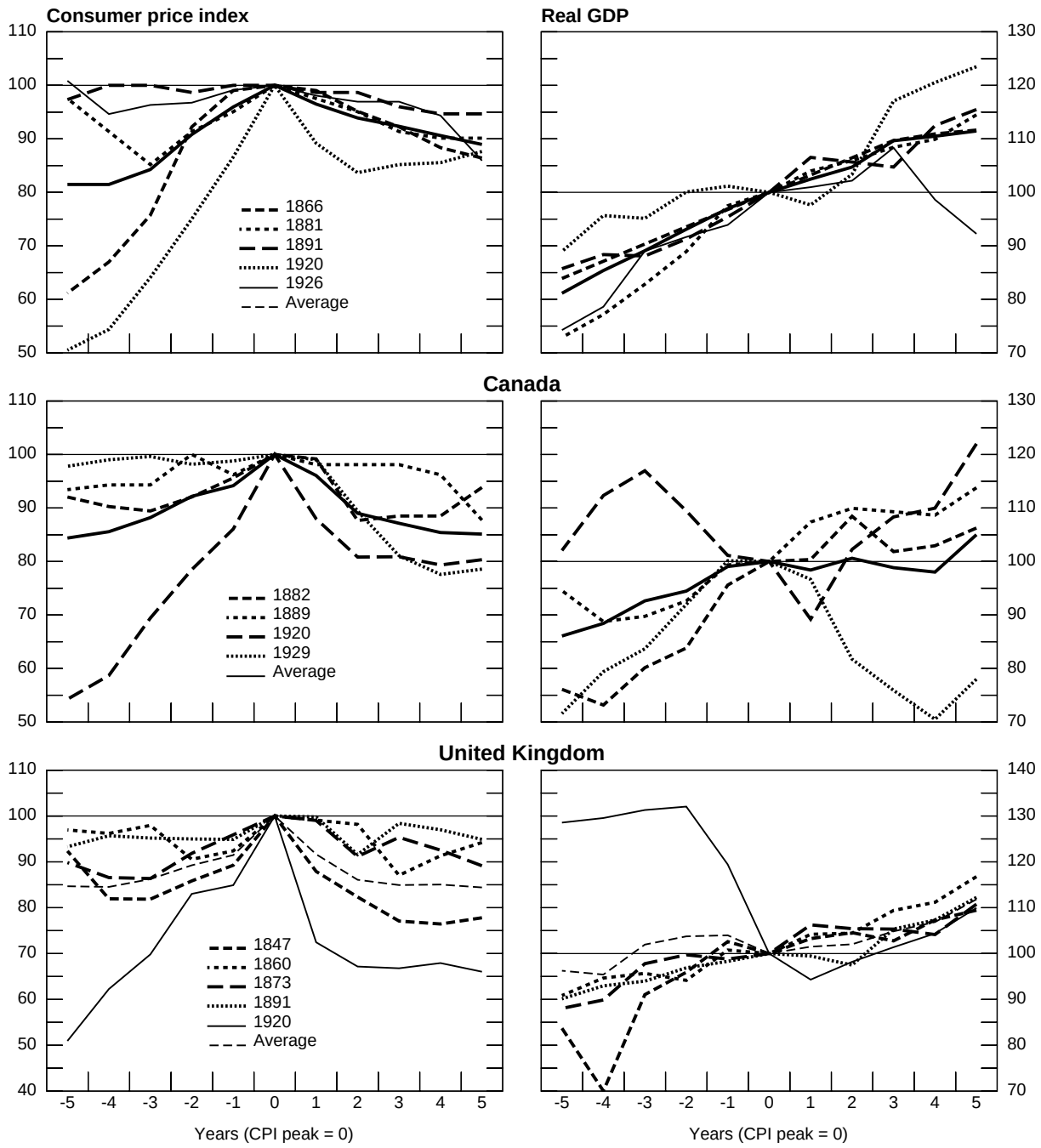


Note: A series for each country is divided into subperiods of five years prior to and after the peak in price. Each subperiod is rebased to 100 at the peak of price level and an arithmetic mean is computed for each country. The G10 average is weighted by 1890 GDP from Maddison (1991). CPI peak years are: Belgium 1873,1891,1901,1929; Canada 1882,1889,1920,1929; France 1871,1877,1884,1902,1930; Germany 1874,1881,1891,1928; Italy 1874,1891,1926; Japan 1920; Netherlands 1892,1920; Sweden 1862,1874,1891,1920; Switzerland 1892,1898; United Kingdom 1860,1873,1891,1920; United States 1866,1881,1891, 1920,1926.

Sources: Bordo et al (2001); Global Financial Data; GGDC and the Conference Board, Maddison (1991); Maddison (2003); National data; BIS calculations.

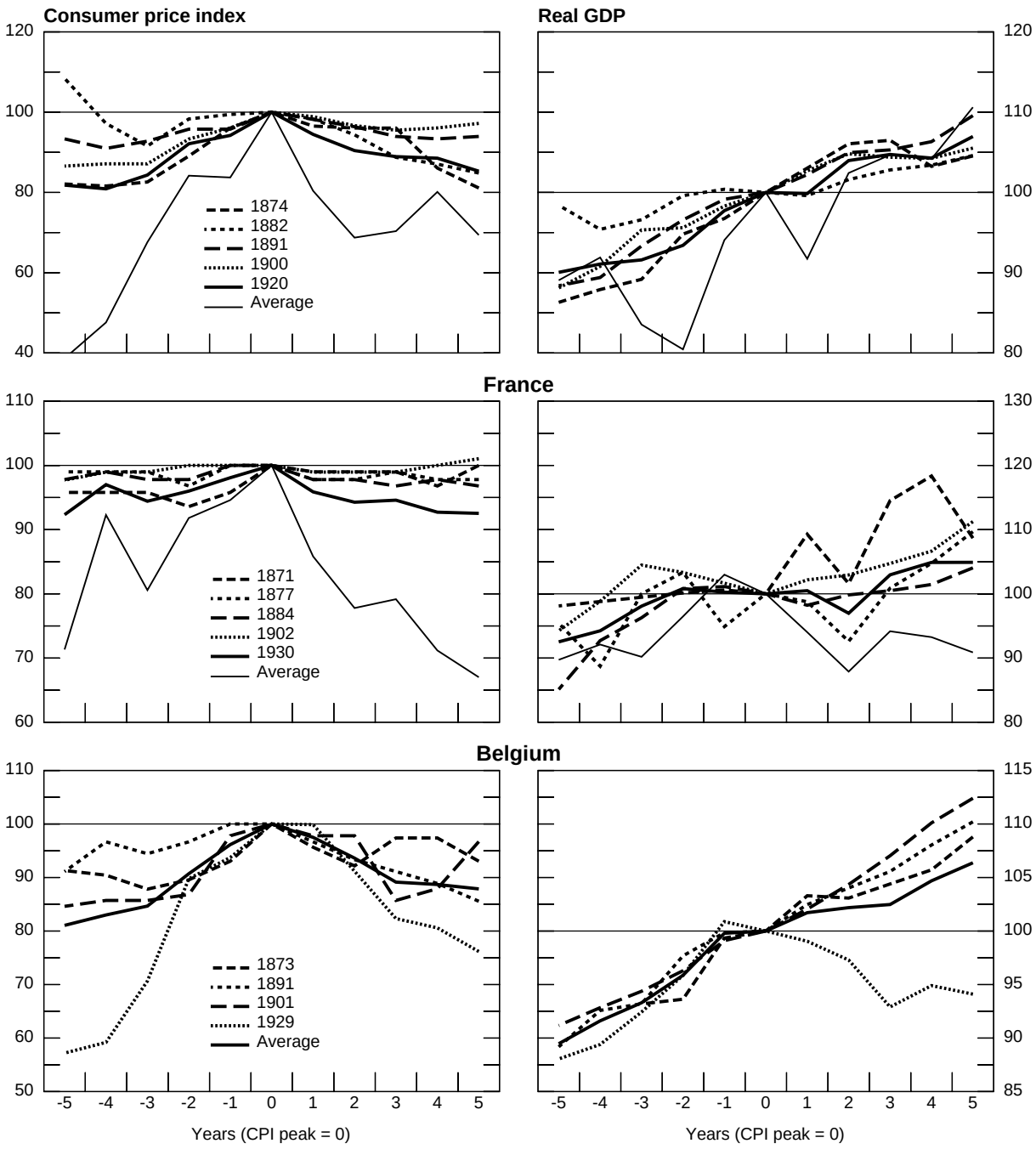
Graph 5

Deflation and GDP in selected countries



Graph 5 (cont)

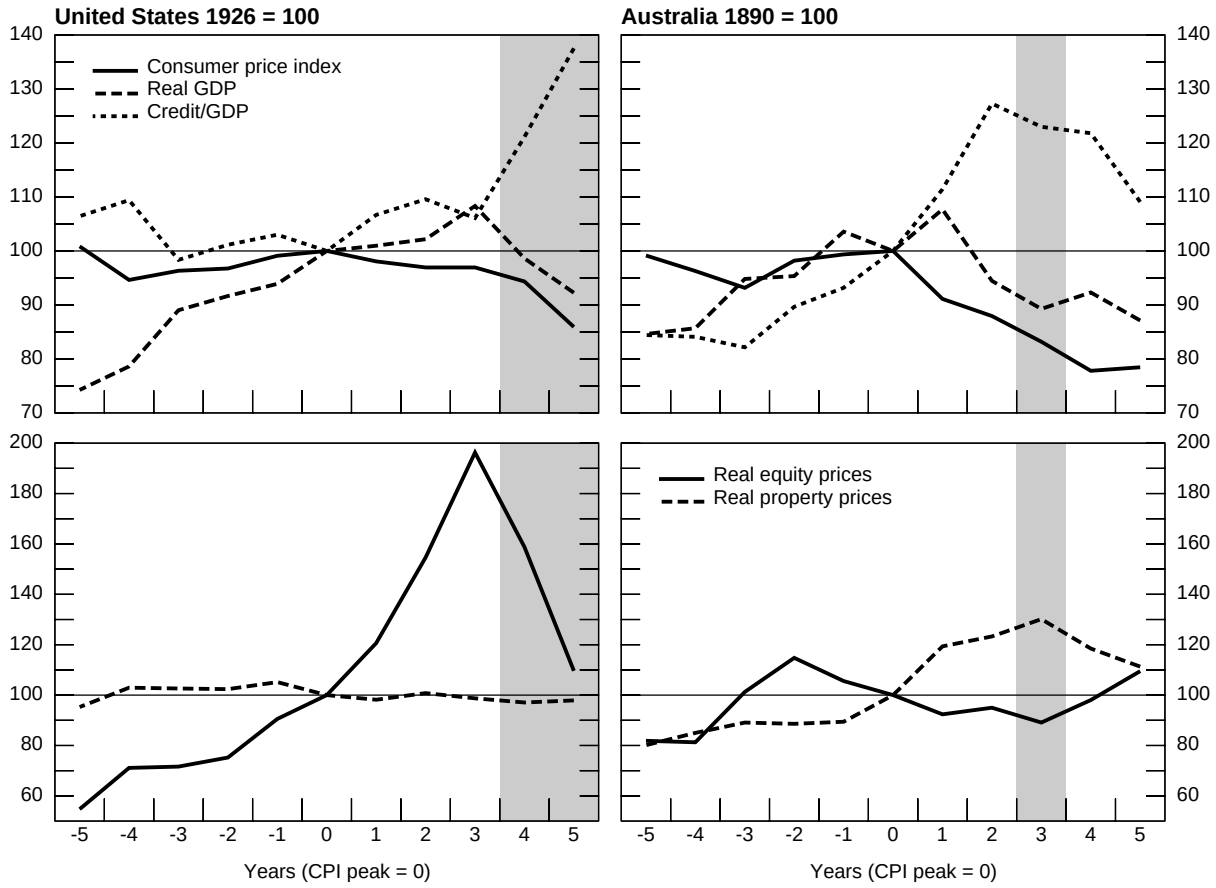
Deflation and GDP in selected countries



Sources: Bordo et al (2001); Global Financial Data; GGDC and the Conference Board, Maddison (1991); Maddison (2003); National data; BIS calculations.

Graph 6

Credit–asset price booms and busts and deflation



Note: The shaded areas represent banking crises.

Sources: Bordo et al; Maddison (2003); Global Financial Data; national data; BIS calculations.

Appendix: Data availability

(starting date of annual series, by country)

Country	Consumer prices	Wholesale prices	Banking crisis	Currency crisis	Credit aggregates	Equity prices	Real GDP	Interest rate long	Interest rate short	Discount rate	Monetary aggregate	Wages	Real estate
Argentina	1884	1913	1880	1880	1971	1980	1875	1994	1977	1993	1884	1937	
Australia	1861	1901	1880	1880	1851	1875	1820	1858	1968	1969	1880	1861	1879
Belgium	1835	1921	1880	1880	1960	1897	1870	1832	1880	1858	1880	1947	1981
Brazil	1861	1937	1880	1880	1960	1954	1850	1900	1948	1948	1890	1946	
Canada	1870	1848	1880	1880	1957	1915	1820	1855	1936	1935	1880	1901	1970
Chile	1800	1928	1880	1880	1968	1894	1810	1995	1977	1925	1948	1937	
China	1975			1971		1990	1950	1990	1980	1990	1977	1952	
Colombia	1864	1948	1971	1971		1927	1913		1982	1923	1948	1938	
Denmark	1815	1876	1880	1880	1962	1915	1820	1821	1972	1864	1885	1870	1970
Egypt	1915	1913	1971	1971		1948	1950		1976	1964	1950	1943	
Euro area	1966	1980				1992	1964	1986	1986		1980	1995	
Finland	1860	1920	1880	1880	1862	1922	1820	1863	1862	1867	1862	1914	1978
France	1810	1900	1880	1880	1959	1856	1820	1800	1863	1800	1880	1800	
Germany	1501	1800	1880	1880	1964	1856	1870	1880	1876	1854	1880	1800	
Hong Kong SAR	1951		1971	1971	1980	1962	1950	1996	1982	1992	1980	1981	1980
India	1870	1914	1971	1971		1921	1820	1800	1957	1873	1948	1927	
Indonesia	1820	1971	1971	1971	1969	1987	1820		1974	1913	1950	1985	
Ireland	1922	1945	1971	1971	1964	1934	1921	1928	1971	1922	1950	1931	1976
Italy	1861	1910	1880	1880	1970	1906	1870	1862	1969	1868	1880	1871	
Japan	1879	1868	1880	1880	1963	1913	1820	1870	1880	1882	1880	1926	
Korea	1948	1930	1971	1971	1960	1962	1950	1983	1977	1964	1948	1956	1986
Malaysia	1948	1984	1971	1971	1965	1970	1950	1961	1974	1959	1950	1985	
Mexico	1900	1887	1971	1971	1964	1930	1820	1983	1978		1948	1938	
Netherlands	1870	1901	1880	1880	1961	1919	1870	1880	1880	1814	1913	1926	1628
New Zealand	1914	1913	1971	1971	1964	1926	1870	1865	1973	1923	1948	1914	1989
Norway	1835	1880	1880	1880	1848	1918	1820	1870	1972	1850	1819	1910	1891
Peru	1913	1980	1971	1971		1927	1913		1980	1923	1948	1946	
Singapore	1948	1974	1971	1971	1966	1966	1950	1998	1972		1963	1963	1988
South Africa	1895	1910	1971	1971	1965	1910	1950	1860	1971	1957	1948	1900	
Spain	1880	1812	1880	1880	1964	1874	1820	1821	1974	1883	1880	1963	1987
Sweden	1820	1955	1880	1880	1970	1901	1820	1868	1963	1856	1880	1861	1970
Switzerland	1880	1810	1880	1880	1963	1911	1870	1880	1880	1892	1880	1913	1970
Taiwan, China	1951	1949	1971	1971	1974	1967	1950	1995	1986	1975	1950	1949	
Thailand	1948	1947	1971	1971	1960	1975	1950	2000	1977	1945	1948	1988	
UK	1271	1790	1880	1880	1963	1693	1820	1840	1824	1694	1880	1830	1968
United States	1820	1720	1880	1880	1916	1795	1820	1800	1857	1914	1880	1785	1890
Venezuela	1914	1830	1971	1971		1929	1950	1984	1982	1964	1948	1964	

Consumer prices	Bordo et al, Catholic University in Chile, Global Financial Data, national data	**Nominal GDP**	Bordo et al
Wholesale prices	Global Financial Data	**Long-term interest rate**	Bordo et al
Banking crisis	Bordo et al	**Short-term interest rate**	Bordo et al, NBER Historical Database (US and UK only)
Currency crisis	Bordo et al	**Discount rate**	Global Financial Data
Credit aggregates	BIS	**Monetary aggregate**	Bordo et al, Mitchell, national data
Equity prices	Global Financial Data	**Wages**	Global Financial Data
Real GDP	Catholic University in Chile , GGDC and the Conference Board, Maddison, Mitchell	**Real estate**	EIchholtz, Fisher and Kent, Gerdrup, Mitchell and Deane, national data, US Census

Sources: Bordo et al (2001); Catholic University of Chile; Eichholtz (1996); Fisher and Kent (1999); Gerdrup (2003); Global Financial Data; GGDC and the Conference Board (2003); Maddison (2003); Mitchell (1998); Mitchell and Deane (1962); national data; NBER Historical Database; US Census (1975).