Back to the future? Assessing the threat of deflation

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Introduction

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 from inflation toward 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 as a decline in the aggregate price level – has so far largely been confined to parts of Asia.

So, are concerns with deflation much ado about nothing? Or, is deflation a clear and present danger? And should deflation per se be a serious concern? Part of the problem in answering these questions is that deflation has been so rare in recent history that it is hard to calibrate the risk. 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 lessons for today on the basis of a cross-country dataset 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 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 deflation risks going forward. In the conclusions, we note some monetary policy options to better manage the risk of 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 deflation has risen. In large part, the greater frequency reflects the success of many countries in achieving low inflation. Second, cross-country evidence confirms the fact that the ZLB was reached only rarely in the past. Third, existing evidence would suggest that during the Gold Standard and inter-war years the onset, and typically the subsequent unfolding, of deflation were largely unanticipated. 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 inter-war years stands out as rather exceptional.

Of course, the historical record can only tell us so much about the risk of deflation ahead. 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 is likely to increase the incidence of the zero lower bound. Similarly, we note that expectations may now adjust faster to deflation. 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.

From this perspective, two different views can be held about the future risks of deflation (Borio, English and Filardo (2003)). A more sanguine view would see the current environment as a natural continuation of that prevailing during the inflation years, and hence tend to downplay deflation risks. By contrast, a more sceptical view would attach greater weight to the similarities between the current environment and that prevailing in the era when deflation was more prevalent. In doing so, it would also highlight the role played by recent

financial imbalances, notably in the form of over-indebtedness and asset price booms and busts. As a result, it would tend to see a somewhat higher risk of one type of deflation 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 in the 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.

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 toward 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 and greater emphasis on inflation objectives.[1]

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 sub-period, when the incidence of deflation was even higher than in the 1914-1949 sub-period. 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, they may obscure shorter bursts of deflationary pressures and not provide the full picture.

The middle panel partly overcomes these drawbacks by focusing on quarterly deflation frequencies across many more countries and measured by different price indexes, albeit only since 1960. It shows that the frequency of deflation in this broader set of countries is higher than what would be inferred from the annual CPI data on the smaller set of countries and that the frequency is highest when deflation is measured with the wholesale 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 (2001) and Lebow and Rudd (2002)). Calculated on this basis, the near-deflation frequencies have been quite high recently. This may also help to explain the heightened awareness of deflation in recent years.

[1] See eg Borio et al (2003) for a more detailed analysis..

Amplitude of deflation.

The amplitude of deflation has fallen significantly over time (Table 3). Somewhat of a surprise, the median size of deflation during the pre-1880 period was actually higher than during the 1914-1949 period, when the Great Depression took place. Despite the decline in the median, the extremes in deflation were greater in the 1914-1949 period. This reflects to some extent attempts by a variety of countries to deflate in order to rejoin the Gold Standard at the pre-WW I parities and the impact of the Great Depression. As might have been expected, the severity of deflation in the past 30 years has been well below that in the earlier period.[2]

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, deflation has rarely persisted more than a year or two. 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 experience in Japan exhibits a relatively long duration by historical standards.

Persistence of the inflation process.

Another characterisation of inflation behaviour across countries and across time is the degree of persistence of inflation rate changes. 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

[2] 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.

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 the more recent period does not provide strong evidence to reject the unit root hypothesis in light of the considerable progress that central banks from around the world have made at reining in inflation. Strong statistical conclusions, however, may be subject to qualification because of the well-known limited power of the unit root tests in small samples (Wu 2001).

Confirming this limitation, the results based on quarterly data show evidence that inflation has indeed become more mean-reverting over time as central banks have put greater focus on fostering an environment of low, stable inflation (second panel of Table 5). Of additional interest are the unit root tests using the log-levels. 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 reasonable outcome for inflation-targeting countries, it is not necessary because most inflation targeting regimes are designed to allow for drift in the price level.[3]

Cross-country correlation of inflation.

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 in the low inflation (or deflation) country relative to the high inflation country. To gain some insight into this possibility, we examine the contemporaneous cross-country correlations in inflation rates (Table 6).

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 1920-1938 period. In contrast, the correlation in the post-Bretton Woods period is generally above 0.7 percent.

There may be several reasons for this. First, it is possible that common shocks are more prevalent now than in the past or that progress of global economic integration has been significant. The latter rationalisation, however, is doubtful because of the extent of openness in the pre-war period, as amply documented elsewhere (see eg, Bordo, Eichengreen and Irwin (1999) and Mussa (2000)). 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 (Eichengreen (1992)). And, "independent" domestic monetary policies may have been more synchronized than generally assumed (due in large part to the role of moral suasion and other means to restrict capital flows).[4] 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

[3] 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.

[4] 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.

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.[5]

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 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 conclusions can be reached based on evidence for specific sub-periods and from the more general behaviour of interest rates.

There is considerable evidence from the Unites 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 deflation became entrenched, inflation expectations continued to be overly optimistic. Temin (1976) reaches a similar conclusion, based on an

[5] 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 Wu (2001) could cast additional light on the hypothesis. In addition, he finds evidence that there is broad mean reversion since 1957 in most G-10 countries.

analysis of forecasts made at the time and other reports from the day. Cooper (1982) draws an analogous inference.[6]

More generally, an examination of the behaviour of nominal and real interest rates would be consistent with the view that the expectation formation mechanism changed considerably between the Gold Standard period and the post-war, inflation era. Specifically, there has been considerable work arguing that conditional expectations of inflation became much more accurate in the post-war 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 7). 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 and the *price level,* the so-called Gibson paradox (not shown).

If, as notably argued by Fisher (1906) and Friedman and Schwartz (1982), sluggish adjustments in expectations to inflation and deflation during the pre-war period can explain these patterns[7], what could in turn account for the sluggishness in those adjustments?

One possible explanation is the limited information available to economic agents at the time. For one, reliable aggregate price data were generally not at hand.[8] 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 would have been less well known. Moreover, even if a wide range of consumer goods prices had been widely available, it is unclear that the notion of an aggregate price index was sufficiently well

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

[7] 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 (1976))

[8] 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.

developed. The theories of Lowe, Laspeyeres, Jevons and others were only in their infancy at the time.[9] And the United Kingdom did not publish aggregate indexes until 1914 and the United States until 1919 (Cooper (1982)). [10]

A complementary possible explanation is that the apparent difference in the degree of sluggishness in the formation of inflation expectations would be 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.

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 around historical levels unless the convertibility constraint came under pressure owing to an internal or external drain, in which case they were raised. In particular, 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.[11] And this constraint would more naturally become in doubt only after cumulative changes in the price level in relation to the gold stock. As a result, it was simply not unreasonable for the private sector to expect both short-term and long-term rates to be, in turn, rather insensitive

[9] 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 "no where in practice."

[10] 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) 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.

[11] And, even then, monetary authorities often used moral suasion and other means to effectively constrain interest rate movements.

to period-by-period inflation developments and to be more closely tied to the price level. 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 post-war 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 purposefully in response to inflation developments. Under the new conditions, a closer link of expectations 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 turns 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.

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)). More recently, Akerlof, Dickens and Perry (1996) have argued that as inflation approaches zero downward nominal wage rigidities can interfere with efficient economic adjustments in labour markets, elongating and deepen economic contractions, which can ultimately feed deflationary forces. Even so, there is still some controversy over the macroeconomic significance of such rigidities, as questioned by Lebow, Saks and Wilson (1999) for the recent period for the United States and by Hanes and James (2001) for the pre-war 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. 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[12] and can make access to external funding harder.[13] These costs would be exacerbated if the very viability of financial intermediaries became impaired, leading to a broader banking crisis. 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 the most daunting challenges for monetary policymakers in a deflationary environment. Since interest rates on riskless assets cannot fall

[12] Deflation can also have a negative impact on banks' profitability through the so-called "endowment effect". Most simply put, if a fraction of deposits does not pay interest, the beneficial effect of inflation on interest margins would be lost.

below zero, as cash guarantees a zero nominal return, once the lower bound is reached 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, serious questions arise regarding the effectiveness of quantitative easing as a substitute for lower real rates.[14] 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.[15]

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 the (unexpected) debt

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

[14] See, eg, Wolman (1998), McCallum (2000) and Reifscheider 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. Under certain curvature conditions of money demand, however, monetary policy can still be effective at zero interest rates as long as the public reaches a satiation point in its money holdings. If satiated, the increased liquidity could stimulate demand by changing the relative price of assets such as equities and capital. As discussed by Meltzer (1999), the ability of monetary policy to be stimulative at zero interest rates depends on the substitutability of money with other assets; Kimura, Kobayashi and Ugai (2003) develop as a means to assess the effect of the Bank of Japan's policy of quantitative easing. See also, eg, Goodfriend (2000) and Buiter and Panigirtzoglou (2002) for means to overcome the ZLB constraint by implementing a Gesell tax on money or using "helicopter drops" of money.

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

This discussions points to two related conclusions, useful for what follows. First, quite apart from reverse causation, part of the weakness in economic activity observed during periods of deflation may clearly arise from deflation itself, but part may result from developments for which, at best, deflation acts as a symptom. For example, given historical ranges of fluctuation, asset price busts can arguably have a considerably larger effect on balance sheets and hence financing constraints than deflation itself (Borio and Lowe (2002). This does not imply that deflation should not be avoided, far from it. It does, however, make the appropriate degree of concern dependent on a broader set of factors and puts a premium in understanding what set of conditions are associated with, and ideally give advanced warning of, the more disruptive forms of deflation.

Second, 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), Selgin (1997)). "Good" deflations would be those reflecting productivity improvements against the background of restraints on the growth of nominal demand. 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 at least "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 a similarly sized positive deviations of inflation from "price stability" objectives.[16] "Bad" deflations would be those where the specific nominal

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

[16] 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 eg 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

rigidities played an important role in undermining economic activity or else where other concomitant developments resulted in serious economic weakness. Taking this terminology further, "ugly" deflations could best be thought as those where deflationary forces conspired with the asymmetries to create a spiral of self-reinforcing disruptions.[17]

The costs of deflation: the historical record

Laying out the configuration of direct and indirect linkages between deflation an 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.

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 5-year moving average of the CPI; then, the final peaks are estimated choosing the highest value of the unsmoothed series in a 5-year window around the candidate peak. The estimated peaks for selected countries are found in Table 8. 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" deflations. Graph 4 shows that in the 19th and early 20th centuries, most deflations were of

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and prices (eg Keynes (1933)), 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, the recent upward adjustment to the target range of the Reserve Bank of New Zealand and controversy of whether the ECB's has an effective lower band to its range at zero suggests that for the foreseeable future desired inflation rates will likely be low, positive numbers.

[17] A third conclusion is that there 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.

the good type, in the sense that output remained broadly on track despite the decline in aggregate prices. This is not simply an artefact of averaging. Looking at the deflationary experiences in the United States and the United Kingdom as well as in two periphery countries for which we have 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 was the most notable one. While the growth rate, on average, slowed a modest (and statistically insignificant) amount during most deflation periods in the sample, the size of the much larger decline is statistically significant for the 1925-39 period (Table 9). 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 inter-war period (Table 10). In particular, during the 1882-1913 period, declines in CPI were 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 inter-war 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 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 associated, in a statistical sense, with the output costs of deflation, a cross-country regression analysis was performed. The output costs are defined in this cross-country framework as the change in the growth rate of output during the 5-year period before the CPI peak, $\dot{y}_{pre}$ minus the growth rate of output during the 5-year period after the peak, $\dot{y}_{post}$. The differencing removes any constant

country-specific effects that might be present. The right-hand-side 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

$$\dot{y}_{pre} - \dot{y}_{post} = \beta_0 + \beta_\pi \Delta\pi_i + \beta_m \Delta(\Delta \log m/p_i) + \beta_{ep} \Delta(\Delta \log equity\ price_i) + \beta_w \Delta(\Delta \log w/p_i) + \beta_c crises_i + \varepsilon$$

The bivariate results (between output and inflation) are consistent with the view that the destabilizing potential of price changes is likely to be nonlinear (Zarnowitz (1992)). 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 inter-war period, correlation becomes larger and statistically significant. This might suggest larger deflations lead to 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.

The results in Table 11 also show that the change in real money growth provides the most statistically reliable correlation during 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 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. The predictive power of equity price was generally insignificant. 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.[18] In addition, the crises indicators were generally uninformative above and beyond the information contained in inflation and real money growth.

The previous analysis noted that the ZLB could potentially be a serious factor undermining economic activity. But how far has it been so in practice? 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 percent 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 percent may provide a more robust assessment of the relevance of the ZLB, at least for the more distant dates for which data availability is problem.

Using these benchmarks, the historical record suggests that the ZLB was binding only rarely, with the relevant observations being largely confined to the inter-war years (Table 9). The percentage of observations of near-zero interest rates during that past two hundred 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 inter-war years, consistently with the apparently overall "good" or "benign" nature of deflations during that historical phase. While some instances seem to emerge for the period 1950-1969, 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

[18] Such a nonwage channel, although weak, was not found in Bernanke and Cary (1996). Their empirical set up and data, however, were quite different from those in this paper.

recently is quite real. We return later to the question of how this evidence should be interpreted when assessing the likelihood of the ZLB constraint being binding in future.

Assessing the risk of deflation in the current low inflation environment

What does the previous analysis tell us about potential deflation risks ahead? Drawing potential lessons is necessarily a more speculative exercise, and depends crucially on the lens used to derive them. Even so, a number of useful clues might be highlighted. By way of background, Table 12 reports the current consensus forecast for 2003. According to it, only Japan and Hong Kong are expected to remain in a deflationary environment and no other country is expected to tip into deflation.

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. Most recently, the uncertainties generated by geopolitical risks are a case in point.

Moreover, the record also suggests that the onset of deflation is typically unexpected. Admittedly, for the reasons suggested before, 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 13).[19]

At the same time, the historical record also suggests that mild deflations need not necessarily be very 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. Some

observers have argued that the recent experience in China may be classified as such a case. As a result, it is also important to try to read the tea leaves for possible signs about the specific nature of any deflationary pressures that might be present.

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. They 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 wit the pre-war era can play a subtle role in the dynamics of deflation. During the Gold Standard, to the extent that expectations adjusted only very gradually to actual deflation, the contractionary effect on output of the real interest channel would be more muted than today.[20] By contrast, the debt deflation channels would have been stronger, although its importance would have hinged crucially on the amount of debt outstanding relative to GDP. Either way, the faster adjustment of expectations nowadays highlights the need to limit the risk of deflationary expectations getting entrenched, putting 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 precisely the higher speed in the adjustment of expectations of price changes, which would tend to put greater downward pressure on market rates as deflation emerged. Another reason is that monetary policy is more activist nowadays.

Table 11 is meant to provide a hypothetical, admittedly very crude and partial, yardstick to get a sense about how an activist monetary policy using an interest rule would have

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

[20] By contrast, to the extent that wage rigidities depend on slow adjustments in expectations, as opposed to broader sociological factors, the real wage channel would have been more important. Sociological factors or other institutional norms, however, may be quite important, and could offset this effect. On this, see, eg Bewley (1995).

altered the frequency of hitting the ZLB in the past. Using a standard specification for a Taylor rule, the results show a significant increase in the frequency 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 1918-69 period.[21] The recent Japanese experience is a clear illustration of this simple point. In Switzerland, too, interest rates are now very close to the ZLB, with a policy rate at a mere 0.25%, even though deflation has not yet emerged.

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.[22] 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 is a clear case in point. Conversely, 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 post-war flexible exchange rate era. Moreover, the risk of competitive depreciations may well be higher were a global deflationary environment to materialise.

For example, despite persistent and sizable deflation, wages in a flexible economy such as Hong Kong have exhibited significant downward rigidities recently.

[21] Another, possibly more satisfying, thought experiment would be to estimate the supply, demand and policy shocks that would be consistent with a fully-articulated macroeconomic model for the time in question. Then, the shocks could be used to simulate a model with a standard policy reaction function such as a Taylor-type rule (see, eg, Orphanides and Wieland (1998)). Instead, the interest rate from the counterfactual experiment can be thought of as the short-term a Taylor-rule type monetary authority would set on a period-to-period basis in response to the current inflation and output conditions at the time. Of course, if nominal interest rate from the rule had been used the time paths for inflation and output would be dramatically different. Nonetheless, the counterfactual provides a useful benchmark to think about how often the ZLB would be approached in a low inflation environment with an activist monetary authority.

Making further inferences about the characteristics of the potential deflation threat requires going further beyond the specific findings of this paper, and conjecturing about the nature of the current economic landscape by comparison with that in which previous episodes of deflation. As argued in detail elsewhere (Borio et al (2003)), two intentionally stylised views can be seen to capture the spectrum of possible perspectives.

The more sanguine 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 shocks, whose effects would have relatively short persistence on economic activity. As a result, this view would probably tend to play down potential deflation risks in the absence of future negative shocks to demand and output.

The more sceptical view would rather emphasise the elements of discontinuity between the current environment and that prevailing in the inflationary years.[23] And rather than seeing the economy as driven by short-lived shocks, would assign greater weight to lower frequency processes. In particular, it would stress the risk of the cumulative build up of financial imbalances, and associated distortions in the real economy, even in periods of low and comparatively stable inflation and 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 with capital accumulation, as possible harbingers of contractionary pressures down the road, exacerbated by financial strains. 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 deflation. As a result, such a view would be more sensitive to potential deflation risks than its counterpart.

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[22] See eg, Eichengreen (1992) and Eichengreen and Sachs (1995) and even Fisher (1933). See also eg,Temin (1993) and Bernard and Bisignano (2002).

[23] For a further elaboration of this view, see eg Borio and Crockett (2000), Borio and Lowe ((2002) and (2003)) and Crockett (2003).

From this latter perspective, to varying degrees the 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 faced deflationary pressures following economic fluctuations not dissimilar from the stylised ones just described, in which inflationary pressures remained benign. 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. This view would also be more sensitive to the potential vulnerabilities associated with the housing price booms experienced by many countries in the current cycle, even as the economies slowed down.

This view would highlight the similarities in the arrangements in the monetary and financial spheres 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 strong measure of price stability. Indeed, the resemblance would seem to be especially close to the first phase of the inter-war period. This 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 its excess gold reserves, monetary policy was not constrained by the availability of gold.[24]

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 lessons for the potential risks ahead. Rather than summarising the various findings and repeating the main

[24] See Eichengreen and Mitchener (2003) for an exploration of the Great Depression seen as a credit boom that went wrong.

conclusions, already anticipated in the introduction, it may be worth to reflect 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 risk of deflation in current monetary policy frameworks. The historical record strongly suggests that many deflationary episodes can be rather benign, but there is no guarantee that future ones will be of the same type. Moreover, the effectiveness of the monetary levers in a deflationary environment, particularly as a result of the ZLB, is far less certain. And the transitional response of economies as they migrate into deflation, an exceptional state of affairs by post-war standards, might be rather unpredictable.

This puts a premium on understanding what configuration of factors tends to herald the risk of unwelcome deflationary pressures down the road and on exploring how monetary policy strategies and tactics might need to be adjusted to limit the risk of disruptive forms of deflation emerging and becoming entrenched. The range of measures is rather broad. It could include adjustments to the inflation objectives themselves, longer policy horizons, greater attention to the balance of risks and asymmetric costs in devising interest rate responses and, possibly, a more deliberate focus on the build up of financial imbalances at the strategic level of policy.[25] Thought could also be given to the effectiveness of alternative measures to escape from deflation - measures that would inevitably require closer coordination with fiscal and, likely, 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 step. As discussed in the paper, statistical gaps prevent a proper analysis of deflation. 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 credit and debt statistics are obvious cases in point. It would be unfortunate if we

[25] Some of these issues are discussed in more detail in Borio et al (2003) and Bean (2003).

had to wait for deflation to materialise and unfold, thus generating the relevant statistics for the analysis.

Table 1

Cross-country inflation statistics

		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
UK	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
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

Note: The starting years for 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 in the average.

Table 2

Deflation frequency, annual, 1801-2002

	1801-1879	1880-1913	1914-1949	1950-1969	1970-1989	1990-2002
United States	31.3	23.5	30.6	5.0		
Japan		29.4	27.8	10.0		38.5
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		
Sweden	20.0	44.1	30.6			7.7
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]

	1960-1969	1970-1979	1980-1989	1990-1999	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]			0.2	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 countries: Argentina, Belgium, Brazil, Canada, Chile, China, Colombia, euro area, France, Germany, Hong Kong, 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, Indonesia, Malaysia, Peru, Singapore, Taiwan (China) and Venezuela. [4] Excluding Argentina, Chile, China, Colombia, Hong Kong, Malaysia, Peru, Singapore, Taiwan (China), Thailand and Venezuela. [5] Excluding China and Hong Kong.

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

	1960-1969	1970-1979	1980-1989	1990-1999	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

Severity of deflation

		1801–1880	1880–1913	1914–1949	1950–1969	1970–1989	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
	Min		–2.2	–1.6	–0.7		–0.1
	Max		–6.8	–18.7	–0.9		–0.9
Germany	Median	–5.2	–1.3	–7.4	–4.0	–0.1	
	Min	0.0	0.0	–0.1	–1.8	–0.1	
	Max	–33.8	–4.0	–9.6	–6.2	–0.1	
France	Median	0.0	0.0	–9.7	–0.7		
	Min	0.0	0.0	–0.4	–0.2		
	Max	–3.9	–2.3	–23.8	–1.1		
UK	Median	–5.5	–2.1	–1.7	0.0		
	Min	–0.1	0.0	0.0	0.0		
	Max	–23.0	–9.4	–27.5	0.0		
Italy	Median	–2.1	–0.9	–3.4			
	Min	0.0	0.0	0.0			
	Max	–14.4	–6.0	–19.1			
Canada	Median		–2.2	–4.3	–1.0		
	Min		0.0	–0.6	–1.0		
	Max		–12.5	–12.0	–1.0		
Australia	Median	–2.3	–2.9	–3.5	–0.2		
	Min	–0.3	0.0	–0.6	–0.2		
	Max	–9.7	–8.9	–9.9	–0.2		
Netherlands	Median		–1.1	–2.5	–0.8	–0.6	
	Min		0.0	0.0	0.0	–0.6	
	Max		–10.8	–14.1	–1.9	–0.6	
Belgum	Median	–3.7	–2.4	–4.4	–0.5		
	Min	0.0	0.0	0.0	–0.3		
	Max	–14.1	–12.4	–12.4	–0.9		
Sweden	Median		–2.2	–1.9			–0.3
	Min		0.0	0.0			–0.3
	Max		–5.3	–19.5			–0.3
Denmark	Median	–3.8	–2.5	–3.0	–0.4		
	Min	0.0	0.0	0.0	0.0		
	Max	–37.5	–5.7	–12.2	–0.8		
Norway	Median	–3.1	–1.8	–4.5			
	Min	0.0	0.0	–0.5			
	Max	–10.4	–5.9	–19.6			
Ireland	Median			–2.3	–1.7		
	Min			0.0	–1.7		
	Max			–6.1	–1.7		
All countries	Median	–3.7	–2.1	–3.4	–0.7	–0.4	–0.5

Note: The starting years for 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 United Kingdom prior to 1801 was -5.5 and -5.6 years respectively.

Table 4

Duration of annual CPI deflation

		1801–79	1880–1313	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		
UK	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		
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**
Percent of countries		100.0	100.0	100.0	85.7	28.6	14.3

Note: The starting years for 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 2 years for both Germany and United Kingdom prior to 1801.

Table 5

Unit root tests for annual CPI

	1800-1880	1881-1913	1918-1939	1945-1969	1970-1989	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 (1926-1939)	R***	NR	NR
Denmark	R*** (1818-80)	R**	NR	R***	NR	R***
Finland		R*** (1883-1913)	R*	NR	R*	NR
India			NR (1924-1939)	R**	R***	NR
Ireland			NR (1925-1939)	R***	NR	NR
Mexico		R* (1903-1913)	R**	R**	NR	NR
Netherlands		R** (1883-1913)	NR	R**	NR	NR
New Zealand			NR (1918-1939)	R*	R*	NR
Norway	R*** (1838-80)	NR	R***	R**	R**	R*
Peru			NR (1918-1939)	NR	NR	NR
Spain		R** (1883-1913)	R*	R**	NR	NR
Sweden		R** (1883-1913)	NR	R***	NR	NR
Venezuela			R* (1918-1939)	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* means the hypothesis can be rejected with a probability of 99, 95 and 90% respectively.

Table 5 (con't)

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	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

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

1920-1938	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

1950-1973	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 7

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, Netherlands, Norway and Sweden.

Table 8

Peak dates for selective countries										
	1830s	**1840s**	**1850s**	**1860s**	**1870s**	**1880s**	**1890s**	**1900s**	**1910s**	**1920s**
US	1837	1847	1857	1866	-	1881	1891	-	-	1920, 1926
UK	-	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: Grey shading indicates no data; dashes indicate no price peak in the decade.

Table 9

Difference between output growth before and after CPI peaks, G-10 countries				
	Mean (μ)	Standard error (σ)	t-stat[1]	Number of observations
1820-2001	0.4	0.4	0.9	50
1820-1914	0.3	1.1	0.3	37
1925-1939[2]	6.2	1.6	3.6	5

[1] The t-stat 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 5-year period and the post-peak 5-year period, and σ is the standard error of μ. [2] The 5 observations correspond to the US (1926), France (1930), Italy (1926), Canada (1929), Germany (1928).

Table 10

Deflation in perspective

	Deflation periods[1]						
	Consumer prices	Output	S-T interest rates	Nominal Wages	Equity prices	Crisis	Years of deflation
	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
	1923–1939						
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 1923–1939 excluding 1930-1933						
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	na	na	na	na	na	na	Na
Belgium	–3.6	1.3	2.1	na	8.6	1	2
Sweden	–3.2	5.9	na	0.0	4.3	0	4
Denmark	–6.0	2.2	na	–2.6	2.0	0	4
Average	–4.2	1.0	3.5	–0.5	–0.1		3

Note: [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] 1901-1913 for equity prices.

Table 10 (con't)

Deflation in perspective (con't)							
	Deflation periods						
	Consumer prices	Output	S-T interest rates	Nominal Wages	Equity prices	Crisis	Years of deflation
	Average annual percentage growth						
	1951–1970						
France	–0.7	3.9	3.8	3.6	40.0	0	2
	1971–1995						
None							
	1996–2002						
Japan	–0.7	0.7	0.2	0.1	–2.9	0	4

Table 10 (con't)

Deflation in perspective (con't)

	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	1.9	25
	1923–1939						
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	1.3	11
	of which 1923–1939 excluding 1930-1933						
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	1.3	10

Table 10 (con't)

Deflation in perspective (con't)

	Inflation periods						
	Consumer prices	**Output**	**S-T interest rates**	**Nominal Wages**	**Equity prices**	**Crisis**	**Years of inflation**
	Average annual percentage growth						
	1951–1970						
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
	1971–1995						
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 11

Cross-country regressions, G-10 countries

Dependent variable: difference of output growth pre- and post-CPI peak

	Pre-1914 period						
Constant	-.06 (.46)	.64 (1.04)	.41 (1.06)	.57 (.81)	-.19 (.68)	.32 (1.12)	
$\Delta\pi$	.10 (.09)	.01 (.27)	.05 (.31)	.08 (.14)	.16 (.12)	.08 (.33)	
$\Delta(\Delta \log m/p)$		.28 (.06)	.28 (.07)			.29 (.07)	
$\Delta(\Delta \log equity\ price)$				.07 (.05)			
$\Delta(\Delta \log w/p)$					.02 (.06)		
Bank crises (post-peak)			.33 (.95)				
Twin crises (pre-peak)[1]						.38 (.90)	
$\overline{R}^2$	.06	.63	.60	.10	-.02	.60	
Num. Obs.	37	13	13	13	17	13	
	Full-sample (excluding peaks in 1919-20)						
Constant	.16 (.60)	1.03 (.98)	1.39 (.89)	.78 (1.15)	.98 (1.19)	.91 (1.41)	.90 (1.03)
$\Delta\pi$	.16 (.09)	.26 (.14)	.26 (.17)	.24 (.20)	.27 (.18)	.30 (.21)	.20 (.19)
$\Delta(\Delta \log m/p)$		.35 (.14)	.32 (.11)	.31 (.14)	.36 (.17)	.10 (.21)	.34 (.14)
$\Delta(\Delta \log equity\ price)$			-.09 (.06)	-.09 (.07)			
$\Delta(\Delta \log w/p)$						.40 (.16)	
Bank crises (post-peak)				1.11 (1.70)	-.10 (1.91)		
Twin crises (pre-peak)							.76 (1.35)
$\overline{R}^2$	.06	.25	.50	.47	.19	.41	.22
Num. Obs.	43	19	11	10	18	11	19

Cross-country regression model

$$\Delta(\Delta \log y_i) = \beta_0 + \beta_\pi \Delta\pi_i + \beta_m \Delta(\Delta \log m/p_i) + \beta_{ep} \Delta(\Delta \log equity\ price_i) + \beta_w \Delta(\Delta \log w/p_i) + \beta_c crises_i + \varepsilon$$

where the variables are changes in the 5-year growth rates of output, prices, real money, equity prices, 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.

[1] The indicator variable for crises is 0 if there are no crises, 1 if either a banking or currency crisis, and 2 if twin crises.

Table 12

Approaching the zero lower bound, observations per period

	<1880			1880–1913		1914–1949		1950–1969		1970–1989		1990–2002
	Dis-count rate	Short-term rate	DR	S-T	DR	S-T	DR	S-T	DR	S-T	DR	S-T
United States												
<1.5 %		○		**1**		**15**		○		○		○
<1.0 %		○		○		**2**		○		○		○
<0.5 %		○		○		○		○		○		○
Japan				**2**		**6**		○		○		**8**
				○		○		○		○		**7**
				○		○		○		○		**4**
Germany		○		○		○		○		○		○
		○		○		○		○		○		○
		○		○		○		○		○		○
France		○		○		**2**		○		○		○
		○		○		○		○		○		○
		○		○		○		○		○		○
Italy								○		○		○
								○		○		○
								○		○		○
UK		○		**2**		**17**		**2**		○		○
		○		**1**		**11**		**2**		○		○
		○		○		○		○		○		○
Canada						**14**		**4**		○		○
						14		**2**		○		○
						7		○		○		○
Belgium				○		**7**		**7**		○		○
				○		○		○		○		○
				○		○		○		○		○
Sweden								○		○		○
								○		○		○
								○		○		○
Denmark										○		○
										○		○
										○		○
Australia								○		○		○
								○		○		○
								○		○		○
Norway										○		○
										○		○
										○		○
Netherlands				?		**13**		**6**		○		○
				?		**5**		**3**		○		○
				?		**2**		○		○		○
Ireland										○		○
										○		○
										○		○

Note: The symbol ○ signifies no observations.

Table 13

Consensus inflation forecast for 2003 (annual % change in CPI)	
North America	2.2
United States	2.1
Canada	2.4
Western Europe[1]	1.9
Euro area	1.8
United Kingdom	2.4
Latin America[2]	12.4
Other Europe[3]	12.5
Asia and Pacific[4] (includes Japan)	0.2
North East Asia[5] (excludes Japan)	0.8
South East Asia[6]	4.3
Australia and New Zealand	2.6
Addendum: forecasts of inflation less than one percent	
Switzerland	*0.7*
Taiwan, China	*0.5*
China	*0.2*
Japan	*–0.7*
Hong Kong	*–1.4*

[1] Germany, France, United Kingdom, Italy, Austria, Belgium, Denmark, Finland, Greece, Ireland, Netherlands, Norway, Portugal, Spain, Sweden and Switzerland. [2] Fourteen countries including Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela; December to December inflation. [3] Nineteen countries, including the Czech Republic, Hungary, Poland, Russia (December to December figures) and Turkey. [4] North East Asia, South East Asia, Australia, New Zealand and Japan. [5] China, Hong Kong, Korea and Taiwan (China). [6] Indonesia, Malaysia, Singapore, Thailand and the Philippines.

Source: Consensus Forecasts (December 2002), published by Consensus Economics Inc.

Table 14

Inflation and output developments in Asia in 2002, percent

	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	–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	

Notes: 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, 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

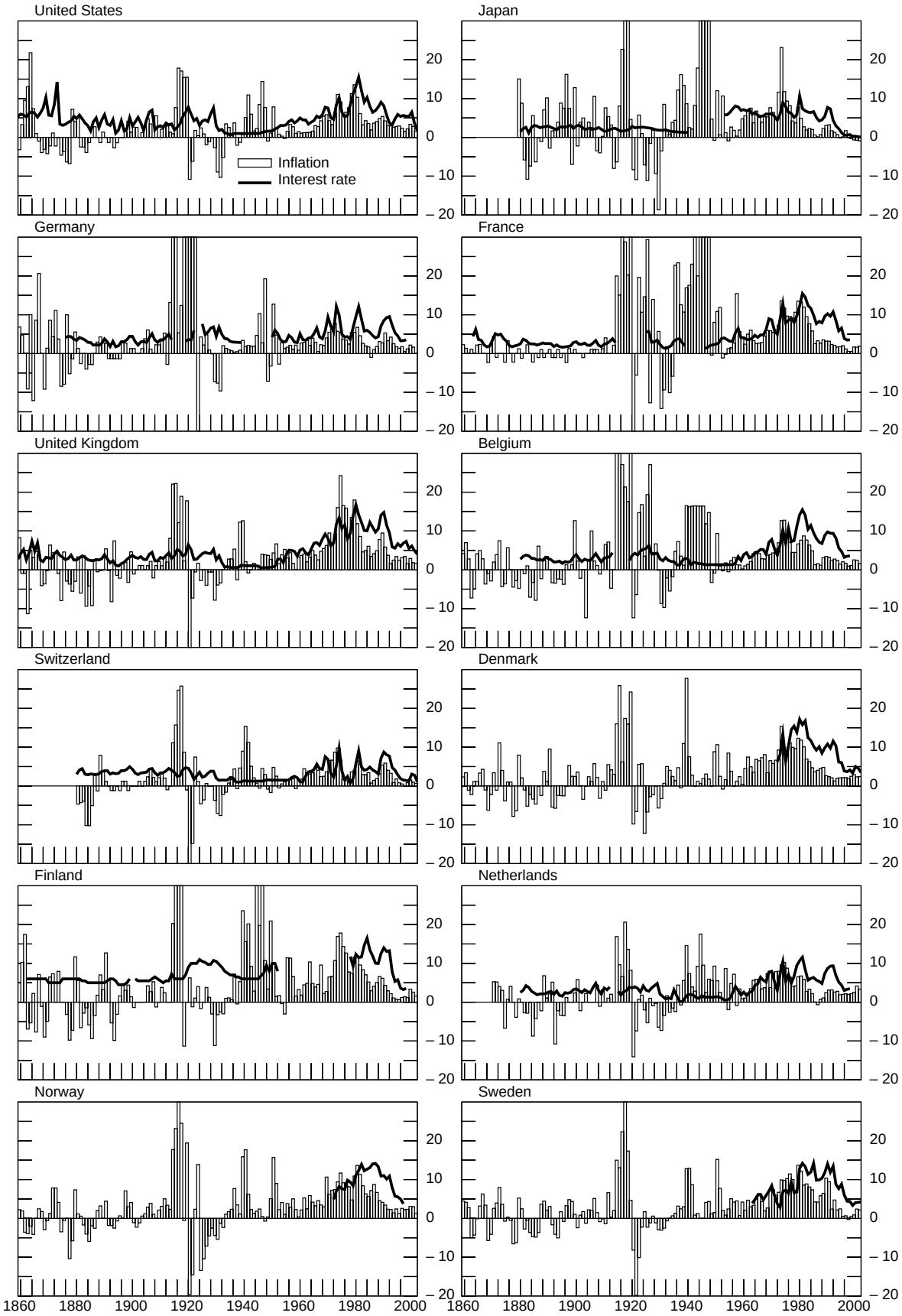
Zero lower bound and activist monetary policy: a counterfactual exercise

	1881-1913	1918-1939	1945-1969	1970-2000
US	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.

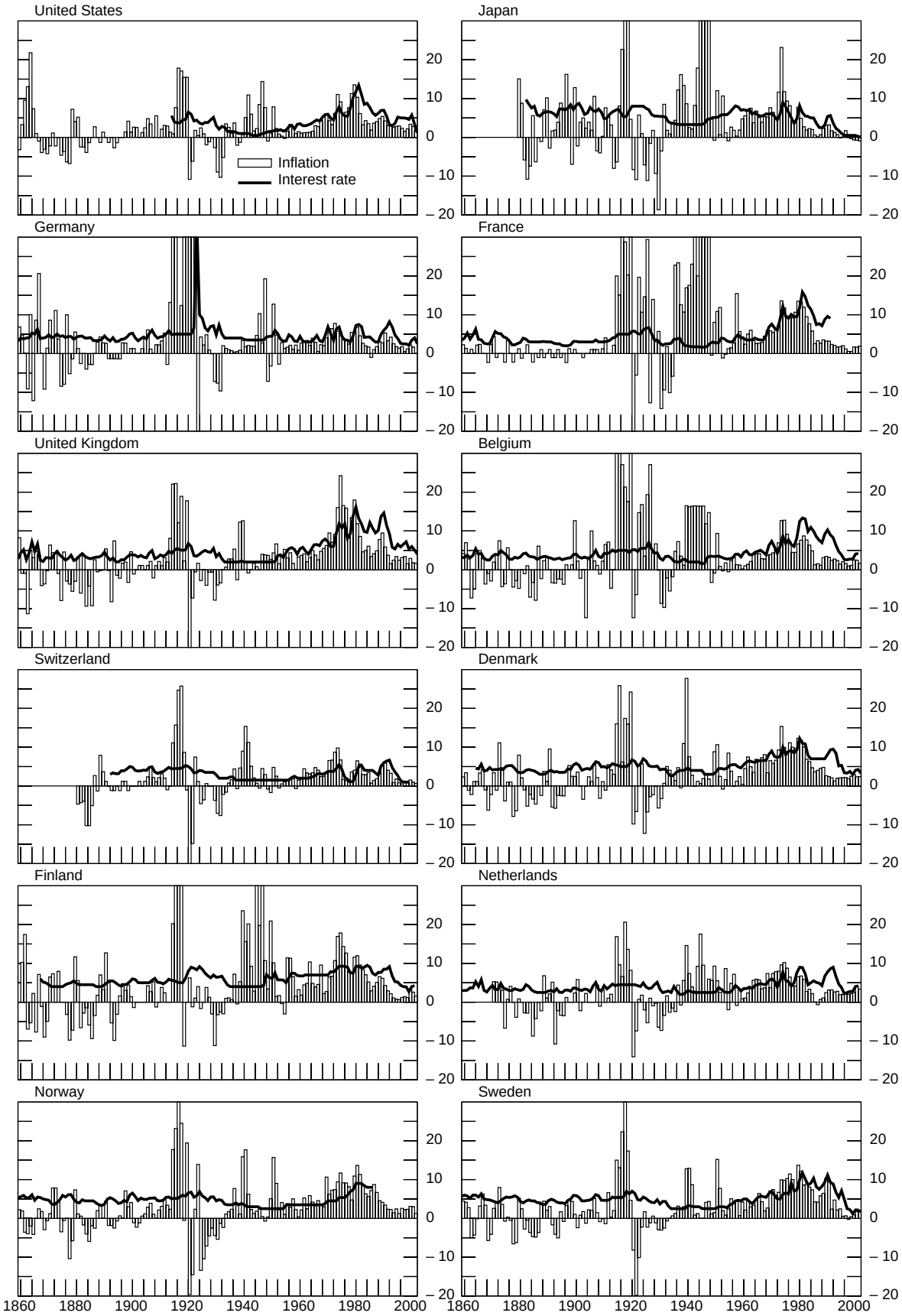
Graph 1

Price inflation and short-term interest rate



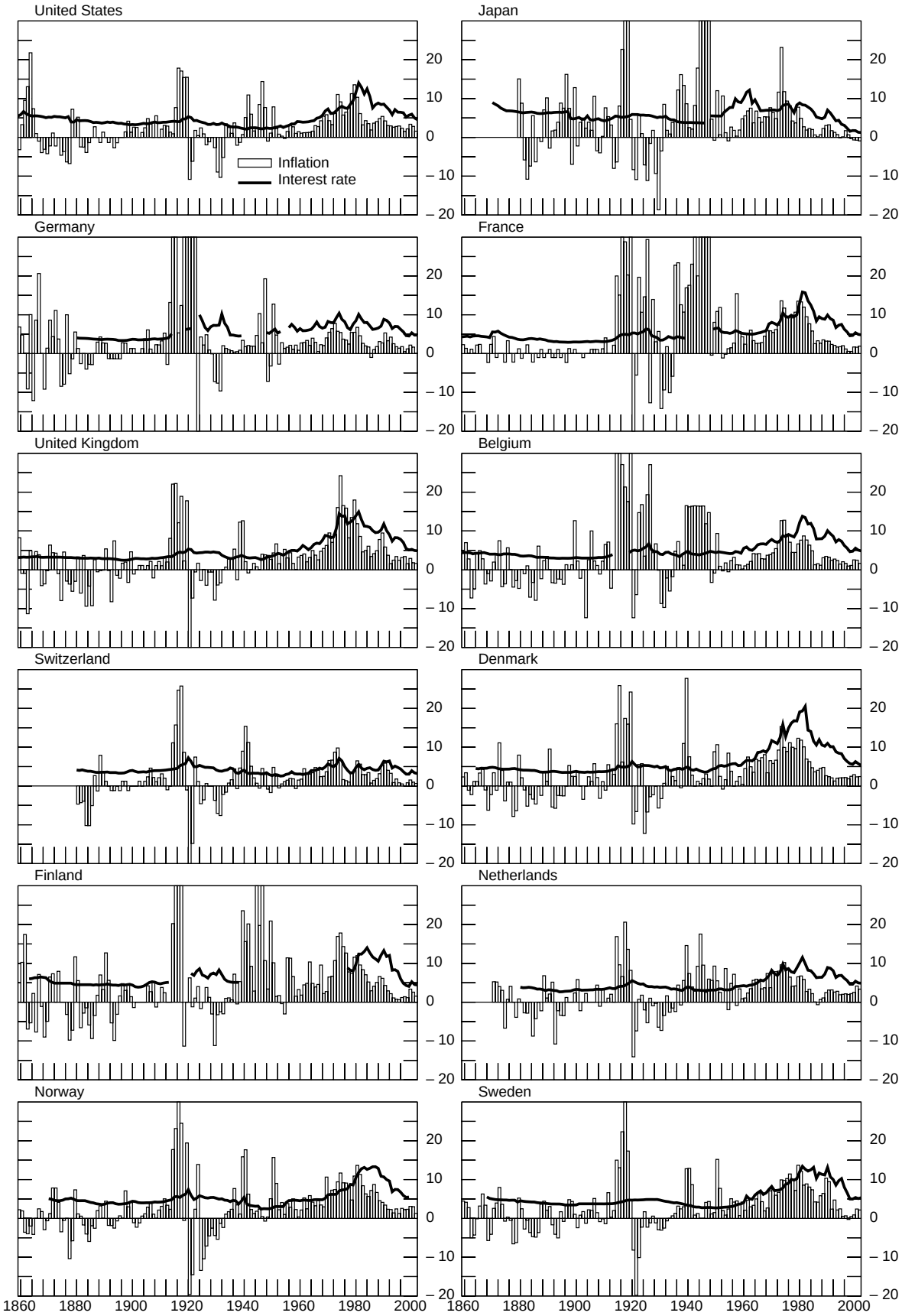
Graph 2

Price inflation and discount rate

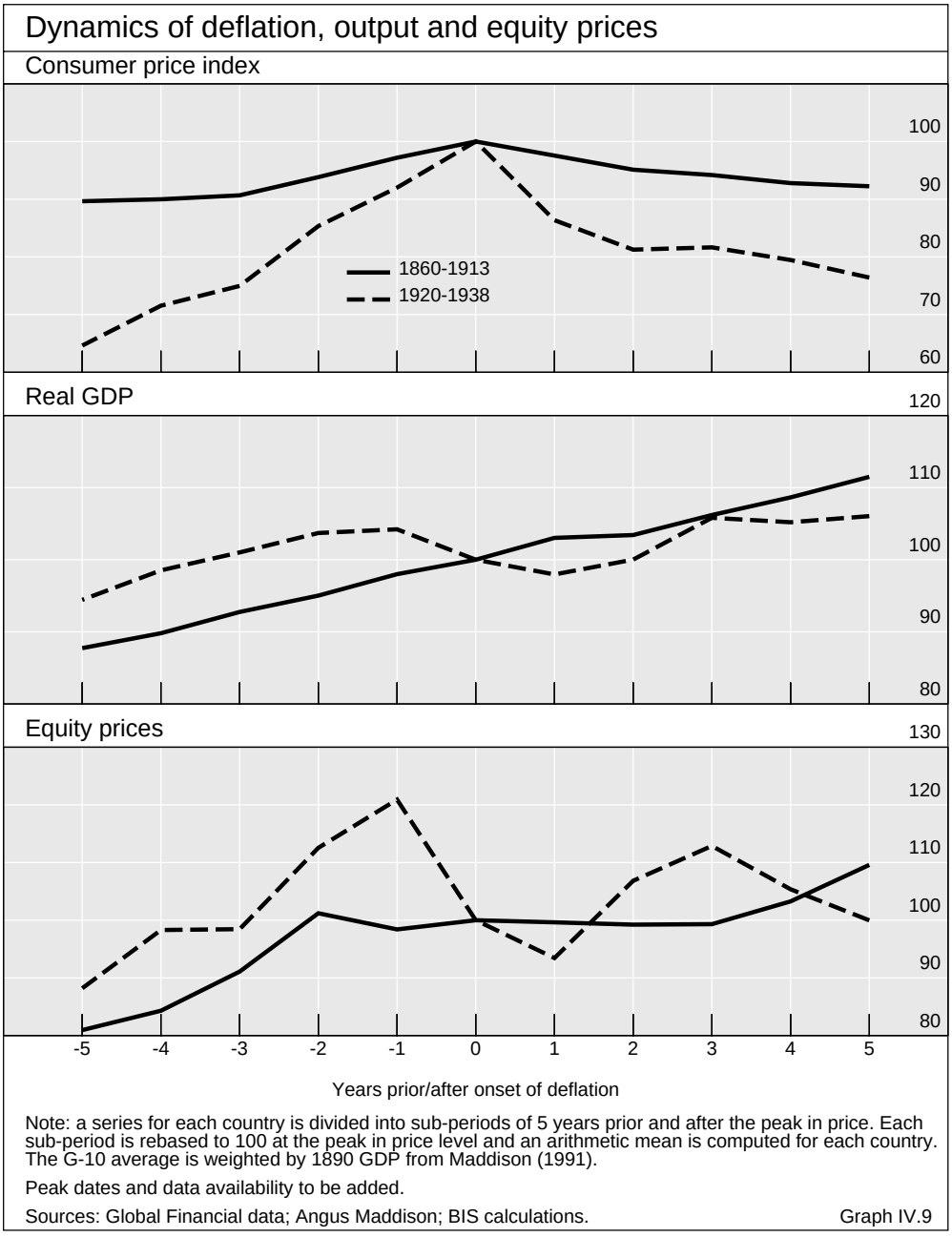


Graph 3

Price inflation and long-term interest rate



Graph 4

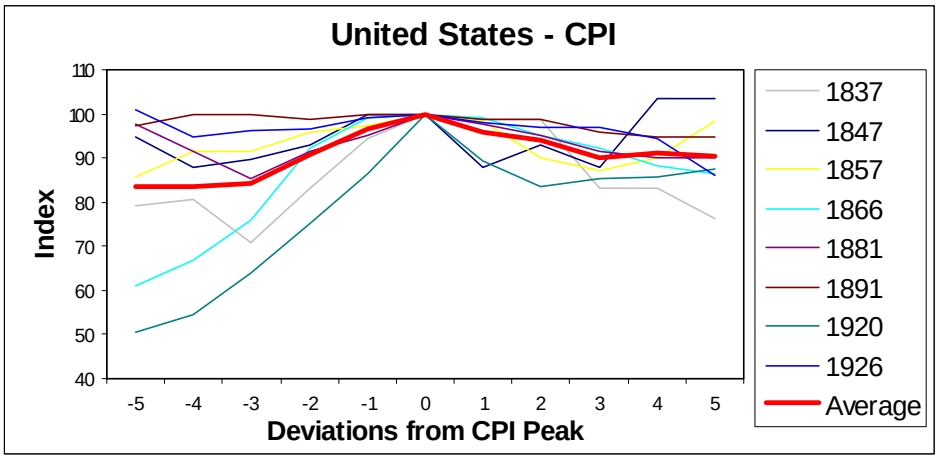


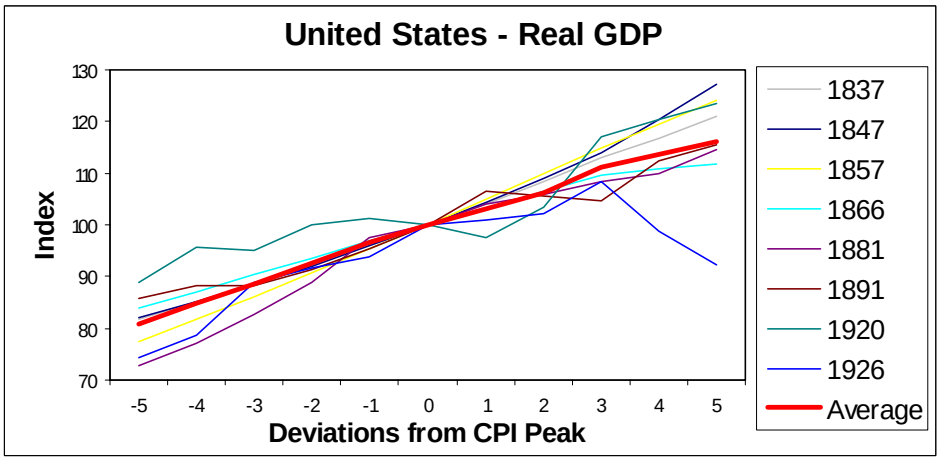
Note: a series for each country is divided into sub-periods of 5 years prior and after the peak in price. Each sub-period is rebased to 100 at the peak in price level and an arithmetic mean is computed for each country. The G-10 average is weighted by 1890 GDP from Maddison (1991).

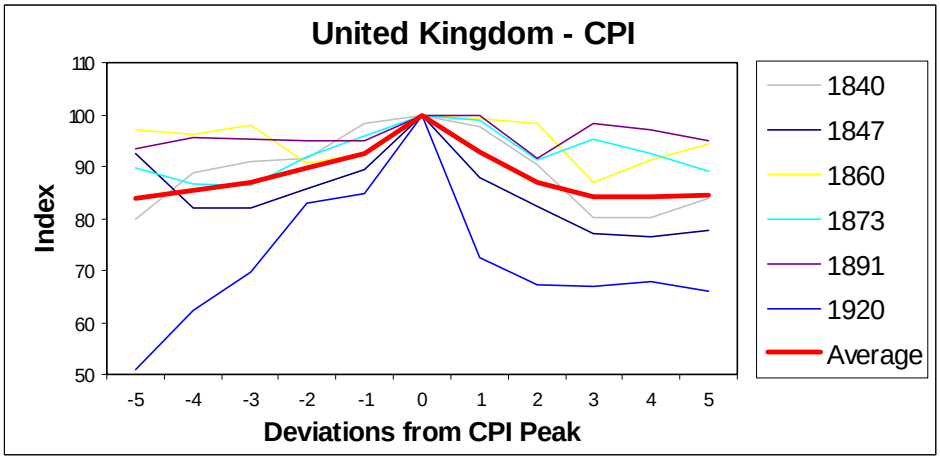
Peak dates and data availability to be added.

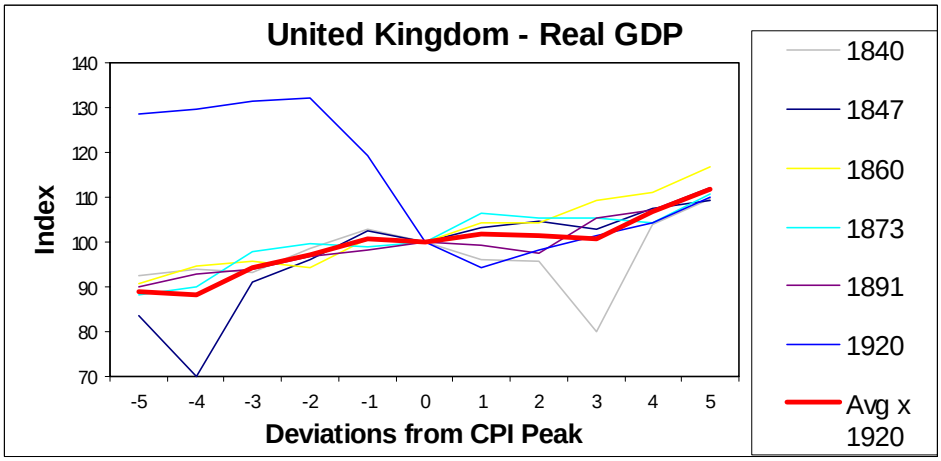
Sources: Global Financial data; Angus Maddison; BIS calculations. Graph IV.9

Graph 5

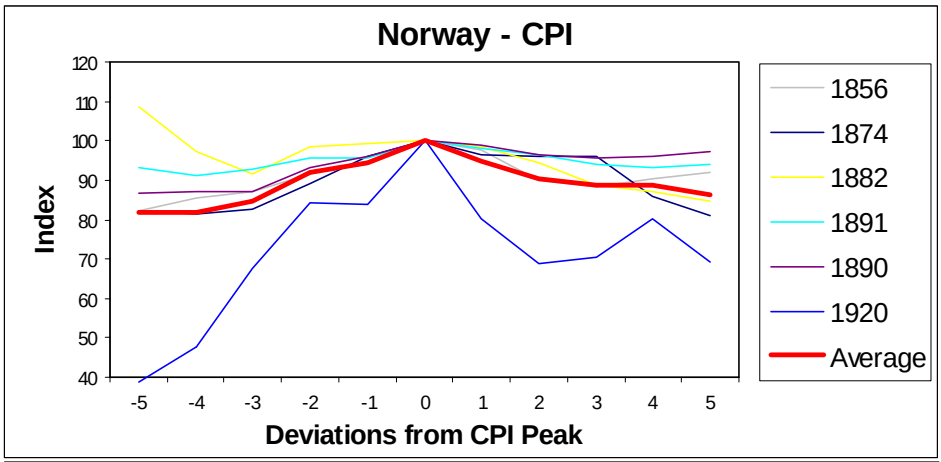

United States - CPI
Index
110
100
90
80
70
60
50
40
-5 -4 -3 -2 -1 0 1 2 3 4 5
Deviations from CPI Peak
1837
1847
1857
1866
1881
1891
1920
1926
Average

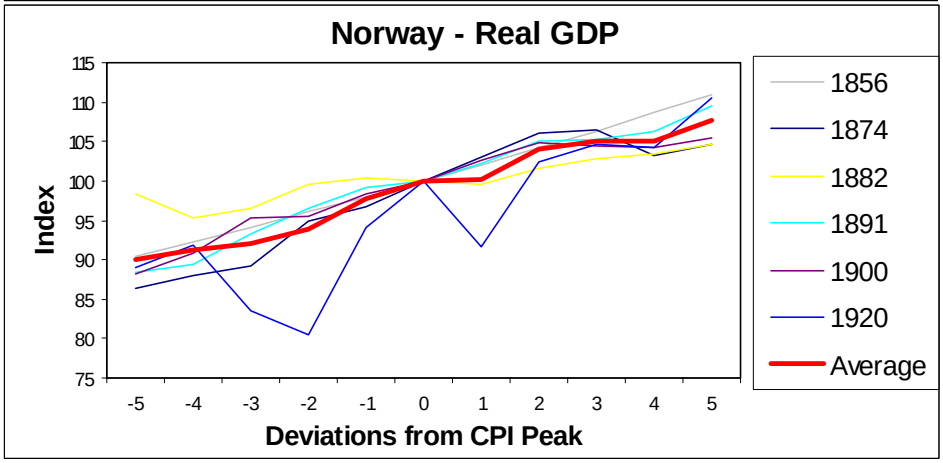

United States - Real GDP
Index
130
120
110
100
90
80
70
-5 -4 -3 -2 -1 0 1 2 3 4 5
Deviations from CPI Peak
1837
1847
1857
1866
1881
1891
1920
1926
Average

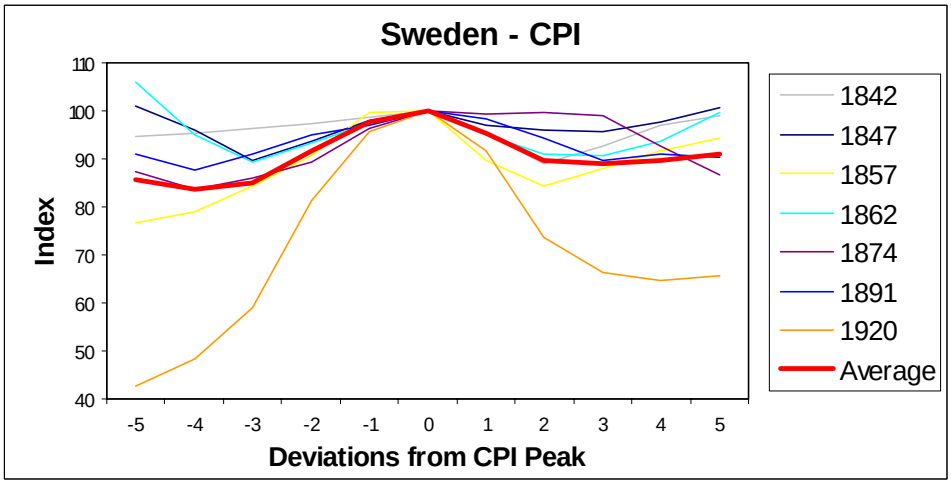

United Kingdom - CPI
Index
110
100
90
80
70
60
50
-5 -4 -3 -2 -1 0 1 2 3 4 5
Deviations from CPI Peak
1840
1847
1860
1873
1891
1920
Average

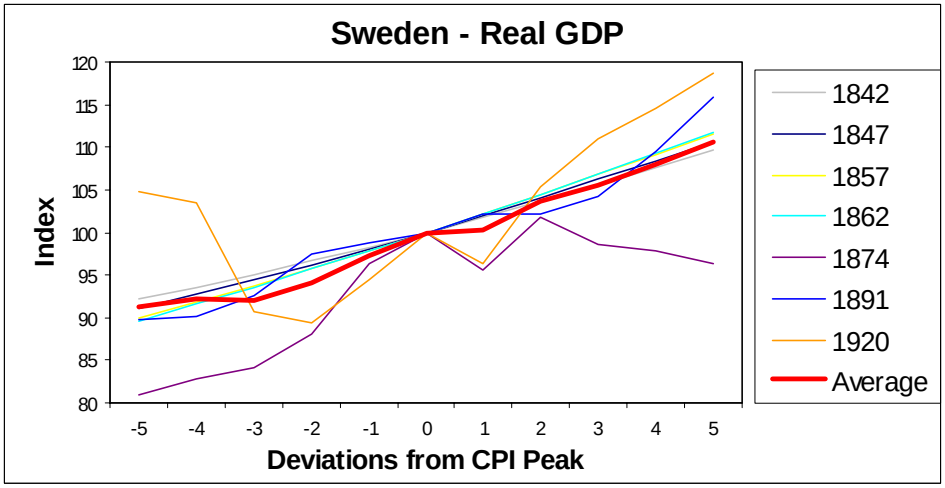

United Kingdom - Real GDP
Index
140
130
120
110
100
90
80
70
-5 -4 -3 -2 -1 0 1 2 3 4 5
Deviations from CPI Peak
1840
1847
1860
1873
1891
1920
Avg x 1920

Graph 5 (con't)


Norway - CPI
Index
120
110
100
90
80
70
60
50
40
-5 -4 -3 -2 -1 0 1 2 3 4 5
Deviations from CPI Peak
1856
1874
1882
1891
1890
1920
Average


Norway - Real GDP
Index
115
110
105
100
95
90
85
80
75
-5 -4 -3 -2 -1 0 1 2 3 4 5
Deviations from CPI Peak
1856
1874
1882
1891
1900
1920
Average


Sweden - CPI
Index
110
100
90
80
70
60
50
40
-5 -4 -3 -2 -1 0 1 2 3 4 5
Deviations from CPI Peak
1842
1847
1857
1862
1874
1891
1920
Average


Sweden - Real GDP
Index
120
115
110
105
100
95
90
85
80
-5 -4 -3 -2 -1 0 1 2 3 4 5
Deviations from CPI Peak
1842
1847
1857
1862
1874
1891
1920
Average

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	Nominal GDP	Industrial Prod	Interest rate long	Interest rate short	Discount Rate	Monetary Aggregate	Wages	Exchange Rate	Population
Argentina	1884	1913	1880	1880	1971	1980	1875	1884	1935	1994	1977	1993	1884	1937	1884	1820
Australia	1861	1901	1880	1880	1964	1875	1820	1880	1957	1858	1968	1969	1880	1861	1880	1820
Belgium	1835	1921	1880	1880	1960	1897	1870	1913	1901	1832	1880	1858	1880	1947	1880	1880
Brazil	1861	1937	1880	1880	1960	1954	1850	1881	1914	1900	1948	1948	1890	1946	1889	1820
Canada	1870	1848	1880	1880	1957	1915	1820	1880	1923	1855	1936	1935	1880	1901	1880	1820
Chile	1800	1928	1880	1880	1968	1894	1810	1949	1927	1995	1977	1925	1948	1937	1949	1810
China	1975			1971		1990	1950	1979	1991	1990	1980	1990	1977	1952	1971	1970
Colombia	1864	1948	1971	1971		1927	1913	1971	1948		1982	1923	1948	1938	1971	1820
Denmark	1815	1876	1880	1880	1962	1915	1820	1880	1927	1821	1972	1864	1885	1870	1884	1820
Egypt	1915	1913	1971	1971		1948	1950	1952	1953		1976	1964	1950	1943	1971	1970
Euro area	1966	1980				1992	1964	1979	1985	1986	1986		1980	1995	1978	1820
Finland	1860	1920	1880	1880	1964	1922	1820	1860	1900	1863	1862	1867	1862	1914	1863	1820
France	1810	1900	1880	1880	1960	1856	1820	1880	1815	1800	1863	1800	1880	1800	1880	1820
Germany	1501	1800	1880	1880	1964	1856	1870	1880	1850	1880	1876	1854	1880	1800	1880	1880
Hong Kong	1951		1971	1971	1980	1962	1950	1961	1966	1996	1982	1992	1980	1981	1971	1970
India	1870	1914	1971	1971		1921	1820	1950	1937	1800	1957	1873	1948	1927	1971	1820
Indonesia	1820	1971	1971	1971	1969	1987	1820	1971	1973		1974	1913	1950	1985	1971	1820
Ireland	1922	1945	1971	1971	1964	1934	1921	1960	1926	1928	1971	1922	1950	1931	1971	1970
Italy	1861	1910	1880	1880	1970	1906	1870	1880	1861	1862	1969	1868	1880	1871	1880	1880
Japan	1879	1868	1880	1880	1963	1913	1820	1886	1874	1870	1880	1882	1880	1926	1880	1820
Korea	1948	1930	1971	1971	1960	1962	1950	1970	1955	1983	1977	1964	1948	1956	1971	1970
Malaysia	1948	1984	1971	1971	1965	1970	1950	1971	1968	1961	1974	1959	1950	1985	1971	1970
Mexico	1900	1887	1971	1971	1964	1930	1820	1971	1900	1983	1978		1948	1938	1971	1820
Netherlands	1870	1901	1880	1880	1961	1919	1870	1880	1925	1880	1880	1814	1913	1926	1913	1900
New Zealand	1914	1913	1971	1971	1964	1926	1870	1971	1930	1865	1973	1923	1948	1914	1971	1970
Norway	1835	1880	1880	1880	1960	1918	1820	1880	1909	1870	1972	1850	1819	1910	1899	1820
Peru	1913	1980	1971	1971		1927	1913	1971	1945		1980	1923	1948	1946	1971	1820
Singapore	1948	1974	1971	1971	1966	1966	1950	1971	1966	1998	1972		1963	1963	1971	1970
South Africa	1895	1910	1971	1971	1973	1910	1950	1960	1916	1860	1971	1957	1948	1900	1971	1970
Spain	1880	1812	1880	1880	1964	1874	1820	1880	1831	1821	1974	1883	1880	1963	1880	1820
Sweden	1820	1955	1880	1880	1970	1901	1820	1880	1861	1868	1963	1856	1880	1861	1880	1820
Switzerland	1880	1810	1880	1880	1963	1911	1870	1880	1959	1880	1880	1892	1880	1913	1913	1920
Taiwan	1951	1949	1971	1971	1974	1967	1950	1961	1912	1995	1986	1975	1950	1949	1971	1970
Thailand	1948	1947	1971	1971	1960	1975	1950	1950	1987	2000	1977	1945	1948	1988	1971	1970
UK	1271	1790	1880	1880	1963	1693	1820	1830	1801	1840	1824	1694	1880	1830	1880	1820
United States	1820	1720	1880	1880	1959	1795	1820	1869	1860	1800	1857	1914	1880	1785	1880	1820
Venezuela	1914	1830	1971	1971		1929	1950	1971	1948	1984	1982	1964	1948	1964	1971	1970

Sources:

Consumer Prices	Eichengreen,Global Financial Data, national sources, Catholic University in Chile	Industrial production	BR Mitchell International Historical Statistics
Wholesale Prices	Global Financial Data	Long-term Interest rate	Bordo and Eichengreen
Banking Crisis	Bordo and Eichengreen	**Interest rate short**	Bordo and Eichengreen & NBER Historical Database (US and GB only)
Currency Crisis	Bordo and Eichengreen	**Discount rate**	Global Financial Data
Credit Aggregates	BIS	**Monetary Aggregate**	Bordo and Eichengreen & BR Mitchell International Historical Statistics & National Data
Equity Prices	Global Financial Data	**Wages**	Global Financial Data
Real GDP	Maddison, BR Mitchell International Historical Statistics, Catholic University in Chile	**Exchange Rate**	Bordo and Eichengreen
Nominal GDP	Bordo and Eichengreen	**Population**	Bordo and Eichengreen & Catholic University in Chile

Sources: Bordo et al (2001), Catholic University of Chile, Global Financial Data, Maddison (University of Groningen and The Conference Board, GGDC Total Economy Database, 2003), Mitchell (1998), National Sources, NBER Historical Database.

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