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Deflation in a historical perspective

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I. Introduction[1]

After 20 years during which inflation was viewed as public enemy number one, the spotlight has recently shifted to deflation, defined as a sustained decline in the aggregate price level. Although deflation has been treated as a new and daunting policy challenge, it is far from new and need not be daunting. In the century before World War I, price levels in many countries declined as often as they rose and, moreover, falling prices were not always associated with recessions. Indeed many deflation episodes were "good" in the sense that they were associated with productivity-driven economic growth. The historical record offers important lessons for policy makers about the current policy environment.

Our paper can be seen as a primer on deflation. We briefly survey some theoretical issues and monetary policy dimensions of deflation. This discussion provides a backdrop with which to interpret the evidence of deflation, which we draw from the historical records of many countries, with a few having data going back as far as the past two centuries.

Our survey of history suggests that deflations of the past fall into three broad categories: "the good, the bad and the ugly". To understand the differences, we first use historical narratives to identify and illustrate each of these three types of deflation. We then provide a more formal statistical evaluation of the costs of deflation by focusing on the determinants of different types of deflationary episodes. Armed with these results, we turn to lessons to be learned about the efficacy of monetary policy in dealing with inflation/deflation, and offer a holistic approach to frame the challenges facing policy makers. In this regard, several different *zones* of price level movements, ranging from high inflation to deep deflation, highlight the differential role of monetary policy in each. From this perspective, the contemporary policy tradeoffs of dealing with deflation are, arguably, put in a clearer light. In particular, the historical record suggests that all deflations are not alike and therefore may require different approaches.

Our historical approach leads us to conclude that most central banks today put too little emphasis on the role of monetary aggregates in assessing the broad policy tradeoffs presented by deflation. History shows that the usefulness of monetary aggregate targeting (versus interest rate targeting) depends nonlinearly on the inflation/deflation zone the economy is in. For high inflation and deep deflation, monetary targeting appears to be a relatively effective guide for policy. When inflation is low, the usefulness of the monetary aggregates may be exceeded by short-term interest rates, especially if velocity is sufficiently unpredictable. In the broader context of monetary frameworks, however, our analysis sheds light on the importance of mixed monetary policy strategies. History suggests that a monetary framework that combines the best features of monetary aggregate and interest rate targeting, not unlike the current approach of the European Central Bank, is more likely to be a robust approach to the varied inflation/deflation challenges, as have been experienced in the past.

II. Theoretical considerations on the costs and benefits of deflation

In theory, "deflation is everywhere and always a monetary phenomenon", to paraphrase Milton Friedman (1968). It is monetary in the sense that the sustained growth in some monetary aggregate relative to the trend growth of real output (adjusted for the trend in velocity) determines the rate of change in the price level.

Theory also provides insights on the costs and possible benefits of deflation. In an economy with fully flexible wages and prices, the costs of inflation arise from the opportunity cost of holding money

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balances. Friedman (1969) argued from a microeconomic perspective that the optimal inflation rate was a deflation equal to the long run growth of the real economy or, in general, equal to the real interest rate.[2] In other words, when the nominal interest rate is zero, the return on money and risk-free bonds would be equilibrated, thereby leading to an optimal outcome.[3] Extending this model to the world of public finance leads to a refinement of this finding. Under particular circumstances, it would be optimal to tax money balances at the Ramsey tax rate. This could suggest a nominal interest rate above zero. But other versions of this model, eg one where money is viewed as an intermediate good, would endorse the original Friedman rule because of the general principle in public finance that only final goods should be taxed (Chari et al (1991), Schmitt-Grohé and Uribe (2001)).[4]

Nominal rigidities, naturally, complicate the cost-benefit analysis. In an economy subject to nontrivial price stickiness, the optimal inflation rate would generally be zero, ignoring the costs arising from the holding of money balances.[5] If both sticky prices and costly money holding motives were operative, the optimal *deflation* rate would be somewhere between 0 and the real interest rate (Chari (2004)). Of note, this range is below conventional implicit and explicit inflation targets used by central banks today.

Costs arising from wage contracting behavior, another form of nominal rigidity, may even justify an optimal positive rate. Akerlof, Dickens and Perry (1996), for example, have argued that downward nominal wage inflexibility could be a significant source of economic costs that could be avoided by keeping the inflation rate sufficiently high. Lebow et al (1999), however**,** have raised doubts about the macroeconomic significance of this view.[6] Indeed, recent wage setting behavior in Asian economies experiencing persistent deflation has exhibited more downward wage flexibility as the deflation environment became more familiar.[7] This all goes to suggest that such notions of downward wage

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[2] The same outcome can be achieved by paying interest on money balances equal to the yield on close money substitutes.

[3] Lucas (2000) estimates, while admittedly with a wide potential range, that the decline in the steady-state inflation rate from zero to a deflation of roughly 3 percent could yield the same economic benefits as a decline of inflation from 11 percent to zero percent.

[4] Feldstein (1999) argues that the interaction of the tax code and inflation causes significant welfare losses at low levels of inflation. More efficient capital taxation would improve intergenerational welfare. In addition, price change volatility would also play a role in jamming the information signals of relative prices.

[5] The literature on price and wage stickiness is based on firm behavior that is still not well understood. For example, Blinder et al (1998) finds considerable explanatory gaps between academic theories of price stickiness and real world survey evidence. While somewhat controversial, there is cross-sectional evidence that supports the notion of downward nominal wage rigidities. McLaughlin (1994, 1999, 2000) argues that standard wage skewness measures may be poor reflections of the degree of wage rigidity. Using the Panel of Income Dynamics, he finds that there is little thinning of the wage change distribution below zero in the United States. Using a different criterion, Kimura and Ueda (2000) found scant evidence of downward wage rigidity using Japan's Monthly Labour Survey data through 2000 – even though such rigidity was evident in an earlier study with a different dataset. This evidence suggests that there might not be particular gains to targeting a positive inflation rate in order to "grease the wheels". In contrast, other research by Kuroda and Yamamoto (2003), Lebow, Stockton and Wascher (1995), Altonji and Devereux (1999) and others have found some evidence of downward wage rigidity. In general this is an important issue, but it should be pointed out that these studies also find evidence of nominal wage cuts and an increased likelihood of wage cuts as the inflation rate declines. Whether the skewness of wage distributions is sufficient to have meaningful macroeconomic consequences remains an open question, the recent experience suggests that rigidities might not be as important as once thought, in part because of lower inflation rates and also because of less union power in labor markets. Looking farther back in time, Hanes (1993) finds that nominal wage flexibility generally fell since 1880. This raises the possibility that the costs of deflation were smaller during the gold standard period.

[6] Even though nominal rigidities are used to justify the shape of a Phillips curve, Lebow et al (1999) argue that the type of nominal rigidity in Akerlof et al (1996) would imply empirical Phillips curves that are highly asymmetric. The empirical literature generally does not find such asymmetries.

[7] Kuroda and Yamamoto (2003) find statistical evidence of nominal wage rigidities in Japan, but one is struck by their figure 1 which shows that nominal wage cuts are far from rare. Likewise, evidence from Switzerland (Fehr and Goette (2004)) and the United States (Lebow et al (1999)) is consistent with the fact that nominal wage cuts are not rare; Fehr and Goette (2004) also show the distribution of nominal wage changes does shift over time, especially as inflation becomes deflation. Han (2003) documents time series evidence of nominal wage cuts in Hong Kong.

Overall, the evidence on nominal wage flexibility is inconclusive. On the one hand, there is ample evidence that nominal wage cuts tend to pile up at zero in cross sectional data, especially in economies that are used to inflation. On the other hand, there is ample evidence of nominal wage cuts, which weakens the argument that employees simply will not accept nominal wage cuts. Moreover, some evidence suggests that total nominal compensation is more flexible than nominal wages (Lebow et al (1999)). On the whole, in low inflation and deflation environments, the empirical record is consistent with

inflexibility that were formed during the Great Inflation may in fact be regime dependent. It is possible that once a low inflation or moderate deflation environment were to become more familiar, the past psychological aversion to downward nominal, rather than real, movements would become less of a constraint.[8]

Another cost of deflation is related to redistributive losses.[9] Friedman's optimum quantity of money assumes that deflation is fully anticipated. If this is not the case, then agents who fail to fully anticipate deflation and are unable to index their contracts would suffer losses relative to those who could. History shows that such redistributive costs can be rather significant, as the losers (for example, debtors, farmers, workers, etc) had at times reacted to their situation through political agitation. Moreover, debt deflation – a fall in the price level that raises the real value of nominal debt – can exacerbate the costs of a deflation (Fisher (1933)). This redistributive cost, however, would not obviously be any different than that of a similarly-sized disinflation in an environment of positive inflation.

Financial stability could also be affected by unanticipated price movements. In an economic environment without complete financial markets in nominal risk sharing, unanticipated price shocks could have important consequences for financial instability and the associated macroeconomic costs (Schwartz (1995)). Bordo, Dueker and Wheelock (2002, 2003) document that, in the pre-1934 period, aggregate price shocks had a significantly negative impact on financial conditions. By the 1970s, however, inflation shocks rather than price shocks were playing the dominant role in this respect.

Deflation is also thought to complicate the conduct of monetary policy in various ways. First, the recent spectre of deflation represents a relatively unfamiliar territory in which central banks have to operate. To the extent that economic relationships that hold in moderate inflation regimes break down during deflations, a central bank may find it harder to interpret economic developments and to understand the monetary transmission mechanism. This new policy environment could also make it more difficult for the monetary authority to communicate its policy stance and future intentions to the public. This, of course, could have real effects on the ability of the private sector to form expectations and plan optimally. One would expect, however, that these costs would be transitory as central banks and the public became accustomed to the new environment.

Second, deflationary environments can hinder the ability of central banks to pursue countercyclical monetary policies. In the extreme, if a deflation was deep enough and expectations became entrenched, a liquidity trap could form (Eggertsson and Woodford (2003), Fujiki et al (2001), Keynes (1936), Krugman (1998)).[10] This is an extreme situation where the tools of monetary policy would be ineffective in stimulating aggregate demand. Such a situation would preclude the generally-presumed benefits of countercyclical policies on economic welfare. Even though the theoretical literature provides a wide range of views on the welfare benefits of countercyclical monetary policy (Kiley (2001)), policymakers generally perceive positive net benefits from pursuing countercyclical monetary policies.

Third, the zero lower bound for short-term nominal interest rates would also adversely complicate monetary policy, if only because central banks could not rely on interest rates to pursue their inflation and output goals. Again, such an environment would be a challenge, at least in the short run, as policymakers would have to alter their tactics and recalibrate their policy tools.

All these policy complications are clearly costs that would have to be factored into the decision to pursue a low inflation/deflation policy. Again, most of the complications might prove to be transitory as the central bank became accustomed to the new policy environment.

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the view that workers appear to reframe their wage expectations, putting more emphasis on real rather than nominal wage changes.

[8] Also, see Bewley (1995). For an opposing view, see Akerlof et al (2000). They argue that near-rational agents may systematically underestimate the costs of low inflation and hence produce an equilibrium with a lower unemployment rate than would be the case in a purely rational expectations model. The quantitative importance of this is not known.

[9] See Humphrey (2003) for a discussion of how classical economists looked at the problem of systematic redistributions during unanticipated deflations. The deflation-induced redistributions were generally seen as having net negative knock-on effects because the consequences for the most leveraged in society were often disproportionately large.

[10] For a dissenting view of the prevalence of liquidity traps in history, see Brunner and Meltzer (1968).

In sum, theory provides some guidance on the optimal inflation rate, but such guidance is somewhat wide ranging. The precise estimate would depend on critical, yet controversial, assumptions. In other words, reasonable, or at least not implausible, assumptions could justify a range of estimates. In general, the optimal inflation rate should be low, possibly as low as a moderate deflation. (In determining a quantitative measure of this rate, policymakers would also have to factor in statistical biases in conventionally-measured inflation rates. The well-known biases in index theory suggest that measured price changes are biased upwards. In theory, the costs of inflation and deflation should be evaluated relative to the economically meaningful, rather than the purely statistical measure. In the United States, for instance, the bias has been estimated to be somewhere between .5 to 1 percent, which may not be too far out of line with ballpark estimates in other economies.[11] If true, actual deflation would likely coincide with a positive rate of measure of inflation somewhere below 1 percent. Of course, inflation illusion may also play a role, but such effects are thought to be small.) From the tenor of the current policy debate, however, one would be led to believe that most policy makers consider deflation to be a subpar outcome. In a narrow sense this might be tautologically true. For explicit and implicit inflation targeters, a deflation outcome indicates a policy failure because, to our knowledge, no central bank targets deflation. But, in a broader sense, the debate about how low the inflation rate should be is still open, with modest steady-state deflation deserving ample consideration.

In policy circles, such a conclusion might still sound impractical, imprudent and, in the extreme, wrong-headed. We will argue below that, historically, deflation was viewed in a more positive light. The reason why, we believe, reflects the experience in the pre-world war I deflationary environment and beliefs about the importance of having a strong nominal anchor to maximize private sector performance. We note with some cautious optimism that the recent inflation and output behavior in the United States, amongst others, may indicate the emergence of a sea change in thinking about the true costs and benefits of price stability. Even though deflation may be a lower target than most would be comfortable with at this time, recent inflation outcomes – especially when factoring in a statistical bias – are much lower than some would have thought prudent just a decade ago.

III. The role of monetary policy in deflation dynamics

There is little doubt that the dynamics of deflation depend on the monetary regime in which policy is being conducted and private sector agents are forming expectations. In this section we review various important dimensions of deflation dynamics that emphasize the relationships amongst monetary policy rules, exchange rate regimes and expectation formation.

III.1 Deflation and interest rates

We start our discussion by looking back to Knut Wicksell (1907) and Irving Fisher (1930), two major monetary theorists from the late nineteenth century and early twentieth century. They developed many of the theoretical tools to analyze the role for monetary policy in maintaining price stability.

Wicksell's framework did not explicitly consider inflation expectations but it was one in which the price level was presumed to be tied down by gold convertibility. The role of central banks was to use their discount rates to preserve macroeconomic balance at all times (ie saving equal to investment). In the case of excess aggregate demand, the central bank would raise its discount rate (bank rate) in an attempt to equate it with the natural rate of interest.[12] Until the adjustment occurred, the price level would rise in a cumulative manner, leading to a gold outflow and downward pressure on the central bank's gold reserves. If the bank rate were above the natural rate, prices would fall. In a modern sense, Wicksell has been seen as one of the pioneers of interest rate targeting. In such an

[11] See, for example, Lebow and Rudd (2003) and Rodriguez-Palenzuela and Wynne (2004).

[12] The excess would be exhibited, for example, in investment being in excess of saving. In this case, the real (ie natural) rate would be above the bank rate set by the central bank.

environment, the central bank would adjust its target rate to the real interest rate required to hit its inflation target, given a measure of disequilibrium.[13]

By contrast, Fisher assumed a world where inflationary expectations were not always zero and would be incorporated in the nominal interest rate (the sum of the real rate and expected inflation), even though he too was writing during the classical gold standard era. In the Fisherian framework, market interest rates would not necessarily give a clear demarcation of the influence of real and nominal forces. Hence interest rate targeting alone would be difficult to implement, ie changes in short-term nominal interest rates by the central bank would not be able to influence real rates sufficiently to affect the output gap and hence the inflation rate.[14] In a modern context, the instabilities of interest rate rules are well known.[15] Interest rate rules alone generally lack a credible nominal anchor to rein in perverse inflation expectations, if they were to materialize.

III.2 Deflation and credible nominal anchors

One perennial question in monetary economics is the importance of nominal anchors in shaping expectations. While theoretically important, the practical importance has been subject to some skepticism. Moreover, the exact nature of the anchor has been a focal point in the debate. In particular, would a price level or an inflation rate anchor make monetary policy more effective generally and more able to deal with unwelcome deflation specifically? In the nineteenth and early twentieth century the emphasis by economists and policymakers was on a price level anchor.

The role of the price level in the classical gold standard provides an example of how this feature was an important consideration. If monetary authorities followed a credible nominal anchor, then inflation expectations would be well anchored. Temporary deviations from a stable price path would be offset by market forces, predictable policy actions and market agents adjusting inflationary expectations towards the long run path. Under the gold standard, the world price level was determined by the demand and supply for monetary gold and, in turn, by a function of gold production and the relative demands on gold for monetary and non-monetary uses (Bordo (1999)). In the long run, prices were anchored by the marginal cost of producing gold; hence with constant costs and zero real growth, the price level, following shocks to the gold market such as gold discoveries, would always revert back towards some stable value, ie prices would tend to be mean-reverting. However, in an environment of positive productivity driven real growth there would be a tendency towards secular deflation unless offset by technical innovation in gold production or by gold discoveries.[16]

The international monetary arrangements at the time meant that the price levels of individual countries would be tied together by commodity market arbitrage and capital flows (Bordo (1999)). Deviations of one country's price level from its trading partners and interest rates from the world financial center in London, would lead to both corrective gold flows and short-term capital flows. In this environment, periods of generalized global inflation following gold discoveries would be succeeded by periods of deflation. Gold discoveries would increase the total world gold stock, the world monetary gold stock and hence the world price level. This would reduce the real price of gold (given the fixed nominal price set by the monetary authorities), in turn reducing gold production and encouraging substitution of gold from monetary to non-monetary uses. Both sets of forces would cause prices to be mean-reverting. Deflation would then follow in the face of productivity growth until rising real gold prices stimulated sufficient gold production (and possible gold discoveries) and substitution of gold from non-monetary uses, to reverse it (Barro (1979)).

Moreover, because market agents believed that in the long run prices would revert to the mean, the expected inflation rate would be roughly zero, especially if the relevant decision-making period – eg the holding period length for financial assets and implicit contract length for wage deals – were

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[13] For further discussion of the relevance of Wicksell in a modern context, see Laidler (2003), Borio, English and Filardo (2003), Amato (2004) and Woodford (2003).

[14] In this regard, the term structure may be a better signal of future output movements in a Fisherian world than one where inflation expectations are anchored (Bordo and Haubrich (2004)).

[15] See, for example, Poole (1970), Taylor (1999) and Benhabib, Schmitt-Grohé and Uribe (2002).

[16] If we view gold as a depletable, durable resource then deflation would be inevitable (Bordo and Ellson (1985)).

sufficiently long. This is because any departure of the price level from the long-run mean would be expected to be reversed eventually so that long run price level uncertainty would be low (Klein (1975)). The implication of the behavior of nominal interest rates in such an environment is discussed in Borio and Filardo (2004).[17] It should be noted, however, that because the timing of the reversals was stochastic, short-run price level uncertainty under the gold standard could wind up being quite high.

In a fiat currency world, an explicit and credible price level targeting scheme could have properties similar to the gold standard. This appears to have been the case for Sweden, who in the 1930s, followed such an approach (Berg and Jonung (1999)). In a more modern context, proposals for price level targeting generally come in two distinct flavors. One version emphasizes a fixed price level target. In this case, a monetary authority would target a given price level at a particular policy horizon. If the price level exceeded (or were expected to exceed) the target, the monetary authority would tighten policy; and if it fell below target, the monetary authority would ease policy. As under the gold standard, this policy would generate alternating periods of transitory inflation and deflation. Such an approach would have the advantage of long-run price predictability, which conventional inflation targeting regimes do not (Bordo, Dittmar and Gavin (2003), Riksbank (2003), Svensson (1999b)). But it could have the disadvantage of short-run volatility in an environment of nominal rigidities. In an alternative version of the scheme, a monetary authority would target a rising price level – in a sense, this would be equivalent to *average* inflation targeting rather than a conventional period-by-period inflation rate target (King (1999)). This approach would still share the favorable feature of long-run price predictability. If a shock were to cause the price level to fall below target, then the central bank would take an accommodative monetary stance to put upward pressure on prices until the price level returned to target. If, however a shock were to cause the price level to exceed the target, the central bank would respond by tightening monetary conditions to return to target. If the central bank were sufficiently patient towards achieving its target, the return of the price level could be achieved without engendering deflation, or at the very least minimizing the need to engender deflation. In sum, the pre-war period is supportive of the notion that price level targeting may be an attractive alternative to current inflation targeting regimes; theory suggests that a flexible version of price level targeting could deliver a credible nominal anchor.

III.3 Deflation and exchange rate regimes

Deflation and its consequences across countries is intrinsically entwined with the choice of exchange rate regime: fixed or floating. That, in turn, appears to be historically related to credibility and financial maturity. Bordo and Flandreau (2003), distinguish between core (advanced) countries and periphery (emerging) countries. Under the classical gold standard, the core countries of Western Europe had the financial maturity and credibility that enabled them successfully to adhere to the gold standard. In that regime, price level movements were determined by the fundamentals of the gold market, which were largely exogenous to individual countries; deflation was an essential part of that process as discussed above and it turned out to be associated with favorable productivity developments (Bordo, Landon-Lane and Redish (2004), BIS (2003), Borio and Filardo (2004)). To the extent that nominal rigidities led to declining output, monetary authorities had some limited flexibility to offset it within the target zone provided by the gold points.[18] In the interwar period and possibly pre-1914, they engaged in sterilization policies to offset the impact of international gold movements (Bloomfield (1959), Dutton (1984), Nurkse (1944)). In addition, some of the effects of deflation were offset by the use of key currencies as central bank reserves instead of gold and by the increasing use of bank money and convertible fiduciary money as gold substitutes (Triffin (1960)).

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[17] If expectation formation is more sticky in credible monetary regimes of price stability, the current monetary policy environment might not only generate more well anchored inflation expectations and reduced exchange rate pass-through, but also might be accompanied by less volatile nominal interest rates.

[18] During the gold standard period, gold parity was bounded by the gold points (the cost of shipping gold among the various financial centers). Following Svensson (1994), Bordo and MacDonald (1997) show that the gold points served as a target zone in the sense of Krugman (1991) and implied some scope for the core countries to temporarily offset real and nominal disturbances such as was the case in England, France and Germany. An important feature of the flexibility was that markets believed that the gold parity would be preserved under virtually all circumstances.

The periphery countries, in contrast, lacked both financial maturity and credibility. They had difficulty maintaining the convertibility of their currencies, but when they opted for floating they often suffered capital flight. Their options were to adopt a currency board arrangement with close to 100% gold reserves or to decouple themselves from capital flows. The periphery countries, therefore, felt the full brunt of deflation and were unable to shield themselves as the core countries did.

Today, the core countries, such as the United States and Europe, have the financial maturity and credibility to float, which has given them the ability to avoid unwelcome deflation.[19] Of course, the ability to float and the choice to float are two different issues as have been pointed out recently by Dooley, Folkerts-Landau and Garber (2003). As they argue, a successful development strategy for the periphery countries is not necessarily to adopt the current practices of the core countries but rather to subordinate the goal of maximizing the return on reserves in order to build up a globally competitive capital stock. Such a strategy, they argue, not only mirrors the experience of Europe and Japan during the Bretton Woods period but also reflects the recognition that the periphery countries may lack the financial maturity to float and to adopt the inflation targeting strategies of the advanced countries. Part of the "fear" of floating is a pragmatic concern that rapid depreciations would uncover currency mismatches and potentially lead to financial crises, as history has shown time and time again (Calvo and Reinhart (2002)). Part is a sober reflection of the fact that financial immaturity may have prevented them from borrowing abroad in their own currencies – a practice that is related to the doctrine of "original sin" (Eichengreen and Hausmann (1999)).[20] These countries then have the options of adopting a hard currency peg such as a currency board which gives them no leeway to offset the effects of unwelcome deflation. Alternatively, they could adopt an intermediate regime (a variant of a pegged exchange rate regime) but they then would need to impose capital controls to shield themselves from potential speculative attacks. One attractive option for emerging market economies is to "learn to float", that is, to develop the necessary financial institutions and to follow credible nominal anchors as the advanced countries have learned to do (Bordo (2003)).

III.4 Deflation and booms, busts and credit cycles

In recent years, there has been a renewed interest in the interaction of monetary policy, asset price booms and busts and credit cycles. One implication from this literature has been that the risks of deflation might be understated in the conventional focus on supply and demand shocks. Instead, if one considers the possibility of asset price booms and busts, credit cycles and the possibility of financial instability, the risks might be several degrees of magnitude bigger. This view, which has its antecedents in Kindleberger (2000) and Minsky (1982), emphasizes the cumulative process of financial imbalances and the possibility that such imbalances may cause sharp, debilitating adjustments, which could generate equally sharp, and probably unanticipated, deflation.

Credit cycles, often associated with excessive leveraging of financial assets, appear to be empirically linked to the incidence of booms and busts.[21] In one variant of the view, an initial productivity boom would engender overconfidence amongst various agents in the economy. Loan demand would be high as confident investors reach for higher and higher perceived risk-adjusted yields. The early stages of such a boom might also be self-reinforcing as perceptions of risks became increasingly exuberant. Credit supply would also be spurred on as risks would appear, at least initially, low. If the boom continued, and the optimistic scenario materialized, all might be well. But, if the productivity gains disappoint the high expectations, the economy would likely retrench. And, if leverage were sufficiently excessive, the retrenchment could cascade into a self-reinforcing contraction. Price pressures would likely fall as inside money would plummet. Real debt service burdens would increase, asset qualities would decline and bankruptcies would inevitably ensue. If the credit and productivity boom was associated with an asset price bubble, the bursting bubble could add to the serious negative developments. According to Borio and Lowe (2002a, 20002b), although this type of scenario has been experienced in the distant past, it also has been relevant in the past decade. In some sense, such boom and bust cycles may be thought of as a permanent feature of the policy environment (Borio,

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[19] The case of Japan will be discussed later.

[20] For an alternative view, see Turner and Goldstein (2004).

[21] On this view, see Borio and Lowe (2002a&b, 2004), Borio et al (2003), Borio and White (2004).

English and Filardo (2004)). Again, a strong nominal anchor arising from a sound policy framework could help to minimize the likelihood of a debilitating deflation, which most likely would be of the unwelcome kind.

III.5 Deflation scares

There is still little consensus, both inside and outside central banks, about how vigorously central banks should fight deflation scares. Deflation scares can be thought of as a forecast of deflation or, in the context of monetary policy risks, as a low but non-trivial probability event. Recently, the issue has been addressed generally from the viewpoint that deflation is unwelcome – so unwelcome, in fact, that even small probabilities of deflation have elicited in some cases a major reorientation of the upside and downside inflation risks. This reaction was especially true in the United States in 2003. This approach is largely predicated on a view that transitory deflation is very costly; therefore, central banks would be wise to avoid it. This approach, however, is not without its risks. Keeping monetary policy more accommodative than otherwise would be the case could raise the upside risks to inflation, especially if the deflation scare proved to be illusory.[22]

If the costs of modest deflation were not asymmetric (relative to the costs of a modest inflation) but rather symmetric, then the asymmetric policy response would not be optimal, ceteris paribus. Indeed, it could not be ruled out that a central bank that followed such an asymmetric policy would cause inflation pressures to build and ultimately materialize, at least in the short run. In other words, such an approach could induce an upward inflation bias. Moreover, this might mean that monetary policy would tend to be "too" accommodative during recessions and recovery periods and would eventually have to be reined in. Such overshooting would create volatility. Finally, deflation scares might be a misnomer in the sense that the modest deflations are not really "scary". As argued above, theory at least provides some support for the notion that a modest steady-state deflation may be welfare enhancing relative to a modest steady-state inflation. In terms of the theory of opportunistic inflation, a deflation scare might be better thought of as a welcome opportunity to lock in even lower rates of price changes at a low macroeconomic cost.

III.6 Deflationary spirals

It has been argued that an economy facing deflation can spiral downward via self-reinforcing waves of price pressures. Expectations play a key role in the process. If expectations of inflation were well anchored, it would be less likely that deflationary spirals could begin or gather sufficient momentum. One particular mechanism that could generate a spiral is consumer expectations. If a deflation were expected, consumers might refrain from spending today in the hope of paying lower prices tomorrow. This would lower velocity, which in turn would reduce prices, and so on. Such an outcome would be more likely in the absence of a fully credible monetary regime as discussed above.[23]

Another mechanism that is thought to be associated with spiraling deflation focuses on the role of asset prices. The spectre of deflation may cause forward-looking investors to expect a reduction in profits and a general decline of economic activity, especially if the economy is subject to nominal rigidities. The decline in asset prices could have a chilling effect on economic activity which would then add to the deflationary pressures. This process could be reinforced by balance sheet problems of firms and households, who might retrench or even renege on debt obligations in bankruptcy (Fisher (1933), Kindleberger (2000), Tobin (1975), Bernanke (1983), Koo (2003), von Peter (2004)). In such a

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[22] One way in which a deflation scare can prove to be illusory is if changes in relative prices are initially interpreted as representing a change in inflation trends.

[23] As a historical note, the classical gold standard regime before World War I provided a credible anchor that constrained the forces that could have led to a deflationary spiral (Bordo and Schwartz (1999a)). In such a regime, agents would expect that declining price levels would eventually be offset by rising prices via the normal operation of a commodity money standard. In the case of modern fiat currency regimes, such commitments are generally not as hard-wired into the monetary framework, even though a credible commitment to an inflation target does go in that direction. With explicit and implicit inflation targets, agents would expect that deviations of the inflation rate from the target would be offset by corrective monetary policy actions. Without a credible commitment, however, expectations could be subject to wide swings and therefore could raise the likelihood of a deflationary spiral.

case, the interaction of the policy regime, the vagaries of human psychology and the economic environment would conspire to generate a perverse disequilibrium. And, of course, such developments would have the potential of distorting the monetary transmission mechanism, which in turn would have implications for velocity. Without a good theory on these types of developments, a monetary authority may have difficulties calibrating the correct response to forestall the deflationary spiral.

IV. Deflation: then and now

In this section, we examine both the historical and statistical record to understand the costs of deflation. One important advantage in looking to the experience of the distant past is that it provides a clearer perspective on deflation behavior. In history, deflation has often coincided with robust economic growth (Atkeson and Kehoe (2003), Bordo, Landon-Lane and Redish (2004), Bordo and Redish (2004), Borio and Filardo (2004)). This is in sharp contrast to the conventional wisdom that generally is drawn from a more limited focus on deflation in Japan in the 1990s and deflation episodes in the Great Depression. This section takes a closer look into historical deflations to better understand the determinants of the different types of deflation. We emphasize that deflations generally fall into three broad categories: the good, the bad and the ugly. Graphs A1-A5 in the appendix provide a graphical summary of the date in our cross-country dataset and spotlight the common and idiosyncratic features of typical good, bad and ugly deflations.

IV.1 Historical narrative: evidence from the nineteenth century

As we discussed above, price levels rose and declined about equally in the long century ending with 1914. Alternating waves of inflation and deflation were an integral part of the commodity-based classical gold standard regime with a general tendency for falling prices from the 1820s to the mid 1840s; then rising prices following the Californian and Australian gold discoveries in the late 1840s until the early 1870s; then deflation from 1873 to 1896; and finally inflation from 1897-1914 following gold discoveries in South Africa and Alaska. This section explores some historical episodes of different types of deflation in the nineteenth and twentieth centuries.

1873-1896: a good deflation that turned somewhat bad

The 1873-1896 episode is a clear example of a "good deflation" when prices fell in many countries by about 2% per year, accompanied by growth of about 2-3% per year (Bordo, Landon-Lane and Redish (2004)). Deflation in that era was driven by both a productivity boom (reflecting the "second industrial or mechanical revolution and the proliferation of railroads across the world (Crafts (2000)), and by a number of major countries (Germany, Netherlands, Belgium and Scandinavia in the early 1870s and France later) joining the gold standard.

Although secular deflation was accompanied by positive growth, it was controversial because of its distributional consequences. Groups whose real incomes fell, such as debtors, farmers or those whose real incomes were perceived to have fallen in an age before price indices complained bitterly and engaged in often disruptive social and political agitation.[24] In the United States, this was manifested in the free silver movement and the rise of organized labor. In Europe it appeared in the growth of both labor unions and labor political parties and in a demand for tariff protection by agricultural groups.

Although real output grew on average in the deflation episode of 1873-1896 in most countries, growth was punctuated by several recessions (1873-1875, 1884-1885, 1890-1896), the worst of which was the last – which may even possibly be characterized as bad. It began with the Baring Crisis of 1890 when Argentina defaulted on its debt. This shock led to banking crises (and stock market crashes) in

[24] Discontent seems to have been less when nominal wages continued to rise than when they fell, although real wages rose in both circumstances (Friedman and Schwartz (1963)).

London, elsewhere on the continent and the United States and other parts of Latin America, especially Brazil (Bordo and Murshid (2003), Triner (2003)). Recession was further aggravated by a wave of banking panics which began in the United States in 1893 and spread to Europe (especially Italy) and Australia (Bordo and Eichengreen (1999)).

1837-1843: bad deflation

An earlier nineteenth century episode of deflation from 1837-1843, often viewed as bad, began with financial crises in London and the Continent (Kindleberger (2000)) and especially in the United States in 1837. Another wave of crises occurred in 1839. In the United States, debate still swirls over whether the crisis and deflation reflected the "Bank War", the struggle between President Andrew Jackson and Nicholas Biddle, President of the Second Bank of the United States (an early central bank) (Rousseau (2003), Wallis (2003)) or events in Europe such as a series of bad harvest failures in England, which led to the importation of wheat from the continent and a drain on the Bank of England's gold reserves leading it to raise its discount rate and precipitate capital flight from periphery countries, especially the United States (Temin (1969)).[25] The annual data for this period may be subject to some questions about their accuracy. For example, although prices fell by 5.6% in the United States, 2.1% in the United Kingdom and 2.0% in France, narratives by contemporary observers viewed the episode as one of serious recession (Thorp (1926)). Available measures of real GDP show an increase in the United States of 3.9% and of 1.3% in France. The United Kingdom, in contrast, experienced a real GDP decline of 2.6%.[26]

IV. 2 Historical narrative: evidence from the twentieth century

1919-1921: bad, possibly ugly for some, deflation

During the immediate post-world war I period, there was a short period of downward price movement in many countries that corresponded with a global contraction in economic activity. For example, annual GDP fell on a peak-to-trough basis by 18**%** in the United States, 29**%** in the United Kingdom, 20**%** in Germany, 24**%** in Canada. Moreover, these years were also accompanied by considerable volatility in output.[27] Given the poor output performance, these deflations would be characterized as "bad". The serious recession and deflation, many would argue, was engineered by tight monetary policies followed by the Federal Reserve, Bank of England, Banque de France and other monetary authorities in countries dedicated to rolling back the high inflation created during world war I and restoring the pre-war gold parity. The expectations of such policies and their likely effects also contributed to the deflationary environment. The collapse in aggregate demand appeared mostly in falling prices, which had increased rapidly during and after the war as a consequence of both wartime scarcity and speculation. It is, however, interesting to note that although real output declined significantly, the decline was not out of line with the experience of earlier severe cyclical contractions (Zarnowitz (1992)). Further analysis of this episode is postponed because of the difficulty in parsing out the various post-war demobilization effects from the policy effects. In addition, the volatility and short duration of the episode complicates the analysis using annual data.

1921-1929: good deflation

The 1920s period represents an example of a good deflation, preceded, as discussed above, by serious recession in many countries in 1919-1921. The rest of the twenties – "the roaring twenties" –

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[25] It is also useful to note that Jackson, a populist, strongly opposed the Second bank under Biddle for its alleged monopoly power over the US banking system.

[26] Without a doubt, the farther one pushes back in history, the less confidence one should have in data for GDP. However, using industrial production estimates from Davis (2002) for the United States corroborates that there is little evidence of a significant production slowdown during this period.

[27] At a higher data frequency in the United States, for example, the unemployment rate rose from 4% in 1920 to 12% in 1921, and industrial production fell 23% (Meltzer (2003)); at the same time, the GNP deflator fell 28% from peak to trough (based on quarterly data from Balke and Gordon (1986)).

observed rapid real growth in many countries (with the principal exception of the United Kingdom mired in a 20-year stagnation) punctuated by two very mild recessions. The period also exhibited mild deflation of 1-2%. Many attribute the 1920s prosperity to a post-war recovery and the proliferation of new "high tech" industries such as automobiles, telephones, radios and refrigerators (White (1990)). The resolution of the post-war reparations and war debt problems in the late twenties, the renewal of international trade with the end of post-war restrictions and the renewal of international capital movements after the major belligerents stabilized their currencies and the gold exchange standard was restored in 1925, and extensive direct and portfolio flows from the United States to Europe (especially Germany) and to Latin America played important roles in spreading the prosperity worldwide (Bordo, Eichengreen and Irwin (1999)).[28]

1929-1933 (the Great Contraction): an ugly deflation

The contraction of 1929-1933 was characterized by both drastic declines in real output (for example, United States -7.6%, Canada -8.4%, Germany -2.7%, United Kingdom -1.0% and France -2.2%) and deflation (United States -6.8%, Canada -6.2%, Germany -5.7%, United Kingdom -3.8% and France -4.4%)**.** In contrast to 1919-1921, more of the contraction of aggregate demand went into output than into prices and nominal wages, reflecting in large part the presence of structural rigidities (Bordo, Erceg and Evans (1997), Hanes and James (2001), O'Brien (1989)).

A voluminous literature exists on the episode. The current consensus view is that the contraction was caused by monetary forces in the United States. The Federal Reserve began tightening monetary policy in early 1928 to help moderate the Wall Street stock market boom which had been underway since 1926. The Federal Reserve was wedded to the real bills doctrine which proscribed bank lending to finance speculative activity (Meltzer (2003)). Deflationary pressure was enhanced by the Banque de France which was following a deliberate gold sterilization policy of gold inflows induced by France's return to the gold standard in 1926 at a greatly depreciated and undervalued parity (Eichengreen (1992)). Tight money then precipitated a recession beginning in August 1929 and the stock market crash in October. Most commentators today believe that the crash was not the main cause of the Great Contraction which followed (Friedman and Schwartz (1963), Romer (1992)) but it did contribute heavily to the first years of serious recession, 1929-1930. The transformation of a serious recession in the United States in 1929-30 into the Great Contraction is universally attributed to a series of banking panics beginning in October 1930 which were unchecked by expansionary Federal Reserve actions (Friedman and Schwartz (1963)).[29]

The contraction was then transmitted to the rest of the world via the fixed exchange rate linkages of the gold standard and by "golden fetters" which prevented the monetary authorities of gold standard adherents from following the expansionary policies needed to offset collapsing demand and a rash of banking panics across the world (Bernanke and James (1991)), without triggering a speculative attack on the gold parity (Temin (1989), Eichengreen (1992)).

The Great Contraction ended by 1933 in most countries except the gold bloc (France, Belgium, the Netherlands, Switzerland, Italy, Poland and Czechoslovakia) which suffered depression until they left gold in 1935-1936. Once countries cut the link with the gold standard, they were able to follow expansionary monetary policies to reflate and recover (Bernanke (1995), Choudhri and Kochin (1980), Eichengreen and Sachs (1985), Eichengreen (1992), Temin (1989)).

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[28] Sargent (1986b) points to the Poincaré miracle as evidence that sound monetary and fiscal reforms during the time allowed France to engineer a relatively costless stabilization of prices, returning the country to the gold standard albeit at a 80% depreciation of the Franc.

[29] The Friedman and Schwartz hypothesis has been supported over the years by considerable research. Bordo, Choudhri and Schwartz (1995), for example, present simulations which show that had the Federal Reserve followed expansionary monetary policies to offset the effects of the banking panics on money supply that the great contraction could have been avoided. A recent paper by Christiano et al (2004) which is based on simulations of a DSGE model of the US economy in the Great depression reaches the same conclusion. Moreover, Bordo, Choudhri and Schwartz (2002) and Hsieh and Romer (2001) present evidence that the Federal Reserve would have been able to follow these expansionary policies without being constrained by its gold reserves as had been argued earlier by Eichengreen (1992).

The process began with the United Kingdom leaving gold in September 1931 followed by two dozen other countries linked to sterling. The United States suffered depression until March 1933; recovery involved expansionary gold purchases by the US Treasury and devaluation of the dollar.

Debate continues over the propagation mechanisms of the contraction in the United States, whether it was via sticky nominal wages (Bordo, Erceg and Evans (2002)), financial disintermediation (Bernanke (1983)), rising real interest rates (Schwartz (1981)), and debt deflation (Fisher (1933)).

The experience of the Great Contraction has colored subsequent views on deflation but the historical record suggests that it is “sui generis”. There is no clear cut evidence on the role of deflation in making the Great Contraction great. We do not know conclusively if falling prices worsened the recession via Irving Fisher’s (1933) debt deflation process (Bernanke and James (1991)) or whether the problem was that prices did not fall enough to clear markets as seems to have been the case in 1919-21. Thus in our work we do not place the Great Depression at center stage in our analysis of deflation but rather we focus on the other experiences with deflation because we view the Great Contraction as special.

1937-38 and 1948-1949: two episodes of bad deflation and the zero nominal bound

Meltzer (1999) documents two recessions in US history characterized both by falling prices and by extremely low interest rates. The recession of 1937-38 was one of the most severe recessions of the twentieth century, characterized by an 18% decline in GNP from peak to trough and the unemployment rate reaching 20%. Prices declined about 5**%** from the quarterly GNP deflator peak in the third quarter of 1937 to the trough in the second quarter of 1939. It was triggered, according to Friedman and Schwartz by a doubling of reserve requirements by the Federal Reserve, beginning in 1936. Other factors include a tight fiscal policy stance by the Roosevelt administration. Short-term interest rates in this episode ranged between 0.03% and 0.5%. Meltzer demonstrates that real interest rates and the real monetary base were highly correlated in this episode reflecting the common influence of deflation.

Real interest rates were perversely related to the evolution of real output whereas movements in real money balances seem to explain well the pace of both recession and recovery. This evidence, he argues, strengthens the case for using monetary aggregates as the major policy instrument when interest rates reach the zero lower bound for nominal interest rates. A similar pattern is observed in the much milder post-world war II recession of 1948-49 which also exhibited falling prices with short-term rates still pegged close to zero. Again, movements in the real base track the real economy whereas real interest rates do not.

Modest deflation in the mid-twentieth century

In the immediate post-world war II era and 1950s, several countries exhibited some proclivities toward very short periods of deflation. In general, the episodes were short-lived when compared to the interwar or pre-1914 period. This may have been a normal aspect of cyclical experience over most of the period before World War II when business cycles typically showed both output and price levels moving procyclically (Cagan (1979), Zarnowitz (1992)). After the mid-1960s, however, we observe a positive price trend in most countries, and, over the business cycle, the pattern of price movements has changed from procyclical levels to procyclical inflation rates. It is only since the return to a low inflation environment in the past 15 years, similar in many respects to the environment that prevailed for much of the preceding century and a half, that the spectre of deflation, ie falling price levels, has reemerged.

IV.3 Statistical analysis of deflation[30]

Incidence of deflation

In looking to the distant past to understand deflation, its relative frequency is striking. In many countries deflation was just as common as inflation during the nineteenth and early twentieth centuries. In contrast, the incidence of deflation during the past 50 years has been relatively rare. (Table 1)

There is good reason to believe that deflation will become a more common phenomenon. The progress over the past decade by central banks in delivering low, stable inflation has been an important achievement (Borio, English and Filardo (2003)). The low inflation environment has not, nor was it expected, to eliminate cyclical fluctuations during more normal times. In the context of a low inflation environment, central banks will always face the possibility of deflation scares, if not deflation itself. In a sense, low inflation economies will always be one recession away from these possibilities.

There are two ways to look at these potential deflation scares. On the one hand, they might suggest that central banks have aimed too low in pursuit of price stability. And, in order to lower the risk, central banks may need to set their sights on a higher average inflation rate. Such a view would be attractive to those who perceive the costs of deflation to be rather high and avoidable. On the other hand, low inflation might be thought of as delivering the constant flow of benefits that theorists have emphasized (as summarized in Section II above). Moreover, under this view, a modest deflation would be perceived as even more welfare-enhancing, especially if the macroeconomic costs of disinflation and reflation were seen to be symmetric and independent of the initial rate of price changes. In this sense, deflation might be seen in a more favorable light, ie to be embraced, not shunned.

Magnitude of deflation

Table 2 presents statistics from the deflationary episodes in the dataset, focusing on the size of the price decline from peak to trough, the duration of each episode and the size of the largest one-year decline during each episode. In contrast to Table 1 which provided an analysis of deflation with an annual frequency, this table emphasizes more persistent deflationary episodes. Each episode was identified by smoothing the underlying price series with a 5-year moving average. Tentative peaks and troughs were identified, thereby eliminating transitory price fluctuations. Then the actual peak and trough dates were chosen using the unsmoothed series.[31]

In contrast to the pattern exhibited in recent decades, long periods of deflation were fairly prevalent. The mean peak-to-trough decline for these episodes was -4.2%. The average duration was 5.4 years. What is particularly important to note is that some of the annual declines in the price level were rather large – in many cases, double digit one-year declines were not uncommon. Of course, the average bundle of consumer goods a century or so ago was relatively dominated by commodities rather than services as is true today. As a consequence, the wide price swings of the past may be more of a reflection of the consumption basket of the past than an indication of the magnitude of price volatility to be expected in today's low inflation environment.

The table also shows quite clearly that deflation episodes were not always associated with a contraction in output. In fact, deflations associated with output contractions were rather rare. Graph 1 highlights this stylized fact and shows that the deep deflations were mostly concentrated in the Great Depression period. Nonetheless, the extreme experiences of the Great Depression arguably still shape – rightly or wrongly – the concerns of the public and policymakers.

Asymmetric persistence of deflation and inflation

Table 3 shows that inflation persistence was generally low in the early period, rose significantly in the twentieth century and then recently fell. This hump-shaped time-series pattern is consistent with the unit root tests on the historical data; the nineteenth century and early twentieth century inflation data

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[30] The details of the cross-country dataset are described in Borio and Filardo (2004).

[31] The algorithm to identify peaks and troughs is consistent with the methodology of Bry and Boschan (1971).

exhibit stationarity, the Great Inflation period is consistent with more persistent changes in inflation rates as would be suggested by a unit root process, and in the past decade there is some evidence that inflation rates have generally become more stationary.[32]

This low-persistence behavior in the distant past was, of course, consistent with the monetary regime implied by the gold standard, both for the core and periphery countries.[33] And, the recent time-series behavior of inflation, as well as the greater frequency of deflation, suggests that the current monetary policy environment is more similar to the distant past than that over the past 40 years.

Another informative comparison of the time-series behavior of persistence addresses whether the size of persistence is deflation dependent. Was transitory deflation more persistent than transitory inflation, as theories emphasizing nominal rigidities would suggest? A threshold autoregressive (TAR) model of the inflation (π) process is adapted from Enders and Granger (1998).

$$\Delta\pi_t = \beta + I_t\rho_1\pi_{t-1} + (1-I_t)\rho_2\pi_{t-1} + \varepsilon_t$$

where I_t is a heaviside indicator function such that $I_t = \begin{cases} 0, \text{ if } \pi_{t-1} \geq 0 \\ 1, \text{ if } \pi_{t-1} < 0 \end{cases}$.[34]

Table 4 presents the results for the pre-1913 period. We find little evidence to suggest that deflation was any more persistent than inflation. The mean value of the persistence parameter during the deflation periods is 0.05 versus 0.15 during the inflationary periods. So, if anything, the persistence during deflations was less than the persistence in inflations. One might be tempted to interpret this as suggesting that there is little role for nominal rigidities, at least during the pre-1913 period. As a corollary, this might suggest that modest deflations were no more costly than modest inflations.[35]

Applying this interpretation to the current monetary policy environment may be subject to many caveats because of obvious differences in the economic environments then and now. For example, some of the differences would include the nature of wage and price rigidities, the importance of debt deflation and the nature of the anchored inflationary expectations. To examine the possible implications for the current period, we apply an analogous method to the Great Inflation period with one key difference. Rather than focusing on periods of inflation and deflation, we examine periods when inflation was above and below its trend. Somewhat surprisingly, the results in Table 5 are rather similar to those in Table 4. The hypothesis tests generally show that negative and positive deviations of inflation around trend exhibit symmetric persistence. If anything, positive deviations, again, are more persistent than the negative ones. The mean persistence is 0.33 for negative deviations and 0.54 for positive deviations.

Further investigations into asymmetry

We check the robustness of the symmetry results in the country-by-country analysis for the gold standard period using panel estimation methods. Table 6 summarizes the results from two groupings of countries. The first grouping is the United States and the United Kingdom. The quality of the data is likely to be the highest for these countries. They also represent two key economies in the gold standard period. The second grouping is for the G10 countries. This provides a larger sample with

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[32] These results are consistent with those of Borio and Filardo (2004), which provide various snapshots of the persistence of inflation in the historical record.

[33] See Burdekin and Siklos (2004).

[34] Enders and Granger (1998) focus on unit root tests in the presence of asymmetric persistence. Consistent with their approach, we account for the possibility of non-standard probability distributions of the test statistics by using Monte Carlo methods even when there is little evidence of unit roots.

[35] Applying these same methods to the immediate post-world war I period is complicated because episodic nonstationarities or other data problems: hyperinflation in some countries, adverse effects of price controls in others during the 1930s and 1940s and some missing data. Some of these factors be responsible for generating behavior consistent with unit roots. In general, for the cases where the data are less likely to have been unduly influenced by episodic nonstationarities, the evidence for asymmetry is weak.

which to improve the accuracy of the analysis. Another key difference between this test and the previous one is that we include additional regressors that may alter our interpretations of the key factors influencing inflation.[36]

The statistical model of inflation is

$$\pi_{i,t} = K_i + \rho_1 I_{i,t}\pi_{t-1} + \rho_1(1 - I_{i,t})\pi_{t-1} + \beta X_{t-1} + \varepsilon_{i,t},$$

where the model is estimated using a pooled regression (unbalanced panel). In this equation, π is the annual inflation rate in country i, K_i is a country specific constant, and X are a set of economic variables associated with inflation determination. I_t is a heaviside indicator function as defined above. The error term is assumed to be distributed normally.

The estimation methodology is straightforward. If the country constants were statistically different at the 95% confidence level, we estimated model with fixed effects; otherwise, we used a common constant. In nearly all the cases, we could not reject the hypothesis that all the country constants were equal to each other. This should not be a great surprise given the nature of the gold standard and its strong nominal anchor on all the countries under consideration.

The hypothesis of symmetry of the inflation process was tested again by comparing ρ_1 and ρ_2. The evidence is quite clear for both groupings: there is no statistically significant evidence that the inflation process is asymmetric. This suggests, as noted above, if there were nominal rigidities in the gold standard period, they did not seem to have a measured impact on the inflation process. The other regressors, X, included in the regression are the first lag of the country-specific annual growth rate of money, the output gap, supply shocks, demand shocks, a banking crisis variable and the annual growth rate of real equity prices (see footnote in the table for further details). In general, they have plausible, economically-meaningful signs, with the lagged of the money growth variable being the most significant. Their inclusion did not change the robustness of the symmetry result.

Statistical determinants of the good, the bad and the ugly deflations

This section investigates the determinants of the good, the bad and the ugly deflations as a means to delve further into the nature of deflation in the distant past. Using information from both the historical narratives and the quantitative measures from the historical dataset, each deflationary episode in Table 2 is classified as being either a good, bad or ugly deflation. This classification is then analyzed using an ordered probit model, employing various economic factors that might help to distinguish the conditions most likely to produce one of the types of deflation. It is important to note that deflation in this model is a persistent decline in aggregate prices.[37]

In the empirical model, the dependent variable can take one of three values which correspond to the deflations that were categorized into the three types of deflation:

$$\Lambda_i = \begin{cases} 0, good\ deflation \\ 1, bad\ deflation \\ 2, ugly\ deflation \end{cases}$$

Assuming a latent variable formulation of the model, the latent variable λ^* is described in terms of observable variables X as[38]

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[36] One might interpret this as a reduced form Phillips curve specification. The key here is whether the specification is nonlinear, as others have argued would occur if nominal rigidities were macroeconomically significant (see, for example, Lebow, Wascher and Stockton (1995), Akerlof et al (1996)).

[37] See Borio and Filardo (2004) for stylized facts about various types of price indexes and data frequencies. In their cross-sectional analysis of the costs of deflation, they also emphasize long swings in prices rather than quarterly or annual changes.

[38] For more details about this formulation of the ordered probit model, see Green (2000).

$$\lambda^* = X\beta + e$$

where *e* is assumed to have a Normal distribution with a mean of zero and a given standard deviation. The relationship between the categorical indicator and the latent variable is

$$\begin{cases} \Lambda_i = 0\,(good\ deflation), if\ \lambda^* \le \alpha_1 \\ \Lambda_i = 1(bad\ deflation), if\ \alpha_1 < \lambda^* \le \alpha_2 \\ \Lambda_i = 2\,(ugly\ deflation), if\ \alpha_2 \le \lambda^* \end{cases}$$

where the α_1 and α_2 are unobserved threshold parameters that must be estimated. The observable variables, *X*, are chosen based on availability and on their relevance in possibly playing a role in determining whether a particular deflation will be of the good, the bad or the ugly type. They include monetary aggregates, the percent deviation of the price level from a steady-state price level (P*) based on the quantity theory, a banking crisis indicator variable, supply and demand shocks, real wage inflation, interest rates and the growth rate of real equity prices.[39] The regressors are five-year averages of the observable variables prior to the peak in the price level.

While these variables have various possible interpretations as to their economic significance, we would like to highlight our views. The monetary aggregates and the P* variables capture a monetarist view of the inflation process. The rapid growth of the monetary aggregates is likely to raise inflation initially and to put pressure on the gold parity constraint. The adjustment process would generally generate conditions fostering deflation. The gap between the price level and P* captures the similar notion that deviations of prices from the nominal anchor would likely prompt an adjustment over time; the larger the deviation, the sharper the likely adjustment. Supply and demand shocks are closely related to possible channels determining whether a deflation is good or bad, as argued above. Real wage inflation, while related to supply and demand conditions, could serve as a proxy for nominal rigidities; if nominal wages exhibited downward rigidities, high real wage growth would likely exacerbate the subsequent adjustment process. The interest rate could also be picking up some cross country differences in financial conditions vis-à-vis the underlying monetary conditions implied by the gold standard. The crises variables offer a possible link between deflation and financial crises.

The results are generally supportive of the monetarist view that monetary conditions are important determinants of the different types of deflation (Table 7). On the one hand, the cross-sectional bivariate correlation between money growth and the probabilities of the good, the bad and the ugly deflations is not particularly high at .04, but is statistically significant at the 95% confidence level. Its R^2 is fairly low at 5%. On the other hand, the P* gap appears to be an important determinant of the different types of deflation, especially when the banking crisis indicator is included in the estimated model. Model 3, for example, explains 24% of the cross-sectional variation, and the model parameters are significant at the 95% confidence level. These variables generate consistent correlations for nearly all the relevant specifications in the table. It is also useful to examine the in-sample fit of the models. The middle panel provides such information. In general, the P* and banking crisis variables account for many of the good deflations – since the crisis variable is generally 0 for the good deflations, this suggests a particular strong role for the P* variable. In addition, it is useful to examine the results of models 7 and 9 when the number of deflation episodes falls to just under two dozen. In these cases, the role of the real wage growth and real equity prices has less to do with their explanatory power than with the fact that data availability cuts down the number of useable data points. The bottom line is that the P* and crisis variables are able to explain at least two dozen deflationary episodes quite well.

One way to gauge the importance of the crisis variable is to examine its marginal effect of the probability of being in the good, the bad and the ugly deflations.[40] In the bottom panel, we look at the marginal effect in model 4. The results are striking. If there is no banking crisis, the probability of the

[39] Data limitations prevented the use of the credit variables. See Borio and Filardo (2004) for suggestive evidence that such considerations may be an important indicator of possible deflation threats. Note however that the money aggregates and the banking crisis variables may be thought of as reflecting information that would be found in the credit variables. Further investigations along this avenue could prove to be fruitful.

[40] It is well known in ordered probit models that the marginal effects of the regressors on the probabilities in not equal to the coefficients.

good, the bad and the ugly deflations are .93, .06 and .01 respectively. If a crisis, the probability of a good deflation drops dramatically to .38, while the probabilities of a bad and ugly rise considerably.

The other explanatory variables in the table provide marginal predictive content but, in general, the contribution is not statistically significant. The coefficients have intuitively plausible signs. For example, the bigger the supply shock, the more likely a good deflation would occur (hence the negative coefficient). The greater the increase in demand shocks and real wages, all else the same, reduces the likelihood of a subsequent good deflation, a result consistent with cyclical price behavior. Equity prices have the same sign as the supply shocks, suggesting that real equity prices may reflect the likelihood of a favorable supply side phenomena, and hence raise the likelihood of a good deflation. But, as mentioned above, the statistical significance of these variables is rather low, especially when compared to the P* and banking crisis variables.

IV.4 Recent experience with deflation

We now turn our focus to recent policy challenges arising from deflation. The most notable case is that of Japan. We also consider Hong Kong (China, hereafter referred to as Hong Kong), China, Singapore, Taiwan (China, hereafter referred to as Taiwan), and briefly discuss the recent "deflation scares" in the United States and Europe. Graph 2 summarizes recent trends in prices, real GDP, real money, the nominal interest rate and equity prices in these areas.

Japan The example of deflation receiving the most attention today is Japan which has had bouts of falling prices since the mid-1990s. It seems to be a case of "bad" deflation characterized by stagnant real activity along with mild deflation (Ahearne et al (2002)). Arguably, the underlying cause of the Japanese problem was not deflation, per se, but the problems in the banking system with its concomitant adverse consequences for the monetary transmission mechanism (Hetzel (2004), Sellon (2004)).[41] To put it another way, it does not seem reasonable in retrospect that a somewhat lower real interest rate of a couple of percentage points would have significantly improved conditions, as experience with the zero interest rate policy and quantitative easing policy has revealed.

Recent data from Japan has once again raised hopes that the economy is truly on the mend. The building momentum in economic activity and tentative signs of progress in dealing with its structural financial issues have been promising. The extent to which the quantitative easing policy has helped to achieve this outcome will surely be of considerable debate for years to come. But, we see this correlation as suggestive evidence that it is still true that aggressive expansion of the monetary base sufficient to boost broader money aggregates can work to revive aggregate demand.

It should be noted that the very accommodative monetary policy has not been without its risks, especially since policy has had to deal with the consequences of an intrinsically non-monetary problem. One potential problem for the Bank going forward is whether the rapid expansion of the monetary base can be reversed in an orderly fashion as more normal monetary conditions take hold in Japan. Relying on monetary policy to boost aggregate demand necessitated the rapid expansion of the central bank's balance sheet. The size of the Bank of Japan's balance sheet is now the largest in its history, growing to ¥140 trillion in early 2004, or roughly 25% of nominal GDP.[42] This means that when the economy returns back to a more normal situation and velocity returns to something closer to its historical average, the Bank will have to reduce this monetary overhang by draining a considerable amount of liquidity from the economy. During the transition, the Bank of Japan may face a delicate balancing act: if it were to withdraw the liquidity too quickly, it risks stalling the recovery – in a sense, patience in this case would be a virtue; if it withdraws the liquidity too slowly, there would be the risk of an excessively strong burst of economic activity and a concomitant surge in inflation, at least in the short run, requiring a significant tightening of monetary policy that could engender considerable volatility.

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[41] For an alternative view, see Hayashi and Prescott (2002), who see the underlying problem as being low productivity growth rather than a breakdown of the financial system. They estimate a sharp slowdown in the rate of total factor productivity. Fukao et al (2003), however, reverse this conclusion in a subsequent study of sectoral productivity trends, arguing that Hayashi and Prescott overestimated the size of the decline due to deficiencies in aggregate data.

[42] By means of comparison, the ECB, the Federal Reserve and the Bank of England have balances sheets that are roughly 12%, 7% and 5% of nominal GDP, respectively.

One additional complication may arise from the need for the Bank of Japan to tap the Ministry of Finance for a recapitalization, if adverse interest rate and exchange rate movements cause losses on its assets. This could raise thorny issues of central bank operational independence (versus financial independence), *de facto* or *de jure*. While the consequences of negative net worth (in an accounting sense) for a central bank is surely different than that for a private bank, as history has shown, such developments, nonetheless, could raise actual or perceived conflicts of interest. Such developments could, in principle, complicate the conduct of monetary policy, if only to weaken the private sector's beliefs about the nominal anchor going forward (Ueda (2003)).

Hong Kong The deflation experience in Hong Kong reinforces our view that the distant past has important implications for the present. The source of the problem has not been a banking problem as in Japan. For example, the banking sector, while feeling the pressures from the unfolding events, does not appear to have suffered from debt deflation (Gerlach and Peng (2002)). Rather, the persistent deflation in Hong Kong appears to reflect the consequences of a sharp property price decline, in the context of a currency board arrangement. The desire to peg to the US dollar meant that the huge wealth shock from the collapse of housing prices would have to be accommodated through the reduction of domestic wages and prices rather than through the exchange rate. And, as was seen in the post-world war I period, those countries that tried to force a large adjustment on domestic prices and wages, rather than adjusting the gold parity, faced greater and more drawn out economic adjustment costs. In an analogous way, the choice to stick to its nominal anchor in the form of a currency board instead of devaluing required considerable labor and product market adjustments.[43]

The experience illustrates several important points. First, asset price booms and busts may be a much more important source of persistent deflation than conventional supply and demand shocks. Second, deflation is more likely to be a symptom rather than the underlying cause of economic difficulties. Indeed, as recent history has shown, persistent and moderate deflation did not result in a deflationary spiral. It is important to note that the financial sector in Hong Kong, while suffering from the large drop in asset prices, remained "resilient" (Latter (2003)). Third, evidence on nominal wage flexibility, while hardly perfectly flexible, shows evidence that as deflation became more entrenched, labor became more concerned with real rather than nominal changes. The sharp deceleration in nominal wage growth in the aftermath of the Asian crisis illustrated some downward flexibility. Nominal wage growth fell to around zero percent during 1998, which led to a rise in real wages as deflation took hold. However, since then, nominal wage and real wage growth has declined (Han (2003)). Fourth, in view of our findings, we would argue that with a well-operating banking system, the HKMA could have reflated the economy more quickly but it would have come at the cost of abandoning their currency board. Some might see some merit to abandoning it, but clearly, in a fiat currency world, credible and adhered-to commitments may far outweigh the transitory cyclical gains associated with abandonment. In sum, the Hong Kong situation illustrates that the cost of reflating the economy might have been more expensive in terms of reputation and commitment than the cost of maintaining a persistent deflation. Of note, underlying deflationary forces appear to have waned recently, reflecting in part the global recovery and the years of domestic adjustments (Yam (2004)).

China China has recently been facing an acceleration in consumer prices, but in the past several prior years, it had experienced modest but persistent deflation. Strong economic growth accompanying its export-driven development strategy generated huge productivity gains that held price pressures in check. In addition, the access to a very elastic supply of low cost labor has helped to cap wage pressures, as has the excess capacity of state-owned enterprises which often have operated at losses. In a historical perspective, the deflation appeared to be of the good type. As recent price developments highlight, the monetary policy transmission mechanism, despite some unique features of the Chinese economy, broadly operates as in other countries. Rapid growth in the monetary aggregates eventually translates into inflation. This also suggests that the traditional monetarist prescription for deflation is an important option for central banks in emerging market economies.

Looking forward, however, a return to deflation, possibly of the bad type, cannot be ruled out. The vulnerabilities in their banking system represent a considerable source of uncertainty (Fung and Ma (2002)). On the one hand, history has shown that banking problems that translate into impediments to

[43] See also Genburg (2003), Gerlach et al (2003) and Razzak (2003) for more in depth views about the deflation in Hong Kong.

the monetary transmission mechanism can lead to bad deflation. And, of course, if the banking problems were to morph into a full-blown banking crisis, a bad deflation could even turn into an ugly deflation. On the other hand, early resolution of any banking problems could prevent an ugly deflation, and even forestall a bad one. Of course, as in the gold standard period or in Hong Kong recently, China's choice of a pegged exchange rate could complicate the adjustment process, especially since many believe that the notional value may be out of line with fundamentals.

Singapore and Taiwan Singapore and Taiwan have also experienced very low inflation rates that in certain years dipped below zero. In general, the deflation rates were rather mild and transitory, and largely corresponded to unexpected slowdowns in economic activity (BIS (2003)). More important, they did not present particularly daunting policy challenges but rather were examples of low inflation economies experiencing the typical procyclical tendencies of inflation during the business cycle.

Deflation scares in the United States and Europe The United States has not experienced deflation in recent years. But it did get uncomfortably close for the Federal Reserve. In 2003, as core CPI inflation continued to fall with only tentative signs of recovery, there was a risk that deflation would materialize. Arguably, if one were to take into account the statistical bias in price indexes, the United States was in the deflation zone for a short period of time. Part of the concern about a more persistent deflation environment came from the assessment that the recovery was still fragile and that strong productivity gains were keeping slack ample. In the end, strong stimulus from monetary and fiscal policy helped support economic growth as the private sector gained momentum. By mid-2004, the risks to deflation appeared to have largely vanished and were replaced by increasing concern about the upside risks to inflation. In some sense, the United States experienced a "good" deflation scare, ie one where the deflation risk arose from better-than-anticipated productivity gains. There is some question about how aggressively monetary policy should respond to good scares. Qualitatively, good scares would generally justify less of a policy response than a bad scare. Part of the reason for this is that good scares would be accompanied by strong output growth. Another reason stems from the analysis of the inflation risks in an uncertain world, especially in the context of real-time policy making. For example, an upside risk to inflation could materialize if the central bank initially misread economic developments. If the monetary authority initially interpreted disinflation coinciding with rising output as a supply shock but later found out it was due to some statistical price anomaly in the context of a demand-driven expansion, the accommodative monetary policy response would prove to be procyclical. Of course, if the central bank perfectly timed the need to drain liquidity as the real or perceived threat waned, all would be fine. But if the central bank were to get behind the curve, the monetary policy accommodation could translate into a rise in inflation above its desired rate before the effects of a subsequently tight policy permeated the economy.

In contrast, the deflation scares in Germany and Austria are probably best thought of as "bad" scares, even though the risks of deflation in the euro area as a whole have been very low (Issing (2002), Svensson (2003a)). In these countries, deficient demand was mostly responsible for the concerns about falling prices. Easy monetary policy with some fiscal expansion (but more limited than in the United States because of the constraints, at least soft ones, imposed by the Stability and Growth Pact) has helped to prevent deflation from materializing as well as the recovery in external demand. In contrast to the US scare, the monetary policy response to a "regional" scare in the euro area has been constrained owing to the fact that euro-wide inflation has been near the upper end of the ECB's preferred range for the inflation rate. The optimality of the policy tradeoff is likely to involve the costs of higher inflation for all versus the cost of deflation for the few.

Switzerland's recent experience illustrates the case where slow productivity growth (possibly causing the Wicksellian natural rate to decline) and cyclical weakness has led policy rates to close in on the zero lower bound for short-term interest rates. As the Swiss National Bank has emphasized, this development has not made monetary policy ineffective, but rather requires greater emphasis on quantitative measures and other alternative policy instruments.[44] Switzerland, being a small open economy, also has had the option, via central bank intervention in foreign exchange markets, to depreciate the Swiss Franc as a means to help ward off unwelcome deflation.[45] Larger countries might

[44] See, for example, Kohli (2003).

[45] See Kugler and Rich (2001) for a discussion of the Swiss National Bank's conduct of monetary policy in the late 1970s low interest rate environment in Switzerland. In that situation, the Swiss National Bank pegged its exchange rate to forestall the

not have such flexibility because of possible perceptions that they may be pursuing "beggar thy neighbor" policies. Again, inflating out of the current situation is a policy choice rather than a binding constraint. Low inflation and modest deflation, even in the context of slow productivity growth, may be more preferable to the long-term corrosive effects of higher inflation.[46]

Sweden offers the latest glimpse into an economy having recently faced a modest deflation scare of the "good" variety. Price changes were unexpectedly low in 2003 and early 2004 arising from several factors, such as low import prices, the unwinding of past relative price increases and, potentially most important, weaker than expected unit labor costs. The unit labor cost developments reflect both faster productivity, which has been helping to support the recovery, and subdued wage trends. The scare, while short in duration, highlighted the risks of a temporary bout of price declines in a low inflation economy, and it highlights some features of the historical experience of deflation: deflation can be unexpected, associated with robust economic growth and be a regular part of a low inflation economy, especially for small economies.

In sum, the spate of deflation scares is an important development in a historical sense. The low inflation environments today, as in the past, have led to higher incidences of deflation scares and deflationary outcomes. In light of this natural outcome in this environment, central banks who have yet to experience deflation, and those who already have but who may not have fully anticipated all the possible contingencies, may need to calibrate their monetary frameworks to deal best with such possibilities. In the next section, we offer a new way to look at the policy challenges that is based on what we have learned from the historical record.

V. Inflation, deflation and monetary policy: the zonal approach

The historical record has provided a wide range of experiences from which to draw some conclusions about the usefulness of monetary policy. In this section we offer a holistic approach to determining the appropriate monetary policy framework. In general, history shows that the appropriate framework depends on the inflation circumstances or, more precisely, the inflation zone in which a central bank finds itself. The zones span the spectrum from high inflation to deep deflation; for a visual summary of this view, see Graph 3. We discuss each zone and its implications for monetary policy tradeoffs, in turn, emphasizing what we have learned from the historical record. It is also important to emphasize that to learn from history, we have to be careful about extrapolating linearly from the past to the present. In a sense, a corrective lens may be necessary at times to view the past clearly. In this section, we remain cognizant of some factors that may be useful in translating the lessons from the past for the future.

V.1 Zone 1: high inflation

Zone 1 is characterized by high and volatile inflation, as experienced in Latin America during much of the twentieth century, as well as in infamous European cases of hyperinflation during the interwar period. These episodes provide the clearest example of Friedman's dictum: inflation is always and everywhere a monetary phenomenon (McCandless and Weber (1995)).

The prescription to avoid such circumstances seems simple enough – reduce and stabilize the growth rate of money. Such a simple policy has often been complicated by political pressures to raise revenues from monetary creation (the seigniorage motive). Hence, to keep high and volatile inflation from reappearing, successful monetary reforms have generally gone hand in hand with fiscal reforms

deflationary pressures coming from the "excessive upvaluation of the Swiss Franc". While defusing the exchange rate and deflation problems, they could not prevent an eventual increase in inflation.

[46] See Zurlinden (2003) for a discussion of Switzerland's deflation experience in the Great Depression.

(Sargent (1986a)). Such monetary reforms historically have included provisions to slow the rate of money growth and to ensure more central bank operational independence.[47]

Moreover, a package of tight money and fiscal balance can be further enhanced if anchored by a credible commitment mechanism to stabilize inflationary expectations with the concomitant effect of stabilizing velocity. Words alone are not sufficient in such a zone. Words must be backed up with actions. History has shown how to design successful private and public arrangements. In the nineteenth century and the early twentieth century, arrangements included adhering to the gold standard (as was the case with the stabilizations in Europe in the 1920s), establishing a provision (by international loans) of gold or other hard currency reserves by a credible authority such as the Bank of England and the Federal Reserve, and, in the interwar period, the Bank for International Settlements. In addition, private sector solutions are possible and, in fact, have been used in the past. Private sector guarantees of international loans, for example, were offered by Rothschilds or JP Morgan both before and after World War I (Bordo and Schwartz (1999b)). In the more recent period, IMF-backed reform programs have often played an important role in successful programmatic reforms leading to the elimination of high inflation.

V.2 Zone 2: moderate inflation

In the case of moderate inflation, such as characterized the experiences of the advanced countries in the 1970s and early 1980s, the prescription to improve outcomes is similar in spirit – tight, credible monetary policy. Two different strategies to achieve low inflation generally have been followed: monetary aggregate targeting and an interest rate approach, which in recent years has been tied to an inflation targeting framework.

In the former strategy, the central bank uses its policy tool (eg open market operations) to achieve a desired growth rate of some monetary aggregate consistent with achieving its inflation goal on quantity theoretic lines (eg Sargent (1986b)).

In the latter strategy, the monetary authority targets a short-term interest rate to achieve the desired inflation target, accounting for the influence of the real economy via the output gap as well as other variables. To achieve a successful strategy, the monetary authority must ultimately focus on the real interest rate, or else the policy could create unstable nominal conditions; one such necessary condition for stability is that nominal interest moves by more than the change in the inflation rate, which is sometimes referred to as the Taylor principle (Taylor (1999)). In a sense the modern approach is more akin to the Wicksellian approach (Woodford (2003)).[48]

Higher levels of inflation have historically been associated with higher inflation uncertainty. Such volatility would naturally mean that ex ante and ex post short-term real interest rates would be quite volatile. This behavior would generally diminish the usefulness of interest rates as instruments of monetary policy and would lead to a preference for monetary aggregate targeting. As inflation declined and credibility for low inflation increased, interest rate uncertainty would likely decrease and variation in the nominal short-term interest rate would largely reflect variation in real rates. This improvement bolsters the case for using a Wicksellian real interest targeting strategy at the lower end of the inflation range in this zone.

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[47] The costs of large credible disinflations are estimated to be rather small (Sargent (1986a&b)). Andersen (1992) and Ball (1994) provide additional cross-country evidence that the costs of disinflation (in terms of the sacrifice ratio) differ systematically with the size and speed of the disinflation and the extent of wage flexibility. Also see Siklos (1995) for a review of twentieth-century inflations and disinflations. Recently, Erceg and Levin (2003) argue that a policy of monetary contraction inevitably would lead to a (temporary) real contraction in the face of inelastic price expectations and nominal rigidities, but the more credibly perceived the commitment to restore price stability, the lower the sacrifice ratio.

Credibility and the cost of disinflation would also depend on future political outcomes and economic shocks – developments which would be difficult to predict with precision. Such developments could also make it difficult to rule out a return to an unfavorable regime of the type seen in the past (Gagnon (1997)).

[48] It took about a decade (1979-1992) for the United States, United Kingdom and other advanced countries to achieve this outcome. Doing so required following a preemptive policy on several occasions (eg 1994) to raise real rates above the prevailing nominal rate and in effect respond to an “inflation scare” (Goodfriend (2003), Orphanides and Williams (2003)).

Also with disinflation, velocity would likely become less predictable in large part because financial innovation would play a more dominant role in its fluctuations, further strengthening the case for interest rate targeting (Poole (1970)). Looking forward, if the pace of and nature of financial innovation were to have a more muted effect on velocity, it is conceivable that central banks would raise the weight of monetary aggregates in their conduct of monetary policy.

In this zone, a mixed monetary policy strategy makes good sense. The monetary aggregates arguably have provided a tried and historically true guide for monetary policy, if only to provide a broad mooring of the price level over time; arguably, the relationship between the monetary aggregates and inflation has been imprecise in the short run but has been fairly close over the medium run in many economies (Graph A6). As history has shown, however, financial innovations have at times adversely affected the stability and predictability of velocity; even some of the recent instability has reflected the lingering vestiges of inefficient Great Depression-era regulatory constraints being lifted. To be sure, interest rate "rules" based on output gaps have had success as guides for policy, especially as inflation becomes moderate or low. But, this does not suggest that the monetary aggregates should be completely ignored. Rather it suggests that relying both on the monetary aggregates and interest rate rules based on economic measures related to short-term price pressures as guides for policy has considerable appeal. The ECB's two-pillar approach is an example of such an approach (Issing (2001), Masuch et al (2002)).[49]

V.3 Zone 3: low inflation/price stability

In this zone, with a credible nominal anchor in place, consumers, workers and investors would incorporate expectations of price stability, or low inflation, into their decision-making. They would also anticipate that departures of the price level from some reference value, or of inflation from the low desired inflation rate, would be transitory and hence would be expected to be offset by corrective monetary actions. In the historical case of the gold standard, the credible commitment to maintain the gold parity, except in cases of wartime emergency, firmly anchored expectations. In credible fiat currency regimes, the anchor could be established as an implicit policy rule to achieve the monetary authority's inflation, or price level, goal.

In the current policy context, two important issues are how a central bank might best enter this zone and how the central bank might maintain it once it is achieved. A deliberate and gradual disinflation into this zone from zone 2 would likely entail transitional costs that could be perceived as being high. An alternative, the opportunistic approach may represent a low-cost strategy (Bomfim and Rudebusch (1998), Orphanides et al (1997)). Under such a strategy, the monetary authority would wait patiently for a favorable price shock to materialize and produce a lower inflation rate. Once achieved, the monetary authority could adopt a more symmetric approach to fighting both rising inflation pressures and declining inflation pressures.

An important potential policy concern that arises in this zone is the proximity of the zero lower bound on short-term interest rates. If inflation were to fall low enough, possibly into deflation, a monetary authority would generally find it increasingly difficult to use short-term interest rates as an accurate measure of the stance of policy or as a reliable policy guide. Moreover, short-term policy rates could prove to be a poor means to communicate the policy intentions of the monetary authority. Again, the evidence from Meltzer (1999) underscores this point.

The problems with short-term interest rates, however, should not be construed to mean that the monetary authority necessarily loses its room for maneuver. In fact, the monetary authority may have ample room, especially if the financial sector is healthy. The monetary authority could adopt various non-conventional measures to conduct policy such as targeting long-term rates, pursuing unsterilized foreign exchange intervention, adopting quantitative easing (by focusing on monetary targets) and

[49] The 2003 restatement of the ECB's policy strategy emphasized its two pillar approach. The pillars do not represent two approaches, per se, but rather complementary ways to assess the overall assessment of the risks to its price objectives. In particular, economic indicators of short-run price pressures are first analyzed and then cross-checked with the medium-term and long-term implication from the monetary aggregates. Issing (2002) offers an analysis of the deflation risk in the euro area which illustrates how a central bank may use the monetary aggregates to assess the monetary environment. For a dissenting viewpoint, see Galí et al (2004). For a more general discussion of some issues, see Viñals (2000).

purchasing goods and commodities outright. History suggests that the most time-tested means at the central bank's disposal is the expansion of the money supply via the monetary aggregates – both narrow and broad measures. In this case, the central bank could use open market operations to increase the reserves of the commercial banks in order to spur aggregate demand and achieve its desired inflation rate (Lucas (2004)).[50]

V.4 Zone 4: low-to-moderate deflation

Some might view this zone with deflation, from roughly 0 to 3, as the next logical step towards truly realizing the benefits of low inflation.[51] Theory suggests that central banks may be able to increase economic welfare by reducing the inflation rate at least to true price stability-ie where the price level on average is flat. As pointed out above, some theories suggest that the optimal inflation rate may be as low as -3%. The attractiveness of the moderate deflation policy would depend on the empirical relevance of several important assumptions in the theories, not least of which includes the nature of nominal rigidities and the benefits of steady-state deflation.[52]

This zone could present some additional complications arising from cyclical variation of price changes around the steady-state deflation rate. First, the zero lower bound for interest rates would be more relevant than with a higher steady-state inflation rate. Naturally, a moderate deflation environment would be associated with low nominal interest rates. The likelihood of reaching a zero nominal rate would depend on the steady-state deflation rate and on the type of shocks affecting the real interest rate. A negative demand shock, for example, would likely generate both a transitory decline in the real rate and disinflation. In this case, the zero lower bound for short-term nominal interest rates would more likely to bind than if the steady-state inflation rate were higher. A similarly-sized supply shock would present less of a problem because of the tendency for the real rate to increase, and therefore offset the disinflationary effect on the probability of hitting the zero lower bound.

Second, as discussed above, the zero lower bound would present complications for policy makers. And, of course, the closer the economy initially is to zero lower bound, the more likely the bound would be reached. This suggests a few possible policy options. Of course, the central bank could steer clear of the zero lower bound by choosing a higher steady-state inflation rate – something in zone 2 or 3. The cost of this choice would be the foregone stream of benefits from the lower inflation rate.

Alternatively, the central bank could rely more heavily on quantitative measures of monetary policy. One interesting idea comes from the theoretical findings of Benhabib, Schmitt-Grohé and Uribe (2002). They argue that a central bank could eliminate some of the problems associated with the zero lower bound for nominal interest rates by switching from an interest rate rule to a monetary aggregate rule when nominal interest rates got sufficiently low. Along these same lines, a monetary authority might use several different types of contingent rules for various policy instruments, which not least of which include exchange market interventions; this particular option, however, may be more feasible for small economies than for large ones, as discussed above.

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[50] For a general discussion of central bank options, see Bernanke and Reinhart (2004). They also highlight the use of communication strategies to shape interest expectations, central bank asset rebalancing to influence the relative market supplies of different types of debt securities and the expansion of the monetary base. See Andres et al (2004) for a recent theoretical model illustrating this general principle that imperfect asset substitution provides a potential channel for US monetary policy if short-term interest rates became less useful. For a truly unwelcome deflation, Svensson (2003b) has offered his foolproof approach to exit it. Kugler and Rich (2001) have raised some doubts about whether it would have worked well in the case of Switzerland in the 1970s. Goodfriend (2000) and Buiter and Panigirtzoglou (2002) discuss the possibility of the Gesell tax on money as an alternative means to increase the room for manoeuvre with interest rate instruments.

[51] Due to statistical biases, the top of the range might best be thought of being about .5 or so. The exact number would vary from economy to economy and would depend on the accuracy of each economy's price indexes.

[52] If nominal rigidities are symmetric and independent of the level of the inflation rate, then there would be no particular need to act in a particularly aggressive countercyclical fashion when average inflation rates are positive than when they are negative, ceteris paribus. If, however, nominal rigidities are asymmetric around zero inflation, then this might dictate more aggressive preventive measures against deflation. Ultimately, this is an empirical issue concerning the nature of nominal rigidities.

Central banks might also find it very important to take actions that more effectively shape private sector expectations.[53] For example, a central bank could adopt a new policy regime with a stronger nominal anchor. As the gold standard period illustrates, a price level anchor can be useful in preventing the zero lower bound from being hit.[54] Another means to shape expectations is through words, rather than actions. Central banks that provide a more transparent and credible policy regime are more likely to achieve their goals (Francasso et al (2003)). Hence, zone 4 would put a premium on central bank credibility in order to prevent adverse outcomes. This suggests that a central bank interested in entering zone 4 would likely want to place particular emphasis on clear, credible communication. Indeed, the stronger the perceived commitment of the monetary authority to maintain the inflation rate in a particular narrow range, or the price level on a particular path, the less likely a pathological expectational channel would be realized.

What we have discussed so far assumes that policy makers fully understand the economic and policy environment. This assumption could be at odds with reality during the transition from a low inflation environment to a low-to-moderate deflation environment. This uncertainty would represent a potential cost policy makers would have to factor into their decision to enter zone 4. The new economic environment could present challenges owing to the possibility that policy makers might need to recalibrate their monetary policy strategies and might find the private sector responding differently than in zone 3. As Lucas (1976) pointed out, when a monetary policy regime changes, the economy might respond quite differently – especially if we don't have good theories to model the change. To be sure, we have seen the problems associated with interest rate instruments for some countries that have moved (or were pushed) from zone 3 to zone 4. But, this is not to say that quantitative measures would be much easier to use in the transition. Quantitative policy measures would also need to be recalibrated in the new policy environment.[55]

Finally, a key concern arising from being in zone 4 is the possibility that a modest shock could initiate a sequence of events that could cause the economy to careen uncontrollably into an ugly deflation. While it is impossible to rule out such possibilities in any of the zones, history has shown that deflationary spirals are extreme outcomes that rarely occur in isolation but rather is a product of the confluence of bad economic shocks, bad policies and bad luck. We consider this unlikely outcome in zone 5.

V.5 Zone 5: deep deflation

In a situation like the Great Contraction of 1929-1933, many have argued – persuasively in our view - that expansionary monetary policy could have softened the blow to the economy. But, as contractionary forces became sufficiently strong and the monetary transmission mechanism sufficiently impaired, expansionary open market purchases could have driven down interest rates to the zero lower bound without the expected stimulus permeating the economy. Clearly, if such an extreme were to occur, a monetary aggregate targeting strategy would be superior in such a situation. Indeed in the 1930s US experience, short-term rates did approach zero by the end of 1932. When the Federal Reserve expanded open market purchases by $1 billion in the spring of 1932, it did succeed in temporarily stimulating the economy. This policy was abandoned after several months, some argue, because of concern over the Federal Reserve holdings of free gold (gold reserves in excess of statutory requirements) (Eichengreen (1992)); the evidence, however, is not thoroughly convincing on this point (Bordo, Choudhri and Schwartz (2002)). Others argue that it was abandoned because

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[53] Indeed, some have argued that the monetary authority need not even use open market operations to achieve its interest rate target; simple announcements to be sufficiently "irresponsible" might be all that is needed (Eggertsson (2003), Eggertsson and Woodford (2003)). However, they do point out that it might be helpful for the monetary authority to adjust the monetary supply to keep the monetary base proportional to the price level as a means for the central bank to signal what it believes the appropriate price level should be. See also the discussion in Masuch et al (2002). They argue that that a reference value for money growth can act as an anchor to prevent a deflationary spiral, which generally is not a property of simple interest rate rules.

[54] See, Borio and Filardo (2004) for a discussion of the zero lower bound in the nineteenth and early twentieth centuries. In general, the zero lower bound was rarely bit, despite episodes of steep deflation.

[55] See, for example, Nelson (2003). For a different view, see Gerlach and Svensson (2003) and Rudebusch and Svensson (2002).

Congress, which had pressured the Federal Reserve to stimulate the economy, went on recess in July 1932 and the Federal Reserve reverted back to its original "liquidationist stance" (Friedman and Schwartz (1963)).[56] Although the zero lower bound was reached in late 1932, a successful reflationary monetary policy was initiated in March 1933 by the US Treasury actively purchasing gold (and silver) in a deliberate attempt to devalue the dollar.[57] This evidence supports the cases both for conducting open market operations in assets other than short-term paper and for the use of monetary aggregate targeting in the case of severe deflation.

In the case of the US Great Contraction, although monetary policy did eventually end the "ugly" deflation, the recovery was attenuated by other policies followed by the Roosevelt administration. The NIRA, established to artificially raise wages and prices by restricting the supplies of labor and commodities reduced aggregate supply in 1934-35 below what it would otherwise have been (Weinstein (1981), Bordo, Erceg and Evans (2000), Cole and Ohanian (1999)).

Japan's recent experience with deflation has had similarities with the US experience in the 1930s. Although the magnitude of deflation and recession is not comparable, Japan has faced difficulty in reflating its economy. It is believed to have faced the zero lower bound, which has hampered the use of conventional interest rate policy instruments in its conduct of monetary policy. The more recent policy of quantitative easing (ie targeting commercial bank reserves) has parallels to the monetary targeting strategy followed by the United States in the 1930s, but has only recently begun to show some signs of boosting momentum in aggregate demand; as of the Spring 2004, deflationary pressures have been waning with some of the upside pressures coming from the transitory influence of relative price changes. Sustained inflation, and expectations that it will persist, have yet to be realized.

The difference between the two experiences, we posit, is largely explained by the persistence of the Japanese banking crisis. The continued weakness of the Japanese banking system, ie the inability to close or recapitalize insolvent banks, may have hampered the Bank of Japan's ability to stimulate bank lending (Hetzel 2004). In contrast, the United States effectively resolved its banking crisis by not allowing forbearance (ie all insolvent banks were closed) and the Banking Holiday of March 1933 in which all of the commercial banks were closed for a week to determine which banks were solvent. At the end of the week one-sixth of the nation's banks were closed. Another policy which aided in resolution was injection of capital into the banking sector by the Reconstruction Finance Corporation (Calomiris and Mason (2004)). Under this view, the moderate deflation in Japan is more symptomatic of deeper supply side problems than the inability of the Bank of Japan to boost aggregate demand via the expansion of the monetary base. Japan's current quantitative easing program, with its huge increase in the money stock, illustrates that inflating the economy via monetary policy alone can only go so far in returning an economy to more normal operating conditions. In particular, monetary policy can certainly boost aggregate demand, as has been clear throughout the historical record and now in Japan, but its impact on supply side developments is much more tenuous. In addition, it is important to note that despite the extremes of conditions, it is not clear that a liquidity trap was truly reached in the Great Contraction. If it had been, the monetary aggregates, as well as other instruments of monetary policy, would have been impotent. In such a situation, the monetary authority would have had few options but to wait for fiscal and prudential policies to return the economy to a greater sense of normalcy. At that point, the monetary policy strategies discussed above could have been used.

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[56] Most Federal Reserve officials believed in the "real bills doctrine" which in simplest terms argued that the central bank should only accommodate member bank lending based on self-liquidating real bills issued to finance commercial activity. They should not accommodate bills financing speculative activity. In this view the Great Contraction was said to have resulted from "over-speculation" and it was further believed that open market purchases would only rekindle further speculative lending.

[57] Bordo et al (2002) demonstrate that had the Federal Reserve followed a stable money policy throughout the Great Contraction, by offsetting the shocks to money demand and supply that occurred, a severe recession could have been avoided. In a similar vein, Christiano et al (2004) conduct a counterfactual exercise in which expansionary monetary policy actions are taken after the shocks are revealed. They are able to avoid the zero lower bound constraint and offset the Great Contraction. Bordo et al (2002) provide simulations which demonstrate that had such policies been followed the Federal Reserve would not have been constrained by its gold reserves.

The zonal approach: summary

In sum, monetary policy can eliminate deflation of any magnitude just as it can eliminate inflation. However, the type of monetary policy strategy followed depends on the zone that a central bank finds itself in. Emphasizing the monetary aggregates appears, from a historical perspective, to be rather important during periods of high inflation and steep deflation. For periods of low inflation, velocity instability over short periods of time has been somewhat more volatile and unpredictable than variation in the natural rate, thereby making the case for the reliance on interest rate instruments in the conduct of monetary policy. However, in the zone of low inflation/price stability, should the zero lower bound become a problem, the case can be made for the monetary aggregates playing a dominant role as the policy instrument of choice. Finally, monetary policy alone, regardless as to how it is implemented, cannot eliminate stagnation reflecting deep-seated structural problems, especially a dysfunctional financial intermediation system.

V. Conclusions

This broad-brush historical approach has yielded important insights about deflation and monetary policy both in the past as well as in the present. One striking feature of the historical record is that deflation was a common phenomenon in the pre-world war II period owing in large part to the low inflation environment and the monetary regime that naturally led to waves of inflation and deflation. In many ways, the current policy environment better resembles that of the distant past than of the period from 1970-1995. This not only suggests that looking to the past may help resolve some current policy issues but also that policy models might benefit from being calibrated to those developments in the distant past.

To an observer looking at the long history, current concerns about deflation may seem to be somewhat overblown. It is abundantly clear that deflation need not be associated with recessions, depressions, crises and other unpleasant conditions. The historical record is replete with good deflations. There are, of course, plenty of bad deflations too. But, it is unclear to us that the bad deflations within the context of stable nominal anchor (ie price stability) regimes were any worse than a similarly-sized disinflation in an inflationary environment. The empirical tests, both on the past and on more recent data, suggest that the asymmetries were not particularly daunting and might be regime-dependent. The recent experience with nominal wage changes also provides some insights into the possibility that as inflation rates remain very low, real rather than nominal compensation changes will play the key role in decision making, as theory would suggest. To be sure, some historical episodes of deflation were, in our typology, labeled as “ugly”. But the historical record makes it clear that most of those were isolated to the Great Depression period. While a return of such conditions cannot be completely ruled out for any particular economy, it is also true that once one digs into the reasons for deflation in the Great Depression it becomes quite clear that the possibility of its reappearance is hard to even imagine.

The perceived costs of deflation are also important. The possible asymmetric nature of the costs associated with deflation has been used to justify asymmetric monetary policy approaches to deviations of inflation around a central bank’s target rate, ie a more aggressive reaction to a deflation scare than to upside risks to inflation of the same size. If the costs are real and asymmetric, such policy reactions might be optimal, but they will nonetheless imply a tendency toward an upward bias to inflation; this policy approach would also tend to be procyclical. Indeed, if the costs of deflation were not asymmetric, such a policy could generate periodic overshooting of the inflation target – particularly during recovery periods.

The gold standard period provides another vantage point with which to compare current regimes to those in the past: the credible nominal anchor. The success in the past decade or so in lowering the average inflation rate underscores the importance of adopting sound and credible monetary policy regimes. A key question going forward is whether the current regimes are really offering the best nominal anchors. In some respects, the current regimes can be improved by adopting a flexible price targeting versus an inflation targeting regime. Other considerations would, of course, have to be considered before embracing such a regime, but at least with respect to the nominal anchor dimension, the price level approach has both theoretical and historical support. Moreover, as pointed out in our zonal approach to monetary policy, the importance of a strong and credible nominal anchor is very important in low inflation and low-to-moderate deflation zones. One additional issue with

respect to credibility is the importance for a central bank to operate in an environment of sound fiscal and prudential frameworks. Having these policies in order will not only reduce the likelihood of a bad or ugly deflation but will also help to strengthen the monetary policy transmission mechanism in the case of an unwelcome, but transitory, deflation.

Our zonal approach to monetary policy highlights several key tradeoffs for monetary policy makers. First, what zone is the best for a particular central bank? Most central banks have shown, by revealed preference, that zone 3 is a generally preferred zone. Theory suggests that zone 4, the moderate deflation zone, might be even better. And, arguably some central banks have been operating in this zone, especially if a biased-adjusted measure of inflation were used. The evidence so far suggests that deflation can be a regular part of a policy environment without excessive fear of the imminent disaster. To be sure, such an environment may involve some transitional costs as agents and policy makers become used to the environment. And, without doubt, some transitions might be bumpy at times. But such behavior should not be extrapolated to suggest that the steady state will be vulnerable to the same type of turbulence.

Second, the choice of the low inflation and low-to-moderate deflation zones would generally dictate the adoption of a mixed strategy towards the conduct of monetary policy. At the very least, the pathological problems with short-term interest rate instruments demand more attention. This emphasis is somewhat at odds with the conventional wisdom. While there are various options that central banks can choose from, the historical record clearly points to greater reliance on the monetary aggregates, if only for cross-checking purposes. If velocity changes were better understood, the role of the monetary aggregates might play a more central role. This, of course, is ultimately an empirical issue.

Third, in the end the tradeoffs for monetary policy appear to be fairly stark. On the one hand, central banks operating in (the lower end of) zone 3 face the fact that they will always be one recession or strong supply shock away from deflation. This means that interest rate rules will routinely become less useful. In our view, this suggests that the study of the role of money in the conduct of monetary policy needs to be reinvigorated at central banks with the goal of designing a mixed policy strategy that relies on the both interest rate rules and monetary aggregate targeting. Of course, the relative weights on these strategies in practice will depend on the inflation/deflation zone as well as the stability of velocity for the monetary aggregates. On the other hand, central banks can choose to avoid most of these potential costs by setting their sights on a higher steady-state inflation rate; this would naturally yield a lower incidence of deflation but at the cost of a steady stream of losses for the foreseeable future associated with the higher inflation.

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Tables

Table 1

Deflation frequency, annual, 1801 – 2002

	1801-79	1880-1913	1914-49	1950-69	1970-89	1990-2002
United States	42.4	23.5	30.6	5.0	0	0
Euro area	...	...	...	0	0	0
Japan	...	29.4	27.8	10.0	0	38.5
Germany	29.1	29.4	11.1	10.0	5.0	0
France	40.6	26.5	22.2	10.0	0	0
Italy	33.3	32.4	25.0	0	0	0
United Kingdom	51.9	44.1	33.3	0	0	0
Canada	66.7	23.5	25.0	5.0	0	0
Belgium	43.2	44.1	25.0	15.0	0	0
Switzerland	...	36.4	36.1	15.0	0	0
Netherlands	22.2	32.4	36.1	10.0	5.0	0
Sweden	27.1	44.1	30.6	0	0	7.7
Denmark	48.4	41.2	25.0	5.0	0	0
Spain	...	42.4	27.8	5.0	0	0
Finland	47.4	32.4	25.0	10.0	0	0
Ireland	...	...	33.3	5.0	0	0
Norway	45.5	35.3	36.1	0	0	0
Australia	61.1	44.1	22.2	5.0	0	0
New Zealand	...	...	20.0	0	0	7.7
China	...	...	...	...	0	23.1
Hong Kong SAR	...	...	...	33.3	0	30.8
Indonesia	61.0	55.9	30.6	10.0	0	0
India	33.3	35.3	36.1	20.0	5.0	0
Korea	...	...		5.0	0	0
Malaysia	...	...	100.0	55.0	0	0
Singapore	...	...	100.0	45.0	10.0	15.4
Thailand	...	...		25.0	5.0	0
Taiwan (China)	...	...	...	16.7	10.0	15.4
Argentina	...	41.4	36.1	5.0	0	23.1
Brazil	27.8	44.1	13.9	0	0	0
Mexico	...	38.5	25.0	10.0	0	0
Chile	48.1	32.4	13.9	0	0	0
Venezuela	...	...	42.9	15.0	0	0
Colombia	6.7	38.2	36.1	10.0	0	0
Peru	...	...	33.3	0	0	0
Egypt	...	...	41.2	25.0	0	0
South Africa	...	33.3	33.3	0	0	0
Mean	40.9	36.7	32.3	10.7	1.1	4.4
Median	42.8	35.9	30.6	7.5	0.0	0.0

[1] Defined as percentage of negative annual changes as a proportion of all available price index data in each episode.

Table 2

Peak to trough measure of price and corresponding output changes, by country and episode

	CPI					GDP				
	Peak year	Average peak-to-trough decline	Total % decline	Duration	Year of extreme deflation	Peak year	Average peak-to-trough decline	Total % decline	Duration	Year of extreme deflation
United States	1837	–5.6	–29.2	6	–15.5	1837	3.9	25.5	6	3.4
	1847	–4.2	–12.1	3	–12.1	1847	4.4	13.8	3	4.3
	1857	–4.5	–12.9	3	–8.7	1857	4.7	14.9	3	4.6
	1866	–3.1	–31.4	12	–6.8	1866	4.6	72.5	12	0.6
	1881	–2.1	–9.9	5	–3.9	1881	2.7	14.5	5	1.4
	1891	–0.9	–5.3	6	–2.7	1891	3.3	21.9	6	–0.9
	1920	–8.5	–16.3	2	–10.8	1920	1.7	3.4	2	–2.4
	1926	–4.4	–26.9	7	–10.3	1928	–5.0	–22.8	5	–13.3
Japan	1920	–6.1	–46.7	10	–18.7	1920	2.3	25.5	10	–7.3
Germany	1820	–8.0	–34.1	5	–25.0					
	1831	–5.8	–26.0	5	–15.9					
	1847	–17.4	–43.6	3	–33.8					
	1855	–2.9	–25.6	10	–18.5					
	1874	–8.2	–15.7	2	–8.4	1875	–0.6	–1.1	2	–0.6
	1881	–2.1	–11.7	6	–4.0	1881	2.8	17.9	6	0.7
	1891	–1.3	–6.5	5	–1.4	1891	4.0	21.4	5	–0.2
	1928	–6.2	–22.6	4	–9.6	1928	–4.3	–16.1	4	–7.6
France	1824	–9.4	–39.0	5	–20.4	1824	1.9	10.0	5	1.8
	1838	–5.2	–14.9	3	–12.1	1838	1.3	4.1	3	1.3
	1847	–1.5	–7.4	5	–3.9	1847	1.1	5.4	5	1.0
	1856	–1.2	–3.5	3	–2.2	1856	0.9	2.6	3	0.8
	1871	–0.8	–3.2	4	–2.2	1872	–7.0	–7.0	1	–7.0
	1877	–0.4	–2.2	5	–2.2	1875	–0.5	–2.4	5	–8.2
	1884	–0.5	–6.4	13	–2.3	1884	1.4	19.3	13	–2.1
	1902	–0.3	–1.0	3	–1.0	1900	–0.4	–1.1	3	–1.6
	1930	–7.7	–33.0	5	–14.2	1929	–2.1	–11.8	6	–6.5
Italy	1874	–2.1	–19.2	10	–14.4	1874	1.0	10.3	10	–6.7
	1891	–0.7	–5.5	8	–1.9	1890	–0.5	–3.4	7	–5.6
	1926	–5.6	–36.7	8	–19.1	1926	0.7	5.4	8	–4.9
United Kingdom	1847	–6.5	–23.5	4	–12.1	1849	–1.7	–1.7	1	–1.7
	1860	–4.5	–12.9	3	–11.3	1860	3.0	9.4	3	–0.8
	1873	–3.3	–35.2	13	–9.4	1873	1.6	22.5	13	–6.1
	1891	–4.3	–8.4	2	–8.2	1891	–1.3	–2.5	2	–2.0
	1920	–5.3	–42.3	10	–27.5	1918	–1.4	–13.6	10	–16.3
Canada	1882	–6.4	–12.3	2	–11.6	1882	4.1	8.5	2	0.4
	1889	–2.5	–14.2	6	–8.8	1891	–0.6	–1.2	2	–0.6
	1920	–5.6	–20.7	4	–12.0	1918	–1.7	–6.6	4	–10.8
	1929	–6.1	–22.4	4	–9.7	1928	–6.8	–29.6	5	–15.4
Belgium	1842	–7.3	–14.1	2	–14.1					
	1847	–2.9	–11.2	4	–7.1					
	1856	–5.3	–15.0	3	–7.1					
	1862	–6.1	–11.8	2	–7.3					
	1867	–2.5	–7.3	3	–3.7					
	1873	–2.6	–28.7	13	–7.9	1873	1.8	26.8	13	–0.2
	1891	–3.1	–14.4	5	–3.8	1891	2.0	10.2	5	0.2
	1901	–5.0	–14.3	3	–12.4	1901	2.3	7.0	3	0.9
	1929	–4.7	–25.2	6	–9.7	1928	–1.2	–6.7	6	–4.5

Table 2 (cont)

Peak to trough measure of price and corresponding output changes, by country and episode

	CPI					GDP				
	Peak year	Average peak-to-trough decline	Total % decline	Duration	Year of extreme deflation	Peak year	Average peak-to-trough decline	Total % decline	Duration	Year of extreme deflation
Switzerland	1892	–0.9	–3.5	4	–1.2	1892	3.9	16.5	4	2.5
	1898	–0.3	–1.2	4	–1.2	1898	3.3	13.9	4	2.9
	1919	–5.9	–34.4	7	–22.2	1919	5.0	40.8	7	–2.5
Netherlands	1892	–5.0	–18.6	4	–10.8	1894	–0.4	–0.8	2	–3.8
	1920	–3.4	–29.3	10	–14.1	1920	4.3	52.8	10	–0.2
Sweden	1842	–5.7	–11.0	2	–6.7	1842	1.8	3.7	2	1.7
	1847	–1.4	–4.2	3	–2.9	1847	2.0	6.2	3	2.0
	1857	–8.2	–15.7	2	–10.4	1857	2.2	4.5	2	2.2
	1862	–3.2	–9.2	3	–5.0	1862	2.2	6.8	3	2.2
	1874	–2.1	–23.7	13	–6.6	1874	0.6	8.7	13	–4.4
	1891	–3.6	–10.4	3	–5.0	1891	1.4	4.3	3	0.2
	1920	–4.8	–38.7	10	–19.8	1920	3.9	46.6	10	–3.7
Denmark	1831	–5.5	–15.7	3	–7.5	1831	2.0	6.1	3	2.0
	1836	–2.5	–18.6	8	–12.8	1836	2.0	17.0	8	2.0
	1847	–5.6	–15.9	3	–11.4	1847	1.9	5.8	3	1.9
	1856	–4.3	–12.2	3	–8.3	1856	1.8	5.6	3	1.8
	1867	–3.2	–9.3	3	–6.2	1867	1.7	5.2	3	1.7
	1874	–1.9	–23.1	14	–7.8	1874	2.0	31.6	14	–2.7
	1891	–3.1	–17.4	6	–5.7	1891	3.0	19.4	6	1.9
	1902	–1.7	–3.4	2	–3.4	1902	4.0	8.2	2	2.1
	1920	–3.6	–31.0	10	–12.2	1920	3.9	46.2	10	–2.9
Spain	1890	–2.7	–10.3	4	–6.9	1890	1.5	6.3	4	1.5
	1907	–1.7	–6.6	4	–3.6	1909	–3.0	–3.0	1	–3.0
	1926	–4.5	–8.8	2	–6.9	1926	3.8	7.8	2	–0.4
	1931	–3.6	–13.6	4	–12.5	1929	–3.6	–25.2	8	–20.0
Finland	1876	–3.1	–29.6	11	–9.8	1876	1.6	18.7	11	–2.7
	1892	–6.1	–17.3	3	–9.9	1892	5.7	18.1	3	–3.0
	1928	–4.6	–21.2	5	–11.2	1929	–1.3	–4.0	3	–2.4
Norway	1856	–2.2	–19.9	10	–7.9	1856	2.1	22.9	10	2.0
	1874	–4.1	–18.9	5	–10.4	1876	–1.3	–2.7	2	–3.0
	1882	–3.2	–15.2	5	–5.9	1882	0.9	4.6	5	–0.4
	1891	–1.7	–6.7	4	–2.5	1891	1.5	6.3	4	0.3
	1900	–1.5	–4.5	3	–2.3	1900	1.4	4.4	3	–0.4
	1920	–6.4	–48.6	10	–19.6	1920	3.6	42.3	10	–8.3
Australia	1873	–1.7	–12.6	8	–4.2	1873	5.2	49.5	8	–0.3
	1882	–2.2	–10.7	5	–3.2	1882	6.6	37.7	5	–5.6
	1890	–6.1	–22.2	4	–8.9	1891	–5.2	–19.1	4	–12.3
	1902	–3.9	–7.6	2	–5.5	1902	7.3	15.2	2	1.0
	1929	–5.8	–21.2	4	–9.3	1927	–3.0	–11.5	4	–4.9
New Zealand	1920	–7.8	–21.5	3	–12.0	1920	–5.0	–9.8	2	–6.6
	1929	–6.2	–22.6	4	–7.6	1929	–5.1	–14.6	3	–8.5
Mean		-4.2	-17.8	5.4	-9.4		1.1	9.3	5.3	-2.3
Median		-4.0	-15.5	4.0	-8.6		1.7	6.3	4.0	-0.6

Table 3

Estimates of inflation/deflation persistence (with standard errors)

	Pre-1880	1881-1913	1918-39	1945-69	1970-89	1992-2001
United States	0.201 (0.129)	0.383 (0.163)	0.573 (0.155)	0.476 (0.185)	0.703 (0.169)	0.274 (0.235)
Japan	... ...	0.144 (0.168)	0.666 (0.156)	0.713 (0.147)	0.665 (0.18)	0.538 (0.201)
Germany	0.191 (0.111)	0.418 (0.159)	–0.048 (0.223)	–0.005 (0.208)	0.8 (0.136)	0.772 (0.184)
France	0.294 (0.081)	–0.045 (0.177)	0.123 (0.212)	0.778 (0.131)	0.854 (0.138)	0.518 (0.198)
United Kingdom	0.197 (0.099)	–0.241 (0.174)	0.029 (0.224)	0.199 (0.208)	0.677 (0.169)	0.080 (0.228)
Italy	0.054 (0.251)	0.116 (0.171)	0.262 (0.192)	0.194 (0.017)	0.788 (0.130)	0.688 (0.177)
Canada	0.284 (0.362)	0.088 (0.179)	0.440 (0.168)	0.408 (0.189)	0.788 (0.144)	–0.048 (0.180)
Argentina	... ...	0.109 (0.191)	0.052 (0.21)	0.106 (0.206)	0.997 (1.079)	0.145 (0.017)
Australia	0.047 (0.248)	0.056 (0.18)	0.297 (0.213)	0.521 (0.175)	0.638 (0.158)	0.281 (0.370)
Belgium	0.096 (0.152)	0.117 (0.178)	0.386 (0.193)	0.581 (0.146)	0.785 (0.149)	0.399 (0.272)
Brazil	–0.183 (0.246)	0.403 (0.164)	0.567 (0.182)	0.764 (0.132)	0.429 (0.392)	0.590 (0.295)
Chile	0.500 (0.098)	0.032 (0.180)	0.075 (0.222)	0.539 (0.173)	0.794 (0.144)	0.706 (0.052)
Colombia	–0.775 (0.281)	0.647 (0.137)	0.040 (0.219)	–0.174 (0.204)	0.532 (0.184)	0.876 (0.165)
Denmark	0.156 (0.127)	0.253 (0.165)	0.362 (0.213)	0.345 (0.193)	0.69 (0.162)	0.295 (0.335)
Finland	0.087 (0.245)	0.456 (0.145)	0.266 (0.203)	0.063 (0.208)	0.765 (0.133)	0.460 (0.219)
India	0.217 (0.438)	0.281 (0.141)	0.560 (0.161)	0.104 (0.195)	0.227 (0.221)	0.255 (0.334)
Ireland	... ...	... ...	0.181 (0.319)	0.181 (0.209)	0.834 (0.142)	0.392 (0.386)
Mexico	... ...	–0.062 (0.245)	0.091 (0.213)	0.092 (0.208)	0.699 (0.162)	0.417 (0.344)
Netherlands	0.178 (0.347)	0.064 (0.18)	0.491 (0.193)	0.251 (0.198)	0.857 (0.134)	0.586 (0.474)
New Zealand	... ...	... ...	0.326 (0.209)	0.337 (0.195)	0.445 (0.206)	0.079 (0.354)
Norway	0.21 (0.152)	0.445 (0.148)	0.273 (0.157)	0.401 (0.189)	0.210 (0.216)	0.016 (0.319)
Peru	... ...	... ...	0.572 (0.161)	0.114 (0.209)	0.762 (0.155)	0.170 (0.029)
Spain	... ...	–0.047 (0.182)	0.523 (0.197)	0.392 (0.195)	0.805 (0.114)	0.730 (0.175)
Sweden	0.416 (0.122)	0.389 (0.159)	0.688 (0.136)	0.197 (0.202)	0.522 (0.174)	0.188 (0.167)
Venezuela	... ...	... ...	0.28 0.218	0.111 0.178	0.735 0.281	0.605 0.317
Mean	.13	.19	.32	.31	.68	.40
Median	.19	.12	.30	.25	.74	.40

Table 4

Asymmetric persistence tests for price changes in the pre-1913 period

Countries	Period	Percent of observations I_t=1	$1+\rho_1$	$1+\rho_2$	F-stat
Argentina	1886-1913	43	-0.41	0.78	17.03***
Australia	1880-1913	44	0.05	0.07	0.01
Belgium	1880-1913	44	0.18	0.12	0.02
Brazil	1880-1913	44	-0.14	0.52	2.53
Canada	1880-1913	24	0.00	0.12	0.11
Switzerland	1882-1913	38	0.87	0.25	4.48*
Chile	1880-1913	32	-0.25	0.58	7.26*
China	...	...	...	...	...
Germany	1880-1913	29	0.09	0.49	1.17
Denmark	1880-1913	41	0.19	0.09	0.07
Spain	1882-1913	44	-0.16	0.02	0.22
Finland	1880-1913	32	0.37	0.30	0.02
France	1880-1913	27	-0.76	0.03	2.02
Hong Kong	...	...	...	...	...
Indonesia	1880-1913	56	-0.38	-0.92	2.50
Ireland	...	...	...	...	...
India	1880-1913	35	0.27	0.00	0.53
Italy	1880-1913	32	0.09	0.05	0.01
Japan	1880-1913	30	-0.21	0.40	4.17*
Korea	...	...	...	...	...
Mexico	1902-1913	42	-0.30	0.12	0.94
Malaysia	...	...	...	...	...
Netherlands	1880-1913	32	0.04	0.07	0.01
Norway	1880-1913	35	0.54	0.11	1.40
New Zealand	...	...	...	...	...
Sweden	1880-1913	44	0.69	0.08	2.89
Singapore	...	...	...	...	...
Thailand	...	...	...	...	...
Taiwan	...	...	...	...	...
United States	1880-1913	24	0.24	0.47	0.43
United Kingdom	1880-1913	44	0.08	-0.54	3.31*
Mean			0.05	0.15	
Median			0.07	0.12	

Note: Inflation tests of the threshold autoregressive (TAR) model during the gold standard period is specified as the following: $\pi_t - \pi_{t-1} = \beta + I_t \rho_1 \pi_{t-1} + (1-I_t)\rho_2 \pi_{t-1} + \varepsilon_t$ where I_t is a heaviside indicator function such that $I_t = \begin{cases} 0, \; if \; \pi_{t-1} \geq 0 \\ 1, \; if \; \pi_{t-1} < 0 \end{cases}$. The significance level of the test of the null of symmetry, $H_0 : \rho_1 = \rho_2$, is reported in the final column using monte carlo generated critical values: * = 90%, ** = 95% and ***= 99%. This tests whether inflation persistence was similar during deflationary and inflationary periods during the heyday of the gold standard period. Assuming that inflation was stationary, the appropriate measure of persistence is $1+\rho_i$.

Table 5

Asymmetric persistence tests for de-trended inflation changes during the great inflation period

Countries	Period	Percent of observations $I_t=1$	$1+\rho_1$	$1+\rho_2$	F-stat
Argentina	1960-2003	61	0.14	0.50	1.43
Australia	1960-2003	50	0.34	0.55	0.42
Belgium	1960-2003	52	0.66	0.58	0.07
Brazil	1960-2003	55	-0.08	1.61	20.61***
Canada	1960-2003	57	0.27	0.79	3.50**
Switzerland	1960-2003	52	0.45	0.68	0.67
Chile	1960-2003	59	0.95	0.61	1.14
China	1977-2003	63	0.46	0.46	0.00
Germany	1960-2003	41	0.50	0.83	14.71***
Denmark	1960-2003	50	0.18	0.24	0.04
Spain	1960-2003	52	0.47	0.60	0.20
Finland	1960-2003	55	0.34	0.53	0.40
France	1960-2003	52	0.50	0.50	0.00
Hong Kong	1960-2003	50	0.10	0.46	1.43
Indonesia	1960-2003	64	-0.04	0.18	0.04
Ireland	1960-2003	57	0.38	0.54	0.34
India	1960-2003	59	0.07	0.41	1.19
Italy	1960-2003	43	0.55	0.69	0.21
Japan	1960-2003	55	1.09	0.33	2.19
Korea	1960-2003	50	0.51	0.44	0.06
Mexico	1960-2003	52	0.21	0.61	1.93
Malaysia	1960-2003	55	0.09	0.88	5.50***
Netherlands	1960-2003	52	0.36	0.43	0.06
Norway	1960-2003	55	0.33	-0.01	1.20
New Zealand	1960-2003	57	0.15	0.22	0.04
Sweden	1960-2003	52	0.20	0.22	0.00
Singapore	1960-2003	55	0.11	0.80	5.54**
Thailand	1960-2003	57	0.08	0.59	2.87
Taiwan	1960-2003	59	0.01	0.47	1.38
United States	1960-2003	59	0.34	0.63	1.01
United Kingdom	1960-2003	55	0.48	0.34	0.15
Mean			.33	.54	
Median			.34	.53	

Note: Inflation tests of the threshold autoregressive (TAR) model during the great inflation period is specified as the following: $\tilde{\pi}_t - \tilde{\pi}_{t-1} = \beta + I_t \rho_1 \tilde{\pi}_{t-1} + (1-I_t)\rho_2 \tilde{\pi}_{t-1} + \varepsilon_t$ where I_t is a heaviside indicator function such that $I_t = \begin{cases} 0, \; if \; \tilde{\pi}_{t-1} \geq 0 \\ 1, \; if \; \tilde{\pi}_{t-1} < 0 \end{cases}$ and $\tilde{\pi}$ is the deviation of inflation from its Hodrick-Prescott trend ($\lambda = 100$). The significance level of the test of the null of symmetry, $H_0 : \rho_1 = \rho_2$ is also reported in the final column. The significance level of the test of the null of symmetry, $H_0 : \rho_1 = \rho_2$, is reported in the final column using monte carlo generated critical values: * = 90%, ** = 95% and *** = 99%. This tests whether the persistence of deviations of inflation from its trend was similar during disinflationary and reflationary periods during the great inflation period.

Table 6

Panel symmetry tests for inflation, 1880-1913

	United States and the United Kingdom				G10 countries				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\pi_{t-1} < 0$	.05	-.01	-.02	.22	.23	.34	.17	.18	.01
	(.20)	(.20)	(.20)	(.36)	(.003)**	(.10)***	(.10)*	(.12)	(.14)
$\pi_{t-1} \geq 0$	-.01	-.13	-.12	-.10	.19	0.28	.16	.19	.09
	(.23)	(.23)	(.23)	(.37)	(.08)**	(.09)***	(.09)*	(.11)*	(.13)
Money growth$_{t-1}$		.18	.22	.08		.15	.14	.14	.12
		(.09)*	(.10)**	(.12)		(.03)***	(.03)***	(.03)***	(.06)*
Output gap$_{t-1}$			-.002				-.001		
			(.002)				(.0007)		
Supply shocks$_{t-1}$				-.06				-.02	
				(.10)				(.03)	
Demand shocks$_{t-1}$				.01				-.00	
				(.05)				(.02)	
Bank Crises$_{t-1}$									.01
									(.01)
Equity prices$_{t-1}$				.08					.05
				(.05)					(.02)**
$\overline{R}^2$	-.03	.01	.02	.01	.04	.11	.11	.09	.08
Symmetry test	.85	.74	.78	.39	.71	.71	.92	.95	.69
Number of obs.	68	68	68	66	371	324	324	319	163

The statistical model is $\pi_{i,t} = \rho_1 I_{i,t} \pi_{t-1} + \rho_1 (1 - I_{i,t}) \pi_{t-1} + \beta X_{t-1} + \varepsilon_{i,t}$, where the model is estimated as a pooled regression (unbalanced panel). If the country constants were statistically different at the 95% confidence level, the model was estimated with fixed effects instead of a common constant. The regressors include the first lag of the country-specific annual growth rate of money, output gap, supply shocks, demand shocks, banking crisis variable and annual growth rate of real equity prices. The banking crisis indicator and money growth is from Bordo et al (2001). The supply and demand shocks were constructed estimated using a Blanchard and Quah (1989) long-run restrictions model for real GDP growth and inflation. The sources for the variables are described in Borio and Filardo (2004).The standard errors are in parentheses and the asterisks indicate the 10%, 5% and 1% significance levels, respectively. The G10 countries include Belgium, Canada, Germany, France, Italy, Japan, the Netherlands, Sweden, Switzerland, the United Kingdom and the United States.

Table 7

Statistical determinants of the good, the bad and the ugly deflation, full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(P-P*)/P*		.07 (.08)	.48 (.25)**	0.48 (.27)*	.48 (.28)*	.48 (.29)*	.78 (.36)**	.47 (.25)*	1.69 (.88)*
Banking crises			1.80 (.70)**	1.79 (.72)**	.1.41 (.79)*	1.41 (.80)	2.68 (.95)***	1.77 (.71)**	5.61 (2.59)**
Money growth	.04 (.02)**			-.004 (0.04)					
Supply shocks					-.32 (.30)	-.31 (.34)			
Demand shocks						.05 (.11)			
Wage inflation							.02 (.10)		
Interest rates								.13 (.30)	
Equity prices									-.04 (.07)
R^2	.05	.02	.24	.24	.28	.29	.44	.25	.72
Number of obs.	57	45	32	32	32	32	23	32	22

Fit - actual/estimated									
Good	39/54	36/45	26/30	25/29	26/31	26/31	18/18	26/31	18/18
Bad	10/0	5/0	4/1	4/0	4/0	4/0	4/5	4/0	3/3
Ugly	8/3	4/0	2/1	2/2	2/1	2/1	0/1	2/1	1/1

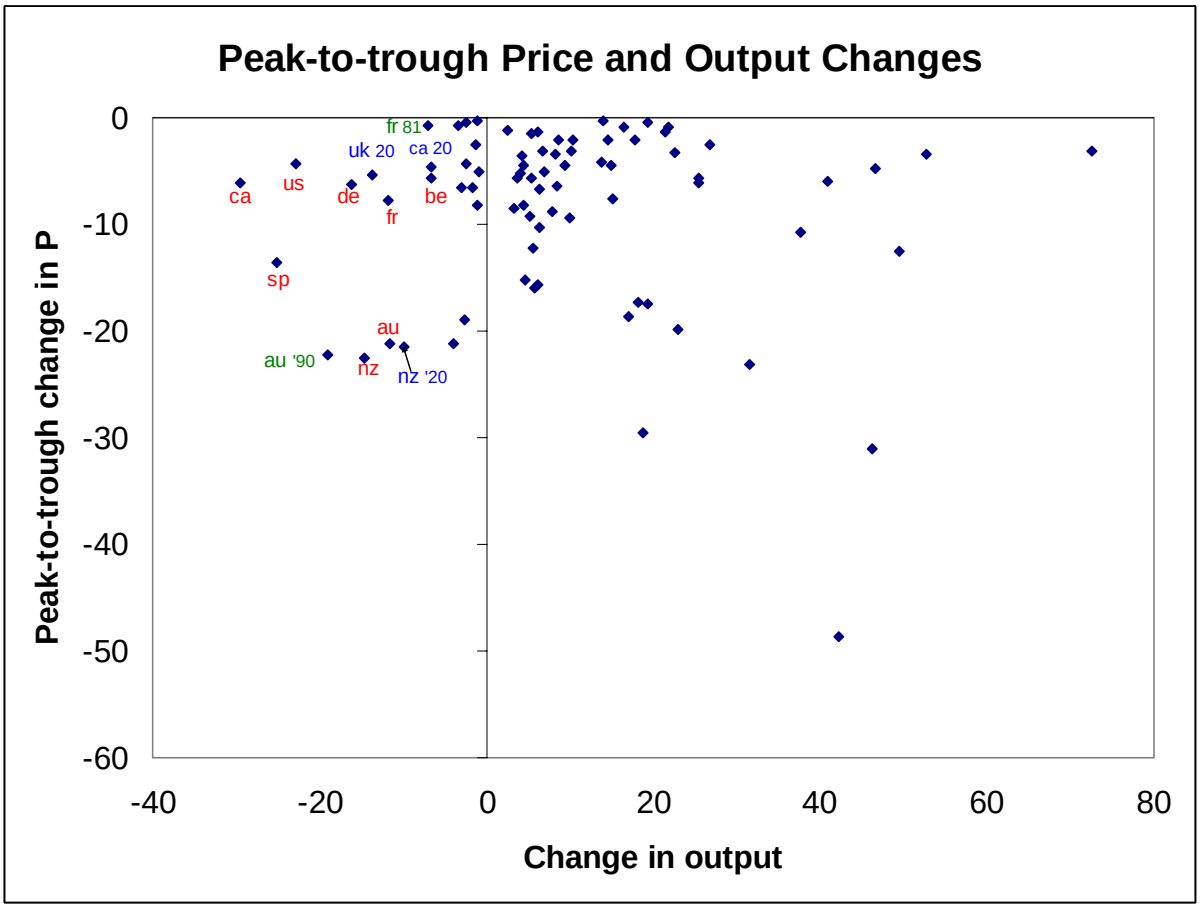
Marginal effect of the crisis indicator on the probability of the good, the bad and the ugly (Model 4)			
	P(good)	P(bad)	P(ugly)
No banking crisis (C_i=0)	.93	.06	.01
Banking crisis (C_i=1)	.38	.34	.28
Difference	.55	-.28	-.27

Notes: The regressors are five-year averages prior to the peak in the price level for each episode. The P* model was estimated using simple versions of the P* model (Hallman et al (1991)). The other variables are described in Table 6. Real wage inflation, long-term interest rates and real equity prices variables are described in Borio and Filardo (2004). The R^2 is measured by the likelihood ratio index. The in-sample fit statistics provide an indication of how well the model fits the data by comparing the actual number of observations of the good, the bad and the ugly deflations in the sample with those implied by the model. The marginal effects are evaluated at the means of the dependent variables in the model, except of course for C_i.

Graphs

Graph 1

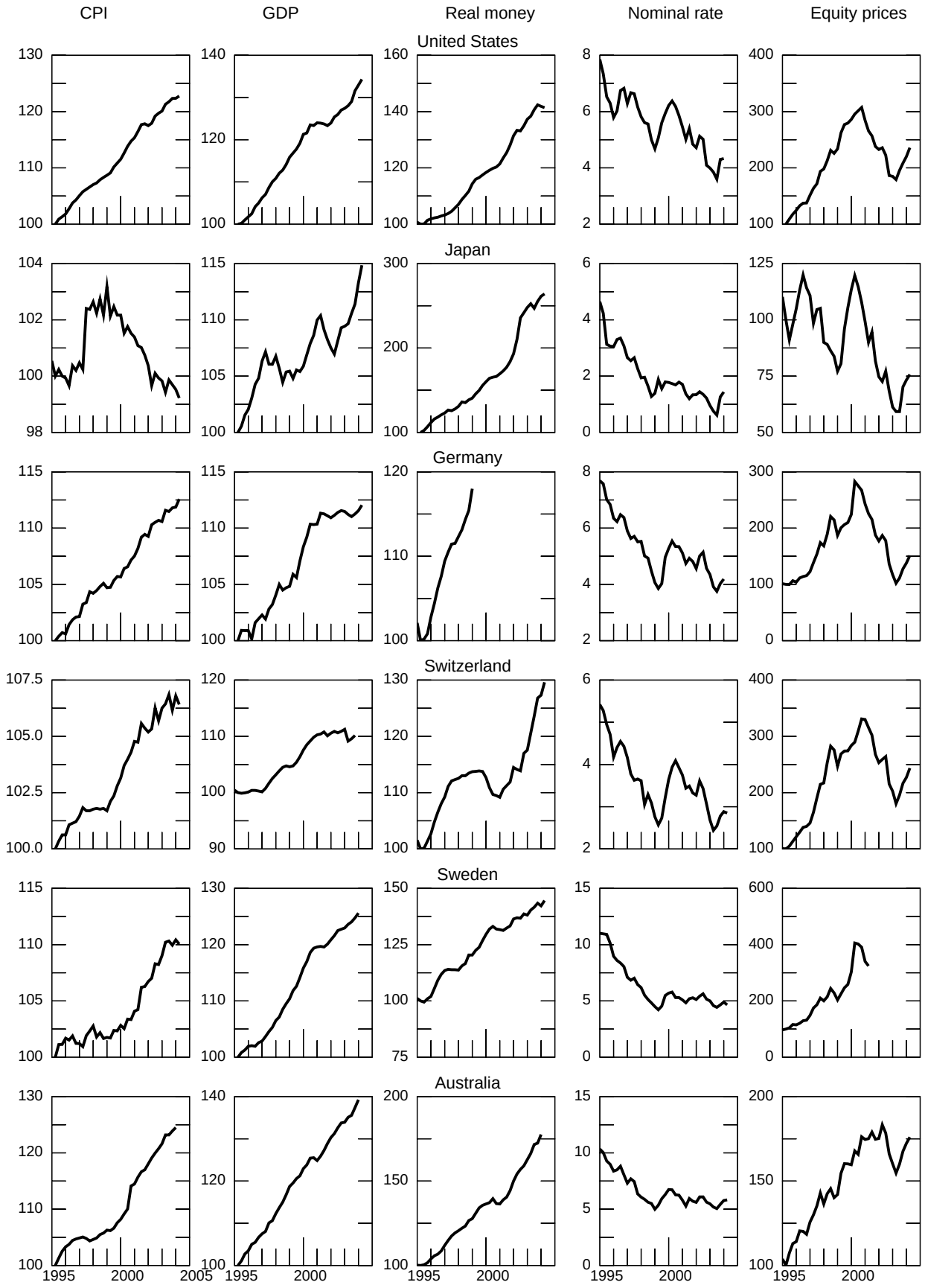
Deflation episodes and output performance



Notes: The data are from Table 2. The non-dated, labelled data points are from those in the Great Contraction era: au = Australia, be = Belgium, ca = Canada, de = Germany, fr = France, sp = Spain, nz = New Zealand, uk = United Kingdom, us = United States. The following dated labels denote deflations with peaks before the Great Contraction: fr ’81 = France (peak 1881), au ’90 = Australia (peak 1890), ca ’20 = Canada (peak 1920), nz ’20 = New Zealand (peak 1920), uk ’20 = United Kingdom (peak 1920).

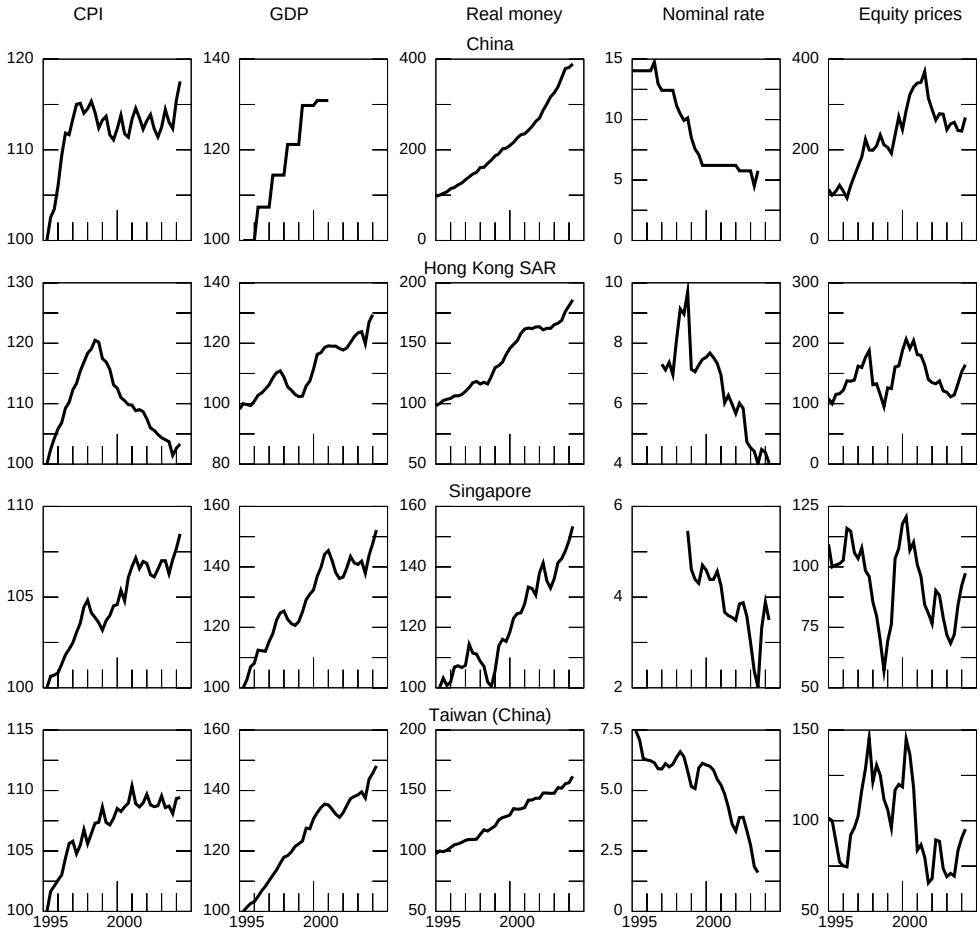
Graph 2

Recent deflation experiences



Graph 2 (cont)

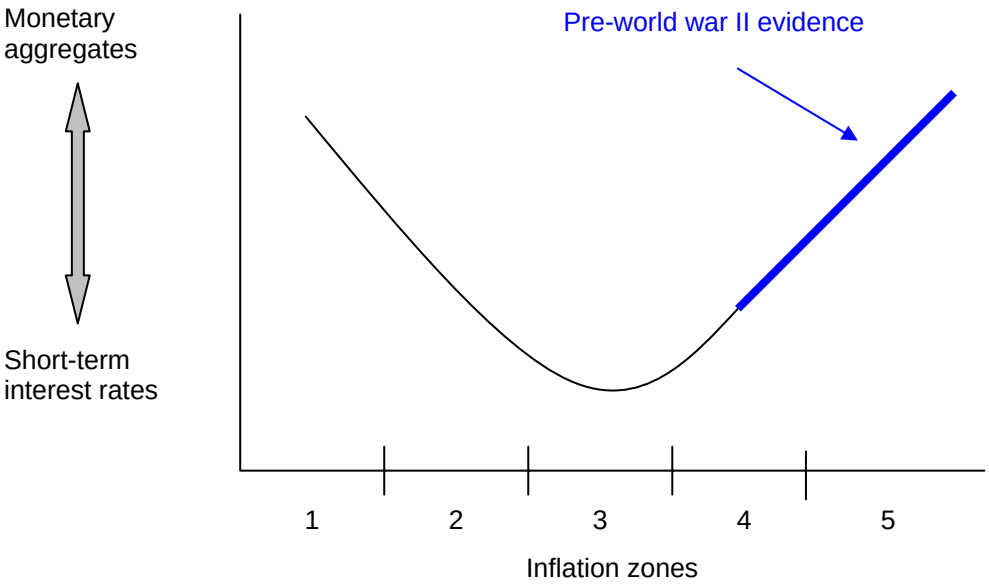
Recent deflation experiences



Graph 3

Monetary policy and deflation: the zonal view

Relative policy value

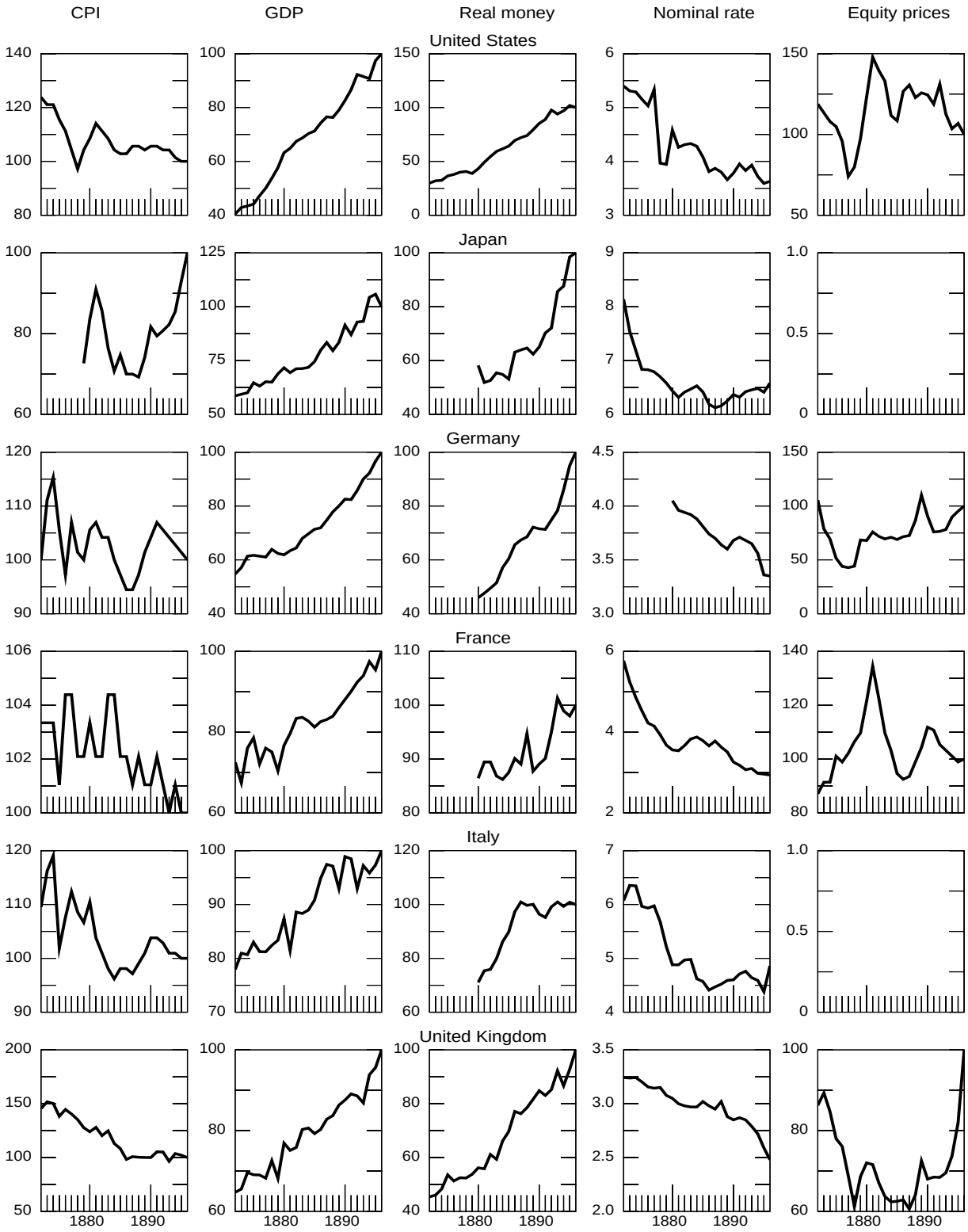


Approximate Zones	
Zone 1:	$\pi > 20$
Zone 2:	$4 < \pi < 20$
Zone 3:	$0 < \pi < 4$
Zone 4:	$-3 < \pi < 0$
Zone 5:	$\pi < -3$

Appendix

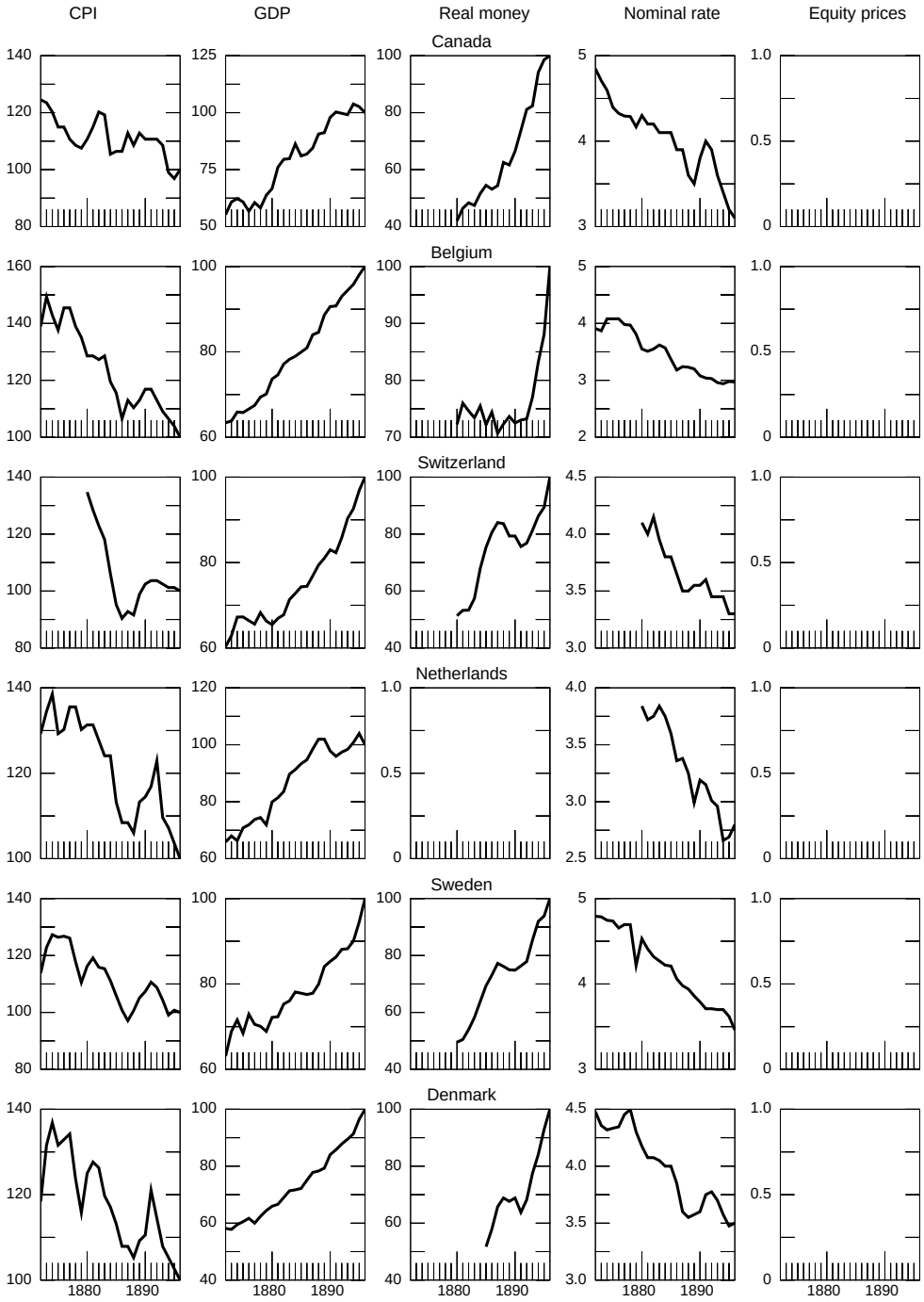
Graph A1

Deflation during the 1873-1896 period



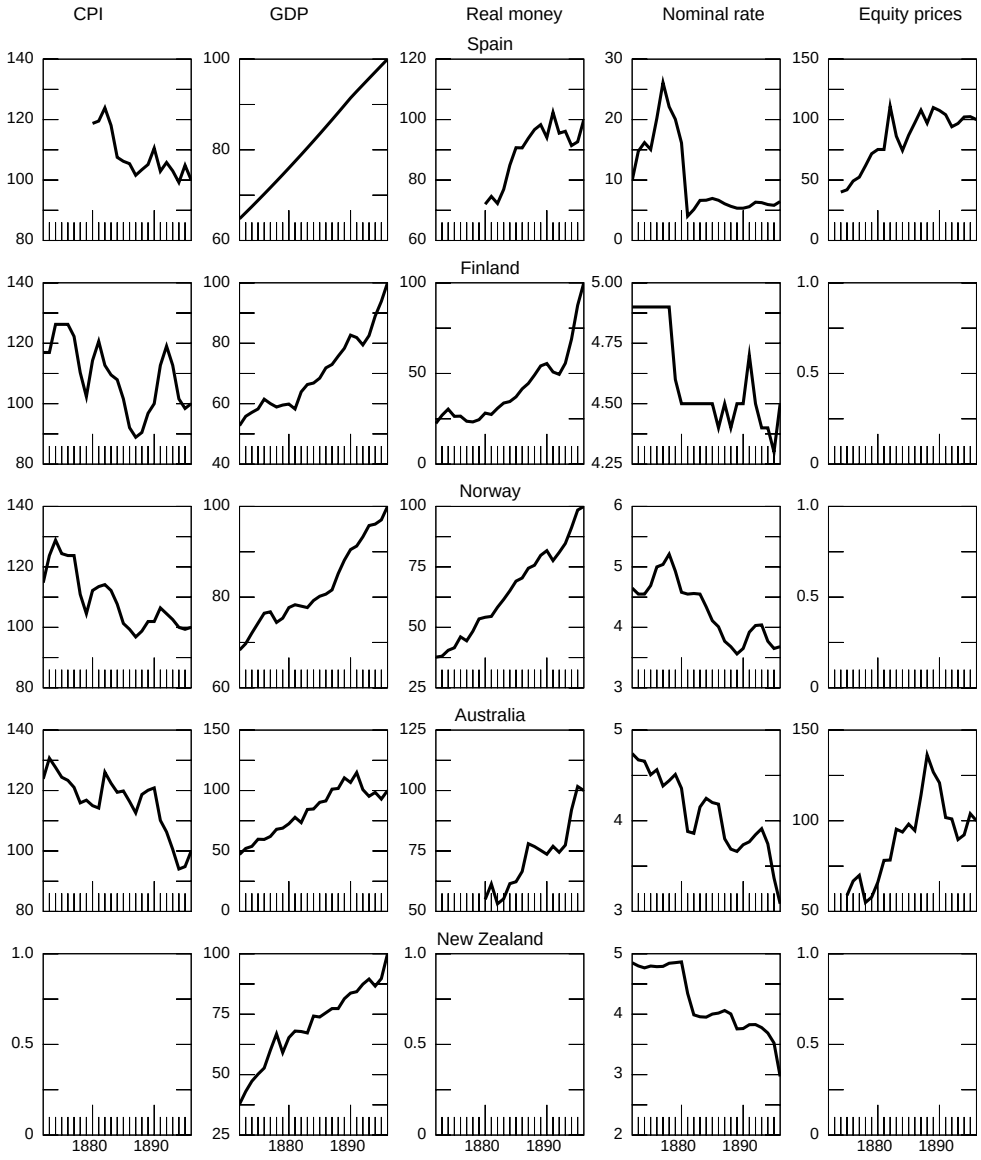
Graph A1 (cont)

Deflation during the 1873-1896 period



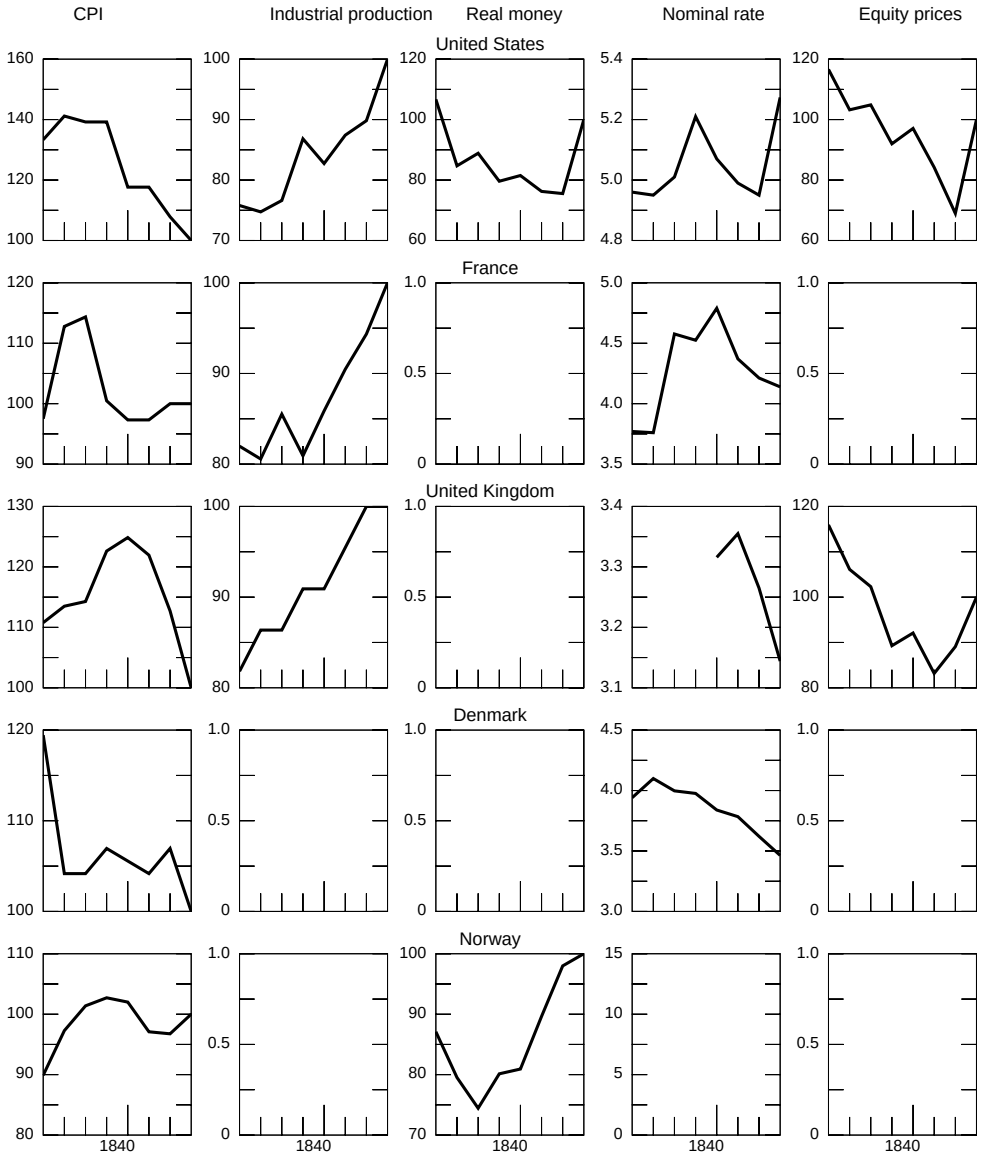
Graph A1 (cont)

Deflation during the 1873-1896 period



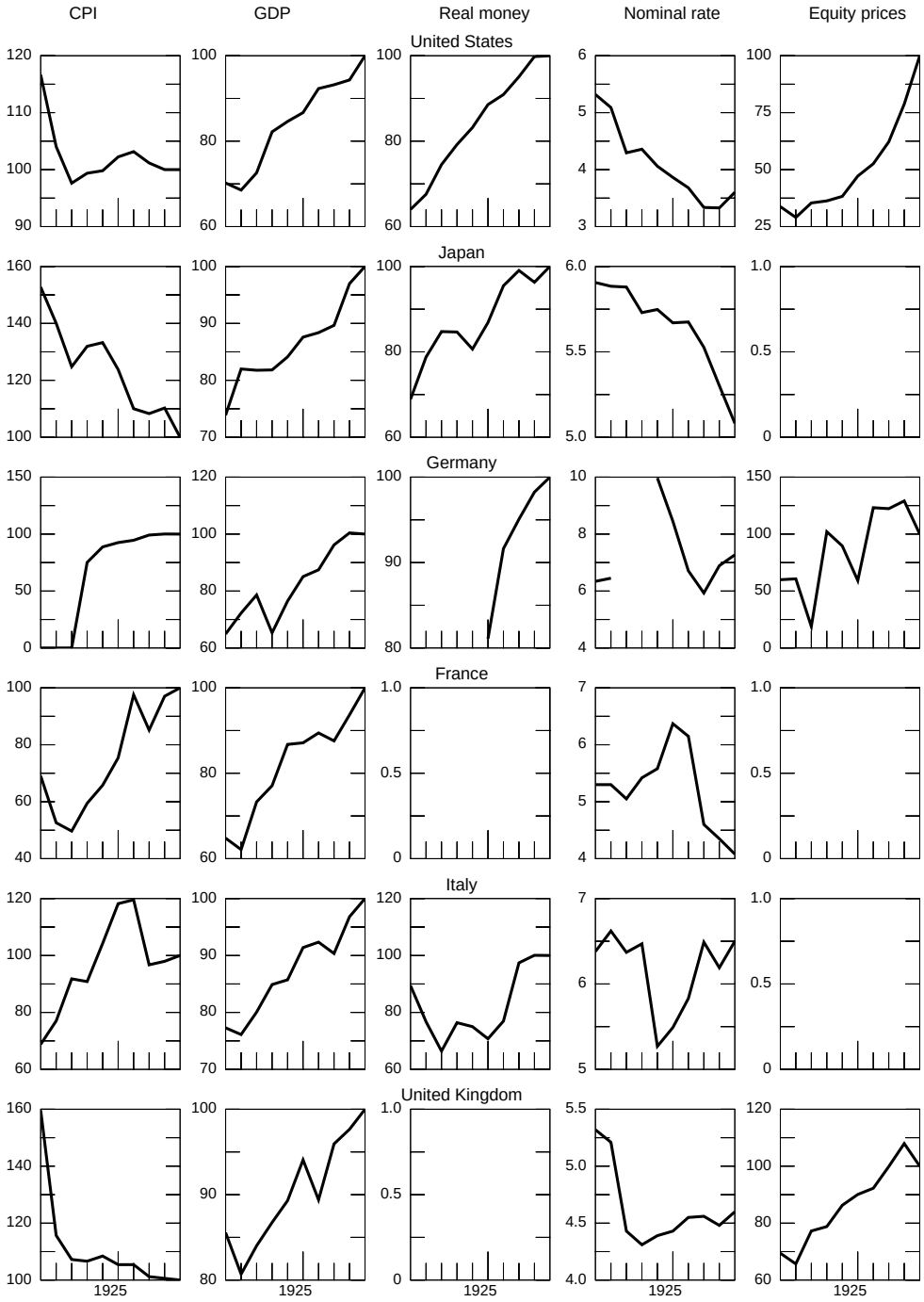
Graph A2

Deflation during the 1837-1843 period (We might cut this graph)



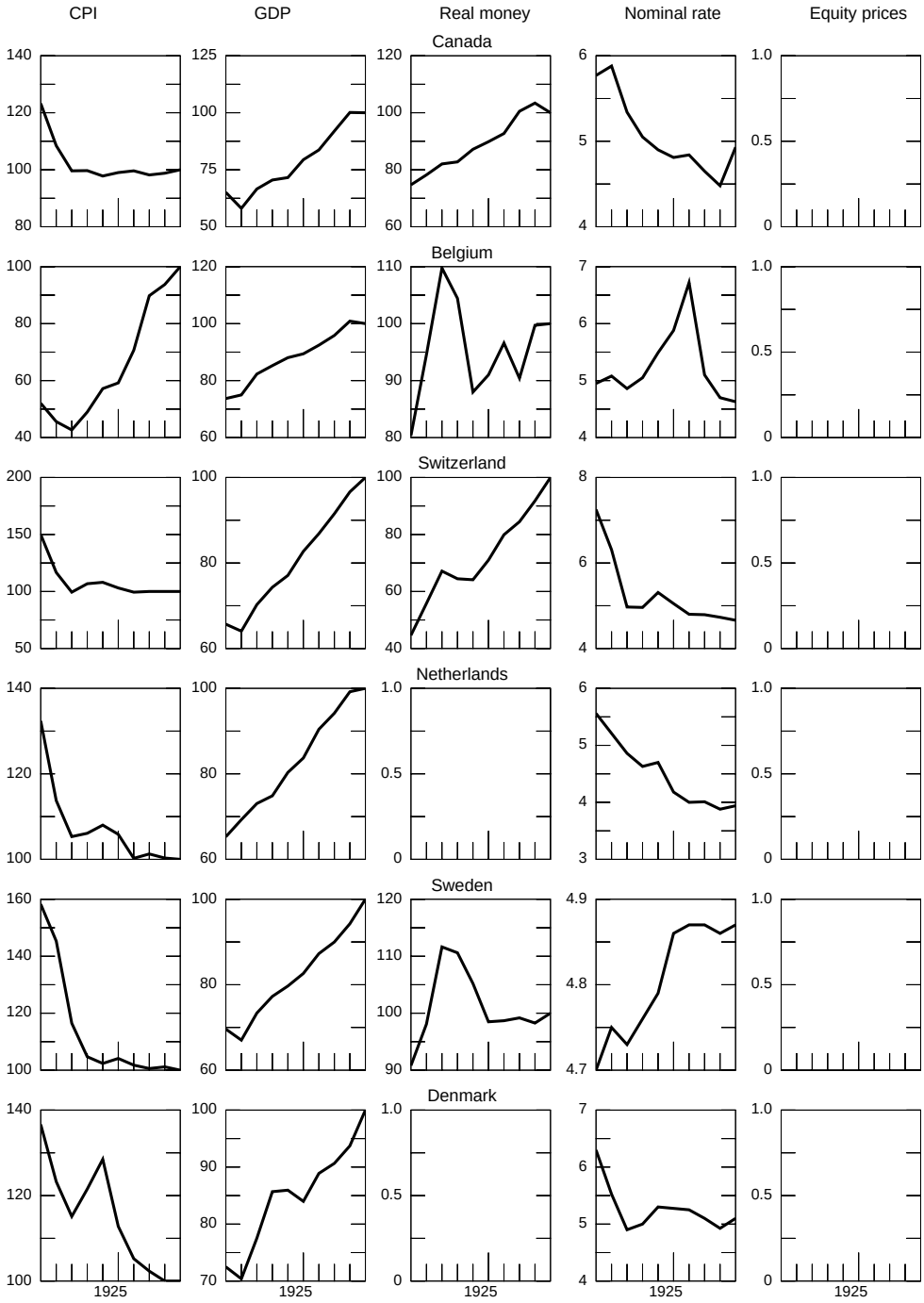
Graph A3

Good deflation in the 1921-1929 period



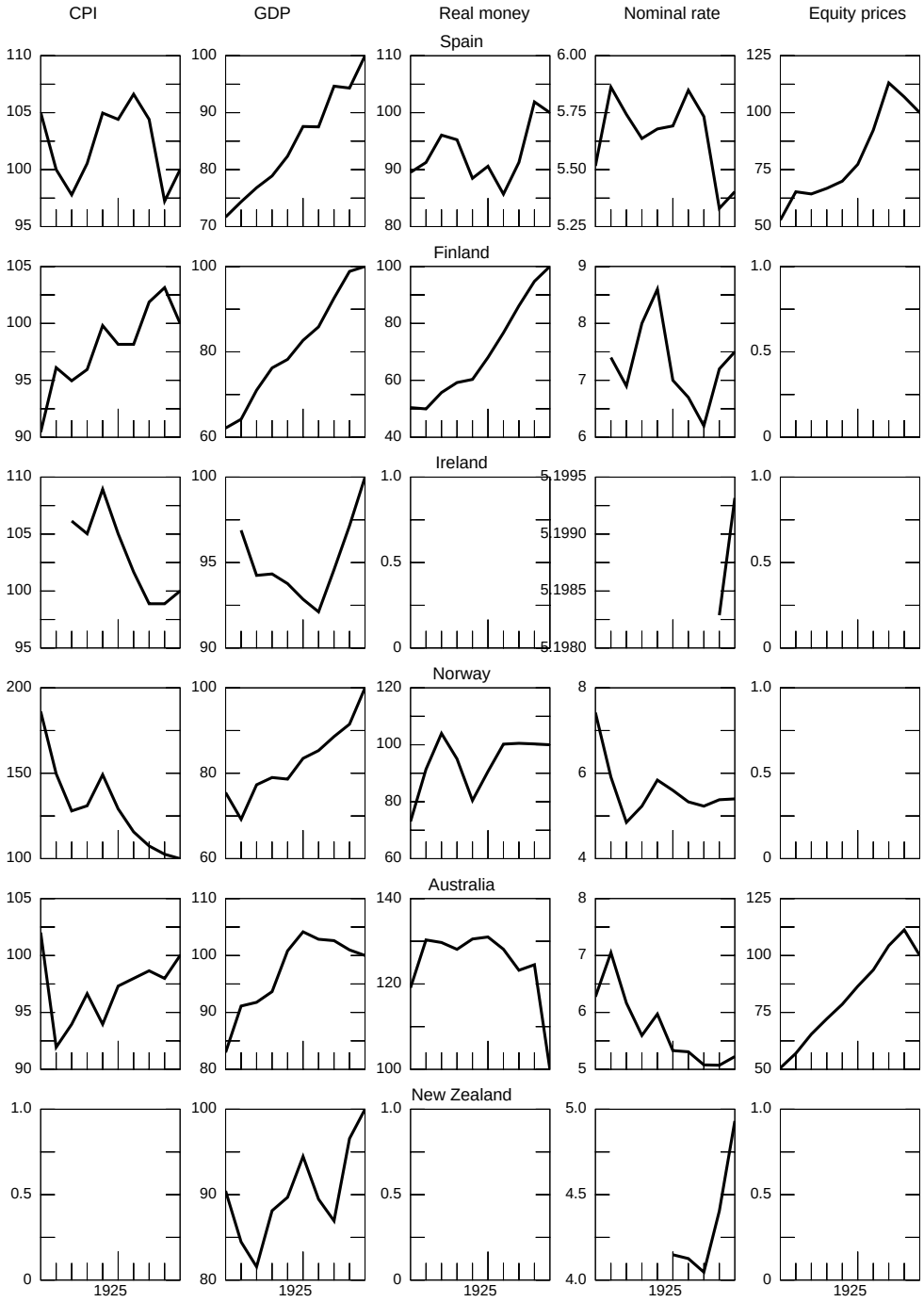
Graph A3 (cont)

Good deflation in the 1921-1929 period



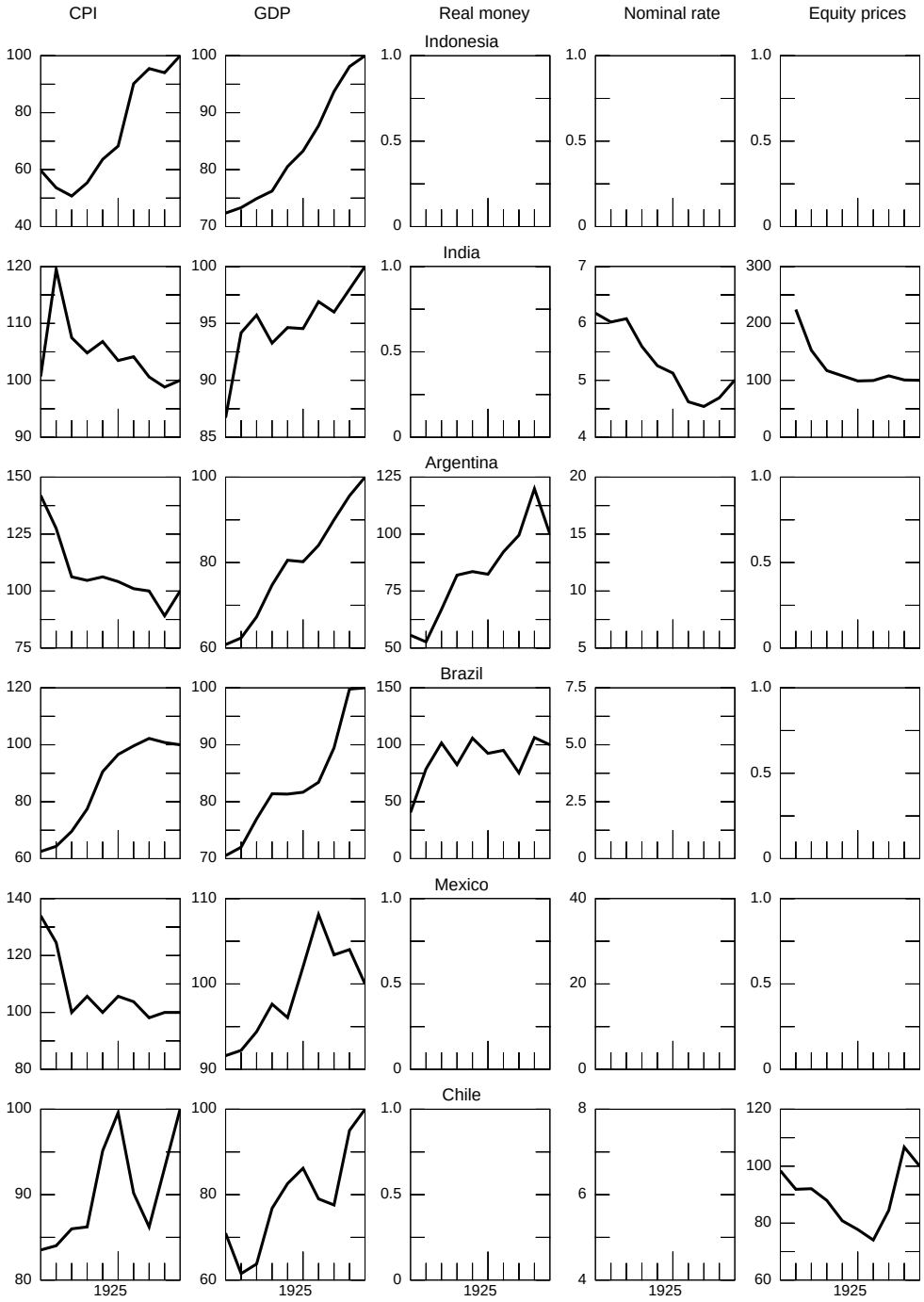
Graph A3 (cont)

Good deflation in the 1921-1929 period



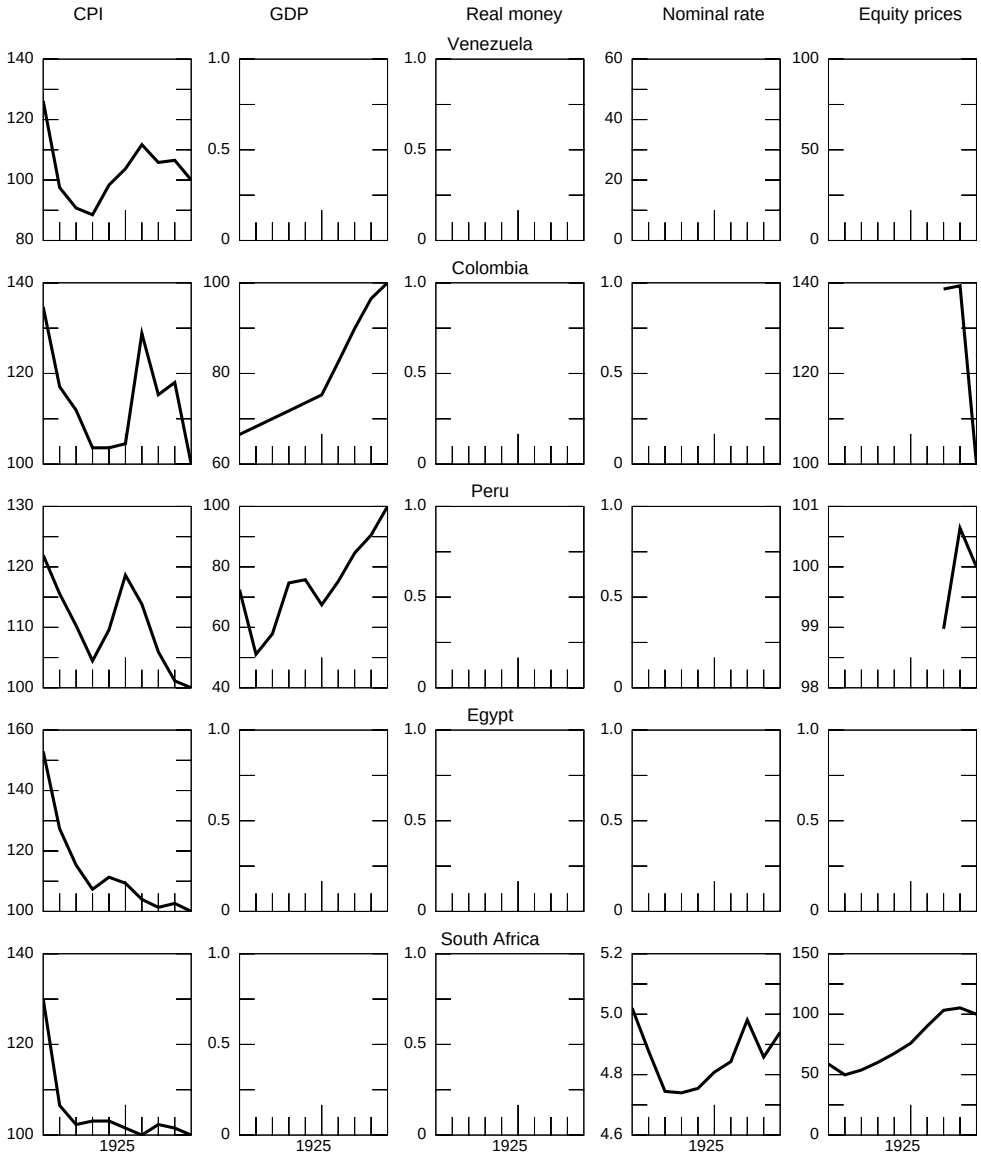
Graph A3 (cont)

Good deflation in the 1921-1929 period



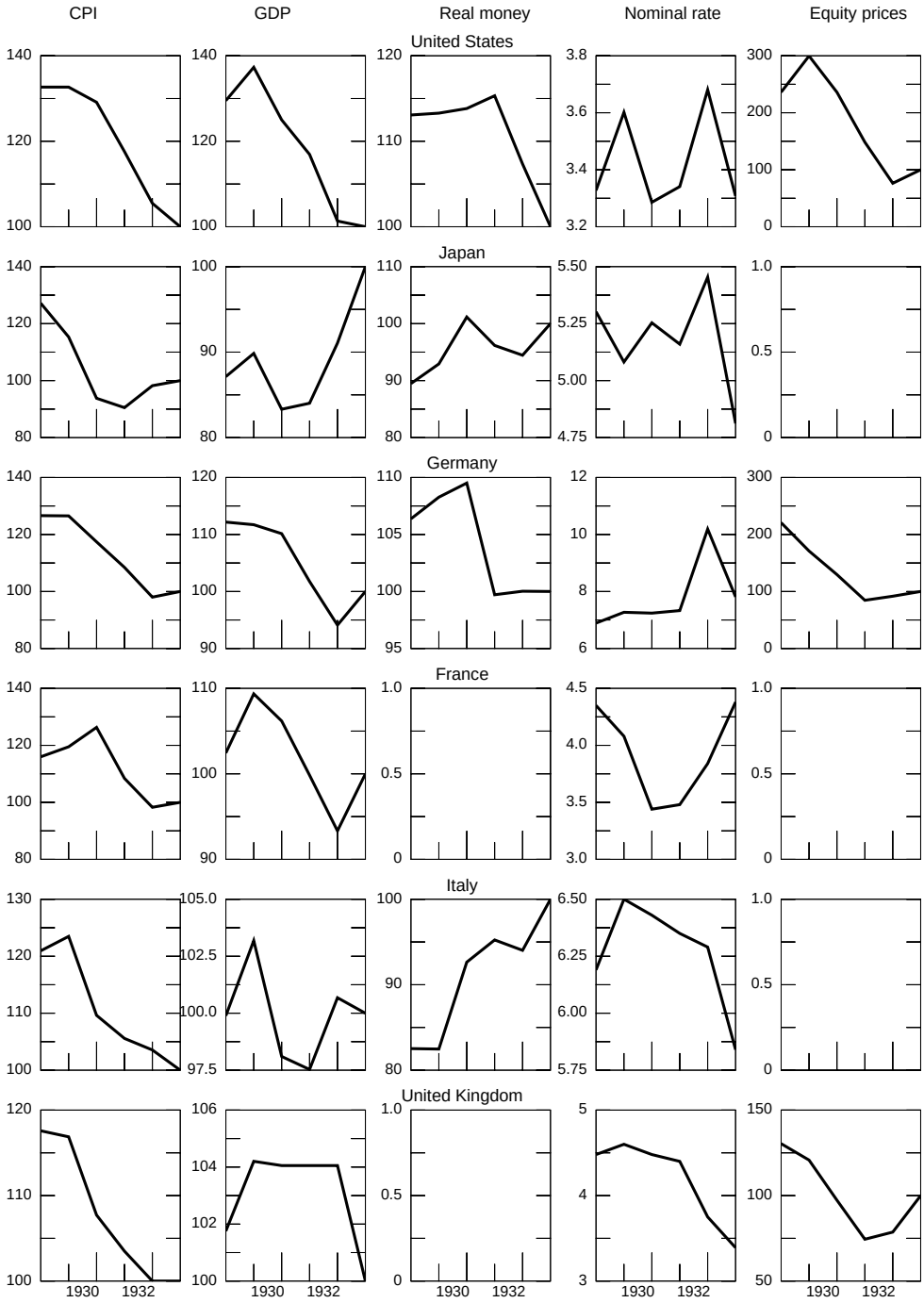
Graph A3 (cont)

Good deflation in the 1921-1929 period



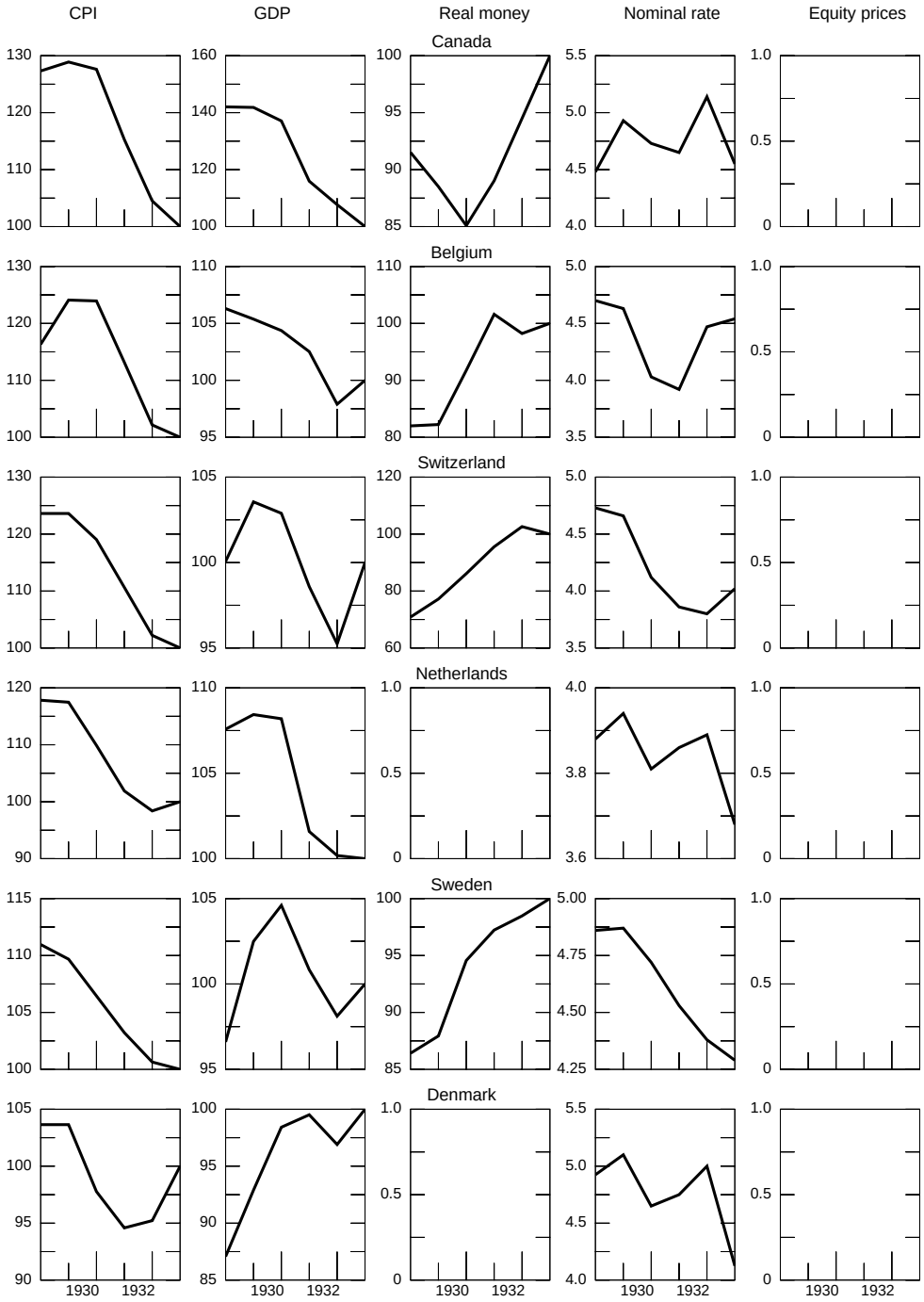
Graph A4

Ugly deflation in the 1929-1933 period



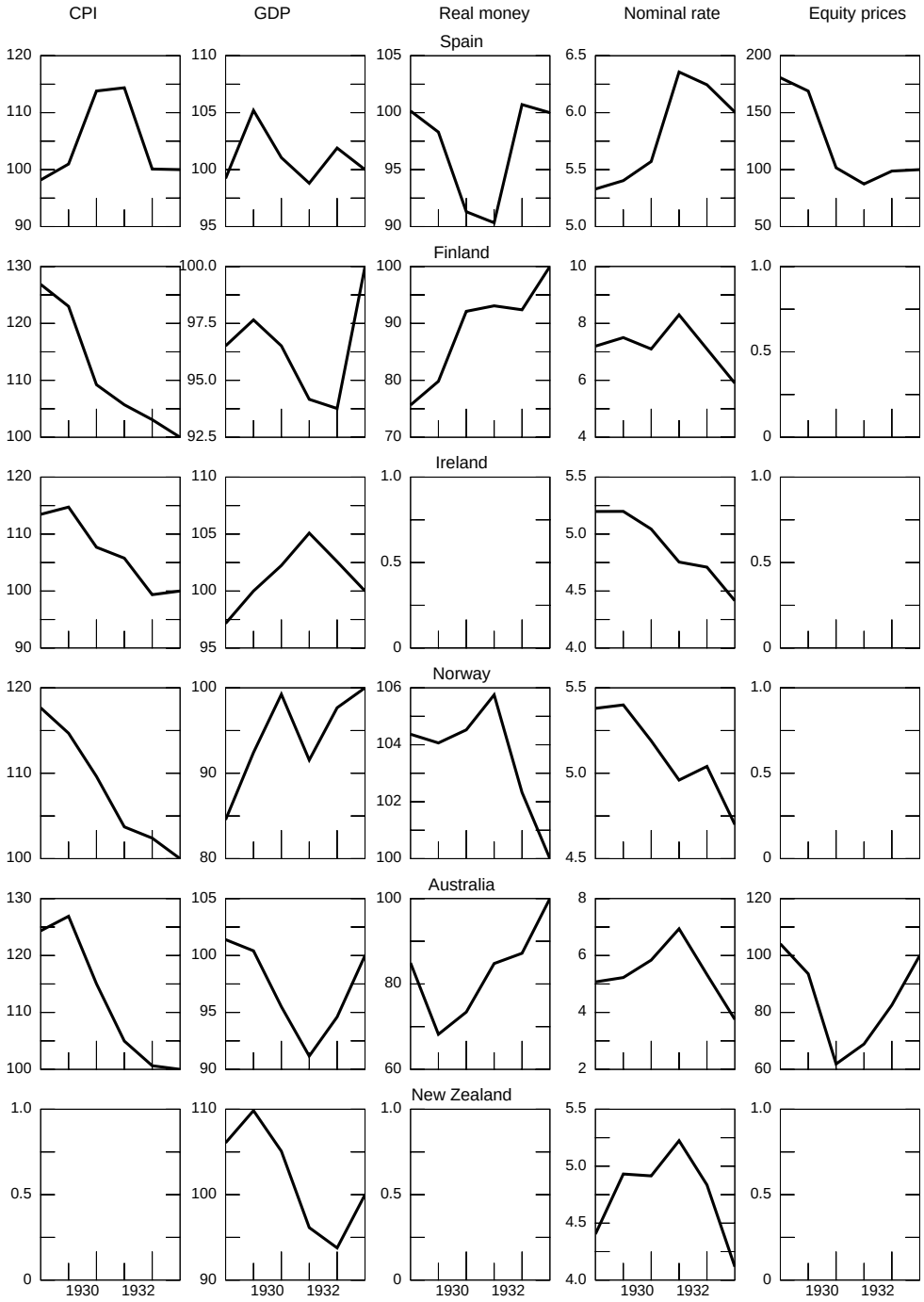
Graph A4 (cont)

Ugly deflation in the 1929-1933 period



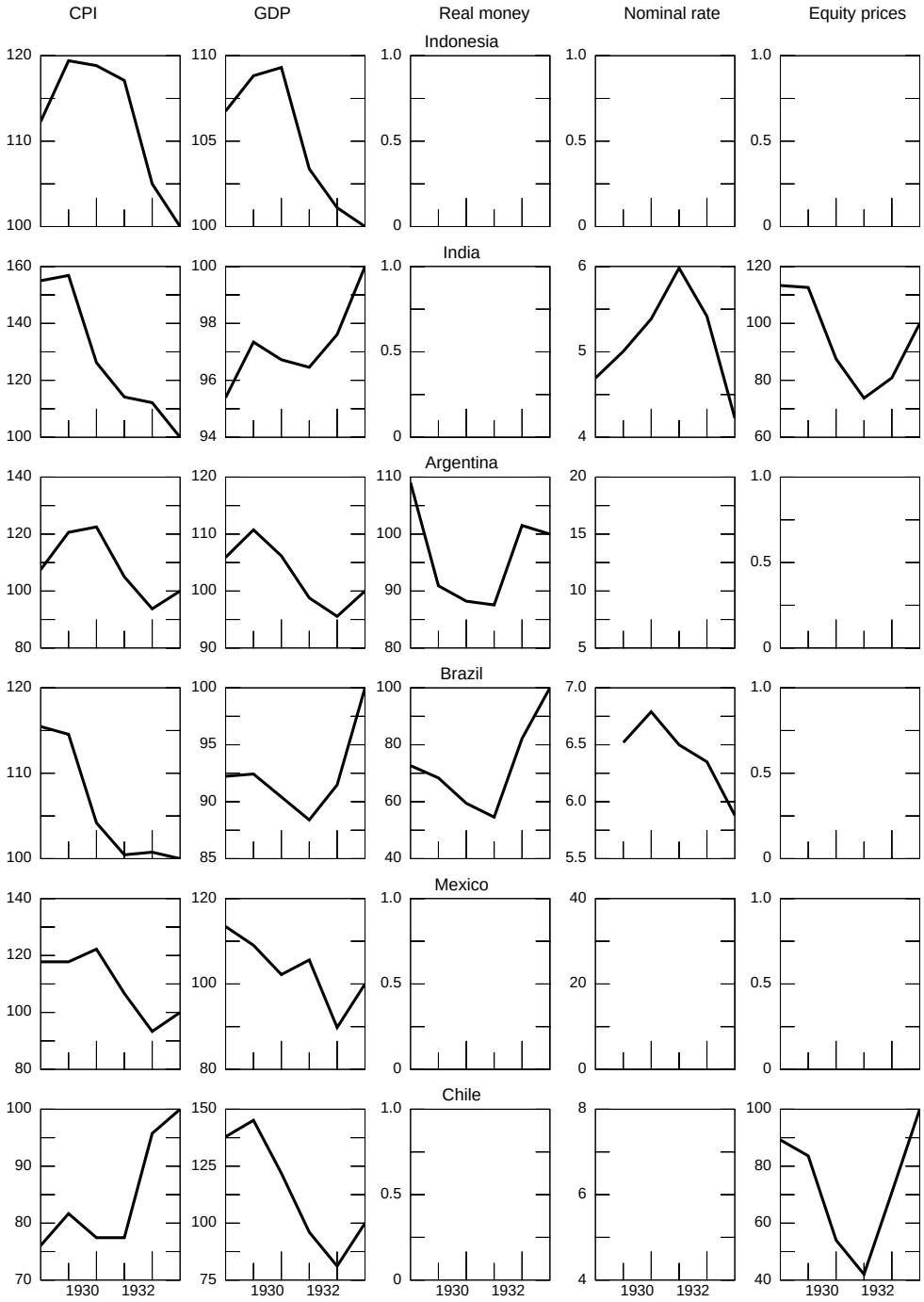
Graph A4 (cont)

Ugly deflation in the 1929-1933 period



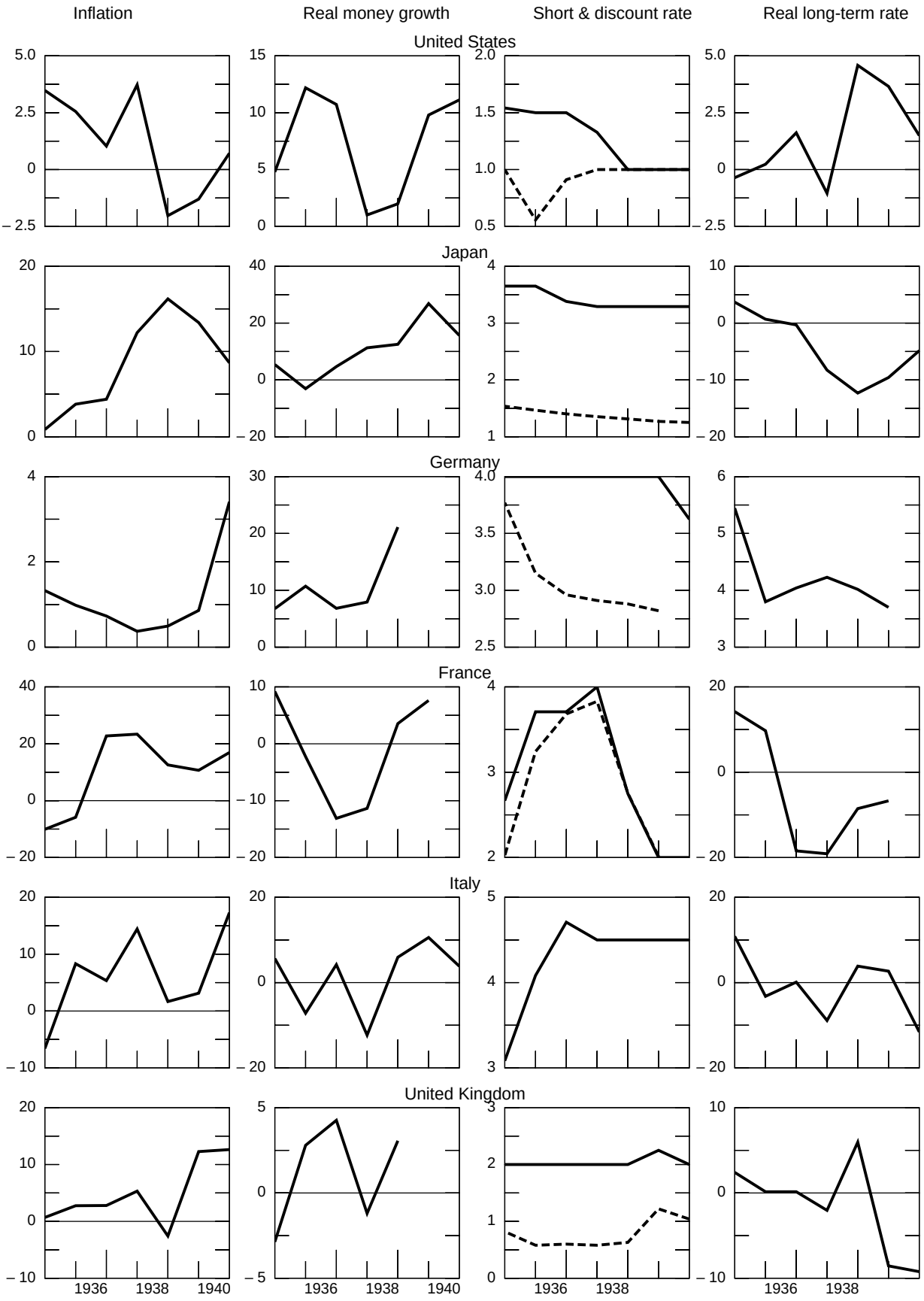
Graph A4 (cont)

Ugly deflation in the 1929-1933 period



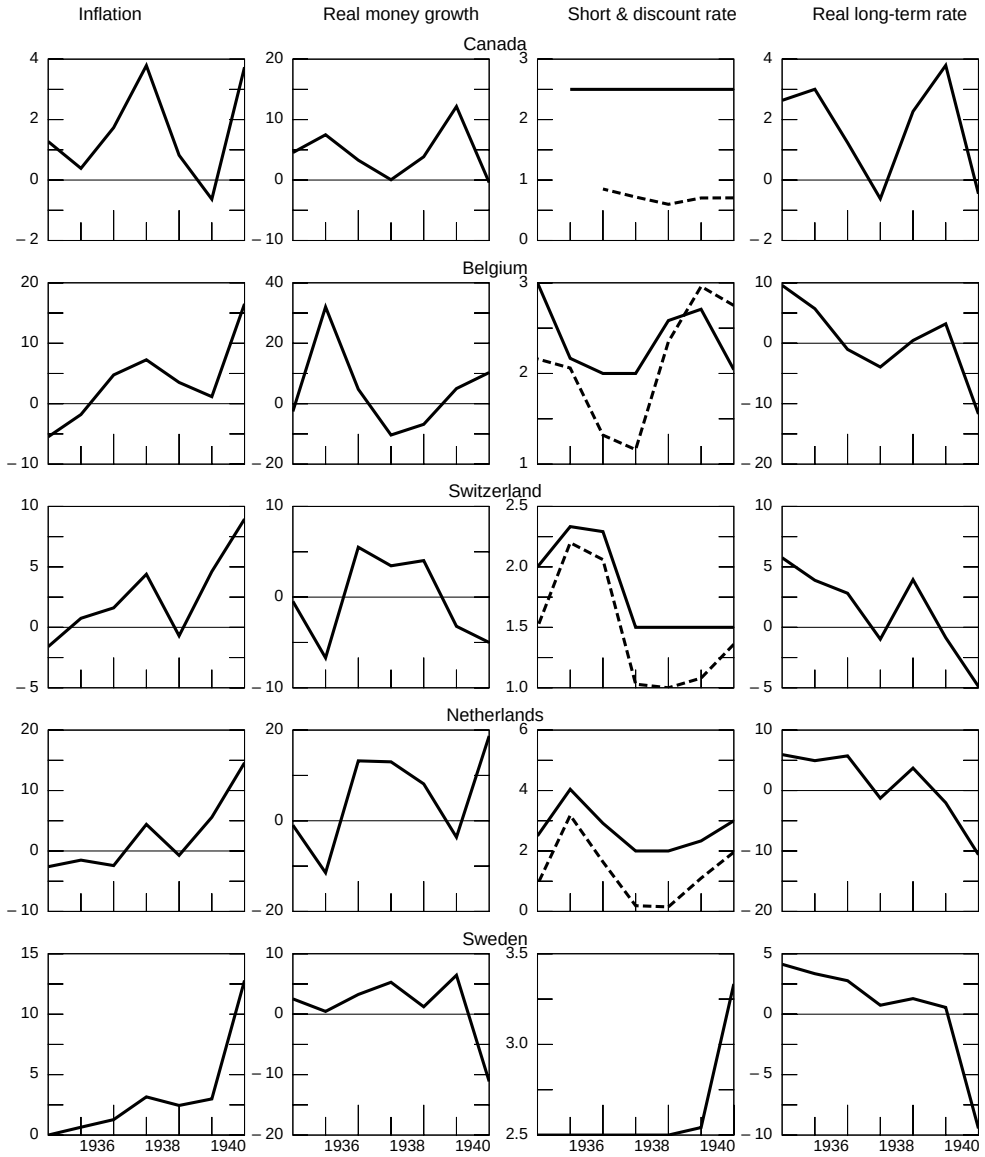
Graph A5

Two episodes of deflation (1937-8 and 1948-49) and the zero lower bound



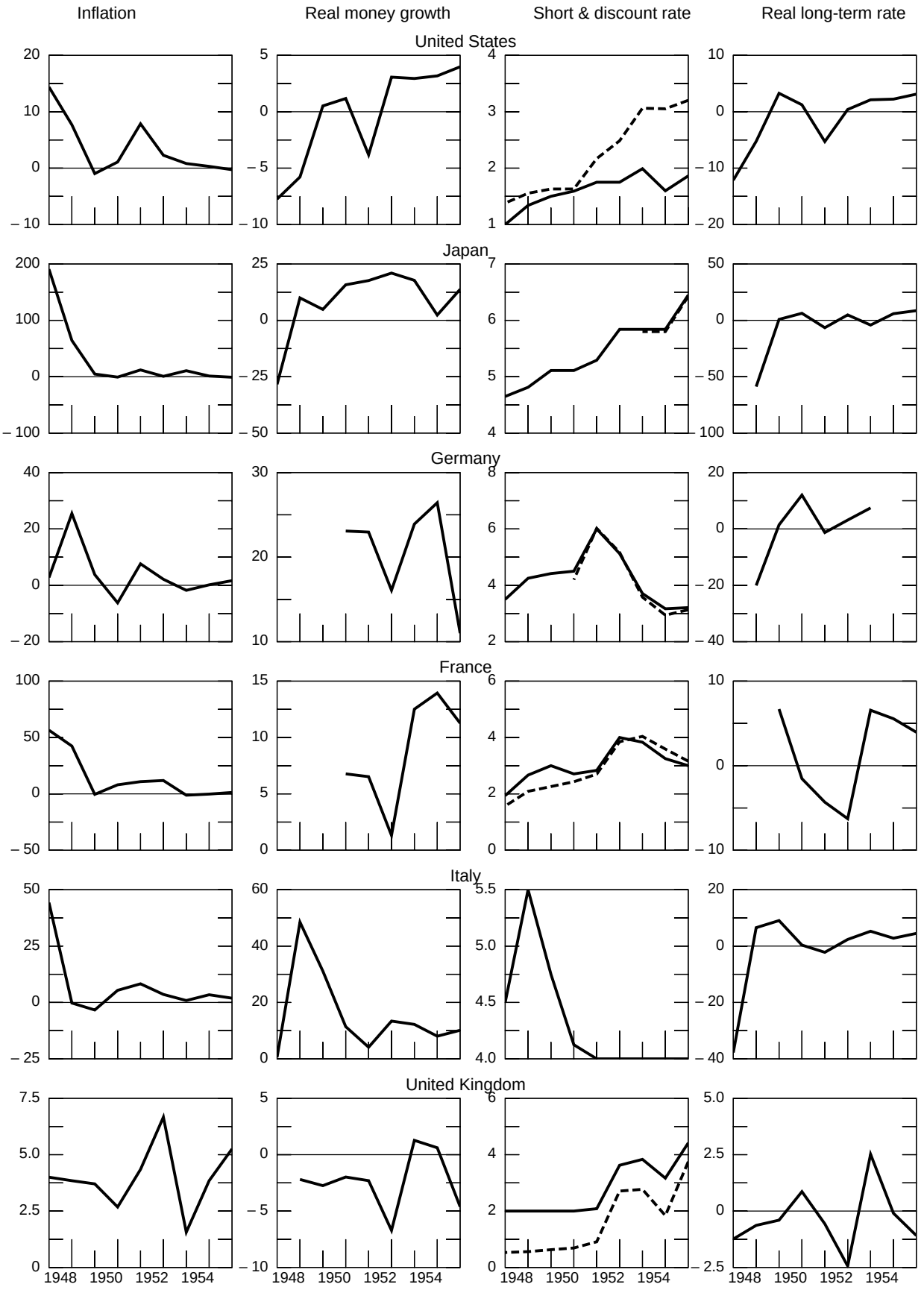
Graph A5 (cont)

Two episodes of deflation (1937-8 and 1948-49) and the zero lower bound



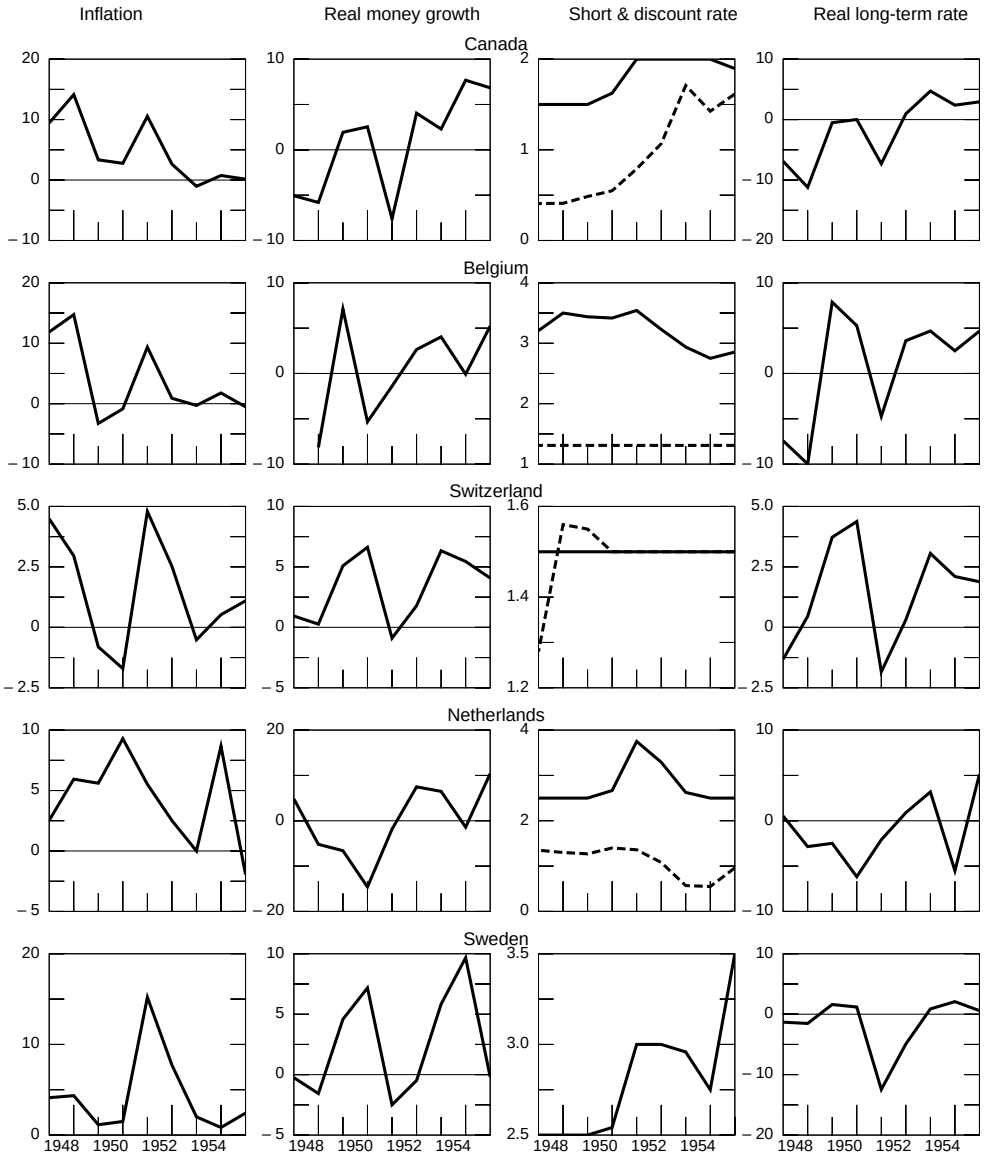
Graph A5 (cont)

Two episodes of deflation (1937-8 and 1948-49) and the zero lower bound



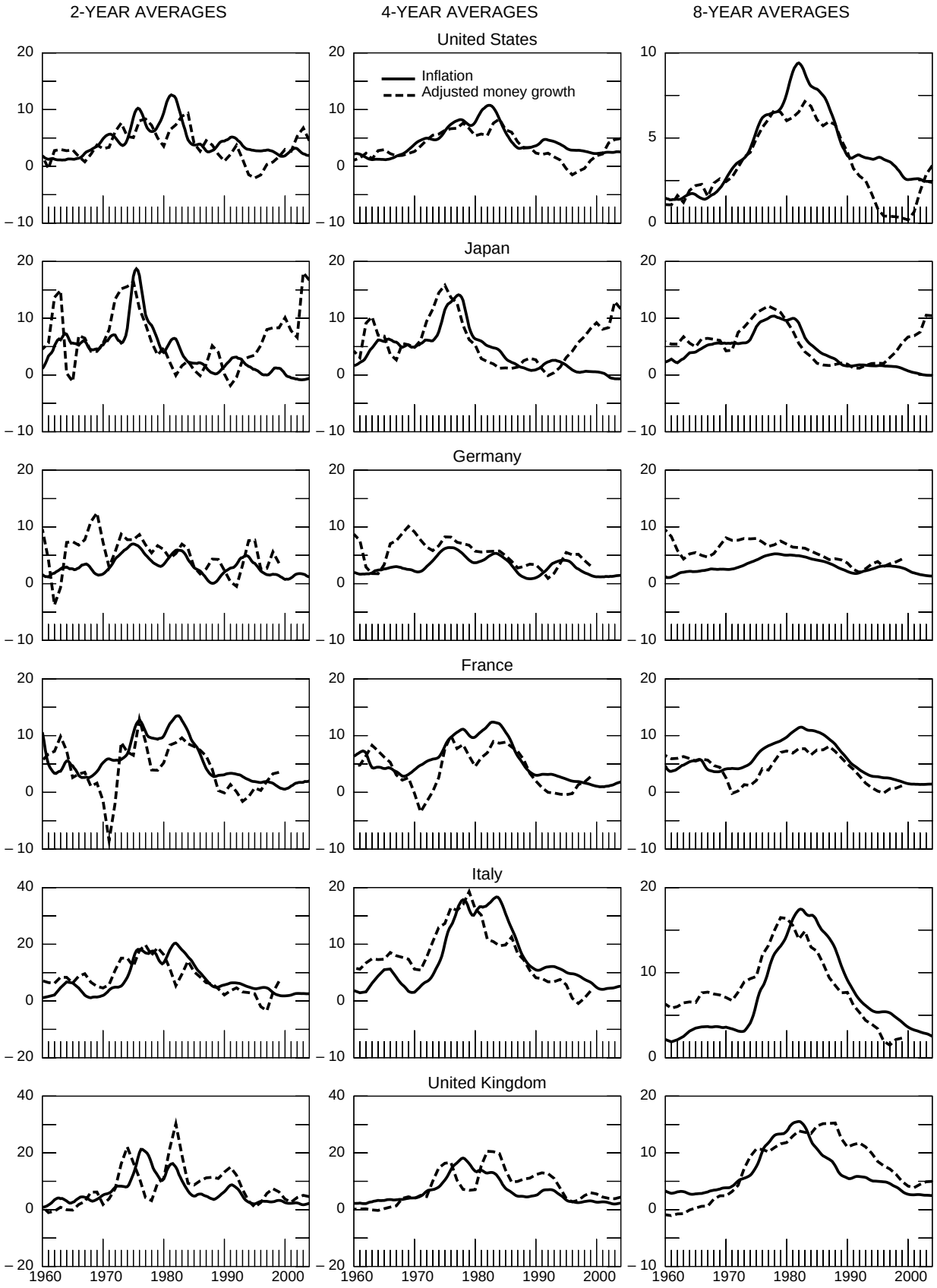
Graph A5 (cont)

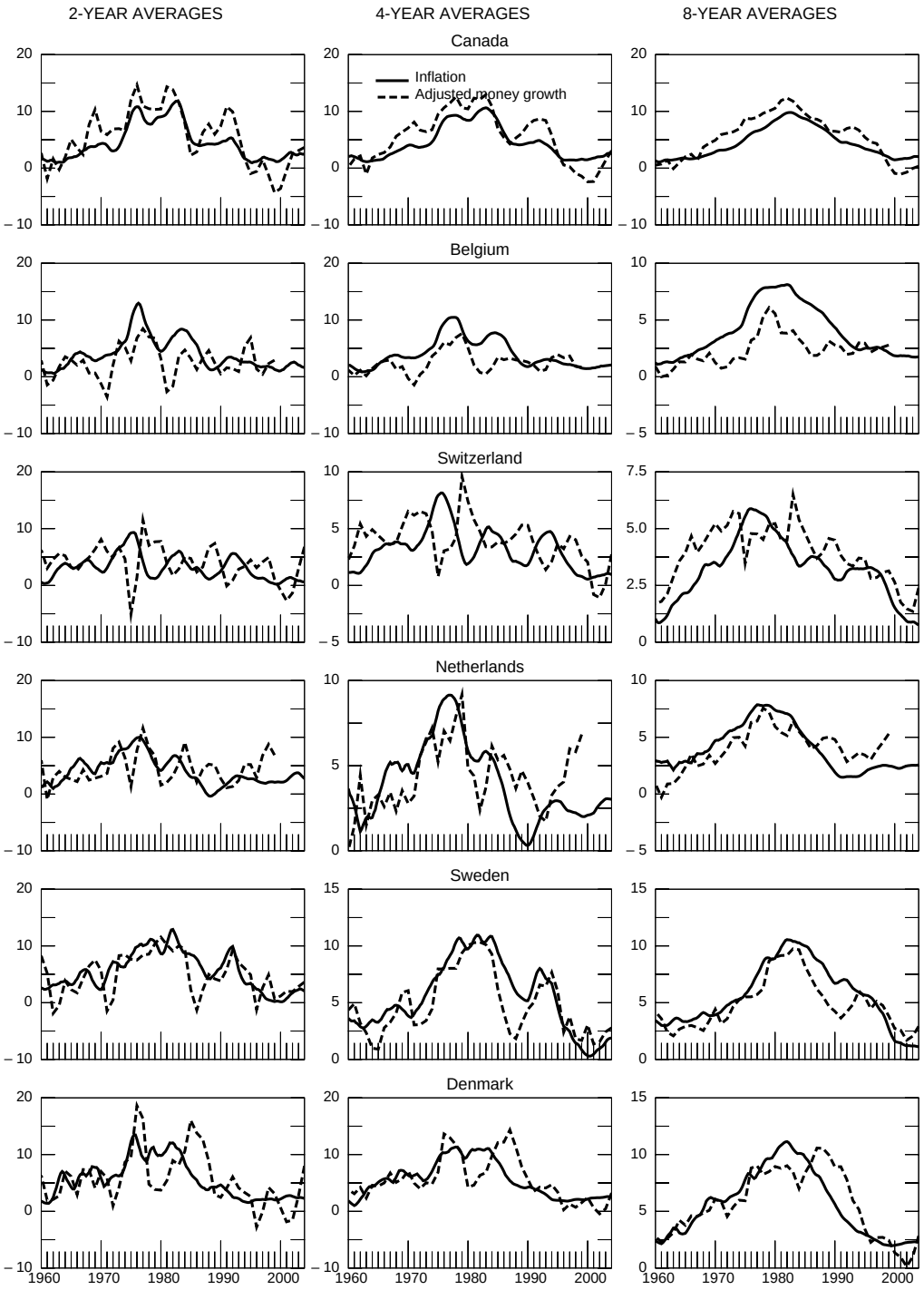
Two episodes of deflation (1937-8 and 1948-49) and the zero lower bound

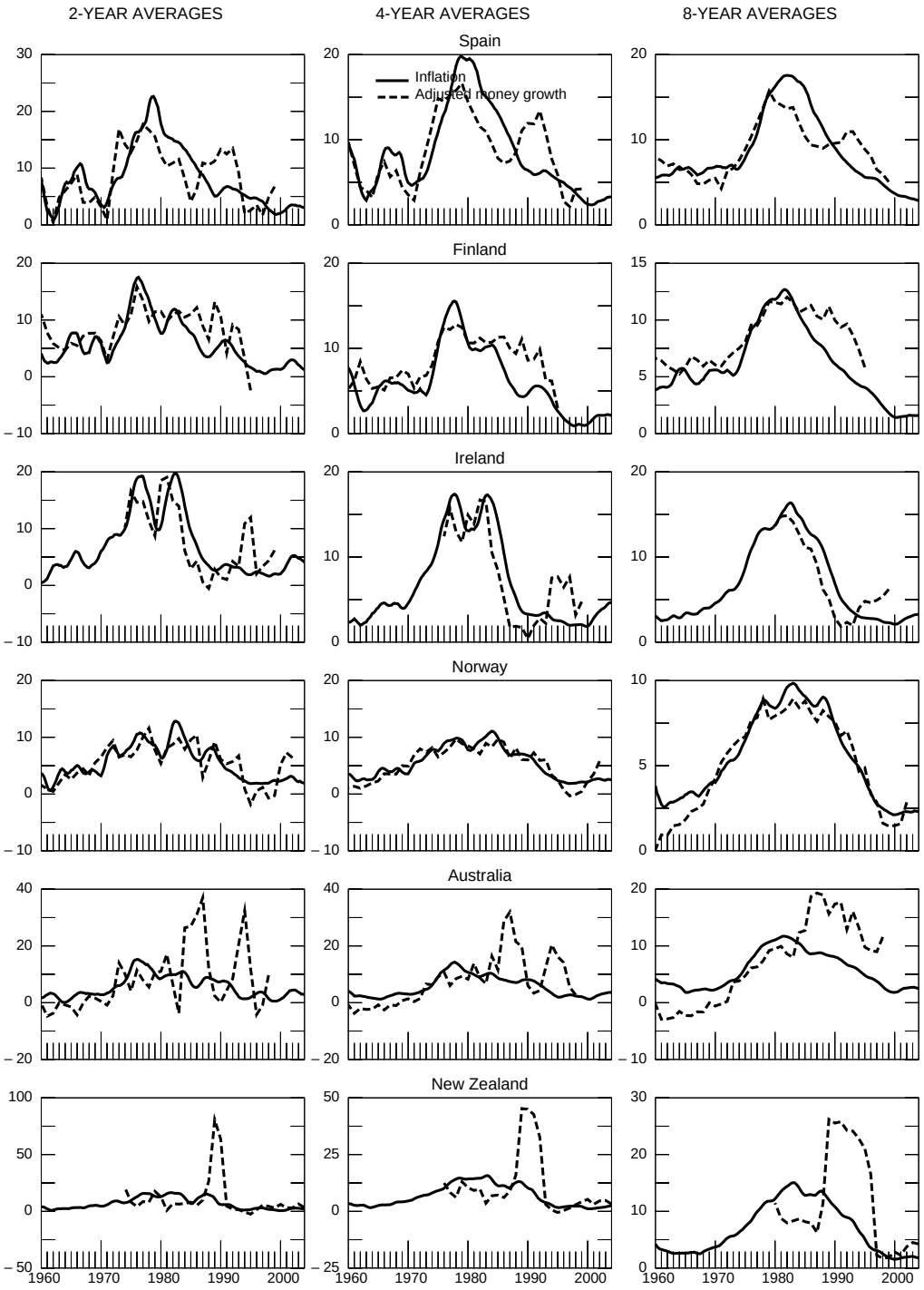


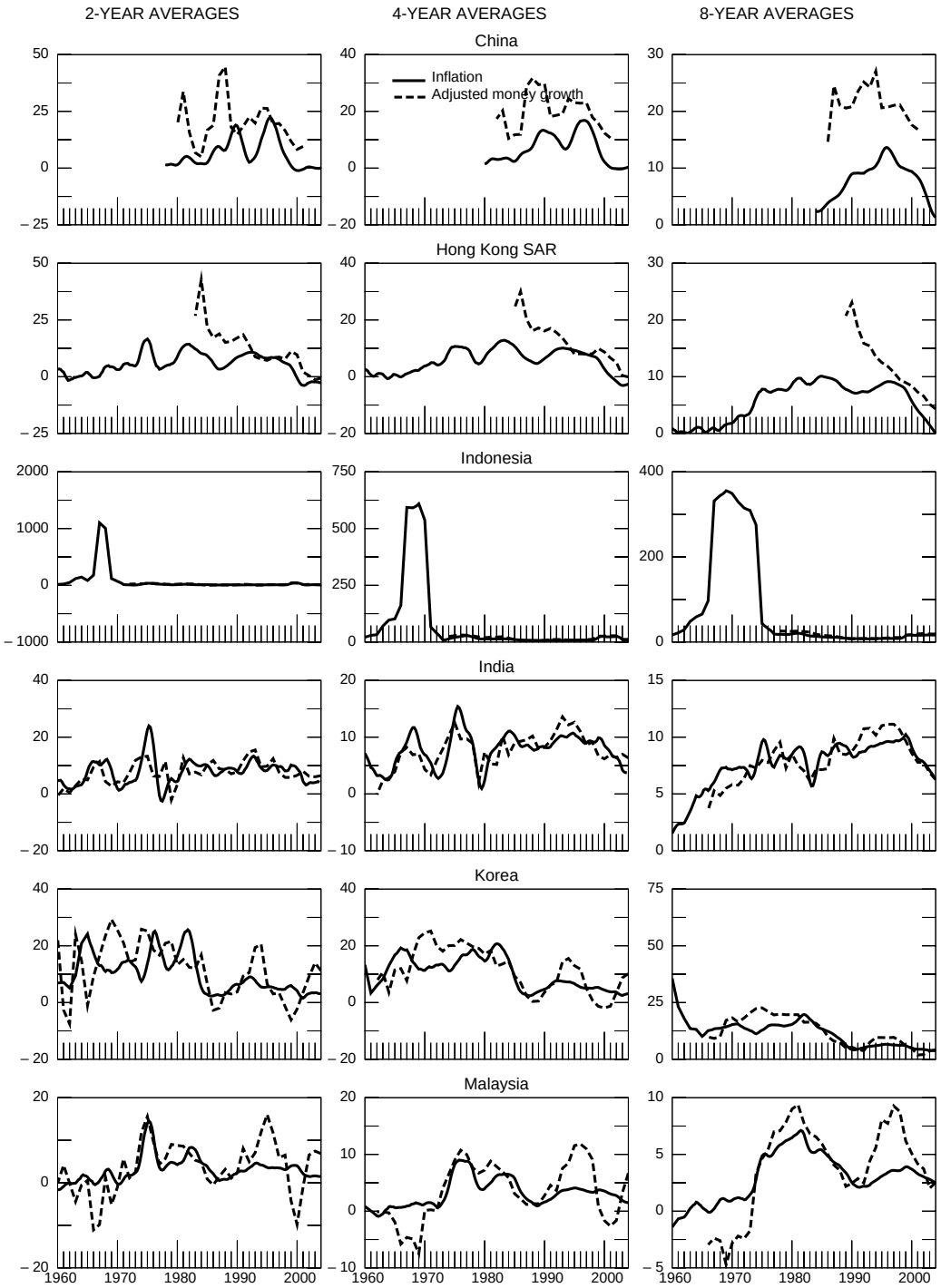
Graph A6

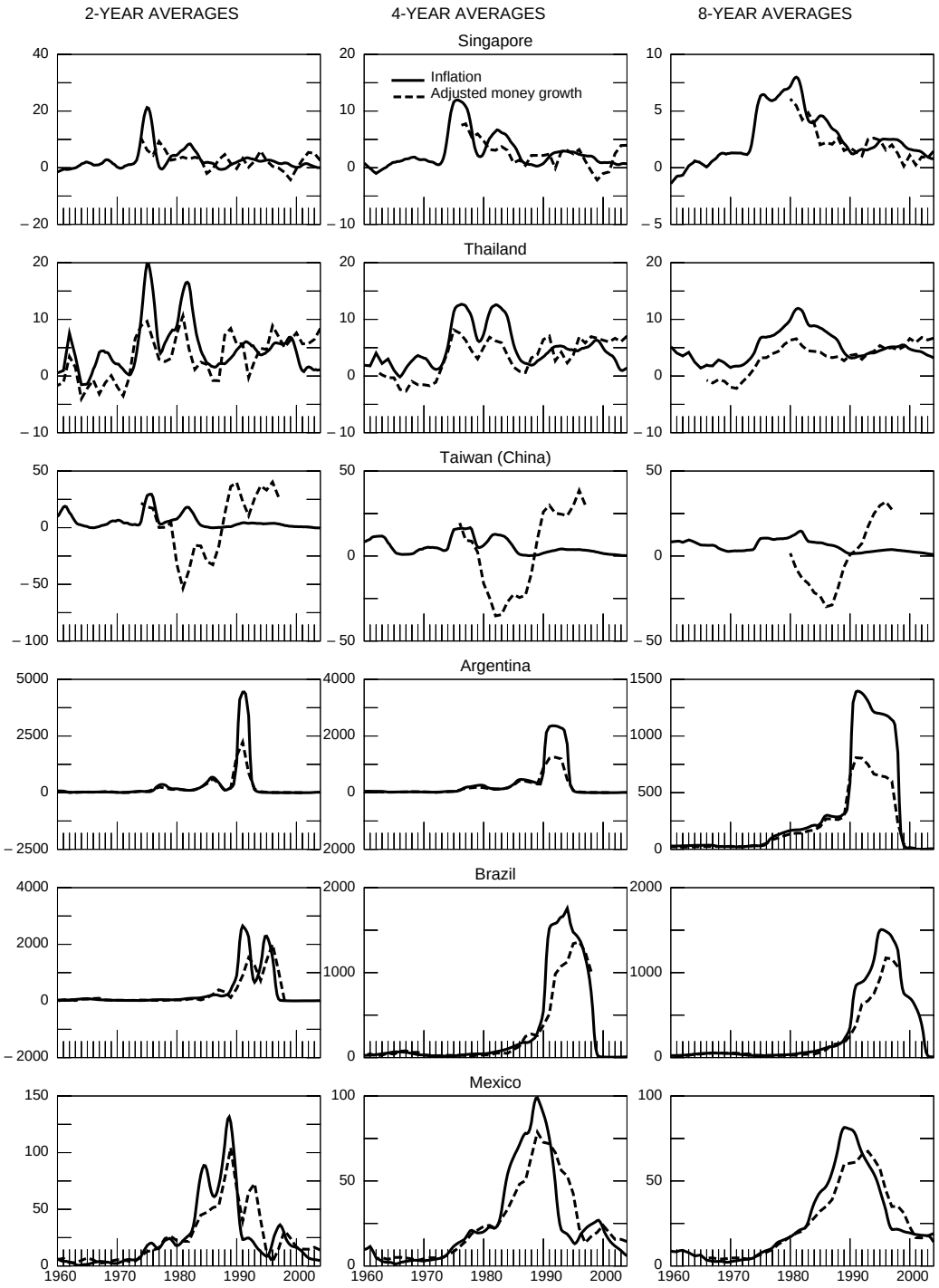
Stability of the money-inflation relationship

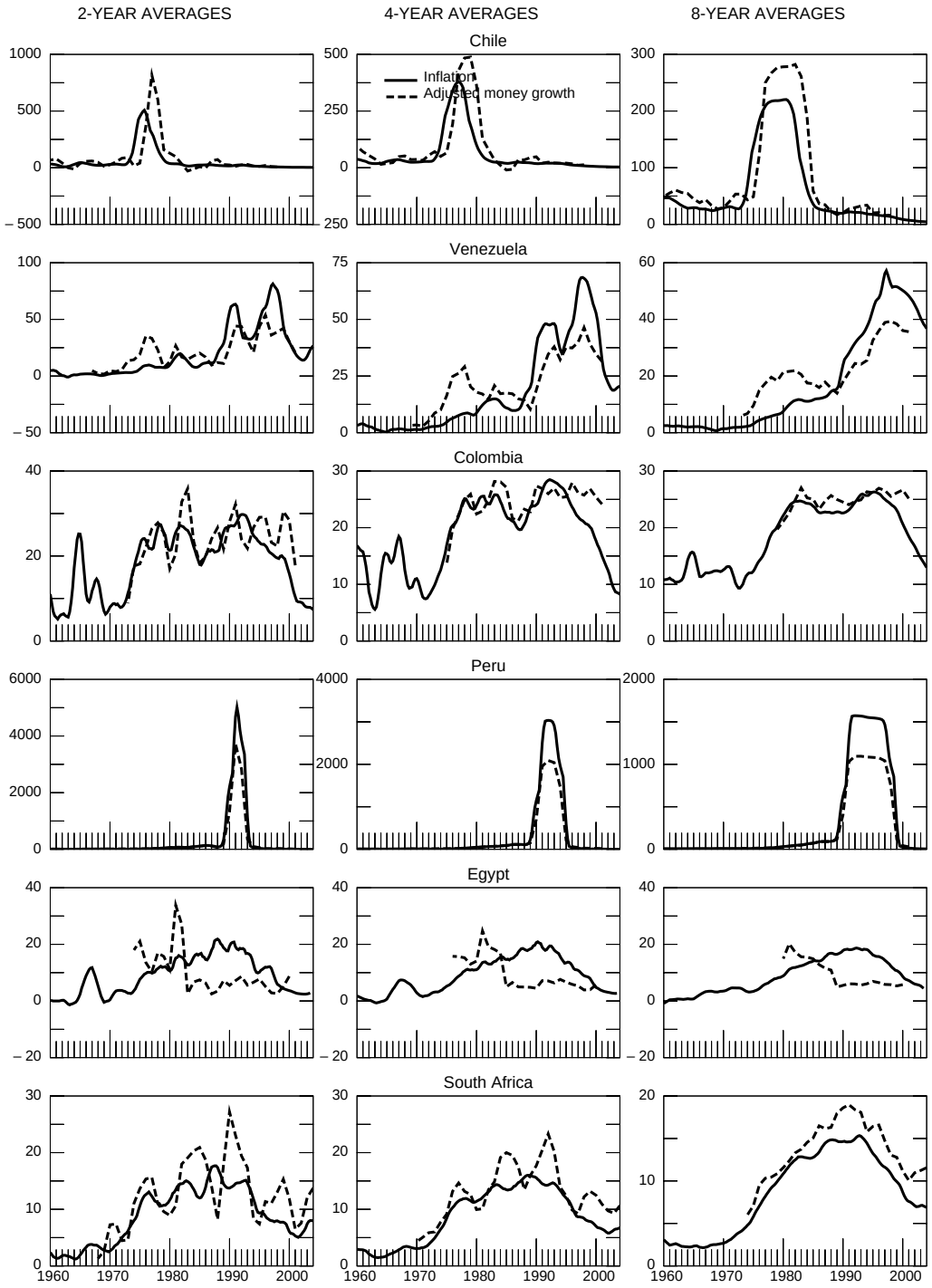



2-YEAR AVERAGES
4-YEAR AVERAGES
8-YEAR AVERAGES
Canada
Inflation
Adjusted money growth
Belgium
Switzerland
Netherlands
Sweden
Denmark
1960
1970
1980
1990
2000


2-YEAR AVERAGES
4-YEAR AVERAGES
8-YEAR AVERAGES
Spain
Inflation
Adjusted money growth
Finland
Ireland
Norway
Australia
New Zealand
1960
1970
1980
1990
2000


2-YEAR AVERAGES
4-YEAR AVERAGES
8-YEAR AVERAGES
China
Inflation
Adjusted money growth
Hong Kong SAR
Indonesia
India
Korea
Malaysia
1960
1970
1980
1990
2000


2-YEAR AVERAGES
4-YEAR AVERAGES
8-YEAR AVERAGES
Singapore
Inflation
Adjusted money growth
Thailand
Taiwan (China)
Argentina
Brazil
Mexico
1960
1970
1980
1990
2000


2-YEAR AVERAGES
4-YEAR AVERAGES
8-YEAR AVERAGES
Chile
Inflation
Adjusted money growth
Venezuela
Colombia
Peru
Egypt
South Africa
1960
1970
1980
1990
2000