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The Spectre of Deflation: A Review of Empirical Evidence

Gregor W. Smith
Queen's University

Department of Economics
Queen's University
94 University Avenue
Kingston, Ontario, Canada
K7L 3N6

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Gregor W. Smith

Department of Economics, Queen's University

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Abstract. What explains the widespread fear of deflation? This paper reviews the history of thought, economic history, and empirical evidence on deflation, with a view to answering this question. It also outlines informally the main effects of deflation in applied monetary models. The main finding is that – for both historical and contemporary deflations – there are many open, empirical questions that could be answered using the tools economists use to study inflation and monetary policy more generally.

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E-mail: smithgw@econ.queensu.ca.

spĕc'tre, n. thing that is thought to be seen but has no material existence; haunting presentiment (of ruin, war, madness *etc.*)

1. Introduction

Economics textbooks sometimes feature examples in which commonsense thinking and economic reasoning lead to very different conclusions. In macroeconomics, perhaps the most dramatic example of this difference concerns deflation. Policymakers and commentators in the business press refer to deflation as something to be feared. According to this popular view, deflation brings recession, leads to layoffs by raising real wages, is linked to a fall in asset prices and loss of wealth, and causes a postponement of consumption spending that reduces output. The 'spectre of deflation' is a cliché that appears in the business press (as a LexisNexis™ or Google™ search will confirm) as a shorthand way to refer to the threat of deflation. There is even a word for the fear of deflation: *apoplithorismosphobia*, coined by Thornton (2003), though I did not have time to pronounce it during the lecture.

Meanwhile the Friedman rule – which prescribes deflation as the optimal monetary policy – has been the benchmark in monetary theory for more than thirty years. According to this view, deflation is *merely* a spectre (in the dictionary sense at the beginning of this article), of which the fear is unjustified. One subject I would like to address is this lecture is why this difference of views persists. Are popular economic commentators unaware of the theory and evidence on deflation? Or are monetary theorists working on models that are missing key ingredients? Is this disjunction any starker than in other areas of economic policy?

In fairness, this matter is not just a question of how economists communicate with others. Within academic economics there also is a range of perspectives. What is one to make of the fact that while some eminent economists – Krugman, Svensson, Feldstein, Auerbach, Obstfeld, Woodford – write on how to avoid or escape deflation (or the liquidity trap) – others – Ireland, Kocherlakota, Uhlig – study how to implement deflationary monetary policy? What characteristics of the economy do these different

views of zero nominal interest rates hinge on, and what empirical evidence can be brought to bear on them?

The question I shall actually address is a simpler one. What is the empirical evidence on deflation? Do deflations have redistributive or aggregate effects that would justify their being feared? The idea of exploring this evidence is that if we are to fear deflation we should do so for the correct reasons, and so perhaps design ways to avoid its costs.

Deflation refers to a general decline in prices and is typically defined as a fall in the consumer price index (CPI). In an economy with low inflation some individual prices rise while others fall over time. (Álvarez *et al* (2005) and Gagnon (2006) provide state-of-the-art evidence on price-setting.) Thus one ought to think of deflation as representing a shift in this balance, with an increased share of prices falling, rather than necessarily as a change in the behaviour of all prices. This perspective in itself tends to make deflation less fearsome.

Deflation is quite common, both across countries today and historically. Kumar *et al* (2003, table 1A) and Bordo and Filardo (2005, table 1) thoroughly documented the incidence of deflation. Early in the twenty-first century roughly 10 percent of countries experienced deflation, for example. China, Japan, Indonesia, and Argentina are examples of large economies with experiences of deflation during the past decade.

Deflation is endogenous, so it cannot be feared the way we would fear a comet strike. We need a model before we can discuss optimal monetary policy or the costs and benefits of deflation. The models that economists use to study inflation can serve as benchmarks. And the limits to our knowledge of monetary policy serve as a reminder of the challenges involved in understanding deflation. Many of the empirical issues in deflation, such as how to measure policy shocks or explain persistence in deflation or measure welfare costs, also are controversial for inflations.

My non-technical review unfolds as follows. Section 2 briefly comments on measurement error in CPI inflation and its implications for studies of deflation. Section 3

offers a brief, amateur history of economic thought on deflation. Section 4 describes empirical evidence on deflation grouped according to five traditional ways of studying its effects. Section 5 outlines the tradeoff in applied monetary economics between deflation's benefits to money-holders and its costs to price-setters.

It is difficult to prove that something does not exist. But the main theme of the review is that there are many gaps in our empirical work on deflations. Section 6 suggests a list of questions one might ask in preliminary empirical work on episodes of deflation. It then presents data from four such episodes, two historical and two contemporary, as a way to encourage further research. Section 7 then concludes.

2. Measurement and CPI Bias

The idea that CPI inflation may overstate inflation in the cost of living has been well-known ever since the Boskin Commission reported in the United States in 1996. The Symposiums in the Winter 1998 *Journal of Economic Perspectives* and in the Spring 2006 *International Productivity Monitor* contain a thought-provoking range of views on the issues. One source of the discrepancy is substitution bias due to the use of a modified Laspeyres (fixed-weight) index. Another is quality change and the treatment of new goods and services. Producers often couple changes in price with changes in quality, so it is challenging to isolate price changes.

Most assessments of the biases in various countries suggest that they might lead CPI inflation to overstate actual inflation by 1 percent per year or so. Thus it is worth bearing in mind that actual deflation might begin at measured inflation rates below 1 percent. If we used this threshold to label deflationary episodes their incidence obviously would increase. The spectre would probably look less ominous also.

It also is possible that the scale of the bias is negatively correlated with the inflation rate. For example, if deflation is associated with rapid productivity growth (so-called 'good deflation') then it may also coincide with rapid quality improvements and the introduction of new goods. Thus the actual deflation rate may be significantly greater than the measured one. I have not found research on this issue.

3. History of Thought

The introduction mentioned that today's economists have a range of views on deflation. Economists held disparate views in the past too. One reason to study their views is that the economists of the nineteenth and early twentieth centuries all had lived through deflation, either of the gradual or sharp variety.

Economists of the late nineteenth century also participated in the debate over the gold standard in the US and Europe. Many opponents of the gold standard favoured a bimetallic standard, based on both gold and silver, that would allow for a larger supply of money. Bimetallists attributed late nineteenth-century deflations and recessions to the gold standard. This debate saw political parties (like the Greenback party or the Gold Democrats in the US) run on monetary policy platforms. The view that demonetizing silver in the 'crime of 1873' had harmed agrarian debtors was central to William Jennings Bryan's campaign as the Populist and Democratic Party candidate for the US presidency in 1896 and 1900. An era in which elections were fought over monetary policy may have lessons for our understanding of the spectre of deflation today.

Humphrey (2004) outlined some of the views of classical economists of the late eighteenth and early nineteenth centuries, including Hume, Ricardo, Thornton, and Christiernin. For these economists, deflation usually meant a return to a stable price level by undoing a previous, wartime inflation. Thus their views pertain to the current debate comparing inflation targetting and price-level targetting. The classical economists suggested a range of short-run, real effects of deflation, depending on sticky prices (Hume), redistribution (Hume), or debt-deflation (Christiernin), and on whether deflation was expected or not (Thornton). Ricardo argued for caution, recommending that monetary policy should offset small inflations with small, gradual deflations, but allowing larger inflations to introduce drift in the price level rather than risking a contraction.

As for the neoclassical economists, Marshall (1886) quoted Thomas Tooke's *History of Prices* (vol II pp 348-9) which gave explanations for the British deflation from 1814 to 1837 that have the ring of 'new economy' explanations for low inflation or

deflation today. Deflation was due to:

> (2) the removal of obstacles from the several sources of foreign supply; a great extension of some of them; and the discovery of new ones.
> (3) a great reduction in the charges of importation, by the low freights and insurances incidental to a state of peace; and the improved, and cheaper, and more rapid internal communications.
> (5) improvements in machinery, in chemistry, and in the arts and sciences generally, all tending to reduce the cost of production of numerous articles, or to provide cheaper substitutes.

What about the effects of deflation? Marshall commented on the redistribution caused by deflation and so argued that it may hurt trade and industry by transferring profits from manufacturers to savers. But my impression is that he was conflicted, much as we are today; he thought deflation was somewhat bad for output but noted the difficulty in backing this impression with evidence. For example, he found little evidence of depression during the late nineteenth century deflation. His main conclusion was that the injurious effects of fluctuations are greater than those of a gradual fall in prices.

Marshall also made an important observation about historical deflations that does not apply today but matters to modelling in economic history. Price indexes generally were not available in the past. Marshall recommended that the government publish a price index to help people make decisions.

Ten years later, Irving Fisher (1896) also argued that a dependable monetary standard need not be invariable but simply forecastable. He also wrote in the context of the bimetallic controversy. Through a series of numerical examples, Fisher argued that foreseen inflation or deflation shows up in nominal interest rates and so does not lead to redistribution. "In general," he wrote (p 36), "business foresight exists." He backed up this claim with a detailed comparison between actual inflation and expected inflation (as implied by nominal bond yields) to show that there were not large, unexpected deflations and hence no large losses to debtors, contradicting the claim of the bimetallists.

Fisher's main goal was to show that real returns need not be affected by inflation

or deflation, in order to take the sting out of contemporary arguments for inflation. But he also seemed to take for granted that inflation generally was procyclical. He suggested a theory as follows. Suppose that borrowers (firms) have better foresight than savers (households). Then in an inflation the nominal interest rate will reflect an average of the rate expected by firms (a positive number) and the rate expected by households (say, zero). Actual inflation then will redistribute to firms, who will prosper. In a deflation, conversely, the nominal interest rate does not fall enough to reflect the more accurate, deflationary expectations of firms, so business is hurt by a high real interest rate. As Fisher wrote (p 78)

> *imperfection* of foresight transfers wealth from creditor to debtor or the reverse, [while] *inequality* of foresight produces overinvestment during rising prices and relative stagnation during falling prices.

This argument was not set in a general equilibrium, but it does foreshadow modern approaches such as a Phillips curve that reflects forecast errors or monetary models that feature heterogeneous agents.

Keynes (1924) in the *Tract on Monetary Reform* also remarked that deflation led to lower output. The mechanism he suggested (p 41) seems implausible to the modern reader though: firms are discouraged from holding stocks of goods or commodities when their prices are falling, and so they produce less output. His writing seems to me to take for granted that deflation is associated with recessions. Perhaps this is not surprising, given the correlation during the sharp deflation of 1921-1922. Overall, Keynes argued for stable prices as the goal of monetary policy.

In the 1920s the debate on deflation again was about whether to deflate and return to the pre-war price level (but no further) or to allow price-level drift and stabilize prices at their current level. Economists considered potential costs of deflation including those arising from bankruptcy, the effects of hoarding cash, and sticky nominal wages. Keynes argued for drift, while Fisher and Wicksell favoured gradual deflations to restore the price level.

Wicksell – as described by Boinaovsky (1998) – argued for the neutrality of perfectly anticipated deflation. And the first half of the twentieth century also saw well-

known economists who went further and positively encouraged a slow deflation as the goal of monetary policy: Robertson, Hayek, von Mises, and Robbins. Nevertheless the view that deflation was linked to depression remained widespread. I next turn to some of the evidence on this link.

4. The Spectre of Deflation

This section reviews evidence on five aspects of the spectre of deflation: that deflation is associated with depressions, that unanticipated deflation is associated with depressions, that deflation propagates to the real economy through sticky nominal wages, that it propagates through nominal debts, and that deflation leads to deferred consumer spending and a deflationary spiral. For excellent surveys of the incidence of deflation and of arguments about its effects, the reader is referred to Kumar *et al* (2003) and Bordo and Filardo (2005).

4.1 Deflation is Associated with Depression

Perhaps the simplest way to begin asking about the spectre of deflation is to look at the correlation between deflation and economic growth. Atkeson and Kehoe (2004) studied output and price data for 17 countries. They averaged inflation rates and output growth rates over five-year periods and then constructed cross-plots of the correlations. Equivalently, they ran an international, cross-section regression for each time period. Only for 1929-1934 is there a positive relationship between the inflation rate and the output growth rate, with deflating countries – such as Canada, the United States, and Argentina – also experiencing depression. Other deflating countries – such as the UK and Japan – did not experience declines in output.

But excluding 1929-1934 there is virtually no link, even though there were other periods of deflation, especially under the gold standard. Japan is the leading modern location for the correlation, but Atkeson and Kehoe argued that Japan had been experiencing slowing output and price growth gradually over decades, not likely due to monetary policy.

One objection to the Atkeson-Kehoe conclusions might be that the correlations do not detect deflation-depression episodes that are either (a) short-lived (say a year or two, as in the early 1920s) because of their time-averaging or (b) country-specific. But their scatter-plots do include country-specific episodes; it is simply the case that most deflations are not accompanied by depressions.

In periods where there is a widespread association between deflation and depressions, as in 1921-1922 or 1929-1933, it is often argued that the depression was caused by unanticipated deflation. But then such episodes are not really relevant to assessing the Friedman rule, which prescribes a steady, predictable deflation.

4.2 Unexpected Deflation is Associated with Depression

The Atkeson-Kehoe correlations also imply that there is little correlation between inflation and booms, yet most models of monetary policy shocks identify some connection between the two, or a type of Phillips curve. Much of the work of economic historians on deflation is concerned with exactly the issues that preoccupy students of any business cycle: how to measure monetary policy shocks and what controls or additional shocks to include in a model. Identifying monetary shocks is controversial and explaining inflation dynamics is challenging today so it is not surprising that studying deflations also is challenging.

Was there a link between deflation and depression in 1929-1933 because the deflation was unanticipated? For the US a series of interesting papers has assessed whether the deflation was unanticipated and who knew what when. Cecchetti (1992) and Evans and Wachtel (1993) used information in interest rates to answer this question. Hamilton (1992) used commodity futures prices, Nelson (1991) used reports in the business press, and Klug, Landon-Lane, and White (2005) used railroad shippers' forecasts. In a similar vein for Sweden's interwar deflations, Fregert and Jonung (2004) looked at information on the reported beliefs of employers, workers, and policymakers. They found that the 1930s differed from the 1920s, perhaps because of lessons learned in the earlier deflation. (Using this same array of methods to assess whether other deflations were anticipated seems a natural research topic.)

Whether shocks are measured using auxiliary information or within a statistical model, the next step is to include them in a model with real variables. Candidates for study include vector autogresssions (VARs), Phillips curves, and dynamic, stochastic, general equilibrium (DSGE) models. (Section 6 below provides a preliminary look at Phillips curves during four episodes of deflation.)

Bordo and Redish (2004) studied the deflations in the US and Canada between 1870 and 1913 using a vector autoregression. Their work thus can be thought of as a check on the Atkeson-Kehoe finding using conditional or partial correlations. They identified a VAR using a Blanchard-Quah-type scheme and concluded that for both countries supply shocks drove changes in output while money shocks drove changes in the price level. During this time period there was a correlation between deflation and depression. For example Canada experienced deflation and slow growth from 1870 to 1896 and inflation and fast growth from 1896 to 1913. But by controlling for other shocks Bordo and Redish concluded that this correlation was a coincidence rather than being causal. Gold discoveries took place at the same time as productivity improvements.

Cole and Ohanian (2004) used a DSGE model, a version of the neoclassical growth model, and argued that the persistence of the US Great Depression was due to restrictive labour market policies associated with the New Deal rather than to deflation interacting with sticky nominal wages. Bernanke and Parkinson (1991) also studied the evolution of labour productivity in the 1930s. Cole and Ohanian found that controlling for productivity shocks reduces the role of monetary shocks and deflation. They concluded that only about a third of the persistence in the Depression was due to that traditional source.

Thus, these studies which measure surprises and which also control for real-side shocks seem to further reduce the fearsomeness of deflation, even in the one time period for which Atkeson and Kehoe found a correlation. Other VAR and DSGE applications to the US Great Depression are discussed in sections 4.3 and 4.4 below. Meanwhile I note that there are very few studies of deflations in other countries that

try to control for or explain productivity trends. This absence of documentation and research work is all the more surprising given the distinction between good and bad deflations that some economists draw based on what is happening to productivity.

One of the key questions in adapting macroeconomic models to deflationary periods is whether the model should change at the point of zero inflation. For example, wage and price-setting institutions may change. Chen and Flaschel (2005) proposed and applied some tests for such changes. And how monetary policy affects the economy and how one measures policy may change, for example at the zero bound for nominal interest rates.

4.3 Sticky Nominal Wages

One of the classic mechanisms by which a deflation is often said to have real effects (like the conditional correlation discussed in section 4.2) is through nominal wages that are sticky. For example, one often reads that the Great Depression in the United States and Canada led to polarized labour-market experiences: while unemployment rates soared, those employed experienced rising real wages as a result of deflation. What is the evidence on this nominal rigidity and on its connection to employment?

O'Brien (1989) found that nominal wages did not decline significantly in the US during the first two years of the Depression, though large declines began in the autumn of 1931. He also argued that this delay was not due to a changing mix of skills; wages were sticky for individual jobs. Also notable was the contrast with the wage flexibility of the early 1920s. Since the 1930s depression also was much more prolonged than the depression of the early 1920s, nominal wage rigidity seems even more worthy of study as part of the transmission mechanism.

O'Brien also pointed out that the 1930s was not an era of multi-year contracts in the US. Rather he argued that firms were inspired by the economic trauma of the early 1920s to try something different. Business groups publicly argued for the coordinated maintenance of nominal wages, to avoid a spiral downturn and to maintain purchasing

power. Moreover, price indexes were still not available as the Great Depression began. Deflating nominal wages by wholesale prices for this time period gives a very different impression than deflating by consumer prices, which may be a further explanation for contracts with a set nominal wage.

How can one judge the effects of nominal wage stickiness in deflations? For the Great Depression, two methods have been employed. First, Eichengreen and Sachs (1985) and Bernanke and Carey (1996) assessed this effect using a cross-section of countries in the early 1930s. For example, Bernanke and Carey related industrial production to real wages across 22 countries for the 1931-1936 period. They found that countries that left the gold standard and reflated had low real wages and high industrial production, while countries that remained on gold had the opposite pattern. Furthermore, the effect seems to come from the real wage and not from some other effect of the price level on output (such as a debt-deflation mechanism).

Cole, Ohanian, and Leung (2005) examined correlations between inflation and output growth and real wages and output growth for 17 countries for an earlier period: 1929-1933. Thus their study focuses more on the cause of the Depression and less on the recovery, relative to that of Bernanke and Carey. If deflation acting through sticky nominal wages were the main cause of the Depression then there should be a positive correlation between inflation and output growth and a negative one between real wages and output growth. But they find both correlations to be near zero. For example, countries with the biggest deflations did not have the biggest depressions. Cole, Ohanian, and Leung argue that there must be a missing shock that shifted around the labour demand curve. Their candidate is productivity, for countries with large depressions also had large falls in labour productivity.

The second method for assessing the sticky-wage hypothesis in aggregate data is to use a DSGE model for a single country. Bordo, Erceg, and Evans (2000) identified the effects of nominal wage stickiness in time series data for the U.S. They constructed a macroeconomic model with overlapping contracts and a single shock to money growth and used it to construct sample paths for a range of US variables. Their model does

very well on the multivariate sample path – including output and real wages – for the early 1930s. But it cannot explain the slow recovery after 1933 despite monetary growth then. They thus concluded that some other real rigidity must have played a role then.

Akerlof, Dickens, and Perry (1996) also studied the US Great Depression. They argued that firms' avoidance of nominal wage cuts caused a kinked, long-run Phillips curve, so that negative demand shocks led to very large increases in the unemployment rate but little deflation. However, they did not conduct tests of their model on data from deflationary time periods.

Cole and Ohanian (2001) used an interesting benchmark to identify what shocks mattered for the US Great Depression. Their argument is that a convincing model also must explain the US deflation of the early 1920s, when there was a price deflation comparable to that of the 1930s but without a great depression. Using this criterion, they ruled out a difference based on whether the deflation was anticipated or not, by examining interest rates. They also argued that debt was similar in the 1920s and so did not focus on debt-deflation. Their DSGE models focus on two remaining explanations for the depth of the US Great Depression: sticky nominal wages and banking disruption. They concluded that neither explanation works completely so that there must be a missing shock. This is the same conclusion reached by Bordo, Erceg, and Evans.

Direct tests for nominal wage rigidity require data on wages that are collected either from individuals or from establishments. Kahn (1997) and Lebow, Saks, and Wilson (2003) developed tests based on the histogram of wage changes. The idea underlying their tests is that the height of the histogram at a given order in the distribution should be lower in years when the position in the order corresponds to a nominal wage cut. Thus the test does not assume that the distribution is symmetric but it does assume that the distribution would be unaffected by the inflation rate in the absence of this rigidity.

Lebow, Saks, and Wilson used micro-data from US establishments, that includes

both wages and benefits. The consensus in this literature is that measurement error is less here than in worker-reported sources such as the PSID. They found evidence of nominal-wage rigidity during 1981-1999 in that there were roughly half as many wage cuts as would have been predicted from a stable distribution. The inclusion of benefits reduces the measured rigidity slightly.

What are the results of these direct tests during deflations? Hanes and James (2003) examined nineteenth-century US data on wages for specific jobs and establishments, using these same methods. For 1841-1891 they found no evidence of downward rigidity in a low inflation/deflation environment. I have not found studies for the 1920s and 1930s US deflations or for recent deflations in other countries that use these statistical methods. Pursuing this research seems fruitful given the debate about how wage-setting institutions and customs change with the rate of inflation or deflation.

4.4 Debt-Deflation

Irving Fisher lived through and made influential observations on the deflations of the 1890s, 1920s, and 1930s. When one asks economists about the effects of deflation they often refer to Fisher's (1933) essay on the causes of business cycles. Fisher argued that depressions begin with debt liquidation, leading to deflation and then to bankruptcies, and to a fall in output and employment. Associated with these events are a fall in nominal interest rates and a rise in real interest rates. Fisher listed nine factors in the propagation mechanism, but the debt problem comes first and precipitates the deflation. He also argued that (p 346)

> it is always economically possible to stop or prevent such a depression simply by reflating the price level ...[and]... immediate reversal of deflation is easily achieved by the use, or even the prospect of use, of appropriate instrumentalities.

Finally, he then discussed why over-indebtedness arose in the first place.

In my amateur excursion in the history of economic thought, I found three surprises. First, Fisher usually is remembered as describing why unanticipated deflation

affects output – through bankruptcy – whereas his paper also was about what causes deflation.

Second, there are very few empirical papers that cite Fisher. In the *Social Sciences Citation Index* I rapidly found 184 citations to Fisher's 1933 article, which is a relatively large number. I also sought citations to Fisher's *Booms and Depressions* (1932) which contained a longer treatment of his views. That search led to 33 citations, most of which also cited the 1933 paper. The SSCI covers the period since 1965, but Dimand (1997, p 444) wrote that Fisher 'found no contemporary audience for his debt-deflation theory of depressions'. Friedman and Schwartz (1963) did not cite Fisher's paper. Of these 184 citations, I estimate that about 8 percent – or 14 published papers in the past 40 years – use empirical methods. The majority of these papers study the Great Depression in the US or, in one or two cases, other developed economies.

King (1994) also described the lukewarm contemporary response to Fisher's essay in reviews in the *Economic Journal* and *American Economic Review*. He speculated that Fisher's poor track record as a forecaster in the Depression contributed to the initial neglect of this part of his work. Fisher's description of depressions also featured no central role for monetary factors, and so was at variance with much of the subsequent debate about the Great Depression.

My third surprise was that the Fisher-citing studies in economic history provide little empirical evidence on the mechanisms Fisher outlined. Fisher's story begins with debt liquidation, then deflation, then bankruptcy and depression. But the many studies on financial variables in the US Great Depression offer little information on either the causes or effects of deflation.

Mishkin (1978) discussed how the Depression affected household balance sheets and was thus propagated, but did not offer a model of deflation. Bernanke's (1983) influential paper argued that financial distress propagated the depression in the US. His hypothesis focused on the banking sector rather than on the indebtedness of households and firms, as Fisher's did. He showed that a measure of the deposits of failed banks was a leading indicator of output declines and argued that this effect was a

cause and not merely anticipatory. His econometric work estimated a Phillips-curve-type relation in levels for 1919-1941. He found that price surprises had a positive effect on output but could not themselves explain the scale and persistence of the Depression.

Mishkin and Bernanke's work led to a revival of work on imperfect capital markets and the capital structure of banks and firms and its impact on cycles. Excellent reviews of this work have been provided by Calomiris (1993) and Calomiris and Mason (2003). In assessing the impact of financial variables some of these studies control for price deflation statistically, but none reports an explanation of the deflation rate.

Anari, Kolari, and Mason (2005) extended Bernanke's work with detailed measurements of bank failures and suspensions. They estimated a vector autoregression with output, wholesale prices, the money supply, and the deposits of closed banks for 1921-1940. They found that this VAR can statistically explain the long duration of the 1930s depression and that the deflation plays an important role. But their main focus was on the role of financial variables in predicting output. They did not report what variables predicted deflation itself, or benchmark the deflation/output growth effects in data from other time periods.

Fackler and Parker (2005) addressed Fisher's hypothesis by clearly showing that: (a) nominal debt was unusually high in the late 1920s and had been growing unusually quickly, and (b) a regime-switching model of inflation suggests there was an unanticipated deflation. This combination of findings shows that the second part of Fisher's story – about deflation leading to bankruptcy – probably was important. But in their study deflation is exogenous, and follows an autonomous time series process.

Eichengreen and Grossman (1997) distinguished between banking crises and the debt-deflation mechanism. They argued that debt-deflation refers to a fall in asset prices that reduces collateral and so inhibits financing. They noted the difficulty in testing for this sequence of events due to the absence of household balance-sheet data. They suggested a proxy variable, roughly the default-risk spread in interest rates. Eichengreen and Grossman included this variable in a VAR for the US in the late

nineteenth century that includes the rate of inflation or deflation, banking failures, and output growth. But they had little success in predicting the inflation rate with this time series model. They included the same interest-rate spread in a cross-country study for the 1930s, but again found that it had little role in explaining deflation.

So the historical research does not seem to me to provide much evidence on the debt-deflation mechanism in the 1930s. What about more recent work on debt-deflation? Fisher's hypothesis implies that high leverage should join monetary policy as a leading indicator of deflation. Goodhart and Hofmann (2000) showed that house price movements do provide extra information that helps forecast inflation (beyond interest rates, money growth, output growth) in eleven countries in the 1980s and 1990s. This finding of course is relevant to the recent debate on whether central banks should respond to asset price increases. But there are no episodes of deflation in the countries and years that they study.

Although there are few empirical studies of the debt-deflation mechanism in deflations, there is of course a rich body of research on financial factors in propagating shocks. In this work the amount of inside debt matters because of some heterogeneity in the economy, such as a difference in the consumption functions of lenders and borrowers. So these models feature heterogeneity of agents combined with incomplete insurance or illiquid capital goods. The classic theoretical paper by Kiyotaki and Moore (1997) is an example.

There also is corresponding empirical work on credit crunches, the financial accelerator, and asset prices in business cycles. Iacoviello's (2005) general equilibrium model of monetary policy and housing prices is an example. To my knowledge these models have not been applied to deflationary episodes, even for Japan, though they could be. (There are general-equilibrium effects of debt deflation that could be studied empirically. For example, should not young debtors whose wealth falls then increase their labour supply?) To my knowledge there is nothing special about zero inflation in these approaches either, though, so they do not come with a built-in spectre of deflation.

4.5 Deferred Spending

One of the most common arguments heard against deflation in the business press is that it leads households to postpone spending in anticipation of lower future prices. This postponement leads to a fall in demand which causes a recession. Shilling (1999, chapters 12 and 13) provides an example of this popular argument. It is a legacy of the Hobson-Keynes idea of underconsumption.

This argument is surely the worst one made against deflation. It is difficult to see why it would be bad to encourage saving by those who hold money, especially if there may be other taxes that make saving inefficiently low. Nor is it clear that raising the saving rate would cause a recession, for it would lower the real interest rate and raise investment. In textbook macroeconomic models with sticky prices an anticipated deflation that might affect saving would not cause a recession, while an unanticipated deflation could cause a recession but would not affect saving.

One way to benchmark such claims made about deflation is to change sign and see how the implied claim about inflation sounds. It is rare to find economic commentators who argue that a central bank should create inflation to cause a consumption boom and discourage saving or who argue against disinflation because it encourages saving. There seems to be a discontinuity in some popular rhetoric at an inflation rate of zero.

In any case, households in developed economies already have many ways to save and it is difficult to see why adding one more – by raising the rate of return on money – would suddenly lead to a large increase in savings. Moreover, estimates of the intertemporal elasticity of substitution in consumption typically are quite low, so that the saving response is likely to be small.

Imagine that households have power utility with marginal utility $u'(c_t) = c_t^{-\alpha}$ and discount factor β. Call the nominal interest rate i_t and the inflation rate π_t. The standard Euler equation for optimal saving then is:

$$c_t^{-\alpha} = \mathrm{E}_t \beta \frac{(1 + i_t)}{1 + \pi_{t+1}} c_{t+1}^{-\alpha}.$$

For the case with no uncertainty and for savers who hold money, with a nominal interest rate of zero, this relationship becomes:

$$\Delta \ln c_{t+1} = \frac{1}{\alpha} \ln \beta - \frac{\pi_{t+1}}{\alpha},$$

so that a decrease in the inflation rate tilts the consumption path and raises saving. Most estimates of α from these Euler equations are quite large, so that this response is likely to be small. However, I have not found any empirical studies that examine the effects of the rate of inflation or deflation on poor households that save only by holding cash, or any tests in aggregate data during deflations.

The slightly more sophisticated version of this argument is that the postponement leads to further drops in prices and begins a deflationary spiral. Section 5.2 offers some theoretical references to this possibility.

5. Optimal Monetary Policy

Deflation is an endogenous variable, so one needs a model to study it. One virtue of this necessity is that a monetary model makes predictions for a range of things, like the deflation rate, welfare, real wages, interest rates, and so on, which provides a framework for studying multivariate data. Formal models of monetary policy also allow economists to weigh tradeoffs involving deflation. The classic example of such a tradeoff is the one between the welfare gains to money-holders and the losses to price-setters during a steady deflation.

5.1 The Friedman Rule: Welfare Gains from Deflation

Section 4 reviewed the traditional arguments against deflation. Working against these arguments is the Friedman rule. The idea is that money is costless to produce so households and firms should be satiated with it, so that they can use real balances to economize on other resources. The nominal interest rate – the opportunity cost of holding money – should be set to zero. At that point there is no deadweight loss from the inflation tax. Friedman's just another word for nothing left to lose.

Woodford (1990) distinguished between the weak and strong forms of the Friedman rule. In the weak form, the nominal interest rate must be zero (so that no asset has rate-of-return dominance over money) so that there is no tax on money holding. In the strong form the money supply is contracted so as to implement this rule. Friedman (1969) originally assumed superneutrality, so that implementing his rule meant setting the money growth rate equal to minus the real rate of interest. Woodford (1990) described ways of implementing the Friedman rule without specifying money growth, by planning a path for the nominal interest rate, or by paying interest on money. Cole and Kocherlakota (1998) and Ireland (2003) provided detailed examples of implementing the Friedman rule in several theoretical environments.

I cannot do justice to the large and interesting research literature on the optimal quantity of money. I shall simply catalogue some of the theoretical and empirical methods and sources. In economic theory, most work on the Friedman rule has been in the applied money field, in which money enters the utility function or a constraint such as a shopping-time technology or cash-in-advance constraint. The main argument against the Friedman rule has been that it may be optimal to tax money when other taxes also are distorting (even confining the analysis to stationary policies and so ruling out inflation as a surprise capital levy to tax away nominal assets). Mulligan and Sala-i-Martin (1997) provided a comprehensive assessment of the Ramsey optimal inflation tax in both money-in-the-utility-function (MIU) models and shopping-time models. They argued that money cannot always be thought of as an intermediate good in such models, so the Diamond-Mirrlees rule against taxing intermediate goods does not rule out a positive nominal interest rate. Roughly speaking, Mulligan and Sala-i-Martin found that the optimal inflation tax is large when the interest-elasticity of money demand is small, as one would expect from traditional tax theory. But the optimal tax also depends on whether taxes are paid with money, the scale elasticity of money demand, and money-demand behaviour at low interest rates since that elasticity may vary with the interest rate itself. Thus the matter cannot be settled by theory.

Three other considerations related to public finance may affect the optimal inflation tax. First, if there is a large underground or offshore economy then it might be taxed via inflation. Second, steady inflation or deflation may have implications for equity even if it does not affect aggregate quantities. For example, deflation may be preferred by the poor if they hold a relatively large share of their income in non-interest-bearing money. (Inflation could be an optimal tax in the Ramsey framework even if it is regressive, for the criterion there is to minimize distortions by using low marginal tax rates.) Third, Feldstein (1999) argued that the benefits of lowering inflation that stem from its interactions with a non-indexed tax system dwarf those from the money-demand changes. Feldstein has emphasized the ongoing benefits of disinflation as a way to reduce both capital income taxes and the subsidy to owner-occupied housing induced by US mortgage-interest deductibility. He also argued that the logic of his calculations implies further gains from a steady deflation. A compelling study of the effects of deflation through tax systems would include tracking the effects on government revenue and so allow for new, distorting taxes to replace any revenue lost to the government under deflation. So far I have found no research on this topic.

Of course much research in monetary economics works with more fundamental models of the trading frictions that create a role for money, rather than with MIU models for example. These models often feature random matching and search. In some of these models monetary policy provides insurance for heterogenous agents, and the optimal policy may not be deflation. Kocherlakota (2005) provides a very lucid review of this area. According to him, so far two features of this work make it difficult to assess the Friedman rule: other taxes and other assets (with rate-of-return dominance over money) typically are not included.

Empirical work on the inflation tax began with Bailey (1956) who used cross-country estimates of money-demand elasticities to give empirical examples of the area under the demand curve and hence the deadweight loss from the inflation tax. Friedman (1969) also used some numbers on U.S. money holding to estimate the ongoing welfare gain from setting the nominal interest rate to zero.

Lucas (2000) used aggregate US data from 1900 to 1994 to estimate the welfare gain from reducing the inflation rate to zero. The main, empirical building block for his numerical work was a scatter plot with a short-term nominal interest rate, i, on the horizontal axis, and the ratio of money holding to nominal income, M/PY on the vertical axis. For the US annual data this scatterplot slopes down. Lucas fit several parametric curves to these data. He then applied Bailey's method: measuring the area under the inverse demand function that could be gained by reducing the interest rate to zero. He gave examples of general equilibrium environments – an MIU example and a shopping time example – in which the parameters of these curves could be used for calibration and hence policy evaluation.

Lucas also extended his analysis to allow for government financing needs and a distorting tax that must be increased when the inflation tax is reduced. But he found this second-best tax effect to be very small and not to lead to a significant departure from the Friedman rule. Mulligan and Sala-i-Martin (1997) also gave numerical examples calibrated to a range of ways of estimating money-demand elasticities. In these numerical examples the optimal inflation tax again is quite low, involving a nominal interest rate of less than 1 percent per year.

One of Lucas's conclusions is that the welfare measures are quite sensitive to the shape of the money-demand curve, whereas there may be relatively little information on the shape of this curve at low or zero nominal interest rates in aggregate data. Mulligan and Sala-i-Martin (2000) instead used cross-section data to measure this elasticity, while Attansio, Guiso, and Jappelli (2002) and Huynh (2004) used panel data.

5.2 Sticky Prices

The applied monetary literature of course deals with monetary policy not just as a steady-state problem of optimal taxation. Usually it combines an MIU objective with an environment in which there is a cost to price adjustment and firms are monopolistic competitors. Woodford's (2003) monograph is the already classic reference.

In aggregate data these costs of price adjustment will manifest themselves in some sort of Phillips curve, relating inflation to marginal cost, the unemployment rate, or the output gap. So this area of research is closely associated with the recent revival in Phillips curve estimation. These models thus can be consistent with the correlations discussed in sections 4.2 and 4.3, at least in response to certain shocks.

In sticky-price models there are three potential arguments against deflation. First, even a steady deflation will lead to ongoing costs of price adjustment. As Friedman (1969, p 46) himself wrote "one practical consideration ... is the literal transaction cost involved in adjusting to a changing price level. The marking up or down of all prices, whether through explicit escalator clauses or otherwise, involves real costs." The compromise proposed by Friedman involved stabilizing nominal factor prices, since they are the ones that are most costly to change, then allowing price deflation so that real wages rise with productivity. If it is prices rather than wages that are costly to change, then the compromise with the Friedman rule would involve some small deflation.

Kocherlakota (2005) noted that policy-makers also could avoid the price-adjustment costs of deflation with falling consumption taxes, so as to implement a zero nominal interest rate and zero inflation simultaneously. Correia, Nicolini, and Teles (2002) showed how to implement the Friedman rule with sticky prices by using flexible consumption and profit taxes. (These models also involve a distortion due to monopolistic competition. The response is a supply-side subsidy of some kind that must be financed. But it is difficult to see this as a compelling reason for an inflation tax.)

Schmitt-Grohé and Uribe (2004) examined the compromise between the costs of price adjustment and the benefits of deflation in a calibrated model. Their environment excluded lump-sum taxes, large profit taxes to finance the supply-side subsidy, and consumption taxes that respond to shocks. With these realistic constraints on fiscal policy, they found that with even a very small degree of price stickiness the optimal inflation rate is zero (so the nominal interest rate is positive). Khan, King,

and Wolman's (2003) analysis is another great example of combining these features; it leads to an optimal policy with mild deflation and with reactions to shocks.

The second argument against deflation is that it will make the zero interest rate constraint on monetary policy binding, whereas monetary policy may have an important stabilizing role when prices are sticky. With this constraint, a central bank cannot use the standard response of reducing the short-term nominal interest rate as part of stabilization policy. In other words, deflation is dangerous because of the liquidity trap.

Bordo and Filardo (2005) documented that many deflations have occurred historically without the the zero bound applying. But this issue has played a large role in discussions of Japan's deflations during the 1990s. Solutions to this problem include using other tools of monetary policy (such as open market operations at longer maturities), using fiscal policy, and, principally, adopting policy rules. For example, Eggertsson and Woodford (2003) described how price-level targetting can avoid the liquidity trap. Any deflation thus leads to the expectation of an offsetting inflation, which lowers the real interest rate. The collection of papers in the May 2004 *American Economic Review* pp 71-90 contains a discussion of other rules.

Discussion of the liquidity trap reminds one that debate about deflation is about monetary policy and its effect on expectations, in other words about policy rules. Once again the costs of not being able to respond to shocks with a policy interest rate can be assessed in a general equilibrium model like that of Khan, King, and Wolman.

The third argument that may be made against a given monetary policy is that it gives rise to a deflationary spiral. For example, it is possible that choosing a monetary policy rule in order to try to implement the Friedman rule leads to multiple equilibria, some of which are sell-fulfilling deflations. Woodford (2003, chapter 2.4) discusses this possibility. This question can be studied only by looking at the nonlinear equations of a given model, under various policy rules. It is difficult to imagine a test for a deflationary spiral, though. Bordo and Filardo (2005) found little evidence of asymmetric persistence across deflation and inflation historically.

The underlying philosophical question in this sticky-price approach is this: Why is monetary policy more flexible than fiscal policy and more flexible than price-setting by firms? The underlying empirical questions concern how to calibrate the costs of price adjustment and the welfare gains from following the Friedman rule.

6. Prelude to Empirical Work

There have been few attempts to generalize about deflations in the same way that economists do so about inflations. As a result, it is difficult to say what the stylized facts about deflation are, even though specific deflations – especially in the US during the 1930s – have been carefully studied.

6.1 Ten Questions

Among the questions one might ask about deflations are:

Question 1. Does a Phillips curve apply during deflations? Section 5.2 described how current theory on monetary policy adopts models with sticky prices. This characteristic shows up empirically in some sort of Phillips curve, relating the inflation rate to the unemployment rate, output gap, or marginal cost.

Question 2. How do holdings of real balances behave during deflations? Lucas (2000) showed how to use US aggregate data to measure the welfare gains from low inflation. It is worth checking whether the same method can be used for other countries, especially during deflations, or whether household or firm-level data will be needed instead.

Question 3. Do real wages rise during deflations? Section 4.3 described some historical evidence on this classic claim about deflations.

Question 4. Are deflations preceded by asset price declines? This empirical finding might be evidence of a debt-deflation effect.

Question 5. Does the yield curve predict the onset or end of deflation? There have been many studies of the ability of the yield curve to forecast real activity. Its sensitivity to inflation news also is well-known. It would be worthwhile to know whether deflations

can be predicted by the yield curve's slope, too. Such an early warning system would be useful to policy-makers. And it has long been argued that the real effects of deflations vary depending on whether they are expected or not.

Question 6. Is there a deflationary spiral? The danger of a deflationary spiral provides an argument against monetary rules that allow for deflation. It might be worthwhile then to further examine the historical persistence of deflation compared to that of inflation.

Question 7. Do deflations coincide with liquidity traps?

Question 8. What happens to investment and durable spending in deflations? In particular, one might wish to study – perhaps using survey methods – whether durable purchases are postponed during deflations.

Question 9. Is there a correlation between productivity and deflation? Deflation has been related to measures of output but not, to my knowledge to measures of productivity. Answering this question would be interesting given the distinction sometimes drawn between good and bad deflations.

Question 10. Is deflation internationally contagious? We know that the gold standard propagated monetary contraction during the Great Depression. Sources on that link include Fisher (1935) (rediscovered by Dimand (2003)) and Eichengreen (2004). But does deflation propagate internationally more generally? And is the exchange-rate regime the only determinant of the contagion?

Having given this ambitious list, this section now more modestly begins by presenting some data from four deflationary episodes, two historical and two contemporary. I study some data related to questions 1-5. The focus thus is on three parts of the economics of deflation: the relation to real activity, the effect on utility through the demand for money, and the predictability of deflation from asset-price changes (including the yield curve).

6.2 Canada 1920-1940

The first data set comes from Canada during the interwar period. Data sources are given in the appendix. The upper left panel of figure 1 shows the Canadian interwar rates of inflation or deflation in the consumer price index (solid line) and the more volatile wholesale price index (dashed line). In concert with other industrialized economies, Canada experienced a sharp deflation in the early 1920s, and a more prolonged deflation in the early 1930s.

I next constructed a cross-plot of the inflation rate against the unemployment rate and saw no evidence of a naive Phillips curve. However, the upper right panel of figure 1 presents the cross-plot of $\pi_t - \pi_{t-1}$ against $u_t - 0.5(u_{t-1} + u_{t-2})$, a traditional, expectations-augmented Phillips curve. One can see that there is a clear, downward-sloping relationship and that it appears to be linear. (I remember the Lucas-Sargent critique of the interpretation of lags in the Phillips curve; the coefficient on lagged inflation depends on the stochastic process followed by inflation and need not be one for long-run neutrality. But I do not have enough data to estimate that process reliably.)

This graph is striking in its ordinariness. From this preliminary evidence there does not seem to be evidence of a deflationary spiral unrelated to the real side of the economy. Nor is there evidence of a nonlinearity whereby resistance to deflation generates extraordinarily large unemployment rates. But there is a link between deflation and depression.

The lower left panel of figure 1 shows the cross-plot of real balances per unit of real GDP against the nominal interest rate. This is exactly the type of plot constructed for the US by Lucas (2000) and that one might hope to use to calculate the welfare gains from deflation. This panel shows two sets of points corresponding to the monetary base (as used by Friedman (1969) in his US calculations) and M1 (as used by Lucas), both made possible by the work of Metcalf, Redish, and Shearer (1998).

For the interwar period there is no evidence of a downward slope, and so no chance of estimating a Bailey triangle. Households did not satiate themselves with

real balances during these deflations, perhaps because these nominal interest rates did not drop to zero. To put this in some perspective, the lower right panel of figure 1 shows the same plot but for 1871 to 1967. Now there is some evidence of a downward slope of the type that Lucas observed for the U.S. The leftmost observations, with high real balances and low nominal interest rates, occurred in the late 1930s and 1940s. The diagrams are less useful when post-1967 data are added, as the patterns tend to become clouds. My conclusion is that there is some chance we shall measure the benefits of deflation from aggregate data but that this may be a challenge.

Next, figure 2 graphs an index of real wages (from *Historical Statistics of Canada*) with the inflation rate. There is a clear negative correlation, just as in the Bernanke-Carey data (though there also is a trend in real wages). Thus the sticky-wage description of the propagation mechanism seems alive and well, especially for the 1930s. Of course this conclusion is tentative given that there are no controls for productivity or for composition bias.

To my knowledge the best source on Canadian wage data in the interwar period is MacKinnon (1996) whose data apply to the 1920s deflations. She argued convincingly that the index used in the *Historical Statistics of Canada* (*HSC*) contains errors. Her table 1 gives potentially more useful information up to 1930 by presenting the nominal wages of CPR railway workers in several occupations and provinces.

In the *HSC* data nominal wages fell in 1921 and in 1922 but not by as much as prices, so real wages rose. Nominal wages rose in 1927 and 1930, with mild price deflations, so real wages rose then too. The CPR wage rates rose from 1920 to 1921 even though the deflation rate was 12 percent. They then fell dramatically in 1922 and again in 1923. This creates the impression of a delayed reaction to the two years of deflation in 1921 and 1922. Like the *HSC* index, the CPR nominal wages rose in 1927 and 1930. Overall then, adopting this more accurate source of nominal wage data does not change the conclusion that real wages rose during deflations.

Figure 2 also graphs the growth rate of the index of stock prices on the Toronto Stock Exchange with the CPI inflation rate. Stock price inflation appears to be a scaled

up version of the CPI inflation or deflation rate, and so to be coincident with it. There is no evidence that it is a leading indicator.

6.3 United Kingdom 1920-1939

One advantage of studying the interwar UK economy is that monthly data are available on many variables, thanks to Capie and Collins (1983). The upper left panel of figure 3 shows the inflation rates of the UK CPI and PPI from 1920 to 1940. The pattern is similar to that in Canada; a sharp deflation in 1921 offsetting the previous year's sharp inflation, then episodes of deflation in the late 1920s and early 1930s.

The upper right panel of figure 3 graphs the CPI inflation rate against the unemployment rate. Now there is a clear, downward slope in this plot. In keeping with my goal of presenting only data in this section, I conjecture that finding this negative correlation is sufficient for finding some kind of Phillips curve, whether it is backward-looking or forward-looking. Again there does not seem to be anything unusual about the links between inflation and unemployment as the zero point is passed on the vertical axis.

The lower panels of figure 3 mimic Lucas's graphs but for the UK for M0 and M1. The results are similar to those for Canada. From 1920 to 1940 there is little evidence of a downward slope, while from 1900 to 1969 there is such a slope for each monetary aggregate. Thus one could apply Lucas's methods to measure the utility gains from deflation, by using UK aggregate data.

Figure 4 shows that the UK real wage moved inversely with the inflation rate, reflecting sluggish movement in the index of nominal earnings. In addition, the 12-month change in the index of London security prices appears to be a leading indicator of deflation. Finally, figure 4 also graphs the inflation rate with the spread between the consol yield and the yield on 90-day treasury bills. Here again there seems to be some useful forecasting information in the financial markets, with the yield curve slope rising before inflations and falling before deflations.

Capie and Wood (2004) used time series methods and bond-market information

to model inflation/deflation expectations for the UK in the late nineteenth century and in the interwar period. They found little evidence of large shocks and unexpected deflation, but rather several years of gradual deflation. That finding leaves open the question of how to explain the very large unemployment rates in the upper right panel of figure 3. That is naturally a central question in the research literature on the interwar UK economy.

6.4 Japan 1980-2005

The most well-known contemporary deflation is that of Japan. The upper left panel of figure 5 shows the inflation rates in the Japanese CPI and PPI since 1980. The episodes of deflation after the early 1990s coincided with a period of very slow growth. Well-known features of this period include a collapse of equity and land prices, persistence of banking system problems, a dramatic increase in government debt, and extremely low central bank discount rates followed by an experiment in quantitative easing. I certainly cannot do justice to the research on Japan's economic malaise, other than to direct the reader to the collection edited by Ito, Patrick, and Weinstein (2005) and to the February 2005 special issue of the Bank of Japan's *Monetary and Economics Studies*. However, I can also note that I have not found applications of DSGE models to the time series data from this period.

The upper right panel of figure 5 graphs Japan's CPI inflation against its unemployment rate since 1980. This naive Phillips curve clearly is downward sloping. There also appears to be a kink in the graph. Nishizake and Watanabe (2000) found evidence of a nonlinearity – with the Phillips curve becoming flatter at low inflation rates – using econometric methods that control for supply shocks. (Smith (2006) provides an alternative perspective on the Japanese Phillips curve.) Perhaps this kink is one reason to fear deflation. Naturally one of the key questions in deflation economics is how wage-setting and employment practices adapt to persistent deflation or deflation beyond some threshold rate.

As for the potential benefits of deflation, the lower panel of figure 5 graphs M/PY against a short-term nominal interest rate, for the monetary base, M1, and M2. For

Japan these graphs slope down, so that again one could apply Lucas's method.

Figure 6 graphs a measure of Japanese real wages beside the CPI inflation rate. There seems to be no evidence for the sticky-nominal-wage view that was reflected in the historical data for Canada and the UK. Kimura and Ueda (2001) studied wage-setting in Japan using data for 18 industries from 1976 to 1998, and found evidence of slow adjustment of nominal wages. But I have not found studies that use micro-level wage data of the type discussed in section 4.3.

Figure 6 also graphs CPI inflation with the rate of change of stock market prices and the slope of the yield curve respectively. In neither case does there appear to be a strong correlation contemporaneously or at a lead that would imply predictability. More formal statistical analysis is needed. Meanwhile, this conclusion is consistent with the findings of Kumar *et al* (2003, section 80) who noted that household and business surveys in the late 1980s in Japan showed that moderate inflation, rather than deflation, was expected.

6.5 Hong Kong 1981-2004

Hong Kong's deflation began in late 1998 after the Asian financial crisis and continued until June 2004: 67 months with a cumulative 16 percent decline in the CPI. At the same time the index of property prices fell from 104 in 1997 to 36 in 2003. Roughly half the decline in the CPI was due to the housing services component. Growth slowed dramatically and the unemployment rate rose significantly over this period. The upper left panel of figure 7 shows the 12-month growth rate in the CPI since 1981. The graph shows that the deflation was a new experience.

Hong Kong experienced two very large shocks during this period. First, the Asian financial crisis in 1997-1998 led to a fall in import prices (as the currencies of many of Hong Kong's Asian trading partners depreciated) and to a fall in export demand. Second, the SARS economic shock of 2003 further reduced demand. Genberg and Pauwels (2005) interpreted this deflation as beginning with these foreign shocks. The shocks were propagated first by Hong Kong's monetary policy; with the self-imposed

constraint of a currency board. Second, sluggish wage adjustment (even in Hong Kong) added to unemployment's persistence.

The upper right panel of figure 7 provides a scatter plot of the inflation rate against the unemployment rate. It shows a negative relationship. Superficially, the relationship appears to be stable across inflations and deflations.

The lower panel of figure 7 graphs M/PY against a nominal interest rate on long-term deposits, for both narrow and broad measures of money. For broad money there is a downward-sloping relationship in the aggregate data that might be used to provide information on the optimal quantity of money. But for narrow money no such relationship is apparent.

The role played by property prices is one of the key issues in the Hong Kong deflation. Genberg and Pauwels used a VAR on a range of indicators and concluded that there was no independent role for property prices in causing general price deflation. Cutler (2005) found that the property-price decline propagated the growth slowdown though. House prices fell by 52 percent while consumption fell by 7.6 percent from 1997 to 2003, a ratio that is consistent with standard models of consumption (with controls for labour income).

Figure 8 graphs the inflation rate and the twelve-month growth rate in the Hang Seng index of stock prices against time, beginning in 1997. It seems that the growth in the stock market index was a leading indicator for the change in the general price level both entering and exiting the deflation. Figure 8 also compares the inflation rate with a second, potential leading indicator, the slope of the yield curve as measured by the difference between the 12-month and 1-month interest rates. Here there is no evidence that the fixed-income market predicted the changes in the inflation rate; for example there was no inversion before the deflation or even as it began. Perhaps this finding is not surprising, for the currency board arrangement in Hong Kong makes its term structure mimic the US term structure very closely.

Whether the deflation reflected long-term adjustment to greater trade with mainland China or cyclical adjustment to shocks is another key question. Schellekens

(2005) distinguished between these possibilities by controlling for price changes in nearby Shenzhen, on the mainland. He concluded that the deflation was mainly cyclical.

6.6 Summary of Evidence

Deflations may not all be alike, and they also may differ from inflations in their statistical properties, so it may be challenging to organize statistical inference on their properties. But this look at data from four deflations can be summarized as follows.

First, one can readily find evidence consistent with some sort of Phillips curve linking both inflation and deflation to unemployment. This finding means that studying deflations need not require some new set of tools, that potentially nothing odd happens as one crosses zero in these diagrams, and that the data can be used to calibrate models of monetary policy with sticky prices. It also means that there is a link between deflation and depression, though, in the form of relatively high unemployment rates. I have not yet reconciled this finding with the studies surveyed in sections 4.1 and 4.2, which found little evidence of a link.

Second, one generally could use aggregate data to parametrize monetary models and measure the welfare gains from steady deflation, as Lucas (2000) did for the US. But downward-sloping, aggregate money-demand curves are not evident for all time periods and countries.

Third, the real wage index moved inversely with the inflation rate in the two cases from the 1920s and 1930s, a fact which may explain the real effects of deflation. Of course this correlation does not control for productivity changes or for the well-known composition bias in measuring the cyclicality of real wages. This correlation was not apparent for Japan though. In any case, we know that micro-level data would be needed in order to measure nominal wage stickiness in contemporary deflations.

Fourth, the evidence that stock-market price changes or bond price changes (in the form of changes in the slope of the yield curve) are leading indicators for deflation is mixed. Perhaps some deflations are more expected than others, a heterogeneity

which might prove useful in testing their effects.

7. Conclusions

Is deflation something fearsome or is it merely a spectre? What precisely goes wrong when the aggregate CPI inflation rate falls below zero? My conclusion is that much work remains to be done before we can answer these questions with confidence.

Section 4 described some of the statistical work on the traditional objections to deflation. Section 5 described the tradeoff between welfare gains from deflation and costs from price-adjustment that plays a central role in general equilibrium models in applied monetary economics. Whatever one's approach, there are many opportunities for research. Examples include applied work on forecasting, the microeconometrics of money holding, microeconomic studies of wage stickiness, controlling for non-monetary shocks and modelling policy rules, and the interaction of deflation with tax systems. I have tried to summarize the work of leading scholars. I hope that someone who reads this article will follow them and add to our knowledge.

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Appendix: Data Sources

Canada:

CPI: *Historical Statistics of Canada* (HSC), 2nd edition, series K8. WPI: HSC K33. Unemployment rate: HSC D132 and D129. Nominal wage index: HSC E198. TSE index: HSC J494. M0, M1, M2: averages of monthly data from Metcalf, Redish, and Shearer (1998). Nominal GDP and the interest rate on 3-5 year government bonds are from Marvin McInnis's Canadian macroeconomic data set at http://library.queensu.ca/webdoc/ssdc/cdbksnew/HistoricalMacroEconomicData/

United Kingdom:

CPI, monthly SA, Capie and Collins (1983) table 2.14. PPI: monthly SA, table 2.2. Unemployment rate: table 4.5. Nominal wage index: spliced tables 4.1 and 4.2. Stock market price index: London security price index from the NBER macrohistory database www.nber.org/databases/macrohistory/contents/uk.html. Yield curve slope: yield on 2.5 percent consols (table 7.5) minus yield on 90-day treasury bills (table 7.1). M0, M1: annual, Capie and Webber (1985). Nominal GDP: annual, Lawrence H. Officer, "The Annual Real and Nominal GDP for the United Kingdom, 1086 - 2004," Economic History Services, September 2005, http://eh.net/hmit/ukgdp/ Interest rate: annual, short-term rate Lawrence H. Officer, "What Was the Interest Rate Then?" Economic History Services, EH.Net, 2003. http://www.eh.net/hmit/interest_rate/

Japan:

CPI, PPI, M1, M2, average earnings: *International Financial Statistics*, monthly. Unemployment rate, bond yield index, 30-day interest rate, monetary base: *Econstats* (www.econstats.com) monthly. Nominal GDP: *IFS* quarterly. Nikkei index: *Bank of Japan* (www.boj.or.jp/en/theme/research/stat/index.htm) monthly.

Hong Kong:

CPI, Hang Seng index: *IFS* monthly. Nominal GDP, narrow money, broad money: *IFS* quarterly (seasonally adjusted with dummy variables). Unemployment rate: *Hong Kong Census and Statistics* (www.censtatd.gov.hk/hong_kong_statistics/index.jsp) monthly seasonally adjusted. 90-day interbank offer rate: *Hong Kong Census and Statistics* quarterly. 1-month and 12-month savings deposit rates: *Hong Kong Monetary Authority* (www.info.gov.hk/hkma/eng/statistics/index_efdhk.htm) monthly.

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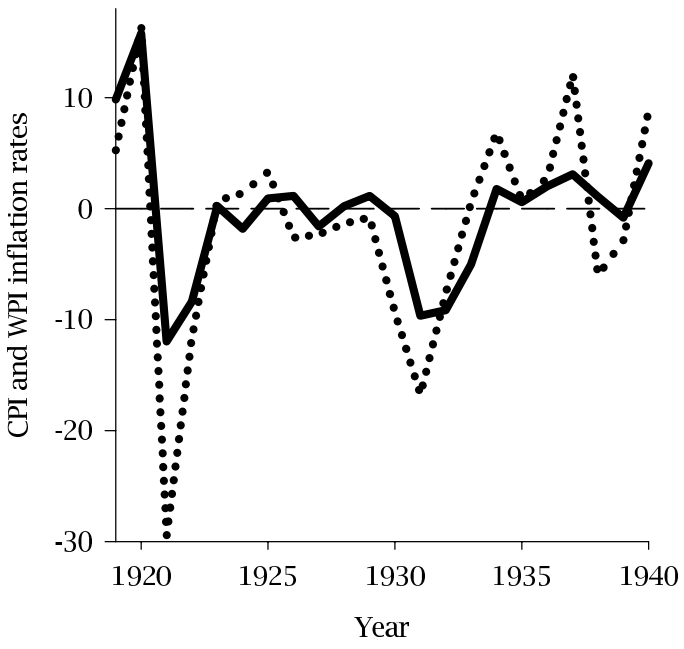
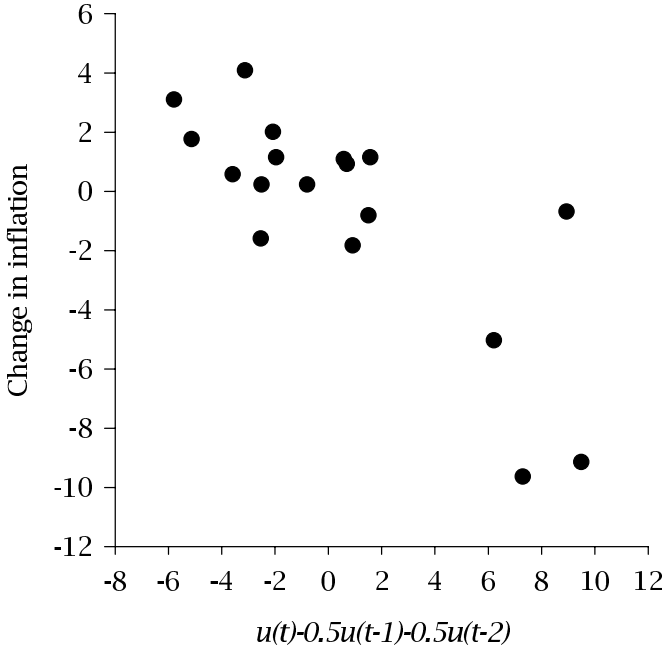
Figure 1: Canada's Interwar Deflations

[Caption:] The upper left panel shows the annual rate of inflation or deflation in the CPI (solid line) or WPI (dashed line) from 1919 to 1940. The upper right panel shows the expectations-augmented Phillips curve, $\Delta\pi_t$ graphed against $u_t - 0.5(u_{t-1} + u_{t-2})$. The lower panels graph M/PY against the nominal interest rate for M0 (solid circles) and M1 (open circles) for the two time periods shown.

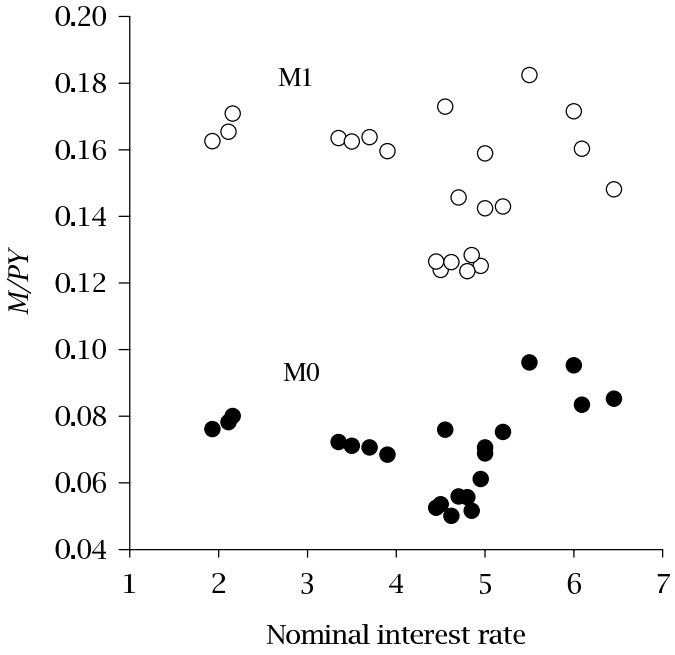
CPI and WPI Inflation Rates



Phillips Curve: 1923-1940



Real Balances: 1919-1940



Real Balances: 1871-1967

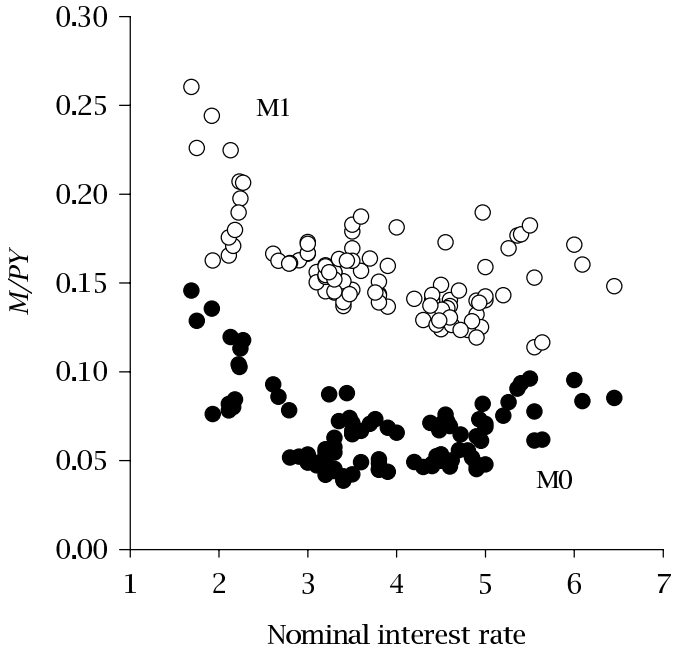
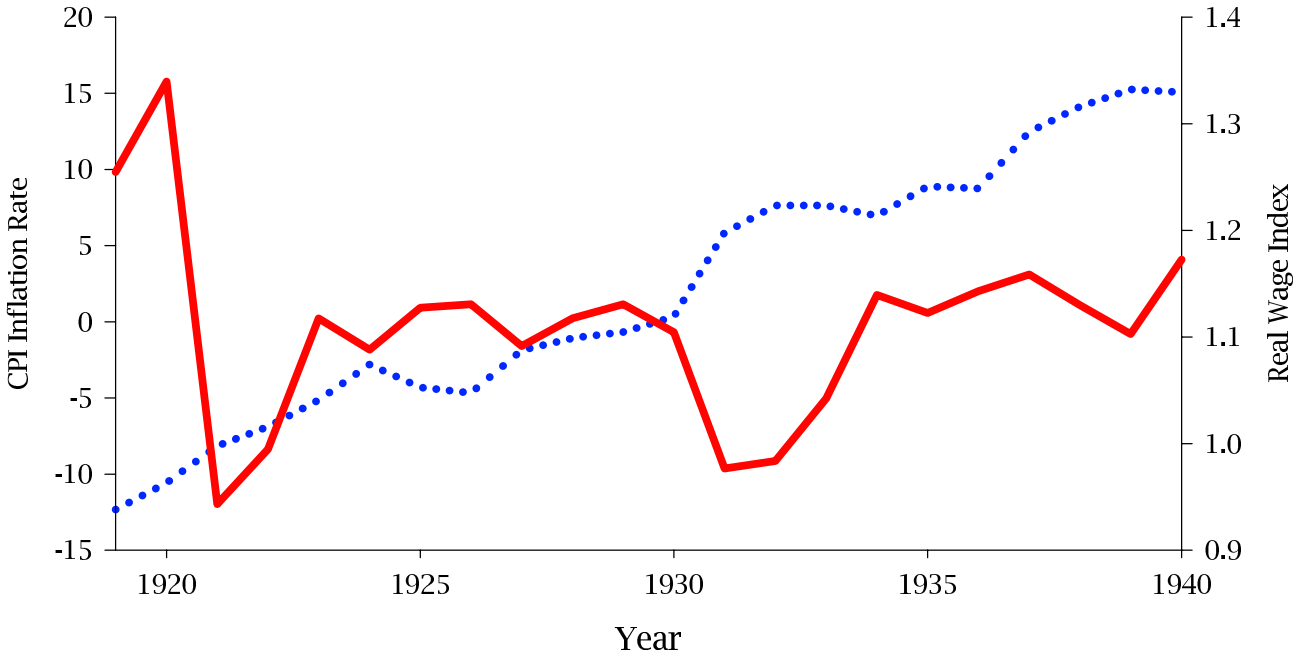


Figure 2: Canadian Real Wages and Stock Market Index

[Caption:] The top panel shows the annual rate of inflation or deflation in the CPI (red, solid line) and an index of real wages (blue, dashed line) from 1919 to 1940. The bottom panel shows the inflation rate (red, solid line) and the growth rate in the index of stock market prices in Toronto (blue, dashed line).

Real Wage Index and Inflation



Stock Market Index and Inflation

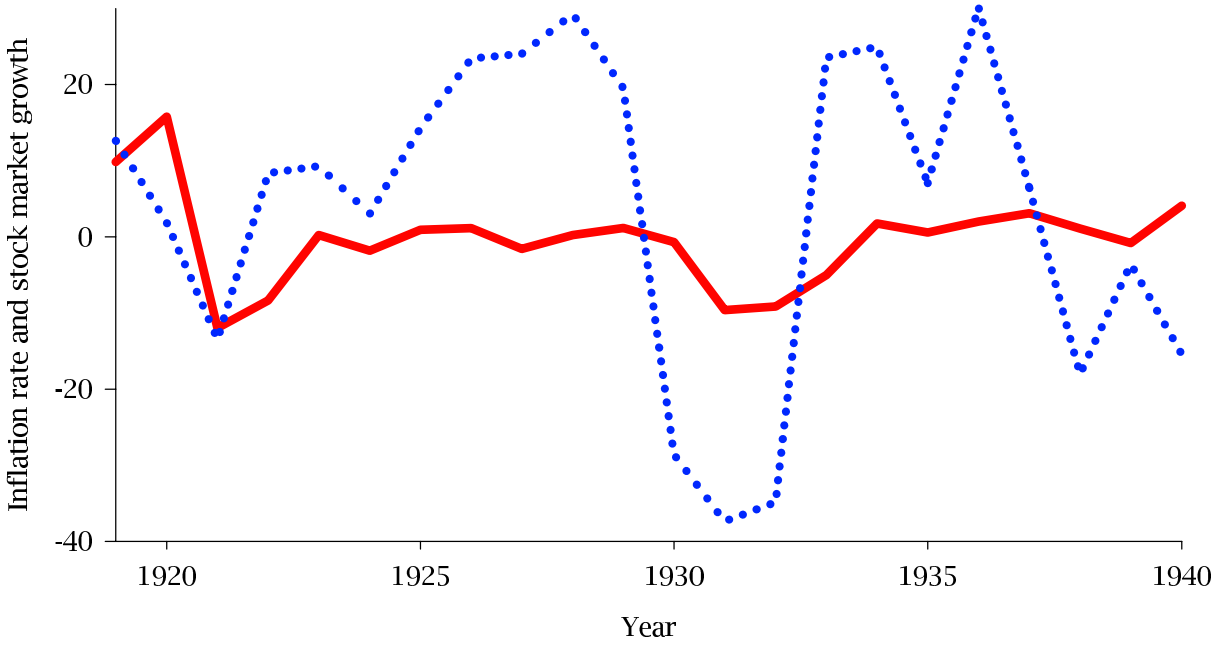
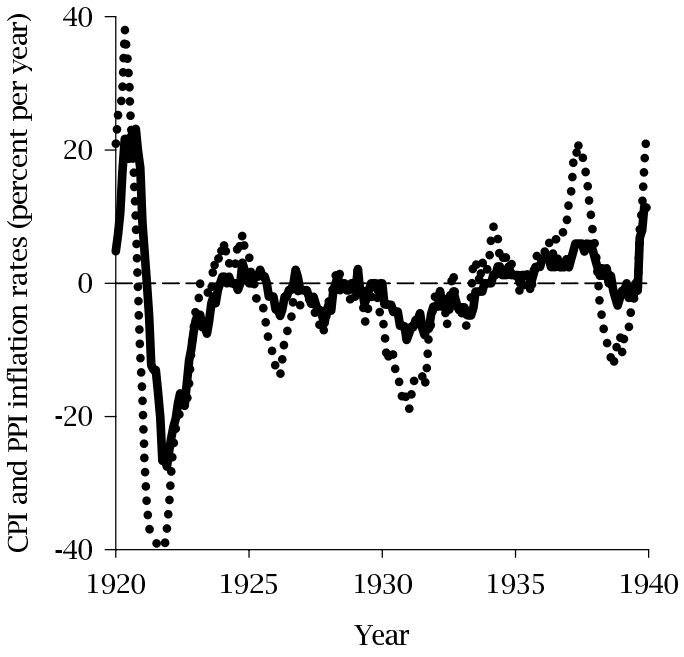


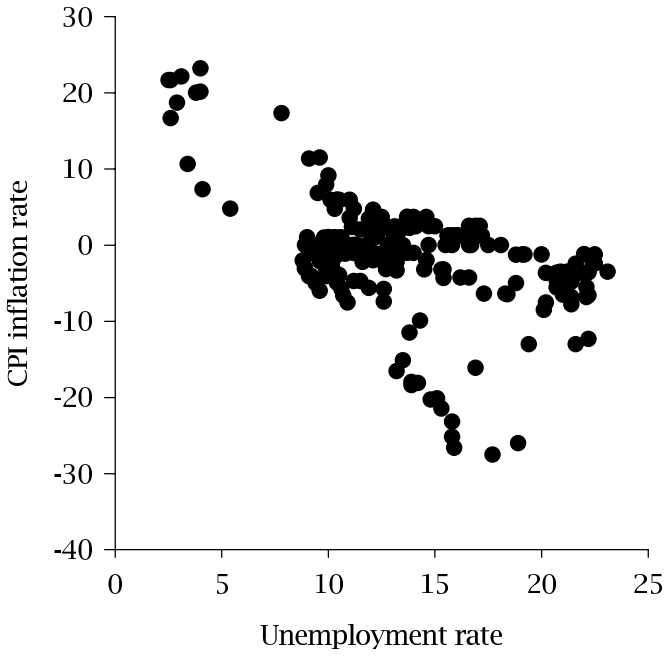
Figure 3: UK Interwar Deflations

[Caption:] The upper left panel shows the monthly rate of inflation or deflation in the CPI (solid line) or PPI (dashed line) from 1920 to 1940. The upper right panel shows the scatterplot of CPI inflation against the unemployment rate. The lower panels graph M/PY against the nominal interest rate for M0 (solid circles) and M1 (open circles) for the two time periods shown.

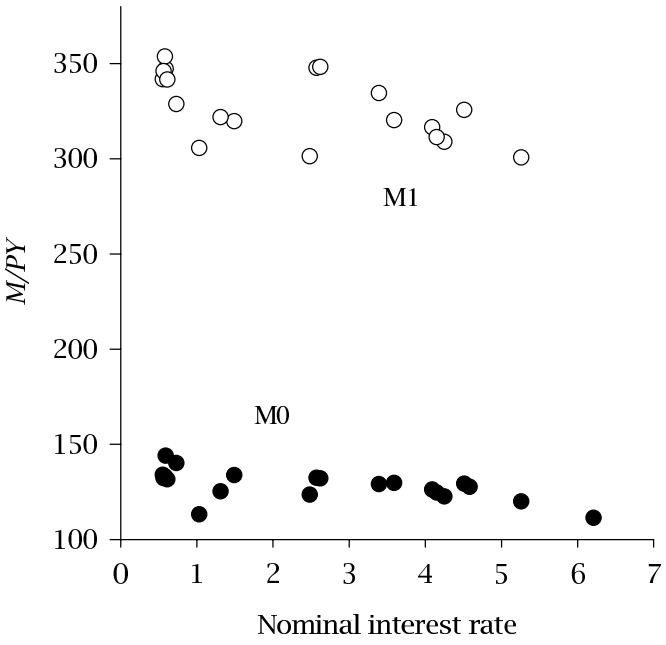
CPI and PPI Inflation Rates



Inflation vs. Unemployment



Real Balances: 1920-1940



Real Balances: 1900-1969

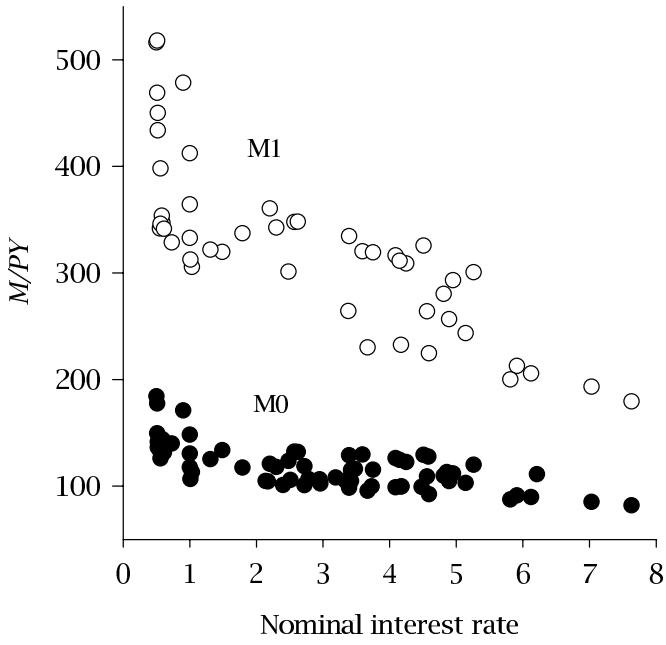
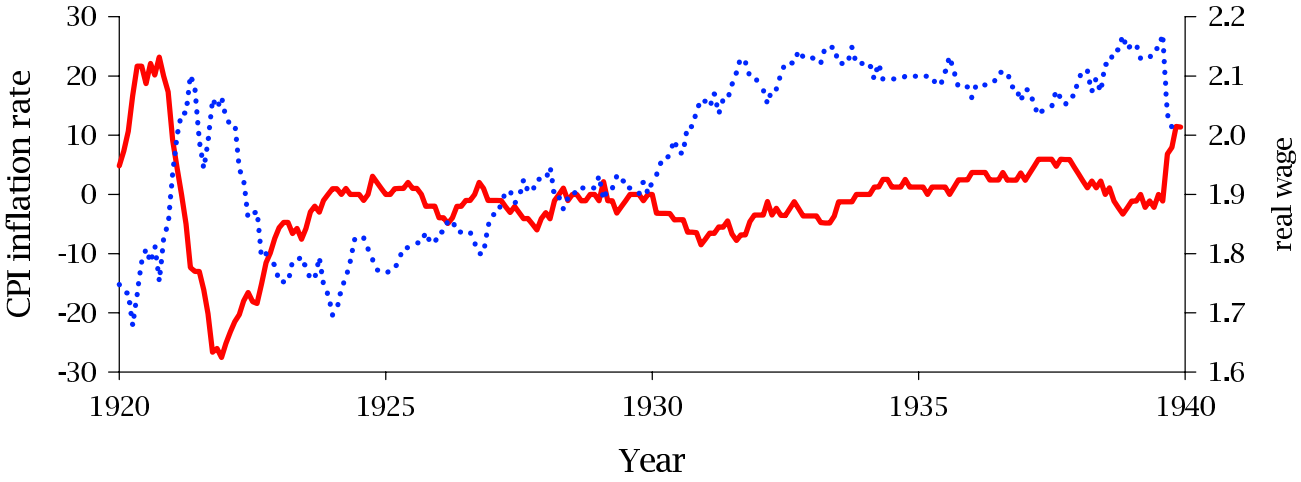


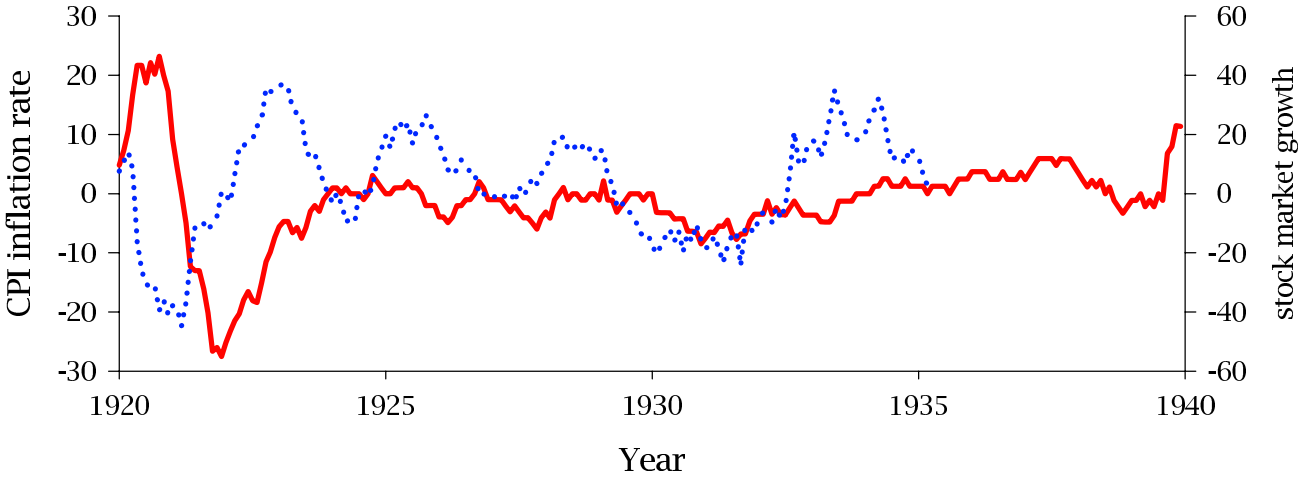
Figure 4: UK Real Wages and Financial Market Indicators

[Caption:] In each panel the solid, red line is the monthly UK rate of CPI inflation or deflation. In the top panel the dashed, blue line is the monthly index of real wages. In the centre panel the dashed, blue line is the growth rate of the index of London stock market prices. In the bottom panel the dashed blue line is the spread between long-term and short-term interest rates.

UK Inflation and Real Wages



UK Inflation and Stock Market Growth



UK Inflation and Yield Curve Slope

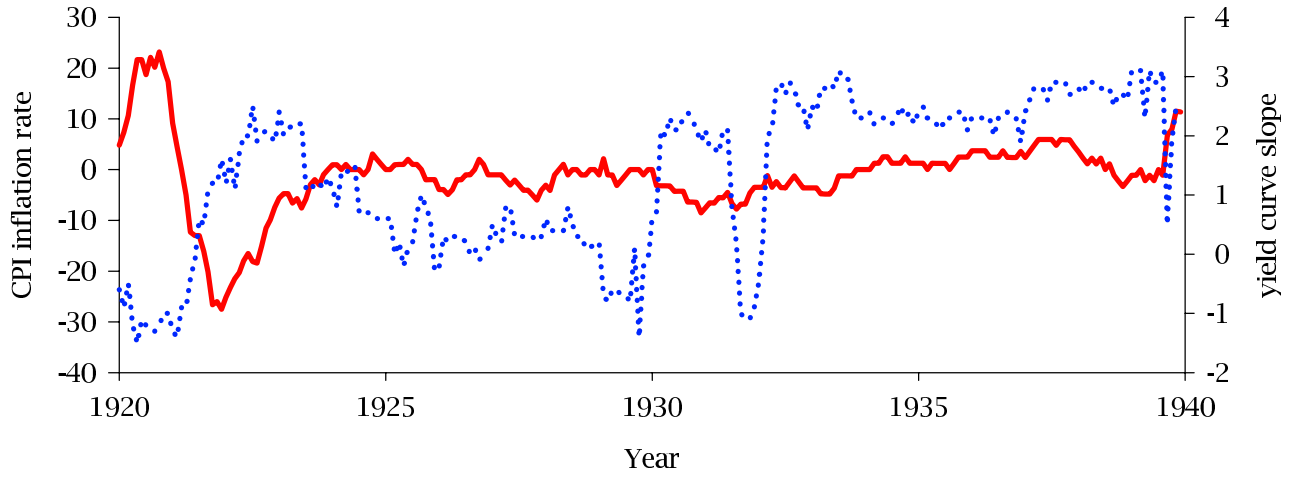
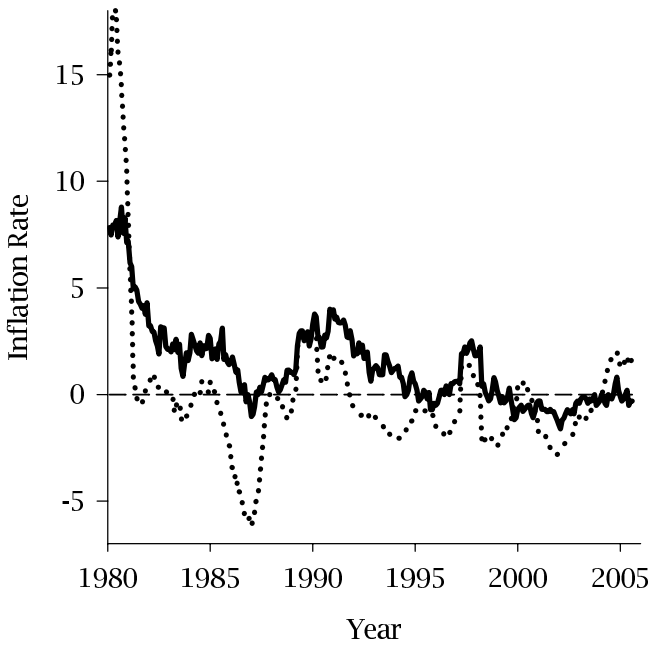


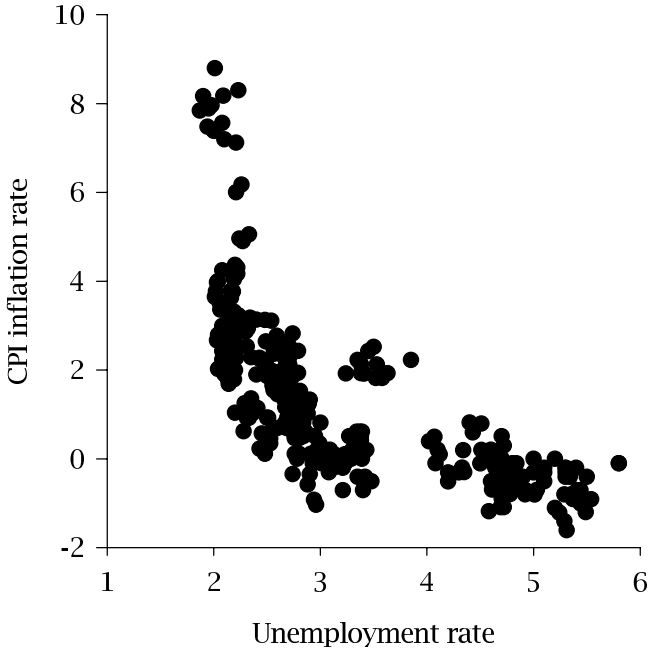
Figure 5: Japan's Deflation

[Caption:] The upper left panel shows the rate of inflation or deflation in the CPI (solid line) or PPI (dashed line) from 1980 to 2005. The upper right panel shows the scatterplot of CPI inflation against the unemployment rate. The lower panel graph M/PY against the nominal interest rate for M0 (solid circles), M1 (open circles), and M2 (triangles) for 1980-2005.

CPI and PPI Inflation Rates



Inflation vs. Unemployment



Real Balances

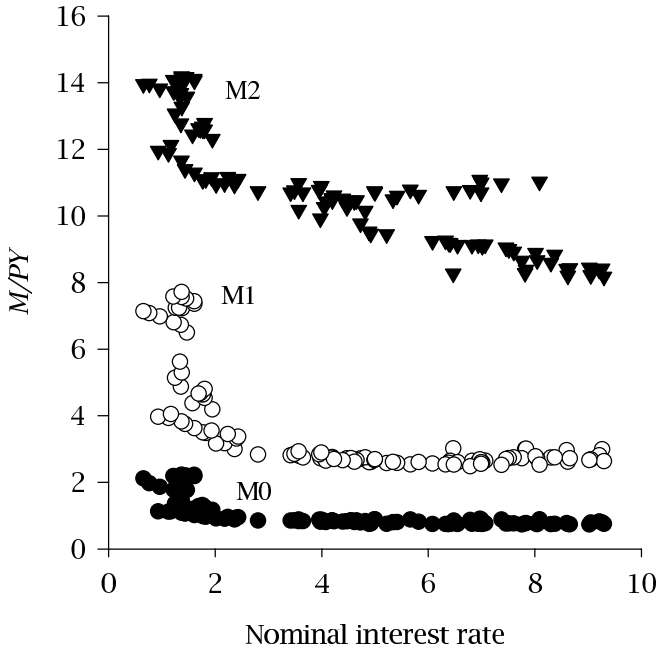
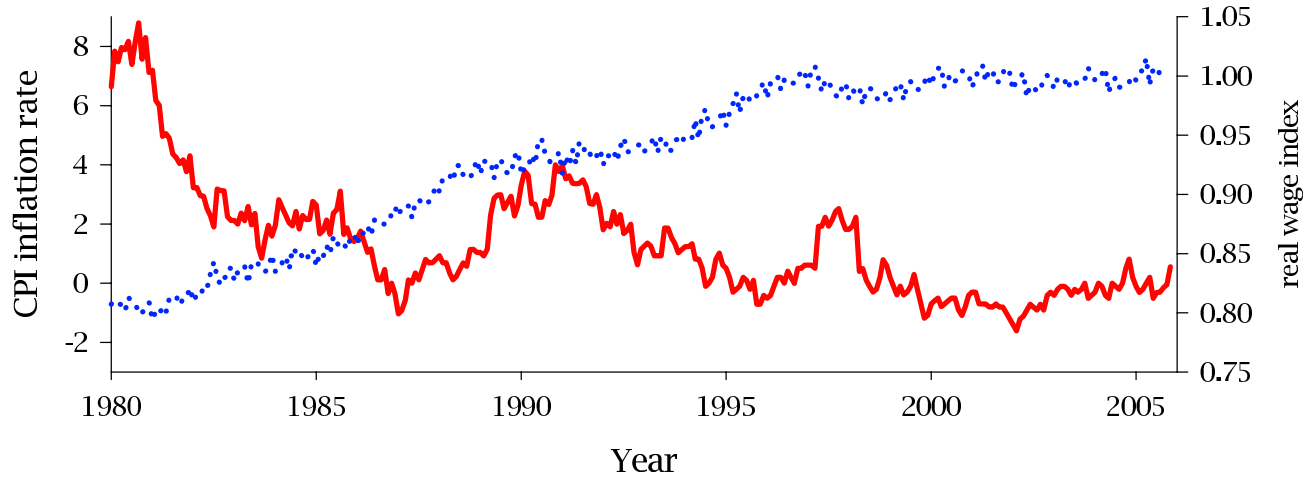


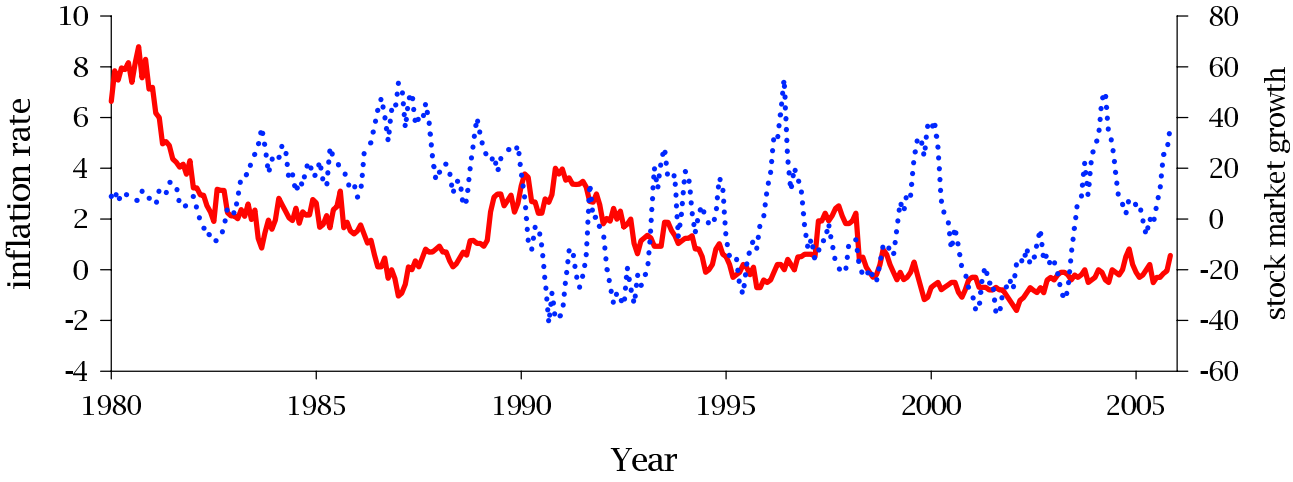
Figure 6: Japan's Real Wages and Financial Market Indicators

[Caption:] In each panel the solid, red line is the Japanese rate of CPI inflation or deflation. In the top panel the dashed, blue line is the monthly index of real wages. In the centre panel the dashed, blue line is the growth rate of the Nikkei index of stock market prices. In the bottom panel the dashed blue line is the spread between long-term and short-term interest rates.

Japanese Inflation and Real Wages



Japanese Inflation and Stock Market Growth



Japanese Inflation and Yield Curve Slope

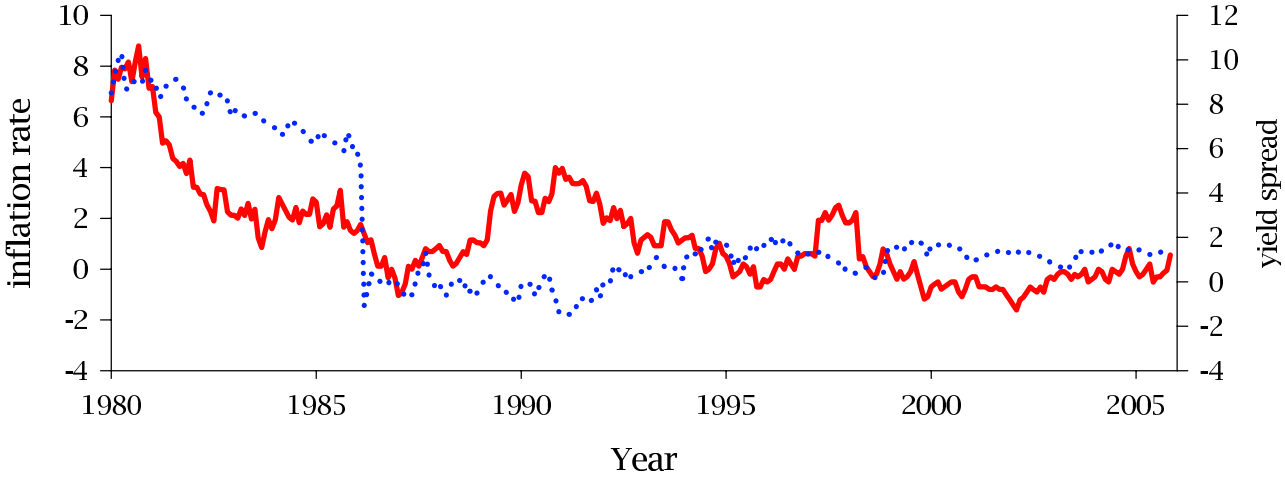
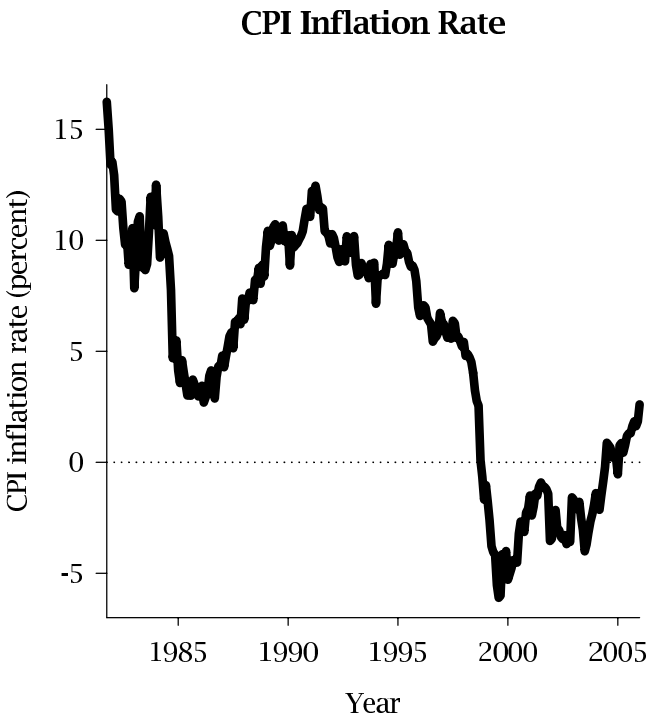
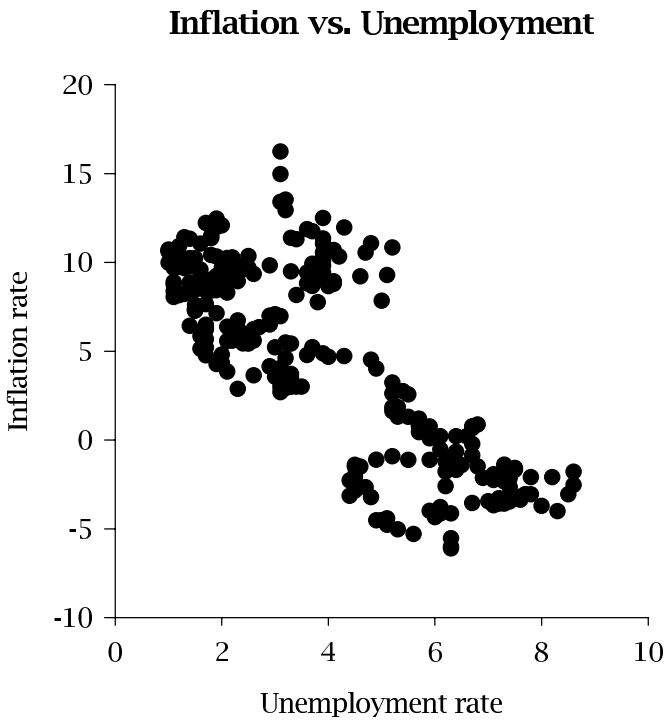


Figure 7: Hong Kong's Deflation

[Caption:] The upper left panel shows the rate of inflation or deflation in the CPI from 1980 to 2005. The upper right panel shows the scatterplot of CPI inflation against the unemployment rate. The lower panel graphs M/PY against the nominal interest rate for M1 (solid circles, left scale) and M2 (open circles, right scale).


CPI Inflation Rate
CPI inflation rate (percent)
15
10
5
0
-5
1985
1990
1995
2000
2005
Year


Inflation vs. Unemployment
Inflation rate
20
15
10
5
0
-5
-10
0
2
4
6
8
10
Unemployment rate

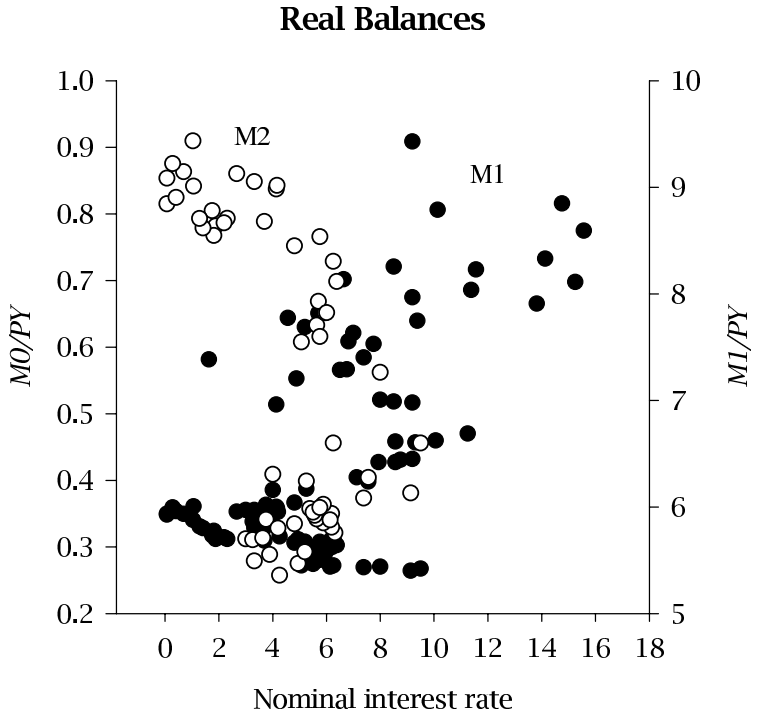
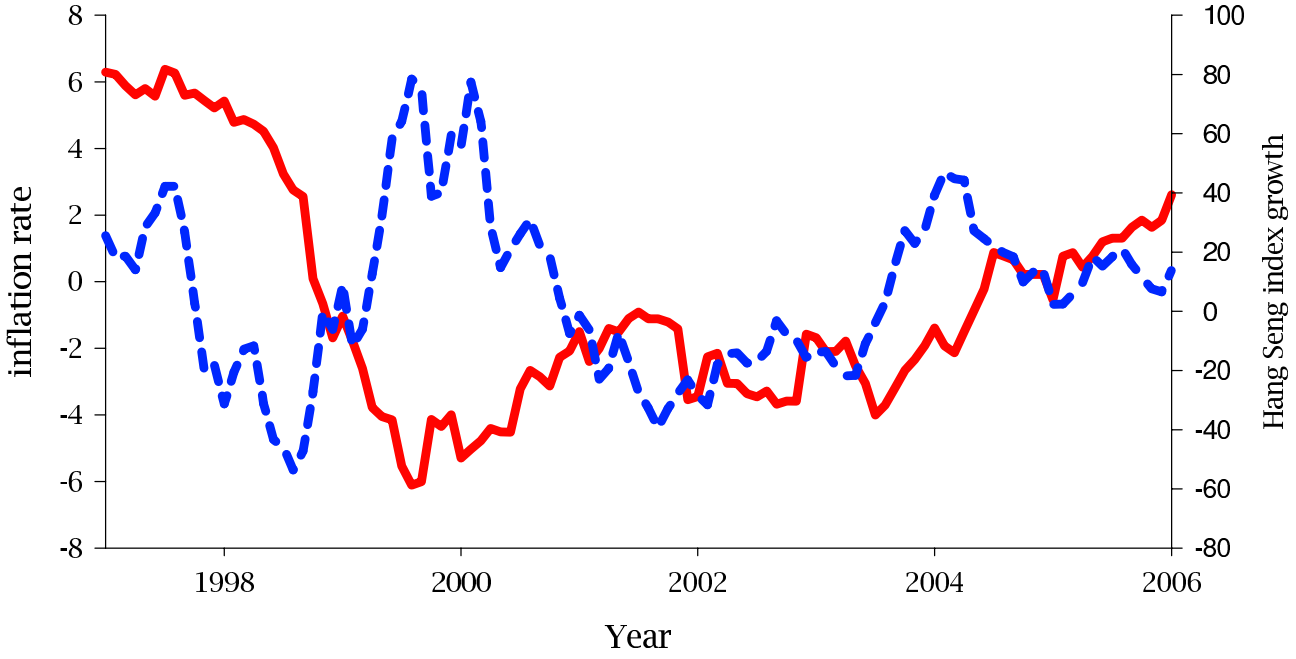

Real Balances
M0/PY
M1/PY
M2
M1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
10
9
8
7
6
5
0
2
4
6
8
10
12
14
16
18
Nominal interest rate

Figure 8: Hong Kong's Financial Market Indicators

[Caption:] In each panel the solid, red line is Hong Kong's rate of CPI inflation or deflation. In the top panel the dashed, blue line is the growth rate of the Hang Seng index of stock market prices. In the bottom panel the dashed blue line is the spread between long-term and short-term interest rates.

Hong Kong Inflation and Stock Market Growth



Hong Kong Inflation and Yield Curve