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DEFLATION: PREVENTION AND CURE

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ABSTRACT

After an absence of almost half a century, the spectre of deflation is once again haunting the corridors of central banks and finance ministries in the industrial world. While preventing or combating deflation poses some unique difficulties not present in preventing or combating inflation, deflation can be prevented and, if it has taken hold, can be overcome, using conventional instruments of monetary and fiscal policy. These include open market purchases of government securities and monetary financing of government deficits caused by expansionary fiscal measures. Base money-financed tax cuts or transfer payments – the mundane version of Friedman's helicopter drop of money – will always boost aggregate demand.

Unconventional monetary and fiscal measures are also available. These include open market purchases of private and foreign securities, negative nominal interest rates (through a carry tax on currency) and temporary tax measures aimed at shifting private consumption from the future to the present, by tilting the intertemporal terms of trade. An example is a cut in VAT today coupled to the credible commitment of a VAT increase in the future.

Deflation results from a combination of bad luck and poor economic management, including the failure to coordinate monetary and fiscal policy. Sustained unwanted deflation is evidence of policy failure. Both the knowledge and the tools exist to prevent unwanted deflation.

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Introduction

After an absence of almost half a century, the spectre of deflation is once again haunting the corridors of central banks and finance ministries in the industrial world. The great deflations of the 19th century and 1930's made way for the post-World War II era of persistent inflation - low to moderate in the advanced industrial countries, moderate to high with occasional bursts of hyperinflation in developing countries, transition countries and emerging markets. The recent renewed concern with deflation is due in part to the historical association, at least during the interwar years, of deflationary episodes with financial crises, recession, stagnation and even depression. It is also prompted by the fear that in deflationary conditions, nominal interest rates may come close to their lower bound of zero, at which point monetary policy is thought to lose most if not all of its effectiveness.

I define deflation to be a sustained decline in the general price level of current goods and services, that is, a persistently negative rate of inflation. In principle, the price index is the ideal cost of living index. Real-world approximations include the Consumer Price Index (CPI) in the US, the Retail Price Indexes (RPI, RPIX and RPIY) in the UK and the Harmonised Index of Consumer Prices (HICP) in the EMU area. For many practical and policy issues, the distinctions between these indices are important. For the purpose of this paper, they are irrelevant.[1]

[1] There is a widely held view that real-world price indices present us with systematically upward-biased estimates of true inflation. This is important for issues ranging from cost-of-living indexation to the choice of an appropriate inflation target by the monetary authority. For reasons of space I will not consider these issues here. A Commission headed by Michael Boskin studied the CPI bias and presented the results of its report on December 5, 1996. It concluded that that CPI inflation in the US was likely to overestimate true inflation by about 1.0 percent to 2.0 percent per year. The sources of this bias in CPI inflation identified by the Boskin Commission were: 1. Substitution bias (0.2 - 0.4 points per year); 2. Outlet bias (0.1 - 0.3 points); 3. Quality changes (0.2 - 0.6 points); 4. New products (0.2 - 0.7 points); 5. Formula bias (0.3 - 0.4 points) (see Boskin et. al. [1996, 1997]). While not every aspect of the methodology used by the Commission, or the magnitude of the bias it found, have been universally accepted, there is widespread agreement that there was a significant upward bias. Changes made since then by the Bureau of Labour Statistics have probably reduced the magnitude of the bias.

What is important is that deflation as used in this paper refers to a declining general price level for *current goods and services*. It does not refer to asset price deflation – a fall in the prices of existing stores of value, either real or financial. Asset price movements are an important part of the transmission mechanism of monetary and fiscal policy actions and other shocks. Asset price movements often complicate the task of the monetary and fiscal authorities and prevent the simultaneous achievement of price stability, full employment and balanced structure of production and demand. Asset price deflation may at times precede, be associated with or even cause downward movement in the general price level of goods and services. Asset price deflation is, however, conceptually quite distinct from deflation in the sense used in this paper.

The timing of the renewal of political concern with and scholarly interest in deflation is not surprising. As shown in Figure 1, in Japan, the central bank discount rate has been at 50bps or less since 1995, raising concern about the zero lower bound on nominal interest rates, at least at the short end of the maturity spectrum. Japan is in a protracted economic slump that started in 1992. Money wages have declined in four of the past five years; the GDP deflator has declined in each of the past 5 years and the CPI in four out of the past 5 years. Short nominal interest rates in Japan are near zero.[2]

Figure 1 here

[2] Percentage annual growth rates of nominal price and wage indices in Japan

	1998	1999	2000	2001	2002*
Nominal Compensation**	-0.7	-1.2	0.5	-0.1	-1.2
GDP Deflator	-0.1	-1.4	-2.1	-1.2	-1.0
CPI	0.7	-0.3	-0.7	-0.7	-1.1

Source: OECD [2002], Annex Table 12.

A number of observers have concluded that there is a liquidity trap at work, that is, monetary policy is incapable of stimulating aggregate demand (see e.g. Krugman [1998a, b, c, d; 1999, 2000], Ito [1998], McKinnon and Ohno [1999], Itoh, Motoshige and Naoki Shimoi [2000], Miyal [2000], Iwata, Shigeru and Wu [2001], Svensson [2001] and Taylor [2001]); for a view that liquidity traps are unlikely to pose a problem, see Meltzer [1999, 2001] and Hondroyiannis, Swamy and Tavlas [2000]).

The risk of the zero lower bound becoming a binding constraint on monetary policy has more recently become a factor also in Western Europe and the United States of America. In the Euro area inflation, on the HIPC measure, averaged 1.1 percent per annum during 1999. The ECB's repo rate reached a local trough of 2.5 percent during April 1999. At the time, this raised the question as to whether a margin of two hundred and fifty basis points provided enough insurance against a slump in aggregate demand. In March 2003 the ECB's repo rate again stands at 2.50 percent and HICP inflation runs at just over 2.0 percent per annum (Issing [2002]).

Figure 2 here

The UK has its Repo rate at 3.75 percent with RPIX inflation just over 2.5 percent.[3] While this appears to provide a reasonable cushion against the risk of getting stuck at the zero lower bound, the fear of deflation is not completely absent even in the UK.

Figure 3 here

Finally, in the US too, with the Federal Funds target rate in February 2003 down at 1.25 per cent, the Fed has shown some concern about the possibility that monetary policy could become constrained by the zero lower bound on nominal interest rates (see e.g. Bernanke [2002]). As early as the Fall of 1999, the Fed organised a conference to discuss the 'zero bound problem' (see e.g. Clouse, Henderson, Orphanides, Small and Tinsley [1999]) and recently its staff have produced a thorough study of Japan's experience in the 1990s and the lessons this holds for preventing deflation (Ahearne et. al. [2002]).[4]

Figure 4 here

There is also a growing number of theoretical contributions on liquidity traps, the zero bound problem, low inflation and deflation (see e.g. Akerlof, Dickens and Perry [1996], Fuhrer and Madigan [1997], Orphanides and Wieland [1998, 2000], Wolman [1998], Porter [1999], Johnson, Small and Tryon [1999], Cristiano [2000], Freedman [2000], Goodfriend [2000], Bryant [2000], McCallum [2000, 2002], Benhabib, Schmitt-Grohé and Uribe [2001, 2002], Buiter and Panigirtzoglou [2001, 2003], Feldstein [2002a,b] and Nishizaki and Watanabe [2002]).

The longest deflationary episode for which we have acceptable quality data is also the one that is probably most relevant for today. It is the great deflation of the 19th century, shown, for the UK, in Figures 5 and 6 .

Figure 5 here

Figure 6 here

As Figure 5 shows, the average rate of inflation over this 115-year period was slightly negative (certainly if we start our count at the end of the Napoleonic wars), and the variability of the inflation rate was high. Figure 6 shows that Bank Rate did

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[3] UK HICP inflation rates are between 0.50 percent and 0.75 percent per annum below its RPIX inflation rate.

[4] The proceedings of the conference were published in the *Journal of Money, Credit and Banking* [2002].

not fall below 2 per cent throughout 115 years preceding World-War I.[5] The UK got through a deflationary century without encountering the zero lower bound constraint on nominal interest rates, let alone the liquidity trap. The deflationary periods between the two World Wars are less relevant to our current experience. Although the failure to deal effectively with deflation no doubt prolonged and deepened the Great Depression of the 1930s, deflation then was the result of a catastrophic collapse of aggregate demand, not the cause of it.

Figures 5 and 6 demonstrate that deflation is an old phenomenon. Is it also an old *problem*? Deflationary episodes have often, but not always, been periods of recession or depression. Can policy makers prevent deflation or eliminate deflation once it has taken hold simply by reversing the policies that have been proven to be effective in preventing or eliminating inflation?

Some of the costs and benefits of deflation are not qualitatively different from the costs and benefits of inflation – there is no obvious discontinuity at zero inflation. For instance, menu costs (costs of changing prices) apply symmetrically to price increases and to price cuts.[6] Anticipated inflation causes welfare losses due to shoe-leather costs of cash management if the opportunity cost of holding cash (the risk-free short nominal interest rate) increases with the expected rate of inflation. Deflation reduces the opportunity cost of holding non-interest bearing cash. Bailey [1956] and Friedman's [1969] optimal quantity of money theorem is the proposition that welfare is maximised when the opportunity cost of holding money is zero, that is, when the risk-free nominal interest rate is zero. If welfare is maximised when the expected rate of inflation equals minus the short real interest rate, and if the short real interest rate is

[5] The temporary collapse in the external value of the U.S. dollar starting in 1861 reflects the exceptional circumstances of the American Civil War and its aftermath, the Greenback period.

positive, deflation characterises the optimal monetary rule. In a Bailey--Friedman world, deflation is not a problem, it is part of the solution.

Unanticipated inflation redistributes wealth from creditors whose contracts are nominally denominated and not index-linked to debtors. Unanticipated deflation redistributes wealth from debtors to creditors. If and to the extent that higher inflation is associated with greater uncertainty about relative prices, higher inflation increases the noise-to-signal ratio of the price signals sent and received by households and enterprises. The same may well apply if the rate of deflation increases in absolute value.

There are four reasons why deflation is not just inflation with the sign reversed. *First*, there is the problem of a zero lower bound on risk-free nominal interest rates caused by the existence of stores of value with a risk-free zero nominal interest rate. These are coin and currency and commercial bank reserves with the central bank.[7] The zero nominal interest rate on base money (high-powered money, the monetary liabilities of the central bank) sets a zero floor under risk-free nominal interest rates for all other stores of value, private and public. If in order to stimulate demand lower real interest rates are required but nominal interest rates are already at their zero lower bound, conventional monetary policy is powerless. Nominal interest rates are more apt to hit the zero floor when there is deflation.

Second, redistributions from debtors to creditors associated with unexpectedly high deflation in a world with imperfectly index-linked debt contracts is more likely to lead to default and bankruptcy than redistributions from creditors to debtors associated with unexpectedly high inflation. Default, bankruptcy and corporate

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[6] Menu costs do not, of course, attach only to changes in the prices of goods and services included in the CPI or GDP deflator. They presumably apply also to changes in money wages and intermediate goods and services and even to changes in the prices of existing assets.

restructuring are not just mechanisms for redistributing ownership and control of assets. These processes also destroy real resources.

'Debt deflation', the increase in the real value of nominal debt caused by a falling general price level was considered an important source of financial distress by the great monetary economists of the 19th century and the first half of the 20th century. Irving Fisher [1932, 1933a] went as far as arguing that the interaction of deflation and large accumulations of private nominal debt could account for every major recession in the USA. Borrowers with short-maturity nominal liabilities and illiquid and/or real or foreign currency-denominated assets are especially vulnerable to deflationary shocks. Commercial banks fit that description, and the incidence of banking crises and bank defaults during the Great Depression of the 1930s and other severe recessions are consistent with a role for debt deflation in the propagation of the business cycle (see e.g. Fisher [1932, 1933a], Keynes [1931, 1936] and Haberler [1937]). Homeowners with mortgages or households with significant outstanding unsecured consumer debt have similar vulnerabilities in their portfolios, as do highly indebted enterprises, (see Minsky [1975, 1986] and King [1994]).

Hyman Minsky's theory of financial fragility, distress and instability (Minsky [1975, 1986]) and modern theories of asymmetric information, adverse selection, moral hazard and agency problems in financial markets (see e.g. Bernanke [1983], Bernanke and Gertler [1995] and King [1994]) have sharpened our understanding of the links between balance sheet revaluations, access to credit and other sources of external finance, investment and consumption demand and fluctuations in output and employment.

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[7] There are countries where commercial bank reserves with the central bank are remunerated, sometimes with close-to-market interest rates.

Third, there is a widely-held view that there exists an asymmetry in nominal wage and price adjustment. According to this view, the degree of downward rigidity in some nominal prices, and especially in money wages, is not matched by a similar degree of upward nominal rigidity.[8] This means that disinflation, the process of bringing down the rate of inflation through a reduction in the growth rate of nominal demand will be more costly, in terms of output and employment foregone (that is, the *sacrifice ratio* will be higher) when the inflation rate falls into the negative range than when it remains in the positive range.

Fourth, in living memory, there has been considerable experience of inflation, and even of hyperinflation, while there has been only limited experience of deflation (and none of hyperdeflation). This fourth point will turn out to be relevant also to the interpretation of the third point.

The proximate cause of deflation is the failure of nominal demand to grow at least at the rate of growth of potential output. It may therefore be *descriptively* correct that recent deflationary episodes have been the result of faster than expected productivity growth in some (significant) parts of the world – the USA and emerging Asia (China, India etc.) are often mentioned in this context. Even if, in an accounting sense, a reduction in inflation is associated mainly with an increase in real GDP growth driven by higher productivity growth rather than with a reduction in nominal GDP growth, such a diagnosis does not absolve the monetary and fiscal policy authorities. Whatever the supply-side of the economy may generate by way of a growth rate of potential output, it is always possible to use monetary and fiscal policy to generate any growth rate of nominal demand and therefore any rate of inflation, in

[8] Note that menu costs do not produce such asymmetries.

the medium term.[9] Sustained deflation is therefore either a policy choice, or the result of policy failure.

1. Three Preliminary Questions

1.1 Why don't we see negative nominal interest rates?

Financial instruments, henceforth *securities*, can be divided into two categories: bearer securities and registered securities. Registered securities are financial instruments for which the identity of the owner is known to the issuer and can be verified by third parties. Bearer securities are financial instruments for which the owner is anonymous - the identity of the owner is unknown to the issuer and cannot be verified by third parties.

Paying interest, at a positive or a negative rate on registered securities is a simple task. Take, for instance, checking accounts or deposit accounts. The bank knows the owner of each account. Payment of interest at any rate, positive, zero or negative, is administratively straightforward. The bank periodically credits or debits the account.[10]

With bearer securities, paying any non-zero interest rate is administratively non-trivial. If the interest rate is positive, care must be taken that the interest due is paid only once during a given payment period. Since the identity of the owner is unknown to the issuer, the same security could be presented multiple times during any

[9] Former Governor Hayami [2002] of the Bank of Japan shows an appreciation of the relationship between technological change, changes in market structure, relative price changes and inflation in the following quote *"At the same time, the basic relationships between structural reforms and prices must be correctly understood. The recent price decline is attributable to various factors such as technological innovation, deregulation, and an increase in low-priced imports. But above all, the major factor is that Japan's economy was not able to achieve a full-scale recovery in the 1990s and that the negative output gap expanded due to lack of demand."*

[10] Positive nominal interest rates on bank accounts have been common for decades. During the 1970s, the Swiss authorities taxed non-resident holders of Swiss bank accounts by paying a negative nominal interest rate during the 1970s**.** After allowing for bank fees, the net nominal rate of return on many checking accounts with a (low) positive nominal interest rate is frequently negative.

given payment period, either by the same holder or by a sequence of different holders. The way around this is to identify, label or mark the security rather than the owner. The security in question is marked in a verifiable manner by the issuer or his agent, whenever the security is presented for payment of interest due. Historically, bearer securities had coupons attached to them that were cut off (clipped) one at a time whenever an interest payment was made.[11] Other ways of identifying bearer securities as being 'ex-interest'[12], such as stamping, or more high-tech identification methods can no doubt be thought of.

If the interest rate on the bearer security is negative, the issuer faces the opposite problem of the holder not presenting himself to pay the issuer the negative interest due on the security. The solution is to find a way first of identifying the bearer security as being ex-interest and second to ensure that securities that are not ex-interest are unattractive to potential owners.

The reason for the second condition becomes clear when one considers the bearer security that is of special interest for this paper: currency, that part of the monetary liabilities of the central bank that is generally accepted as means of payment and medium of exchange in the central bank's jurisdiction.[13] [14] Today, currency is fiat money. It has no intrinsic value as a consumer good, a capital good or an intermediate input, other than the value of the paper it is printed on. It has value today if and only if the public believe it will have value tomorrow. For the issuer (the central bank) to put an expiry date on a bank note would be ineffective if the public chose to ignore it. To make paying negative interest on currency possible it must (a)

[11] This would be problematic for a bearer perpetuity such as the British Consols.
[12] I use 'ex-interest' analogously with 'ex-dividend' for common stock. A security is ex-interest for a given payment period if the interest due on it (positive or negative) has been paid.
[13] And at times are accepted outside that jurisdiction, as with the US dollar and the Euro today.
[14] The monetary liabilities of the central bank consist of currency in circulation and commercial bank balances with the central bank. Banks' balances with the central bank are registered securities. The

be possible to identify bank notes as being *ex-interest* and (b) be possible to attach a sufficiently severe penalty to holding money that is not *ex-interest* after the date the interest is due. Fines, and, in the limit, confiscation or worse, would be required to enforce negative interest on currency.

The idea of taxing currency is not new. It goes back at least to Gesell and the Social Credit movement in the second and third decades of the 20th century. No less an economist than Irving Fisher viewed the idea sympathetically. (See Gesell [1949], Fisher [1933b], Porter [1999]). It has recently been revived and proposed by Buiter and Panigirtzoglou [2001, 2003] and by Goodfriend [2000]. Taxing currency by paying negative interest on it would be a costly administrative exercise. These costs must be set against the cost of being stuck at the zero nominal interest rate floor or the cost of pursuing a sufficiently high inflation target to minimise the risk of the zero nominal interest rate floor becoming a binding constraint.

1.2 Do asymmetric, downward nominal price and wage rigidities make deflation particularly costly?

Conventional economic theory has a rather easy time explaining real rigidities, but a hard time explaining any kind of nominal rigidities, let alone asymmetric nominal rigidities. Empirically there appear to be important nominal rigidities, but mainstream economic theory does a poor job explaining why the numéraire matters. *A fortiori*, mainstream economic theory has little to say about asymmetries in the incidence and or severity of nominal rigidities. For instance, menu costs do not generate asymmetries between upward and downward price adjustments, although they can account for the spike in the frequency distribution of individual price

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identity of the owner is known to the issuer. Any interest rate, positive or negative, can be charged on it with negligible administrative expense.

changes at zero. Neither do other state-contingent or time-contingent contracting stories.[15]

Nominal price rigidity, symmetric or asymmetric, has never been attributed to nominal asset prices, or to the prices of freely traded homogeneous commodities. Its domain has never been argued to encompass more than the money prices of highly processed goods and services and to money wages. With nominal price cuts becoming more frequent in the low inflation environment of the last ten years (see e.g. the divergent behaviour of prices for goods and prices for services in the UK, shown in Table 1), those who argue for the importance of asymmetric downward nominal rigidity are focussing mainly on the labour markets (see e.g. Bewley [1999]).

Table 1 here

There is no coherent theory of asymmetric nominal rigidity in the labour market. Arguments based on fairness (Kahneman, Knetch and Thaler [1986], justice and morale miss the point, since fairness, justice and morale should concern real wages and/or relative real wages, over time and across reference groups, not money wages (see Blinder [1995], Akerlof, Dickens and Perry [1996], Card and Hyslop [1997] and OECD [2002]). Detailed micro-data based empirical studies for the UK, include Smith [2000] and Nickell and Quintini [2003] for the UK and McLaughlin [1994] for the US. The observation, painstakingly documented in hundreds of interviews by Bewley [1999], that both workers and managers will strongly resist money wage cuts can plausibly be attributed to the fact that the interviewees (in the 1990s) had known only positive inflation rates during their working lives. When nominal prices and wages have on average been rising for more than forty years, a

[15] Surveys on price setting by supermarkets and other firms show a marked bunching of the frequency distribution of price changes at zero, for instance - but such observations tell us nothing about the existence of asymmetries in the degrees of downward and upward nominal price stickiness or rigidity.

nominal wage cut is likely to be a real wage cut also. Resisting a cut in money wages is a pretty good first stab at (indeed almost certainly a necessary condition for) resisting a real wage cut and, in decentralised labour markets, a relative wage cut.

Nickell and Quintini [2003], using a unique UK micro-date set on nominal wage changes for the period 1975-99, find that the proportion of individuals whose nominal wages fall from one year to the next is large (reaching 20 percent in periods of low inflation). They also find that there is evidence of some rigidity at a nominal wage change of zero. However, while this causes a statistically significant distortion in the distribution of real wage changes, the magnitude of the impact is "very modest".[16]

The policy relevance of even this very modest estimated impact is contingent on the degree of downward nominal wage rigidity being 'structural', that is, invariant under changes in the long-run rate of inflation. With high and even moderate inflation becoming a thing of the past throughout the industrial world, any nominal rigidities, and asymmetries in downward and upward nominal wage rigidity due to memories acquired and mental reference frames constructed during inflationary episodes will become less important as time passes. Finally, the spike in the empirical frequency distribution of contract wage changes at zero is, at most, evidence of nominal wage rigidity, not of *asymmetric* nominal wage rigidity. I conclude that while there is convincing empirical evidence that nominal price and wage rigidities exist, there is no evidence that these nominal rigidities are asymmetric.

1.3 How can we disentangle the effects of monetary and fiscal policy?

The distinction between monetary and fiscal policy instruments is an unimportant definitional issue. It sometimes gets tangled up with important issues involving the institutional arrangements for the decentralisation and delegation of the fiscal, financial and monetary management activities of the state. To understand the economic fundamentals that determine how monetary and fiscal policy affect aggregate demand, one should think of the central bank and the general government sector as a single, consolidated unit – the state, or the sovereign. The balance sheet, budget constraint and solvency constraint that matter are the balance sheet, budget constraint and solvency constraint of the consolidated general government and central bank. When we consider the practical, operational aspects of implementing certain policies in a specific country, it is indeed helpful to consider the particular institutional arrangements in that country. Often we will have to focus on the central bank as a separate agency of the state, with a distinct legal personality, charged with the management of the legal tender liabilities of the state and frequently also with the management of the official international foreign exchange reserves.

I could define monetary policy as 'whatever the central bank does', but a slightly more restrictive definition will turn out to be more useful in framing the analysis and organising the argument.

I consider four potential monetary instruments, one of them unconventional, the other three conventional.[17] The unconventional monetary instrument is the nominal interest rate on base money (conventionally zero on coin and currency, but

[16] They calculate that, if long-run inflation were to rise from 2.5 percent to 5.5 percent per annum, the equilibrium unemployment rate would fall from around 6 percent to around 5.87 percent (Nickell and Quintini [2003]).

[17] I restrict the analysis to monetary and fiscal policy in reasonably well-functioning market economies. Quantitative credit controls and other government-imposed forms of credit rationing are not

not necessarily on the other component of the monetary base, commercial bank reserves held with the central bank). The three conventional monetary policy instruments are (1) the short risk-free nominal interest rate on non-monetary financial claims, henceforth the short nominal interest rate (in the UK this would be the 2-week Repo rate; in the US the Federal Funds rate, although the Fed does not peg that rate exactly); (2) the stock of base money; and (3), the nominal spot exchange rate (the relative price of foreign currency in terms of domestic currency). Of these four monetary instruments, the interest rate on base money will, except in Section 3.4c, be treated as a policy instrument whose value is set equal to zero. Out of the short nominal interest rate, the quantity of base money and the exchange rate, only one can be chosen independently by the authorities if there is unrestricted international capital mobility and the country is small in global capital markets.[18]

In practice, countries either have a managed exchange rate (the exchange rate is the policy instrument) or they use the short nominal interest rate as the monetary instrument. I know of no country that uses (or used) the monetary base as the policy instrument, although in principle it is possible. Only when, in Section 4.3, I consider a rigorous version of Friedman's 'helicopter drop of money', is the stock of base money treated as a policy instrument.

I define a conventional monetary policy action as any change in the quantity of base money, in the short nominal interest rate, or in the exchange rate which, at given prices and activity levels, does not change the financial net worth of the state (the consolidated general government and central bank), now or in the future.

considered. Changes in deposit reserve requirements are best viewed as fiscal measures (changes in the taxation of deposit-taking activities).

[18] A 'small' country in a particular market is a price taker in that market. All countries except the US, can for practical policy purposes be treated as small in global capital markets.

Conventional monetary policy is therefore a subset of the state's financial portfolio management. The state's financial portfolio management comprises any changes in the composition of the government's portfolio of financial assets and liabilities which, at given prices and activity levels do not change the financial net worth of the state now or in the future. This includes the sale and purchase of long-dated government debt instruments financed by matching changes in shorter-maturity instruments, changes in the currency composition of the government's financial assets and liabilities (including sterilised and non-sterilised foreign exchange market intervention, changes in the mix of nominal and index-linked debt, public debt retirement financed through privatisation of state assets, swaps, trading in contingent claims markets etc).

Monetary policy involves a subset of such asset swaps. For our purposes, it always includes issuance or retirement (contraction) of base money financed through the purchase or sale of government interest-bearing debt (generally of a short maturity) or of foreign exchange reserves. Sterilised foreign exchange market intervention (purchases or sales of foreign in exchange for non-monetary liabilities of the government that do not alter the monetary base) also are generally conducted by the central bank. Note, however, that in the UK, most of the foreign exchange reserves are owned by the general government (the Treasury), although the Bank of England manages them as agent of the government. Most debt management operations not involving changes in the monetary base are no longer conducted by the Bank of England.

Fiscal policy includes any change in public spending or tax rules, regardless of whether they alter, at given prices and activity levels, the sequence of net financial balances of the state.

2. A Model of Aggregate Demand and Money Demand

The purpose of this Section is to present a simple formal model to guide the discussion of the conditions under which monetary and fiscal policy, conventional and unconventional, can or cannot stimulate aggregate demand. Monetary (and fiscal) policy ineffectiveness concerns the inability of monetary and fiscal policy to influence nominal aggregate demand. How a change in nominal aggregate demand is translated into changes in real GDP or in the general price level, depends on the details of the specification of the 'supply side' of the economy. As regards the key issues involved in preventing or curing deflation, the details of the determination of equilibrium prices quantities are irrelevant. Any combination of real output and general price level increases (including the two extremes of real output only and price level only) would be satisfactory. The paper therefore does not try to determine how any change in aggregate demand affects the general price level of prices of goods and services, real output and employment, asset prices or other variable of interest.[19] The detailed derivation of the decision rules of Section 2 can be found in Buiter [2003].

There are two goods, domestic output and imports. Aggregate demand for domestic output, e, is the sum of private consumption demand for domestic output, c_H, private investment demand for domestic output, ι_H, government spending on domestic output, g_H and export demand, x, that is,

$$e = c_H + \iota_H + g_H + x \qquad (1)^{20\ 21}$$

[19] In Buiter and Panigirtzoglou [2001, 2003], a simple continuous time, closed, endowment economy, represent agent version of the aggregate demand and money demand model developed here is combined with an old Keynesian (in Buiter and Panigirtzoglou [2001]) and a New Keynesian Phillips curve (in Buiter and Panigirtzoglou [2003]).

[20] For brevity's sake, we do not differentiate between public consumption spending and public sector investment.

[21] e, c_H, ι_H, g_H and x are all measured in units of domestic output.

2.1 Households

There is a composite private consumption good that is a constant elasticity of substitution (CES) function of the consumption of domestic output and imports. Consumption of imports is denoted c_F, and aggregate consumption, measured in terms of domestic output is $c \equiv c_H + \frac{SP^*}{P} c_F$. The domestic currency price of domestic output is P, the foreign currency price of imports is P^* and S is the spot price of foreign currency in terms of domestic currency, or the nominal spot exchange rate. Let $\theta > 0$ be the static elasticity of substitution between private consumption of domestic output and of imports, and let $0 < \eta \leq 1$. The CES price index for the private domestic consumption bundle, $\tilde{P}$, is given by

$$\begin{aligned} \tilde{P} &= \left(\eta P^{1-\theta} + (1-\eta) \left(SP^* \right)^{1-\theta} \right)^{\frac{1}{1-\theta}} \qquad &\text{if } \theta \neq 1 \\ \tilde{P} &= P^{\eta} \left(SP^* \right)^{1-\eta} \qquad &\text{if } \theta = 1 \end{aligned} \tag{2}$$

Private consumption of domestic output is related to aggregate private consumption of the composite commodity as follows:

$$\begin{aligned} c_H &= \eta \left(\frac{P}{\tilde{P}} \right)^{1-\theta} c = \eta \left[\eta + (1-\eta) \left(\frac{SP^*}{P} \right)^{1-\theta} \right]^{-1} c \qquad &\text{if } \theta \neq 1 \\ &= \eta c \qquad &\text{if } \theta = 1 \end{aligned} \tag{3}$$

The home country is fully specialised in the production of the domestic good. Domestic households supply the labour used in domestic production and own the domestic capital stock. There are four stores of value, base money, M, issued by the central bank, with a one-period nominal interest rate i_M, one period nominal domestic government bonds, B, with a one-period nominal interest rate *i,* one-period foreign bonds, B^*, with a one-period nominal interest rate i^* and the capital stock, K. The nominal value of a unit of installed capital is P_K. All non-monetary stores of value are perfect substitutes in private portfolios and earn the same expected rate of return. Money yields direct utility ('convenience services') in addition to being a store of value.

Domestic output equals domestic value added in our model, which does not have imported intermediate or raw materials inputs. The proportional rate of change in the price of domestic output, $\pi(t) \equiv \frac{P(t)}{P(t-1)} - 1$ is therefore also the GDP-deflator rate of inflation. The real interest rate using domestic output as the numéraire, r, is defined by $r \equiv \frac{1+i}{1+\pi} - 1$. Let Ω be the nominal value of the dividend paid out to shareholders per unit of capital and let ξ be the proportional rate of depreciation of the capital stock. Equalisation of expected rates of return on non-monetary assets then implies

$$\frac{1}{P_K(t)}[\Omega(t+1) + \frac{1}{1+\xi} P_K(t+1)] = 1 + i(t+1) \tag{4}$$

and

$$1 + i(t) = \left[1 + i^*(t)\right] \frac{S(t)}{S(t-1)} \tag{5}$$

There are two kinds of consumers. The first group always consumes its current disposable income. It neither saves nor borrows. This group is meant to capture the behaviour of consumers who are cash-flow constrained or liquidity-constrained; they have no liquid assets that they can draw down to finance consumption, nor can they obtain consumption loans. We refer to them as 'Keynesian' consumers. The aggregate real wage bill (measured in domestic output) is denoted w and real aggregate taxes on labour income τ. For simplicity, everyone currently alive is assumed to earn the same wage and pay the same taxes. Aggregate consumption by Keynesian consumers, c^K is given by

$$c^K = \lambda(w - \tau) \qquad\qquad 0 \le \lambda \le 1 \tag{6}$$

where λ is the fraction of the household population that is liquidity-constrained.

The second group of households has access to perfect financial markets. These 'permanent income' consumers can lend and borrow freely subject only to the constraint that the present value of their consumption programme not exceed the value of their initial net financial resources plus the present discounted value of their future after-tax labour income. Formally, we model these households using the discrete time version of the Yaari-Blanchard overlapping generations model (Yaari [1965], Blanchard [1985]) as generalised by Buiter [1988, 1990]. There is a constant birth rate $\beta \ge 0$, and a constant death rate, $1 \ge \delta \ge 0$. There are perfect annuities markets, so no-one leaves involuntary bequests. The individual's probability of death is also the fraction of each age cohort (and therefore of the population as a whole) that dies in any given period. The probability of death raises both the effective subjective discount rate and the market rate of interest earned by surviving households. There is no other uncertainty. Agents have rational expectations. The aggregate consumption of this group, c^P, is proportional to its *comprehensive* wealth, the sum of its financial wealth, a^P, and its human wealth, h^P

$$c^P = \mu\left(a^P + h^P\right) \tag{7}$$

In the model, all financial wealth, a, is owned by permanent income consumers, so $a^P = a$. The human wealth of a Keynesian consumer is the same as that of a permanent income consumer; the difference between them is that the Keynesian consumer cannot borrow against the discounted value of his future after-tax wage income. If economy-wide human wealth is denoted h, it follows that $h^P = (1-\lambda)h$. Equation (7) can be rewritten as

$$c^P = \mu\left[a + (1-\lambda)h\right] \tag{8}$$

Economy-wide aggregate consumption is given by:

$$c = c^P + c^K = \mu[a + (1-\lambda)h] + \lambda(w-\tau) \tag{9}$$

The law of motion for economy-wide financial wealth is given in equation (10).

$$a(t+1) \equiv [1 + r(t+1)]\left(a(t) + (1-\lambda)[w(t) - \tau(t)] - c^P(t) - \left[i(t) - i_M(t)\right]\frac{M(t)}{P(t)} \right) \tag{10}$$

and

$$a(t) \equiv \frac{[1+i(t)]\left(M(t)+B(t)\right) + [1+i^*(t)]S(t)B^*(t) + \left[(1-\xi)P_K(t) + \Omega(t)\right]K(t)}{P(t)} \tag{11}$$

Human wealth is the present discounted value of future after-tax labour income. Aggregate labour income is assumed not to be risky, so the appropriate discount rate is the risk-free real interest rate. Current consumption can only be driven by the human wealth owned by those currently alive. We calculate this by discounting future aggregate after-tax labour income at a higher rate than the risk-free rate of interest. The difference is the birth rate, β, the rate at which 'new entrants' arrive to join the future labour force and the future cohorts of tax payers.

Note that the government will tax both current and future generations. The birth rate does not enter the government's intertemporal budget constraint. If current generations were linked to future generations through an operative chain of intergenerational gifts and bequests, the birth rate will also be absent from the human wealth definition in equation (12) below.

$$h(t)=\sum_{j=t}^{\infty}\prod_{\ell=t}^{j}\left(\frac{1}{[1+r(\ell)][1+\beta]}\right)\left[w(j)-\tau(j)\right] \quad (12)^{22}$$

The marginal propensity to consume out of comprehensive wealth, μ is given in equation (13):

$$\mu(t)=\left\{\sum_{j=t}^{\infty}\left[\begin{array}{l}\prod_{\ell=t}^{j}\left(\frac{1}{[1+r(\ell)](1+\delta)}\right)\left[1+\left(\frac{1-\alpha}{\alpha}\right)\left(\left(i(j)-i_M(j)\right)(1+\delta)\right)^{1-\varphi}\right]\\ *\prod_{\ell=t}^{j}\left(\frac{1+r(\ell)}{1+\rho}\right)^{\sigma}\left[\frac{1+\left(\frac{1-\alpha}{\alpha}\right)\left(\left(i(\ell)-i_M(\ell)\right)(1+\delta)\right)^{1-\varphi}}{1+\left(\frac{1-\alpha}{\alpha}\right)\left(\left(i(\ell-1)-i_M(\ell-1)\right)(1+\delta)\right)^{1-\varphi}}\right]^{\frac{\sigma-\varphi}{\varphi-1}}\end{array}\right]\right\}^{-1} \quad (13)$$

The expression for the marginal propensity to consume out of comprehensive wealth in (13) simplifies when future real and nominal interest rates are expected to be constant. In that case, we get

$$\mu=\left[1+\left(\frac{1-\alpha}{\alpha}\right)\left[(i-i_M)(1+\delta)\right]^{1-\varphi}\right]^{-1}\left[\frac{(1+\delta)(1+\rho)^{\sigma}-(1+r)^{\sigma-1}}{(1+\delta)(1+\rho)^{\sigma}}\right] \quad (14)$$

When $\varphi=\sigma=1$ (logarithmic intertemporal preferences and a unitary elasticity of substitution between the composite consumption good and real money balances), the marginal propensity to consume out of comprehensive wealth simplifies to the expression given in equation (15) below.

$$\begin{array}{l}\mu=\alpha\left(\frac{(1+\rho)(1+\delta)-1}{(1+\rho)(1+\delta)}\right)\\ \rho>0;\ \delta\geq 0;\ 0<\alpha\leq 1\end{array} \quad (15)$$

Assuming that only permanent income consumers hold money balances, the demand for money is given by

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[22] We adopt the notational convention that $\prod_{\ell=t}^{t}x(\ell)=1$

$$\frac{M(t)}{P(t)} = \left(\frac{1-\alpha}{\alpha}\right)\left(\frac{1}{\left[i(t)-i_M(t)\right](1+\delta)}\right)^{\varphi}\left(c(t)-\lambda[w(t)-\tau(t)]\right)$$

$$0 < \alpha \leq 1;\ \varphi > 0;\ i \geq i_M \tag{16}$$

The parameter $\rho > 0$ is the subjective rate of time preference. The intertemporal substitution elasticity is $\sigma > 0$ and $\varphi > 0$ is the static elasticity of substitution between the composite consumption good and real money balances.

The demand for real base money depends negatively on the financial opportunity cost of holding money, that is, the excess of the short nominal interest rate over the short nominal interest on base money. The aspect of equation (16) that matters most is the second line, constraining the nominal interest rate on non-monetary financial claims to be at least as high as the nominal interest rate on base money. This floor on the nominal interest rate will be present as long as the non-pecuniary marginal utility of money does not become negative. A simple arbitrage argument then suffices to establish the floor. Consider the case where $i_M = 0$. If the short nominal interest rate on non-monetary assets could be negative, there would be risk-free way of making infinite profits by borrowing at the negative rate of interest and investing in base money. Our money demand function also has the property that the non-pecuniary marginal utility of money goes to zero only as the real stock of money balances relative to consumption goes to infinity, but that is not important for anything that follows.

2.2 The government

The government's budget identity is given in equation (17) below and its intertemporal budget constraint or solvency constraint in equation (18). Note that government here means the consolidated general government and central bank.

Government non-monetary debt refers to general government debt held outside the central bank.[23] The government spends g_H on domestic output, g_F on foreign output, raises taxes T in nominal terms, issues base money with a nominal interest rate i_M, issues domestic currency-denominated debt with a nominal interest rate i and holds foreign exchange reserves D^* that earn a nominal interest rate i^*.[24] We shall call $S(t)D^*(t) - B(t) - M(t)$ the financial net worth of the government. Assuming only households pay taxes to the government, we have $\tau \equiv \frac{T}{P}$. We also define

$g \equiv g_H + \frac{SP^*}{P} g_F$.

$$\begin{aligned} &M(t+1) + B(t+1) - S(t)D^*(t+1) \\ &\equiv P(t)g_H(t) + S(t)P^*(t)g_F(t) - T(t) \\ &+[1+i_M(t)]M(t) + [1+i(t)]B(t) - S(t)[1+i^*(t)]D^*(t) \end{aligned} \tag{17}$$

$$\begin{aligned} &\frac{[1+i(t)]B(t) - [1+i^*(t)]S(t)D^*(t)}{P(t)} \\ &= \sum_{j=t}^{\infty} \prod_{\ell=t}^{j} \left(\frac{1}{1+r(\ell)} \right) \left(\tau(j) - g(j) + \frac{\Delta M(j+1)}{P(j)} - i_M(j) \frac{M(j)}{P(j)} \right) \end{aligned} \quad (18)^{25}$$

We assume that government spending decisions can be represented by an exogenous sequence of aggregate public spending measured in domestic output, $\{g(j);\ j \geq t\}$. International relative prices then distribute this aggregate across domestic goods and imports according to equation (19) with $0 < \hat{\eta} < 1,\ \hat{\theta} > 0$,

$$\begin{aligned} g^H &= \hat{\eta} \left(\frac{P_H}{P} \right)^{1-\hat{\theta}} g = \hat{\eta} \left[\hat{\eta} + (1-\hat{\eta}) \left(\frac{SP^*}{P_H} \right)^{1-\hat{\theta}} \right]^{-1} g \qquad && \hat{\theta} \neq 1 \\ &= \hat{\eta} g && \hat{\theta} = 1 \end{aligned} \tag{19}$$

[23] In general, it would also include central bank non-monetary liabilities held outside the general government. We ignore this in what follows.
[24] We assume for simplicity that the government earns the same interest rate on its international reserves as the private sector does on its foreign-currency-denominated securities.

Forward-looking permanent income consumers internalise the government's intertemporal budget constraint. In equation (20) below, private aggregate consumption is represented after interest-bearing government debt is eliminated from the consumption function of the permanent income consumers given in (8), using (11) and the government's intertemporal budget constraint (18). It aggregates the behaviour of the permanent income consumers who fully internalise the future taxes and monetary issuance decisions of the government, and the behaviour of the myopic Keynesian consumers.

$$c(t)=\mu(t)\left\{\begin{array}{l}\dfrac{\left(\begin{array}{r}[1+i(t)]M(t)+[1+i^{*}(t)]S(t)[B^{*}(t)+D^{*}(t)]\\ +\left((1-\xi)P_K(t)+\Omega(t)\right)K(t)\end{array}\right)}{P(t)}\\ +\displaystyle\sum_{j=t}^{\infty}\left[(1-\lambda)\prod_{\ell=t}^{j}\left(\frac{1}{[1+r(\ell)](1+\beta)}\right)w(j)-\prod_{\ell=t}^{j}\left(\frac{1}{1+r(\ell)}\right)g(j)\right]\\ +\displaystyle\sum_{j=t}^{\infty}\left[\prod_{\ell=t}^{j}\left(\frac{1}{1+r(\ell)}\right)-(1-\lambda)\prod_{\ell=t}^{j}\left(\frac{1}{[1+r(\ell)](1+\beta)}\right)\right]\tau(j)\\ +\displaystyle\sum_{j=t}^{\infty}\left[\prod_{\ell=t}^{j}\left(\frac{1}{1+r(\ell)}\right)\left(\frac{\Delta M(j+1)}{P(j)}-\frac{i_M(j)M(j)}{P(j)}\right)\right]\end{array}\right\} \quad (20)$$

$$+\lambda[w(t)-\tau(t)]$$

The real value of a unit of capital carried into period t is (from equation (4)) given by the present discounted value of the future dividend stream:

$$\frac{P_K(t)}{P(t)}\equiv\sum_{j=t}^{\infty}\prod_{\ell=t}^{j}\left(\frac{1}{(1+\xi)[1+r(\ell)]}\right)\left(\frac{\Omega(j)}{P(j)}\right) \quad (21)$$

2.3 Private investment

There is a composite private investment good, $\tilde{\imath}$, represented by a CES function of domestic output and imports. The price index for the composite investment good is, with $0<\overline{\eta}\leq 1$ and $\overline{\theta}>0$,

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[25] Δ is the backward difference operator, that is, $\Delta M(t+1)=M(t+1)-M(t)$.

$$\tilde{P}_I = \left[\overline{\eta} P^{1-\overline{\theta}} + (1-\overline{\eta}) \left(SP^* \right)^{1-\overline{\theta}} \right]^{\frac{1}{1-\overline{\theta}}} \qquad \text{if } \overline{\theta} \neq 1$$
$$= P^{\overline{\eta}} (SP^*)^{1-\overline{\eta}} \qquad \text{if } \overline{\theta} = 1 \qquad (22)$$

There are quadratic internal adjustment costs associated with investment. Both the production function and the adjustment cost function are constant returns to scale. Private investment can therefore be represented as a function of 'Tobin's q'. With $v > 0$, we have, letting $\iota = \frac{\tilde{P}_I}{P} \tilde{\iota}$:

$$\iota(t) = \frac{1}{v} \left[\frac{P_K(t) - \tilde{P}_I(t)}{P(t)} \right] K(t)$$
$$= \frac{1}{v} \left[\frac{P_K(t)}{P(t)} \left[\overline{\eta} + (1-\overline{\eta}) \left(\frac{S(t)P^*(t)}{P(t)} \right)^{1-\overline{\theta}} \right]^{\frac{1}{\overline{\theta}-1}} - 1 \right] K(t) \qquad \text{if } \overline{\theta} \neq 1 \qquad (23)$$
$$= \frac{1}{v} \left[\frac{P_K(t)}{P(t)} \left(\frac{S(t)P^*(t)}{P(t)} \right)^{\overline{\eta}-1} - 1 \right] K(t) \qquad \text{if } \overline{\theta} = 1$$

Private investment demand for domestic output is given by

$$\iota_H = \overline{\eta} \left[\overline{\eta} + (1-\overline{\eta}) \left(\frac{EP^*}{P} \right)^{1-\overline{\theta}} \right]^{-1} \iota \qquad \text{if } \overline{\theta} \neq 1$$
$$= \overline{\eta} \iota \qquad \text{if } \overline{\theta} = 1 \qquad (24)$$

Private investment demand for imports is denoted ι_F .

2.4 Export demand

Without modelling the rest of the world in any detail, we want to specify export demand for domestic output, x, analogously to the import demand functions implicit in our specification of consumption, public spending and private investment. We therefore assume that the home country takes as given aggregate spending in the rest of the world in terms of foreign output, and that the ideal price index for foreign spending (the price, in terms of foreign currency) of some appropriate foreign composite commodity, is

$$\tilde{P}^* = \left[\eta^* P^{*1-\theta^*} + (1-\eta^*) \left(\frac{P}{S} \right)^{1-\theta^*} \right]^{\frac{1}{1-\theta^*}} \text{ if } \theta^* \neq 1 \text{ and } \tilde{P}^* = P^{*\eta^*} (\frac{P}{S})^{1-\eta^*} \text{ if } \theta^* = 1 .$$

Let f^* denote aggregate rest-of-the-world demand measured in foreign output. Export demand for home country output is given by:

$$\begin{aligned} x &= \left(1-\eta^*\right) \left[\eta^* \left(\frac{P}{SP^*} \right)^{\theta^*} + (1-\eta^*) \frac{P}{SP^*} \right]^{-1} f^* && \text{if } \theta^* \neq 1 \\ &= \left(1-\eta^*\right) \frac{SP^*}{P} f^* && \text{if } \theta^* = 1 \end{aligned} \tag{25}$$

In the next Section, we study the effects of monetary and fiscal policy on aggregate demand using the model developed in this Section as a benchmark, but going beyond it where necessary.

3. Monetary Policy and Aggregate Demand

The model of aggregate demand for domestic output is summarised in equations (1), (3), (18), (19), (20), (21), (23), (24) and (25). In the formal model, the effect of conventional monetary policy on aggregate demand for domestic output means the effect on current aggregate demand for domestic output, $e(t)$, of changes in the current short nominal interest rate, $i(t+1)$,[26] and/or credible announcements about changes in one or more future short nominal interest rates, $i(j),\ j > t+1$, holding constant all other (expected) future short nominal interest rates. Also held constant are the initial values of all asset stocks (money, $M(t)$, government debt, $B(t)$, net private holdings of foreign debt, $B^*(t)$, foreign exchange reserves, $D^*(t)$ and the domestic capital stock, $K(t)$), and current and future (anticipated) values of (1) the domestic general price level $\left\{P(j),\ j \geq t\right\}$;[27] (2) the nominal exchange rate $\left\{S(j),\ j \geq t\right\}$;(3) real wage income $\left\{w(j),\ j \geq t\right\}$; (4) real tax revenues $\left\{\tau(j),\ j \geq t\right\}$; (5) aggregate real public spending $\left\{g(j),\ j \geq t\right\}$; (6) aggregate real spending in the rest of the world $\left\{f^*(j),\ j \geq t\right\}$; (7) nominal interest rates on base money $\left\{i_M(j),\ j \geq t\right\}$; (8) foreign nominal interest rates $\{i^*(j),\ j \geq t\}$; (9) foreign prices $\{P^*(j),\ j \geq t\}$; (10) capital rental rates $\left\{\Omega(j),\ j \geq t\right\}$; (11) seigniorage $\Delta M(j+1),\ j \geq t$.

3.1 A cut in the current short nominal rate of interest

As long as the lower bound on the nominal interest rate is not binding ($i(t+1) > i_M(t+1)$) the monetary authorities can reduce the current short nominal rate of interest, $i(t+1)$. A reduction in the current short nominal interest rate $i(t+1)$ will boost both private consumption demand and investment demand (because we allow for endogenous changes in the value of capital, P_K).

For $n \geq t$

$$\begin{aligned}\frac{\partial c(t)}{\partial\left(1+i(n)\right)} &= \mu(t)\left(\frac{\partial a(t)}{\partial\left(1+i(n)\right)} + \left(1-\lambda\right)\frac{\partial h(t)}{\partial\left(1+i(n)\right)}\right) \\ &\quad + \left(a(t)+(1-\lambda)h(t)\right)\frac{\partial \mu(t)}{\partial\left(1+i(n)\right)}\end{aligned} \tag{26}$$

In general, consumption demand is affected by changes in *real* interest rates through three channels: the income effect, the substitution effect and the revaluation effect. In our model, the income and substitution effect work through the marginal

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[26] Note that $i(t)$ is predetermined in period *t*.

[27] and therefore also current and anticipated future values of domestic inflation rates, $\left\{\pi(j),\ j \geq t\right\}$.

propensity to spend out of comprehensive wealth, μ. It is clear from equation (13) that the marginal propensity to spend out of comprehensive wealth will be independent of current and future real interest rates if and only if (1) income and substitution effects of a real interest rate change cancel each other exactly, that is, if $\sigma = 1$ and (2) the income effect and substitution effect of a change in $i - i_M$, the opportunity cost of holding base money, cancel each other out, that is, if $\varphi = 1$. In our model this will be the case if the period utility function is logarithmic in a Cobb-Douglas function of aggregate consumption and real money balances (see Buiter [2003]).

From equation (13), *ceteris paribus,* a lower real rate of interest (in the current period or anticipated in the future) will raise (lower) the marginal propensity to consume out of comprehensive wealth if and only if $\sigma > 1$ ($\sigma < 1$).[28] Also, *ceteris paribus*, a lower nominal rate of interest (in the current period or anticipated in the future) will raise (lower) the marginal propensity to consume out of comprehensive wealth if and only if $\varphi < 1$ ($\varphi > 1$).[29]

This is intuitively obvious: if there is a sufficiently strong willingness to shift consumption between the present and the future in response to changes in intertemporal relative prices, a cut in current or anticipated future real interest rates will boost consumption. Also, if the elasticity of real money demand with respect to

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[28] For instance, from equation (14), the steady-state effect of a permanent change in the real interest rate on the marginal propensity to consume (holding constant the nominal interest rate) is

$$\left.\frac{\partial \mu}{\partial(1+r)}\right|_{i-i_M=\overline{i-i_M}} = -\left[1+\left(\frac{1-\alpha}{\alpha}\right)\left[(i-i_M)(1+\delta)\right]^{1-\varphi}\right]^{-1}\frac{(\sigma-1)(1+r)^{\sigma-2}}{(1+\delta)(1+\rho)^{\sigma}}.$$

[29] For instance, from equation (14), the steady-state effect of a permanent change in the nominal interest rate, holding constant the real interest rate, is given by

the nominal interest rate is less than unity (in absolute value), a lower nominal interest rate will raise the share of consumption of the composite commodity in total spending on the composite commodity and the services provided by money balances.

In our Sidrauski-type model, money is not super-neutral unless both the intertemporal substitution elasticity and the elasticity of substitution between the composite consumption good are equal to one.[30] When only the elasticity of substitution between money and consumption is unity, there will be no steady-state nominal interest rate effect on the marginal propensity to consume (equation (14)), but there will be temporary effects. Only when both the intertemporal elasticity of substitution and the elasticity of substitution between money and consumption are unity ($\sigma = \varphi = 1$, see equation (13)) will there be neither steady-state nor dynamic effects of the nominal rate of interest on the marginal propensity to consume.

There is no consensus on the magnitude of the intertemporal substitution elasticity. Empirical studies based on the representative agent, time-separable expected utility paradigm in which the constant of relative risk aversion is the reciprocal of the intertemporal substitution elasticity, typically find that the intertemporal substitution elasticity is close to zero (or equivalently, that the degree of relative risk aversion is very high). Examples are Hansen and Singleton [1983], Hall [1988] and Yogo [2002]. Allowing the period felicity function to be non-separable in consumption and leisure can raise the (implied) estimate of the elasticity of

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$$\left.\frac{\partial \mu}{\partial (i - i_M)}\right|_{r=\bar{r}} =$$

$$(\varphi - 1)\left[1 + \left(\frac{1-\alpha}{\alpha}\right)\left[(i - i_M)(1+\delta)\right]^{1-\varphi}\right]^{-2}\left(\frac{1-\alpha}{\alpha}\right)\left[(i - i_M)(1+\delta)\right]^{-\varphi}(1+\delta)\left(\frac{(1+\delta)(1+\rho)^{\sigma} - (1+r)^{\sigma-1}}{(1+\delta)(1+\rho)^{\sigma}}\right)$$

[30] See Sidrauski [1967] and Fischer [1979a,b] for a similar result for the case where money is separable from consumption in the direct utility function.

intertemporal substitution to around 0.35 which, while significantly different from zero is also significantly below one (see Basu and Kimball [2000]).

There have been four distinct approaches that attempt to rebut this finding. Mulligan [2002] argues that earlier studies measured rates of return incorrectly and that making the appropriate corrections yields results consistent with an intertemporal elasticity of substitution of one. The second rejects the representative agent assumption and models heterogeneous consumers/portfolio holders. For instance, Guvenen [2003], permits the intertemporal elasticity of substitution to increase with household wealth and assumes that many low wealth consumers do not participate in the financial markets at all (rather like the Keynesian consumers of this paper).

The third alternative drops time-separability, that is, the current period felicity function depends not just on current consumption, but also on past consumption. Habit formation is a portmanteau explanation for such specifications (e.g. Abel [2000]). Finally, the expected utility hypothesis has been dropped in favour of alternatives, such as the Epstein-Zinn [1989, 1991] utility functions, that allow intertemporal substation and risk aversion to be modelled and estimated independently (see e.g. Hyde and Sherif [2002]). An outsider trying to sum up the results of this literature can only conclude that it is difficult to argue that the intertemporal substitution elasticity is close to unity and virtually impossible to conclude that it is significantly above unity.

As regards the interest elasticity of the demand for base money, most empirical studies do not favour the constant elasticity specification of the model.[31] The popular log-linear specification implies a negative nominal interest rate elasticity whose absolute value starts at zero when the nominal interest rate is zero and

[31] Few empirical studies use private consumption as the scale variable in the money demand function. Income (current or permanent) and financial wealth are more commonly found in that role.

increases without bound as the level of the nominal interest rate increases. When the nominal interest rate is near the zero floor, the (absolute value of the) interest elasticity of money demand is therefore likely to be less than one, which would strengthen the positive impact on aggregate demand of a cut in the nominal rate of interest.

The *revaluation effect* of a change in a real interest rate refers to the change in comprehensive wealth as some element in the sequence of current and future real interest rates changes (see equations (11), (12) and (20)). We can further distinguish the financial wealth revaluation effect and the human wealth revaluation effect.

The effect of a change in the period *n* real interest rate ($n \geq t+1$) on human wealth in period *t* is:

$$\frac{\partial h(t)}{\partial\left[1+r(n)\right]} = -\frac{1}{\left[1+r(n)\right]}\sum_{j=n}^{\infty}\prod_{\ell=t}^{j}\left(\frac{1}{\left[1+r(\ell)\right](1+\beta)}\right)\left[w(j)-\tau(j)\right] \qquad (27)^{32}$$

The revaluation effect of a cut in the period *n* real interest rate (brought about in our example by a cut in the period *n* nominal interest rate holding constant the (anticipated) period *n* rate of inflation) is positive if after-tax labour income in period *n* and beyond is 'on average' positive.

As regards the financial wealth revaluation effect, the lower real interest rate associated with a lower nominal interest rate at a given inflation rate will also boost Tobin's *q,* the market value of a unit of installed capital (see equation (21)).[33] By boosting $q \equiv \frac{P_K}{P}$, both private consumption (equation (20)) and private investment

[32] In equation (27), the government's intertemporal budget constraint has not been substituted into the private sector comprehensive wealth definition.

(equation (23)) will be stimulated. The revaluation effect of a lower interest rate boosts demand regardless of the value of the intertemporal substitution elasticity.

The marginal propensity to consume multiplies the change in comprehensive wealth due to the valuation effect to get the effect on consumption. The marginal propensity to consume out of comprehensive wealth is likely to be a rather small number, probably similar in magnitude to the long-run real rate of return on an annuity, say 0.045 at most (that is 4.5 percent per annum).[34]

A cut in short nominal interest rates may further boost private spending through a number of channels not considered in the formal model. With imperfect financial markets (due, for instance, to asymmetric information and associated adverse selection and agency problems) there can be further effects on the cost and availability of funds to enterprises (or through the lending channel or the credit channel) and further effects on private investment. Inventory investment, including investment in working capital (not formally modelled here) are further transmission mechanisms of changes in short nominal interest rates.

3.2 Credible announcements of future cuts in nominal interest rates

The effect of a cut in current nominal interest rates can be leveraged through credible announcements of future cuts in interest rates. Permanent income consumers will respond to such anticipated future cuts in interest rates through the same

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[33] $$\frac{\partial\left(P_K(t)/P(t)\right)}{\partial\left[1+r(n)\right]} = -\left(\frac{1}{1+r(n)}\right)\sum_{j=n}^{\infty}\prod_{\ell=t}^{n}\left(\frac{1}{[1+r(\ell)](1+\xi)}\right)\frac{\Omega(j)}{P(j)} \qquad n>t .$$

[34] Interpret the unit period to be one year. The rate of pure time preference, ρ is, say, 0.03. The death rate δ is, say, 0.015. In the Cobb-Douglas case, α is the ratio (for permanent income households) of annual consumption to the sum of annual consumption and the value of the annual liquidity services yielded by money. The monetary base in the UK in 2002 was about £36bn. Household consumption (which includes the consumption of the Keynesian consumers who don't hold money) was probably around £650 bn. That sets a lower bound on α of 0.945 approximately. These numerical values imply $\mu \approx 0.0412$.

substitution, income and revaluation channels (see equations (26) and (27) and footnote (28)). In addition, both permanent income consumers and enterprises will raise spending through the effect of lower anticipated future interest rates on Tobin's q (see footnote (33)).

3.3 Devaluation

Instead of treating the short nominal interest rate as the monetary instrument, we can take the current nominal exchange rate to be the instrument.[35] It is easily checked that, for given sequences of current and expected future values of economy-wide endogenous variables and exogenous variables, and for given values of current and future nominal interest rates $i(j),\ j \geq t+1$, a devaluation will increase the demand for domestic output if and only if it increases the trade balance surplus. The trade balance surplus, measured in domestic output, is denoted ς, that is,

$$\varsigma \equiv x - \frac{SP^*}{P}\left(c_F + \iota_F + g_F\right) \tag{28}$$

First consider the effect on the trade balance of an increase in the real exchange rate, $\frac{SP^*}{P}$, holding constant the three domestic aggregate spending components, c, ι and g in terms of domestic output and holding constant f^*, rest-of the world spending in terms of foreign output. A depreciation of the real exchange rate, or (for given values of the domestic and foreign GDP deflators) a devaluation will increase the trade balance surplus from an initial position of balance if and only if sum of the export and import price elasticities of demand is greater than one - the familiar Marshall-Lerner conditions.

[35] We should think of this devaluation as an unanticipated, immediate and permanent devaluation, if it is to be consistent with given sequences of domestic and foreign nominal interest rates and UIP.

Consider the case where the public spending and private investment are split among domestic output and imports in the same way as private consumption, that is, $\theta = \overline{\theta} = \hat{\theta}$ and $\eta = \overline{\eta} = \hat{\eta}$. In this case

$$\left.\frac{\partial \varsigma}{\partial S}\right|_{\substack{c=\overline{c}\\ \iota=\overline{\iota}\\ g=\overline{g}}} = \frac{x}{S}\left[\eta^{*}\left(\frac{SP^{*}}{P}\right)^{-\theta^{*}} + (1-\eta^{*})\left(\frac{SP^{*}}{P}\right)^{-1}\right]^{-1}\left[\theta^{*}\eta^{*}\left(\frac{SP^{*}}{P}\right)^{-\theta^{*}} + (1-\eta^{*})\left(\frac{SP^{*}}{P}\right)^{-1}\right]$$
$$-(c_F + \iota_F + g_F)\left\{1-\left[\eta\left(\frac{SP^{*}}{P}\right)^{-\theta} + (1-\eta)\left(\frac{SP^{*}}{P}\right)\right]^{-1}\left[\theta\eta\left(\frac{SP^{*}}{P}\right)^{-\theta} + (1-\eta^{*})\left(\frac{SP^{*}}{P}\right)\right]\right\} \quad (29)$$

In the Cobb-Douglas case, for instance, with $\theta = \overline{\theta} = \hat{\theta} = \theta^{*} = 1$, the Marshall-Lerner conditions are satisfied because the sum of the import and export price elasticities equals two.

As defined here, the Marshall-Lerner conditions therefore do not necessarily capture the total effect of a devaluation on the trade balance or on aggregate demand. While g and f^{*} can for our purposes be taken to be exogenous, both aggregate private consumption, c, and aggregate private investment, ι, are endogenous and will in general depend on the exchange rate.

Aggregate consumption will also be affected by a devaluation through a wealth effect. From equation (20) it is clear that:

$$\frac{\partial c(t)}{\partial S(t)} = \mu(t)[1+i^{*}(t)][B^{*}(t)+D^{*}(t)] \quad (30)$$

Thus if $B^{*}+D^{*}$, the net stock of foreign-currency-denominated assets held by the domestic private sector and government, is positive (negative), devaluation will boost (lower) aggregate demand through a wealth effect.

Total private investment measured in domestic output, ι, will decline, other things being equal, when the exchange rate is devalued. From equation (23) it is apparent that

$$\frac{\partial \iota}{\partial S} = -(1-\bar{\eta})\frac{P^* P_K}{vP^2} K \left[\bar{\eta} + (1-\bar{\eta})\left(\frac{SP^*}{P}\right)^{1-\bar{\theta}} \right]^{\frac{2-\bar{\theta}}{\bar{\theta}-1}} \left(\frac{SP^*}{P}\right)^{-\bar{\theta}} < 0. \tag{31}$$

The reason is that a devaluation raises the price of the composite investment good, P_I relative to the price of installed capital, that is, it reduces Tobin's *q*.

A devaluation or sharp depreciation of the yen has been recommended as a cure for Japan's deflationary ills by McKinnon and Ohno [1999] and Svensson [2000]. It is clear that devaluation is not guaranteed to work: the Marshall-Lerner conditions may not be satisfied; a country may be a net debtor in foreign currency-denominated assets $B^*(t) + D^*(t) < 0$, and the effect of a real depreciation on aggregate investment is negative in our model. On the other hand, if a devaluation boosts aggregate demand, it does so regardless of the level of nominal interest rates: devaluation can boost demand even when nominal interest rates are at their zero lower bound.

Empirical evidence on the response of the trade balance to a devaluation appears to be supportive of the proposition that the Marshall-Lerner conditions are satisfied at least in the long run. The short-run picture is mixed (see Goldstein and Khan [1985] and Rose [1991]). This conclusion appears to have survived the co-integration revolution (see e.g. Bahmani-Oskooee and Alse [1994]).

3.4 Unconventional monetary policy when short nominal interest rates are zero.

Without loss of generality, consider practically relevant case where the nominal interest rate on base money, i_M, is zero. Assume the current short nominal interest rate i is at its zero lower bound. Assume also that the authorities have credibly committed themselves to keep future short nominal interest rates at zero. What else can monetary policy do to stimulate aggregate demand?

3.4a. Generalised open market operations.

Our formal model assumes that all non-monetary stores of value are perfect substitutes. If this is not the case, even the credible announcement of a future policy of systematically keeping future short nominal interest rates at zero would not necessarily reduce the nominal yields on outstanding stocks of longer-maturity government securities to zero. The could be term premia, liquidity premia and a variety of risk premia not recognised in models of efficient financial markets. If such is the case, it is clear that monetary policy has not been exhausted. Open market purchases of all government securities that have a positive nominal yield can be undertaken. As long as there is a positive amount outstanding of any nominally denominated government security with a positive nominal yield, monetary policy has not yet run out of steam.

The central bank can also expand the monetary base through purchases of foreign exchange reserves or indeed through purchases of foreign-issued and foreign-currency-denominated securities of any maturity, including options and other derivatives. It can also engage in purchases of foreign exchange reserves financed not by issuing additional base money but by reducing its holdings of general government securities. There is little evidence to support the view that such 'sterilised foreign exchange market intervention' is an effective and reliable instrument for bringing down domestic interest rates, but even if it does not help, it is unlikely to hurt (unless markets begin to wonder why the central bank is engaging in pointless financial transactions).

Even after monetising the entire public debt and purchasing large amounts of foreign securities, the central bank has options left. It could turn its attention to the domestic private sector by purchasing private domestic securities. In times of financial stress and turbulence, central banks already have a well-established practice of easing the eligibility requirements for private securities that are acceptable as collateral in Repo operations.[36] The central bank can also expand the list of eligible counterparties that it is willing to deal with. Beyond that, open market purchases of private bonds and other private financial instruments, including stocks and shares, options and other derivatives are, in principle possible. Conceivably, the central bank could engage in 'open market' purchases of commercial, industrial or residential real estate.

There are difficult issues involved in such transactions, including integrity problems, moral hazard, adverse selection and governance problems. To make the (temporary) socialisation of private financial securities palatable, the central bank would have to buy something like a representative index fund of the eligible classes of securities, and refrain from interfering in the management of any enterprises it might acquire a significant ownership stake in.

3.4b Spitting in the wind: introducing an inflation target or raising the target rate of inflation when the zero lower bound is binding everywhere

Some authors (e.g. Krugman [1998d, 1999, 2000]) have proposed the credible announcement and immediate introduction of an inflation target as a means of escaping from the zero interest floor. Assume the economy experiences deflation and that not only current short and long nominal rates of interest but also all anticipated future nominal interest rates are zero. Under these circumstances, introducing an inflation target, or raising the inflation target rate, is spitting in the wind: it will not

[36] The Bank of Japan now accepts a broader range of private debt as eligible collateral, and provides loans directly to private commercial banks at very low interest rates (see Bank of Japan [2003]).

affect the behaviour of the economy, as the target announcement has no implications for the current and future behaviour of the monetary policy instruments.

Adopting a sufficiently high inflation target while one is not in the zero bound trap and pursuing it assiduously may well prevent one from ever getting into a generalised zero nominal interest rate trap and will in any case make such an eventuality less likely (King [. Once you are in a generalized zero bound trap, announcing an inflation target without having any instruments, now or in the future, for achieving it is a pointless gesture (see Buiter and Panigirtzoglou [2001, 2003] for a formal demonstration of this intuitively obvious point).

A number of Japanese monetary policy makers have argued against the aggressive use of monetisation of government debt as counter-deflationary policy on the grounds that this risked creating *hyperinflation*. An inflation target and a credible commitment to use the available policy instruments to pursue but not to exceed that target could be useful if it allayed fears that the implementation of an effective anti-deflationary policy would create excessive inflation (or even hyperinflation).

3.4c Lowering the zero floor on nominal interest rates by imposing a carry tax on currency.

The reason we don't see negative nominal interest rates on private securities and non-monetary government debt instruments is that the zero interest rate on base money sets a floor under all nominal interest rates. If the authorities could pay negative interest on base money (effective impose a 'carry tax' on base money), the zero nominal interest rate floor would be lowered, and this constraint on the conduct of monetary policy would be removed. Once the policy-determined nominal interest on base money (i_M in our model) has been set below zero, other, market-determined nominal yields on non-monetary public and private securities would follow, driven by the forces of arbitrage and competition.

Paying negative interest on commercial bank reserves held with the central bank is trivially simple. Think of these reserves as akin to bank accounts held by the general public. Households and enterprises get paid interest on the balance in these accounts and are charged for the cost of operating the accounts. Commercial bank balances with the central bank (electronic ledger entries) are 'registered securities', in the terminology of Section 1 of this paper. Paying any interest rate, negative or positive, can be done by electronically debiting or crediting the account. It would be an administratively costless exercise.

Paying negative interest on currency, the bearer bond component of the base money stock, would be administratively cumbersome and costly. There would have to be a sufficiently large and credible penalty for non-payment to induce the anonymous holders of currency to come forward, receive their negative interest (pay their tax) and have their currency notes marked as 'current' in a way that cannot be forged easily and is recognisable by all. Resort to a carry tax on currency would be justified if the cost of the alternative (either living with a binding zero floor or the best alternative policy for escaping from the zero nominal interest rate floor trap) were higher. We shall see in Section 4 that there is at least one alternative policy that always will boost aggregate demand, and does not involve significant implementation costs.

4. Fiscal Policies To Stimulate Aggregate Demand

If the deflationary problem has not been solved by any of the monetary measures considered in Section 3, the state still is not powerless. Fiscal or mixed monetary and fiscal policy options remain and one of these, the 'helicopter drop of money' of Friedman fame, will always be able to boost nominal aggregate demand. To focus the argument, I will in what follows assume that $i_M = 0$, that is, the nominal interest rate on base money is zero, and that $i(j) = 0,\ j \geq t+1$, that is, all current and future short nominal interest rates are also zero. In the formal model, monetary policy has become incapable of boosting nominal aggregate demand.

4.1 Debt-financed tax cuts.

It is clear from equation (20), that a debt-financed tax cut in period *t* will stimulate aggregate private consumption demand in period *t* through two channels: increased spending by Keynesian consumers whose current disposable income has increased and increased spending by permanent income consumers for whom postponing taxes through borrowing raises the present discounted value of lifetime taxes. Permanent income consumers raise their consumption because part of the postponed taxes will be paid by new households who are not yet born at the time of the tax cut, and who therefore will not reduce their consumption.

Consider the effect of a tax cut in period *t* accompanied by the credible announcement of an increase in taxes in period *t+1* of equal present value, that is, $d\tau(t+1) = -[1+r(t+1)]d\tau(t) > 0$. The effect of the period *t* tax cut on the Keynesian consumers is given by $-\left.\frac{\partial c^K(t)}{\partial \tau(t)}\right|_{d\tau(t+1)=-[1+r(t+1)]d\tau(t)} = \lambda$. The future tax increase does not affect the current spending behaviour of the Keynesian consumers.

Forward-looking permanent income consumers change their period *t* consumption by $-(1-\lambda)\mu d\tau(t)$ in response to the period *t* tax cut, and their period *t* consumption by $-\mu\frac{(1-\lambda)}{[1+r(t+1)](1+\beta)}d\tau(t+1) = \mu\frac{(1-\lambda)}{(1+\beta)}d\tau(t)$ in response to the anticipated increase in taxes in period *t+1*. The net effect of this postponement of taxes financed by borrowing is

$$-\frac{\partial c(t)}{\partial \tau(t)}\bigg|_{d\tau(t+1)=-[1+r(t+1)]d\tau(t)} = \lambda + \mu(1-\lambda)\left(\frac{\beta}{1+\beta}\right) \qquad (32)^{37}$$

Only part of the boost to aggregate consumption demand will fall on consumption demand for domestic output (see equation (3)).

If there are no Keynesian consumers, $\lambda = 0$, there still is a positive effect on consumer demand of a debt-financed tax cut that satisfies the government's intertemporal budget constraint. In that case:

$$-\frac{\partial c(t)}{\partial \tau(t)}\bigg|_{\substack{d\tau(t+1)=-[1+r(t+1)]d\tau(t)\\ \lambda=0}} = \mu\left(\frac{\beta}{1+\beta}\right) \qquad (33)$$

Only if the birth rate is zero ($\beta = 0$) and we are effectively in a representative agent model, will there be debt neutrality or Ricardian equivalence: debt-financed tax cuts will not stimulate aggregate demand:

$$-\frac{\partial c(t)}{\partial \tau(t)}\bigg|_{\substack{d\tau(t+1)=-[1+r(t+1)]d\tau(t)\\ \lambda=0\\ \beta=0}} = 0 \qquad (34)$$

4.2 A tax- or debt-financed temporary increase in public spending on goods and services.

Without Keynesian consumers and with a zero birth rate, temporary increases in public spending will still stimulate aggregate demand. Consider a one-period increase in government spending on goods and services in period *t*. The public spending increase directly raises aggregate demand one-for-one. Aggregate demand for domestic output increases by the increase in public spending increase times the marginal share of public spending on domestic output in total public spending (see equation (19). Aggregate private consumption by permanent income consumers will be reduced less than one-for-one, even if the period *t* public spending increase is financed with a balanced budget (by raising taxes in line with public spending in period *t*). The impact of any tax increase on consumption by a permanent income household is spread out over its remaining lifetime. When $\lambda = \beta = 0$ (and, for simplicity also $\varphi = \sigma = 1$), we have:

$$\left.\frac{\partial c(t)}{\partial g(t)}\right|_{d\tau(t)=dg(t)} = -\mu = -\alpha\left(\frac{(1+\rho)(1+\delta)-1}{(1+\rho)(1+\delta)}\right) \tag{35}$$

Since $0 < \mu < 1$, a temporary increase in public spending financed ultimately or immediately by tax increases, will boost aggregate demand. A permanent increase in public spending would have associated with it an increase in the present discounted value of future taxes whose negative effect on current private consumption would be similar in magnitude to that of the public spending increase.

$$\begin{aligned}\sum_{j=t}^{\infty}\left.\frac{\partial c(t)}{\partial g(j)}\right|_{\sum_{j=t}^{\infty}\prod_{\ell=t}^{j}\left(\frac{1}{1+r(\ell)}\right)(d\tau(j)-dg(j))=0} &= -\mu\sum_{j=t}^{\infty}\prod_{\ell=t}^{j}\left(\frac{1}{1+r(\ell)}\right) \\ &= -\mu\left(\frac{1+r}{r}\right) \qquad \text{if } r(\ell)=r,\ \ell \geq t\end{aligned} \tag{36}$$ [38]

In an open economy, a permanent, tax-financed public spending increase can boost demand for domestic output even if it does not boost aggregate demand for the composite commodity. This will be the case if at the margin government spending is more concentrated on domestically produced goods than private spending, that is, if $\hat{\eta} > \eta$.

[37] We know that the tax cut is debt financed, because, from equations (18) and (20), if either public spending were cut or base money were issued to finance the tax cut, there would be additional effects to be considered.

[38] In the double logarithmic case, $\mu\left(\frac{1+r}{r}\right) = \alpha\left(\frac{(1+\rho)(1+\delta)-1}{(1+\rho)(1+\delta)}\right)\left(\frac{1+r}{r}\right) \approx 1$.

Only if public consumption were a private substitute for private consumption would a temporary, tax financed increase in public spending could fail to boost aggregate demand in a world with just permanent income consumers. The formal model assumed that any utility households may derive from public spending is separable from that of private consumption, so such 'direct crowding out' does not occur.

4.3 The one that always works: Friedman's helicopter drop of money.

Finally, there is the monetary-fiscal policy combination that always succeeds in stimulating aggregate demand: the tax cut or transfer payment financed by issuing base money. We reproduce the consumption function of equation (20) as equation (37), making all the assumptions necessary to emasculate monetary and fiscal policy to the maximum extent: $i_M(j) = i(j) = 0,\ j \geq t+1$ (all nominal interest rates are at their zero lower bound), $\lambda = 0$ (there are no Keynesian consumers) and $\beta = 0$ (there is debt neutrality).

$$c(t) = \mu(t)\left\{\begin{array}{l} \dfrac{\left(M(t) + [1+i^*(t)]S(t)[B^*(t)+D^*(t)] + \left((1-\xi)P_K(t) + \Omega(t)\right)K(t)\right)}{P(t)} \\ +\displaystyle\sum_{j=t}^{\infty}\left[\prod_{\ell=t}^{j}\left(\frac{1}{1+r(\ell)}\right)[w(j)-g(j)]\right] \\ +\displaystyle\sum_{j=t}^{\infty}\left[\prod_{\ell=t}^{j}\left(\frac{1}{1+r(\ell)}\right)\left(\frac{\Delta M(j+1)}{P(j)}\right)\right] \end{array}\right\} \quad (37)$$

The effect of a tax cut in, say, period t, financed through an increase in the nominal money stock in, say, period t, is given by:

$$-\frac{\partial c(t)}{\partial \tau(t)}\bigg|_{d\tau(t)=-\frac{d\Delta M(t+1)}{P(t)}<0} = \mu > 0 \qquad (38)^{39}$$

This effect can be enhanced by announcing a sequence of current and future tax cuts, all financed by increasing the future stock of base money. The timing of the tax cuts and timing of their monetisation does not matter; as long as the future tax cuts are credible, only their present value matters for private consumption.

What we are describing here is, of course, Milton Friedman's 'helicopter drop of money'.[40] The lump-sum gift or transfer payment from the state (equivalent to a lump-sum tax cut for households) is financed by printing money (and dropping it from a great height). There are no future tax liabilities implied by this transfer payment, because it is financed through the issuance of zero nominal interest-bearing base money. Even if there are no Keynesian consumers, such money-financed tax cuts or transfer payments will boost aggregate demand. In the current Japanese context this would be called a combination of tax cuts and 'quantitative monetary easing'.

The proposition that money-financed tax cuts or transfer payments always boost consumption demand is not contingent on the details of the specification of the objective function of households. All that is required is that aggregate consumption in any given period is a *normal* good. As long as this holds, an increase in household resources (and *a-fortiori* an increase in household resources that takes the form of an perfectly liquid increase in current disposable income) will boost aggregate demand.

The effect of a public spending increase in period t , financed through an increase in the nominal money stock in, say, period t, (or equivalently, though any

[39] We know that increase in the base money stock finances a tax cut because we are holding the sequence of public spending constant. From equations (18) and (20) (or (37)), the counterpart to the base money increase can only be a tax cut.
[40] Technically, Friedman's helicopter drop of money represents a *capital transfer* rather than a one-off tax cut or current transfer payment. Behaviourally, the distinction between capital and current transfers is irrelevant.

sequence of current and future money issues equal in present discounted value to the increase in current public spending) is given by:

$$\left.\frac{\partial c(t)}{\partial g(t)}\right|_{dg(t)=\frac{d\Delta M(t+1)}{P(t)}} = 0 \qquad (39)^{41}$$

This means that aggregate demand (for domestic and foreign goods) increases by the same amount as the increase in public spending, when the increase in public spending is financed by printing money.

4.4 Feldstein's proposal: using indirect tax changes to tilt the intertemporal terms of trade in favour of current consumption

During the past few years, Martin Feldstein has made proposals for tax policy measures to counteract deflation in Japan that do not in the first instance work through the income or wealth effects of tax cuts (see Feldstein [2002a, b]). Feldstein relies on the strength of the intertemporal substitution effect in household consumption behaviour. He proposes an immediate cut in value added tax (VAT) rates accompanied by the credible announcement of a future VAT rate increase above its current level. This combination early tax rate cut and later tax rate increase could be made revenue-neutral in present value terms. The effect of such a tax package would be to reduce the real interest rate 'at market prices' relevant to household consumption decisions. This real interest rate 'at market prices', denoted $\underset{\sim}{r}$, involves the comparison of market price indices at two dates. Market prices are the sum of prices at factor cost plus indirect taxes. More precisely, letting *P* denote the GDP deflator at factor cost, *r* the real interest rate 'at factor cost' and θ the VAT tax rate, we have

$$1+\underset{\sim}{r}(t) \equiv \left[1+i(t)\right]\frac{P(t-1)\left[1+\theta(t-1)\right]}{P(t)\left[1+\theta(t)\right]} = \left[1+r(t)\right]\frac{\left[1+\theta(t-1)\right]}{\left[1+\theta(t)\right]} \qquad (40)$$

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41 We know that increase in the base money stock finances a tax cut because we are holding the sequence of public spending constant. From equations (18) and (20) (or (37)), the counterpart to the base money increase can only be a tax cut.

At any given real interest rate at factor cost, a lower VAT rate today and/or a higher VAT rate tomorrow reduce the current real interest rate. It becomes cheaper to consume today and more expensive to consume tomorrow. If we interpret Feldstein's proposal as revenue-neutral in present value terms, the income effect of the tax rate changes is approximately zero, and the effect on current consumption will reflect solely the substitution effect of a cut in the current real interest rate (at market prices) faced by consumers. This will boost consumption.

There is a long history of temporary tax and subsidy measures of this kind that were targeted at enterprise investment decisions rather than at household consumption. For instance, a temporary investment tax credit or a temporary investment subsidy will bring investment forward to take advantage of the shift in the intertemporal terms of trade in favour of earlier rather than later investment. Measures targeted at the enterprise investment decisions are generally thought to have been reasonably effective.

5. Institutional Arrangements To Tackle Deflation: How Much Can The Central Bank Do On Its Own?

To evaluate implementation issues, we break down the consolidated budget constraint and solvency constraint of the general government and central bank into separate accounts each for the general government and the central bank.

The central bank has the monetary base (M, currency plus commercial bank reserves with the central bank) on the liability side of its balance sheet.[42] On the asset side it has the stock of international foreign exchange reserves (D^*) and the stock of domestic credit. For simplicity, in what follows domestic credit is restricted to central bank credit to the general government, that is, central bank holdings of nominally denominated general government interest-bearing debt (B^{CB}).[43]

Equation (41) is the budget identity of the general government and equation (42) that of the central bank.[44] Note that B is the stock of general government interest-bearing debt held outside the central bank, that τ^{P} is real value of the tax payments by the domestic private sector to the general government, τ^{CB} the real value of taxes paid by the central bank to the general government and h the real value of the transfer payments made by the central bank to the private sector ('helicopter drops' if they are monetised).

$$\frac{B(t+1)+B^{CB}(t+1)}{P(t)} \equiv g(t)-\tau^{P}(t)-\tau^{CB}(t)+i(t)\frac{[B(t)+B^{CB}(t)]}{P(t)} \tag{41}$$

$$\begin{aligned}&\frac{M(t+1)}{P(t)}-\frac{B^{CB}(t+1)}{P(t)}-S(t)\frac{D^{*}(t+1)}{P(t)}\\ &\equiv \tau(t)^{CB}+h(t)-[1+i(t)]\frac{B^{CB}(t)}{P(t)}-[1+i^{*}(t)]S(t)\frac{D^{*}(t)}{P(t)}\end{aligned} \tag{42}$$

The usual solvency constraints, ruling out Ponzi finance by both the government and the central bank, imply the following intertemporal budget constraints for the general government (equation (43)) and for the central bank (equation (44)).

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[42] For simplicity, all of the monetary base is treated as non-interest bearing ($i_{M}=0$).

[43] In many transition countries and developing countries the central bank also holds significant amounts of private sector debt instruments among its assets and interest-bearing, non-monetary liabilities among its liabilities.

[44] Note that the familiar proposition that the change in the monetary base equals domestic credit expansion plus the value of the change in the stock of foreign exchange reserves is correct if and only if the central bank makes no *after-tax* profits, that is, its before-tax profits, $i(t)\frac{B^{CB}(t)}{P(t)}+S(t)i^{*}(t)\frac{D^{*}(t)}{P(t)}-h(t)$, are paid as taxes to the Treasury or Ministry of Finance:

$\Delta M(t+1)\equiv \Delta B^{CB}(t+1)+S(t)\Delta D^{*}(t+1)$ iff $\tau^{CB}(t)\equiv i(t)\frac{B^{CB}(t)}{P(t)}+S(t)i^{*}(t)\frac{D^{*}(t)}{P(t)}-h(t)$.

$$[1+i(t)]\left(\frac{B(t)+B^{CB}(t)}{P(t)}\right)=\sum_{j=t}^{\infty}\prod_{\ell=t}^{j}\left(\frac{1}{1+r(\ell)}\right)\left(\tau^{P}(j)+\tau^{CB}(j)-g(j)\right) \qquad (43)$$

$$-\left(\frac{[1+i(t)]B^{CB}(t)+[1+i^{*}(t)]S(t)D^{*}(t)}{P(t)}\right) \le \sum_{j=t}^{\infty}\prod_{\ell=t}^{j}\left(\frac{1}{1+r(\ell)}\right)\left(-\tau^{CB}(j)-h(j)+\frac{\Delta M(j+1)}{P(j)}\right) \qquad (44)$$

Summing (41) and (42) and noting that $\tau \equiv \tau^{P}-h$ gives the budget identity of the state, that is, of the consolidated general government and central bank, in equation (17) and the intertemporal budget constraint of the state in equation (18).

Consider the balance sheet of the central bank in Table 2

Table 2 **Central Bank Balance Sheet**	
Assets	**Liabilities**
B^{CB}	M
SD^{*}	
	N^{CB}

The central bank's financial net worth, N^{CB}, is the excess of its financial assets, general government debt, B^{CB}, and foreign exchange reserves, D^{*}, over its monetary liabilities, M. Note that, in principle, there is nothing to prevent N^{CB} from being negative. Financial net worth excludes the present value of anticipated or planned future non-contractual outlays and revenues. It is therefore perfectly possible, in principle, for the central bank to survive and thrive with a negative financial net worth.

From the central bank's balance sheet in Table 2 and its budget identity in (42), it follows that

$$N^{CB} \equiv B^{CB} + SD^{*} - M \tag{45}$$

The central bank's intertemporal budget constraint given in (44) can therefore also be written as (46).

$$\begin{aligned}[1+r(t)]\frac{N^{CB}(t)}{P(t-1)} &\equiv \frac{[1+i(t)]\left[B^{CB}(t)-M(t)\right]+[1+i^{*}(t)]S(t)D^{*}(t)}{P(t)} \\ &= \sum_{j=t}^{\infty}\prod_{\ell=t}^{j}\left(\frac{1}{1+r(\ell)}\right)\left(\tau^{CB}(j)+h(j)-i(j)\frac{M(j)}{P(j)}\right)\end{aligned} \tag{46}$$

The value of the central bank's financial net worth has to be sufficient to pay (in present discounted value) for future transfers to the Treasury and to the private sector, allowing for the fact that future interest savings permitted by the issuance of non-interest-bearing base money are another source of revenue that the central bank can draw upon.

5.1 What kind of open market operations can the Central Bank engage in on its own?

While most central banks can buy and sell most general government securities and are permitted to buy or sell foreign exchange reserves, many central banks are not permitted to buy and sell private financial sector instruments such as corporate bonds or stocks, shares and real estate (other than their own offices). Whenever the central bank is not permitted to buy a particular financial instrument (private or public, domestic or foreign), the economically equivalent outcome can be achieved by the general government (typically the Treasury or the Ministry of Finance) buying that financial instrument and borrowing from the central bank to finance that purchase. The central bank then monetises the transaction.

In the Euro area, the ECB and the other members of the European System of Central Banks are not permitted to extend credit directly to the general government sector or to purchase general government securities directly, in the primary issue market. However, the economically equivalent result can always be achieved by the general government selling its debt instruments to the market and the central bank purchasing the same amount of general government debt in the secondary market.

Equations (44) or (46) allow us to give precise expression to a concern expressed by the Bank of Japan when confronted with proposals that it purchase private sector debt instruments, equity or other nominal or real assets. If these assets were to be bought at a price in excess of their fundamental values (or if, despite having been bought at a fair price, unexpected subsequent developments were to depress the value of these assets), the central bank can maintain its solvency only by building up its holdings of earning assets (B^{CB} or D^*) either through the issuance of additional base money, $\frac{\Delta M}{P}$, or through transfers by the general government, $-\tau^{CB}$, that is, by being recapitalised by the general government.

What is surprising is that, even under deflationary conditions, senior members of the Bank of Japan Policy Board worry about possible inflationary consequences of additional monetary issuance. In this case (and up to a point), higher inflation (a lower rate of deflation) is not a problem but part of the solution (see e.g. Bank of Japan [2002] and Kirchner [2002]).

5.2 Can the central bank perform a 'helicopter money drop' on its own?

Technically, if the central bank could make transfer payments to the private sector, the entire Friedmanian helicopter money drop could be implemented by the central bank. At time t there would be a large increase in $H(t)$ financed by increasing the monetary base ('printing money'). A vivid example would be for the Governor of the central bank to issue a $1,000 cheque (or its local currency equivalent), drawn upon the central bank's account, to every man, woman and child in the country. On the balance sheet of the central bank this would show up as an increase in the stock of base money and a corresponding reduction in the financial net worth of the central bank. In its budget constraint there would be a transfer payment to the private sector finance through base money issuance.

The legality of such an implementation of the helicopter drop of money by the central bank alone would be dubious in most countries with clearly drawn boundaries between the Central Bank and the Ministry of Finance or the Treasury. The Central Bank would be undertaking an overtly fiscal action, which is normally the exclusive province of the Treasury or the Ministry of Finance. An economically equivalent implementation of the helicopter drop of money would be a tax cut (or a transfer payment) implemented by the general government, financed through the sale of government debt to the Central Bank, with the Central Bank then monetising that debt increase. If the direct sale of general government debt to the Central Bank (or Central Bank lending to the general government) is prohibited (as it is for the countries that belong to the Euro area), the monetisation of the government tax cut could be accomplished by the general government financing the tax through the sale of interest-bearing debt to the domestic private sector or overseas, with the Central Bank purchasing that same amount of interest-bearing debt in the secondary markets. If a $1,000 cheque does not do an adequate job of boosting demand, the number of zeros on the cheque can be increased until spending picks up as required.

6. Conclusion

Preventing or combating deflation poses some unique difficulties for the monetary authorities - difficulties that are not present in preventing or combating inflation. Nevertheless, deflation can always be prevented and, if it has taken hold, can always be overcome by co-ordinated actions of the monetary and fiscal authorities.

Monetary policy alone cannot always prevent or cure deflation, if we restrict ourselves to conventional monetary policy, that is, reductions in the risk-free short nominal interest rate or a devaluation of the nominal exchange rate. Monetary policy alone is *likely* to prevent or cure deflation if the monetary authority is willing and able to monetise (if necessary without limit) the outstanding stock of public debt (short, long, nominal or index-linked), and/or perform open market purchases of a wide range of foreign and private domestic securities. If the monetary authorities are willing and able to contemplate an even more unconventional monetary instrument - the payment of negative nominal interest rates on base money through the imposition of a carry tax on currency - the zero lower bound on nominal interest rates disappears as a constraint on monetary policy.

To say that deflation can be prevented or cured using conventional monetary and fiscal policy is not to say that all economic problems faced by the most prominent current example of a deflation-afflicted economy - Japan - can be solved using conventional monetary and fiscal policy. The Japanese banking sector is paralysed by a massive overhang of bad debt. Other financial intermediaries, especially insurance companies, are suffering the cumulative impact on their balance sheets of the most spectacular asset boom and collapse in modern history – the stock market and real estate boom of the 1980s and its unravelling since 1989 (see Figure 1).

Cleaning up the balance sheet of the Japanese banking sector, reducing the size of the banking sector and recapitalising key viable non-bank intermediaries will be a painful and protracted process. In the non-financial economy it will manifest itself as increased redundancies, idle capacity, bankruptcies and business failures. It does not seem plausible, however, that this inevitably painful structural adjustment would be facilitated by persisting with the deflationary demand management policies of the last few years.

Deflation is problem that can be avoided. If it has taken hold, it is a problem that can be solved. A tax cut (or transfer payment) directly aimed at households and financed by increasing the stock of base money will surely boost aggregate demand. So will a base-money-financed increase in public spending.

Achieving a sustained reduction in inflation is likely to require tax increases or public spending cuts. It therefore tends to be politically unpopular. Anti-deflationary policies involve tax cuts, increased transfer payment or increased public spending. They will tend to be politically popular. It is therefore somewhat of a mystery why a policy programme that makes economic sense and should be politically popular does not get implemented. The clue to solution of this mystery probably lies in the fact that, with conventional monetary policy nearly exhausted, further effective anti-deflationary policy requires the co-operation of the central bank and the Ministry of Finance in the design and implementation of a co-ordinated monetary-fiscal stimulus.

Some of the central banks that acquired operational independence only recently have interpreted central bank independence to means the absence of co-operation, co-ordination and at times even communication with the fiscal authorities.

Mutual distrust between operationally independent monetary and fiscal authorities is probably the root cause of a persistent failure to address a deflation problem.

Milton Friedman argued that inflation (and by implication deflation) is always and everywhere a monetary phenomenon – and he was right.[45] Sargent and Wallace [1981] showed that, in the long-run, because of the government's intertemporal budget constraint which limits the government's capacity to borrow, money (and therefore inflation and deflation) is always and everywhere a fiscal phenomenon – and they too were right. Structuralists, and political economists inform us that excessive public sector deficits are the result of unresolved social and political conflict about the size and composition of state spending and about who should pay for it. They too may well be right. I would like to add to this sequence of truths the proposition that persistent unwanted deflation is always and everywhere evidence of unnecessary, avoidable macroeconomic mismanagement. Governments through the ages have demonstrated an uncanny ability to create inflation, often to undesirable and at times disastrous levels. It is hard to believe that the very simple analytics and attractive politics of making inflation have been forgotten in the new Millennium.

[45] It follows from the propositions I have so far stated that *inflation is always and everywhere a monetary phenomenon* in the sense that it is and can be produced only by a more rapid increase in the quantity of money than in output. However, the reason for the rapid increase in the quantity of money may be very different under different circumstances. It has sometimes reflected gold discoveries, sometimes changes in banking systems, sometimes the financing of private spending, sometimes—perhaps most of the time—the financing of governmental spending. (Friedman [1973])

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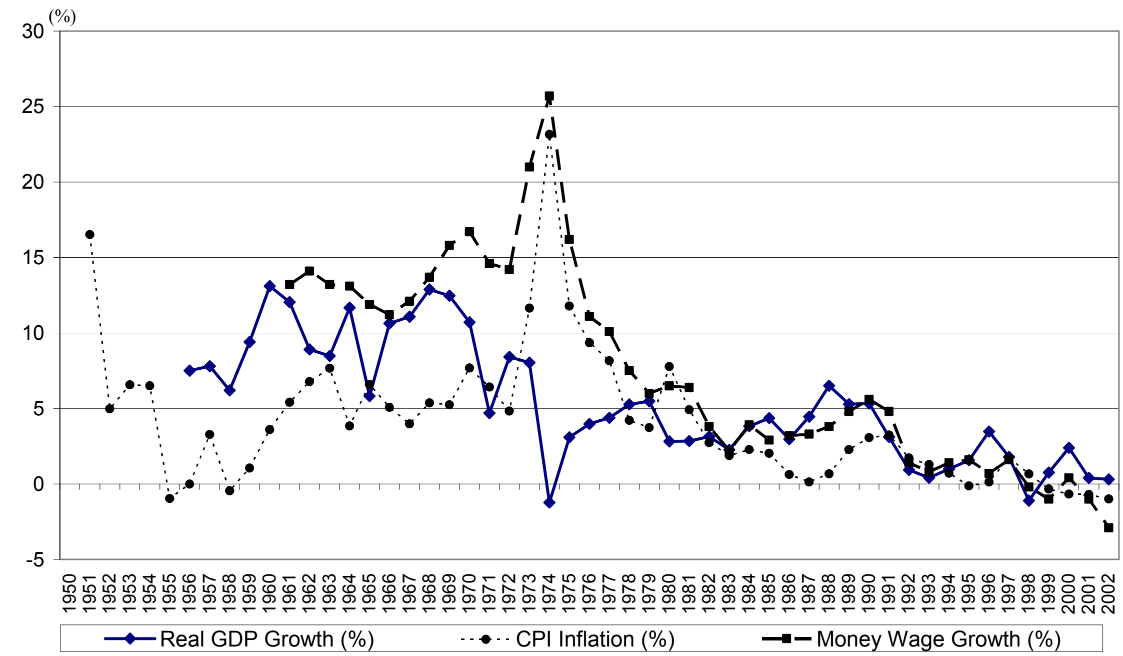
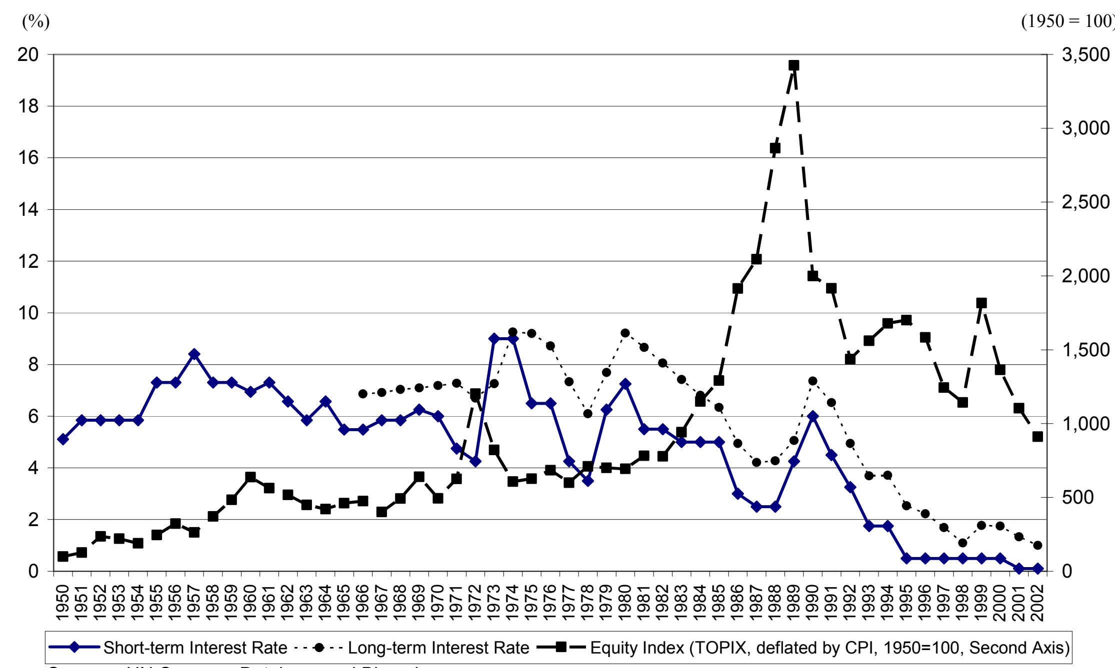
Figure 1

Japan



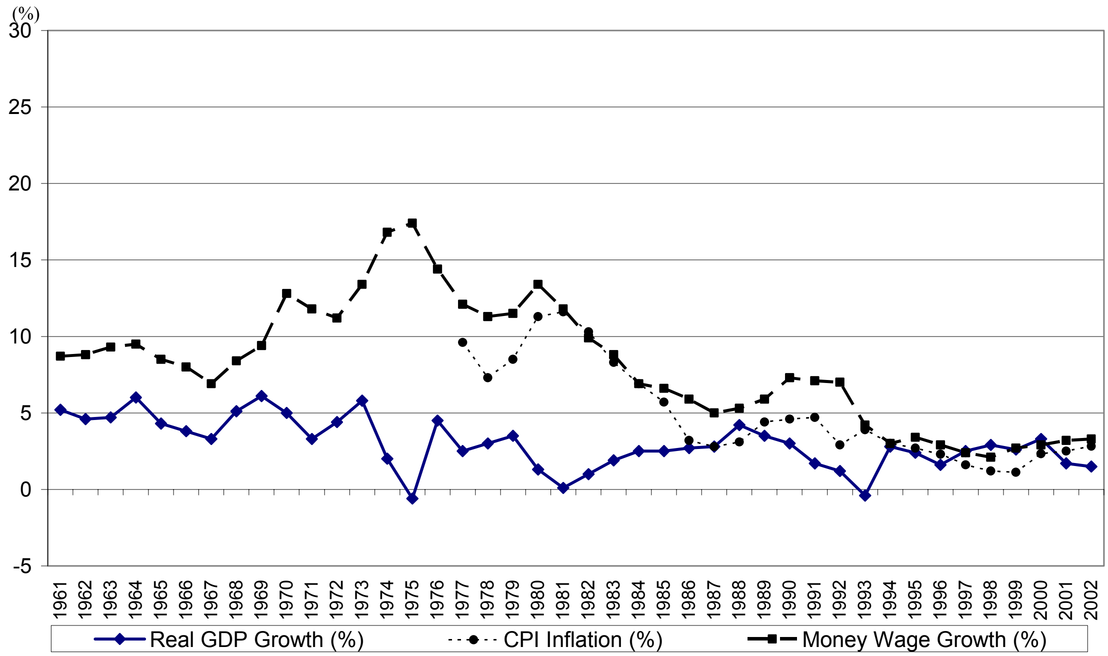
Sources: UN Common Database and European Commission.



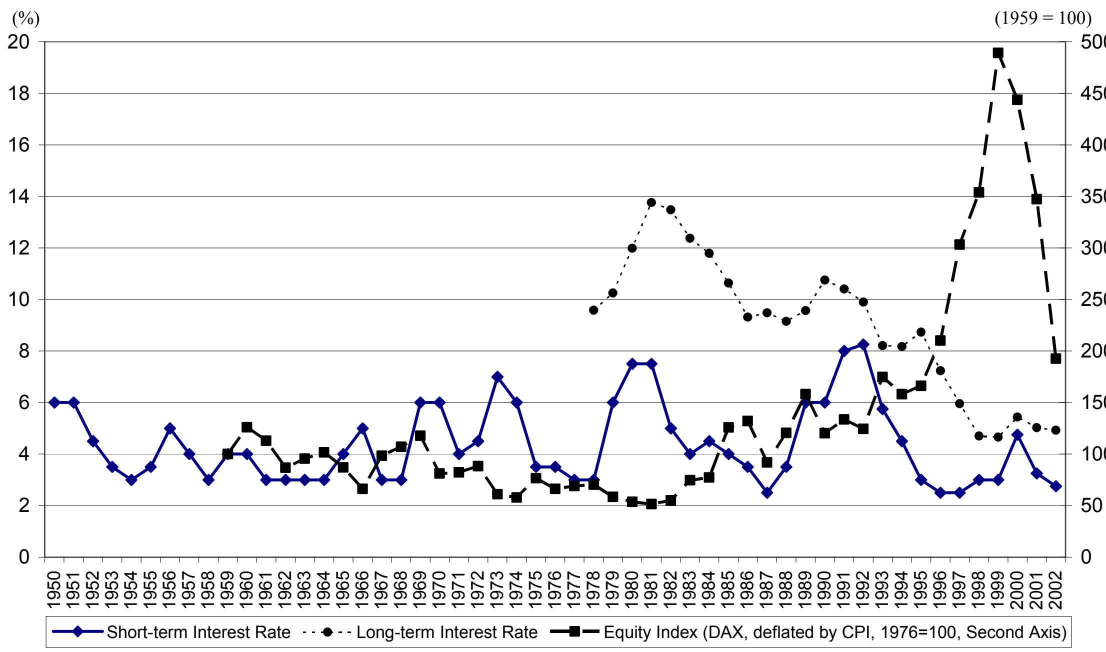
Sources: UN Common Database and Bloomberg.

Figure 2

European Union



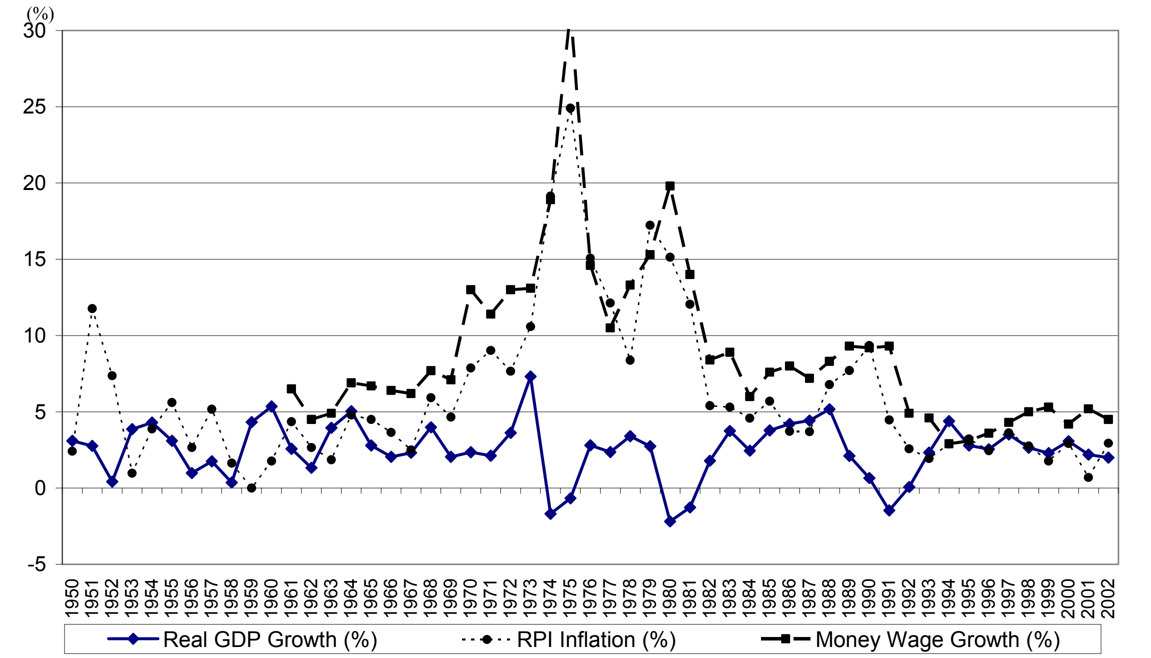
Sources: IMF and European Commission.



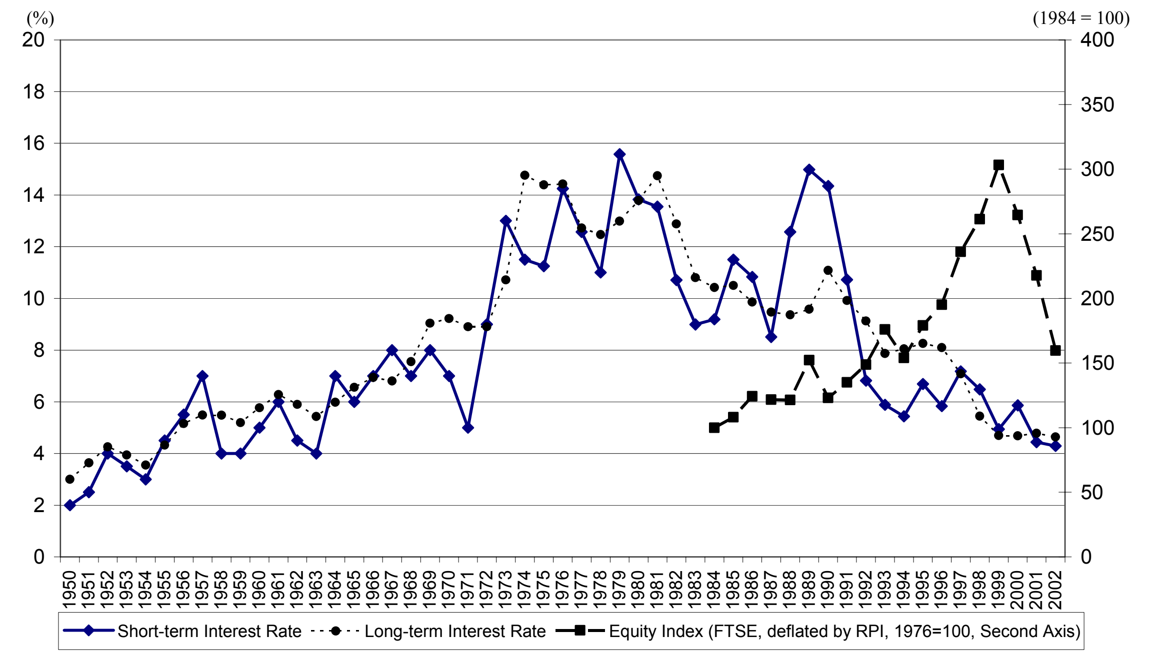
Sources: UN Common Database, Bundes Bank and Bloomberg.

Figure 3

UK



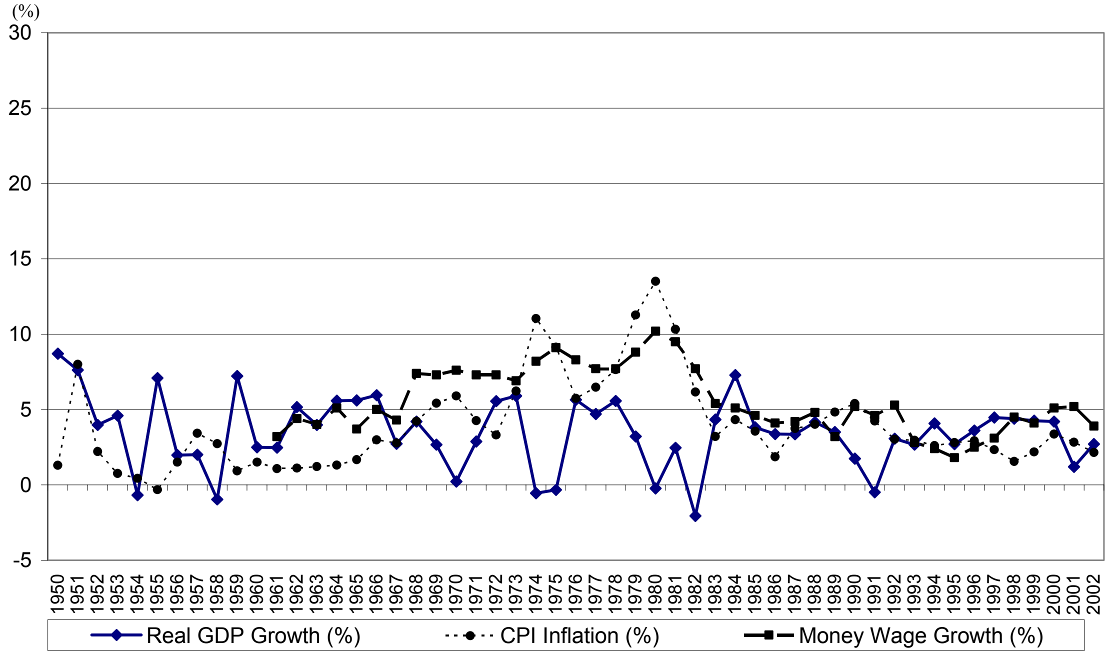
Sources: UN Common Database, Wolfbane Cybernetic and European Commission.



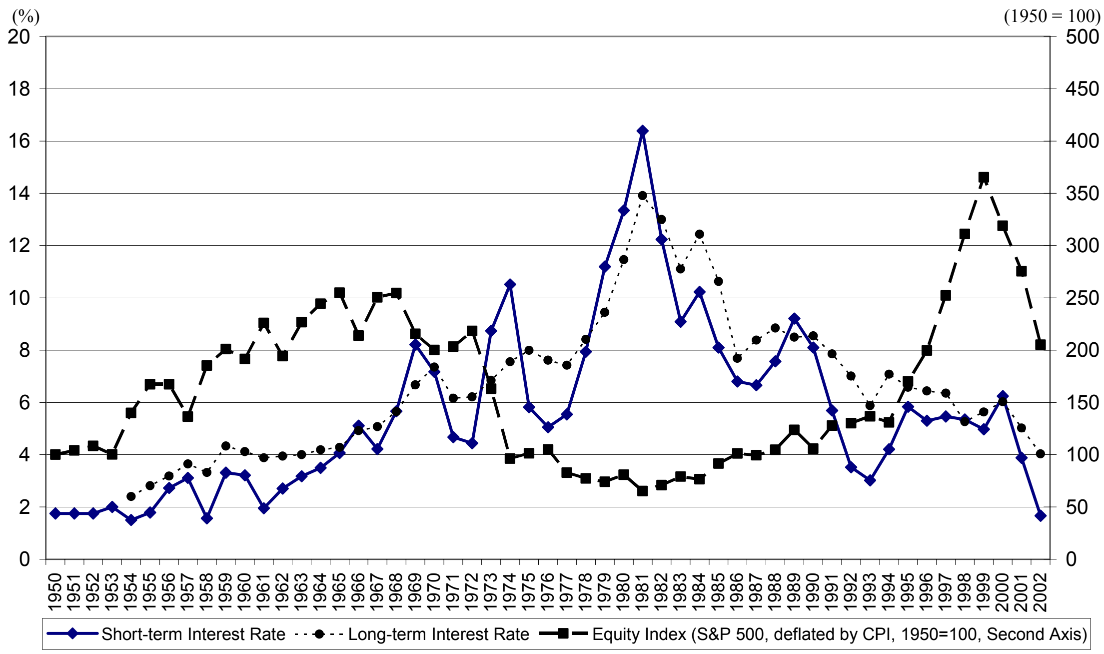
Sources: UN Common Database, Bank of England and Bloomberg.

Figure 4

USA



Sources: UN Common Database and European Commission.



Sources: UN Common Database, Federal Funds and Bloomberg.

Figure 5

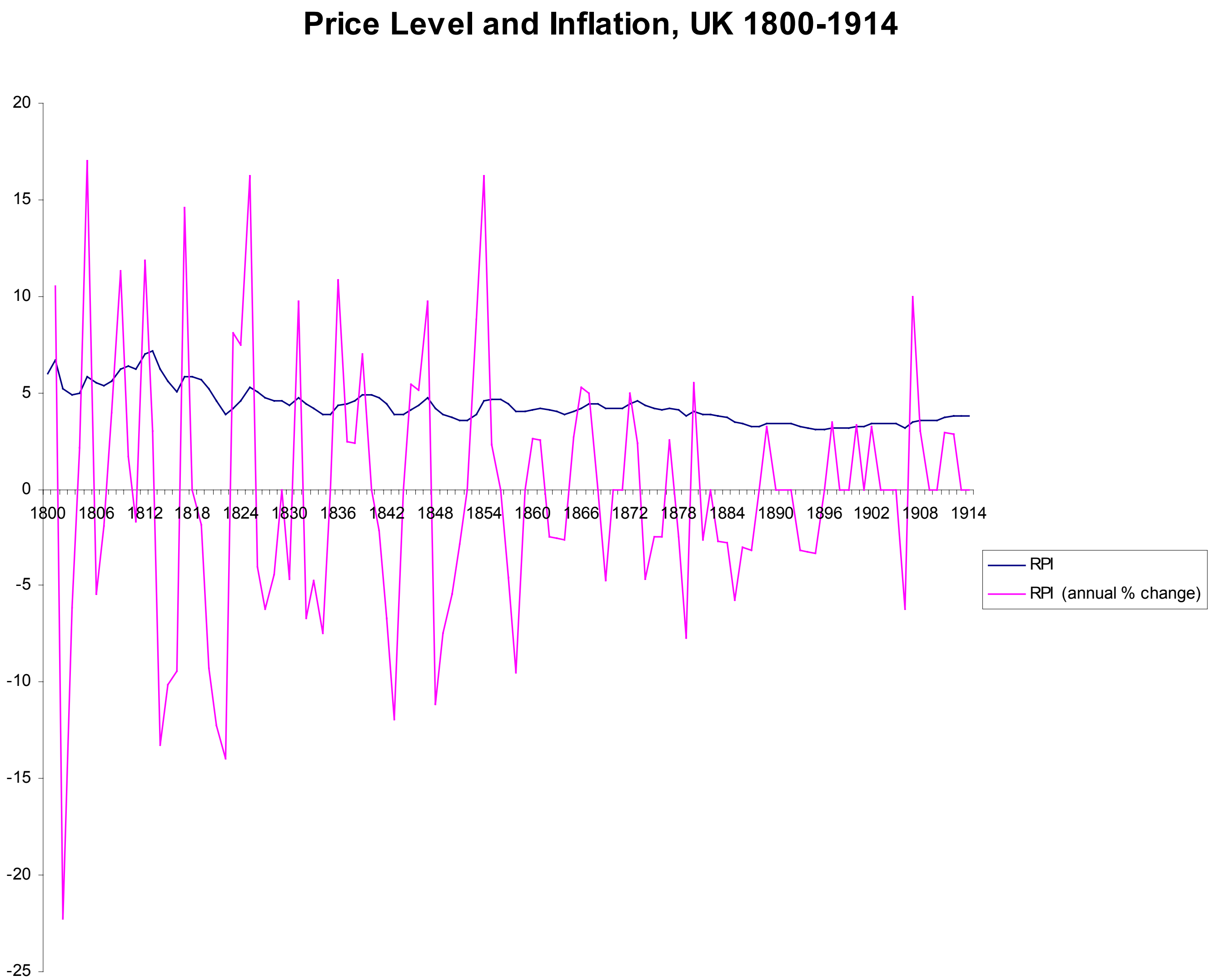

Price Level and Inflation, UK 1800-1914
20
15
10
5
0
-5
-10
-15
-20
-25
1800
1806
1812
1818
1824
1830
1836
1842
1848
1854
1860
1866
1872
1878
1884
1890
1896
1902
1908
1914
RPI
RPI (annual % change)

Figure 6

Bank rate, inflation and £/$ exchange rate, 1817-1914

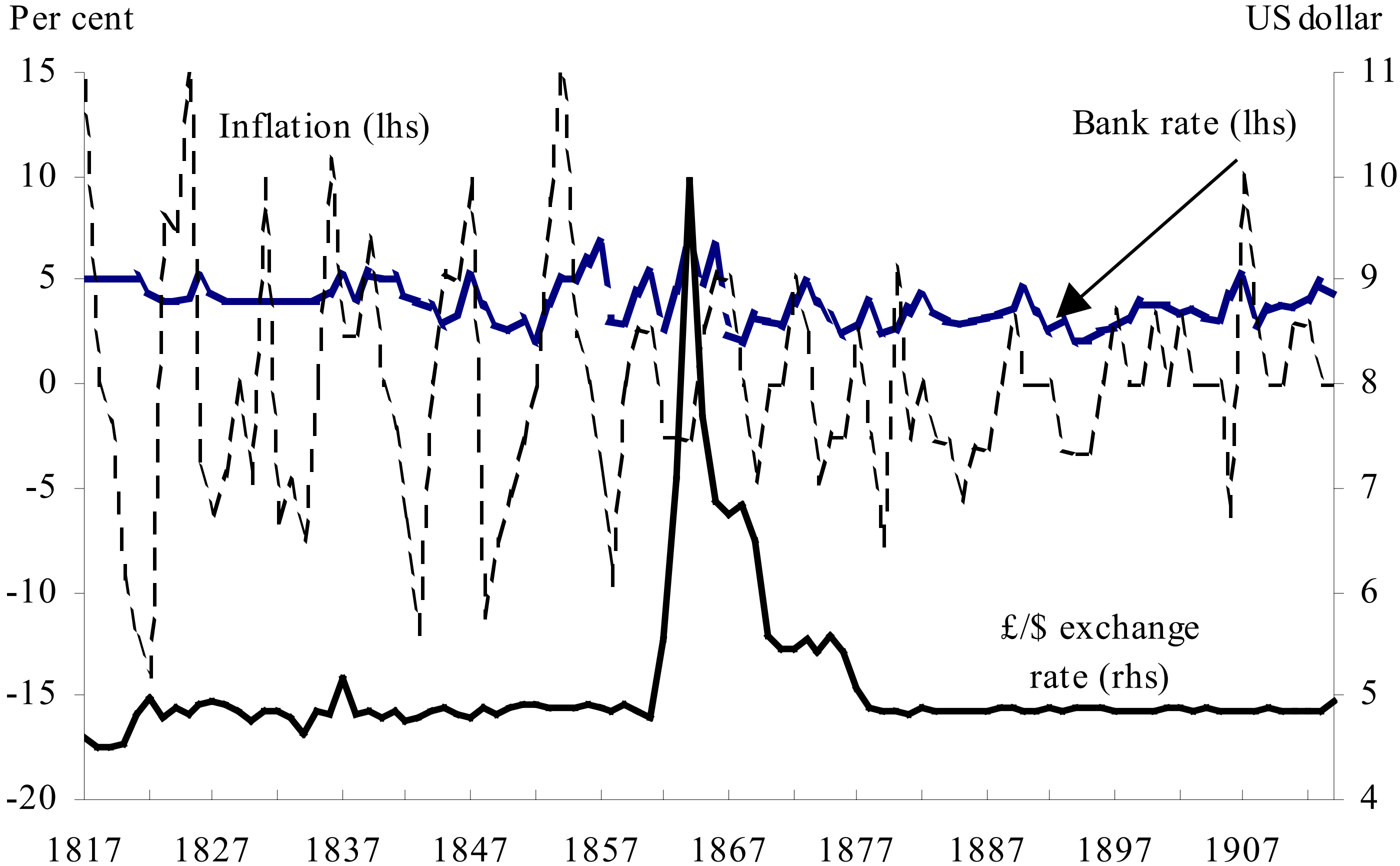


Table 1

Total, Goods and Services Inflation in the UK

	UK	US	Euro area	Japan
CPI inflation*	**1.9**	**1.7**	**2.2**	**-0.9**
CPI goods*	**-1.1**	**-0.1**	**1.4**	**-1.6**
CPI services*	**4.6**	**3.1**	**3.3**	**0.0**
Services - goods inflation, 1990-97	**1.6**	**1.6**	**1.6**	**1.3**
Services - goods inflation, 1990-2002	**2.3**	**1.8**	**1.3**	**1.3**

* year to August 2002.
Inflation rates are calculated as the total increase in the price index over the indicated period, based on monthly data , expressed as a twelve month growth rate.
Sources: Table taken from King [2002]; ultimate source: ONS (for UK) and Thomson Financial Datastream for data on US, Euro Area and Japan.