



ARTICLES

PRICE STABILITY AND GROWTH

The notion that inflation harms macroeconomic performance, and that preserving price stability is the best contribution monetary policy can make to sustainable economic growth, job creation, prosperity and social cohesion, is part of the contemporary consensus on monetary policy. Inflation has a negative impact on economic growth via several channels. In particular, within an inflationary environment it becomes comparatively more difficult to disentangle changes in relative prices (which would bring about a change in the allocation of resources) from changes in the general price level (which would not trigger such a change), with the result that resources are misallocated, the productivity of factors of production is degraded, and overall macroeconomic performance worsens. Inflation also has a negative impact on capital accumulation, and therefore on the long-term productive potential of the economy, because of the non-indexation of the tax system. The fact that depreciation allowances are not indexed causes a systematic distortion of business investment decisions, with higher inflation artificially increasing, ceteris paribus, investment in short-lived capital equipment and inventories, to the detriment of long-lived capital goods. This effect is compounded by the fact that, first, higher inflation has historically been associated with higher inflation variability, which discourages capital accumulation by increasing macroeconomic uncertainty across the board; and second, by adding an inflation risk premium to risk-free nominal interest rates, inflation uncertainty causes real rates to be higher than they would be otherwise, thus further discouraging capital accumulation. Empirical evidence confirms the existence of a negative relationship between inflation and output growth, with a 100 basis point permanent increase in inflation being associated with a 10 to 30 basis point decrease in trend output growth.

This article discusses the reasons why inflation should be expected to have a systematically detrimental effect on real economic activity, and reviews some of the empirical evidence on the relationship between inflation and output growth. The contemporary consensus on the detrimental impact of inflation on real economic activity makes a compelling case for assigning central banks an explicit mandate to maintain price stability, over and above the justification provided by the traditional argument of monetary neutrality. In this way, monetary policy not only minimises the costs associated with inflation, but also helps to maximise the long-run productive potential of the economy.

I INTRODUCTION

The contemporary consensus on monetary policy stresses the notion that inflation harms macroeconomic performance, and that, by preserving price stability, monetary policy can make its best contribution to sustainable economic growth, job creation, prosperity and social cohesion. Such a consensus developed in the wake of the major economic disruptions which followed the so-called Great Inflation of the 1970s. With high inflation being systematically associated with sub-par macroeconomic performance in terms of both output growth and unemployment rates within a large cross-section of countries, the Great Inflation acted, in a fundamental sense, as a large-scale experiment which

helped to better understand the nature of some underlying structural economic relationships. By illustrating the corrosive effects of inflation on macroeconomic performance, that episode cemented the contemporary agreement, among both policy-makers and academics, that pursuing price stability ought to be the fundamental goal of monetary policy.

EVOLVING CONSENSUS ON THE TRADE-OFF BETWEEN INFLATION AND ECONOMIC ACTIVITY

From a long-term perspective, it is worth noting that the consensus has returned to where it was fifty years ago, around the time of the enunciation of the so-called Phillips curve. Before the publication of A. W. Phillips' analysis of the relationship

between unemployment and inflation in the United Kingdom,¹ it had always been a widely-shared conviction, among economists and policy-makers alike, that inflation would be detrimental to macroeconomic performance.² Phillips' discovery, on the basis of almost a century of UK data, of a negative correlation between inflation and the unemployment rate was interpreted by many as offering policy-makers various combinations of inflation and unemployment from among which they could choose. In particular, it was thought that society could opt to trade off a permanently higher inflation rate against a permanently more dynamic macroeconomic performance.

Research published around the mid-1960s³ and largely inspired by the Phillips curve paradigm suggested another potential benefit of higher inflation: by increasing the cost of holding money balances, a higher rate of inflation might induce agents to switch part of their wealth from "unproductive" money to physical capital, thus stimulating capital accumulation and leading, in equilibrium, to a higher endowment of capital per worker, and thus higher output.

These positions did not go unchallenged. The notion of a permanent trade-off between inflation on the one hand and unemployment and growth on the other, from which society could choose at will, was criticised on the basis of the impact that sustained inflation would ultimately exert on the state of agents' expectations and, through that channel, on the stability of the Phillips curve. Three prominent advocates of such a channel, E. Phelps, M. Friedman and R. Lucas,⁴ pointed out how permanently higher inflation would automatically become embedded in agents' expectations, thus leading to higher wages, higher costs of production, reduced employment and therefore to the ultimate disappearance of any positive association between inflation and economic growth.

The reaffirmation of the classical principle of monetary neutrality – which states that monetary policy can only affect nominal variables, leaving the determination of real variables to real factors

outside the control of central banks – implied that the only effect of a monetary policy aimed at systematically stimulating macroeconomic performance beyond an economy's equilibrium level of production would be a permanently higher inflation rate, with no lasting gain in terms of real economic activity.

The Great Inflation provided decisive support for the notion that the inflation-growth relationship was not positive and could not be counted on for the type of policy experiments that had been suggested in the previous decade. But the implications of the dismal macroeconomic performance of the 1970s were even starker than would have been implied by the notion that inflation was neutral vis-à-vis growth. By clearly showing higher inflation to be associated with a systematically worse macroeconomic performance, the experience of the 1970s suggested that the long-run relationship between inflation and growth could in fact be negative, with a permanent increase in inflation associated with a permanent loss of output, real income and, ultimately, economic welfare.⁵

Since the 1970s, a vast body of research has explored the mechanisms through which higher inflation has a systematically detrimental impact on overall macroeconomic performance, and has

1 See Phillips, A. W. (1958), "The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957", *Economica*, 25(November), 283-299.

2 In August 1958, for example, Federal Reserve Chairman William McChesney Martin, Jr. stated that "[...] if inflation should begin to develop again, it might be that the number of unemployed would be temporarily reduced [...] but there would be a larger amount of unemployment for a long time to come. If inflation should really get a head of steam up, unemployment might rise to ten million or fifteen million" (as quoted in Romer, D., and Romer, C. (2002a), "A Rehabilitation of Monetary Policy in the 1950s", *American Economic Review*, 97(2), on p. 123). At the time of Martin speaking, unemployment stood at five million.

3 See Tobin, J. (1965), "Money and Economic Growth", *Econometrica*, 32, 671-684.

4 See Phelps, E. (1967), "Phillips Curves, Expectations of Inflation, and Optimal Unemployment Over Time", *Economica*, 34, 254-281; Friedman, M. (1968), "The Role of Monetary Policy", *American Economic Review*, 58, 1-17; and Lucas, R. E., Jr. (1972), "Expectations and the Neutrality of Money", *Journal of Economic Theory*, 4 (April), 103-124.

5 The shift in the intellectual climate was exemplified by Milton Friedman's 1977 Nobel Lecture.

documented and quantified such an impact within both a cross-section of countries and a time-series context. The next section discusses in detail these mechanisms, while Section 3 reviews the empirical evidence in support of the wide consensus that price stability is the best contribution monetary policy can make to economic growth. Section 4 discusses several implications for the design of monetary institutions.

2 THE COSTS OF INFLATION FOR ECONOMIC ACTIVITY

Economists have identified several reasons why inflation has a negative impact on real economic activity, which will now be discussed in turn.

First, a well-functioning market economy crucially depends on the ability of the price system – its fundamental conveyor of information – to bring about an efficient allocation of resources. In this respect, the key damage inflicted by inflation has to do with the fact that within an inflationary environment it becomes comparatively more difficult to disentangle changes in relative prices (which would bring about a change in the allocation of resources) from changes in the general price level (which would not trigger such a change). If the variability of relative prices were unrelated to the average inflation level, it would not be more difficult to interpret a change in prices in a high-inflation regime. The signal extraction problem mentioned above would be equivalent in both a high-inflation and low-inflation environment. Historically, however, the variance of relative prices has exhibited a strong positive correlation with average inflation, thus implying that, in practice, high inflation is associated with more variability in relative prices. Given that an increase in such variability automatically makes it more difficult for economic agents to extract the signal (i.e. the changes in the relative price levels) from the noise (i.e. the changes in the overall price level),⁶ an increase in inflation can safely be expected to be conducive to a misallocation of resources, thus ultimately leading to a degrading of overall macroeconomic performance. The highly volatile inflation rates of the 1970s most

likely played, through this channel, a fundamental role in generating the mediocre macroeconomic performance of that decade. This volatility most likely created fundamental difficulties for businesses in interpreting any observed price change – whether due to a shift in the relative demand for that particular good or in its relative scarcity, or whether it might merely reflect an equi-proportional drift in all prices – and in appropriately reacting to such a change.

A second channel through which inflation has an impact on real economic activity is capital accumulation. A key characteristic of a significant proportion of investment projects is their essentially irreversible nature.⁷ To put it differently, if market conditions did turn out, *ex post*, to be worse than expected, a large part of the initial investment costs could not be recovered. It has been shown that, under these circumstances, investment decisions tend to be very sensitive to the perceived riskiness of the investment, so that even a moderate increase in risk – whatever its specific origin, macroeconomic or otherwise – can exert a large negative impact on investment spending. Historically, the variance of inflation has exhibited a strong positive correlation with its average level,⁸ thus implying that, in practice, high inflation is associated with more variable – and therefore more uncertain – inflation, which has a negative impact on investment.⁹

Table 1 provides simple evidence of this. It shows, for the euro area, the United States,

6 This was the key theme of Robert E. Lucas, Jr.'s classic 1972 paper, "Expectations and the Neutrality of Money", *Journal of Economic Theory*, 4(April), pp. 103-124.

7 There is a large academic literature on this. A good reference is Pindyck, R. and Solimano, A. (1993), "Economic Instability and Aggregate Investment", in Blanchard, O. J. and Fischer, S., eds., *NBER Macroeconomics Annuals 1993*, Cambridge, The MIT Press.

8 See, for example, Kiley, M. (2007), "Is Moderate-To-High Inflation Inherently Unstable?", *International Journal of Central Banking*, 3(2), 173-201.

9 The recent work of Ascari and Ropele shows that, within standard New Keynesian models, an increase in trend inflation is systematically associated with an increase in overall macroeconomic volatility, and so also in the variance of inflation. See, in particular, Ascari, G. and Ropele, T. (2007), "Trend inflation, Taylor principle and indeterminacy", presented at the conference "Defining price stability: Theoretical options and practical experience", Frankfurt Am Main, 26-27 November 2007. The paper is available at: <http://www.ecb.europa.eu/events/conferences/html/dps.en.html>.

Table I Means and standard deviations of inflation by decades

	Euro area ¹		United States		Japan		United Kingdom	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
1950s	N.A.	N.A.	2.1	2.4	3.2	6.9	1.8	1.6
1960s	3.3	1.0	2.4	1.5	5.4	1.7	3.5	1.5
1970s	8.8	2.0	7.1	2.8	9.1	6.0	12.6	5.7
1980s	5.9	3.2	5.5	3.5	2.4	2.4	7.5	4.5
1990s	2.6	1.1	3.0	1.1	1.2	1.3	3.7	2.4
2000s ²	2.2	0.3	2.8	0.9	-0.4	0.4	2.8	0.9
	Canada		Australia		Sweden		Switzerland	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
1950s	1.8	1.0	1.6	0.4	N.A.	N.A.	N.A.	N.A.
1960s	2.5	1.3	2.5	1.5	3.9	1.6	2.9	0.9
1970s	7.4	2.9	9.8	4.1	8.6	2.2	5.0	3.2
1980s	6.5	3.2	8.4	2.2	7.9	3.1	3.3	1.8
1990s	2.2	1.7	2.5	2.1	3.3	3.7	2.3	2.1
2000s ²	2.3	0.8	3.3	1.2	1.4	0.9	1.0	0.5

1) For the 1960s, based on the simple average of the inflation rates in Germany, France and Italy.

2) For the 2000s, data refer to the period 2000-07.

Japan, the United Kingdom, Canada, Australia, Sweden and Switzerland, both the mean and the standard deviation of consumer price inflation by decade. The correlation between the level of inflation and inflation volatility is very high, and especially apparent for the United States, the United Kingdom, Canada and Switzerland. This implies that, by increasing macroeconomic uncertainty, higher inflation can be expected to discourage, *ceteris paribus*, investment decisions, thus ultimately causing the economy to end up, *ex post*, with a lower capital stock than it would otherwise.

The negative impact of inflation on capital accumulation is reinforced by a third, conceptually related mechanism. As a very general rule, for an economic agent to commit resources to a specific investment project under conditions of uncertainty, he or she will demand compensation for the risk such uncertainty entails, over and above the rate of return the agent would demand under conditions of certainty. Under plausible assumptions, such additional compensation – known as the risk premium – is higher the higher the extent of uncertainty. By adding an inflation risk premium to risk-free nominal interest rates, inflation uncertainty therefore causes real rates to be higher than they would be otherwise, further discouraging capital accumulation beyond the effect mentioned in the previous paragraph.

A fourth negative impact of inflation on economic activity has to do with the fact that, within an inflationary environment, both individuals and businesses tend to spend a significant proportion of their time and resources trying to protect their wealth from inflation, rather than carrying out their more productive activities. This has to do with the fact that inflation acts as a tax on money holdings, with the tax rate equal to the rate of inflation, and the tax base equal to the amount of money holdings. As a result of this distortion in individuals' and businesses' optimal allocation of their time and resources, overall macroeconomic performance is inevitably degraded.

A fifth set of negative effects has to do with the interaction between inflation and the tax system.¹⁰ This perverse interaction between inflation and the tax system has several facets. For example, the fact that depreciation allowances are not indexed causes a systematic distortion of business investment decisions, with

¹⁰ This has been extensively discussed by Martin Feldstein in a series of studies. See, in particular, Feldstein, M. (1997), "The Costs and Benefits of Going from Low Inflation to Price Stability", in Romer, D. and Romer, C., eds., *Reducing Inflation: Motivation and Strategy*, the University of Chicago Press; and Feldstein, M. (1999), "Capital Income Taxes and the Benefits of Price Stability", in Feldstein, M., ed., *The Costs and Benefits of Price Stability*, The University of Chicago Press.

higher inflation artificially increasing, *ceteris paribus*, investment in short-lived capital equipment and inventories, to the detriment of long-lived capital goods. This effect compounds the previously discussed negative impact of inflation uncertainty on long-term investment, and causes the economy to equip itself, in the long run, with a lower capital stock than it would otherwise, thus reducing its long-term productive potential. By the same token, the fact that progressive tax brackets on personal incomes might not be entirely indexed to the drift in the price level induced by inflation causes the inflation rate to determine over time an increase in the real incidence of taxes. In the medium term, inflation-induced decreases in the real after-tax salary and in the real after-tax return on savings can lead to a diminished incentive to supply labour and capital, respectively, which in turn curtails the economy's long-run growth perspectives.

A final and sixth mechanism through which inflation instability has a negative impact on macroeconomic performance has to do with its influence on the anchoring of inflation expectations. Recent research¹¹ has shown that, under monetary regimes that are founded on price stability, inflation expectations tend to be well-anchored, and quite insensitive to macroeconomic news. By contrast, under monetary regimes that lack a clear definition of price stability, inflation expectations tend to be revised with new releases of macroeconomic data. The explanation for this finding is that under the former regimes, when trying to forecast the implications of any new economic data releases for future inflation, agents tend to discount a stabilising response on the side of the central bank, and expect that this response will largely offset any adverse influence of the shock on observed inflation at medium-term horizons. This prediction helps to insulate current inflation expectations from potentially unsettling news. In turn, this mechanism has two important implications. First, as price-setting behaviours are partly dependent on agents' anticipations of future inflation, such anchoring of inflation expectations moderates the impact of the

macroeconomic shocks on observed inflation. Second, such relative unresponsiveness of inflation to macroeconomic shocks allows the central bank to adopt a less aggressive stance in the face of any given sequence of adverse innovations. In a sense, owing to a virtuous self-equilibrating response of inflation expectations and inflation outcomes, the central bank can afford a more moderate and steady course of policy than would be possible if inflation expectations were less firmly anchored. This clearly illustrates the benefits of having achieved a high degree of credibility: precisely because the central bank is regarded by the private sector as credible at stabilising inflation, its job is easier than it would have been had its credibility been lower. The final result is therefore not only stable inflation, but also a lower variability of interest rates than would have otherwise been the case, thus benefiting consumption and investment decisions and creating a more predictable environment which is conducive to economic growth.

In this respect, a comparison between the current situation and the 1970s is instructive. In both episodes, commodity prices have undergone a marked and sustained increase, which – by weighing on the cost structure of businesses – has created pressures on output prices. Despite these similarities, however, the macroeconomic outcomes in the two respective episodes are quite different. Both inflation expectations and actual inflation surged in the 1970s in a large part of Europe, while business profitability and employment suffered markedly. In a monetary environment which lacked the firm anchor that had been previously secured by the Bretton Woods regime, inflation expectations in many countries became unanchored and started to incorporate the repeated oil price shocks. In such an environment, central banks – in an

11 See, in particular, Ehrmann, M., Fratzscher, M., Gürkaynak, R. S. and Swanson, E. (2007), "Convergence and anchoring of yield curves in the euro area", ECB Working Paper no 817, October 2007, and Beechey, M. J., Johannsen, B. K. and Levin, A. T. (2007), "Are Long-Run Inflation Expectations Anchored More Firmly in the Euro Area than in the United States?", CEPR Working Paper 6536, October 2007.

attempt to reign in inflation spirals – were often forced to engineer sudden and severe anti-inflationary strikes, which contributed to, rather than contained, macroeconomic volatility. By contrast, the increases in the price of oil observed in recent years did not produce a major dislocation of inflation expectations, with the result that central banks' reactions could be comparatively more measured.

Having discussed conceptual reasons why high and volatile inflation should, in general, be expected to have a negative impact on macroeconomic performance, the next section surveys the available empirical evidence.

3 EMPIRICAL EVIDENCE

This section reviews the empirical evidence in favour of the contemporary consensus. The key message emerging from this section is that both cross-country and time-series studies clearly point towards a detrimental impact of inflation on economic activity.

CROSS-COUNTRY STUDIES

The negative association between inflation and economic performance, which is so apparent in the 1970s data, is not confined to that episode. Several authors¹² have documented a negative relationship between inflation and output growth – once controlling for other macroeconomic variables – within large groups of countries over the post-Second World War period. Based on a sample of 100 countries over the period from 1960 to 1990, for example, it was found that an increase in trend inflation by ten percentage points had been associated with a decrease in output growth by 0.2-0.3 percentage point per year.¹³

¹² See, in particular, Fischer (1993), cit.; De Gregorio, J. (1993), "Inflation, Taxation, and Long-Run Growth", *Journal of Monetary Economics*, 31, 271-298; Barro, R. J. (1996), "Inflation and Growth", *Federal Reserve Bank of St. Louis Economic Review*, May/June 1996; and Andres, J. and Hernando, I. (1999), "Does Inflation Harm Economic Growth? Evidence from the OECD", in Feldstein, M., ed., *The Costs and Benefits of Price Stability*, The University of Chicago Press.

¹³ See Barro, R. J. (1996, cit.).

Box I

DECOMPOSING AND QUANTIFYING THE IMPACT OF INFLATION ON OUTPUT GROWTH

There are strong conceptual reasons to believe that inflation has an impact on output growth by negatively affecting both capital accumulation and the productivity of the factors of production. Research has not only confirmed these insights, but has also allowed the relative importance of the two channels to be quantified.

Working within the same cross-country framework of Barro, Fischer (1993, cit.) estimated that an increase in inflation by ten percentage points is associated with a decrease in the rate of growth of the capital stock by 0.4 percentage point, a comparatively large effect. This amount – which is already significant in itself – becomes even more impressive once it is considered that it refers to a rate of growth, so that its effects tend to compound over time. Similar results have been obtained by De Gregorio (1993) based on a sample of 12 Latin American countries.

As for the impact of inflation on productivity growth, Fischer (1993) estimated an increase of inflation by ten percentage points to lead to a decrease in the rate of growth of productivity by 0.2 percentage point per year. Although, at first sight, the effect may appear small, it is important to consider, once again, that since it pertains to a rate of growth it tends to compound over time, thus leading to significant shortfalls in the level of real output after several years.

One possibility is that the impact of inflation upon growth exhibits non-linearities: for example, it might be strong for comparatively high rates of inflation, and much weaker, to the point of being hard to detect, at lower inflation rates. In order to control for this possibility, Fischer (1993, cit.) re-estimated the basic regressions by splitting the overall dataset into three subsets, corresponding to countries with inflation rates of 15% or less, between 15% and 40%, and above 40%. Evidence suggests that the impact of inflation on growth is indeed non-linear, but that, contrary to what might be expected, the effect weakens as the level of inflation rises. In particular, the impact on output growth of a percentage point increase in inflation in the low-inflation group, at -0.13 percentage point, is 60% greater than in the middle group, and is almost seven times greater than in the high-inflation group.

Such a negative association continues to hold if inflation is replaced with other macroeconomic variables which proxy for it, in order to take into account the joint determination of inflation and output within a macroeconomic context. One of these variables is past inflation. As has been extensively documented, over a large part of the post-Second World War era inflation rates in many countries exhibited, in general, a remarkable persistence, in the sense that the deviation of inflation from its average in one period was a good indicator of deviations in subsequent periods. Such characteristics of post-Second World War inflation are largely due to the significant inflation fluctuations associated with the Great Inflation of the 1970s in many countries and the subsequent gradual stabilisation. However, these characteristics have disappeared in recent years in countries and economic areas characterised – like the euro area – by monetary regimes clearly oriented towards price stability.¹⁴

This means that, over the entire post-Second World War period, past inflation represents a good proxy – technically, a so-called instrument – for current inflation. As many studies have shown, substituting past inflation for current inflation produces qualitatively the same results, with inflation and growth being, again, significantly negatively correlated. In the spirit of the quantity theory of money, replacing inflation with the rate of growth of monetary aggregates produces, once again, the same results qualitatively,¹⁵ with a ten percentage point increase in the rate of money growth associated with a decrease in output growth by 0.2 percentage point.

To sum up, the cross-country literature on the relationship between inflation and output growth clearly suggests a negative impact of higher inflation on growth, with high-inflation countries exhibiting systematically lower growth.

TIME SERIES ANALYSES

While cross-country panels of data give an indication of how institutional differences across economies' monetary arrangements can have an impact on their relative growth performance, time series analyses are useful to gauge the extent to which growth and inflation co-move over time.

The most immediate approach to such an analysis is to compare shifts in the trend components of inflation and output growth.¹⁶ Chart 1 plots smoothed series of data on CPI inflation and real GDP growth for a number of economies over the post-Second World War period constructed in order to extract their low-frequency – i.e. very slowly-moving –

14 See Benati, L. (2008), "Investigating Inflation Persistence Across Monetary Regimes", *Quarterly Journal of Economics*, forthcoming, also available as ECB Working Paper no 851, January 2008.

15 See Barro (1996, cit.).

16 The analysis of Clark, P. K. (1982), "Inflation and the Productivity Decline", *American Economic Review*, 72(2), 149-154, provides an early example of this approach applied to productivity growth, as opposed to output growth. In particular, Clark suggested that the productivity slowdown of the 1970s had been due to the Great Inflation. A more recent analysis in the spirit of Clark can be found in Sbordone, A. and Kuttner, K. (1994), "Does Inflation Reduce Productivity?", *Federal Reserve Bank of Chicago Economic Perspectives*, November/December.

components.¹⁷ Such a low-frequency statistical component of the data considered is indicative of the trend underlying and driving the respective variable over sufficiently long periods of time. A remarkably strong negative correlation between the low-frequency components of the two series is clearly apparent, with fluctuations in trend inflation having been consistently associated with corresponding fluctuations in trend output growth in the opposite direction for all countries.

At first sight, a possible explanation for this evidence could invoke an accidental preponderance of supply shocks over the sample period. By causing both an increase in inflation and a decrease in output growth, a negative supply shock – such as an increase in the price of oil – would induce a negative correlation between the two variables at any frequency, and so also at the low frequency associated with fluctuations in the trend components. If this were the key explanation, one would also expect to detect a difference between the 1970s – a period undoubtedly dominated by two large negative oil shocks – and the previous and subsequent periods.¹⁸ However, the fact that such a correlation remained remarkably stable over the entire post-Second World War era – as is particularly apparent in the case of the euro area, Sweden and Switzerland after the mid-1980s, and the United States and Canada before and after the Great Inflation – suggests that this is most likely not the key explanation for the evidence reported in Chart 1. In contrast, the relationship identified in the chart most likely reflects deep structural features of the economy.

Indeed, a number of studies¹⁹ have further refined analyses along these lines by looking for evidence of the predictive power of one variable onto another. The intuition behind this approach is that a measure of such a predictive power

(or lack thereof) provides an indication of the likely direction of causality. Results from these analyses point, once again, towards an empirical validation of the principle that higher inflation exerts a detrimental effect on growth.

Another interesting approach is to focus on inflation crises, which can be defined as episodes in which inflation temporarily surges to levels in excess of a certain threshold, and then eases back to more normal levels.²⁰ Empirical evidence, which is discussed more extensively in Box 2, suggests such episodes to be characterised by a very consistent pattern, with the inflation crisis being accompanied by a systematic and statistically significant fall in output growth which is below average, while the end of the crisis is associated with an above-average growth upsurge.

17 Low-frequency components have been extracted via the statistical filter described in Christiano, L. J. and Fitzgerald, T. (2003), "The Band-Pass Filter", *International Economic Review*, 44(2), pp. 435-65. Following established conventions in business-cycle analysis, the low-frequency components of the two series have been defined as those associated with cycles with periods of longer than eight years (see, for example, Stock, J. and Watson, M. (1999), "Business Cycle Fluctuations in U.S. Macroeconomic Time Series", in Taylor, J. B. and Woodford, M., eds., *Handbook of Macroeconomics*, Amsterdam, North Holland).

18 This point was first made, within the context of multi-country panel studies, by Fischer, S. (1993), *cit.*

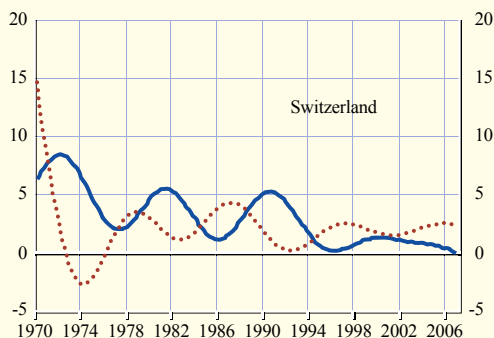
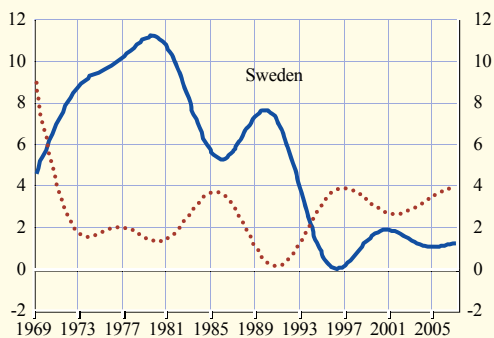
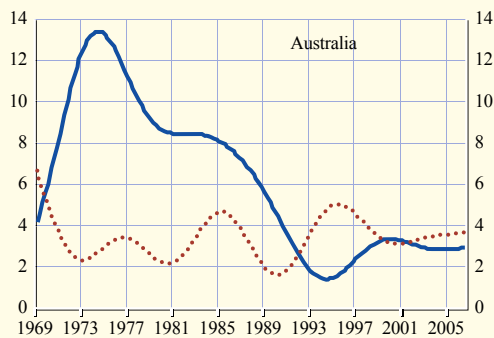
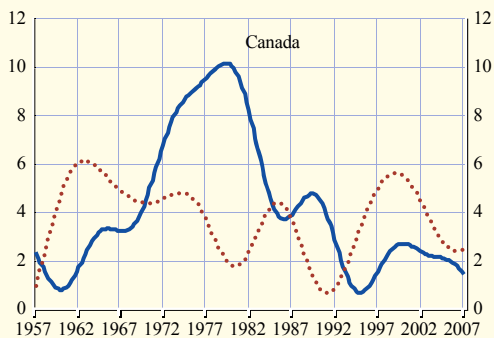
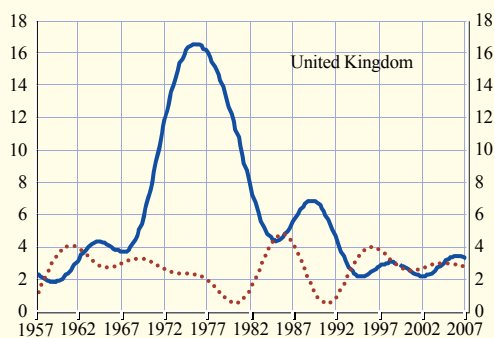
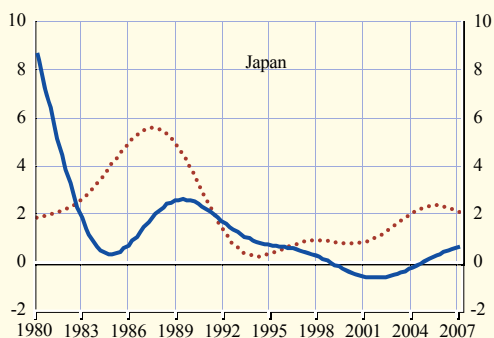
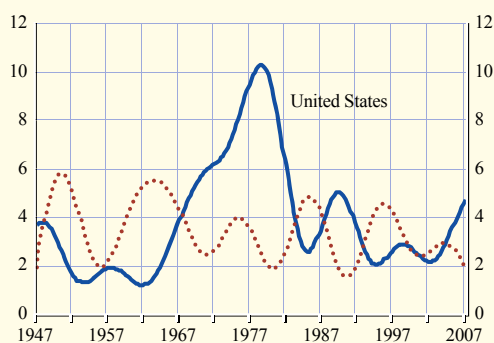
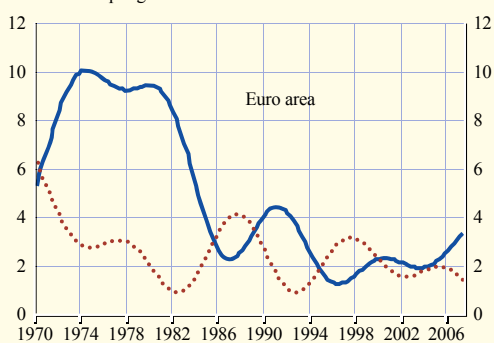
19 This is typically performed via so-called Granger-causality tests. See, for example, Sbordone, A. and Kuttner, K. (1994, *cit.*), and Andres, J. and Hernando, I. (1999), "Does Inflation Harm Economic Growth? Evidence from the OECD", in Feldstein, M., ed., *The Costs and Benefits of Price Stability*, The University of Chicago Press, 315-41. Sbordone and Kuttner (1994) find that, within a bivariate context, inflation has a marginal predictive power for productivity growth once controlling for past productivity growth, while the opposite is not true. Andres and Hernando (1999) find that inflation exhibits the same property towards income within a panel of OECD countries.

20 This approach was first proposed in Bruno, M. and Easterly, W. (1998), "Inflation Crises and Long-Run Growth", *Journal of Monetary Economics*, 41, 3-26.

Chart I Low-frequency components of inflation and output growth

(annual percentage changes)

— inflation
 output growth



Source: ECB calculations.

EVIDENCE FROM INFLATION CRISES

Bruno and Easterly (1998, cit.) defined as inflation crises episodes in which inflation increased temporarily beyond 40% per year for at least two years, and then fell back below such a threshold. The application of this criterion selected 41 inflation crises in 31 countries over the 1961-94 period. Based on either per capita growth or the deviation of per capita growth from the world average, the pattern identified was extremely strong, with an average fall in growth by 2.4 percentage points from the pre-crisis to the crisis period, and a subsequent increase in the post-crisis period by 3.3 percentage points, thus broadly compensating for the temporary output shortfall. These results provide clear evidence that an increase in inflation is associated with a fall in macroeconomic activity.

These results were robust to several changes in the basic specification. It could be reasonably argued, for example, that crises of different durations might be associated with different patterns of output growth shortfalls and recovery. In order to check for this, the overall dataset was split into two, separating countries with a duration of the inflation crisis below the group median (equal to six years) from countries with a duration above the median, with 18 and 23 crises in the two groups, respectively (six crises lasted exactly six years). The decrease in the deviation of the rate of growth of per capita output from the world average was equal to 1.9 and 2.6 percentage points in the two groups, respectively, although this difference was not statistically significant, thus pointing towards a clear robustness of the basic results.

A more sophisticated approach is based on vector autoregressions (VARs), which model the joint dynamics of time-dated macroeconomic indicators in terms of their past evolution. Since the beginning of the 1980s, VARs have become increasingly prominent within macroeconomic research as they allow, first, to effectively capture, in a parsimonious way, the dynamics of a set of macroeconomic variables; and, second, to identify the impact of structural shocks on the variables of interest, by imposing a limited number of assumptions suggested by economic theory.

Box 3 discusses the results of an analysis of the long-run impact of permanent inflation shocks on trend output growth in what would become the euro area, before the start of Economic and Monetary Union. Restricting the analysis to a pre-EMU period

reflects the empirical finding discussed in Box 3: since January 1999 euro area inflation – as should be expected under a monetary regime oriented towards price stability – has not exhibited permanent shifts, so that EMU data are not informative for the issue at hand.

Evidence suggests that a permanent increase in inflation by 1% causes a decrease in trend output growth of around 0.1% to 0.2%. In other words, these estimates imply that, were trend inflation to rise in the euro area by two percentage points, trend output growth would decrease by between 0.2 and 0.4 percentage point per annum, thus implying that, in ten years' time, the level of GDP would be between 2.0% and 4.1% lower than it would have been in the absence of such a shift.

Box 3

IDENTIFYING THE IMPACT OF PERMANENT INFLATION SHOCKS ON TREND OUTPUT GROWTH

A recent strand of literature has documented how post-Second World War inflation appears to contain a sizeable permanent component,¹ in the sense that, over this period, a non-negligible fraction of inflationary shocks did not ultimately dissipate, but rather remained in the system, thus having an impact on trend inflation. The euro area is a case in point. As shown by Benati (2008),² euro area inflation fluctuations were largely permanent before the start of EMU, in January 1999, whereas they have been almost entirely transitory since then (to put it differently, under EMU euro area inflation has exhibited a very strong mean reversion). Econometric estimates of the size of the permanent component of euro area HICP inflation,³ for example, suggest that before January 1999 permanent shocks (i.e. shocks having an impact on trend inflation) had accounted for 47.3% of the quarter-on-quarter variation in inflation. The corresponding figure for output growth – i.e. the fraction of shocks to growth which has an impact on its trend – is 9.1%. This is in line with anecdotal evidence: in the 1970s the simple means of HICP inflation and output growth had been equal to 8.8% and 3.6% respectively, while in the 1990s they had been equal to 2.5% and 2.1% respectively, thus clearly suggesting significant shifts in the trend components of the two series.

This suggests that, if inflation were to really negatively affect output growth, it should be possible to detect its effect by analysing the long-run impact on trend output growth of permanent inflation shocks in pre-EMU euro area data. Permanent inflation shocks are identified within a VAR framework via the assumption that they are the only shocks to affect trend inflation.⁴ The impact on trend output growth of a 100 basis point permanent inflation shock is estimated to be between -11 basis points (based on the HICP) and -19 basis points (based on the GDP deflator), in line with Barro's estimate for the low-inflation group of countries discussed in Box 1, equal to -13 basis points.

1 For the United States, for example, see Stock, J. and Watson, M. (2007), "Why Has U.S. Inflation Become Harder to Forecast?", *Journal of Money, Credit, and Banking*, 39(1), pp. 3-33.

2 See, for example, Benati, L. (2008, cit.).

3 Estimates are based on Cochrane's variance ratio estimator – see Cochrane, J. H. (1988), "How Big Is the Random Walk in GNP?", *Journal of Political Economy*, 96(5), 893-920.

4 This is the assumption used in Roberts, J. M. (1993), "The Sources of Business Cycles: A Monetarist Interpretation", *International Economic Review*, 34(4), 923-934, and in Bullard, J. and Keating, J. (1995), "The Long-Run Relationship Between Inflation and Output in Post-War Economies", *Journal of Monetary Economics*, 36, pp. 477-496.

4 IMPLICATIONS FOR THE DESIGN OF MONETARY INSTITUTIONS

If the position entertained by many scholars and analysts in the 1960s were true – that permanently higher inflation could effectively be traded off for permanently higher real economic activity – the implications for monetary policy would be simple. Society would, first, reliably identify the set of feasible combinations of inflation and real activity, and then select and implement the preferred one.

However, the implications of the position associated with pure monetary neutrality – i.e. a lack of a long-run trade-off between inflation and real activity – which emerged as the failures of the macroeconomic experiments of the 1960s and the 1970s became increasingly apparent, are radically different. And the contemporary consensus on the detrimental impact of inflation on real economic activity – grounded on the evidence collected on longer and more accurate spans of data – makes this position even stronger. The case for a central bank to be explicitly

mandated to maintaining price stability is now significantly reinforced relative to the case that could be built on the long-term neutrality of monetary policy. It has become clear that, in its pursuit of price stability, monetary policy not only minimises the costs associated with inflation, but also, crucially, helps to maximise the economy's long-run productive potential.

While the detrimental consequences of inflation would seem to argue in favour of a long-term inflation rate as close to zero as possible, in identifying a precise numerical definition of price stability a central bank is faced with important considerations.²¹ First, a protracted period of deflation at a time of faltering growth may constrain a central bank in the conduct of its monetary policy, since nominal interest rates cannot be reduced below zero. Indeed, any attempt to bring the nominal interest rate below zero would fail, as the public would prefer to hold cash rather than to lend or hold deposits at a negative rate. In a deflationary situation, the existence of a lower bound for nominal interest rates limits the room for manoeuvre of the central bank to reduce real interest rates in order to stimulate demand and counteract deflationary pressures.

Second, for various reasons, consumer price indices may be subject to measurement errors. Such errors may arise if prices are not adequately adjusted for changes in quality or if relevant transactions remain systematically out of the sample used to construct the index. However, in the case of the HICP the possibility of there being a measurement bias is of minor importance for setting a safety margin for inflation rates above zero when viewed against considerations relating to the risks of deflation.

Third, movements of relative prices are a key element for the efficient allocation of resources in a market economy. The economic adjustment of relative prices to shocks could become too sluggish if wages and prices were subject to downward nominal rigidities, i.e. a resistance to accept nominal reductions in prices and wages. In this respect, it has been argued that some inflation may actually “grease” the adjustment of

relative prices and thus also the real adjustment of the economy to various shocks.

Fourth, in principle inflation differentials across regions are and should be considered a normal feature of any monetary union. They are an integral part of the adjustment mechanism resulting from demand and supply shocks in the regions' economies. However, inflation differentials may also have a structural component in every currency union, for example owing to differences in income levels and an ongoing catching-up process in terms of standards of living. Given these unavoidable inflation differences, it has been argued that monetary policy should aim to achieve, over the medium term, an inflation rate for the euro area as a whole that is high enough to prevent regions with lower inflation rates from facing significant costs of downward nominal rigidities or entering periods of a protracted decline in prices.

The ECB's decision that, in the pursuit of price stability – defined as a year-on-year increase in the HICP for the euro area of below 2% – it will aim to maintain an inflation rate close to 2% in the medium term reflects a balance of all the above-mentioned considerations.

Following the end of the Great Inflation, over the last two decades the new consensus on the detrimental impact of inflation on macroeconomic activity has been enshrined into law within a growing number of countries. Whatever the specific technical differences between the various existing stability-oriented monetary regimes – Economic and Monetary Union, inflation-targeting regimes, the post-1999 Swiss new monetary policy concept, and Japan's monetary regime – they all share the fundamental principle that, because of the previously discussed reasons, inflation ought to be kept low and stable. In this respect, the Great Inflation did leave at least one positive legacy. By providing a stark practical demonstration of

²¹ For a detailed description of the reasons behind the ECB's definition of price stability, see the article entitled “The outcome of the ECB's evaluation of its monetary policy strategy” in the June 2003 issue of the Monthly Bulletin.

the corrosive effects of inflation, it convinced legislators to encode the lessons learned from that experience into law in order to prevent such an episode from ever happening again, by granting central banks greater independence and assigning them the task of keeping inflation under control. Hence, the ECB's mandate – with its primary objective of maintaining price stability and its complete independence from any other political or institutional body – appears as especially appropriate for the successful pursuit of price stability.

As history has repeatedly shown, periods of high inflation have been systematically associated with sizeable redistributions of both income and wealth, thus increasing social tension to the point of sometimes triggering social unrest and political turbulence. By preserving price stability, monetary policy can therefore make its best contribution not only to sustainable economic growth, job creation and prosperity but also – and crucially – to social stability.

5 CONCLUSION

The contemporary consensus among policy-makers and academics alike is that inflation exerts a systematic detrimental effect on macroeconomic performance. By making it difficult for economic agents to disentangle variations in relative prices from changes in the general price level, high and variable inflation causes a systematic misallocation of resources, thus negatively affecting the productivity of the factors of production. Furthermore, owing to both the macroeconomic uncertainty generated by the variability of inflation and the fact that the tax system is not indexed, inflation causes, through several channels, a systematic reduction in the rate of growth of capital accumulation, thus ultimately leaving the economy with a lower capital stock than it would otherwise.

Empirical evidence confirms the existence of both effects, and suggests their magnitude to be, for low-inflation countries, quite sizeable,

with a 100 basis point permanent increase in inflation being associated with a 10 to 30 basis point decrease in trend output growth. This has fundamental implications for the design of monetary institutions. In particular, the fact that any inflation rate in excess of an extremely small amount is detrimental to macroeconomic performance advocates the need to keep inflation very low and stable.