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Is Inflation Bad for Growth?

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Contents

1 Introduction

Economists have long been interested in the effects of inflation on real economic variables. In the past two decades, this line of research has expanded greatly, spurred on by the relatively high inflation rates in the developed economies beginning in the 1970s and the coincident slowing in the rate of output growth. During the past few years, the inflation rate has fallen in almost all industrial countries, and is by now back at its 1960s level. The elimination of inflation and the maintenance of price stability has become one of the principal goals for most central banks. Nearly all governments now accept that low inflation is essential for sustainable growth, and not, as was once thought, a contradiction to it.

One argument for price stability as a primary goal of monetary policy rests on the approximate long-run neutrality of money. Money cannot raise the level of output in the long run, but it can provide for a stable store of value. As a consequence, it is argued that monetary policy should focus on the only variable it can control in the long run, the price level. Those in favour of price stability argue that it would make possible the fastest long-term growth. Critics either believe that some inflation is healthy or argue that the costs of reducing inflation are greater than the costs of inflation itself. Some economists argue that it is the uncertainty about the future inflation rate that is the real problem with inflation, and that the volatility of inflation is more important than its level. Their conclusion is that policy-makers do not need to eliminate inflation but merely to stabilise the rate, to make it easier to predict and so less harmful.

The purpose of this paper is to study the relationships between the level and variation of the inflation rate, and the growth in gross domestic product. Since it does not exist any useful general equilibrium model that analyses the effect of money, the empirical section of this paper only considers the statistical relations. What differs this study from previous empirical studies in this field, is mainly that consideration is taken to the fact that the hypothesized relationships may depend upon the length of the time period considered.

A sample of fourteen OECD countries is used to examine the relationship between inflation and growth. The empirical analysis covers the period 1960-1992, using disaggregated (time-series) data. The method of estimation is ordinary least squares. The mean and variation of inflation are allowed to change over time, using overlapping data for 4, 16 and 32 quarters, respectively. The use of overlapping data causes a known form of serial dependence. To correct for this dependence, the technique of Newey and West (1987) is used. A problem with the growth in the gross domestic

product as a measure of economic performance is that it may increase just because there is an increased use of inputs. This suggests that the growth in labour productivity might be a better indicator of the performance of the economy. Thus, the relationships between the level and variation of inflation, and the growth in labour productivity, are also considered.

The analysis ignores many important issues that must be considered in the conduct of monetary policy. Foremost among these issues are the transition costs of lowering inflation and weighing the costs of the transition against the benefits of a low inflation rate. These are difficult and controversial issues to resolve. Instead, this paper abstracts from these considerations and focus on the relationships between the level and variation of inflation and the growth in gross domestic product and labour productivity.

The organisation of the paper is as follows. Chapter 2 discusses some of the effects of inflation. There seems to be much confusion about why inflation should be costly. So what are the costs? The following chapter presents a brief review of some previous empirical studies. Chapter 4 examines how the level and variation of inflation have related historically to the growth in gross domestic product and labour productivity. Finally, chapter 5 concludes with a brief summary.

2 The Costs of Inflation

A number of considerations suggest a positive relationship between higher average rates of inflation and greater variability (or uncertainty) of inflation, which in turn leads to greater uncertainty in production, investment, and marketing decisions, and thus, to greater variability in real growth. One reason may be that at a high average rate of inflation, a country is likely to be less consistent in its application of fiscal and monetary policies as it tries various approaches to control inflation and bring it within a politically tolerable range while simultaneously attempting not to violate other political constraints.

The costs of inflation depend on whether and when the inflation was anticipated, and on the institutional structure of the economy. There is therefore no short answer to the question of the costs of inflation. Further, since the inflation rate is not an exogenous variable to the economy, there is some logical difficulty in discussing the costs of inflation per se rather than the costs and benefits of alternative policy choices. Anticipated inflation is inflation that is built into the expectations and the behaviour of the public before it occurs. Unanticipated inflation is inflation that comes as a surprise to the public, or at least before people have had time to adjust fully to its presence. In contrast to the opinion that only unanticipated inflation has real effects, economic theory suggests that even fully anticipated inflation can have distortionary consequences.

This chapter discusses some of the relevant effects of inflation.[1] The effects are organised by their source. Section 2.1 focuses on the consequences of anticipated inflation. The effects arising from unanticipated inflation and the associated uncertainty about future inflation are discussed in Section 2.2.

2.1 The Real Effects of Anticipated Inflation

Anticipated (or expected) inflation represents a tax on real currency holding, since it reduces the real return earned by currency holders. The demand for real currency should be expected to fall as a result of the increased cost of holding it. That is, individuals will attempt to economise on money holdings during periods of inflation by making extra trips to the bank or automatic teller machine. This cost in time and effort is called the shoe-leather cost of inflation.[2]

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1 For a more exhaustive list and detailed analysis of the effects of inflation, see Fischer and Modigliani (1978). Clark (1982) discusses the effects of inflation on productivity.

2 Fischer (1981) estimates that the shoe-leather cost of a 10% perfectly anticipated inflation is about 0.3% of GNP.

The other side of the tax analysis is that the government obtains tax receipts that indirectly accrue to individuals. As the optimal inflation tax literature has stressed, the optimal rate of inflation may not be zero. Optimal taxation enters the analysis because the revenues lost by eliminating inflation will need to be offset by other distorting taxes. The costs of inflation have to be calculated relative to that rate of inflation that, as part of the overall pattern of taxation, minimises the social costs of raising government revenue. There are welfare costs from inflation that is below the optimum rate, as well as from inflation above the optimum rate.[3]

Other types of effects of inflation are the so called menu costs.[4] The menu costs of inflation arise in the custom markets, which include those for labour, manufactures, much of wholesale and retail trade, transportation, pay telephones and parking meters. Price adjustments occur at discrete times rather than continuously. Assuming that price changes are not synchronised, anticipated inflation can generate relative price changes in the short run. Since these inflation-induced relative price changes do not reflect real, fundamental changes in the economy, they can create a misallocation of resources, resulting in a welfare loss in addition to the explicit costs of changing prices. The frequency of price changes is expected to increase with the rate of inflation. The menu costs of inflation could become dramatic at high rates of inflation. Under these rates of inflation, the economy would probably switch over to the use of indexed pricing. The transitional costs of moving to such a system would be large. Thus, menu costs are expected to rise with the (anticipated) inflation rate up to some fairly high rate of inflation, at which time the system would start switching over to another unit of account that expresses the value in real terms. The costs of changing prices thereafter will largely be the costs of calculating nominal prices from the stated real prices.

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[3] Friedman (1969) argues that inflation should be negative and nominal interest rates zero, thereby preventing the deadweight loss associated with inefficient economization of real money balances. Phelps (1973) means that, in the absence of lump sum taxes, a tax on the liquidity services of money may form part of a scheme of optimal taxation. Phelps' opinion conflicts with Friedmans' proposition. In the absence of lump-sum taxation, government financing is necessarily distortionary. In this context the relevant question about a tax is how inefficient it is. Optimal taxation produces a mix of taxes, perhaps including the inflation tax, aimed at minimizing the welfare consequences of raising a given amount of revenue. When all taxes cause distortions, such an analysis would be unlikely to choose an optimal inflation rate exactly equal to zero. A measure of the inefficiency of a tax is the ratio of excess burden to government revenue. Tatom (1979) calculates, for the United States, that the marginal revenue to the government in moving from 9 to 10 percent inflation is $0.9 billion, with the excess burden being $0.75 billion. Thus, the marginal inefficiency ratio is 0.83. Hausman (1981) estimates the inefficiency ratio for labour income taxation to be below 0.3, suggesting that the inflation tax is an inefficient way of raising needed government revenue.

[4] The concept borrows its name from the fact that restaurants often need to write in higher prices of the dishes on their menus, and perhaps print new menus, as the prices of their inputs increase.

Many of the real effects of inflation depend on the structure of the tax system. If the income tax system is progressive and not completely indexed against increases in the price level, inflation will expose individuals' incomes to higher average and marginal tax rates. Even if wages fully adjust to inflation so that the real before-tax wage rate is approximately constant, an individual's real after-tax income will decline. This effect could be removed by indexation of tax brackets, a change that has been introduced in Canada and some other countries.

The effects of taxes on corporations and asset holders are potentially more important than those arising from non-indexation of brackets. Taxes are levied on the total nominal interest income received by individuals. The nominal interest rate required by lenders includes two components. The first component is a payment to the lender for not consuming today and, therefore, constitutes income. The second component is a premium to compensate the lender for the anticipated lost purchasing power due to inflation. Because the latter component serves to preserve the value of the principal, it is not income in an economic sense. Yet, like income, it is taxed. Thus, if the pre-tax real rate of return on an asset remains constant as the inflation rate increases, the after-tax real rate will fall. This would likely lead to an increase in the cost of capital for firms, and reduced investments.[5]

If nominal interest paid on personal debts is deductible from income on which taxes are levied, there would be a redistribution of income from creditors to debtors. Even if nominal rates adjust fully so as to leave the real rate unchanged, preventing a redistribution from creditors to debtors in pre-tax income, there would still be a redistribution of after-tax income.

If corporations too are allowed to deduct nominal interest from their profits before the corporate tax liability is calculated, anticipated inflation will induce corporations to finance an expansion of their operations by creating debt. This bias for debt finance, which increases with anticipated inflation, could be costly if, by increasing future debt obligation as a fraction of expected future cash flows, it increases the chances of future default.

If depreciation is charged off at historical cost, the present discounted value of the depreciation deduction from taxes falls as the inflation rate rises, given any particular depreciation schedule. This unambiguously raises the cost of capital to a corporation. This effect is greatest for firms using the longest lived capital. As the inflation rate increases, there would presumably be a fall

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[5] Fischer (1981) estimates that the inflation-induced welfare loss of taxation of savings, is about 0.7 percent of GNP (in the United States).

in the rate of investment, and a shift to shorter-lived capital.[6] If the cost of sold goods is measured at original cost, an overstatement of profits will follow when there is a high inflation. Further, if firms can choose between LIFO and FIFO inventory accounting methods, their profits can differ only because of the chosen accounting method. This possible difference will rise as the inflation rate rises.[7]

Inflation also affects the real value of the tax burden when there are significant lags in tax collection. Tax obligations are accrued at a certain point, but the payment is made at a later date. If no mechanism exists to maintain the real value of the tax liability during this lag, any increase in the rate of inflation reduces the tax burden. This phenomenon is known as the Olivera-Tanzi effect[8] and it can lead to a vicious circle. An increase in the fiscal deficit pushes up inflation, which in turn reduces tax revenues. Lower tax revenues, in turn, further increase the fiscal deficit, and so on. This process can be very destabilizing, and it has contributed to many of the high inflation rates in the developing world in the 1980s.

2.2 The Real Effects of Unanticipated Inflation and Inflation Uncertainty

Unanticipated inflation can also result in a misallocation of resources. The primary effect that has received major attention is the redistribution of wealth among people. Its impact on individuals' behaviour is not obvious however, but the uncertainty associated with these possible future redistributions distorts economic behaviour. In addition, and at least as important, there are possible changes in the level of economic activity and misallocations arising from ignorance about relative prices.

The wealth redistributions arising from unanticipated inflation are from nominal creditors to nominal debtors. Not suspecting the possibility of a divergence between actual and expected inflation, a lender would require a rate of return that compensates him only for not consuming today and for the lost purchasing power due to anticipated inflation. When actual inflation exceeds anticipated inflation, the purchasing power of the return on the loan

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6 It should be noted that the effects of inflation that work through the tax treatment of depreciation are not present in countries that allow a hundred percent write-off of investment expenses in the first year.

7 Ragnar Lindgren (1982) means that the present accounting rutines and institutional structure of the capital market unambiguously causes a fall in the rate of investment when the inflation rate increases. He also finds that taxes have a negative effect on savings and, thus, the real interest rate will rise with an increased inflation rate.

8 This effect takes its name from Julio Olivera and Vito Tanzi. See Olivera (1967).

falls below that expected at the time the loan was made. At the same time it reduces the liability of the debtor.

In general, economic agents hold both nominal assets and liabilities. Thus, the full effect of unexpectedly high inflation for individual agents depends on their net asset positions. Net creditors in nominal assets will lose and net debtors will become better off. If the household sector is a net nominal creditor while corporations and the government are net debtors, an unexpected increase in inflation benefits firms and the government at the expense of households. Within the household sector there are also strong differences. Homeowners with mortgages on their homes, for example, benefit from unexpected inflation. The net asset position for households also varies with age. Older people tend to hold more net nominal assets than younger people. Thus, unexpected rises in the general price level tend to redistribute wealth away from the old. There is also some evidence that inflation redistributes wealth from the top and bottom of the wealth distribution to the middle.[9]

If wage contracts are fixed in nominal terms for some time, unanticipated inflation reduces an individuals' real wage while decreasing an employer's wage bill in real terms. If inflation is lower than expected, however, the individual benefits and the employer loses.

Although the wealth redistributions arising from unanticipated inflation are important, it is difficult to attach a social cost to them.[10] For every loser there is a gainer, so that there is no net change in wealth. However, the redistributions present private profit opportunities. People may therefore devote a lot of time and effort to searching out and exploiting such gains. Human capital, like any other input, is scarce, so less will be available to help generate profit by, for example, the creation of new goods. Privately the reallocation of scarce resources induced by inflation may be profitable, but socially it is costly. Furthermore, because most people do not like risk, the risk of significant gains or losses arising from unanticipated inflation makes people feel worse off and hence is a cost of unanticipated inflation.

Uncertainty about the future inflation rate also affects the demand and supply of nominal denominated debt. The greater the inflation uncertainty is, the more uncertain is the opportunity cost of holding a long-term nominal bond. A given permanent unexpected movement in the inflation rate will also have a greater impact on the market value of the longer-term bond and, thus, a

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9 This has been documented by Bach and Stephenson (1974).

10 Evaluation of the magnitudes and costs of the redistributions awaits further work.

greater impact on the realized rate of return. Risk-averse lenders may therefore be less willing to purchase long-term nominal bonds over short-term nominal bonds. To compensate lenders from taking on additional risk, the required nominal yield on a bond with a longer maturity will embody a greater risk premium. The uncertainty associated with future inflation creates an element of uncertainty about future rates of return on all investments whose returns are not fixed in real terms. The more uncertain the future inflation rate is, the greater the risk premia for all bonds of any given maturity. The cost of capital to a firm increases, which would reduce the rate of investment and bias investment to shorter-lived assets.

In the presence of fixed nominal wage contracts, inflation uncertainty can depress the supply and demand for labour. Uncertainty about the future inflation rate makes wage negotiations more complex and costly. The greater the inflation uncertainty is, the less willing will individuals and firms be to lock themselves into fixed nominal contracts.

For people locked into labour contracts, an increase in inflation that exceeds expectations means a deterioration of their real wages. This happens not only to those who have contracts without cost-of-living adjustment clauses, but also to those with indexing clauses that operate with a lag. In general, high inflation increases the variability of a worker's wage over time. Just after a wage increase, the real wage tends to be high. Then, as inflation continues while the wage remains unchanged, the real wage declines, until the time when a new wage is set. Even if inflation does not affect the average real wage of the worker, it affects the variability of the real wage.

Misallocation of resources also arise because unanticipated inflation distorts the price mechanism by making it difficult for both consumers and producers to distinguish changes in relative prices from changes in the general price level. Unanticipated inflation can make a producer experience a rise in product demand. Whether the increase in demand is a consequence of the producer's failure to raise prices according to the actual inflation rate or a result of a real shift in consumer demand preferences may be indistinguishable to any given producer. Some producers may guess the former and raise prices, others may guess the latter and build additional capacity. To the extent that such guesses are wrong, abnormally large fluctuations in relative prices may follow. More importantly, to the extent relative price variation creates additional producer uncertainty, it is highly likely that the inability to distinguish real shifts in demand from "nominal" shifts, real growth in investment will be more variable than it would be in an environment where less guessing as to the source of an increase in nominal demand was necessary.

2.3 Summary

Inflation has a number of costs. Price increases, even if fully anticipated, impose a tax on the public. In addition, inflation produces pure efficiency losses. Expected increases in inflation reduce average money balances held by the public. Attempts to economise on money involve real costs. Menu costs are other effects of anticipated inflation. Real resources are spent in making the adjustments required by higher prices as costs of production increase. Anticipated inflation also leads to resource misallocation through its effects on the tax system, if the tax system is not indexed. The costs attributed to anticipated inflation, described in this chapter, are large and real in most countries. However, with the exception of the costs arising from the inability to pay interest on currency (the shoe-leather costs), they could almost entirely be avoided through the use of indexed tax systems.

Higher than expected inflation causes wealth redistributions from creditors to borrowers when financial assets are not indexed to inflation. Unanticipated inflation also leads to income redistributions among the different sectors of the population. It can also impose costs by inducing firms and households to make erroneous supply and demand decisions, for example by making firms confuse an overall increase in prices with a specific increase in prices for the firms own product.

The costs of inflation are clearly complicated and many. Table 1 summarizes the effects of inflation that have been discussed in this chapter.

Table 1. Some real effects of inflation

1	Anticipated inflation
1.1	Shoe-leather costs.
1.2	Menu costs.
1.3	Increases the average and marginal income taxes.
1.4	Redistributes income from creditors to debtors.
1.5	Reduces costs of borrowing and increases debt finance.
1.6	Raises the cost of capital to a firm.
1.7	Olivera-Tanzi effect.
2	Unanticipated inflation and inflation uncertainty
2.1	Redistributes wealth from nominal creditors to nominal debtors.
2.2	Redistributes income from labour to employers.
2.3	Misallocates resources because people search for private profit opportunities.
2.4	Makes risk-averse individuals feel worse off.
2.5	Increases the risk premia on all nominal bonds, especially on long-term nominal bonds. The cost of capital to a firm increases, especially for longer-lived investments.
2.6	Makes wage negotiations more complex and costly.
2.7	Increases the variability of the real wage.
2.8	Confusion about the source of price movement. Causes excessive relative price variability and a misallocation of resources.

3 A Review of Recent Empirical Studies

Empirical studies of the effects of inflation tend to follow one of three broad approaches. The first is that used by Okun (1971), who gathers data for 17 industrial countries for the period from 1951 to 1968 and calculates the mean and variability of the inflation rate for each country. By plotting the mean inflation rate versus the standard deviation of the inflation rate for these countries, he finds that these two variables are positively related. Logue and Sweeney (1981) use Okun's methodology in a cross-section study for the period 1950 - 1971, and find that both the mean and variance of inflation are positively related to the variance of output growth. They do not find any significant relationship between the rate of output growth and the mean and variance of inflation, however.

This approach has been criticised largely on two grounds. First, the sample variance of the inflation rate for a country over 15 or 20 years is unlikely to be the best measure of uncertainty about future inflation rates, because the sample variance of inflation does not separate predictable and unpredictable changes in the inflation rate. For example, if the inflation rate moves in a perfectly predictable way, inflation uncertainty is zero, but the computed sample variance of inflation would be positive. A second criticism is that this approach requires a certain homogeneity across countries to validate inferences about the variation of inflation and output growth across those countries. Logue and Sweeney suggest that their cross-section regressions can be derived from a number of models. They mean that if Phillips curve slope coefficients are equal across countries, their regressions follow. This assumption is unlikely to be exactly valid, but they argue that random variations in these parameters across countries will bias their estimates downward and will understate the significance of the relationships. Gale (1981) gives reasons to doubt that this homogeneity exists, including non comparability of indexes and different levels of development across countries. Katsimbris (1985) strongly rejects the hypothesis of homogeneity across countries. He means that slope differences across countries are unlikely to be due to random factors, but rather are due to structural and social differences among countries. Phillips curves may shift because of domestic social and structural changes and/or international supply shocks and changes in the "world" inflation rate. The extent of the shift will depend on the individual country's degree of openness and dependence on foreign supplies, he argues. Katsimbris suggests further that the existence of these outside disturbances may imply that the observations used in the cross-country studies are not independent and are probably subject to serial correlation.

A second approach allows the mean and variance of inflation to change within a country through time. Katsimbris (1985) does this for 18 OECD countries for the period 1955 - 1983. He lets the time-varying mean and variance of inflation and output growth be represented by eight-quarter, non-overlapping moving averages. He finds few countries for which the mean and variance of inflation are related in a statistically significant way and even fewer for which the mean and variance of inflation and the variance of output growth are related. This approach's main feature is the representation of inflation uncertainty.

Katsimbris' moving average for the mean inflation rate does not necessarily capture the predictable elements of the inflation process, however. Therefore, his measure of the variance confounds the uncertainty of future inflation with predictable changes in inflation. In addition to Katsimbris' eight-quarter, non-overlapping, moving averages, other estimate time series models for the inflation rate and real variables and use the residuals to construct overlapping moving-average measures to represent the time-varying variance of inflation.

A third approach to study the effect of inflation uses survey data from individual inflation forecasts to represent the inflation uncertainty. Mullineaux (1980), uses the standard deviation of individual inflation forecasts about the mean value to measure inflation uncertainty. He finds that the sum of current and lagged values of this measure of inflation uncertainty is significantly and negatively related to the level of industrial production. A more recent study by Hafer (1986) confirms these results with an alternative survey of inflation expectations.

A problem with this approach is that the inflation uncertainty measure, measures the dispersion of point estimates of the inflation rate across individuals, which does not necessarily capture the degree of uncertainty about future inflation rates. For example, if all individuals in the survey report the same forecast, but none of them are certain of the forecast, the constructed measure of inflation uncertainty would equal zero.

4 Empirical Results

In chapter 2, some of the costs of inflation were discussed. These arguments suggest that, in a real world that cannot foresee the future, the economy would perform better when the inflation level is low. But what are the historical facts on this matter?

In this chapter, disaggregated (time series) data, from a sample of fourteen OECD countries[11] are used to examine the empirical relationships between the rate of inflation, the variability of inflation, the growth in real gross domestic product (GDP), and the productivity growth. The purpose is to see if these parameters have been correlated in the past. The empirical analysis covers the period from 1960:1 to 1992:4. The study follows the second approach discussed in the previous chapter. That is, the mean and variation of inflation, and the mean of the growth in gross domestic product and labour productivity, are allowed to change over time. Inflation uncertainty is not directly an issue here, however, since only the standard deviation of the inflation rate is examined. There is no distinction made between the effects of anticipated inflation, unanticipated inflation, and inflation uncertainty. It is important to note that the specifications of the relationships considered are just ad hoc statistical relationships. This is because it does not exist any structural model that can be used for this papers purpose.

There are both permanent and temporary shocks to inflation, GDP growth and productivity growth. Permanent shocks are shifts in the trend, while temporary shocks are fluctuations around the trend. Ball and Cecchetti (1990) mean that uncertainty about next quarter's inflation depends mainly on the variance of temporary shocks, while uncertainty about inflation over several years depends mainly on the variance of permanent shocks. They therefore argue that the level of inflation has a much stronger effect on the variance of permanent shocks in inflation than on the variance of temporary shocks, and thus a stronger effect on inflation uncertainty at long horizons. This may also be a reasonable assumption concerning the relationships between inflation and output growth. That is, one might expect that if inflation has distortionary effects on growth, these effects may have a greater impact when the period of high inflation or high inflation variability is longer. In addition, a longer period accounts for a possible time lag in the effect of inflation on output, and smoothes the effects of the business cycle. For that reason, the relationships are estimated for different length intervals, using overlapping data. The time horizons considered are 4, 16 and 32 quarters.

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[11] Since quarterly observations are used, data availability limits the sample to only fourteen countries. The countries included are Austria, Canada, Finland, France, Germany, Greece, Italy, Japan, Netherlands, Norway, Sweden, Switzerland, United Kingdom and United States.

One reason to use overlapping data is that the number of observations increases.

The method of estimation is ordinary least squares. The use of overlapping data causes a known form of serial dependence. When heteroskedasticity and autocorrelation are present, the ordinary least squares estimators are unbiased, but the estimates of the variances are biased, thus invalidating the tests of significance.[12] In calculating the statistical significance of these relationships, the technique of Newey and West (1987) is therefore used to take explicit account of the serial dependence of the observations.[13] The statistic programming language GAUSS is used to make all the estimations.

Quarterly data for the consumer price index (CPI, all items), real GDP and total employment were obtained from OECD Main Economic Indicators. Inflation is the rate of change of the price level. In practice, however, there is not a single measure of the price level. Instead there are many different price indexes, or price level measures, each covering a different group of goods and services and having its own rate of inflation. Two important types of price indexes are consumer price indexes and producer price indexes. The consumer price indexes (CPIs) measure the prices of fixed baskets of consumer goods. The major consumer price index, measures prices of all the goods and services, including food and energy, used by typical urban households. This is the price index that is used in this paper. There are also versions of the CPI that exclude food and energy prices in order to get a picture of consumer prices that is not influenced by the sharp fluctuations that sometimes occur in the agricultural and energy sectors. In addition, there are two important differences between the CPI and the producer price indexes (PPIs). First, the PPI measures the prices of goods at an early stage in the process of production and retailing and so may reflect changes in inflation at an earlier stage than the CPI does. Thus, forecasters sometimes use the PPI as an early warning device for future inflation in consumer prices. Second, the CPI includes the prices of domestically and foreign produced goods and services, but the PPI focuses more narrowly on domestically produced goods.

A weakness with the CPI as a measure of the price level is that it tends to overstate the true rate of inflation. First, it fails to adjust fully for improvements in quality. Second, the weights used to add together the prices

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[12] See for example Kmenta (1986) pp 276-279, 308-311.

[13] Andrews and Monahan (1992) means that the method of Newey and West is not an optimal method when there is considerable temporal dependence in the data. They argue that the Newey and West method in such cases yield confidence intervals whose coverage probabilities are too low, that is, yields test statistics that reject too often.

of the different goods and services that go into the index are often out of date. This exaggerates the increase in the cost of living, since it does not allow for the fact that consumers shift from goods which become relatively expensive to cheaper alternatives. The exact size of the upward bias will vary from country to country but is one reason why central banks tend to define price stability as an annual increase in the CPI within the range of 0 - 2 percent, rather than zero.[14]

The level of inflation is calculated as the absolute value of the mean quarterly percent change in prices over the interval.[15] The variability of the inflation rate is measured by the standard deviation of the quarterly inflation rates from the mean inflation in the interval. The growth in GDP is calculated as the mean quarterly percent change in real GDP over the interval. The productivity is calculated as GDP divided by total employment. The productivity growth is calculated as the mean quarterly percent change in productivity over the interval.[16]

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[14] I have chosen to use the consumer price index as a measure of the price level, but perhaps the producer price index would have been a better choice. It would be interesting to do the regressions that follow with several different price indexes and compare the results.

[15] The absolute value of the mean rate of inflation is used because it is deviations from zero inflation that are hypothesized to affect economic performance. For example, there are few reasons to believe that deflation would be beneficial for economic performance. This is not a major concern in this paper, however, since deflationary periods are rare.

[16] The level of inflation is calculated as

$$P_t = abs\left(\frac{1}{freq} * \sum_{k=t-freq}^{t} INFL_k\right), \text{ where } INFL_t = \frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}$$

where $freq$ is the time horizon considered and $INFL_t$ is the percent change in prices (CPI) between quarter t-1 and t.

The standard deviation of inflation is calculated as $STDP_t = \sqrt{\frac{1}{freq} \sum_{k=t-freq}^{t} (INFL_k - P_t)^2}$

The growth in real GDP is calculated as $GDP_t = \frac{1}{freq} \sum_{k=t-freq}^{t} \left(\frac{rGDP_k - rGDP_{k-1}}{rGDP_{k-1}}\right)$,

where $rGDP$ is real gross domestic product. Due to data limitations, the productivity is represented by real GDP divided by total employment, instead of real GDP divided by the number of working hours. That is, the productivity is calculated as $rPDTY_t = rGDP_t / EMP_t$, where EMP is total employment. The productivity growth is calculated as $PDTY_t = \frac{rPDTY_t - rPDTY_{t-1}}{rPDTY_{t-1}}$ where $rPDTY$ is real productivity.

The hypotheses to be tested are:
1 The variability of the inflation rate depends positively on the rate of inflation.
2 The growth in GDP and labour productivity depend negatively on the inflation rate.
3 The growth in GDP and labour productivity depend negatively on the variability of the inflation rate.

Section 4.1 examines the first hypothesis. The following hypothesis is tested in section 4.2, while section 4.3 examines the validity of hypothesis 3.

4.1 The Empirical Relationships between the Rate of Inflation and the Standard Deviation of Inflation

In this section the first hypothesis, that the variability of the inflation rate is positively related to the level of the inflation rate, is tested. The following regression equation was estimated for each country with the number of quarters in each observation equal to 4, 16 and 32, respectively:

$$(1)\quad STDP_{it} = a_{1i} + b_{1i}P_{it} + \varepsilon_{1it}$$

where P_{it} is the level of inflation for country i in period t; $STDP_{it}$ is the standard deviation of the inflation rate; a_{1i} and b_{1i} are parameters to be estimated; and ε_{1it} is a random error term.

The results from estimating equation (1) for the period 1960:1 - 1992:4[17] are reported in table 2, page 21. A positive and significant relationship between the inflation rate and its variability was found for Greece, Italy, Japan, the Netherlands, Sweden, Switzerland, United Kingdom and the United States, at all three time horizons considered. For France the relationship was positive and significant when the number of quarters in each interval equalled 4 and 16. Canada obtained a significant and positive relationship at a length interval of 16 quarters. For Austria, Finland, Germany and Norway the relationship was significant only when the number of quarters in each observation equalled 4. It should be noted that the relationship was never significantly negative for any country.

Figure 1, page 22, plots the correlations between inflation and the standard deviation of inflation, as shown in table 2, against the annual average of the inflation rate. The correlations shown in the figure are those obtained when the number of quarters in each observation equalled 16.[18] The figure shows

[17] Due to data restrictions, the period for the Netherlands was 1960:2-1992:4.

[18] 16 quarters are choosen simply because it is the midpoint of the quarters reported in the table.

Table 2. Estimation of the relationships between the rate and standard deviation of inflation
Period 1960:1 - 1992:4

$STDP_{it} = a_i + b_i P_{it} + \varepsilon_{it}$

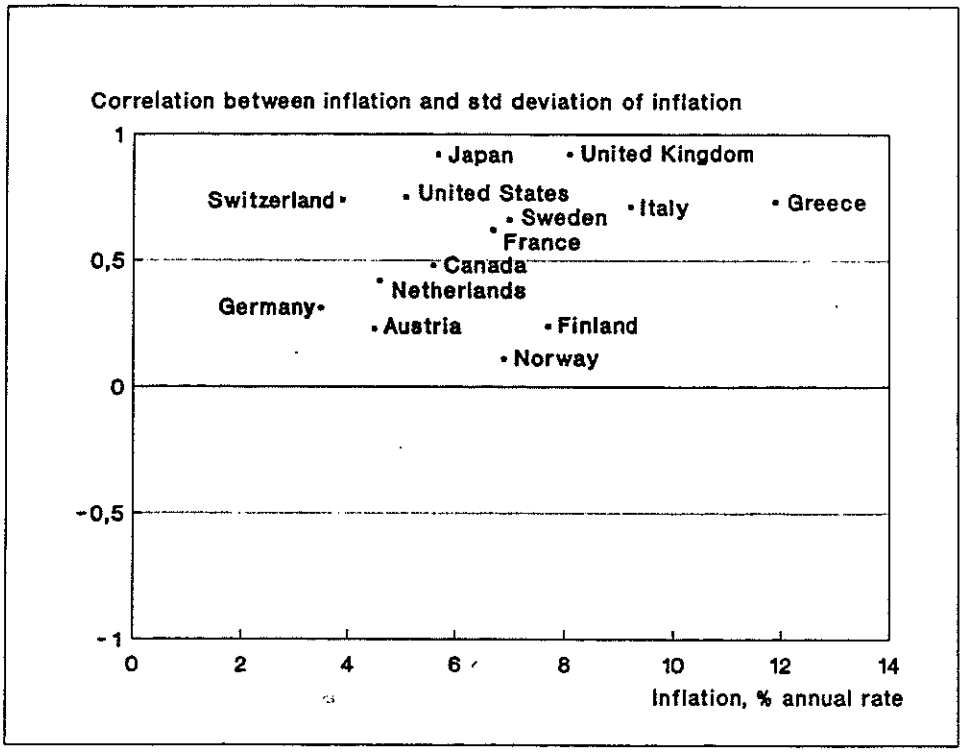
	Number of quarters in each observation:								
	4			16			32		
Country	a	b	correlation	a	b	correlation	a	b	correlation
Austria	-0.00003	0.015*	0.35	0.00044	0.028	0.23	0.00172	0.002	0.01
	(0.53)	(2.32)		(1.58)	(1.28)		(2.96)	(0.04)	
Canada	0.00004	0.001	0.19	0.00009	0.025*	0.48	0.00063	0.049	0.41
	(3.30)	(1.43)		(0.73)	(2.37)		(1.34)	(1.56)	
Finland	0.00007	0.007*	0.31	0.00099	0.023	0.24	0.00194	0.091	0.29
	(1.67)	(2.25)		(2.14)	(1.08)		(1.78)	(1.67)	
France	0.00002	0.002**	0.39	0.00006	0.025**	0.62	0.00082	0.045	0.34
	(1.51)	(3.27)		(0.62)	(3.93)		(1.07)	(1.20)	
Germany	0.00006	0.005*	0.18	0.00030	0.022	0.31	0.00048	0.076	0.48
	(2.19)	(2.13)		(1.47)	(1.27)		(1.00)	(1.82)	
Greece	-0.00064	0.064**	0.74	-0-00054	0.237**	0.73	0.00375	0.375**	0.66
	(1.87)	(4.37)		(0.74)	(5.20)		(0.88)	(3.22)	
Italy	-0.00003	0.010**	0.60	0.00004	0.065**	0.71	0.00201	0.116*	0.49
	(0.74)	(4.46)		(0.14)	(3.62)		(1.58)	(2.36)	
Japan	-0.00023	0.039**	0.81	-0.00194	0.280**	0.92	-0.00452	0.646**	0.95
	(3.60)	(7.20)		(3.86)	(8.56)		(4.03)	(11.02)	
Netherlands	-0.00001	0.015**	0.33	0.00014	0.060*	0.42	-0.00005	0.153**	0.55
	(0.12)	(2.62)		(0.36)	(2.10)		(0.05)	(2.86)	
Norway	-0.00009	0.019*	0.37	0.00106	0.018	0.11	0.00325	-0.007	-0.03
	(0.83)	(2.28)		(2.14)	(0.75)		(3.46)	(-0.17)	
Sweden	-0.00007	0.017**	0.52	0.00016	0.061**	0.66	0.00095	0.106**	0.67
	(-1.27)	(4.35)		(0.61)	(4.72)		(2.10)	(5.73)	
Switzerland	-0.00010	0.020**	0.68	-0.00039	0.104**	0.74	-0.00222	0.385**	0.84
	(-1.90)	(3.05)		(2.77)	(5.84)		(4.90)	(9.03)	
Unit.Kingd.	-0.00022	0.029**	0.79	-0.00137	0.182**	0.92	-0.00263	0.408**	0.94
	(2.83)	(6.38)		(5.54)	16.74)		(2.69)	(9.73)	
Unit. States	0.00002	0.003**	0.39	-0.00019	0.056**	0.75	-0.00027	0.137**	0.70
	(1.43)	(3.08)		(-2.04)	(6.74)		(-0.87)	(4.66)	

P = rate of inflation, $STDP$ = standard deviation of the inflation rate. The t-values are estimated with the method of Newey and West, and shown in parenthesis. * indicates significance at the five percent level, ** indicates significance at the one percent level.

that Germany, Austria and Canada have all had quite modest inflation rates, compared with the rest of the countries in the sample. Both Germany and Austria are among the three countries with the lowest inflation rates. This suggests that the hypothesized relationship between inflation and inflation variability may only be significant when the rate of inflation in a country exceeds a certain level. One reason for this might of course be that a low rate of inflation, say about 1 - 2 percent, measured by the CPI, would correspond to zero inflation if the inflation rate had been measured with a better price index. The results for Finland and Norway conflicts with this proposition, however. The relations are not significant in any of the two countries, although both Finland and Norway have had considerable inflation.

For Sweden the correlation is positive and significant at all three time-horizons considered. As shown in the table, the correlation gets stronger at lower frequencies. That is, long periods of high inflation have been associated with long periods of high inflation variability. This increase in the strength of the correlation at lower frequencies is also found for Japan, Netherlands, Switzerland and United Kingdom.

Figure 1. Inflation and the correlation between inflation and the standard deviation of inflation, period 1960-1992



4.2 The Empirical Relationships between the Rate of Inflation and the Growth in Gross Domestic Product and Labour Productivity

Here follow tests of the next hypothesis, which postulates that the growth in gross domestic product and labour productivity depend negatively on the rate of inflation. The equations below were estimated for each country with the number of quarters in each observation equal to 4, 16 and 32, respectively:

$$(2)\quad GDP_{it} = a_{2i} + b_{2i}P_{it} + \varepsilon_{2it}$$
$$(3)\quad PDTY_{it} = a_{3i} + b_{3i}P_{it} + \varepsilon_{3it}$$

where GDP_{it} is the growth in gross domestic product for country i in period t; $PDTY_{it}$ is the growth in labour productivity; P_{it} is the level of inflation; a_{2i} a_{3i} b_{2i}, and b_{3i} are parameters to be estimated; ε_{2it} and ε_{3it} are random error terms. The results from estimating equation (2) and (3) for the period 1960:1-1992:4[19] are reported in table 3, page 24, and table 4, page 25, respectively.

A negative and significant relationship between the inflation rate and the growth in real GDP was found for Canada, Finland, France, Greece, Italy, Sweden, United Kingdom and the United States, i.e. for eight out of fourteen countries, at all three time horizons considered. No significant relationship could be found for Austria, Germany, Japan, Norway or Switzerland. For the Netherlands, the relationship was significantly positive when the number of quarters in each interval equalled 32.

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[19] Due to data restrictions, the period for the Netherlands, in estimating the relationships between inflation and GDP growth, was 1960:2-1992:4. Due to limitations on the availability of productivity data, the period analyzed, in estimating the relationships beween inflation and productivity growth, differs among the countries in the sample. The period for Canada, United States, Finland, Italy, United Kingdom and Japan was 1960:1-1992:4. The periods for the rest of the countries were: Sweden 1961:2-1992:4, Austria 1969:1-1992:2, Greece 1962:1-1991:3, Netherlands 1960:2-1992.4, Norway 1972:1-1992:4, Switzerland 1966:3-1992:4, Germany 1981:1 - 1992:4. France is excluded from the sample since productivity data could not be obtained.

Table 3. Estimation of the relationships between the rate of inflation and the growth in GDP Period 1960:1 - 1992:4

$GDP_{it} = a_i + b_i P_{it} + \varepsilon_{it}$

	Number of quarters in each observation:								
	4			16			32		
Country	a	b	correlation	a	b	correlation	a	b	correlation
Austria	0.009	-0.053	-0.05	0.008	0.072	0.07	0.005	0.282	0.22
	(3.89)	(-0.28)		(2.68)	(0.40)		(1.05)	(0.99)	
Canada	0.015	-0.331**	-0.39	0.015	-0.299*	-0.58	0.015	-0.284**	-0.60
	(10.08)	(2.92)		(10.75)	(2.61)		(11.79)	(3.93)	
Finland	0.014	-0.239*	-0.32	0.014	-0.213**	-0.50	0.013	-0.185**	-0.54
	(6.39)	(2.41)		(7.49)	(2.71)		(8.39)	(3.38)	
France	0.013	-0.258**	-0.39	0.014	-0.305**	-0.62	0.016	-0.383**	-0.70
	(9.72)	(3.90)		(6.14)	(3.40)		(5.95)	(3.85)	
Germany	0.004	0.104	0.04	0.005	-0.061	-0.06	0.007	-0.282	-0.33
	(1.25)	(0.31)		(2.21)	(0.31)		(2.15)	(0.99)	
Greece	0.023	-0.370**	-0.71	0.023	-0.369**	-0.91	0.024	-0.376**	-0.94
	(10.44)	(6.59)		(20.16)	(11.74)		(19.71)	(10.14)	
Italy	0.014	-0.178*	-0.35	0.013	-0.172**	-0.60	0.014	-0.191**	-0.70
	(7.99)	(2.13)		(8.57)	(2.86)		(9.85)	(4.23)	
Japan	0.011	0.036	0.02	0.010	0.085	0.05	0.005	0.382	0.20
	(2.69)	(0.15)		(1.25)	(0.21)		(0.53)	(0.85)	
Netherlands	0.008	0.003	0.002	0.006	0.181	0.20	0.003	0.369**	0.38
	(4.93)	(0.02)		(2.70)	(1.53)		(1.06)	(2.46)	
Norway	0.012	-0.149	-0.19	0.010	-0.045	-0.08	0.010	-0.020	-0.06
	(6.42)	(1.48)		(4.79)	(0.37)		(11.23)	(0.34)	
Sweden	0.014	-0.394**	-0.53	0.015	-0.441**	-0.82	0.015	-0.469**	-0.93
	(9,67)	(5.59)		(10.96)	(7.58)		(23.47)	(17.45)	
Switzerland	0.010	-0.305	-0.22	0.009	-0.267	-0.22	0.008	-0.244	-0.16
	(4.30)	(1.24)		(4.16)	(1.42)		(2.59)	(1.03)	
Unit. Kingd.	0.011	-0.241**	-0.51	0.010	-0.176**	-0.68	0.009	-0.154**	-0.78
	(10.38)	(4.68)		(13.00)	(4.58)		(29.73)	(6.40)	
Unit. States	0.013	-0.421**	-0.53	0.012	-0.353**	-0.74	0.011	-0.290**	-0.82
	(11.61)	(5.14)		(11.99)	(4.33)		(11.87)	(4.94)	

GDP = growth in gross domestic product, *P* = rate of inflation. The t-values are estimated with the method of Newey and West, and shown in parenthesis. * indicates significance at the five percent level, ** indicates significance at the one percent level.

Table 4. Estimation of the relationships between the rate of inflation and the growth in labour productivity
Period 1960:1 - 1992:4[20]

$PDTY_{it} = a_i + b_i P_{it} + \varepsilon_{it}$

	Numbers of quarters in each observation:								
	4			16			32		
Country	a	b	correlation	a	b	correlation	a	b	correlation
Austria	0.004	0.166	0.13	-0.0004	0.449**	0.49	-0.004	0.669**	0.70
	(1.76)	(0.97)		(0.17)	(2.82)		(1.41)	(3.10)	
Canada	0.006	-0.208**	-0.38	0.006	-0.158*	-0.48	0.005	-0.136**	-0.59
	(6.97)	(4.02)		(5.41)	(2.38)		(7.32)	(3.60)	
Finland	0.012	-0.302**	-0.29	0.011	-0.231*	-0.41	0.011	-0.204	-0.42
	(6.35)	(3.90)		(3.53)	(2.09)		(2.76)	(1.40)	
Germany	-0.003	0.685**	0.67	-0.002	0.599*	0.61	-0.007	1.335**	0.67
	(3.44)	(5.74)		(2.23)	(2.30)		(5.39)	(5.68)	
Greece	0.015	-0.280**	-0.66	0.014	-0.259**	-0.86	0.013	-0.241**	-0.88
	(9.89)	(6.02)		(14.53)	(8.20)		(14.14)	(7.50)	
Italy	0.014	-0.244**	-0.46	0.014	-0.237**	-0.65	0.015	-0.259**	-0.72
	(8.04)	(3.34)		(5.96)	(3.34)		(5.44)	(3.31)	
Japan	0.006	0.128	0.07	0.005	0.216	0.13	-0.0005	0.529	0.30
	(1.68)	(0.58)		(0.65)	(0.58)		(0.06)	(1.35)	
Netherlands	0.003	0.475*	0.30	-0.0003	0.794**	0.74	-0.001	0.869**	0.87
	(1.24)	(2.33)		(0.27)	(8.27)		(2.22)	(20.97)	
Norway	-0.004	-0.151	-0.33	0.001	-0.497	-0.20	-0.004	-0.383	-0.10
	(0.97)	(0.72)		(0.22)	(0.94)		(0.86)	(0.07)	
Sweden	0.011	-0.365**	-0.50	0.012	-0.397**	-0.72	0.013	-0.442**	-0.87
	(6.43)	(4.58)		(6.15)	(4.30)		(7.34)	(5.53)	
Switzerland	0.006	-0.069	-0.08	0.003	0.145*	0.24	-0.00002	0.441**	0.71
	(3.02)	(0.41)		(4.72)	(2.40)		(0.01)	(3.57)	
Unit. Kingd.	0.008	-0.144**	-0.37	0.007	-0.090**	-0.43	0.007	-0.078*	-0.50
	(8.44)	(3.19)		(7.54)	(3.87)		(6.06)	(2.11)	
Unit. States	0.007	-0.348**	-0.62	0.006	-0.321**	-0.84	0.006	-0.287**	-0.87
	(7.68)	(5.78)		(6.03)	(4.93)		(5.90)	(4.69)	

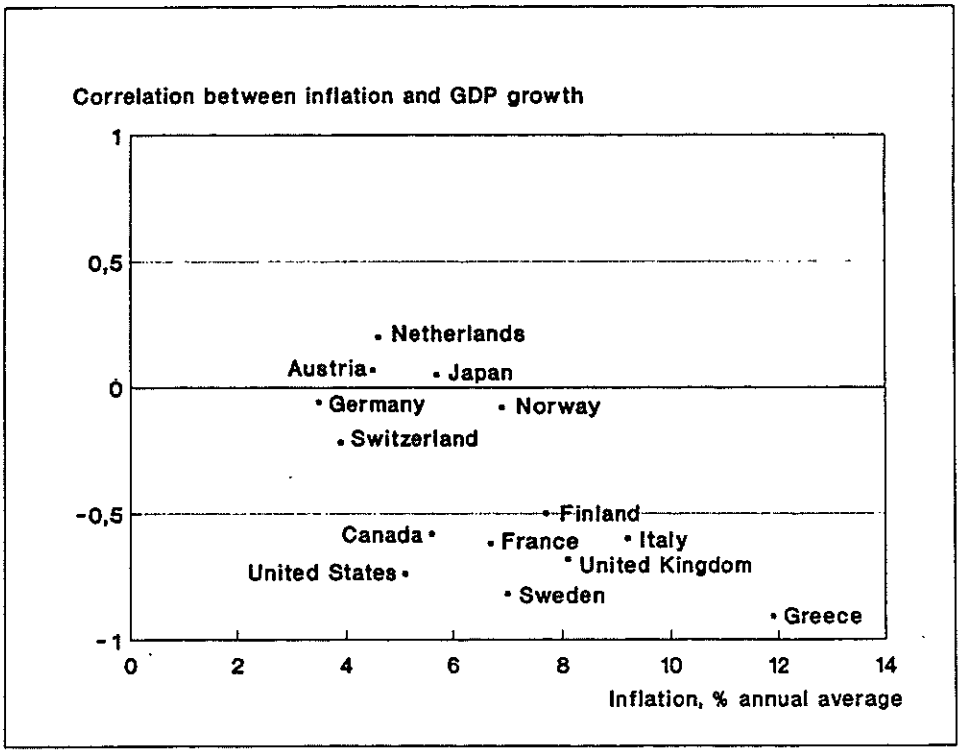
PDTY = growth in labour productivity, *P* = rate of inflation. The t-values are estimated with the method of Newey and West, and shown in parenthesis. * indicates significance at the five percent level, ** indicates significance at the one percent level.

20 See footnote 19.

A negative and significant relationship between the rate of inflation and the growth in labour productivity was found for Canada, Greece, Italy, Sweden, United Kingdom and the United States, i.e. for six out of thirteen countries, at all three time horizons considered. Finland obtained a significant negative relationship at 4 and 16 quarters. For Austria and Switzerland the relations were significantly positive at 16 and 32 quarters. The relations were significantly positive at all three time horizons for Germany and the Netherlands. However, the analysed period for Germany was only 12 years. Japan and Norway never obtained any significant relationships.

Figure 2 below and 3, page 27, plot the annual average of the inflation rate against the correlations between the rate of inflation and the growth in GDP and labour productivity, respectively.[21] The figures show that the countries that did not obtain any significant negative relationships are all, except for Norway, among the group of countries that have had the lowest inflation

Figure 2. Inflation and the correlation between inflation and the growth in GDP, period 1960-1992

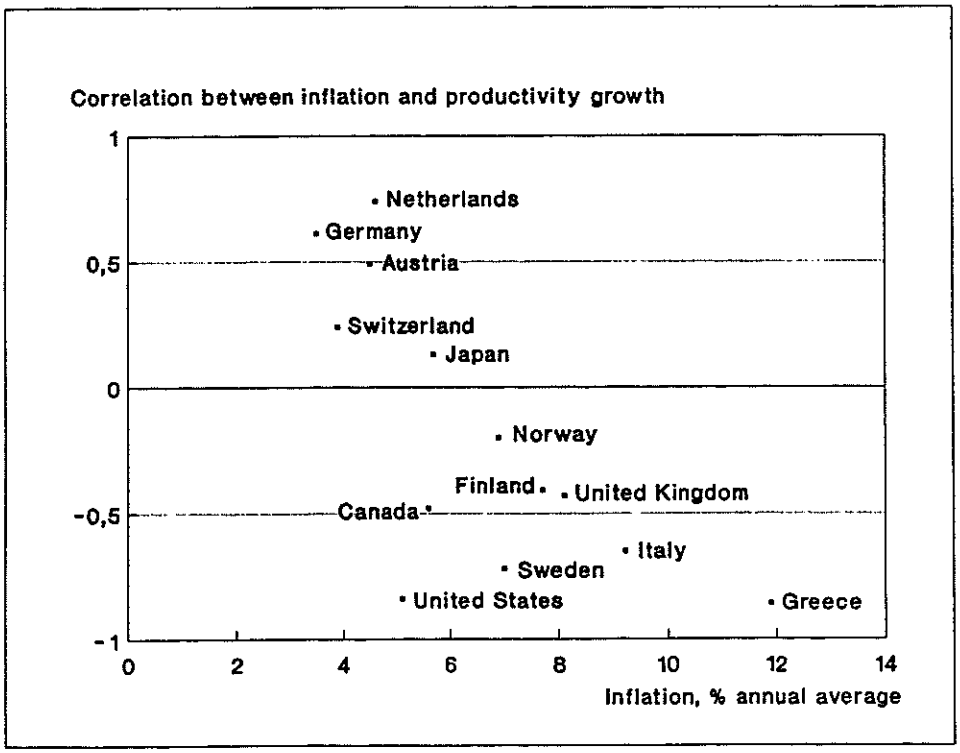


21 See footnote 19.

rates during the analysed period. It is not a main concern that the low-inflation countries did not confirm the hypothesized relations. The inflation rates in these countries may have been so low that no relations are really expected.

Focusing on Sweden, the tables show that the correlation is negative and significant at all three time horizons considered. The correlation gets stronger at lower frequencies. That is, long periods of high inflation have been associated with long periods of depressed growth in both GDP and labour productivity. The increase in the strength of the negative correlation at lower frequencies is also found for Canada, Finland, France, Greece, Italy, United Kingdom and the United States, considering the relationships between inflation and GDP growth; and for Canada, Greece, Italy, United Kingdom and United States, considering the relationships between inflation and productivity growth.

Figure 3. Inflation and the correlation between inflation and the growth in labour productivity, period 1960-1992[22]



22 See footnote 19.

4.3 The Empirical Relationships between the Standard Deviation of Inflation and the Growth in Gross Domestic Product and Labour Productivity

In this section the last hypothesis, that the growth in gross domestic product and labour productivity are negatively dependent on the standard deviation of the inflation rate, is tested. The equations below were estimated for each country with the number of quarters in each observation equal to 4, 16 and 32, respectively:

$$(4) \quad GDP_{it} = a_{4i} + b_{4i}STDP_{it} + \varepsilon_{4it}$$
$$(5) \quad PDTY_{it} = a_{5i} + b_{5i}STDP_{it} + \varepsilon_{5it}$$

where GDP_{it} is the growth in gross domestic product for country i in period t; $PDTY_{it}$ is the growth in labour productivity; $STDP_{it}$ is the standard deviation of the inflation rate; a_{4i}, a_{5i}, b_{4i} and b_{5i} are parameters to be estimated; ε_{4it} and ε_{5it} are random error terms. The results from estimating equation (4) and (5) for the period 1960:1 - 1992:4[23] are reported in table 5, page 29, and table 6, page 30, respectively.

A negative and significant relationship between the standard deviation of inflation and the growth in GDP was found only for Greece, Sweden, United Kingdom and the United States, at all three time horizons considered. France and Switzerland obtained significantly negative relationships at 16 and 32 quarters. For Norway, the relation was significantly negative at 4 quarters. A significant and positive relationship was obtained for Austria at 32 quarters, Finland at 16 and 32 quarters, Germany at 4 quarters, and for the Netherlands at all three time horizons. Canada, Italy and Japan never obtained any significant relationships.

A negative and significant relationship between the standard deviation of inflation and the growth in labour productivity was, just as the relationship between the standard deviation of inflation and the growth in GDP, found only for Greece, Sweden, United Kingdom and the United States, at all three time horizons considered. Austria and Norway obtained significantly negative relationships at 4 quarters. The relationship for Germany was also significantly negative at 4 quarters, but significantly positive at 32 quarters. The analysed period for Germany was only 12 years, however. A significant and positive relationship was obtained for Finland at 16 and 32 quarters, for the Netherlands at all three horizons, and for Switzerland at 32 quarters. Canada, Italy and Japan again never obtained any significant relationship.

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23 See footnote 19.

Table 5. Estimation of the relationships between the standard deviation of inflation and the growth in GDP
Period 1960:1 - 1992:4

$GDP_{it} = a_i + b_i STDP_{it} + \varepsilon_{it}$

	Number of quarters in each observation:								
	4			16			32		
Country	a	b	correlation	a	b	correlation	a	b	correlation
Austria	0.009	-1.914	-0.07	0.009	-0.397	-0.05	0.004	2.637*	0.33
	(8.30)	(0.67)		(3.83)	(0.20)		(1.25)	(2.49)	
Canada	0.011	-7.129	-0.06	0.011	-1.146	-0.12	0.012	-0.855	-0.22
	(9.17)	(0.42)		(8.70)	(0.42)		(6.76)	(0.82)	
Finland	0.009	2.498	0.08	0.008	1.314**	0.29	0.008	0.509**	0.46
	(6.40)	(0.78)		(10.78)	(3.36)		(11.09)	(7.24)	
France	0.009	-3.549	-0.03	0.012	-5.936*	-0.49	0.013	-2.444**	-0.60
	(8.47)	(0.31)		(7.21)	(2.12)		(5.98)	(3.47)	
Germany	0.003	22.614**	0.26	0.004	2.459	0.17	0.003	1.328	0.25
	(1.81)	(2.79)		(3.35)	(1.11)		(4.20)	(1.75)	
Greece	0.016	-3.291**	-0.55	0.016	-0.704*	-0.56	0.016	-0.319*	-0.45
	(10.32)	(4.50)		(7.45)	(2.34)		(5.39)	(2.08)	
Italy	0.009	2.102	0.07	0.010	-0.657	-0.21	0.011	-0.318	-0.28
	(7.56)	(0.42)		(5.74)	(1.22)		(4.75)	(1.10)	
Japan	0.012	-0.385	-0.01	0.012	-0.358	-0.06	0.010	0.235	0.08
	(3.36)	(0.10)		(1.91)	(0.35)		(1.15)	(0.35)	
Netherlands	0.007	8.747**	0.33	0.004	4.830**	0.78	0.002	3.132**	0.89
	(5.89)	(4.54)		(3.00)	(5.48)		(1.63)	(8.33)	
Norway	0.010	-2.790**	-0.18	0.010	-0.416	-0.12	0.009	0.279	0.19
	(11.24)	(2.62)		(6.60)	(0.61)		(4.51)	(0.58)	
Sweden	0.008	-5.302*	-0.24	0.010	-2.493*	-0.43	0.011	-1.583*	-0.50
	(7.84)	(2.04)		(5.64)	(2.27)		(4.24)	(2.06)	
Switzerland	0.007	-6.751	-0.14	0.010	-5.199**	-0.62	0.009	-1.858**	-0.57
	(6.24)	(0.88)		(7.94)	(7.45)		(4.88)	(3.59)	
Unit. Kingd.	0.009	-6.810**	-0.53	0.008	-0.885**	-0.67	0.008	-0.343**	-0.76
	(10.51)	(3.79)		(14.57)	(3.72)		(23.90)	(4.23)	
Unit. States	0.010	-42.991**	-0.42	0.010	-4.178**	-0.66	0.009	-1.282**	-0.70
	(10.63)	(4.54)		(9.86)	(4.47)		(10.84)	(3.30)	

STDP = standard deviation of the inflation rate, *GDP* = GDP growth. The t-values are estimated with the method of Newey and West, and shown in parenthesis. * indicates significance at the five percent level, ** indicates significance at the one percent level.

Table 6. Estimation of the relationship between the standard deviation of inflation and the growth in labour productivity
Period 1960:1 - 1992:4[24]

$PDTY_{it} = a_i + b_i STDP_{it} + \varepsilon_i$

	Number of quarters in each observation:								
	4			16			32		
Country	a	b	correlation	a	b	correlation	a	b	correlation
Austria	0.008	-18.594*	-0.28	0.009	-5.902	-0.33	0.004	0.633	0.05
	(4.98)	(2.19)		(3.58)	(1.61)		(1.60)	(0.32)	
Canada	0.003	-2.328	-0.04	0.003	0.485	0.08	0.003	0.126	0.07
	(4.77)	(0.41)		(3.61)	(0.62)		(3.39)	(0.24)	
Finland	0.006	1.732	0.04	0.003	2.456*	0.42	0.004	0.696**	0.44
	(4.39)	(0.60)		(2.27)	(2.60)		(3.12)	(2.93)	
Germany	0.003	-40.611*	-0.38	0.001	0.005	0.0001	-0.002	6.729**	0.64
	(2.80)	(2.47)		(1.03)	(0.00)		(5.28)	(6.24)	
Greece	0.010	-2.936**	-0.63	0.011	-0.685**	-0.78	0.011	-0.357**	-0.75
	(9.90)	(8.40)		(6.83)	(3.98)		(9.55)	(6.31)	
Italy	0.009	-1.718	-0.05	0.010	-1.043	-0.27	0.010	-0.406	-0.28
	(7.04)	(0.38)		(4.24)	(1.37)		(3.16)	(0.99)	
Japan	0.008	0.951	0.02	0.008	0.052	0.01	0.005	0.464	0.17
	(2.36)	(0.26)		(1.31)	(0.06)		(0.68)	(0.77)	
Netherlands	0.010	4.801*	0.16	0.007	4.423*	0.63	0.005	3.179**	0.83
	(6.71)	(2.04)		(3.54)	(2.43)		(3.03)	(4.22)	
Norway	0.008	-13.778**	-0.34	0.006	-0.724	-0.22	0.006	-0.169	-0.15
	(7.26)	(4.15)		(7.36)	(1.50)		(16.08)	(1.79)	
Sweden	0.007	-6.873**	-0.33	0.007	-2.218*	-0.42	0.010	-1.726*	-0.53
	(6.09)	(3.65)		(3.95)	(2.14)		(3.12)	(2.01)	
Switzerland	0.005	1.783	0.06	0.005	0.166	0.04	0.003	0.723*	0.48
	(5.31)	(0.41)		(4.68)	(0.38)		(9,82)	(2.51)	
Unit. Kingd.	0.007	-4.038**	-0.37	0.006	-0.488**	-0.46	0.007	-0.171*	-0.47
	(9.20)	(3.62)		(8.41)	(3.80)		(7.34)	(1.99)	
Unit. States	0.004	-18.566**	-0.26	0.004	-2.829**	-0.56	0.004	-0.967*	-0.58
	(4.67)	(2.63)		(3.80)	(2.73)		(3.61)	(2.12)	

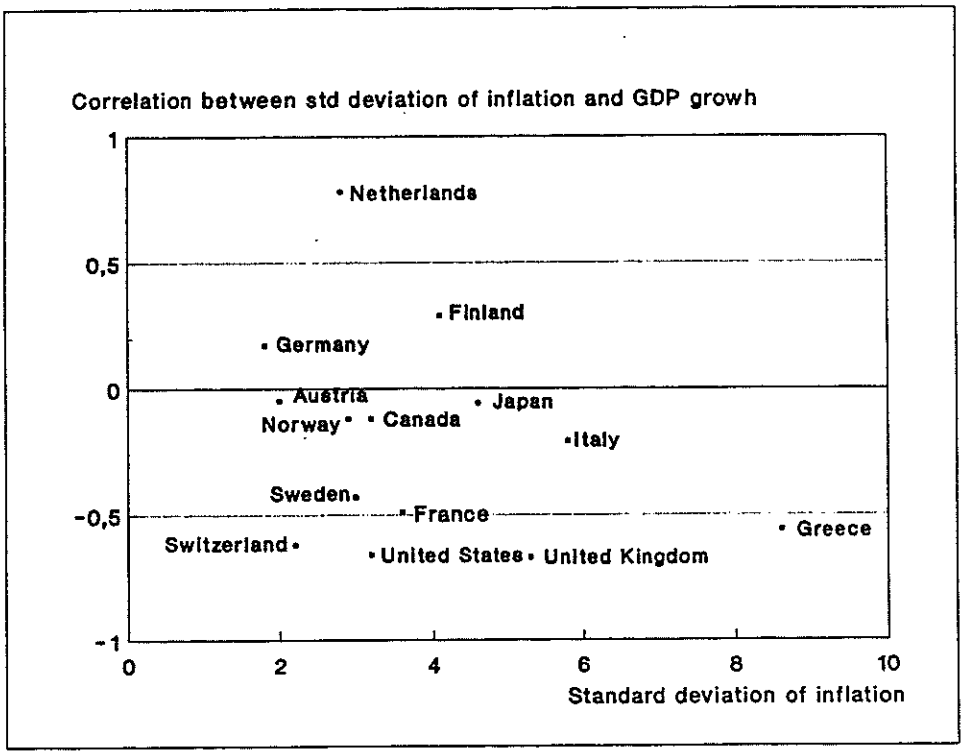
STDP = variance in the inflation rate, *PDTY* = productivity growth. The t-values are estimated with the method of Newey and West, and shown in parenthesis. * indicates significance at the five percent level, ** indicates significance at the one percent level.

24 See footnote 19.

Figure 4 below, and figure 5 on page 32, plots the standard deviation of inflation against the correlations between the standard deviation of inflation and the growth in GDP and labour productivity, respectively.[25] The figures show that some countries that have had a high standard deviation of inflation, like Greece and United Kingdom, obtained a strong negative correlation, while other countries that have had a high inflation variability, like Japan, Italy and Finland, obtained significantly positive correlation or no significant correlation at all.

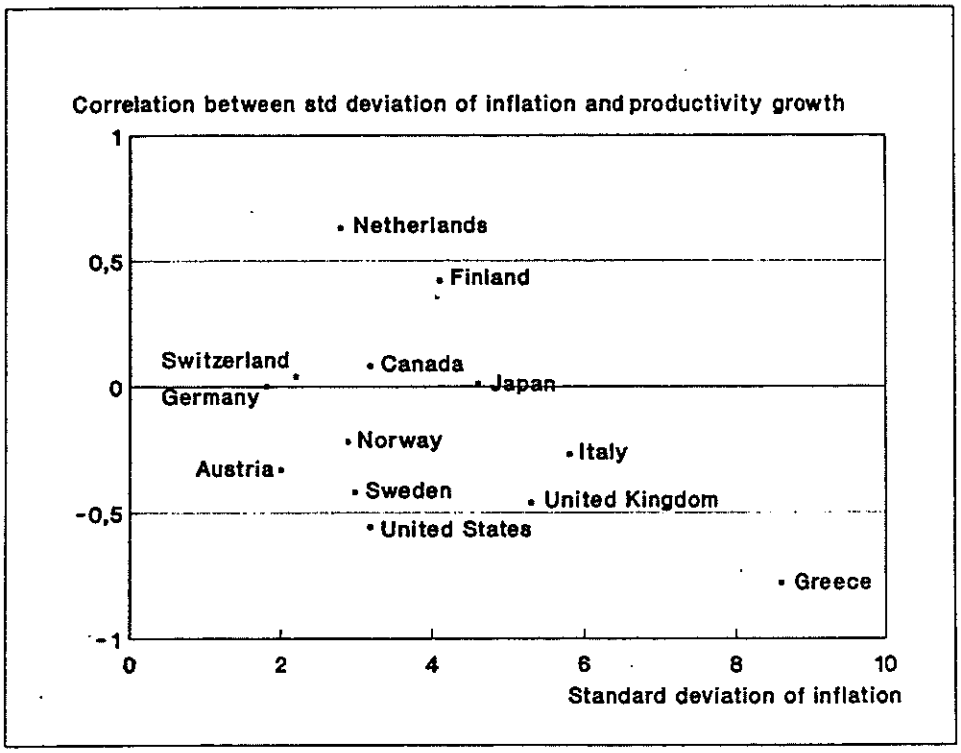
Looking closer at Sweden, table 5 and 6 show that the correlation is negative and significant at all three horizons considered. The correlation gets stronger at lower frequencies. That is, long periods of high inflation variability have been associated with long periods of depressed growth in gross domestic product and labour productivity. This increase in the strength of the negative correlation at lower frequencies is also found for United Kingdom and the United States.

Figure 4. Standard deviation of inflation and the correlation between the standard deviation of inflation and growth in GDP, period 1960-1992



25 See footnote 19.

Figure 5. Standard deviation of inflation and the correlation between the standard deviation of inflation and the growth in labour productivity, period 1960-1992[26]



26 See footnote 19.

5 Summary and Conclusion

This paper has attempted to describe some of the costs of inflation, and to provide some historical and empirical facts about the relationships between the level and variation of inflation, and their effect on the growth in real gross domestic product and labour productivity. The subject is large and complicated and this paper is merely a small step on the way of analysing the relationships stated above.

The costs of inflation depend on whether or not the inflation is anticipated. Some of the costs of a fully anticipated inflation are the so called shoe-leather costs, menu costs and costs arising from the Olivera-Tanzi effect. Further, anticipated inflation increases the average and marginal income taxes, given a progressive tax system that is not completely indexed against the effects of inflation. It also reduces the real interest rate and redistributes income from creditors to debtors. The cost of borrowing decreases which induces firms to finance investments by creating debt. The main effects of unanticipated inflation are redistributional. Surprises in inflation lead to shifts of income and wealth between various groups in the population. Income is redistributed from labour to employers, wealth is redistributed from net nominal creditors to net nominal debtors. There are also misallocations of resources because people search for private profit opportunities, and because of confusion about the source of a price movement. Unanticipated inflation increases the risk premia on all nominal bonds, especially on long-term nominal bonds. The cost of capital to a firm therefore increases, especially for longer-lived investments.

These effects of inflation suggest a negative relationship between the level and variability of the inflation rate and the growth in gross domestic product and productivity. The following hypotheses were tested on a country-by-country basis in the empirical section of the paper:

(1) The variability of the inflation rate depends positively on the rate of inflation.
(2) The growth in gross domestic product and labour productivity depend negatively on the inflation rate.
(3) The growth in gross domestic product and labour productivity depend negatively on the variability of the inflation rate.

The results of the tests are mixed. There is some evidence that the rate of inflation is positively related to the variability of inflation. Eight out of fourteen countries obtained a significant positive correlation for all three time horizons considered. No country obtained a significantly negative correlation. Except for Finland and Norway, the results suggest that the

hypothesized relationship between inflation and inflation variability may be significant when the rate of inflation in a country exceeds a certain level. One reason for this might be that a low rate of inflation measured by the consumer price index, corresponds to zero inflation, if the inflation rate had been measured with a better price index.

There is also some evidence that the rate of inflation is related to the growth in gross domestic product. A significant negative relationship for all three horizons, was found in eight out of fourteen countries for all three horizons. Five countries did not obtain any significant relationship at all, while one country obtained a significant positive correlation. Five of these six countries have all had quite modest inflation rates during the analysed period, however. It is not a main concern that low-inflation countries do not confirm the hypothesized relations. The inflation rates in these countries have been so low that no relations are really expected.

The results from estimating the relationships between the rate of inflation and the growth in labour productivity are a little weaker. Six countries out of thirteen obtained a significant negative relationship at all three time horizons. Two countries did not obtain any significant relationship at all, while four countries obtained significantly positive relationships. Again, all the countries, except one, that did not obtain any significantly negative relationships, have been low-inflation countries.

Labour productivity was considered as an alternative indicator of the performance of the economy because it was suspected that the negative effects of high inflation would affect the growth in labour productivity more directly than it would affect the growth in gross domestic product. The results in the empirical section of the paper suggest that this has not been the case. One reason for this might be that labour productivity is not well represented by GDP divided by total employment, but should instead be measured by GDP divided by the total number of working hours.[27]

There is no evidence that the variability of the inflation rate has been related to the growth in gross domestic product or labour productivity.

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27 Only annual data for productivity measured by GDP divided by the total number of working hours could be obtained. When estimations were done to examine the relationship between the inflation level and productivity, using this alternative measure of productivity and annual non-overlapping data, eight out of fourteen countries obtained a significant negative relationship. The countries were Canada, Finland, France, Italy, Norway, Sweden, United Kingdom and the United States. No country obtained a significant positive correlation. When estimations were done using a horizon of two years and overlapping data, nine countries: Canada, Finland, France, Greece, Italy, Norway, Sweden, United Kingdom and the United States, obtained a significant negative correlation, while one country, the Netherlands, obtained a significant positive correlation.

Historically, in Sweden, there is certainly evidence that high inflation periods have been periods of high inflation variability and depressed growth in gross domestic product and labour productivity. The correlations get stronger at lower frequencies. That is, the longer the periods of high inflation have been, the stronger is the correlation with inflation variability and depressed growth in gross domestic product and labour productivity.

There are also some other countries for which the correlations get stronger at lower frequencies. A number of interesting issues are raised by the fact that the correlations showing an adverse effect of inflation on economic performance grow larger when one considers longer time intervals. These low frequency relationships may point to one reason why building a constituency for low inflation is difficult. For the monetary authority, the benefits will take a long time to reveal themselves, requiring considerable patience on the part of policy-makers. For elected officials, the benefits occur in time frames far longer than the electoral cycle. Even among economists, there is a strong tendency to focus on high frequency relationships simply because there are so few data with which to estimate relationships at low frequencies. Nevertheless, these low frequency relationships may be important to understanding the long-term consequences of inflation.

Is inflation bad for growth?
Taken as a whole, there is no evidence to suggest that the economy performs better with higher inflation, at either short or long horizons. However, there is some evidence to suggest that lower inflation is associated with better-than-average economic performance.

One cannot lean heavily on these estimated relationships however. Without a clear structural context, they are subject to a wide variety of interpretations. One might be that inflation has adverse consequences for the rate of growth of gross domestic product and productivity. The potential deleterious effects of inflation on productivity seem likely to build over time and to be more apparent at longer intervals than shorter intervals. If any of the relations reflects causality running in this direction, the argument in favour of low inflation would be considerably strengthened. However, a second interpretation is that the causality runs from productivity to inflation. A shortfall in the growth in productivity causes an increase in inflation unless the growth in nominal factor payments drops to offset the productivity decline. But this argument ought to hold more strongly over shorter intervals than over longer ones. A third interpretation is that inflation and growth in gross domestic product and productivity, all reflect the same disturbances to the economy rather than the effects of exogenous inflation on growth, or exogenous growth on inflation. The estimated relationships may thus reflect the independent effect of the energy price shock of the 1970s on both

inflation and growth. In contrast to the second explanation, this channel of influence might remain apparent over longer intervals if the monetary authority accommodated the higher prices associated with a supply shock by raising money growth.

6 References

Andrews, Donald W. K., and J. Christopher Monahan. "An Improved Heteroskedasticity and Autocorrelation Consistent Covariance Matrix Estimator", Econometrica, vol. 60 (July 1992), pp. 953-966.

Bach, G., and J. Stephenson. "Inflation and the Distribution of Wealth", Review of Economics and Statistics (February 1974).

Ball, L., and S. Cecchetti. "Inflation and Uncertainty at Long and Short Horizons", Brookings Papers on Economic Activity 1 (1990), pp. 215-245.

Clark, P. "Inflation and the Productivity Decline", American Economic Review, vol. 72 (1982), pp. 149-154.

Cukierman, Alex. "Relative Price Variability and Inflation: A Survey and Further Results", Carnegie-Rochester Series on Public Policy (Autumn 1983), pp. 103-158.

Fischer, Stanley, and Franco Modigliani. "Towards an Understanding of the Real Effects and Costs of Inflation", Weltwirtschaftliches Archiv (1978), 114:810-830.

Fischer, Stanley. "Towards an Understanding of the Costs of Inflation: 2.", Carnegie-Rochester Conference Series on Public Policy. vol. 15 (1981), pp. 5-42.

Friedman, Milton. "The Optimum Quantity of Money", The Optimum Quantity of Money and Other Essays (Aldine, 1969) pp. 1-50.

Gale, William A. "Temporal Variability of United States Consumer Price Index", Journal of Money, Credit, and Banking (August 1981), pp. 273-297.

Hafer, R.W. "Inflation Uncertainty and a Test of the Friedman Hypothesis", Journal of Macroeconomics (Summer 1986), pp. 365-372.

Hausman, J. A. "Labor Supply", In Aaron and Pechman eds., How Taxes Affect Economic Behaviour, Washington D.C.: Brookings Institutions (1981).

Katsimbris, George M. "The Relationship between the Inflation Rate, Its Variability, and Output Growth Variability: Disaggregated International

Evidence", Journal of Money, Credit, and Banking (May 1985), pp 179-188.

Kmenta, Jan. "Elements of Econometrics", Second Edition (1986), Maxmillian Publishing Company.

Lindgren, Ragnar. "Hur påverkar inflationstakten företagens investeringar?" Uppsats i investerings- och finanseringsteori, The Institute of Economics, University of Stockholm (February 1982).

Logue, D., and R. Sweeney. "Inflation and Real Growth: Some Empirical Results", Journal of Money, Credit, and Banking (November 1981), pp. 497-501.

Logue, D., and T. Willet. "A Note on the Relation Between the Rate and Variability of Inflation", Economica (1976), 43:151-158.

Mullineaux, Donald J. "Unemployment, Industrial Production, and Inflation Uncertainty in the United States", Review of Economics and Statistics (May 1980), pp. 163-169.

Newey, Whitney K. and Kenneth D. West. "A Simple, Positive Semidefinite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix." Econometrica. vol. 55 (1987), pp. 703-708.

Okun, Arthur M. "The Mirage of Steady Inflation", Brookings Papers on Economic Activity (2:1971), pp. 485-498.

Olivera, Julio. "Money, Prices, and Fiscal Lags: A Note on the Dynamics of Inflation", Quarterly Review, Banca Nazionale del Lavoro (September 1967), pp 258-267.

Phelps. Edmund S. "Inflation in the Theory of Public Finance", Swedish Journal of Economics (March 1973), pp 67-82.

Pindyck, Robert S., and Daniel L. Rubinfeld. "Econometric Models and Economic Forecasts", Third Edition (1991), McGraw-Hill.

Tatom, J. A. "The Marginal Welfare Cost of the Revenue from Money Creation and the Optimal Rate of Inflation" The Manchester School (1979), 47 (4), pp 359-368.