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The Long-Run Costs of Moderate Inflation

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By Gregory D. Hess and Charles S. Morris

Long-run price stability is generally considered to be a primary goal of monetary policymakers in many countries. One reason policymakers care about inflation is that it can harm economic performance. Numerous studies of the impact of inflation on economic performance have focused on whether increases in inflation reduce economic growth in the long run (Barro, Fischer 1993, Bruno and Easterly, and Clark). These studies have found that prolonged *high* inflation does in fact reduce economic growth, but they were not able to detect a significant long-run relationship between real growth and low or moderate inflation. Because anti-inflationary policies typically have short-run costs, such as higher unemployment and slower economic growth, the results from these studies may lead people to ask whether such policies are appropriate when inflation is low or moderate.

It is contended here that anti-inflationary policies may be appropriate, even if low to moderate long-run inflation does not reduce long-run growth, if inflation harms the economy in other ways. Three potentially harmful consequences of inflation are considered: (1) inflation uncertainty, (2) real growth variability, and (3) relative price volatility. These consequences are costly because they reduce economic efficiency—and therefore the level of economic output—and consumer welfare.

This article discusses the costs of inflation uncertainty, real growth variability, and relative price volatility, and examines their empirical relationship with inflation. The article shows that inflation uncertainty, real growth variability, and relative price volatility all tend to rise as long-run inflation rises from low to moderate levels. As a result, it is concluded that policymakers may find it justifiable to pursue anti-inflationary policies even when inflation is low.

DOES INFLATION UNCERTAINTY RISE WITH INFLATION?

One possible consequence of rising inflation is that inflation uncertainty may also rise. Inflation uncertainty is costly to an economy because it can lead to higher real interest rates, which in turn reduces real economic activity and consumer welfare. However, inflation may not be associated with greater inflation uncertainty if inflation is only moderate. This section discusses the costs of inflation uncertainty and shows that

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inflation uncertainty is higher in countries with moderate long-run inflation rates than in countries with low long-run inflation rates.[1]

Why is inflation uncertainty costly?

To understand how inflation uncertainty raises real interest rates, it is useful to consider how nominal interest rates respond to expected price increases. A simple example involves the purchase of a 1-year Treasury bill. If there were no uncertainty about inflation, the nominal interest rate on the bill would equal the sum of the real return required by investors to purchase the bill and the expected inflation rate over the 1-year investment horizon. The real return is the amount that investors would require in order to part with their money for a year in the absence of inflation. With inflation, however, the bill's principal will purchase fewer goods and services at the end of the year than at the beginning. For the principal to buy the same amount of goods and services when the bill matures, the return on the bill must be boosted by the inflation rate. Since the interest rate is determined when the bill is purchased, the interest rate can only incorporate the *expected* inflation rate as opposed to the actual inflation rate.

Accounting for expected inflation still may not fully insulate investors or borrowers from the risk of inflation because actual and expected inflation are rarely equal. If actual inflation turns out to be greater than expected, then the investor's real return is less than initially anticipated. Conversely, if actual inflation is less than expected, borrowers end up paying more than is necessary to compensate investors for the loss of purchasing power caused by inflation. Thus, unexpected inflation—the difference between actual and expected inflation—leads to a transfer of wealth between investors and borrowers. Borrowers lose when inflation is unexpectedly low, while investors lose when inflation is unexpectedly high.

To compensate investors for the risk of unexpected inflation, nominal interest rates also include an inflation risk premium in addition to the expected inflation premium. In general, risk averse investors will hold a risky asset only if its return is higher than the return on a comparable, less risky asset. For example, corporate bonds typically pay higher rates than comparable Treasury bonds because corporations can default on their bonds while a default by the U.S. Treasury is highly unlikely. The nominal interest rate on a bond or any other fixed income asset, then, is the sum of the required real return in the absence of inflation, expected inflation, and any premiums required to compensate investors for the risks associated with the asset. And, one of those risks is uncertainty about future inflation.

In addition to higher nominal interest rates, inflation uncertainty may also lead to higher real interest rates. Real rates are the difference between nominal rates and expected inflation. To the extent that inflation uncertainty leads to an inflation risk premium, the increase in nominal rates will directly increase real rates. Indeed, according to one study, the effect of inflation uncertainty on real rates could be as high as 1.25 percentage points (Campbell).[2]

Higher real interest rates due to inflation uncertainty are costly because they reduce economic activity and consumer welfare. Economic activity and consumer welfare are directly affected because higher real rates reduce spending in interest-sensitive sectors of the economy, such as housing, business investment, and consumer durables. Moreover, if the rise in real rates leads businesses to substitute labor for capital in the production process, production efficiency will fall, leading to a further loss of real output.

While inflation uncertainty may be costly, it is useful to ask why higher inflation might lead to greater inflation uncertainty. For example,

investors might be just as uncertain about future inflation when there is no inflation as when inflation is 10 percent. One reason why inflation and inflation uncertainty may rise together is that the public could become more uncertain about the central bank's attitude toward inflation when inflation increases (Ball). When inflation is low, everybody wants to keep it low. But at higher levels, some analysts believe, central banks face a short-run tradeoff between inflation and real growth and unemployment—that is, lower inflation can be achieved only at the expense of lower growth and higher unemployment in the short run. This tradeoff makes it more difficult to predict the central bank's actions and, ultimately, the future course of inflation. For example, central bankers who are primarily concerned with inflation might move immediately to lower inflation, while those less committed to controlling inflation might not do so because it could sacrifice jobs and real growth. Thus, inflation uncertainty might rise with inflation because the central bank's response to inflation becomes less certain when inflation is high.[3]

Another reason rising inflation might lead to greater inflation uncertainty is that low inflation might not be the principal goal of policymakers (Cukierman and Meltzer). According to this view, policymakers who care more about preventing recessions than maintaining low inflation are likely to adopt policy procedures that make it easier to stimulate the economy but harder to control inflation. For example, a country might choose to target broad monetary aggregates, which by their nature cannot be closely controlled by the central bank. Such a procedure, according to Cukierman and Meltzer, allows policymakers to stimulate the economy at the expense of higher inflation, while attributing the rise in inflation to the uncontrollability of money. To the extent that countries not committed to low inflation adopt such procedures, the variability of monetary policy—and therefore inflation uncertainty—will rise with inflation.

Empirical results

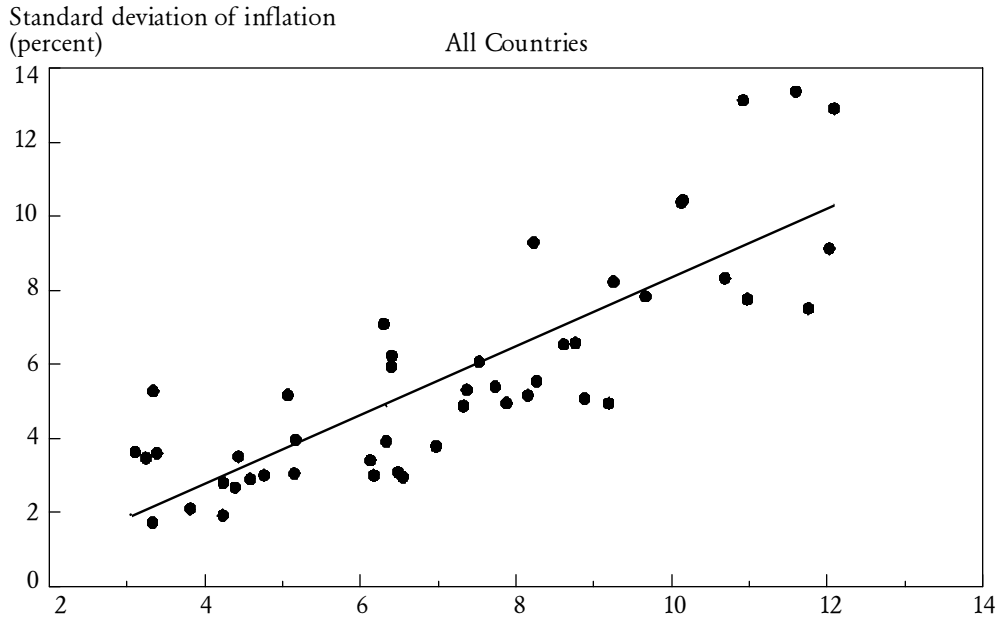
While inflation uncertainty might in theory be positively related to inflation, the relationship might not exist empirically. Golob (1993, 1994) surveyed 21 studies of the relationship between inflation and inflation uncertainty and found that 17 of the studies suggested a positive relationship. In his own study, Golob (1994) also found that inflation uncertainty rises with inflation. Many of these studies, however, focused on the short-run relationship between inflation and inflation uncertainty in individual countries. Moreover, while others examined inflation and inflation uncertainty across countries over longer periods of time, many of these studies compared only a few countries or have become outdated. This article addresses these empirical problems by examining recent data from 47 countries with low to moderate rates of inflation over long periods of time.[4] The results, as described below, indicate a strong long-run positive relationship between inflation and inflation uncertainty.

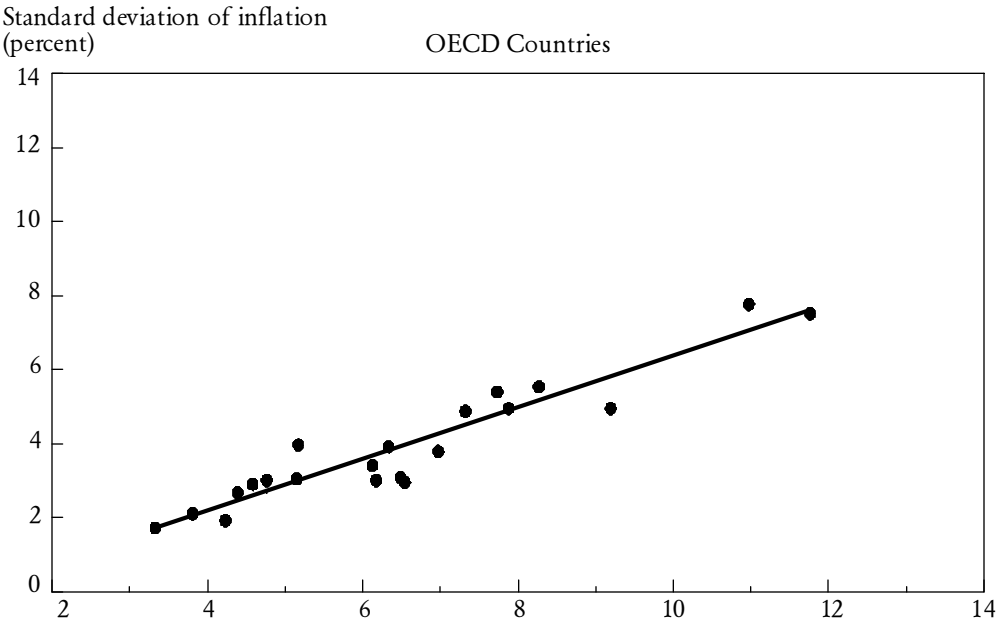
Chart 1 shows the relationship between inflation and inflation uncertainty for 47 low-to-moderate inflation countries (top panel), and for 21 industrialized countries (bottom panel). The long-run inflation rate for each country is measured on the horizontal axis by the average growth in the Consumer Price Index (CPI). The inflation rates are averaged for most countries over a 33-year period from 1960 to 1992.[5] The average annual inflation rate for every country in the sample is low to moderate—less than 15 percent a year. Inflation uncertainty is measured on the vertical axis by the standard deviation of inflation. The standard deviation of inflation measures the typical difference between a country's annual inflation rate and its average inflation rate over the sample period.[6]

The top panel of the chart shows that the long-run relationship between inflation and inflation

Chart 1

INFLATION AND INFLATION UNCERTAINTY





Source: Authors' calculations from the *International Financial Statistics*.

uncertainty for the entire sample of countries is positive and strong. One summary measure of the relationship between inflation and inflation uncertainty is the correlation among the data. For data that are positively related, the correlation coefficient can vary between zero (no relationship) and one (a perfect positive relationship). The correlation coefficient for the whole sample of countries is 0.83 and is highly statistically significant—the probability that there is no correlation is less than 0.1 percent. The solid line represents the regression of inflation uncertainty on inflation, which measures the average response of inflation uncertainty to a change in inflation. The regression line has a slope of 0.93, indicating that inflation variability moves almost one-for-one with inflation across countries.

The bottom panel of Chart 1 shows that the positive relationship between inflation and inflation uncertainty for industrialized countries is even stronger. This chart is the same as the top one except that it includes just 21 countries that belong to the Organization for Economic Cooperation and Development (OECD).[7] The correlation between inflation and inflation uncertainty is 0.95 and is also statistically different from zero at less than the 0.1 percent level. The regression line shows that inflation variability is less responsive to inflation in the OECD countries than for the sample as a whole—on average, a one percentage point increase in inflation is associated with a 0.70 percentage point increase in the standard deviation of inflation.

DOES VARIABILITY OF REAL GROWTH RISE WITH INFLATION?

A second potential consequence of inflation is that the growth of real output may become more variable. More variable real growth reduces the likelihood that the economy will operate at its full potential, reducing consumer welfare and economic efficiency. At issue, as with inflation uncertainty, is whether real growth variability is empirically related to inflation in low-to-moderate inflation countries. The empirical results presented in this section show a positive and statistically significant long-run relationship between inflation and the variability of real output growth for these countries.

Why is highly variable real output growth costly?

An important goal of policymakers is to help ensure the economy produces goods and services at its full potential. Potential output is what an economy produces when labor and capital are fully employed. When an economy operates below potential, consumer welfare is reduced as unemployment rises above the full employment rate and capital is underutilized. Conversely, when the economy operates above potential, labor shortages put upward pressure on wages and prices, causing inflation to rise and consumer welfare to fall. Moreover, to the extent that labor shortages lead to longer working hours and greater strains on capital equipment, production efficiency may decline.

As the variability of real output growth rises, the economy is less likely to produce at its full potential. When an economy is producing at full potential—that is, actual real output equals potential output—it will continue to operate at potential only if actual output grows at the same rate as potential. But if actual real output grows faster than potential, it will raise inflationary pressures, while if real output grows slower it will raise unemployment. Because potential output tends to grow steadily, actual real output will deviate from potential more often if real growth is highly variable.

Greater variability of real growth due to higher inflation is costly because it reduces consumer welfare and economic efficiency. Consumer welfare and production efficiency will fall because the economy will more often operate either above

or below potential output. In addition, since greater output fluctuations affect the availability of goods and services, consumer welfare will be further reduced. Finally, because labor and capital markets are subjected to the fits and starts of increased output fluctuations, productive efficiency will also fall.

Higher inflation might lead to greater variability of real growth for the same reasons that it leads to greater inflation uncertainty. As discussed earlier, policymakers may not be committed to low inflation and therefore might follow monetary policy procedures that lead to both higher inflation and highly variable policy actions. Since changes in monetary policy affect real output in the short run, more variable policy actions might cause real output growth to become more variable when inflation rises.[8]

Empirical results

Only a few studies have investigated the relationship between inflation and the variability of real output growth. While these studies have found a positive relationship, they are either outdated or focus on industrial production, which is a fairly narrow measure of real output.[9] This analysis uses more recent data, a broader measure of real output, and a larger cross section of countries to show that inflation is positively related to real growth variability in the long run.

The positive relationship between inflation and real growth variability is shown in Chart 2. The horizontal axis shows the same average inflation rates used in Chart 1. The variability of real growth for each country is measured on the vertical axis by the standard deviation of per capita real GDP growth.[10] The solid line represents the regression of real growth variability on inflation. The correlation coefficient for the whole sample (top panel) is 0.33 and is statistically significant at the 2.6 percent level. The positive relationship between inflation and real growth variability for the sample of 21 OECD countries (bottom panel) is almost twice as strong—the correlation coefficient is 0.60 and is statistically significant at the 0.4 percent level. The regression lines on the two charts indicate that, on average, a one percentage point increase in inflation is associated with 0.24 percentage point increase in real growth variability for the whole sample, and a 0.19 percentage point increase in real growth variability for the OECD countries.

DOES RELATIVE PRICE VOLATILITY RISE WITH INFLATION?

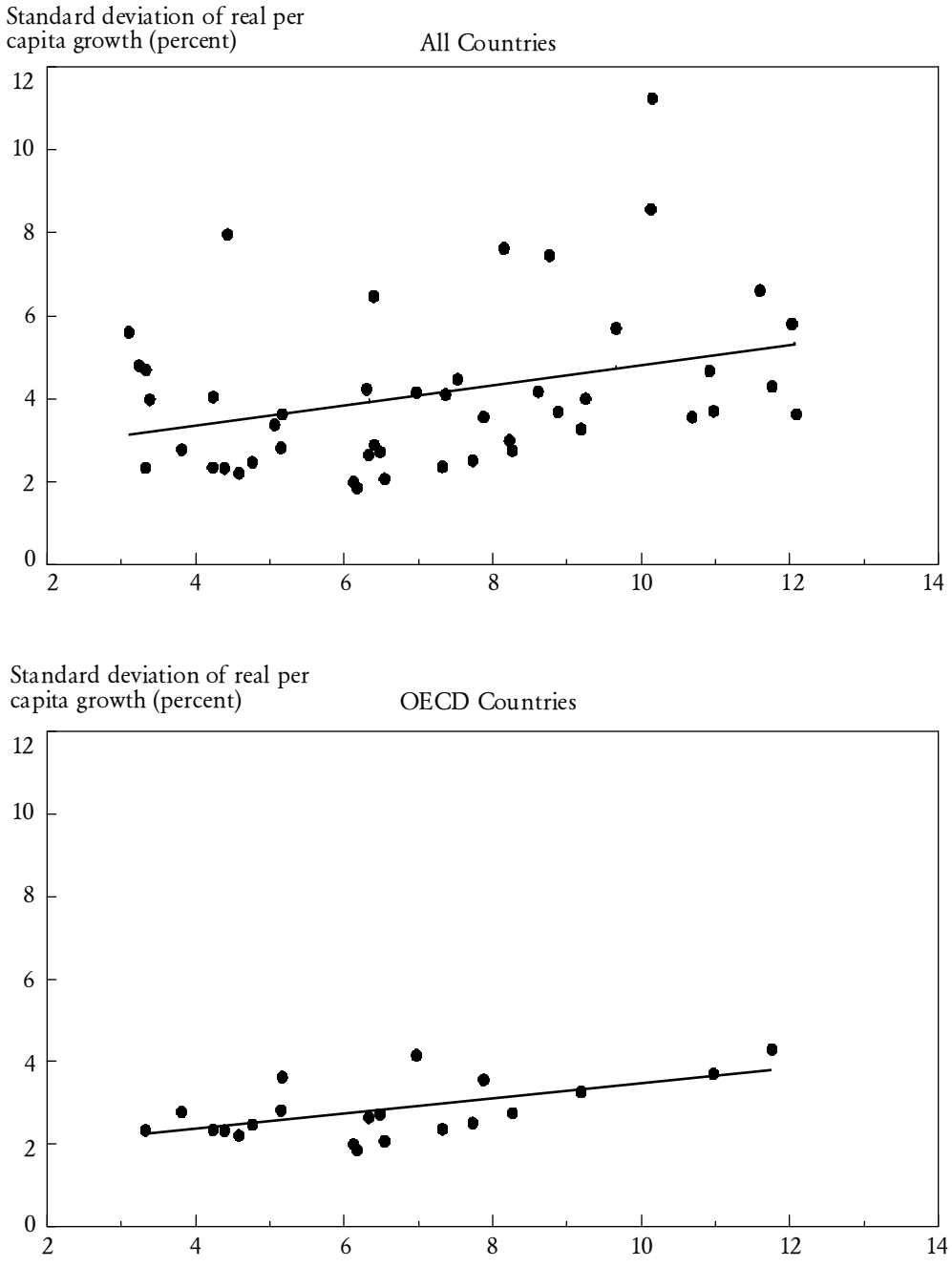
A third potential consequence of inflation is that relative prices might become more volatile. The relative price of a good is its price relative to the price of another good or, more typically, to the price of a basket of goods such as the CPI. While some relative price variability is necessary for a market economy to function efficiently, excessive relative price volatility can reduce economic efficiency, making consumers and businesses worse off. This section discusses the costs of excessive relative price volatility and shows that countries with moderate long-run inflation rates have greater relative price volatility than countries with low long-run inflation rates.

Why is excessive relative price volatility costly?

In a market economy, relative prices are the key variables used by consumers and businesses to determine what and how much to consume and produce. The demand for oranges, for example, depends on the relative price of oranges. If the price of oranges rises relative to, say, the price of apples, consumers will demand fewer oranges and more apples. But if the prices of apples and everything else goes up by the same percentage as oranges, so that relative prices do not change, consumers will demand the same amount of oranges as before. Similarly, businesses choose

Chart 2

INFLATION AND REAL GROWTH VARIABILITY



Source: Authors' calculations from Summers and Heston (1991) and the International Financial Statistics.

the relative amounts of labor and machinery to use according to the relative prices of labor and capital—the cheaper labor is relative to capital, the more labor that a business will use in its production process.

A market economy produces the optimal amount of goods and services if relative prices are determined by fundamental demand and supply. The demand for oranges, for example, indicates how many oranges a person wants to buy given the relative price—the higher the price, the lower the demand. When the relative price is determined solely by demand and supply, the amount of oranges that people want to consume will equal the amount produced. Because consumers get exactly what they desire, the amount of oranges consumed and produced is optimal.

For relative prices to depend solely on demand and supply conditions, relative prices must change when demand and supply conditions change. Suppose a hard freeze in Florida kills a large share of the season's orange crop, reducing the supply of oranges. At the initial price, consumers will demand more oranges than are available, creating a shortage. The shortage, in turn, will put upward pressure on the relative price, causing consumers to switch from oranges to other types of fruit. The price of oranges will continue to rise until it reaches a level at which the amount of oranges that consumers want to buy equals the smaller supply. At this higher price, the amount of oranges consumed equals what is available and is, once again, optimal. Thus, for the price system to work best, relative prices must respond to changes in demand and supply.

But excessive changes in relative prices unrelated to changes in demand and supply are costly to the economy because they lead people to make decisions that are inconsistent with their fundamental desires. Suppose the government taxes oranges but not other types of fruit. In the short run, people will demand fewer oranges and more apples, creating an orange surplus and an apple shortage. Over time, orange production will subside and apple production will rise until a balance is reached between the demand for, and supply of, each type of fruit. In this case, however, people are not consuming the amount of oranges or apples based on their fundamental demands. In general, any policy that obscures the true relative price of goods and services reduces consumer welfare because it leads people to make choices that are not in accord with their interests. Moreover, to the extent the relative prices of labor and capital are altered, real output will be lower because businesses will choose less efficient methods of production.[11]

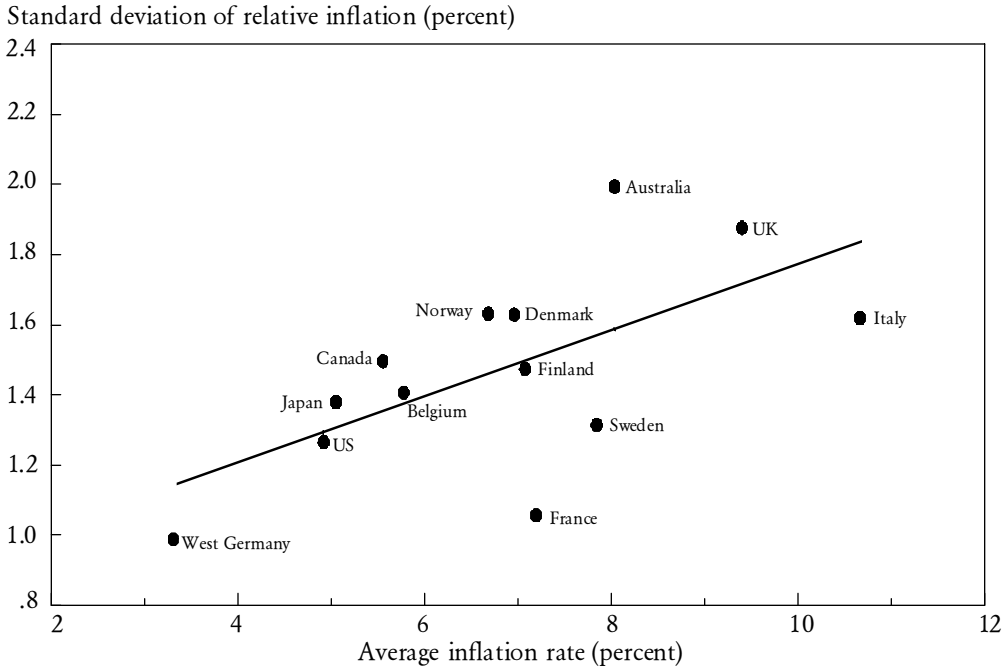
Inflation is potentially a main source of excessive changes in relative prices that are unrelated to fundamental changes in demand and supply. One reason inflation might lead to excessive relative price variability is that it is costly to change prices often (Fischer 1981). For example, restaurants do not change their prices daily because it is costly to reprint menus. When inflation rises, according to this "menu" cost view, a business will raise prices only if the increase in its costs reduces profits by enough to make the effort worthwhile. Since the cost of changing prices varies across industries, some businesses will change their prices for a given increase in inflation while others will not. As a result, as long as an increase in inflation leads firms to reset prices in a staggered or nonsynchronized pattern, an increase in inflation will lead to excessive changes in relative prices.[12]

Empirical results

Many studies have examined the relationship between inflation and relative price volatility, and most have found a positive relationship (Golob 1993). The implications of these studies for industrialized countries with low to moderate

Chart 3

INFLATION AND RELATIVE PRICE VOLATILITY
(Group A)



Source: Authors' calculations from Meyer zu Schlochtern and Meyer zu Schlochtern (1994) and *International Financial Statistics.*

inflation are limited, however, because the focus has generally been on high inflation countries and on the short-run impact of inflation instead of the long-run impact.[13] This section focuses on the long-term impact of low to moderate inflation on relative price volatility by using data averaged over long periods of time for several OECD countries. The results indicate that relative price volatility is higher in moderate inflation countries than in low inflation countries.

The data on relative price variability are constructed from the OECD Sectoral Data Base (Meyer zu Schlochtern and Meyer zu Schlochtern). This data set contains measures of nominal and real output from several sectors for 14 OECD countries.[14] The availability of data by sector varies across countries, however, creating a necessary tradeoff between the number of countries and the number of sectors that can be included in the measure of relative price volatility. In other words, increasing the number of sectors included in the measure of relative price volatility requires reducing the number of countries that can be used. Because of this tradeoff, two data sets are used to examine the relationship between inflation and relative price volatility. The first data set (Group A) uses 13 of the 14 countries but includes only six sectors. The second data set (Group B) uses seven countries and includes 14 sectors (appendix).[15]

Chart 3 shows the long-run relationship between inflation and relative price volatility for

Table 1

CORRELATIONS BETWEEN INFLATION AND RELATIVE PRICE VOLATILITY

	Sample period				
	Whole sample	Whole sample (Exc. 1973 and 1979)	1970-80	1981-91	Pooled (Cols. 3 and 4)
Group A	.63	.67	.53	.67	.74
	(2)	(1)	(6)	(1)	(0)
Group B	.61	.68	.51	.64	.68
	(15)	(9)	(25)	(12)	(1)

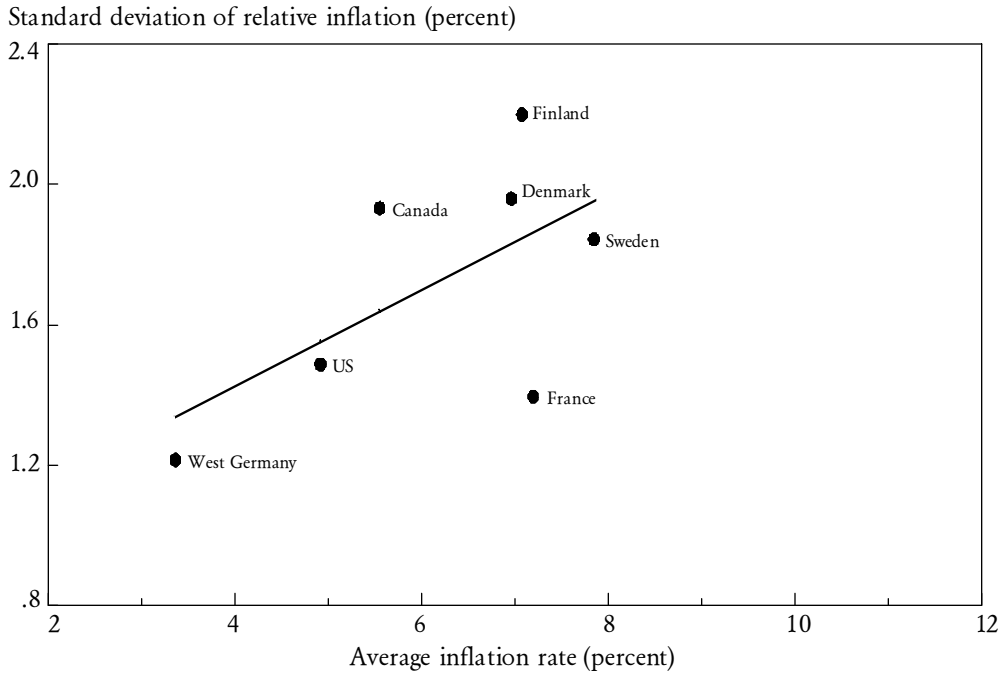
Notes: This table shows the correlation between inflation and relative price volatility over several sample periods for two groups of countries (*p*-values times 100 are in parentheses). Inflation is measured by the annual growth rate of the Consumer Price Index (CPI) averaged over the sample period. Relative price volatility is measured by the standard deviation of relative inflation across sectors averaged over the sample period (see endnote 17 for details on the construction of the measure of relative price volatility). The CPI data are from the International Financial Statistics (IFS) tapes, and the relative price data were constructed by the authors from the Organization for Economic Cooperation and Development (OECD) Sectoral Data Base (Meyer zu Schlochtern and Meyer zu Schlochtern). Group A consists of 13 countries and six sectors, and group B consists of seven countries and 14 sectors (appendix). The results in column 2 are from data averaged over all of the available sample years excluding the oil price shock years of 1973 and 1979. The pooled results come from combining the observations averaged over the years from 1970 to 1980 (column 3) and the observations averaged over the years from 1981 to 1991 (column 4).

the 13 countries in Group A. As in the previous charts, inflation is measured along the horizontal axis by the annual average growth rate of the CPI.[16] The time period over which inflation is averaged varies across countries from 20 to 32 years depending on the availability of sectoral output data. The average inflation rates vary from a low of 3.4 percent in West Germany to a high of 10.7 percent in Italy. On the vertical axis, relative price volatility for each country is measured by taking the standard deviation of relative inflation across sectors in each year and then averaging the results over the available sample period.[17] The standard deviation of relative inflation measures the typical deviation of the individual sectoral inflation rates from the average inflation rate across sectors. For example, Italy's average standard deviation of relative inflation over the whole sample is 1.6 percent, which indicates that the typical sector's inflation rate differed from the average inflation rate by 1.6 percentage points.

The chart shows that the long-run relationship between inflation and relative price volatility for the Group A countries is positive and strong. The correlation coefficient is 0.63 and is statistically significant—the probability that there is no correlation is just 2 percent (Table 1). Moreover, the relationship between inflation and relative price volatility is not only statistically significant but also economically significant for these relatively low inflation countries. The solid line on Chart 3, which represents the regression of relative price

Chart 4

INFLATION AND RELATIVE PRICE VOLATILITY
(Group B)



Source: Authors' calculations from Meyer zu Schlochtern and Meyer zu Schlochtern (1994) and *International Financial Statistics.*

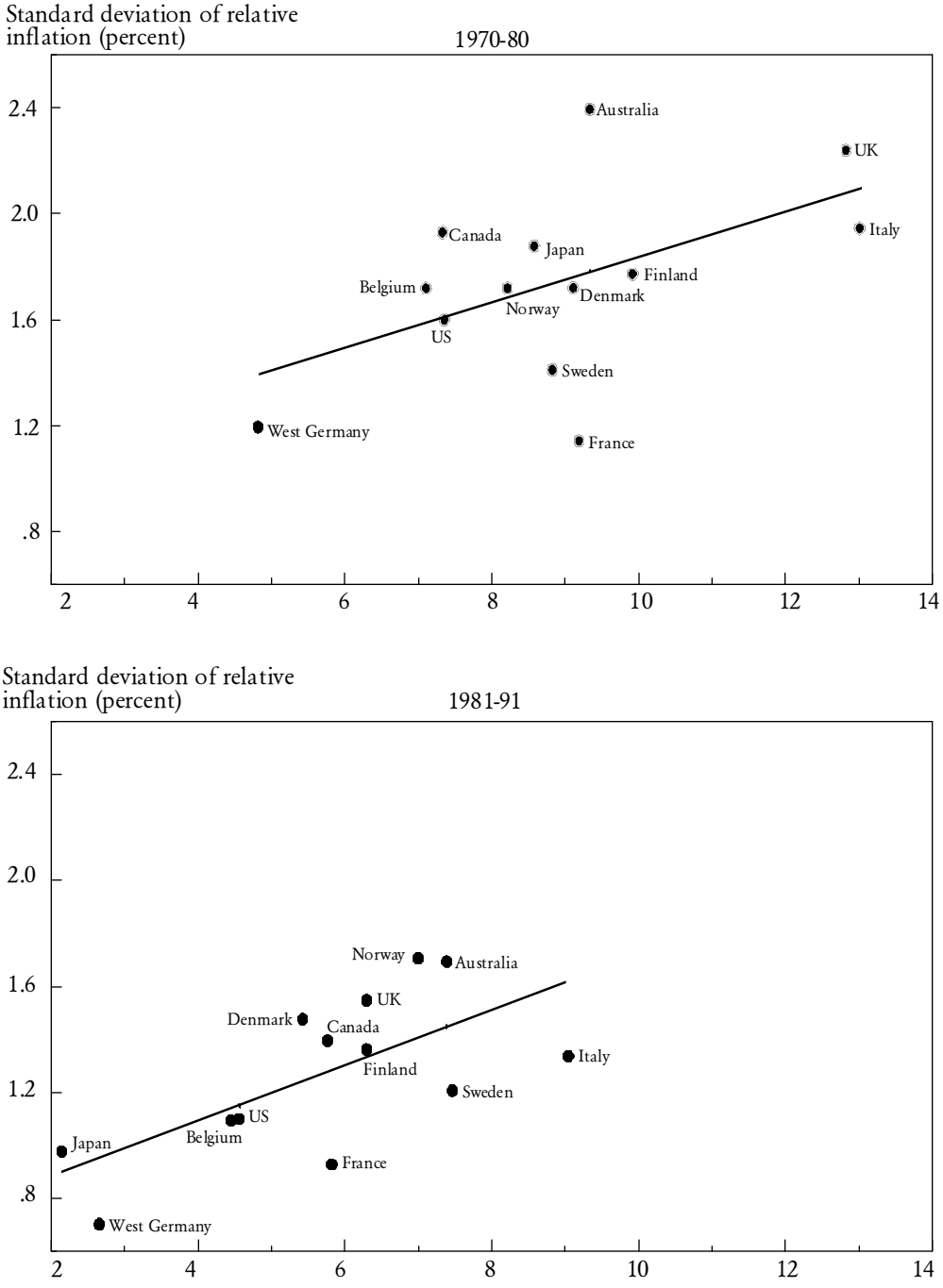
volatility on inflation, indicates that, on average, a one percentage point increase in inflation is associated with a 0.09 percentage point increase in relative price volatility. Thus, for example, a reduction in Italy's inflation rate from 10.7 percent to West Germany's 3.4 percent would be associated with about a 40 percent decline in Italy's relative price volatility (0.09 percentage point times the 7.3 percent decline in inflation divided by Italy's relative price volatility of 1.6 percent).

Using more sectors to compute relative price volatility does not qualitatively change the results (Chart 4). The correlation coefficient for the Group B countries is 0.61, about the same as for Group A, although it is not statistically significant at conventional significance levels (Table 1). The lack of significance is not totally unexpected, however, because there are only seven countries.

A potential problem with interpreting the correlations between inflation and relative price volatility is whether inflation leads to greater relative price volatility or relative price volatility leads to greater inflation. For example, relative price shocks, such as the sharp increases in oil prices in 1973 and 1979, can lead to temporary increases in inflation. To see whether the results are due to such relative price shocks, the correlations were recalculated after excluding data from 1973 and 1979 (Table 1). The second column of the table shows that excluding the years of the oil price shocks actually increases the correlations slightly. In fact, the correlation for Group B

Chart 5

INFLATION AND RELATIVE PRICE VOLATILITY



Source: Authors' calculations from the *International Financial Statistics*.

Table 2
CORRELATION BETWEEN INFLATION AND RELATIVE PRICE VOLATILITY
(by country)

Country	Group A	Group B
Australia	.35 (11)	
Belgium	.64 (0)	
Canada	.25 (8)	.41 (3)
Denmark	-.09 (67)	-.29 (17)
Finland	.46 (1)	.54 (0)
France	-.11 (65)	.41 (7)
Italy	.44 (4)	
Japan	.70 (0)	
Norway	.26 (18)	
Sweden	.04 (87)	.19 (4)
United Kingdom	.09 (67)	
United States	.29 (3)	.53 (0)
West Germany	.27 (19)	.31 (12)
Pooled correlation	.30 (0)	.39 (0)

Notes: This table shows the correlation between inflation and relative price volatility using annual time series data for each country (*p*-values times 100 are in parentheses). Definitions of the variables and data sources are in the notes to Table 1. The correlations are partial correlations calculated from a regression of relative price volatility on inflation, an oil price dummy for 1973 and 1979 representing the oil price shocks, and the oil price dummy interacted with inflation. The U.S. regressions also include a price control dummy that equals 1 in 1971 and 1972 and -1 in 1973 and 1974. The correlation for the row labeled "Pooled correlation" is from a regression that combines all of the data and that includes an intercept dummy for every country except the United States. The data are annual observations, and the number of observations for the individual countries varies from 20 to 32. The pooled regressions included 330 observations for Group A and 193 observations for Group B. For all regressions, the last observation was in either 1990, 1991, or 1992.

becomes statistically significant at less than the 10 percent level.

Another way to check the sensitivity of the results to the oil shock years is to see whether the correlations differ between the 1970s and the 1980s (Chart 5 and Table 1). The charts and table indicate that the positive relationship is stronger in the 1980s than in the 1970s, suggesting that the results are not due to the effect of oil prices on inflation. The top panel of Chart 5 shows the Group A data averaged over the years from 1970 to 1980, while the bottom panel shows the data averaged over the years from 1981 to 1991. Columns 3 and 4 of Table 1 show the corresponding correlations. Both panels of the chart show a positive relationship between inflation and relative price volatility, with the primary difference being that inflation and relative price volatility were uniformly higher in the 1970s than in the 1980s. In addition, the data in the 1980s chart are less dispersed around the regression line, indicating a tighter relationship. This tighter relationship is confirmed in the table—the correlation coefficient for the 1980s is higher and more significant than the correlation coefficient for the 1970s. Finally, if the 1970s and 1980s data are combined, the correlation coefficient is 0.74 and is statistically significant at less than the 0.1 percent level (Table 1, Column 5). Dividing the Group B data between the 1970s and 1980s produces results almost identical to the Group A results (Table 1). Thus, the positive relationship between inflation and relative price variability does not appear to be due to relative price shocks leading to greater inflation.

The analysis in this section has focused on the long-run relationship between inflation and relative price volatility by using the cross-country data. As a final check on the robustness of the results, it is useful to see whether the relationship between inflation and relative price volatility over time is consistent with the cross-section results and the results of previous studies. As shown in Table 2, the correlation over time between inflation and relative price volatility is positive for most countries. The correlations for each country are partial correlations that control for the oil price shocks in 1973 and 1979.[18] For Group A, Denmark and France are the only countries with negative correlations, but the correlations are far from conventional levels of statistical significance. Among the other 11 countries with positive correlations, the correlations are significantly different from zero at less than the 10 percent level for six countries—Belgium, Canada, Finland, Italy, Japan, and the United States. For Group B, Canada, Finland, France, Sweden, and the United States have significantly positive correlations. When the data for each group are combined into a single regression, the correlation coefficient for each group is positive and highly significant. Thus, the time series data appear to be consistent with both the cross-section results presented here and the results of previous studies.

CONCLUSIONS

Long-run price stability is an important goal of policymakers in many countries. Because anti-inflationary policies are costly in the short run, though, it is useful to ask whether there are any costs of allowing even low inflation to rise. This article has identified three potential consequences of inflation—inflation uncertainty, real growth variability, and relative price volatility. The article argues that these consequences are harmful to the economy because they reduce economic efficiency—and therefore the level of economic output—and consumer welfare. Using long-run data from countries with low to moderate inflation, the article shows that rising inflation is associated with greater inflation uncertainty, real growth variability, and relative price volatility. These results suggest there are long-run benefits to keeping inflation from rising from even low levels.

APPENDIX
COMPOSITION OF GROUPS

Group A

Countries	Sectors
Australia	Agriculture
Belgium	Construction
Canada	Manufacturing
Denmark	Services (community, social, and personal)
Finland	Transportation (transport, storage, and communications)
France	Utilities (electricity, gas, and water)
Italy	
Japan	
Norway	
Sweden	
United Kingdom	
United States	
West Germany	

Group B

Countries	Sectors
Canada	Agriculture
Denmark	Basic metal products
Finland	Chemicals
France	Construction
Sweden	Food (food, beverages, and tobacco)
United States	Machinery and equipment
West Germany	Nonmetallic mineral products
	Other manufactured products
	Paper (paper, printing, and publishing)
	Services (community, social, and personal)
	Textiles
	Transportation (transport, storage, and communications)
	Utilities (electricity, gas, and water)
	Wood and wood products

ENDNOTES

1 Golob discusses in greater detail the costs of inflation uncertainty (1994) and why inflation uncertainty might rise with inflation (1993, 1994).

2 Campbell estimates that the inflation risk premium ranges from -0.25 to 1.25 percentage points. Shen argues that the inflation risk premium can be negative because bond issuers might be compensated for their exposure to inflation risk by paying a lower rate on their bonds. The sign on the risk premium depends on whether issuers or investors are more risk averse—specifically, if issuers are more risk averse, then the inflation risk premium may be negative.

3 This argument was first recognized by Milton Friedman (p. 466) in his Nobel prize acceptance speech: "A burst of inflation produces strong pressure to counter it. Policy goes from one direction to the other, encouraging wide variation in the actual and anticipated rate of inflation. And, of course, in such an environment, no one has single-valued anticipations. Everyone recognizes that there is great uncertainty about what actual inflation will turn out to be over any specific future interval."

4 The countries in the sample are the same as those used in the next section to examine the relationship between inflation and the variability of real growth. The real output data in that sample are from the Penn World Table Mark 5.6 data set constructed by Summers and Heston. A country was included if (1) its data were at least C– quality as determined by Summers and Heston, (2) it was not an outlier in Clark's study of the relationship between inflation and per capita real GDP growth, (3) it had at least 25 years of inflation data beginning after 1959, and (4) its average annual inflation rate over the sample was no greater than 15 percent. The countries excluded for reasons other than data quality, with the reason for exclusion in parentheses, are Morocco (2), Tanzania (4), Tunisia (3), Jamaica (2), Mexico (2), Colombia (2), Ecuador (4), Hong Kong (2), India (2), Indonesia (2), South Korea (2), Iceland (2), and Turkey (2).

The countries in the sample are Austria, Australia, Bangladesh, Barbados, Belgium, Canada, Costa Rica, Cyprus, Denmark, Dominican Republic, El Salvador, Finland, France, Greece, Guatemala, Honduras, Ireland, Italy, Ivory Coast, Japan, Kenya, Luxembourg, Malaysia, Malta, Netherlands, New Zealand, Norway, Pakistan, Panama, Paraguay, Philippines, Portugal, Senegal, Singapore, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Syria, Thailand, Trinidad & Tobago, United Kingdom, United States, Venezuela, West Germany, and Zimbabwe.

5 Annual inflation data were available for the whole sample for 42 of the 47 countries. The smallest sample was 25 years. The data are from the International Financial Statistics (IFS) data base.

6 Golob (1993, 1994) provides a detailed discussion of alternative measures of inflation uncertainty. Some studies use surveys of consumers and economists. Other studies measure inflation uncertainty using econometric models that forecast inflation. A third measure is simply the variability of actual inflation, measured by the variance or standard deviation of inflation over time. This measure implicitly assumes that expected inflation is the average inflation rate over the period of time under study.

Because this article focuses on a broad group of countries, the only feasible measure of inflation uncertainty is the standard deviation of inflation. The sample used here consists of 47 countries, less than half of which are industrialized. As a result, inflation surveys are available for very few of the sample countries. In addition, not only is it infeasible to estimate econometric inflation models for so many countries, but also data are not available to do so for many of the countries.

7 The OECD sample excludes Iceland, Luxembourg, and Turkey. Iceland and Luxembourg are often excluded from long-run studies of OECD countries because of the small size of their economies. Iceland also had a 21 percent average annual inflation rate over the sample. Turkey was excluded because its average annual inflation rate over the sample was 24 percent.

8 More formally, a positive relationship between inflation and real output variability can be derived from a Lucas supply curve, which links deviations in real output from potential to unexpected changes in inflation. The Lucas supply curve can be written as

$$(y_t - y_t^*) = \gamma(\pi_t - \pi_t^e), \gamma > 0,$$

where y is real output, y^* is potential output, π is inflation, and π^e is expected inflation. Given this equation, the variance of real output would be positively related to the variance of inflation. If the variance of inflation is used to measure inflation uncertainty, then higher levels of inflation could lead to greater real output variability through inflation uncertainty.

9 Logue and Sweeney find that CPI inflation is positively related to real growth variability in the long run using data

averaged over the period from 1950 to 1971 for the 24 OECD countries. Katsimbris finds a positive relationship for 6 of the 18 OECD countries that he studies using time series data from 1955 to 1983. Katsimbris only explores the short-run relationship between inflation and real growth variability due to the time series methodology that he uses.

[10] Per capita real GDP is calculated as real GDP (chain weighted) divided by population using the Penn World Table Mark 5.6 data set constructed by Summers and Heston. See endnote 4 for the criteria used to choose the countries included in the data set.

[11] The costs of unwarranted changes in relative prices are exacerbated to the extent individuals enter into long-term relationships using current relative prices as indicators of future prices (Ball and Romer; Tommassi). When relative prices change for reasons unrelated to fundamental demands and supplies, current prices become less informative about future prices. Accordingly, unwarranted changes in relative prices cause customers involved in long-term relationships to either accept the higher prices or incur the costs of searching for a new supplier.

[12] Golob (1993) provides a more detailed discussion of why inflation might cause greater relative price volatility.

[13] The short-run focus of previous studies is due to the time series methodologies that they use. Glejser uses cross-country data to analyze whether inflation leads to greater relative price volatility, but his study uses data only through 1958.

[14] Summing the output across sectors does not equal total GDP because the data base does not include all sectors of the economy. The number of years for which sectoral output data are available varies across countries from 20 (1971 to 1990 for Belgium) to 32 (1961 to 1992 for Finland). The samples are fairly current—every country has data through either 1990, 1991, or 1992.

[15] The Netherlands is excluded from the sample because data were not available for too many sectors.

[16] The CPI inflation data are the same IFS data used in the previous charts and are not from the OECD Sectoral Data Base.

[17] Specifically, relative price volatility for each country is measured by the weighted standard deviation

$$SD_t = \left[\sum_{i=1}^{n} w_{i,t} \left(\pi_{i,t} - \pi_t\right)^2 \right]^{1/2}$$

$$\pi_t = \sum_{i=1}^{n} w_{i,t} \pi_{i,t} ,$$

where $\pi_{i,t}$ is the inflation rate in the i^{th} sector at time t, $w_{i,t}$ is the weight for the i^{th} sector at time t, and n is the number of sectors (Parks). The weight for the i^{th} sector at time t, $w_{i,t}$, is the ratio of real output in the i^{th} sector at time t to the sum of the sectoral real outputs at time t. Note that the weights sum to 1 at each point in time. The inflation rate for each sector is calculated by first creating the implicit deflator for each sector as the ratio of nominal to real output, and then differencing the logs of the implicit deflators. Note that the aggregate inflation rate, π_t, is a Divisia aggregate—it is the weighted sum of the inflation rates for each sector—and is not the CPI or GDP deflator. In addition, the aggregate inflation rate for a given country differs for Group A and Group B because the number of sectors differ.

[18] The correlations are partial correlations calculated from a regression of relative price volatility on inflation, an oil price dummy for 1973 and 1979 representing the oil price shocks, and the oil price dummy interacted with inflation. The U.S. regressions also include a price control dummy that equals 1 in 1971 and 1972 and -1 in 1973 and 1974. The correlation for the row labeled "Pooled correlation" is from a regression that combines all of the data and that includes an intercept dummy for every country except the United States. The data are annual observations, and the number of observations for the individual countries varies from 20 to 32. The pooled regressions included 330 observations for Group A and 193 observations for Group B. For all regressions, the last observation was in either 1990, 1991, or 1992.

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