Output, Growth, Welfare, and Inflation: A Survey

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Formal statistical analyses fail to find a significant positive correlation between inflation and per capita output growth.

Inflation's effect on economic activity, and ultimately on people's well-being, is a primary concern of monetary policymakers and has been the focus of much study. For instance, analysts have questioned whether a permanent change in the inflation rate raises or lowers the rate of economic growth.

In this article, I review both theoretical and empirical literature on this subject. I begin with the theoretical literature, which examines the relationship between monetary policy and welfare, the level of output, and the rate of output growth. Like Stein (1970) and Orphanides and Solow (1990), I find that equally plausible models yield qualitatively different predictions for the relationship between the inflation rate and per capita output. However, when the inflation rate is initially steady at zero and then increases permanently, there is no ambiguity—the average person suffers a welfare loss. Thus, policymakers may face a dilemma: reducing inflation may raise the average person's welfare, but the growth rate of per capita output may fall.

I next survey the empirical literature on the correlation between inflation and per capita output growth. The preliminary evidence shows a significant negative correlation. However, recent studies have raised doubts about this relationship, showing that the correlation may not be robust. In particular, researchers have shown that inflation is not significantly related to per capita output growth when either a common set of control variables is included in the regressions or a different measure of the trend rate of output growth is used. Notably, the formal statistical analyses fail to find a significant positive correlation between inflation and per capita output growth. Thus, with all the caveats, the evidence suggests a nonpositive relationship between inflation and output growth.

The neoclassical growth model is the framework for analysis in this article. Adoption of this framework makes it easier to account for the qualitative differences in the relationship between inflation and output growth. As in previous surveys, there is still disagreement about the direction in which output moves in response to a change in inflation, even in the neoclassical economies. What distinguishes the model economies is the role for fiat money. In some cases, the researcher highlights money's transactions features, whereas others focus on money as a store of value. My review suggests that money's different roles are key determinants of the direction output growth takes in response to a change in inflation.

I also review some recent developments in the inflation–output growth literature. Several researchers have raised the issue of whether permanent changes in the inflation rate can permanently affect the rate of output growth. In the neoclassical model, long-run growth is driven by perpetual technological advancement. Because inflation does not drive technological advancement, movements in the inflation rate potentially affect the growth rate only along the transition path from one steady-state value of the capital–labor ratio to the next. In short, inflation may have permanent effects on output level but not on output growth rates. The endogenous-growth literature, led by Romer (1986) and Lucas (1988), shows that economies can unboundedly grow in equilibrium without exogenous technological change. In view of the Romer and Lucas results, it is natural to wonder whether differences in inflation rates account for any of the differences in growth across countries.

The first section of the article reviews the various mechanisms through which inflation affects capital accumulation in the neoclassical setting. Next, it briefly surveys the theoretical studies on inflation and growth. The third section is an overview of the empirical results on the correlation between inflation and growth. The final section summarizes the survey.

Theories on inflation and growth

Persistent inflation is a post–World War II phenomenon. Before then, the history of price indexes shows bouts of inflation followed by periods of deflation. In other words, the price level cycles showed no discernible upward or downward trend.[1]

In the absence of persistent inflation, the early inflation–output growth theories were built on such cyclical observations. Economic expansions generally coincided with inflation, and contractions typically coincided with deflation.[2] Theory, therefore, sought to account for a positive correlation between inflation and output growth. The textbook aggregate demand–aggregate supply framework could account for a positive correlation between inflation and output growth. In that theory, the chief mechanism is a positive association between aggregate demand and the growth rate of money. Inflation and faster output growth are joint products of faster money growth.

Mundell (1963) was the first to articulate a mechanism relating inflation and output growth through something other than the excess demand for commodities. In Mundell, an increase in inflation immediately reduces people's wealth. To accumulate the desired wealth, people save more, thus driving down the real interest rate. Greater saving means greater capital accumulation and thus faster output growth.

Neoclassical economies. Tobin's (1965) contribution to the inflation–output growth literature is a study of the issue in the context of the neoclassical growth model. Tobin follows Solow (1956) and Swan (1956) in making money a store of value in the economy. Hence, people can save for future consumption by either holding money or acquiring capital. In Tobin's setup, people hold a fraction of their income to meet their transaction needs, despite capital's offering a higher rate of return.

To formalize the portfolio mechanism, consider the following simplified version of Tobin's economy. The model is characterized by the following two equations:

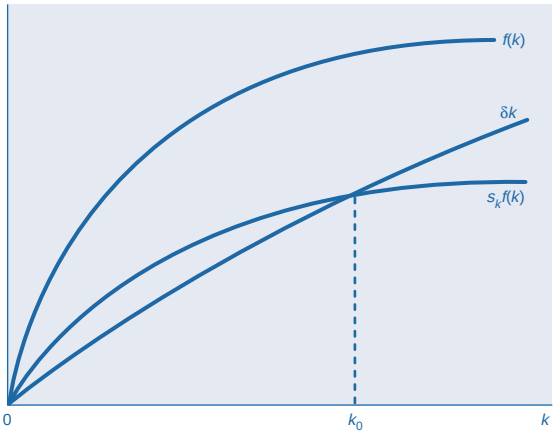
$$(1) \qquad k_{t+1} = (1 - \delta)k_t + i_t, \text{ and}$$

$$(2) \qquad i_t = s_k f(k_t),$$

where k is the capital stock; i is gross investment spending; $f(k)$ is the production technology, using capital as the sole input; δ is the constant rate of capital depreciation; and s_k is the fraction of output saved to acquire additional capital stock.

Equations 1 and 2 describe how this economy operates by characterizing how capital evolves over time and by specifying the equilibrium condition, respectively. In equilibrium, saving, characterized as a known fraction of output, equals gross investment; that is, $s_t = s_k f(k_t) = i_t$. In steady state, the capital stock is constant over time, so that equation 1 reduces to $\delta k = s_k f(k)$. In Figure 1, which depicts the equilibrium for this simple economy, the steady state occurs

Figure 1
Steady State in the Neoclassical Economy



where the δk line intersects the s_k line.

Figure 2 depicts the portfolio mechanism. Consider a once-and-for-all increase in the inflation rate from π_0 to π_1 ($\pi_1 > \pi_0$), which is equivalent to saying that the return to money has fallen. In Tobin's portfolio mechanism, people will substitute away from money, with its lower return, and toward capital. In Figure 2, this substitution is depicted by a shift in the s_k line to s_k'. As Figure 2 shows, the portfolio mechanism results in a higher steady-state capital stock (from k_0 to k_1).

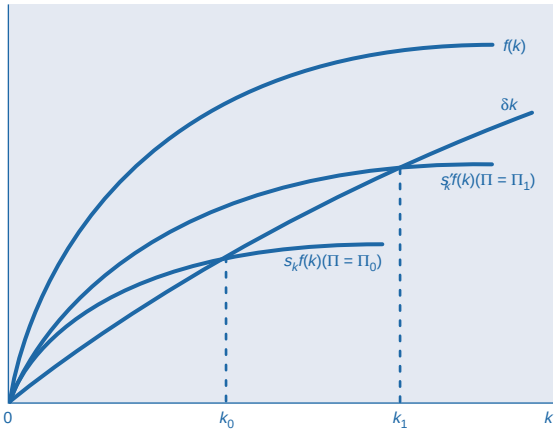
As Figure 2 shows, once the economy has achieved steady state, there is no growth. Instead, Tobin's framework shows that a permanently higher inflation rate permanently raises the level of output. However, the effect on output growth is temporary, occurring during the transition from steady-state capital stock, k_0, to the new steady state with capital stock, k_1.[3] Indeed, growth in the neoclassical economy is driven by exogenous technological advancement—upward shifts in the $f(k)$ curve—not by a once-and-for-all change in the inflation rate.

Within the neoclassical setup, the next major development in the study of inflation effects comes from Sidrauski's (1967) superneutrality result. In Sidrauski's study, people choose the saving ratio to maximize their happiness, as opposed to Tobin's assumption that saving is a fixed ratio of output. Money has an implicit transaction feature in Sidrauski. Formally, this is reflected in the notion that people's happiness is directly related to their holdings of real money balances.[4] The main result in Sidrauski's economy is that an increase in the inflation rate, for example, does not affect the steady-state capital stock. Thus, neither output nor output growth is related to changes in the inflation rate.[5]

Why is Sidrauski's result different from Tobin's? People's saving behavior plays a crucial role in determining whether inflation affects output growth. In Tobin's model, the portfolio mechanism describes how people move from money to capital when inflation rises. In Sidrauski's economy, people's saving ratio falls in response to an increase in inflation, as do their real money balances. Indeed, people match their decline in saving dollar for dollar with a decline in money balances. Capital is unchanged in the Sidrauski model.

To demonstrate that the Tobin effect does not depend on the assumption that saving is a constant fraction of output, I review several model economies in which a Tobin effect is present and people choose their saving rate optimally.

Figure 2
The Tobin Effect



One example is a study by Freeman and Huffman (1991) in which they specify an economy populated by heterogenous people; specifically, people are identifiable by their level of wealth. To consume in the future, people can either hold money or hold capital.[6] The rate of return on money is strictly less than the rate of return on capital, but people willingly hold money because a flat fee must be paid to acquire capital. The fixed cost means that capital's after-fee real return is inversely related to the size of the capital stock purchase. In other words, small savers will prefer to hold money. Provided that people are identical except for their wealth holdings, Freeman and Huffman derive a break-even value for saving, w^*, at which the return to money is identical to the after-fee return to capital. Correspondingly, people saving less than w^* will hold money balances, and people saving more than w^* will prefer capital.

Consider an increase in the inflation rate in the Freeman–Huffman model. With a lower return on their money holdings, some of the small savers who had held money will now find it more appealing to pay the fee and acquire capital. The bottom line is that Freeman and Huffman specify a simple portfolio-substitution effect in an explicit, optimizing framework. As in the Tobin economy, an increase in the inflation rate results in a permanently higher steady-state level of output.

Ireland (1994) also presents a model in which a Tobin effect is present, but it results from a consumption–saving decision rather than a portfolio-substitution mechanism. Ireland specifies two alternative payment forms: government money and credit. In using credit, people must pay for an intermediary's services. Two key assumptions are made regarding the intermedi-

ary's cost function: at a given date t, costs increase with the amount of credit, and for a given quantity of credit, costs decline over time. The latter assumption is designed to capture financial innovations, while the former assumption is crucial for people to want government money.

The inflation rate affects the composition of consumption financed by credit and by government money. With a cash-in-advance restriction, people must acquire money balances one period prior to their actual expenditures. Consequently, with an increase in the inflation rate, people buy less with money because its purchasing power erodes at a faster rate. In this economy, time also plays an important role. Instead of substituting away from money and toward more credit, people may wait and consume more when financial innovations have lowered the cost of using credit. Capital is the means by which people can practice such patience. Over the near term, greater capital accumulation yields temporarily faster growth. Eventually, people will draw down their capital reserves at a faster rate to enjoy more consumption. Hence, a rise in inflation initially results in output growing faster than trend, but then output grows slower than trend at some future date. In the long run, output grows at the same trend rate, regardless of the inflation rate.

The research by Sidrauski and Freeman and Huffman shows that money can play a decisive role in terms of output's long-run response to an increase in the inflation rate. Sidrauski identifies money as a means of payment, whereas Freeman and Huffman see money as competing with capital as a store of value. Feenstra (1986) offers an interpretation of the Sidrauski model that makes the distinction clear. According to Feenstra, an increase in the inflation rate causes people to economize on their money balances. Moreover, the composition of output shifts from the consumption good to financial services. As in Sidrauski's model, total output—the sum of consumption and financial services—is unchanged. An increase in the inflation rate, therefore, does not affect the level of total output but does affect its composition. Thus, the Feenstra interpretation shows that how we pay for total output—in this case, the ratio of output to money—may respond to the inflation rate, but the overall level of economic activity is unaffected. In Freeman and Huffman, because money is a competing store of value, a rise in the inflation rate makes capital more attractive. Inflation induces people to produce more total output, not just change output's composition.

Welfare considerations. Although a rise in the inflation rate does not instigate a change in the level of output in the Sidrauski model, it would be incorrect to conclude that inflation has no effect on people's welfare. Here again, Feenstra's interpretation is useful for assessing the welfare costs associated with an increase in the inflation rate. As noted above, the composition of total output shifts away from the consumption good and toward financial services as the inflation rate rises. Since people's happiness is directly related to the quantity of the consumption good, welfare is unambiguously lowered when the inflation rate goes up.

An increase in the inflation rate also reduces people's welfare in the models presented by Freeman and Huffman and by Ireland. In Freeman and Huffman, all moneyholders suffer when the inflation rate rises because the return to money falls. With a lower real return, less savings are available to acquire the consumption good. In Ireland's research, people's consumption–saving decision is distorted by inflation. People save more to avoid the increased costs associated with purchasing the consumption good with either financial services or with lower yielding money.

Thus, even though output may rise in response to an increase in the inflation rate, a review of the neoclassical economies shows that people's welfare will fall.[7] As such, the theoretical evidence points to a conundrum: if monetary policy raises the inflation rate, output could increase, but what the benevolent policymaker seeks to maximize—people's happiness—would fall.

The Stockman effect. Stockman (1981) develops a model in which an increase in the inflation rate results in a lower steady-state level of output and people's welfare declines. In Stockman's research, money is a complement to capital, accounting for a negative relationship between the steady-state level of output and the inflation rate.

Stockman's insight is prompted by the fact that firms frequently put up some cash in financing their investment projects. Sometimes the cash is directly part of the financing package, whereas other times, banks require compensating balances. Stockman models this cash investment feature as a cash-in-advance restriction on both consumption and capital purchases. Since inflation erodes the purchasing power of money balances, people reduce their purchases of both the cash good and capital when the inflation rate rises. Correspondingly, the steady-state level of output falls in response to an increase in the

inflation rate. Insofar as money acquisition is necessary for capital accumulation, Stockman presents a model in which money and capital are complementary goods. The term *Stockman effect* generally applies to all theoretical results in which output is inversely related to the inflation rate.

Inflation and labor. The Stockman effect can also operate through effects on the labor–leisure decision. Greenwood and Huffman (1987) develop the basic labor–leisure mechanism, and Cooley and Hansen (1989) identify the implications for capital accumulation.

In Greenwood and Huffman's research, people hold money to purchase the consumption good and derive utility from both consumption and leisure. Fiat money is valued because there is a cash-in-advance constraint on the consumption good. Greenwood and Huffman show that the return to labor falls when the inflation rate rises. Cooley and Hansen simplify the mechanism, noting that people substitute away from the cash good—consumption—and choose to enjoy more leisure. Consequently, people facing an increase in the inflation rate will substitute away from consumption and toward leisure.

Cooley and Hansen (1989) extend the Greenwood–Huffman mechanism to consider capital accumulation.[8] The key assumption is that the marginal product of capital is positively related to the quantity of labor. Thus, when labor quantity declines in response to a rise in the inflation rate, the return to capital falls and the steady-state quantities of capital and output decline. As Cooley and Hansen show, the level of output permanently falls in response to an increase in the inflation rate. The mechanism described by Cooley–Hansen emphasizes labor's role in determining the response of steady-state output to inflation.

With an increase in the inflation rate, the typical person suffers a welfare loss in the Stockman and Cooley and Hansen setups. In the Stockman economy, inflation distorts people's decisions regarding the purchase of all cash goods, including capital. With less wealth, people can afford a smaller stream of consumption spending, making them worse off. In the Cooley–Hansen setup, people respond to an increase in the inflation rate by wanting less of the cash good and more of the credit good, leisure. While more leisure partially offsets the loss of the consumption good, the main point is that an increase in the inflation rate has distorted people's choices. In effect, the Cooley–Hansen resident consumes too much leisure and too little of the consumption good, resulting in a welfare loss.

The literature review shows that models in the neoclassical framework can yield very different qualitative results with regard to inflation's effect on the steady-state level of output. Depending on money's role, an increase in the inflation rate can result in less output (the Stockman effect), more output (the Tobin effect), or no change in output. The theoretical review does, however, reveal one consistent result: people's welfare is inversely related to changes in the inflation rate.

Endogenous growth models. Kaldor (1961) observed persistent differences across countries in terms of growth rates of per capita output. This observation stimulated efforts by Romer (1986) and Lucas (1988) to specify economies that could grow unboundedly.

One feature accounts for the chief difference between the endogenous growth models and the neoclassical economies. In the neoclassical economy, the marginal product of capital declines as more capital is accumulated. In the simplest versions of the endogenous growth models, per capita output continues to increase because the marginal product of capital does not fall below a positive lower bound. Indeed, for unbounded growth, the marginal product of capital must be greater than the rate at which people discount future consumption.[9] The basic intuition is that only if the rate of return on capital is sufficiently high will people be induced to continue accumulating it.

Several studies have looked at the effect inflation has on output growth. The studies reviewed here find that an increase in the inflation rate retards growth. As with the Stockman effect, a welfare loss accompanies a rise in the inflation rate. In the endogenous growth models, the distortionary effects identified above are compounded by the reduction in growth. As will be seen, the way in which money is introduced has a great bearing on the size of the inflation rate effects on output growth.

The earliest versions of the endogenous growth economies find that the inflation rate effects on growth will be small. Gomme (1993) studies an economy similar to the one specified by Cooley and Hansen; that is, an inflation rate increase results in a decline in employment. In Gomme's research, efficient allocations satisfy the condition that the marginal value of the last unit of today's consumption equals the marginal cost of the last unit of work. With a rise in the inflation rate, the marginal value of today's last unit of consumption falls. Accordingly, the efficiency condition is satisfied provided people work less. With less labor, the marginal product

of capital is permanently reduced, resulting in a slower rate of capital accumulation. Gomme calculates the effect a permanent change in the inflation rate would have in this economy. He finds that eliminating a moderate inflation rate (for example, 10 percent) results in only a very small (less than 0.01 percentage point) gain in the growth rate of output.

Jones and Manuelli (1995) use fiscal policy distortions as the mechanism through which inflation might affect growth. Jones and Manuelli specify a model in which the tax code includes a nominal depreciation allowance. With a rise in the inflation rate, the discounted value of depreciation tax credits falls; hence, the effective tax on capital income is higher. People accumulate capital at a lower rate because of the reduction in after-tax real returns. Correspondingly, there is a reduction in output growth. As in Gomme, Jones and Manuelli calculate the inflation rate effect, finding that the growth rate reduction will be quite small. In both Gomme and Jones and Manuelli, inflation does not directly influence capital accumulation. Instead, the capital accumulation response is a second-order effect.

Alternative models examine how inflation might directly affect capital accumulation and hence output growth. Marquis and Reffert (1995) and Haslag (1995) specify economies in which capital and money are complementary goods. Marquis and Reffert examine inflation rate effects in a Stockman economy: there is a cash-in-advance constraint on capital. In Haslag's research, banks pool small savers but are required to hold money to satisfy a reserve requirement. The reserve requirement is binding because money offers a return strictly below that of capital. In a reserve requirement economy, the equilibrium return to deposits is then a weighted sum of returns to money and capital. Thus, an inflation rate increase drives down the return to deposits, resulting in deposits being accumulated at a slower rate. Since capital is a fraction of deposits, capital accumulation and output growth both slow. In both the Marquis and Reffert and Haslag studies, the inflation rate effects on growth are substantially greater than those calculated in Gomme and Jones and Manuelli. For instance, Haslag finds that economies with 10 percent inflation will grow 0.2 percentage point slower than economies with zero inflation.[10]

Economic theory reaches a striking variety of conclusions about the responsiveness of output (or the growth rate of output) to changes in the inflation rate. In the neoclassical models, money's role in the economy determines whether a permanent increase in the inflation rate stimulates, retards, or has no effect on the level of output. In short: (1) if money is a complement to capital, inflation and the output level are negatively related; (2) if money and capital are substitutes, inflation and the level of output are positively related; and (3) if money is primarily a medium of exchange and some substitute payment medium exists, inflation and the output level are independent. Whereas the neoclassical models predict that the inflation rate affects the level of output, the newer literature asks how a rise in the inflation rate can affect the growth rate of per capita output. In the endogenous growth setting, research shows that money's role determines whether the quantitative effects are large or negligible.

Theories are useful insofar as they account for some observed phenomenon. In the next section, I review the literature on the empirical evidence relating inflation to growth.

The empirical evidence on inflation and growth

The chief aim of this section is to identify the relationship between inflation and growth. More specifically, Is the secular trend in the inflation rate systematically related to the secular trend rate of output growth?

Table 1 summarizes the findings of the empirical papers cited in this article. Clearly, a majority of studies find that inflation and growth are systematically and negatively related. However, Levine and Renelt (1992), Bullard and Keating (1995), and Ericsson, Irons, and Tryon (1993) fault this conclusion. Levine and Renelt contend that the inflation–output growth relationship is simply too tenuous. Bullard and Keating and Ericsson, Irons, and Tryon question whether the early studies use the correct notion of trend.

Figure 3 plots the average values for the inflation rate and per capita real GDP growth rate across countries. The sample consists of average rates of inflation and per capita real GDP growth for eighty-two countries. The sample means are based on annual observations spanning the period 1965–90. The plot shows a weak negative correlation between per capita output growth and the inflation rate. The countries with lower than average growth rates tend to be the ones that have higher than average inflation rates. The notion of trend applied in these data is multiyear averages. (The issue of what constitutes trend is examined in greater detail later in this survey.)

In the literature, regression analysis is a

Table 1
Empirical Evidence on the Inflation–Growth Relationship

Author(s)	Samples	Methodology	Synopsis of results
Kormendi and Meguire	46 countries 1948–77, varying periods	Cross-country regression using sample means	Negative and significant relationship between output growth and inflation exists.
Fischer	73 countries	Comparison of sample means from fast- and slow-growing groups	Inflation in fast-growth group is lower than in slow-growth group.
DeGregario	12 Latin America countries, 1950–85	Cross-country regression using 6-year averages, nonoverlapping	Negative and significant relationship between output growth and inflation exists.
Gomme	82 countries 1949–89, varying periods	Cross-country simple correlations using annual data	Output growth and inflation are negatively correlated.
Bullard and Keating	58 countries	Regressions for each country	Inflation has no significant long-run effect on the level of output.
Ericsson, Irons, and Tryon	G–7 countries	Regressions for each country	Inflation has no significant long-run effect on output growth.

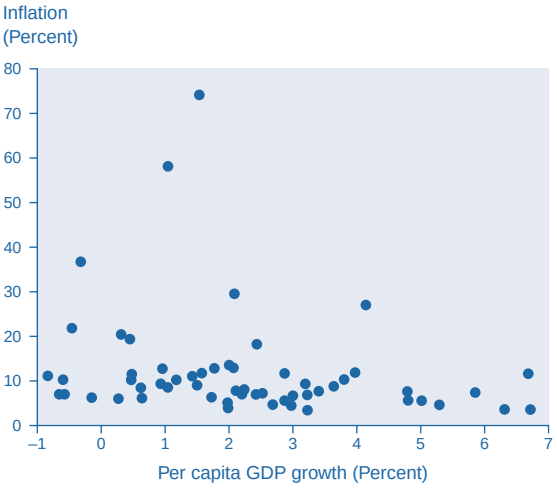
frequently used tool. Examples include Kormendi and Meguire (1985), Fischer (1991), DeGregario (1993), and Gomme (1993).[11] In general, these studies find that the correlation between inflation and per capita output growth is negative and significant. Thus, the more formal analyses are consistent with the ocular econometrics used in analyzing Figure 3: countries with higher than average inflation typically experience slower than average output growth.

In addition to regression analysis, Fischer employs simple nonparametric methods to look at inflation and growth. He calculates the average inflation rates for two smaller groups of countries; namely, those that grow at least one standard deviation faster than the average rate and those that grow, at most, one standard deviation slower than the average rate. Fischer reports that the slow-growth countries have an average inflation rate slightly above 30 percent, while the fast-growth countries average only 12 percent inflation.

An obvious concern is whether the inflation–output growth relationship is robust. Sarel (1996) and Judson and Orphanides (1996) ask whether the relationship between inflation and growth is linear. The idea is that a 1 percentage point increase in a low inflation rate may have a smaller effect on output growth than a 1 percentage point increase in a moderate to high inflation rate. Both studies find that the effect of an increase in the inflation rate depends on whether the initial rate is high or low. Specifically, an inflation rate increase does retard output growth when the inflation rate is moderate or high (defined as an inflation rate exceeding 10 percent) but is not significantly related to output growth when inflation is low (less than 10 percent). Thus, the cross-country evidence suggests that the inflation–output growth relationship is robust but most likely depends on the initial inflation rate.

Other researchers have questioned whether a systematic relationship between the inflation

Figure 3
Cross-Country Plots of Inflation Versus GDP



SOURCE: International Financial Statistics.

rate and growth even exists. Levine and Renelt (1992) argue that one must first control for a set of essential growth determinants before testing for a systematic relationship between inflation and output growth. Levine and Renelt find that after including measures of physical and human capital accumulation rates, the inflation rate is not significantly related to per capita output growth.[12] Thus, Levine and Renelt conclude that the inflation–output growth relationship is fragile. The implication is that policymakers should not assume that a rise in the inflation rate will, on average, slow growth.

The Levine–Renelt criticism may overstate the weakness in the inflation–output growth relationship. The theoretical literature shows that inflation effects operate through movements in capital accumulation—both physical and human. If one controls for capital accumulation directly in the regression—as Levine and Renelt do—it is less likely that inflation will be significantly related to output growth. Barro and Sala-i-Martin (1995) show that per capita output growth is the sum of total factor productivity growth and growth in both physical and human capital. Based on this growth accounting expression, it is difficult to imagine how inflation, or any policy variable, could be significantly related to per capita output growth in regressions that include measures of physical and human capital accumulation rates.

Even before Levine and Renelt's investigation, researchers were wary of putting too much faith in the inflation–output growth relationship. In particular, high-inflation countries are also likely to experience highly volatile inflation rates. If only inflation is included in the estimated regression equation, it is impossible to determine whether it is the inflation rate or inflation uncertainty that is determining growth.[13]

The final issue is whether multiyear averages should be used to measure the trend rate of output growth.[14] Statistical methods permit the extraction of trend from annual observations. The implication is that much greater country-specific variation in the trend will occur when the dataset has a time series of trend rates than when the trend is single valued. Greater variability in the time series highlights the basic trade-off facing a researcher; potentially, too much of the high-frequency (read business cycle) movement in the series will be incorporated into the trend measure. Consequently, regressions with more variable trend rates of output growth potentially pollute the attempt to identify the relationship between long-run output growth and inflation.

In Bullard and Keating's research, the cross-country evidence shows that there is no systematic long-run relationship between inflation and the level of output. Bullard and Keating (1995) identify trend inflation and output for fifty-eight countries. Here, trend is associated with long-run relationships between series with stochastic trends. The authors do not pool results across countries. Instead, they estimate separate regressions for each country, permitting each country's long-run relationships and short-run dynamics to be different. In their examination of the long-run relationship, Bullard and Keating find that permanent changes in the inflation rate are not systematically related to the level of output.[15]

Summary and conclusions

In this article, I survey the theoretical and empirical literature examining the relationship between movements in the inflation rate and output, output growth, and welfare. In the theoretical literature, an inflation rate increase unambiguously reduces the average person's welfare. However, inflation's qualitative effect on the level of output is ambiguous. I suggest that inflation's effect on output depends on why people hold money. If the researcher emphasizes money as a substitute for capital, a rise in inflation raises the long-run level of output. If the researcher emphasizes money's role as a complement to capital, a rise in inflation results in lower long-run levels of capital.

The most recent theoretical research has studied inflation's effect on growth rates. These theories generally find that a rise in inflation either results in slower growth or has no impact on the growth rate.

In the empirical literature, research attempts to find the relationship between the trend rate of per capita output growth and the trend inflation rate. In this article, empirical results differ, owing mostly to the notion of trend applied. Many cross-country studies use multiyear averages as the measure of trend. Early studies show that high-inflation countries tend to grow slower that low-inflation countries. More recent studies suggest that countries with inflation rates above 10 percent tend to exhibit a negative relationship between inflation and growth, whereas in countries with average inflation rates below 10 percent, there is no significant relationship. Studies that use the trend rate of growth each year fail to find a significant relationship between per capita output growth and inflation.

Thus, the survey produces two uncontested

findings. First, there is no empirical evidence that there is a positive relationship between the secular trend rate of inflation and the secular trend rate of output growth. Second, economic theory tells us that an inflation rate increase makes the average person worse off.

Notes

[1] For example, the U.S. producer price index in 1943 was slightly below its 1810 value.

[2] Fischer's (1926) original study established the negative comovement between inflation and the unemployment rate. With Okun's law, the negative association between inflation and unemployment is a positive relationship between inflation and output growth.

[3] The capital stock monotonically approaches its steady state in the neoclassical economy. Under different conditions, the capital stock could cyclically converge to its steady state. With cyclical convergence, the capital stock could exhibit periods in which it rises and falls as it approaches the new steady-state level. Hence, growth could either rise or fall in response to a rise in the inflation rate.

[4] Rather than interpreting real money balances as something that makes people happier, the money-in-the-utility-function specification is a proxy for some transaction technology. Feenstra (1986) shows that money in the utility is functionally equivalent to a cash-in-advance payment technology.

[5] See Abel (1985) and Koenig (1987) for details on the capital–labor ratio along the transition path.

[6] More precisely, people can hold deposits that are used to finance capital.

[7] In much of this research, the optimal inflation rate is equal to the person's time rate of preference—the Friedman rule. Akerlof, Dickens, and Perry (1996) argue that a moderate steady inflation rate permits maximum employment. Inflation substitutes for the desire to avoid lowering nominal wages. Akerlof et al. compare outcomes by the effect on employment and output, not welfare. Consequently, their findings do not overturn the welfare implications reported in this article.

[8] Cooley and Hansen are primarily interested in the business-cycle properties of an economy in which the inflation rate changes. Interestingly, they find that the business-cycle properties are not substantially affected by changes in the inflation rate. My interest here is in the features of their model related to inflation's effect on the steady-state levels of capital and welfare.

[9] The assumption that the marginal product of capital does not always diminish is based on the common definition of capital, which includes physical quantities—buildings and machines—and human features, such as accumulated knowledge.

[10] The impact of the inflation rate on growth depends on the size of the reserve requirement. With a 15 percent reserve requirement, an economy with 10 percent inflation grows at a rate 0.67 percentage point slower than an economy with zero inflation. With only a 5 percent reserve ratio, the effect on growth is only 0.2 percentage point.

[11] These studies differ primarily in terms of the variables included in their regressions. Kormendi and Meguire, for example, include measures of fiscal policy, whereas Fischer includes measures of physical and human capital accumulation. Details on the countries sampled and the time periods are in Table 1.

[12] Levine and Renelt's baseline regression includes the investment share of real GDP, the initial (1960) level of real GDP per capita, the initial secondary-school enrollment rate, and the annual rate of population growth.

[13] Tommassi (1994) models the effect of inflation uncertainty on economic activity. In Tommassi, inflation uncertainty results in people putting more effort into activities that are not counted in national income accounts.

[14] Ericsson, Irons, and Tryon (1993) identify three methodological problems with the typical cross-country regressions: aggregation over countries, aggregation over time, and the use of growth rates instead of output levels. Aggregation over countries lumps low-inflation countries with high-inflation countries. Ericsson et al. argue that the systematic relationship owes almost entirely to the inclusion of a small group of African and Latin American countries. In aggregation over time, the unit of observation is average inflation over periods as long as several decades. Ericsson et al. show that contemporaneously uncorrelated variables can be either positively or negatively related when averaged data are used. Finally, using first-differences as the unit of observation, the authors point out, imposes an unnecessary restriction on the dynamic relationships in the data.

[15] In Bullard and Keating, the first-difference in the inflation rate and output growth is a stationary series. The interpretation is that the sample mean is the best forecast of output growth over an infinite horizon. Bullard and Keating's forecasting equations, in which output growth eventually returns to its long-run average value, are consistent with the neoclassical theory that a permanent change in the inflation rate can have only temporary effects on output growth. Interestingly, Bullard and Keating find evidence that the transition phase exhibits cyclical convergence, as opposed to the monotonic convergence predicted by the neoclassical models.

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