

## REVIEW

MAY/JUNE 1996

## Editor's Introduction

In present-day industrialized economies, inflation has been characterized as low and stable, but generally positive and expected to remain positive. In part because of this, the papers presented at the Federal Reserve Bank of St. Louis' twentieth annual Economic Policy Conference were brought together under the rubric "Price Stability and Economic Growth." Our intent was to focus discussion on core issues in monetary theory and policy. Specifically, we wanted to get a feel for current thinking on the research frontier as to whether, and to what extent, low-to-moderate inflation might have a lasting impact on economic growth. Should policymakers in the largest industrialized countries move aggressively to squeeze the remaining inflation from their economies? If so, on what theoretical or empirical basis can such action be justified? And if not, what is it that makes a policy of indefinite low-to-moderate inflation a desirable outcome?

As the conference participants confirmed, the answers to these questions differ markedly depending on what types of mechanisms one wishes to emphasize in creating a macroeconomic model, or on the statistical techniques one wishes to employ in conducting a macroeconomic study. And certainly monetary economists are far from providing a compelling analytical framework that would unite the thinking of economic researchers on these matters with that in the international business community, in financial markets, and among leading policymakers. But even if that holy grail seems far from being attained, there is a great deal to learn from these papers, which might be viewed as reflecting the economic profession's slow-but-steady progress toward coherent thinking about macroeconomic systems in which monetary policy and inflation play important roles.

### FINANCIAL INTERMEDIATION AND GROWTH

Two papers presented at the conference addressed, from different perspectives, the question of including aspects of financial intermediation in fully articulated macroeconomic models. In "Inflation, Financial Markets and Capital Formation," authors Sangmok Choi, Bruce D. Smith, and John H. Boyd work in the context of an equilibrium model in which higher inflation reduces real rates of return received by agents that save, and through this channel monetary policy can have an important influence on the level of real activity and capital formation. They de-emphasize the direct effects of this mechanism, however, to study its effects when interacting with an adverse selection problem in financial markets. In particular, lower real rates of return discourage saving and encourage borrowing, and in this model the new borrowers entering are of lower quality, since they have higher default risks. Lenders respond to this dismaying lower return, higher-risk situation by rationing credit, so that higher inflation often leads to more severe rationing, less capital formation, and a lower level of real activity.

The results obtained in this environment are notable for their nonlinearity. A threshold effect exists in that, at low rates of inflation, the adverse selection problem has no effect on the equilibrium set of the model; therefore, easier monetary policy leads to higher inflation and a higher level of real activity. Beyond a threshold level of inflation, however, the informational friction begins to play an important role. Thus, when inflation is too high, credit is rationed, and further increases in inflation only serve to exacerbate the adverse selection problem. This leads to less capital formation and a lower

level of real activity. In addition, the equilibrium set is much more complicated in the high-inflation case, so that the model predicts endogenously arising volatility in inflation if the monetary policy supports inflation rates that are higher than the threshold. Development traps—situations where economies are stuck in equilibria with a low level of real activity—are also a more likely outcome for economies with high-inflation policies. Choi, Smith, and Boyd argue that these predictions are consistent with element of the historical record as well as recent empirical work, and the authors also present some additional empirical evidence to bolster their case. They stress that similar results have been obtained in related research that emphasizes alternative informational frictions in financial markets: The key feature is not the friction itself, but the friction is exacerbated by higher inflation.

In a discussion of the paper, Pamela Labadie notes the restricted nature of the parameter space governing the model. According to Labadie, a key condition for existence of monetary steady states may not hold in practice, in which case credit rationing would not occur, and most of the interesting results emphasized by Choi, Smith, and Boyd would not be observed. Satyajit Chatterjee adds that the authors do not include any stochastic features in the model, so that highly variable unanticipated inflation cannot drive the relationship between high inflation and the level of real activity, even though that is the mechanism many economists have in mind.

In the second paper, titled “Inflation, Growth, and Financial Intermediation,” V.V. Chari, Larry E. Jones, and Rodolpho Manuelli conduct a quantitative-theoretic investigation of a range of endogenous growth models in which there is a well-defined demand for money. The authors begin by citing elements of the empirical literature that have suggested a negative relationship between average inflation and long-run real output growth of 0.2 to 0.7 percentage points for every 10 percentage points of inflation. They accept estimates on this order of magnitude as constituting

a stylized fact, and then turn to study a set of well-known endogenous growth models—augmented in standard ways to motivate a demand for money—to find a class of equilibrium models that replicate the stylized fact when calibrated to the postwar U.S. experience. The cross-product of possible endogenous growth mechanisms with methods of introducing money creates an initial matrix of 12 possible models. The results of this search are negative: Quantitative versions of these models cannot deliver such a large effect of average inflation on the long-run rate of economic growth.

The authors then address this puzzle by introducing a form of regulated financial intermediation into the models. In particular, banks face reserve requirements, and the intermediated capital they provide is an imperfect substitute for other forms of capital. By itself, this does not provide enough of a distortion to match the stylized fact according to the quantitative experiments considered by the authors, because increased inflation alone does not have a substantial enough effect on growth. But when rates of monetary expansion are altered in concert with changes in reserve requirements in a way that is consistent with the empirical relationship between these policy changes found in the data (reserve requirements tend to rise when inflation rises), the quantitative effect on economic growth approaches the lower bound given by the stylized fact. Chari, Jones, and Manuelli conclude that models that include an important role for financial intermediation might provide the most promising avenue for future research on the relationship between average inflation and the long-run rate of economic growth.

In his remarks on this paper, Gary Hansen points out that the authors are interested, above all, in a reasonably calibrated case of a theoretical framework in which inflation adversely affects the long-run growth rate of real output. Since the models themselves are generally not limiting in this regard—inflation does adversely affect growth in most cases—the

calibration is providing the constraint. According to Hansen, the authors might profitably spend more time thinking about appropriate parameter values, especially for key parameters that have not been extensively researched. Alan Stockman is skeptical of the results, concluding that the authors overstate the magnitude of the relationship between inflation and real output growth found in the empirical literature, which often confuses level with growth rate effects. He adds that the authors insist on a calibration based on the postwar U.S. experience, whereas the empirical research uses data from a broad cross-section of countries. This could be leading the authors to falsely reject classes of models which may in reality be fully consistent with the empirical evidence.

## POLICY RULES

Two papers at the conference emphasized policy rules as an optimal method of conducting monetary policy. In “Discretion, Rules and Volatility,” Costas Azariadis and Vincenzo Galasso analyze certain types of restrictions on median voting that can improve equilibrium outcomes in a dynamic, infinite-horizon economy populated by finitely lived agents playing a transfer payments game. The restrictions they study are constitutional rules under which a minority has veto power over policy changes proposed by the majority. They interpret such a scheme as a form of partial precommitment. Azariadis and Galasso stress that the issues they address in the context of a fiscal policy question apply with equal force to all issues with an intergenerational dimension, including the maintenance of price stability.

In the model, the discretionary regime corresponds to pure majority voting in which the largest political block can enforce policies that reduce the consumption of the smaller political block. This regime has many equilibria, some of which involve volatile or cyclical consumption patterns. The indeterminacy is traced directly to the inability of voters to commit successive generations to a particular policy. The

less discretionary regime in the model corresponds to a type of constitutionalism under which it is harder to change policies inherited from the past. In this setting, knowledge of the past policy setting helps predict the course of future policy. The equilibrium set in this case is characterized by social optima free of fluctuations. Azariadis and Galasso argue that better understanding of the consequences of completely versus partially discretionary policy in contexts like theirs holds many lessons for policy design in the United States and other industrialized countries.

In a discussion of the paper, Robert Becker emphasizes that a key assumption driving the success of the rules regime in eliminating volatility is that the constitution is in place before time begins. What is it that caused the agents to agree to be bound by the constitutional arrangement? Russell Cooper praises the paper for its rich dynamics and clear statement of equilibrium outcomes. Cooper suggests that the agents’ agreement to be bound by the complex political process of a constitutional system might be justified by introducing costs of changing policy.

Inflation targeting is a particular type of monetary policy rule that has attracted considerable interest among the world’s central bankers. Robert King and Alexander Wolman study the effects of inflation targeting on equilibrium outcomes in their paper, “Inflation Targeting in a St. Louis Model of the 21st Century.” They adopt a framework in which sticky prices play a central role because firms behave as monopolistic competitors. A representative, infinitely-lived household maximizes expected utility over time-separable, consumption-leisure bundles. A well-defined demand for money is introduced via a shopping time technology. There is an exogenously given price-setting structure, meant to capture important aspects of observed price adjustment, such that firms can change their posted prices only infrequently and are otherwise constrained to satisfy demand at their posted prices. Monetary policy has real effects in this model in the short run.

King and Wolman study optimal long-run inflation policy first. In this type of model, there is an unambiguous welfare gain for the representative consumer if inflation is increased above the rate that would constitute the Friedman rule—a zero nominal interest rate scenario. Some may use this fact to argue for the optimality of positive nominal interest rates in a fully articulated macroeconomic model. But the computational experiments King and Wolman conduct, using a conventional calibration, show that the welfare-maximizing rate of inflation in this model is quantitatively very close to the Friedman rule across a number of assumptions on the pace of price adjustment, the magnitude of the markup, and the parameters in the shopping time technology. The authors then turn to studying an inflation-targeting rule as a method of coping with business cycle shocks arising from disturbances to both productivity and money demand. The inflation-targeting regime is of an extreme form—the money supply is manipulated in such a way that inflation never varies from its target—to get a feel for the potential of such a rule. They find that the economy under the inflation targeting regime behaves almost the same, in a welfare sense, as the model in which no sticky price problem exists. The inflation targeting policy rule also outperforms a constant money supply rule.

Julio Rotemberg praises the paper, noting in remarks that the welfare consequences of alternative policy rules are actually worked out in a Keynesian-style model, and that this level of rigor in analyzing policy has frequently been missing in models within this tradition. But he also takes issue with the thrust of the paper, arguing that while low and stable inflation is probably a good idea, such a conclusion does not necessarily follow from the analysis carried out by the authors. Edward Prescott notes that the model studied by the authors has nearly equal average rates of return to capital and short-term government debt, which contradicts available evidence. He finds this prediction worrisome for a model

hoping to contribute to discussions of monetary policy.

## INTERNATIONAL THEORY AND EVIDENCE

Three papers at the conference addressed the issues from an international perspective. The first paper in this group, entitled “Search-Theoretic Models of International Currency,” by Albert Trejos and Randall Wright, provides a summary and analysis of a two-country, two-currency model of monetary exchange. The authors emphasize that search-based models of money are, in principle, well-suited to providing answers to key policy questions in international monetary economics, in part because the important issue of which currency is held by whom is decided endogenously in this framework. The paper begins with a presentation of the standard two-country, two-currency model in this class, along with a discussion of the possible configurations of the equilibrium set. Three possible regimes are identified, and likely conditions for their existence given, corresponding to (1) each currency is held by agents in the home country only—dollars in the United States and pesos in Mexico, (2) each currency is held in each country, and (3) one currency is held in both countries but the other currency is held only in the home country. For much of the parameter space of the model, more than one regime is possible, so much so that multiple equilibria is the rule rather than the exception. Trejos and Wright then turn to a discussion of their extension of this model, in which the helpful but unsatisfactory assumption that all trades are one-for-one swaps is relaxed by allowing divisible output. They again analyze the conditions under which each of the three regimes exist as stationary equilibrium outcomes, and again, much of the parameter space is characterized by multiple equilibria.

In a section of the paper on policy implications, Trejos and Wright give some examples of policy questions that can be profitably addressed in this search-

theoretic framework. There are potential welfare gains to be had from currency unification, for instance, but there is also the possibility that one country would experience a welfare loss. Future research might therefore be able to provide an interesting analysis of this type of issue in the case where countries differ in terms of preferences or production technologies.

Remarks on the paper by Joseph Ritter mention the pervasiveness of multiple equilibria in the model and encourage the authors to pursue the idea of monetary policy regimes tailored to the goal of equilibrium coordination. Ritter also points out that while the original search-theoretic models of money featured endogenous currency holding, in this more recent vintage, agents are forced to use currency to accomplish trade. Neil Wallace praises the paper and offers remarks on assumptions he would like to see changed or relaxed. Among these are the assumptions that consumption precedes production, as well as the fact that currency is indivisible, coupled with the limitation on individual holdings.

The two remaining papers offer perspectives on the international empirical evidence regarding inflation and economic growth. The paper by Michael Bruno and William Easterly, "Inflation and Growth: In Search of a Stable Relationship," summarizes the research in this area, with special emphasis on the authors' recent findings with respect to inflation crises. Bruno and Easterly define a high-inflation crisis as a span of two or more years in which the annual inflation rate exceeds 40 percent in a given country. In their data set, they find 32 such crises scattered among 26 countries, and they regard these episodes as discrete experiences which they wish to analyze independently. Typically, inflation is very high during the crisis—on average exceeding 100 percent at an annual rate—before falling back to an average of 20 percent once the crisis subsides. By considering these episodes independently, Bruno and Easterly are able to document a simple and robust pattern: The pace of economic growth

falls precipitously during the crisis and resumes—and even exceeds the pre-crisis growth rate—once the crisis is over.

The authors go on to argue that results like these can help in forming interpretations of other findings in the inflation and growth literature. In cross-country growth regressions, for instance, the finding has generally been that inflation is not robustly related to long-run growth. Bruno and Easterly argue that this is because the periods of collapse and recovery approximately average out among the countries that have experienced inflation crises, so that it appears, in the type of specifications that have typically been estimated, that inflation does not influence growth. They also stress that they find no evidence of a reliable relationship between inflation and growth for low-inflation countries, and that inflation crises apparently have no lasting effects: Countries that experience inflation crises tend to return to normal growth once the crisis is over.

Jon Faust, in a discussion of the paper, praises Bruno and Easterly for exploiting the time series properties of the data to try to better understand the dynamics of inflation and growth. But he also warns against interpreting the results as evidence that inflation, even at very high levels, is directly responsible for lowering growth, since the correlations established in the paper say little about the direction of causality. Kenneth West notes that the paper usefully brings together the growth-regression literature with the inflation-stabilization literature, but he is somewhat skeptical that the authors have satisfactorily interpreted the lack of a robust correlation between inflation and growth documented in the former set of papers.

The growth regression literature is visited more directly in the paper by Robert Barro, "Inflation and Growth." Barro reports on recent work in which a standard convergence framework is used to assess the effects of policy variables like inflation on economic growth. The data set covers more than 100 countries

from 1960 through 1990, and emphasizes cross-sectional features. Many factors that might affect growth are represented in the regression specifications, and when inflation is included as an explanatory factor, it enters with a significantly negative coefficient for the full sample. The results for the full sample suggest that a permanent 10 percentage point increase in inflation would reduce the growth rate of real output per capita on impact by about 0.02 to 0.03 percentage points per year. This reduction in the rate of economic growth is the net effect of a change in the level of per capita income, since the convergence framework assumes the economy will return to its long-run growth rate in the limit. Still, the level of output would be some 4 to 7 percent lower after 30 years under the regime of higher inflation. Barro is careful to note that the statistical significance of this estimate disappears if a set of high inflation countries are removed from the sample. Barro then discusses the possibility that causality in the results runs from growth to inflation, rather than from inflation to growth. The discussion emphasizes a response to Kocherlakota's comments, as well as the possibility that the use of certain instrumental variables might help clarify this matter.

In a discussion of the paper, Narayana Kocherlakota employs a standard cash-in-advance monetary model in which monetary policy has no effect on the growth rate of real output. In this model, he shows that the equilibrium relationship between the rate of inflation and the rate of real output growth is negative. To get an idea about the magnitude of this effect, Kocherlakota calibrates the model and finds that an econometrician would estimate a coefficient of about  $-0.024$  in response to a 10 percentage point increase in inflation. Since this is approximately Barro's estimate, he concludes that Barro's results are consistent with the idea that there is no effect of inflation on growth. Chris Sims emphasizes the single equation aspect of the specification estimated by Barro, and suggests ways in which one

might interpret the equation as part of a complete system. In the more complete system, however, it is not clear how the coefficient Barro has estimated should be interpreted.

## SUMMARY

As this introduction makes clear, a wide variety of issues and methodologies were represented at this conference. A definitive characterization of the relationship between inflation and economic growth is still far from the grasp of economic science, but leading economists at the conference emphasized many ingredients that will undoubtedly be important in some kind of final reckoning. The role of explicit models of financial intermediation in influencing results in fully articulated macroeconomic frameworks should not be underestimated, for example. Similarly, there is much to learn about the nature and influence of certain types of policy rules on the behavior of macroeconomic systems. Despite the concerns of policymakers, economists generally have little well-grounded advice to dispense on the question of the optimal structure of the international monetary system, in part because research into coherent models of international money is still in its infancy. And reliable inferences from the international data may require years of careful work to be fully convincing. I hope this collection of papers and remarks will encourage further thoughtful research in these areas, so that additional progress in understanding the relationship between inflation and economic growth can be made.

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June 26, 1996