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Monetary Policy Rules?

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All aspects of our behavior, economic and otherwise, are governed and organized by various rules. The most routine aspects of our lives become unpredictable and even chaotic when not governed by well-defined and generally accepted rules. For example, in the 20th century, every country has adopted a legal rule that governs automobile traffic. In the United States, it is understood that automobiles are driven to the right; in the United Kingdom, the rule is to drive to the left. If, as a U.S. driver, you travel to England and are unaware of the rule for driving or choose to ignore it, it is quite likely that the outcome will be tragic.

In a similar vein, the convention in the United States is to walk to the right. Generally this works well, and pedestrian traffic flows smoothly even along crowded walkways. In some cultures, the rules for pedestrian traffic do not appear to be as clearly understood. There it is common to observe considerable zigging and zagging in dense traffic as pedestrians seek to avoid collisions in the absence of a systematic decision process on how to proceed. The absence of a well-understood convention for pedestrian traffic increases transit times and can result in considerable irritation. Resources, which could be used productively, are wasted.

What is a rule? A rule can be defined as "nothing more than a systematic decision process that uses information in a consistent and predictable way."[1] The concept of a monetary policy rule is the application of this principle in the implementation of monetary policy by a central bank. Why, then, the question mark in my title? There is a large body of economics literature on the rules-versus-discretion debate over monetary policy. I do not intend to analyze, or psychoanalyze, this debate here. I especially do not intend to address the political side of this debate —whether it would be desirable for a national legislature to enact a monetary policy rule to be executed by the country's central bank. Rather, my purpose is to examine what we mean by a monetary policy rule followed by a central bank, and to examine what we know about the construction, or design, of the rule.

I will first discuss some general issues in the design of rules. Next, I'll discuss what monetary policy can achieve—we need to be clear about what a policy rule is supposed to accomplish. I'll also review how the Federal Reserve conducts monetary policy today to provide the background necessary to understand the practical design issues for a monetary rule. My final topic will be the critical requirements that must underlie any satisfactory rule. That will bring me to our current understanding of a practical rule.

Before digging into this topic further, however, I want to emphasize that the views I express here reflect my thinking and do not necessarily reflect official Federal Reserve views. Bob Rasche, until recently a member of the Department of Economics at Michigan State University, is really a co-author of this lecture; he deserves credit for its strengths and I'll accept responsibility for its errors.

SOME GENERAL CONSIDERATIONS IN DESIGNING RULES

How are rules constructed? In many cases, rules govern our interaction with

[1] Allan H. Meltzer, "Commentary: The Role of Judgment and Discretion in the Conduct of Monetary Policy," *Changing Capital Markets: Implications for Monetary Policy*, Federal Reserve Bank of Kansas City, 1993, p. 223.

the environment, and the optimal rule can be established as the solution to a well-defined engineering problem. Given advances in technology, many rules, formerly executed manually, are now performed by automatic devices. For example, thermostats that control the heat in our homes and autopilots that control the progress of aircraft embody such rules. A second type of rule governs our interactions with others. When the absence of well-defined rules of behavior or the failure to conform to a convention seriously harms the welfare of others, the government implements a rule by law and imposes penalties for disobedience. You will be apprehended quickly if you insist on driving on the right side of the road in England.

A third type of rule involves the formulation of policy decisions. Here, a systematic decision-making process is complicated because individuals and market participants observe or infer the actions of the policymakers and adjust their behavior in ways that work to their benefit, given their understanding of the policy regime. This is the type of problem faced by monetary policy decision-makers.

This point is so important that it deserves special emphasis. Compare two card games: solitaire and poker. Solitaire is a game against nature—the characteristics of a deck of cards. Those characteristics do not change from one day to the next. Poker is a game against intelligent agents. The players may change from one day to the next. Players learn about each other's playing styles over time and change how they play. Designing an optimal rule, or strategy, for poker is a *much* more difficult problem than designing an optimal rule for playing solitaire.

Monetary policy, needless to say, is more like poker than solitaire. The goal of monetary policy, however, is to make the economy better off, not to go home at the end of the evening with your friends' money. The fact is, though, that monetary policy affects interest rates, people make or lose money from interest-rate fluctuations, and therefore, the markets are constantly trying to forecast the next monetary policy adjustment. This interaction—policymakers trying to understand and interpret markets, and markets trying to predict what policymakers will do—makes the task of designing an optimal monetary policy rule a very, very difficult problem.

WHAT CAN MONETARY POLICY ACHIEVE?

At the beginning of the 1960s, economists generally believed that central banks could and should be significant players in the effort to achieve multiple social objectives: low inflation, high growth, low unemployment and low nominal interest rates. In addition, the Federal Reserve was expected to contribute to specific efforts such as encouraging balanced payments with the rest of the world and a strong housing sector.

The notion that central banks can provide a low-cost, over-the-counter "aspirin" that will alleviate almost any ill that a society can face is no longer credible. There is now a consensus among economists and central bankers that the only long-run effect a monetary authority can have on an economy is to determine the sustained, or trend, rate of inflation. That rate will result from the rate at which the monetary authority injects money into the economy.

The view that price stability depends upon monetary conditions has a long history in monetary economics. Indeed, the basic proposition that the amount of money determines the price level originated long before economics was recognized as a discipline. Simply put, I would like to note that in the late 19th and early 20th centuries, economists were precise about the nature of the connection between money and the general price level. Irving Fisher, among others, made important contributions to monetary theory long before the Great Depression. This idea—that the general price level and its rate of increase depends primarily on the level of the money stock and its rate of increase—fell out of favor with the rise of Keynesian analysis in the 1930s and 1940s. The idea was revived in the 1950s by Milton Friedman, who has lived to win the intellectual battle that sustained inflation is everywhere and always will be a monetary phenomenon.

[2] David Wessel, "With Inflation Tamed, America Confronts an Unsettling Stability." *Wall Street Journal*, February 22, 1999, p A. 1.

A consensus also exists that erratic monetary policy has sometimes produced instabilities in the economy. Most analysts now agree that Federal Reserve actions contributed significantly to the severity of the Great Depression in the United States. Monetary policies can make the economy either more or less stable. It is generally acknowledged that at least some—I think a lot—of the credit for the stability of the U.S. economy during the past 15 years is due to Federal Reserve policy under Chairmen Paul Volcker and Alan Greenspan. Finally, it is generally accepted that central banks are responsible for acting as a lender of last resort in the event of a generalized liquidity crisis to maintain the soundness and function of the payments mechanism. Most economists accept the view that prompt Federal Reserve actions in October 1987, after the stock market crash and again last September after the Russian default, were appropriate policy interventions. Of course, we continue to debate the appropriate extent of Fed actions to alleviate a liquidity crisis—indeed, even what truly qualifies as a liquidity crisis—but that debate does not detract from acceptance of the general principle that a central bank response is desirable when the crisis is severe.

The problem of designing monetary policy to achieve sustained low inflation and more, rather than less, stability is far from trivial. We know much less about this task than we should. At this point, no consensus exists on the size or reliability of the short-run impact of monetary policy on an economy. A considerable amount of professional opinion, the general popular feeling, and financial-market commentary hold that monetary policy actions initially affect output, unemployment, and real interest rates, even though the long-run impact on these real variables is nil. Research efforts to quantify these initial effects, however, have failed to provide precise measures of the impact, and at least one school of thought maintains that such short-run effects are negligible.

To judge monetary policy and central bankers, we must concentrate on what they can reasonably be expected to achieve, given our current state of knowledge. There is a compelling case, I believe, that the success or failure of monetary policy must be judged first and foremost by whether a central bank is able to achieve a low-inflation environment on a sustained basis. That environment is, in turn, conducive to maximum growth and efficient utilization of the resources available to a society. High growth and efficient utilization of resources depend on government policies beyond the central bank's control. That fact, however, does not change the proposition that a central bank's contribution should be judged primarily by the average rate of inflation, and secondarily by the stability, or lack thereof, of the overall economy.

By this standard, the history of the second half of the 20th century, in the United States and in other countries, is not kind to central bankers. For a short period during the late 1950s and early 1960s, the U.S. economy (for all practical purposes) experienced price stability. The return to low inflation following the Korean War was consistent with prior U.S. experience that inflation was a wartime phenomenon. During peacetime, citizens generally were unconcerned about inflation.

Periodically, the Gallup poll has asked, "What do you think is the most important problem facing the country today?" One of the response choices was: "Inflation or the high cost of living." In 1956, several years after the end of the Korean conflict, only 13 percent of respondents indicated this concern. By 1964, the fraction of respondents selecting this response had dropped to six percent.

Sixteen years later, in 1980, the economy was at the peak of the inflation that had started during the Vietnam War. Inflation as measured by the consumer price index (CPI) had reached double-digits. Short-term interest rates exceeded 20 percent. People came to understand that this inflation could not be attributed to war; the Vietnam War had ended by the mid-1970s, but inflation persisted and indeed rose for the rest of the decade. The fraction of Gallup poll respondents who ranked

inflation as the No. 1 problem facing the economy rose almost continuously—from 27 percent in 1972, to 47 percent in 1976, to 61 percent in 1980. All segments of society shared this concern.

Today, the price tranquility of the late 1950s and early 1960s has been reestablished, both in the United States and in most other industrial countries. In the United States, annual inflation during each year from 1983 through 1989 was close to 4 percent. With the exception of a brief increase just before and during the Persian Gulf conflict in 1991, the inflation rate has declined steadily to the point where the economy last year was close to practical price stability. By 1993, only 1 percent of Gallup poll respondents ranked inflation as the most important problem facing the country. An article in the *Wall Street Journal* last month reflected on a survey conducted by Yale University economist Robert Shiller:[2]

> It is now widely accepted that high rates of inflation can damage an economy by distorting markets, undermining public faith in government and forcing all sorts of wasted effort. Mr. Shiller's 1996 survey found that 84% of the public—though only 46% of economists—felt that preventing high inflation was as important as preventing drug abuse or deterioration of schools. A return of inflation would be jarring: The last time the Labor Department checked, only one in five major union contracts included an automatic cost-of-living adjustment, down from 60% in the early 1980s. A spread of the Japanese-style deflationary spiral, in which falling prices exacerbate a recession, would also be painful.
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> But right now, the U.S. has neither. Instead, it is experiencing an absence of inflation. Without inflation, the old-fashioned notion that young couples can buy a house and grow into their mortgage payments with ever-bigger paychecks may soon be as quaint as a telephone with a dial. And retirees living off interest on certificates of deposit and government bonds will be shocked when their securities mature to see how far interest rates have fallen as inflation ebbs. Already, rates on six-month certificates of deposit are down to an average of 4%, according to BanxQuote Inc., and some big banks are paying little more than 1% on regular savings accounts.

Clearly, our economy—indeed many aspects of our broader society—is deeply affected by inflation and by the absence of inflation. The public has no doubt, and I have no doubt, that the absence of inflation is better. A critical question facing all of us at the present time is whether the inflation experience of the past 16 years will be sustained. Or, will this period ultimately be viewed in history as a wonderful stroke of good luck—an anomaly in an age of otherwise nearly permanent inflation?

HOW DOES THE FED CONDUCT MONETARY POLICY TODAY?

The Federal Reserve has practiced a consistent approach to the implementation of monetary policy at least since the mid-1980s. Monetary policy decisions are the responsibility of the Federal Open Market Committee (FOMC). The FOMC consists of the seven governors of the Federal Reserve System, the president of the Federal Reserve Bank of New York, and four of the presidents of the remaining 11 regional Federal Reserve Banks, on a rotating basis. This committee meets eight times a year, to discuss the current state of the economy and the prospects for near-term developments. The committee then votes on instructions—the Directive to the System Open Market Account Manager—that specify a target value for the federal funds interest rate. The federal funds rate is the rate at which depository institutions borrow and lend to each other their reserve balances on the books of the Federal Reserve Banks. The Fed usually refers

to the target federal funds rate as the intended rate.

Once these instructions have been approved, it is the responsibility of the staff of the Open Market Desk at the Federal Reserve Bank of New York, in consultation with the Chairman and members of the Open Market Committee, to keep the actual funds rate close to the intended rate. The Desk proceeds by buying and selling U.S. government securities for the Federal Reserve's account, or by engaging in transactions that are the practical equivalent of buying and selling government securities. When the Account Manager desires to offset market forces that are driving the funds rate above the intended rate set by the FOMC, the Desk purchases securities in the open market for the Fed's account. When the Account Manager desires to offset market forces that are driving the funds rate below the intended rate, the Desk sells securities into the market from the Fed's account. The direct result of such purchases and sales is that the amount of currency and/or balances of depositories at the Federal Reserve Banks is increased or decreased.

This approach to implementing monetary policy is not new. Exactly the same procedures were employed during the late 1960s and throughout the 1970s, the period of rising inflation. Therefore, there is no guarantee that the tactics of monetary policy, as currently practiced by the FOMC, will be successful in maintaining a low-inflation environment; the exact same procedures delivered the Vietnam-era inflation.

KEY DESIGN CONSIDERATIONS FOR A MONETARY POLICY RULE

We must address two critical issues in the process of designing a rule for monetary policy. First, the rule must take into account the fact that the individuals' regarding the Fed's future actions are an important determinant of economic outcomes. Second, the rule must be very explicit about the information the FOMC uses to determine how to change the intended federal funds rate.

An important development—if not *the* important intellectual development throughout the past 25 years in our understanding of how the macroeconomy works—is the recognition that expectations play a central role in affecting economic behavior. Previously, to the extent that expectations were considered at all, they were treated in a rather mechanical fashion. Contemporary analyses now postulate that individuals do not simply look to past economic outcomes to project the future path of important conditions like the inflation rate. Instead, individuals understand that it is in their self-interest to contemplate seriously what path the Federal Reserve likely will pursue for monetary policy and to align their expectations about future inflation with their perceptions of Fed actions.

Such a role for expectations is not just an element of elegant and stylized economic theories. Expectations influence market activities day in and day out. Traders in the federal funds futures contracts on the Chicago Board of Trade, for example, pore over testimony and speeches of the Chairman and Federal Reserve officials, searching for hints about whether the FOMC will change the intended federal funds rate at its next meeting, or some meeting after that. Financial markets can gyrate widely in response to a remark whose interpretation is contrary to the prevailing impression.

A monetary policy rule must take into account these market expectations and speculations. The goal should be that interest rates and other market prices will respond to objective information about the economy—the same information that monetary policy itself depends on. The fact that markets so often respond to comments and speeches by Fed officials indicates that the markets today are not evaluating monetary policy in the context of a well-articulated and well-understood monetary rule. The problem is a deep and difficult one. The Fed does not know how to specify its monetary policy decisions so that the market can look at the same data the Fed looks at and arrive at the same conclusion. I make this statement not by way of any criticism of my Fed colleagues or staff, but

simply as an honest statement of how things are today. We apply our best judgment to the task and do not rely on a formal rule, because we do not have a formal rule we trust.

My point here is that a critical part of designing a rule is dealing with the interaction of the Fed and the markets. Given this interaction, an important first feature of any rule must be that it is formulated in a systematic fashion and can be communicated easily to the public. A rule the public does not understand will not work satisfactorily because policy changes resulting from application of the rule will constantly take the markets by surprise. The public will not and should not accept a procedure that creates policy changes that seem totally unpredictable and, therefore, arbitrary and capricious.

Second, a policy rule must have the correct long-run properties. A rule that, if followed religiously, would permit inflation to rise or fall to unacceptable levels would obviously be deficient. This aspect of designing a rule is, fortunately, relatively straightforward.

Third, I think it is desirable, though I confess substantial uncertainty on this point, that a rule rely heavily on the market itself. On the whole, markets do a good job in allocating resources efficiently and making judgments about things that are difficult to predict. I think a rule will work best if it can establish a solid and predictable base for monetary policy, leaving maximum room for markets to set interest rates and other prices. For example, if we knew of a direct way to set the rate of inflation to zero directly, then market interest rates could be free to rise and fall as credit demands rise and fall.

MONETARY POLICY RULES

Now I'm down to the bottom line of this lecture—what might an actual monetary policy rule look like?

The place to begin is with the policy rule advocated by Milton Friedman, among others, starting during the 1950s. The long-standing controversy over monetary rules derives in large part from this particular rule. Friedman's proposed rule was that the Federal Reserve should establish a constant rate of growth for the stock of money and maintain that growth rate no matter what emerged from the state of the economy. Friedman's opponents argued that, should the Fed adopt such a rule, it would default on its responsibilities to stabilize cyclical fluctuations of the economy. They felt that such stabilization required that the Fed exercise discretion in the conduct of monetary policy. Friedman countered that historically the Fed was the principal cause of cyclical fluctuations in the economy and that much of the desired stabilization of the economy would be achieved if money growth were constant.

Nothing in the modern concept of a monetary policy rule requires that the Fed pursue a policy invariant to the state of the economy. The restrictions imposed on Fed decision-making by the monetary-rule process, as defined here, only require that decisions to change or not change the intended federal funds rate repeatedly incorporate the same information and respond to that information in the same way.

Critics of the rule approach argue that the Fed must consider all available information about the economy. There is nothing in the concept of a monetary rule, however, that precludes the FOMC from reaching its decisions based on a wide variety of information. All that is required is that the same information be considered and incorporated into the decision-making process in the same fashion each time the intended federal funds rate level is reassessed. Neither the data consulted, nor the weight placed on particular pieces of information, should be altered in repeated decisions. Furthermore, operating under a monetary rule requires that the basis for deciding whether to change the intended federal funds rate be clearly communicated to the public. Everyone should be able to make informed predictions about the future course of policy, given knowledge of the same facts about the state of the economy.

The rule calling for a constant growth rate of the money stock has many desirable features:

- It is easy for the public to understand.
- The rate of inflation cannot take off toward plus infinity or minus infinity if money growth is held constant.
- Interest rates are free to fluctuate in response to changing market conditions.

The Friedman rule, however, has not gained general acceptance. One reason why is that the term "money" must be defined in an acceptable way if the rule is to work and be easily understood by the public. Many, and perhaps most, economists today believe that changes in the amount of money demanded by the public are of sufficient size and duration that keeping the money stock on a steady path will likely lead to much larger fluctuations in the inflation rate and level of economic activity than we'd like. The better way of stating this point is to say that a central bank using its best judgment can beat the performance of the Friedman rule, and that this claim is well demonstrated by the Fed's performance since it began to attack inflation in 1979. There are other criticisms of the Friedman rule. My purpose here, however, is not to review this whole debate but to discuss the issue of rules more generally.

Others—especially Allan Meltzer and Bennett McCallum—have worked on variants of the Friedman rule. These are quantity-based rules that yield a changing growth rate of the money stock or the monetary base. The research is promising and deserves more attention than it gets.

Another approach is an interest-rate rule, in contrast to the quantity rules just discussed. The policy rule for interest rates that has been discussed most often for several years now was proposed by Stanford economist John Taylor in 1993. His rule is an attractive one to consider because it is so closely linked to traditional Fed practice in setting an intended federal funds rate.

Taylor proposed that the federal funds rate be determined by a rule with three basic terms in it. First, the funds rate should equal an estimate of the economy's real rate of interest at a zero rate of inflation plus the Fed's target rate of inflation. For example, with an estimate of an equilibrium real rate of interest of 2 percent, and a long-run target rate of inflation of 1 percent, the base rate for the federal funds rate would be 3 percent.

The second term in the Taylor rule calls for an adjustment to the intended federal funds rate when the inflation rate deviates from the FOMC's target inflation rate. Continuing with the illustration that the target inflation rate is 1 percent, if the actual inflation rate is 2 percent, then the inflation deviation is 1 percentage point. The Taylor rule multiplies that deviation by a specified coefficient and adds the product to the intended federal funds rate. For example, if the coefficient is 1.5, then the inflation deviation of 1 percentage point yields an intended federal funds rate that is higher by 1.5 percentage points.

Taylor has emphasized the importance of having a coefficient on the inflation deviation term that is higher than 1.0. If the coefficient is below 1.0, then an increase in inflation will call forth an increase in the intended federal funds rate that is smaller than the increase in inflation. That means that the real rate of interest would fall when inflation rises, which is a recipe for a never-ending increase in inflation. Everyone agrees that the coefficient on the inflation deviation needs to be above 1.0, but how much above is unknown at this time. There also is an issue of how to define the inflation rate—what index to use and what time period. Using the inflation rate over the last month would introduce a great deal of random noise into the federal funds rate set by the rule; using the inflation rate averaged over the last five years would yield a rule that responds too slowly to changing conditions. The optimal length of the averaging period is not known at this time. Using an inflation forecast might be better, but whose forecast?

The third term in the Taylor rule is the deviation of real gross domestic product

(GDP) from the path of potential GDP. We can call this quantity the GDP deviation. Several ideas lie behind this term. One is that if the Fed were to follow a money growth rule in an economy in which the problems with that rule did not exist, then interest rates would rise and fall as credit demands rise and fall with the strength of the economy. In this sense, the Taylor rule mimics the behavior of interest rates under a constant-money-growth rule. More generally, it seems sensible that if the economy is booming—running well above potential—then interest rates should be somewhat higher to check the excessive pressure on available labor and capital resources. If the economy is slack—operating below potential—then interest rates should be somewhat lower to encourage greater utilization of available resources.

The argument for a term in the policy rule reflecting the GDP deviation is attractive. The optimal size of the coefficient on this term is not known, however. Whether the federal funds rate should change by an amount equal to 0.5, or 2.0, or some other number times the GDP deviation is being investigated. Moreover, potential GDP is not an observable variable.

Although different researchers have different ideas about which is the best method of measuring potential GDP, I do not regard this issue as critical, because an error here will not send the economy off permanently in one direction or the other. The rule will be stabilizing, though not perfect, if potential GDP is misestimated. The size of the coefficient on the GDP deviation is an important issue, however, as it determines how stabilizing the rule is likely to be. This is a complicated matter—too large a coefficient might induce economic cycles around potential GDP and too small a coefficient might permit sustained departures from a desirable path that would tend to destabilize the rate of inflation.

Taylor argued that the behavior of the federal funds rate incorporated in his rule is a reasonable approximation to the actual process of adjustment of the funds rate targets the FOMC used between 1987 and 1993—a period during which monetary policy was quite successful. But his rule is much more than a simple effort to fit the data. It incorporates important and sound theoretical principles that need to be followed if monetary policy is to be successful. As I have already emphasized, however, there is much we do not understand about the optimal construction of a monetary policy rule. We should be wary about accepting coefficients that seem to come out of a small slice of history, no matter how successful policy was during that period. Every empirical economist is all too familiar with the phenomenon of a great model fit during a sample period, followed by utter disillusionment with the performance of the model outside the sample period.

As you can imagine, there are numerous potential problems with the Taylor rule; I've mentioned just a few. But these problems also are problems with the current conduct of monetary policy. Gauging the current interest rate against the equilibrium real rate of interest is an important part of our job today, but we don't know what the equilibrium real rate is in precise numerical terms. We need to judge the current level of the economy against its potential, but we don't know in precise numerical terms what that potential is. Criticizing the Taylor rule, or any other rule, for such reasons does not help solve the problems policymakers face, nor does it make a convincing case that what we do now is better than following an imperfect rule.

The Taylor rule has figured more prominently than other proposed rules in recent discussions of monetary policy rules. Undoubtedly, interest in the Taylor rule reflects the fact that the current implementation of monetary policy around the globe focuses on manipulating a short-term interest rate. Thus, the adoption of a Taylor-type rule would not require the Federal Reserve to alter its operating procedures; the Taylor rule is an effort to formalize the decision-making process that generates the operating instructions in the Fed's current practice.

Another approach to monetary policy, known as inflation targeting, has been instituted by the central banks in several foreign countries.[3] The practice, which

[3] Guy Debelle, Paul Masson, Miguel Savastano, and Sunil Sharma, "Inflation Targeting as a Framework for Monetary Policy," *Economic Issues* 15,

varies from country to country, started with the Reserve Bank of New Zealand, and has been adopted by the Bank of Canada, the Bank of England, the Bank of Finland, the Swedish Riksbank, and the Reserve Bank of Australia. These central banks announce in advance their policy objective for an inflation rate. This announcement reflects a public commitment of the central bank to the policy objective. In none of these cases has the central bank specified the decision rule that it will use to achieve the stated objective. In no market economy can the central bank control the inflation rate or the price level directly. It must intervene in some market to manipulate a price or a quantity to steer the economy toward the desired objective—whether this objective is announced or not. The variable manipulated by the central bank is defined as the policy instrument. The monetary rule indicates the process by which the central bank adjusts the policy instrument when information on the performance of the economy relative to its policy objective is received. Thus, merely announcing a policy objective in terms of the inflation rate does not assure that the central bank is operating under a monetary policy rule. However, I believe that it is desirable for central banks to be clear about their objectives, and in this regard I believe that inflation targeting is a desirable practice.

THE PATH TO PROGRESS IN MONETARY POLICY DECISIONS

I believe that the Taylor rule is a promising approach to better understanding monetary policy. From what I have already said, however, it should be clear that I do not believe that this rule is ready for adoption. We need a lot more research.

Two areas deserve special attention. One concerns a role for monetary aggregates and the second a role for market interest rates, or some other piece of market information.

As a general proposition, we can extract information from markets by studying both prices and quantities. The total neglect of information about the monetary aggregates in the Taylor rule opens up a natural avenue to extend the rule. This is not the place to present current research results, especially since I don't have any of this kind. I am simply saying that, given all the evidence supporting Milton Friedman's proposition that "inflation is now and everywhere a monetary phenomenon," it seems to me that we ignore the behavior of the monetary aggregates at our peril.

Obviously, interest rates reflect market expectations about the future. Might we incorporate rates in the rule in some fashion? The idea is intriguing, but there is a circularity problem because it appears that the bond and money markets respond significantly to changes in Fed policy and to changes in expectations about Fed policy. The more confidence the market has in the Fed, the more the market will concentrate on what the Fed is doing and the less the market will concentrate on fundamentals other than the Fed. Consider an analogy: If you are an investor but know little about investing, it makes sense to choose your investments by observing the decisions of an investor known for his superior performance. This strategy is likely to work better for you than concentrating on investment fundamentals themselves, which by assumption, you may not understand very well. The market watches the Fed because the Fed is well informed and because the Fed is the dominant player in the money market.

The more confidence the market has in the Fed's willingness to do whatever is necessary to maintain low inflation, the more sense it makes for the market to concentrate on the Fed's actions rather than forming an independent judgment about future inflation prospects. Therefore, the Fed cannot use the behavior of interest rates in the bond market to provide useful information on how it should adjust the federal funds rate.

If, however, the Fed is able to adopt a precise rule in the future, which is based on information everyone can observe—such as that employed in Taylor's rule—then there may well be a place for an interest rate

term in the rule. If the market could be confident that the Fed would change the federal funds rate, only in response to the observed inflation rate and the GDP deviation (and whatever other observable information the Fed included in the rule), then market forecasts would be incorporated in interest rates. Adding an interest rate term to the rule would be a way to add forecasts to the rule, which, in principle, should make it work better than a rule based solely on past data.

CONCLUDING REMARKS

The concept of a monetary rule is attractive for many reasons. To repeat the definition offered at the beginning of this lecture, a rule is "nothing more than a systematic decision-making process that uses information in a consistent and predictable way." Operating under a monetary rule imposes accountability and transparency upon a central bank. It requires that the policymakers be specific about the rationale behind their policy actions. The record of the decisions will then contain information from which future decision-makers can learn.

A policy rule ought not be considered irrevocable or unchangeable. At any time, our understanding of the short-run impact of monetary policy on the economy is imperfect. Policymakers necessarily operate within constraints imposed by the current state of knowledge and should not be blamed for outcomes that are impossible to avoid given that knowledge. One of the benefits of a policy rule is that a historical record will exist that can be analyzed, and from this analysis we can obtain an understanding of why past policy actions did not produce the intended effects. The knowledge gained from such analysis can and should be incorporated into the formulation of future policy rules. Possible changes in the rule should be studied and debated. When the analysis indicates that the rule can be improved, the Fed should announce the changes in advance and explain the rationale for them.

A policy rule also provides the surest method to pass the accumulated knowledge about the effective operation of monetary policy to future generations. This, after all, is how engineers, using engineering theory and observation of skilled human pilots, constructed autopilots. These devices had to be tested and refined, and the process took time. The devices are subject to continuous improvement. Under normal flying conditions, an autopilot now does a better job than a human pilot at keeping an aircraft on its desired course. As I have emphasized, designing a monetary rule is a difficult task intellectually, but it seems obvious to me that this is the path we must travel.

In short, pursuing the path of developing and then adhering to a rule provides the best approach—perhaps the only approach—to improving the practice of monetary policy over the long run.

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Wages and Risk-Taking In Occupational Credit Unions: Theory and Evidence

William R. Emmons
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Credit unions are regulated and insured depository financial institutions dedicated to the saving, credit, and other basic financial needs of selected groups of consumers.[1] Previous research has tended to suggest that credit unions operate inefficiently. In particular, given widely dispersed ownership and—in the case of employer-based or *occupational credit unions*—the presence of one or more sponsors primarily engaged in non-financial activities, there are reasons to believe that a managerial agency problem may be important.

In this article, we present a simple model of an occupational credit union in which the manager wishes to engage in expense-preference behavior. The sponsor must choose whether to accept this behavior and deduct the monetary equivalent from the manager's wage—what we call the Demsetz solution, as described in Demsetz (1983)—or to offer higher, so-called efficiency wages to discourage it. We show how wage expenses and risk-taking by the credit union are intimately connected.

We simulate the theoretical model to build intuition about the relationship among credit union size, wages, and risk-taking. Then we provide empirical evidence that supports a link between the size of occupational credit unions and the levels of wage expense and risk-taking. In particular, larger credit unions tend to have higher wage expenses and take less risk. We also document an important role for external control mechanisms, namely, local deposit-market competition. Wage expense is higher and risk-taking is lower in credit unions that face a less competitive local deposit market.

The article is organized as follows: The first section reviews previous research on credit unions. The second section presents our simple model of a credit-union sponsor who chooses both the compensation scheme for the credit-union manager and the amount of risky lending the credit union will do. This model nests both the Demsetz wage regime, in which the manager is allowed to shirk, that is, loaf on the job, but is paid a low wage, and an efficiency-wage regime, in which the manager is promised a high wage but is punished severely if caught shirking. The third section presents a nonstochastic simulation, comparative-statics results, and testable hypotheses. The simulation illustrates that the optimal choice of a compensation regime depends on the configuration of parameter values and exogenous variables that happen to exist. The fourth section contains a description of our empirical methods and results. The final section presents our conclusions. An appendix provides details on the empirical methodology, the dataset, and the variables we employ.

PREVIOUS RESEARCH ON CREDIT UNIONS

It is useful to distinguish between two main approaches taken in economic research regarding credit unions. One approach focuses on the legal structure of credit unions as consumer-owned cooperatives and explores how credit unions produce and distribute financial services. We refer to this branch of the literature as *the structural*

[1] See Srinivasan and King (1998) for an overview of credit unions and a discussion of current issues surrounding credit unions.

approach to credit unions. The other approach—and the one this article follows most closely—focuses on the important yet largely extralegal and unregulated relationship between the management of a credit union and its members and sponsor(s). We call this *the agency approach* to credit unions.

The Structural Approach to Credit Unions

Early theoretical research on U.S. credit unions in the structural tradition includes Taylor (1971), Flannery (1974), Smith, Cargill, and Meyer (1981), and Smith (1984). These papers highlight an important conflict of interest that arises between members in determining the policies of the credit union. Savers—members who have deposits in the credit union but insignificant or no loans outstanding—want the highest possible deposit interest rate, while borrowers—members who have borrowed a significant amount of money from the credit union relative to their deposits—prefer the lowest possible lending rate. Clearly, these two objectives conflict. The question becomes, what policy will a given credit union follow?

Empirical research on whether credit unions are in fact saver-dominated or borrower-dominated finds mixed results. Flannery (1974) finds a tendency toward borrower domination in U.S. credit unions (i.e., low borrowing rates), Patin and McNiel (1991) find evidence of saver domination (high deposit rates), while Smith (1986) finds no evidence of domination by either group. One might surmise from this inconclusive evidence that there is no general pattern among all credit unions with respect to rate-setting policy, and hence, domination by either savers or borrowers.

More recent theoretical research in the structural tradition includes Besley, Coate, and Loury (1993), who analyze member incentives in rotating saving and credit associations in developing countries; Hart and Moore (1996, 1998), who model member incentives and conflicts in stock exchanges and cooperatives more generally; Banerjee, Besley, and Guinnane (1994), and Emmons and Mueller (1998), both of whom study member incentives in cooperative banks in Germany; and Davis (1998), who looks at the long-term sustainability of cooperative financial institutions. Although modeling techniques have changed in recent years, the basic issues investigated by newer research still revolve around the governance and incentive structures implied by cooperative ownership of financial institutions.

Some recent empirical work in the structural tradition examines the operating efficiency of credit unions. Fried, Lovell, and Vanden Eeckaut (1993) find evidence of widespread operating inefficiency among credit unions of about the same degree as found by many other researchers studying other types of depository financial institutions. Extending the work of Fried et. al. (1993), Fried, Lovell, and Yaisawarng (1998) find that credit-union mergers may be effective in raising the performance of underperforming acquired institutions.

Emmons and Schmid (1999) adopt a somewhat different empirical approach to focus on the role of common bonds in credit unions. Using a semi-parametric estimation technique like the one used in this article, they show that the smaller the potential membership group, the higher member participation rates are in credit unions. These authors attribute the size-participation rate relationship to the declining ability of credit unions to satisfy member preferences as member heterogeneity increases. This result may point toward agency problems in credit unions that are aggravated as member attachment to the credit union declines, although they do not test for such problems explicitly.

The Agency Approach to Credit Unions

Credit unions have a comparatively weak governance structure compared to shareholder-owned financial institutions in the sense that no private individual or small group of individuals has the financial incentive to intervene strongly to discipline the management when the credit union's

policies or performance go astray (Rasmusen, 1988, p. 397). This is because a one-person, one-vote governance structure quickly leads to free-riding incentives as the number of members increases. Reinforcing this tendency of monitoring incentives to weaken in larger credit unions is the lack of a disciplining role for takeovers since building a controlling coalition of credit-union members may be difficult.[2]

One implication of its weak governance structure is likely to be that a credit union's management becomes the *de facto* residual claimant to the institution's surplus. That is, even though a credit-union manager cannot profit by paying excessive dividends to large stockholders (including perhaps himself) or through gains on underpriced stock options, he may be able to convince the board of directors to pay him a large salary and grant him other nonwage perquisites of control, such as a luxurious office, extra staff, generous travel allowances, or simply a "quiet life." Hence, agency problems may be of the first order of importance in credit-union management and performance.

How can credit unions and other mutual financial institutions survive if they are subject to potentially large managerial agency problems? Two reasonable explanations have been offered corresponding to the period before and after the introduction of federal deposit insurance in the United States. Rasmusen (1988) suggests that mutual financial institutions thrived in the pre-deposit insurance era precisely because the manager had substantial power and discretion. An agency problem could help mutual financial institutions to survive because any risk-averse manager with substantial discretion could be expected to operate in a very conservative manner to preserve his position, salary, and consumption of perquisites. In contrast to stockholder-owned banks, whose managers are likely to be large holders of the bank's stock and thus more interested in gambling with depositors' funds, credit-union managers have no way of obtaining option-like pay-offs (i.e., pay-offs that are skewed toward large positive returns and protected against negative returns by limited liability). Relatively poorly informed and highly risk-averse depositors seeking a safe savings institution will find a mutual institution such as a credit union quite attractive, according to Rasmusen. Even though the manager engages in petty misappropriation of funds for his own use, he has a strong interest in avoiding risky investments that might jeopardize his position. Thus, compared to a stockholder-owned bank, a mutual bank would be preferred by uninformed and risk-averse depositors and might survive even though it operates inefficiently.

The advent of government regulation of banks and the creation of deposit insurance for virtually all depository institutions eliminates the advantage to risk-averse depositors of a mutual bank compared to a stockholder-owned bank. In effect, the government assumes the risk borne previously by depositors, so the risk-taking of the bank is of no consequence to depositors. Depositors have no reason to prefer a risk-averse manager, and in fact, they become risk-loving if the safe return they are promised is higher as a consequence of the risk. Thus, the expansion of credit unions in the post-deposit insurance era must be due to something besides depositors' fear of bank risk-taking.

Hansmann (1996, pp. 259-60) suggests that employer-sponsored credit unions continue to thrive today because employers are willing to subsidize them:

> Employers can also benefit from having a credit union for their employees. The credit union ties the employees more tightly to the employer, improves the employees' financial situation (and consequently their effective wage), and helps keep the employees out of financial difficulties that may interfere with their work or create bother for the employer (such as garnishment of wages). For these reasons employers have often helped promote the formation of credit unions, for example, by providing free office space and free time off to the employees who administer them.

[2] These circumstances stand in stark contrast to those of a stockholder-owned firm (although there is ample evidence that governance of modern stock banks also is rife with inefficiencies). Individuals can assemble large and powerful blocks of stock ownership either to exert control over the existing management or to execute a takeover and replace the management.

Thus, a key feature of occupational credit unions today may be the willingness of employers to subsidize their existence. Note that the managerial agency problem is likely to persist because the sponsor may not be well-suited (or motivated) to supervising a banking business.

Empirical work following the agency approach to credit unions and other mutually owned banks includes Akella and Greenbaum (1988), Mester (1989, 1991), Keating and Keating (1992), Schmid (1997), and Gorton and Schmid (forthcoming). All of these papers (and many others) document "expense-preference behavior," a positive relationship between more diffused ownership of a financial institution and the level of its expenses relative to those of institutions with more concentrated ownership.

We confirm the basic thrust of these results in our empirical investigations below. We also find evidence that the degree of local deposit-market competition is linked to the extent of the agency problem we observe.

THE MODEL

This section describes a model of an occupational credit union that nests two competing hypotheses regarding the compensation of agents who can engage in opportunistic behavior. It also allows us to derive hypotheses concerning the risk-taking of the credit union. The model is based on the costly-state verification paradigm introduced by Townsend (1979). The problem to be solved is one of conflicting interests between the manager and the sponsor with respect to the manager's consumption on the job, which we term expense-preference behavior or "shirking." We assume that the sponsor can observe the manager's shirking but must wait for a government regulator to be able to prove it. An inspection occurs if (and only if) the credit union encounters financial distress. Although the regulator carries it out, an inspection adds to the operating costs of the credit union (as discussed below).

We consider two competing hypotheses. Demsetz (1983) suggests that firms may accept shirking by the manager and subtract the pecuniary equivalent of the expected amount of shirking from the manager's monetary compensation (wage). The manager's *total* compensation from the job still may be high enough to compete with other job offers.

The efficiency wage literature provides a competing hypothesis to describe how firms deal with an agency problem.[3] In these models, the principal (the sponsor) increases the agent's (the manager's) opportunity costs of shirking to a level that makes shirking disadvantageous to the agent. This is accomplished by randomly inspecting the manager's performance and threatening to fire him if he is caught shirking. It is important to note that both the Demsetz pay structure and efficiency wage compensation are generally second-best solutions. That is, the total costs of running the firm are higher than in the absence of an agency problem.[4]

We consider one sponsor, the set of credit-union employees, and many credit-union members in a one-period model. For simplicity, we represent all credit-union employees with one employee, whom we call the manager. The sponsor and the manager are risk-neutral, while the members may be either risk-neutral or risk-averse without changing our results. In our model we assume that it is the sponsor who hires and (possibly fires) the manager, sets his wage, and defines the lending rulebook. Since, in reality, these decision rights reside in the board of directors of the credit union, we implicitly assume that the sponsor is in control of (or in complete agreement with) the board. We also assume that the manager is compensated at the end of the period. This allows the sponsor to tie the manager's wage to his behavior in a one-period model.

We assume that the benefit the manager enjoys from shirking, G, is discrete and known to the sponsor. We also assume that the sole purpose of the credit union is to make loans. The task of the manager is to screen loan applicants according to the rulebook. The rulebook is public knowledge, which implies that the manager's decisions on loan applications are transparent to the

[3] For an overview, see Milgrom and Roberts (1992), or Ritter and Taylor (1997).

[4] Demsetz (1983) claims that his compensation scheme leaves both parties as well off as without shirking, thus eliminating the agency problem. This holds true if (and only if) the manager's shirking causes a loss to the sponsor that is equal to the benefit it offers to the manager. If the sponsor's loss exceeds the manager's benefit, the costs of running the firm are higher than in the absence of an agency problem. In the unlikely case that the sponsor's loss from shirking is lower than the manager's benefit, the manager's shirking leads to a Pareto improvement. This case does not pose an agency problem, so we do not consider it.

sponsor and the members. We assume that the lending decisions are verifiable before the court at zero cost. This means that there is no agency problem between the sponsor and the manager with respect to lending, allowing us to model the lending decisions as if the sponsor made them himself.

We assume that the credit union cannot cover its costs without receiving subsidies from the sponsor, who is thus the *de facto* residual claimant of the credit union. For simplicity, we assume that the credit union's operating costs consist of management compensation and, in the event of financial distress, the sponsor's costs associated with inspection, C. In addition, if the manager shirks, the credit union loses an amount, H, that corresponds to inflated expenses.

The sponsor enjoys a benefit from the credit union's lending that mirrors the productivity-enhancing effect this lending has on the sponsor's employees. There are two kinds of loans. First, there are safe loans, such as those that are fully collateralized. The benefit the sponsor receives from these loans equals the lump-sum amount B. It is optimal for the sponsor to define the lending rulebook such that all safe loans are made. These loans are riskless, so there are never any financial-distress costs associated with them. Risky loans are the second type of lending done by the credit union; these are less than fully collateralized loans. The sponsor attaches a value, γ, to each dollar of risky loan granted. We assume that additional lending always increases the total risk of the portfolio. This is because, for any given dollar amount of lending, L, the sponsor chooses the least risky loan portfolio. To increase lending, the credit union must take on lower-quality loans, and hence, more risk.

The total risk of the loan portfolio causes the credit union to become insolvent with some probability, p. The probability of distress is related to the risk of the credit union's loan portfolio by the cumulative normal density function $\Phi(lnL)$ with lnL being the natural log of the amount of lending and $\phi(lnL)$ denoting the corresponding normal probability density function. The higher the risk, the more likely the credit union will enter distress, in which case the credit union is inspected by the regulator with certainty and the sponsor incurs costs of C.

Thus, in this model, the credit union's financial distress has two implications. First, inspection by the regulator reveals the true state of the credit union's cost situation. This means that the sponsor obtains legally verifiable evidence if the manager has shirked. Second, the sponsor incurs costs, C. These costs include the monetary equivalent of the damage to the sponsor's reputation both within and outside the firm, extra managerial and legal resources the sponsor has to allocate to the distressed credit union, and payments made by the sponsor to assist in the workout of the credit union.

The sponsor chooses between an efficiency-wage compensation scheme and a Demsetz-style compensation structure. In any regime, total compensation must amount to at least W^a, where W^a is the manager's reservation wage. The reservation wage is the amount of compensation the manager can obtain in an alternative employment.

In the efficiency-wage regime, the sponsor can increase the manager's opportunity costs of shirking to the point that the manager becomes indifferent between shirking and not shirking. This is achieved by paying the manager a premium in addition to his reservation wage such that his benefit from shirking, G, equals the expected value of losing his job. The efficiency wage, W^e, is the sum of the reservation wage, W^a, and the wage premium, where $W^e > W^a$. The expected cost of losing the job is $p \times (W^e - W^a)$. Since we use a one-period model, losing the job in an efficiency-wage framework is a metaphor for getting paid only the reservation wage W^a at the end of the period. The manager will shirk if (and only if) the expected gain of expense preference behavior, G, is strictly greater than the expected loss from shirking, $p \times (W^e - W^a)$. In equilibrium, there is no shirking.

In the Demsetz compensation regime, there is shirking in equilibrium but there is no wage premium. Under the assumption

that the manager's benefit from shirking, G, is no greater than his reservation wage W^a, the sum of nonpecuniary and pecuniary compensation is the reservation wage in equilibrium. The sponsor has no reason to pay the manager more than it takes to attract him to this job.

The sponsor chooses the compensation scheme with the highest expected pay-off. If the sponsor's expected pay-off is negative, his participation constraint is violated and the credit union will not exist.

Thus, there are two considerations bearing on the sponsor's choice of compensation regime. First, if the sponsor switches from an efficiency-wage compensation to a Demsetz solution, he saves the wage-premium (W^e-W^a) but will face increased operating costs caused by shirking, H. Second, changing to a Demsetz wage may affect the sponsor's expected pay-off by changing the optimal amount of lending, L. A change in L affects the sponsor's benefit from lending as well as the probability that he will incur costs associated with the credit union's financial distress and inspection.

The Efficiency-Wage Hypothesis

If the sponsor installs an efficiency-wage compensation schedule, he maximizes his expected pay-off, Z_E, by solving the following optimization problem:

(1a) $Max.\ Z_E = B - (W - W^a) - W^a - pC + \gamma L$
$lnL,\ W\text{-}W^a$

s.t.

(1b) $p \times \left(W - W^a\right) \geq G$

(1c) $p = \Phi(lnL)$

(1d) $L \leq L^p$

(1e) $L > 0$.

Condition 1b is the manager's incentive-compatibility constraint. In equilibrium, this condition binds because the sponsor does not pay more than it takes to make the manager indifferent between shirking and not shirking.

Depending on the values for the parameter γ and the exogenous variables G, C and L^p, the model's solution may be one of two possible corner solutions or an interior solution. There also are strictly positive vectors (γ, G, C) for which there is no positive amount of risky lending, L, that solves the model.[5] In what follows, we concentrate on the interior solution to the model.

The interior solution for L in the efficiency-wage model satisfies the first-order condition expressed in terms of the optimal probability of inspection p*:

$$(2a)\quad \Phi(\ln L) = \left(\frac{G}{C - \frac{\gamma L}{\phi(\ln L)}} \right)^{\frac{1}{2}} .$$

Note that an interior solution requires $C\text{-}\gamma L / \phi(lnL)$ to be greater than zero. An alternative way of writing the interior solution is

$$(2b)\quad \phi(\ln L) = \frac{-\gamma L}{\frac{G}{\Phi(\ln L)^2} - C} .$$

The first-order condition requires that $G/\Phi\,(lnL)^2\text{-}C$ is smaller than zero.[6] Under this condition it is apparent that the right-hand side (RHS) of Equation 2b is strictly convex in L. Since the probability density function is single-peaked, there are two values of L solving Equations 2a, b.[7] Only the smaller one satisfies the second-order condition, representing a (local) maximum. The larger of these two values of L lies in a (local) minimum (see Figure 1).[8] We define L* as the value of L that solves Equations 2a, b and satisfies the second-order condition.

Solving the sponsor's maximization problem for the efficiency wage premium, $W\text{-}W^a$, the interior solution is defined by:

$$(2c)\quad W^e - W^a = \left(G \frac{C - \gamma L^*}{\phi(\ln L^*)} \right)^{\frac{1}{2}} .$$

[5] For instance, for $\gamma = 0.7$, $G=0.07$, $C>3.3$, there is no positive value for L that solves the maximization problem 1. For zero risky lending, the probability of inspection is zero. Consequently, the sponsor does not pay a wage premium, which means that the efficiency wage model does not apply.

[6] In the optimization problem 1, the first-order condition for the optimal amount of lending reads $\phi(lnL) \times (G/\Phi(lnL)^2 \cdot C) + \gamma L = 0$.

[7] In the case that the probability density function $\phi(lnL)$ is tangent to $\gamma L / (C\text{-}G/\Phi(lnL)^2)$, there is only a single value of L solving Equations 2a, b.

[8] It can be shown easily that for L going to infinity, the value of the sponsor's objective function $Z_E(L)$ approaches infinity. Also, except for the case where the single-peaked probability density function $\phi(lnL)$ is tangent to $\gamma L / (C\text{-}G/\Phi(lnL)^2)$, there are two intersection points. Consequently, the optimum for the low value of L must be a (local) maximum while the one for the high value of L must be a (local) minimum.

Again, an interior solution requires that the expression $C - \gamma L^*/\phi(\ln L^*)$ is positive.

There are two corner solutions, in both of which constraint 1d is binding for L^*. The interpretation of a corner solution is that the credit union fully exploits its lending potential, i.e., $L = L^p$. This amount of lending determines the optimal inspection probability, p^*, via Equation 1c, which in turn determines the optimal wage premium, $W^e - W^a$, by virtue of the binding incentive-compatibility constraint 1b.

One corner solution holds if $C - \gamma L^*/\phi(\ln L^*) > 0$ and $L^* > L^p$. In this case, the optimal risk of the credit union's loan portfolio is $\Phi(\ln L^p)$, its highest possible value. The efficiency-wage premium, $W^e - W^a$, equals $G/\Phi(\ln L^p)$, its lowest possible value.

The other corner solution occurs when $C - \gamma L/\phi(\ln L)$ is nonpositive. In this case, there is no positive efficiency-wage premium that solves the optimization problem . Since the first derivative of Z_E, with respect to the wage premium, is strictly negative for $C - \gamma L/\phi(\ln L) \leq 0$, the optimal wage premium equals its minimum value, $G/\Phi(\ln L^p)$, which leads to the first corner solution, discussed above.[9]

In summary, the efficiency-wage regime has one interior solution that satisfies the second-order condition (Figure 1). It also has two (identical) corner solutions. The values of the exogenous variables and the parameters determine whether the efficiency-wage or the Demsetz compensation scheme will be better for a particular sponsor. The sponsor will install an efficiency-wage compensation regime if (and only if) the following two conditions hold: First, the relevant efficiency- wage solution is superior to the relevant Demsetz solution and, second, it satisfies the sponsor's participation constraint.

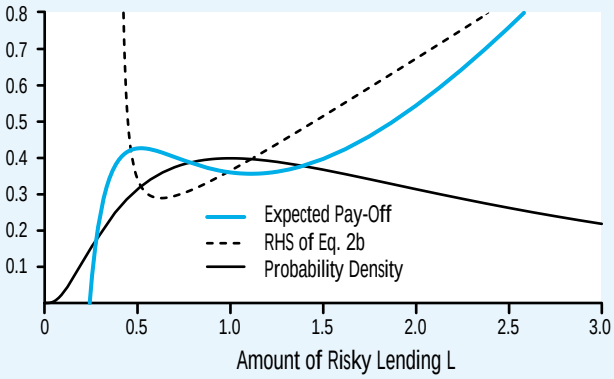
The Demsetz Hypothesis

The sponsor's optimization problem under the Demsetz hypothesis is:

(3a) $\underset{L,\ln L}{Max.}\ Z_D = B - H - W - pC + \gamma L$

Figure 1

Solution to the Efficiency Wage Model



s. t.

(3b) $W = W^a - \min\{G, W^a\}$

(3c) $$p = \begin{cases} \Phi(\ln L) & \text{for} \quad L > 0 \\ 0 & \text{for} \quad L = 0 \end{cases}$$

(3d) $0 \leq L \leq L^p$.

Depending on the values for the parameter γ and the exogenous variables C and L^p, the model may have either one of two possible corner solutions or an interior solution. The interior solution satisfies the first-order condition:

(4) $$\phi(\ln L) = \frac{\gamma L}{C}.$$

Since the right-hand side of Equation 4 is linear in L and the probability density function is single-peaked, there are two values of L that solve Equation 4.[10] Only the smaller one, L^*, satisfies the second-order condition (see Figure 2).[11]

One of two possible corner solutions occurs if $L^* > L^p$. In this case, the amount of risky lending takes on its maximum value L^p. Another corner solution ensues when there is no positive amount of lending, L, that solves Equation 4.[12] In this case, the amount of risky lending and the probability of inspection are zero. The credit union might, nevertheless, exist if the benefit from

[9] When solving the optimization problem 1 for the wage premium ($W - W^a$), the first derivative of the sponsor's objective function Z_E ($W - W^a$) reads $-1 + G/(W - W^a)^2 \times (C - \gamma L/\phi(\ln L))$.

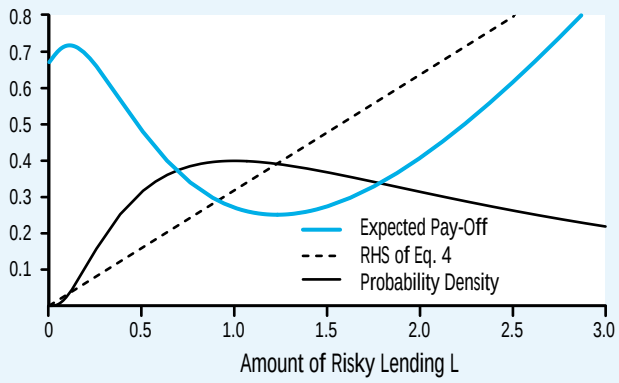
[10] In the case where the probability density function $\phi(\ln L)$ is tangent to $\gamma L / C$, there is only a single value of L solving Equation 4.

[11] Similar to the efficiency wage regime, we can argue that the sponsor's objective function $Z_D(L)$ goes to infinity for L approaching infinity. Consequently, the optimum for the low value of L must be a (local) maximum while the one for the high value of L must be a (local) minimum.

[12] This holds, for instance, for $\gamma = 0.7$ and $C > 2.5$.

Figure 2

Solution to the Demsetz Model



granting risk-free loans, B, is sufficiently high. For any solution, the pecuniary wage equals W^a-G, and the risk of the loan portfolio is independent of the benefit the manager reaps from shirking, G. Note that in the Demsetz regime there is no benefit from verifying the true cost situation of the credit union since shirking is part of the compensation package.

The sponsor will install a Demsetz compensation scheme if (and only if) the following two conditions hold. First, the relevant Demsetz solution is superior to the relevant efficiency-wage solution and, second, it satisfies his participation constraint.

Comparison of Compensation Regimes

We compare Equation 2b to Equation 4 and find that in interior solutions, $\phi(lnL)$ is higher in the efficiency wage regime. Since the solution for L in the Demsetz regime is located on the upward-sloping section of the graph of $\phi(lnL)$, lending, and consequently, portfolio risk $\Phi(lnL)$ are higher in the efficiency-wage regime than in the Demsetz regime. For corner solutions, the amount of lending, L, equals L^p and the inspection probability, p, equals $\Phi(lnL^p)$ in both regimes. For both interior and corner solutions, the pecuniary compensation always is lower in the Demsetz regime because in this regime, shirking is part of the compensation package.

SIMULATION

In this section we present a simple nonstochastic simulation of the model to help build intuition and to derive hypotheses for the empirical analysis. First, we study the first-order conditions of the efficiency wage and the Demsetz solutions as displayed in Equations 2b and 4. Second, we present a comparative-static analysis of the effects of the sponsor's costs associated with financial distress and regulatory inspection, C, on the credit union's managerial compensation and risk-taking.[13] Third, we derive two testable hypotheses regarding the pecuniary wage level and loan risk of credit unions.

Optimums

Figure 1 displays the two interior solutions to Equation 2b, the efficiency wage regime. It shows the probability density $\phi(lnL)$, the right-hand side of Equation 2a, and the sponsor's expected pay-off. The points of intersection between the solid and the dashed black lines mark (local) optima. As the objective function (blue line) shows, the left one is a local maximum while the right one is a local minimum. The corresponding graph for the Demsetz regime is displayed in Figure 2.[14]

Comparative Statics

Figure 3 displays the optimal pecuniary wage for the efficiency-wage regime and for the Demsetz regime across a range of values of C, the costs incurred by the sponsor when the credit union enters distress and is inspected. While the Demsetz pecuniary wage component is constant (and below the reservation wage), the efficiency wage is constant (and equal to the reservation wage) only for low values of C (corner solution at $L=L^p$). The efficiency wage increases thereafter. At $C-\gamma L/\phi(lnL)=0$, the graph of the efficiency wage model has a discontinuity. As the graphs show, the efficiency wage model has no solution for sufficiently high values of C. That is, the sponsor will choose a Demsetz compensation scheme if the costs associated with distress and inspection are sufficiently

[13] We chose the following values for the exogenous variables: $B = 1.9$; $G = 0.07$; $H = 0.3$; $L^p = 3$; $W^a = 1$. The value chosen for the parameter γ was 0.7. For Figures 1 and 2 we set the costs of distress, C, equal to 2.2.

[14] To help understand the mechanics of the model, Figures 1 and 2 were drawn without imposing the sponsor's participation constraint $Z_{E,D} \geq 0$ and the lending constraint $L^* \leq L^p$.

high (but low enough to allow for an expected pay-off greater than zero).

Figure 4 shows the optimal risk of the credit union's loan portfolio as the cost of distress and inspection, C, is allowed to vary. For low levels of C, the risk level takes on its maximum value and is independent of the compensation regime (corner solutions at $L=L^p$ in both regimes). As C increases, the optimal risk level in the Demsetz regime switches from the corner solution to the interior solution at $C=\gamma L^p/\phi(lnL^p)$. In the efficiency wage regime, this changeover occurs at $C=\gamma L^p/\phi(lnL^p)+G/\Phi(lnL^p)^2$, a higher value of C than in the Demsetz regime. For the range of C in which an interior solution obtains, the optimal risk level decreases with an increase in the costs of distress. For sufficiently high values of C, there are no solutions for the efficiency wage model while the Demsetz model switches discontinuously to a corner solution with zero risk (because of zero risky lending). Comparing interior solutions across compensation regimes shows that for any given value of C, the risk level in the Demsetz regime is lower than in the efficiency wage regime.

Figure 5 displays the sponsor's expected pay-offs for the two compensation regimes. As in Figure 4, the graphs exhibit discontinuities at the values of C that mark the border between corner solutions and interior solutions. For corner solutions at $L=L^p$, the expected pay-offs are linear in the costs of distress. The vertical difference between the two graphs equals the difference between the sponsor's loss from shirking and the wage premium. For interior solutions, the pay-offs are strictly convex in C. In the corner solution of zero risky lending in the Demsetz regime, the pay-off is independent of the costs of distress.

In the case displayed in Figures 3 to 5, the sponsor chooses an efficiency wage compensation structure for low values of C. As C increases, the pecuniary wage level and the risk of the loan portfolio are left unchanged as long as the corner solution prevails. When, for a sufficiently high value of C, the efficiency wage switches from the corner solution to the interior solution, wage and risk change discontinuously. While the wage increases, risk falls. With further increases in C, the wage rises continuously and the portfolio risk declines continuously. When the switch to the Demsetz compensation regime eventually occurs, the pecuniary wage and portfolio risk drop discontinuously. While the wage adopts its minimum value and remains unchanged for further rises in C, the risk declines continuously as C increases before

Figure 3

Simulation: Effect of Changes in C on Wage Level

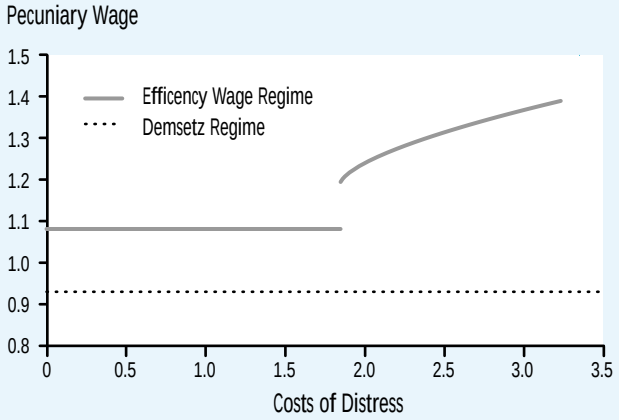


Figure 4

Simulation: Effect of Changes in C on Risk-Taking

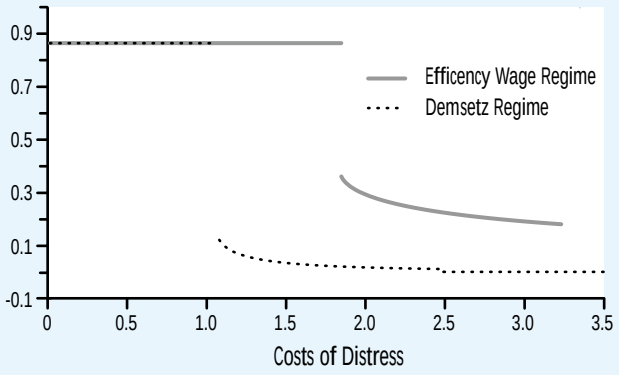
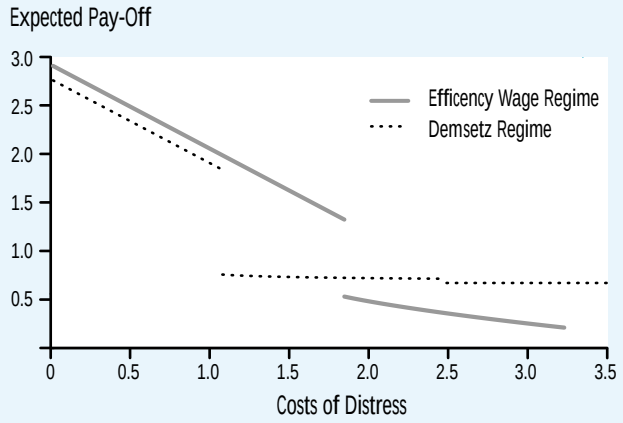


Figure 5

Simulation: Effect of Changes in *C* on Sponsor's Expected Pay-Off



it falls to zero in the corner solution corresponding to zero risky lending.

Alternative sequences of regimes are possible as *C* increases. For instance, the efficiency wage regime may dominate the Demsetz regime over the whole range of values of *C* for which it has a solution.[15] Alternatively, the Demsetz scheme may be superior to the efficiency wage compensation structure for all values of *C*.[16] It also is possible that for low values of *C*, the Demsetz regime dominates, followed by the efficiency wage regime for medium values of *C*, while for high values of *C*, the Demsetz regime dominates again.[17]

Hypotheses

We summarize the preceding discussion by stating two testable hypotheses relating the credit union's costs of distress and inspection to its wage expense and risk-taking. The first hypothesis concerns the predicted level of wages.

HYPOTHESIS 1 (WAGE LEVEL)

The impact of the costs of credit union distress and inspection on the credit union's wage expense is either:

1. Constant (if the Demsetz regime prevails for all values of *C*), or

2. Nonincreasing (if the interior solution of the efficiency-wage regime never dominates, or if in the relevant range of *C* the Demsetz regime is not followed by an efficiency wage regime as *C* increases), or

3. Nondecreasing (if in the relevant range of *C* the efficiency-wage regime is not followed by the Demsetz regime as *C* increases), or

4. Hump-shaped (if the interior solution of the efficiency-wage regime is followed by the Demsetz regime as *C* increases, or if the efficiency-wage regime is neighbored by Demsetz regimes on both sides).

If we find evidence consistent with cases one or two, we would conclude that occupational credit unions do not use efficiency wages. If, on the other hand, we find evidence consistent with cases three or four, we would conclude that efficiency wages are being used by sponsors of occupational credit unions.

The second hypothesis concerns the credit union's risk-taking as predicted by the model.

HYPOTHESIS 2 (RISK-TAKING)

The risk of the credit union's loan portfolio is nonincreasing in the costs of credit union distress.

Notice that the risk-taking hypothesis is invariant to the compensation regime used by a credit union, in contrast to our predictions for wage expense. Thus, risk-taking does not allow us to test the efficiency-wage predictions against the Demsetz predictions, although it would allow us to reject the hypothesis that occupational credit unions employ either efficiency wages or a Demsetz compensation scheme.

[15] This holds when the values of *G* and *H* that were used for Figures 1 through 5 are changed to 0.02 and 0.5, respectively.

[16] This holds when the values of *G* and *H* that were used for Figures 1 through 5 are changed to 0.08 and 0.1, respectively.

[17] This holds when the values of *G* and *H* that were used for Figures 1 through 5 are changed to 0.11 and 0.1, respectively.

EMPIRICAL METHODS AND RESULTS

This section describes our dataset, the empirical methods we use, and empirical results. The Appendix contains more details on the first two of these topics.

Dataset

We examine a subset of all federally chartered and federally insured occupational credit unions during 1996. Table 1 provides a breakdown of our sample according to the type of membership group characterizing each credit union. Note that the table distinguishes between credit unions with a single common bond and those with multiple common bonds. Credit unions sponsored by a single manufacturing firm, for example, numbered 744 in our sample. Credit unions with multiple common bonds that predominantly were associated with manufacturing firms, numbered 821, and so on, for the other membership types. We dropped credit unions whose sponsors were in the financial-services sector (TOM codes 20 and 50) because we could not obtain data on sectoral returns on equity. For more details, see the Appendix.

We examine balance-sheet data as of year-end 1996 and income data for calendar year 1996 for our sample of credit unions. Our dependent variables include a measure of the credit union's average wage level relative to local wages (WAGE) and the credit union's loan-loss allowance (ALLOWANCE). More specifically, WAGE is constructed by dividing a credit union's per-capita wage of full-time equivalent credit union employees by the average wage in the credit union's home county, and then taking the logarithm of this ratio. ALLOWANCE is the logarithm of the ratio of provisions made by a credit union for loan losses divided by its total loans. We dropped 14 (out of 2,628) observations because these institutions reported zero loan-loss allowances. Table 2 indicates that the median relative wage level of credit unions in our sample was about two percent above the local wage level, with the overall credit-union relative wage level almost precisely matching local mean wage levels. Loan-loss allowances, meanwhile, averaged 1.7 percent of total loans, with a median value of about 1.2 percent.

Table 1

Distribution of Credit Unions by Type of Membership

Number of Credit Unions †	Type of Membership (TOM) Codes ‡	Type of Membership
744	10-15	Manufacturing
432	21-23	Services
821	40-49	Multiple group – primarily manufacturing
631	51-53	Multiple group – primarily services

† 2,628 observations.

‡ National Credit Union Association (NCUA), Instruction No. 6010.2, July 28, 1995.

Independent variables we use include the logarithm of total assets (ASSETS), the logarithm of the number of members in the credit union (MEMBERS), the Herfindahl index of the local deposit market (HERF), the return on equity in the sponsor's two-digit SIC-code industry (ROE), the existence of multiple common bonds among the credit union's membership (MULTGROUP), the growth rate of real gross state product in the credit union's home state (GRREALGSP), and an indicator variable for sponsors in the service sector (SERVICES). The SERVICES variable appears only in the wage regressions because we expect systematic differences between wage levels in manufacturing and service industries. All other control variables are used in both hypotheses. Table 2 also gives descriptive statistics for ASSETS, MEMBERS, and HERF.

We use ASSETS and MEMBERS as proxies for *C*, the sponsor's costs associated with financial distress of the credit union and inspection by the regulator. This is because larger credit unions are more likely to be complex organizations and to offer a broad array of financial services to their members. Small credit unions typically offer a limited range of services such as savings and checking accounts and automobile loans (U.S. Treasury, 1997, p. 23). Mean-

Table 2

Descriptive Statistics

	Minimum	Median	Mean	Maximum	Standard Deviation
Relative Wage Level †	2.258×10^{-2}	1.019	9.963×10^{-1}	3.925	3.784×10^{-1}
Loan-Loss Allowance ‡	2.055×10^{-4}	1.178×10^{-2}	1.700×10^{-2}	3.600×10^{-1}	1.975×10^{-2}
Total Assets †	4.300×10^{4}	5.031×10^{6}	2.266×10^{7}	1.947×10^{9}	7.797×10^{7}
Number of Members †	4.500×10^{1}	1.581×10^{3}	4.694×10^{3}	1.672×10^{5}	1.104×10^{4}
Herfindahl Index †	5.346×10^{-2}	2.001×10^{-1}	2.093×10^{-1}	1	9.391×10^{-2}

† Based on 2,628 observations.
‡ Based on 2,614 observations.

while, 95 percent of large credit unions (more than $50 million in assets) also offer mortgages, credit cards, loans to purchase planes, boats or recreational vehicles, ATM access, certificates of deposit, and personal checking accounts. Consequently, regulatory inspection is likely to be more difficult, time-consuming, and potentially expensive for the sponsor of a relatively large credit union. At the same time, interruption of a large credit union's activities is likely to be more disruptive to members—and hence also to the sponsor—because they may depend on these activities to meet a larger proportion of their financial needs.

One of the control variables we use is the ROE of the sponsor's industry sector. We cannot identify the sponsors from our dataset, but we are able to identify the sponsor's industry. The ROE of the sponsor's industry serves as a crude control for the parameter γ, the marginal valuation of credit union lending, in the sponsor's objective function.

Empirical Method

We test our hypotheses using a semiparametric model of credit-union performance of the form

$$(5)\quad y_i = x_{pi} \times \beta_p + f(x_i) + \varepsilon_i, \quad i = 1,\ldots,n$$

where y_i is the i-th observation of the dependent variable; x_{pi} is a row vector consisting of the i-th observation of the explanatory variables of the linear (parametric) part of the model; β_p is a (column) vector of the parameters of the linear part of the model; x_i is a vector consisting of the i-th observation of the explanatory variables in the nonparametric part of the model; and ε_i is the i-th realization of the error term. We use a semiparametric model to isolate independent variables whose effects we expect to be nonlinear, such as the number of members or total assets. The parametric part of the model contains independent variables whose effects may be approximately linear; these variables include the Herfindahl index, the sponsor's industry return on equity, and the growth rate of real gross state product in the credit union's state. In addition, indicator variables for the existence of multiple common bonds and for sponsor firms in the services industry are included in the parametric part of the regression. For more details on this methodology, see the Appendix.

Results

We test the two hypotheses that we derived from our model of occupational credit-union agency problems. First, we test the hypothesis that higher costs associated with financial distress impact the credit union's wage level. We also test for a negative relationship between distress costs and risk-taking by the credit union.

The series of plots presented in Figures 6-9 are "conditioning plots."[18] In each plot, one variable is kept at its median value while the other variable (identified on the abscissa) is allowed to vary. The graph displays the

[18] See Cleveland and Devlin, 1988; also see the Appendix of this paper for details.

impact of this independent variable on the level of the dependent variable. In other words, the slope of the graph at a particular point reflects the marginal impact of the independent variable at that point. The intercept is not identified in regressions of this type, so only vertical distances are meaningful (not the level itself). The dotted lines are 90-percent confidence bounds.

Hypothesis 1: Wage Level. Figure 6 plots the partial effect of an increase in the log of total credit-union assets (a proxy for *C* in the theoretical model) on the relative wage level of a credit union, where the relative wage is measured as the log ratio of a credit union's per-capita wage to the local average wage. We hold the number of members at its median value for each level of assets. It is clear that the relationship is non-linear, particularly at the smallest credit unions. We suspect that the high incidence of subsidies from employers and members who volunteer their time accounts for some of the unusual behavior of wages at the smallest credit unions. An upward slope in the relationship between total assets and the relative wage level is apparent, though, except for the very large credit unions. Judging from the wide confidence intervals for the largest institutions, however, the relationship is not estimated very precisely in this segment. The observed upward slope is consistent with the hypothesis that larger costs associated with financial distress translate into increased relative wage levels, as predicted by the interior solution of the efficiency wage model (Hypothesis 1, cases 3 and 4). Thus, the efficiency-wage theory is supported, while the Demsetz hypothesis—which predicts constant wages—is not.

Figure 7 basically makes the same point as Figure 6. The relative wage level of a credit union increases as the log number of members—another proxy for *C*—increases, holding the level of total assets at its median value for a given number of members. As before, the relationship is unusual and quite nonlinear at the smallest credit unions and appears to be upward-sloping over the full set of credit unions.

Figure 6

Wage Level and Total Assets

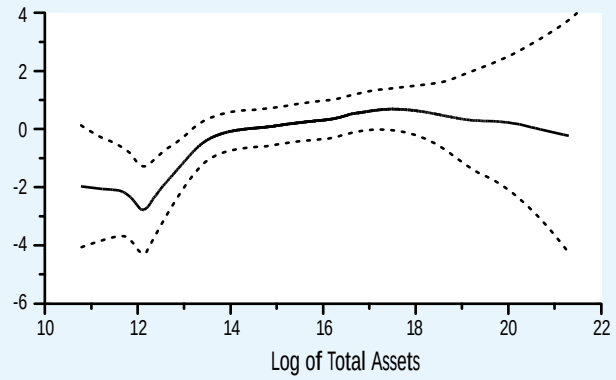


Figure 7

Wage Level and Number of Members

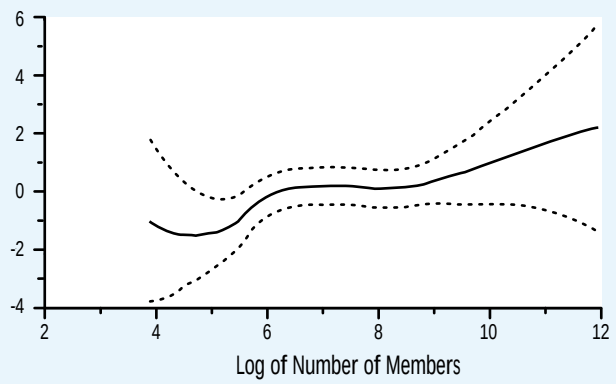


Table 3 presents results from the parametric part of the model. The significant positive coefficient on HERF indicates that, as the level of concentration increases in the local banking market, and presumably the intensity of competition decreases, the relative wage level of a credit union rises. If competition in the local deposit market is an important external source of control for agency problems, then higher concentration may indicate weak market discipline felt by the management.

Table 3

Dependent Variable: Wage Level

Independent Variable	Coef cient	*t*-statistic
HERF	2.734×10^{-1}	3.265 ***
ROE	-1.695×10^{-2}	-3.402 ***
MULTGROUP	2.426×10^{-2}	1.437
GRREALGSP	1.057	1.349
SERVICES	-5.276×10^{-2}	-2.893 ***
Number of Observations	2628	

*** Significant at the 1 percent level (two-tailed tests).

Table 4

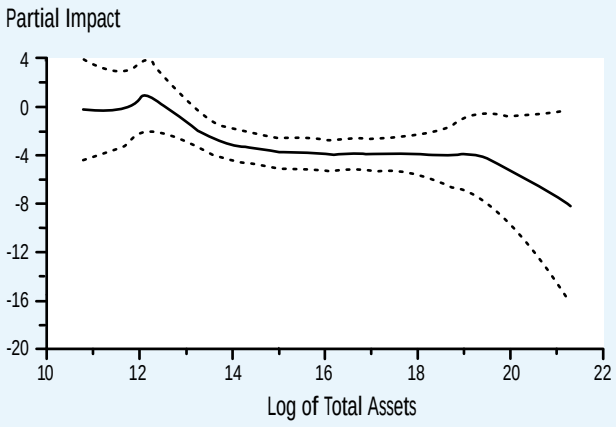
Dependent Variable: Allowance for Loan Losses

Independent Variable	Coef cient	*t*-statistic
HERF	-1.310	-6.742***
ROE	-1.066×10^{-2}	-1.279
MULTGROUP	1.556×10^{-2}	0.438
GRREALGSP	-7.387	-5.637***
Number of Observations	2614	

*** Significant at the 1 percent level (two-tailed tests).

Figure 8

Allowance for Loan Losses and Total Assets



Hypothesis 2: Risk-taking. The intuition for this hypothesis is that sponsors try harder to avoid financial distress and regulatory inspection when they are more costly. This is accomplished by choosing a less risky loan portfolio. We use the log ratio of a credit union's allowance for loan losses to total loans as a proxy for risk-taking because this is an unambiguous measure of the amount of risk the credit union sponsor believes is in the portfolio.

Figure 8 plots the partial effect of an increase in the log of total credit-union assets on a credit union's loan-loss allowance, holding the number of members at its median value at each level of assets. The overall relationship is clearly downward-sloping, as predicted by our model. A nearly identical plot was obtained when we weighted the ratio of loan allowances to loans by each credit union's loan-to-asset ratio (not shown).

Figure 9 shows a similar result, this time allowing the log number of members in the credit union to vary while holding fixed the credit union's assets. A similar result was obtained when we weighted the ratio of loan allowances to loans by each credit union's loan-to-asset ratio (not shown). Thus, in both cases, our proxies for greater costs associated with financial distress (higher total assets and more members) are associated with less risky loan portfolios.

Turning again to the parametric part of the model, Table 4 provides one more piece of evidence supporting the predictions of our model. The significant negative coefficient on HERF indicates that, as the local banking market becomes more concentrated and presumably less competitive, a credit union's loan-loss allowance falls. This is consistent with the notion that credit unions that face less competition will take on less risk. In contrast to our wage regressions, the coefficient on the sponsor's industry ROE is not significantly different from zero in the risk-taking equation.

CONCLUSIONS

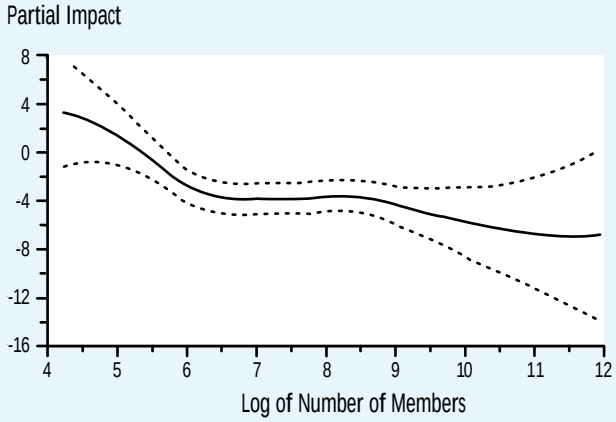
This article presents a theory that explores and provides evidence that is consistent with an efficiency-wage view of managerial agency problems at occupational credit unions. When costs associated with financial distress are likely to be high, we

find that credit unions tend to have relatively high wage levels and their loan portfolios tend to contain relatively low levels of risk. We also find that local deposit-market competition and the profitability of the sponsor's industry are related to wages and risk-taking.

Despite some informational and incentive advantages associated with the common bond that unites occupational credit-union members, these institutions face many obstacles going forward. Recent legislation, which is widely seen as favorable for credit unions, is not an obvious panacea because the expansion of credit unions to encompass multiple common bonds threatens to dilute the advantages associated with these bonds. Managerial agency problems may take on even greater significance as the credit-union movement advances.

Figure 9

Allowance for Loan Losses and Number of Members



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Appendix

DATASET, VARIABLES, AND ECONOMETRIC METHODOLOGY

The Dataset

We draw our sample from the December 1996 semiannual Report of Condition and Income for Credit Unions (NCUA 5300, 5300S). This dataset includes all federally chartered and federally insured credit unions. The data include income statements covering the calendar year 1996 and balance sheets from year-end 1996. We use data for total assets and the number of members from year-end 1995 to avoid endogeneity.

We concentrate on the manufacturing and services sponsor groups among occupational credit unions. Thus, we exclude community, associational, and corporate credit unions, and occupational credit unions with sponsors of the following types: educational, military, federal, state, and local government. Type of Membership (TOM) classification codes are from the NCUA (Instruction No. 6010.2, July 28, 1995).

We use the following criteria to exclude credit-union observations:

- Missing TOM codes
- Activity codes other than "active"
- Number of members (or potential) members not greater than one; applies to actual and to lagged values
- Nonpositive values for total assets or lagged total assets
- Number of employees given as zero
- Value for "employee compensation and benefits" given as zero.

Definition of Variables

Our dependent variables are restricted to be nonnegative. We use natural logarithms to ensure that these variables are not bounded and satisfy the assumption of normally distributed error terms. For data taken from the Report of Condition and Income for Credit Unions, produced by the NCUA, the item numbers are in brackets.

Dependent Variables: 1) WAGE: Relative Wages of the Credit Union. To calculate the relative per-capita wages of credit unions, we divide average per-capita wages of a credit union by the county-specific average annual wages for workers covered by the state and federal unemployment insurance programs (from the Bureau of Labor Statistics, Covered Employment and Wages (ES-202) Program). In a few cases, data were suppressed to protect the anonymity of an employer. We discard all credit unions in these counties.

The procedure is as follows: Divide employee compensation and benefits [CUSA4137] by the weighted sum of the number of full-time employees [CUSA6047] and the number of part-time employees [CUSA6048]. We assign a weight of 0.5 to part-time employees and a weight of 1 to full-time employees. According to NCUA Form 5300, full-time is defined as 26 hours or more per week and part-time is 25 hours or less. Then, divide the per-capita credit-union wage by the per-capita wage in the county.

2) ALLOWANCE: Ratio of Loan-Loss Allowances to Loans. Divide allowance for loan losses [CUSA3123] by total loans [CUSA1263]. Fourteen (out of 2,628) observations were dropped due to a Tobit problem (reported zero allowances).

Independent Variables: Total assets (measured in dollars) and the number of members are lagged by one period and transformed into natural logarithms when used as regressors. Other independent variables include:

1) HERF: the Herfindahl index. We calculate county-specific Herfindahl indexes as measures of concentration in the local banking market. A Herfindahl index is defined as the sum of squared

market shares, which we measure as the fraction of total bank deposits within a county based on FDIC Summary of Deposits data as of June 30, 1996 (available online at <http://www2.fdic.gov/sod/>). By definition, a Herfindahl index is greater than zero; with a maximum value of one.

2) ROE: Return on Book Value of Equity by Industry. ROE is defined as the ratio of net profit after taxes to net worth. First, we match SIC two digit codes with their corresponding TOM codes of credit unions. If a TOM code matches an odd number of SIC codes (including the case that it matched a single SIC code), we take the median ROE value of these industries. If the number of SIC codes is even, we take the mean of the two central ROE values of these industries. The data are taken from several annual volumes of *Industry Norms and Key Business Ratios*, published by Dun & Bradstreet (Murray Hill, N.J.).

3) MULTGROUP: Multiple Common Bonds of Membership. We use an indicator variable set equal to one if the credit union has multiple common bonds of membership, and to zero otherwise.

4) GRREALGSP: Logarithmic Change in the Real Gross State Product. Log growth rates of real gross state product (GRREALGSP) are calculated from data provided by the U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Analysis Division <http://www.bea.doc.gov/bea/dr1.htm>, to control for differing economic conditions facing credit unions.

5) SERVICES: Sponsor in the Services Sector. We use an indicator variable set equal to one if the sponsor of the credit union belongs to the services sector, zero otherwise. The classification is based on the TOM codes of the credit unions. Because we use an intercept in the nonparametric part of the regression, we drop the indicator variable for the manufacturing industry.

Econometric Methodology

We estimate a semi-parametric model of the additive partially linear type:

(A1) $y_i = x_{pi} \times \beta_p + f(x_i) + \varepsilon_i, \quad i = 1,...,n$

with

- y_i : i-th observation of the dependent variable
- x_{pi} : row vector of the i-th observation of the explanatory variables of the linear (parametric) part
- β_p : (column) vector of the parameters of the linear part
- x_i : vector of the i-th observation of the explanatory variables in the nonparametric part
- ε_i : i-th realization of the error term.

We estimate the model following Speckman (1988). In a first step, y is smoothed on the variables in the nonparametric part of the semiparametric model. The "smoother" matrix, S, establishes a linear relationship between y and the estimate $\hat{y}$:

(A2) $\hat{y} = S \times y.$

We use the smoother LOESS (locally weighted regression) as developed by Cleveland and Devlin (1988) and Cleveland, Devlin, and Grosse (1988). In contrast to univariate smoothers (e.g., kernel methods) that are used in conjunction with the backfitting algorithm, this so-called locally weighted running-line smoother does not impose the restriction that the influence of the explanatory variables within the nonparametric part is additive (Hastie and Tibshirani, 1990, pp. 29-31). We use locally quadratic fitting with a smoothing parameter of 0.3.

In a second step, the vector containing the dependent variable and the matrix of the explanatory variables of the parametric part are adjusted for the influence of the nonparametric part:

(A3a) $\tilde{y} = (I - S) \times y$

(A3b) $\tilde{X}_p = (I - S) \times X_p$

with I being the identity matrix.

In a third step, the vector β_p is estimated using ordinary least squares:

(A4) $\hat{\beta}_p = (\tilde{X}'_p \tilde{X}_p)^{-1} \times \tilde{X}'_p \tilde{y}.$

As Speckman (1988) has shown, the bias of the estimator $\hat{\beta}_p$ is asymptotically negligible.

The estimated impact of the explanatory variables in the partially linear model is

(A5) $\hat{f}_p = S \times (y - X_p \hat{\beta}_p).$

Thus, we obtain as the estimated vector of the dependent variable the following:

(A6) $\hat{\hat{y}} = X_p \hat{\beta}_p + \hat{f}_p.$

It is then straightforward to show that $\hat{\hat{y}}$ is a linear function in y:

(A7a) $\hat{\hat{y}} = L_S \times y$

with

(A7b) $L_s = X_p (\tilde{X}'_p \tilde{X}_p)^{-1} \tilde{X}'_p (I - S) + S_F$

(A7c) $S_F = S[I - X_p (\tilde{X}'_p \tilde{X}_p)^{-1} \tilde{X}'_p (I - S)].$

Based on the linearity of A7a, we use results from Cleveland and Devlin (1988, p. 599) on the distribution of the residuals of LOESS regressions to estimate standard errors for $\hat{\beta}_p$ as proposed by Speckman (1988, p. 421). We correct these standard errors for heteroskedasticity following White (1980).

We present the impact of each of the variables of the nonparametric part (partial impact) in so-called conditioning plots (Cleveland and Devlin, 1988). While one of these variables is set equal to its median, the other one is varied over all observations. Since the intercept in the estimated semi-parametric model is not identified, only the changes in the values on the ordinate, not the values themselves, should be interpreted. The graphs we present include bands representing 90 percent confidence intervals.

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Going Down: The Asian Crisis and U.S. Exports

Patricia S. Pollard and
Cletus C. Coughlin

The Asian economic and financial crisis has attracted attention to the trade links among the United States and countries throughout Asia.[1] The trade channel is undoubtedly an important mechanism through which this crisis affects the U.S. economy. As the effects on Asian economies became more pronounced and the effects of the crisis spread to other countries in spring and summer 1998, changes in U.S. trade became more visible and concerns about the possibility of a U.S. recession increased.[2] Nonetheless, the U.S. economy remained robust in 1998. Declining commodity prices (partly a result of reduced demand in Asia) and declining interest rates (partly a result of *flight-to-quality* capital inflows and the Federal Reserve's easing of monetary policy in reaction to the Asian crisis) helped spur consumption and investment spending. This spending tended to offset the weakening of export spending, especially spending on goods destined for Asia.

Our primary goal in this paper is to provide some rough estimates of the sizes of the export shock to the U.S. economy, generally, and the shock to specific sectors associated with the Asian crisis. We begin by providing some background material, such as facts about both the magnitude and changes of U.S. exports over time. Next, we examine the flow of exports to Asia and other regions. The Asian crisis has reduced recent growth, as well as near-term growth prospects throughout Asia, and has caused large declines in the U.S. dollar exchange value of many Asian currencies. These changes have caused a reduction in U.S. exports to Asia. We estimate the reduction in U.S. exports—first on an overall basis and second on an industry basis. In the process we attempt to identify any recent worsening of export performance and any damage being suffered by specific industries.

HOW IMPORTANT ARE EXPORTS FOR THE U.S. ECONOMY?

During 1997, U.S. exports totaled $965.4 billion; 71 percent were exports of goods, and 29 percent were exports of services. Exports are a relatively small, albeit increasing, share of U.S. economic activity. A straightforward calculation of the current dollar value of exports in 1997 divided by gross domestic product (GDP) reveals an export share of 11.9 percent, as shown in Figure 1. In 1960 this share was 4.8 percent. Another calculation, which adjusts both exports and GDP for their respective price changes, yields a slightly different result. Real exports of goods and services accounted for 16.7 percent of real GDP in 1997, 11.9 percentage points higher than its level in 1960.[3] Thus, the increase in the importance of the export sector is larger when the dollar values of exports and output are adjusted for relative price changes. This is because the prices of all goods and services included in GDP have increased by more than the prices of goods and services that are exported. Figure 1 also indicates the sharp increase in the importance of the export sector to the overall economy since the mid-1980s. Adjusted for relative price changes, the share of U.S. output that is exported has doubled during the past 15 years.

The growth of the export sector has been a driving force in the current expansion, as shown in Figure 2. For example, growth in exports of goods and services accounted for 1.6 percentage points of the

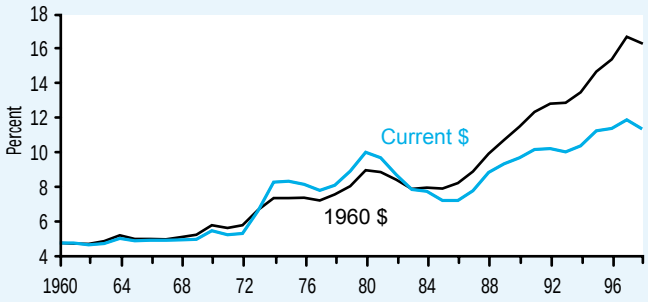
[1] The economic and financial crisis in Asia has spawned voluminous popular and academic literature. An excellent source that identifies much of this literature is a web page produced by Nouriel Roubini that can be found at the following Internet address: <http://www.stern.nyu.edu/~nroubini/asia/AsiaHomepage.html>. For an elementary introduction to the Asian crisis, see Neely (1999).

[2] For example, Alan Greenspan in his September 1998 testimony before the U.S. Senate Committee on the Budget (1998, p. 1) said: " ... it is just not credible that the United States, or for that matter Europe, can remain an oasis of prosperity unaffected by a world that is experiencing greatly increased stress."

[3] Since both price indexes use 1960=100, the nominal and relative price adjusted shares for 1960 are equal.

Figure 1

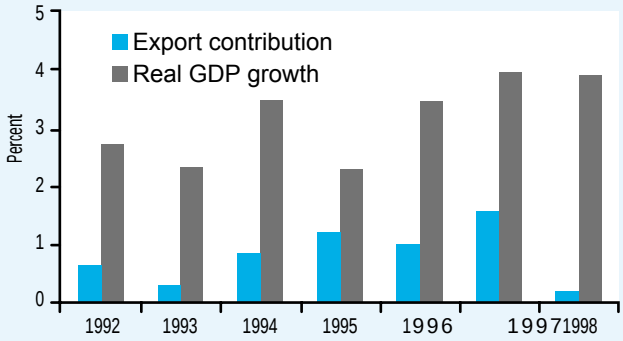
Exports of Goods and Services
Percent of GDP, 1960-98



Source: U.S. Department of Commerce, Bureau of Economic Analysis.

Figure 2

Export Contribution to Growth
1992-1998



Source: U.S. Department of Commerce, Bureau of Economic Analysis.

3.9 percentage point growth in real GDP during 1997. During 1992–97, growth in exports accounted for more than 30 percent of the growth in real GDP.

After growing by 8.5 percent in 1996 and 12.8 percent in 1997, real exports of U.S. goods and services rose by only 1.6 percent in 1998. Moreover, exports declined during each of the first three quarters of 1998 (on an annualized basis) before rising sharply in the fourth quarter. Thus, in contrast to the 1992–97 period, exports accounted for only 0.2 percentage points of the 3.9 percentage point growth in real GDP in 1998.

Because data on U.S. exports of services are not available by country of destination for all East Asian countries, the remainder of this article focuses on exports of goods. Similar to the results associated with exports of goods and services, exports of goods have been especially important for the current expansion, at least until 1998. Between 1992 and 1997, exports of goods in nominal terms grew at an annual rate of 9.0 percent, increasing the ratio of exports of goods to GDP from 7.2 percent to 8.5 percent. The growth of exports is even more impressive when expressed in real terms. Between 1992 and 1997, real exports of goods increased at an annual rate of 13.1 percent. Adjusted for their respective relative price changes, the ratio of exports of goods to GDP increased from 7.2 percent to 11.5 percent.

GEOGRAPHICAL PATTERN OF U.S. EXPORTS

Coinciding with the increase in U.S. exports has been a shift in its geographical pattern, as shown in Figure 3 and Table 1. Figure 3 shows the destination of U.S. exports of goods by geographical area during the periods 1970–75 and 1992–97. Table 1 lists the 10 countries that received the most U.S. exports during these periods. The Western Hemisphere has been the most important region for U.S. exports during both periods, and its importance has grown slightly. As shown in Table 1, this is a result of an increase in the share of exports going to Mexico, some of which can be attributed to the effects of the North American Free Trade Agreement (NAFTA). In contrast, Africa and the Middle East have never been important export markets for the United States. These two areas combined receive only 5 percent of U.S. exports.

The most notable change in the pattern of U.S. exports during the past three decades has been the increasing importance of the Asia-Pacific area and the declining importance of Europe. Over the period 1970–75, 32 percent of U.S. exports were shipped to European countries, whereas 22 percent of U.S. exports were shipped to Asia-Pacific countries. Over the period 1992–97, Europe received 25 percent of U.S. exports and the

Asia-Pacific region received 31 percent. During the earlier period, six of the 10 most important export markets for the United States were in Europe, whereas currently only four of the top 10 markets are in Europe.[4] In contrast, over the period 1970–75, Japan was the only Asia-Pacific country in the top 10 list, whereas currently four countries in the region are on the list. Moreover, the emergence of the Asia-Pacific region as the second-most important geographic area for U.S. exports is not due to growth in exports to Japan relative to all other areas; rather, it has resulted from the growing importance of the markets in the rest of East Asia, as shown in Figure 4.[5] In fact, the share of U.S. goods exports shipped to Japan has fallen sharply during the 1990s relative to the late 1980s. Meanwhile, with the exception of Taiwan, the share of U.S. goods shipped to other countries throughout East Asia rose sharply during the 1990s relative to the late 1980s.

Undoubtedly, the key factor underlying the increasing relative importance of markets in East Asia for U.S. production has been the rapid income growth in most East Asian countries. Table 2 shows that, excluding Japan, countries in East Asia generally grew much faster during 1992–97 than other economies—especially the major European trading partners of the United States. In addition, the relatively slow economic growth in Japan is consistent with the fact that the increasing importance of the Asia-Pacific region for U.S. exports is not due to Japan.

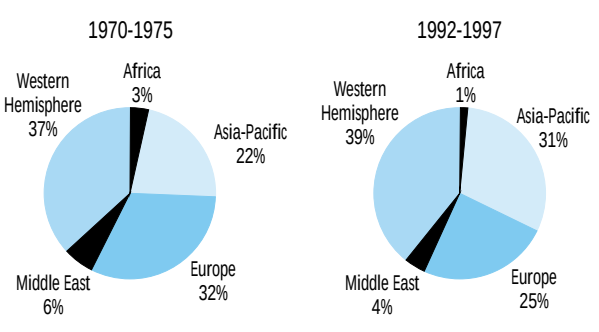
EXPORTS TO ASIA AND U.S. ECONOMIC GROWTH

It is precisely the increased importance of the East Asian markets for U.S. exporters that has made the U.S. economy more vulnerable to the substantial income and exchange rate changes associated with the Asian crisis. Table 3 contains information on the sharp decline in growth and, in many cases, absolute declines in overall economic activity throughout East Asia between 1997 and 1998. In seven of the 10 countries listed, total activity shrank during 1998. For Indonesia, Thailand, Korea, Malaysia and Hong Kong, the declines were particularly large. Only China and Taiwan had strong economic growth in 1998. In both countries, however, economic growth slowed in 1998 relative to 1997.

In addition to the sharp declines in growth, many countries in East Asia have experienced sharp declines in their currencies relative to the U.S. dollar. Table 4 shows

Figure 3

Global Distribution of U.S. Goods Export



Source: U.S. Department of Commerce, Bureau of the Census

Table 1

Top Ten Destinations of U.S. Goods Exports

(By Share of Total U.S. Exports)

1970-75		1992-97	
Country	Share (Percent)	Country	Share (Percent)
Canada	21.4	Canada	21.5
Japan	10.2	Japan	10.4
Germany	5.4	Mexico	9.3
United Kingdom	4.9	United Kingdom	5.2
Mexico	4.4	Germany	3.9
Netherlands	3.9	Korea	3.8
France	3.1	Taiwan	3.2
Italy	2.9	Netherlands	2.8
Brazil	2.7	France	2.6
Belgium-Luxembourg	2.3	Singapore	2.5

Sources: U.S. Department of Commerce, Bureau of the Census and International Monetary Fund, *Direction of Trade Statistics.*

[4] Belgium and Luxembourg are counted as a single country in the trade data.

[5] In this article, East Asia is defined as China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand.

Table 2

Real GDP Growth: Asia and Europe

(Percent)	1992-1997 Compound Annual Rate
Asia	
China	11.0
Hong Kong	5.1
Indonesia	7.0
Japan	1.4
Korea	7.2
Malaysia	8.7
Philippines	5.3
Singapore	8.8
Taiwan	6.2
Thailand	6.2
Europe	
France	1.5
Italy	1.2
United Kingdom	2.9
Germany	1.4
World	3.7

Source: International Monetary Fund, *International Financial Statistics.*

Table 3

Asian Real GDP Growth

(Percent)

	1997	1998
China	8.8	7.8
Hong Kong	5.3	-5.1
Indonesia	4.6	-13.7
Japan	1.4	-2.8
Korea	5.5	-5.5
Malaysia	7.7	-6.8
Philippines	5.2	-0.5
Singapore	8.0	1.5
Taiwan	6.8	4.9
Thailand	-0.4	-8.0

Source: International Monetary Fund, *World Economic Outlook* (May 1999).

the measured changes for two periods—May 1, 1997 to January 30, 1998 and May 1, 1997 to December 31, 1998. Between May 1, 1997 and January 30, 1998, seven of the 10 East Asian countries experienced declines of more than 15 percent in the value of their currencies relative to the U.S. dollar. The declines in the Indonesian rupiah and the Thai baht were especially sharp—both currencies fell more than 50 percent against the U.S. dollar. When the longer period is examined, one sees that the Asian currencies have recovered somewhat. The fact remains, however, that between May 1, 1997 and December 31, 1998, seven of the 10 countries listed saw their currencies decline more than 10 percent against the U.S. dollar.[6]

Undoubtedly, these income and exchange rate changes adversely affected U.S. exports to Asia. One rough estimate of the export effect of the Asian crisis on the U.S. economy can be obtained by calculating the effect of the decline in U.S. exports to Asia on the growth rate of output.[7] Real merchandise exports to East Asia fell by 11.6 percent in 1998. This decline reduced the growth rate of real GDP by 0.36 percentage points. Consequently, the growth rate of real GDP in 1998 was 3.85 percent rather than 4.21 percent. The quarterly data show that exports to East Asia fell by 7.4 percent on a year-over-year basis in the first quarter of 1998, by 16 percent in both second and third quarters, and by 7.1 percent in the fourth quarter.[8] These declines had the effect of lowering the growth rate of real GDP by 0.2 percentage points during the first and fourth quarters and 0.5 percentage points in the second and third quarters. These data provide some evidence that the worst effects of the Asian crisis may be over.

Industry Effects

The recent declines in exports to East Asia have not equally affected the output of all industries. The effect of declining exports to Asia on a particular U.S. industry depends on the following two factors: the extent to which exports to Asia have declined and the importance of these exports to the output of a particular industry. To examine these effects, we grouped industries according to the two-digit Standard Industrial Classification (SIC) system. Details regarding the data are provided in the shaded insert

[6] To be precise, real exchange rate changes, which adjust the nominal exchange rates for the relative rates of inflation, should be used. The use of real exchange rates would not alter the conclusion that many countries in East Asia have experienced sharp declines in their currencies relative to the U.S. dollar.

[7] Clearly, these estimates are rough. An important assumption is that the resources that would have been used to produce the exports are not put to other uses immediately. Also, to the extent that the decline in demand for U.S. products by the East Asian countries has resulted in a rise in inventories, the negative effects on measured output are reduced. That is, the decline in exports may be offset by a rise in inventories in the GDP accounts. Unless producers find other markets for these inventories, however, production ultimately will be affected.

[8] Year-over-year (rather than quarterly annualized) comparisons are used because the country-level export data are not seasonally adjusted. Thus, fluctuations in quarterly data could reflect seasonal patterns rather than economic factors.

"Details of Industry Level Export and Output Data."

Declining Exports. First, we look at the change in exports by industry. As Table 5 indicates, in real terms every industry studied, with the exception of the transportation equipment industry (SIC 37), saw a decline in goods exported to East Asia in 1998. Exports of transportation equipment rose by 3.5 percent during 1998. These exports rose in all but the second quarter of 1998. Of those industries with declining exports, the food and kindred products industry (SIC 20) experienced the smallest decline (3.3 percent) during 1998. Metallic ores and concentrates industry (SIC 10) exports fell by the greatest amount (34.9 percent). More than half of all the U.S. industries studied saw their exports to East Asia fall 20 percent or more during 1998.

Though the change in exports of some industries showed a great deal of quarterly variation (even on a year-over-year basis), exports in other industries fell sharply during each quarter. For example, crude oil and natural gas (SIC 13) exports declined by more than 30 percent during the first, third and fourth quarters but rose by 28 percent during the second quarter. In contrast, five industries—forestry and fishing (SIC 08-09), stone, clay, glass and concrete products (SIC 32), apparel and related products (SIC 23), rubber and miscellaneous plastic products (SIC 30), and furniture and fixtures (SIC 25)—experienced year-over-year declines in exports of 15 percent or more during each quarter.

In most of the industries studied, the five Asian countries most directly associated with the crisis—Indonesia, Malaysia, Philippines, South Korea and Thailand—experienced the largest declines in exports. China has been the one bright spot in East Asia for many industries. More than half of the industries studied had increased exports to China.

Examining the export data at a more disaggregated level can provide more information on what is driving the changes in exports at the two-digit industry level.[9] For example, the 3.5 percent increase in transportation equipment (SIC 37) exports occurred as a result of rising aircraft exports, primarily to China. In contrast, passenger car exports fell throughout 1998.

Table 4

Exchange Rate Change
US $/Foreign Currency
(Percent)

	May 1, 1997 - January 30, 1998	May 1, 1997 - December 31, 1998
China	0.2	0.6
Hong Kong	0.1	0.0
Indonesia	-76.6	-68.8
Japan	-0.4	12.0
Korea	-41.4	-25.8
Malaysia	-40.7	-34.0
Philippines	-38.1	-31.9
Singapore	-15.7	-12.4
Taiwan	-19.2	-14.2
Thailand	-50.8	-28.5

Source: Federal Reserve Bank of New York.

Another industry experiencing a relatively small decline in exports to East Asia is tobacco products (SIC 21). Overall, tobacco exports to East Asia fell by 4.9 percent in 1998. A slight rise in the export of chewing and smoking tobacco was more than offset by a decline in cigarette exports.

Turning to industries that have experienced sharp declines, the decline in exports of finfish are primarily responsible for the decline in forestry and fishing (SIC 08-09) exports. Meanwhile, declines in corn, soybeans and cotton exports accounted for nearly all of the decline in agriculture and livestock products (SIC 01-02) exports.

These export data suggest both the widespread and differential effects of the Asian crisis on U.S. exporters. Obviously, certain industries have experienced much larger drops in exports than other industries. Understanding the full extent of the export effect across industries, however, requires examining the importance of exports to East Asia for the industries studied.

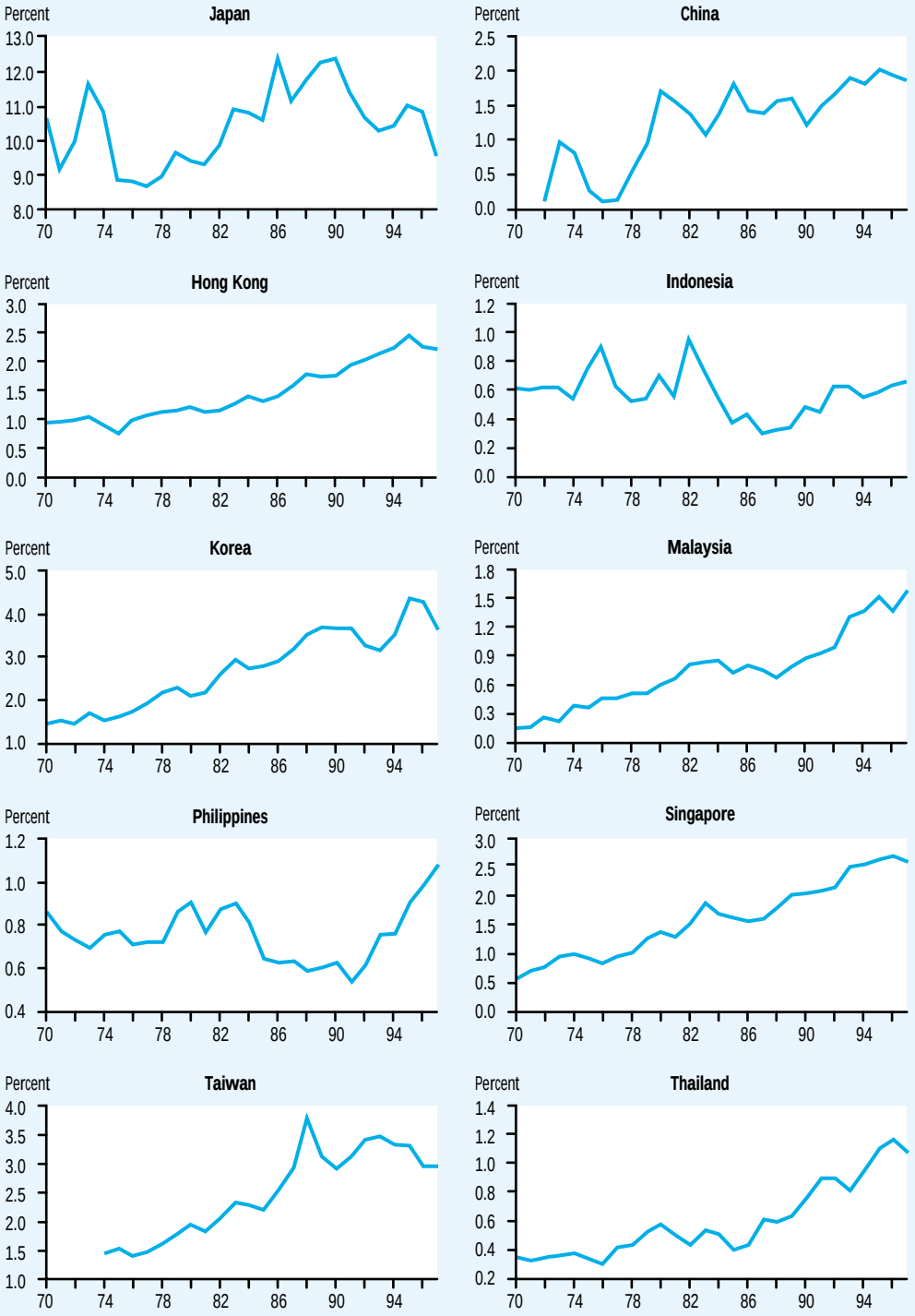
Industry Dependence on Exports. The electrical and electronic machinery, equipment and supplies industry (SIC 36) is the only industry whose exports to East Asia accounted for more than 10 percent

[9] These data are available on request.

Figure 4

U.S. Goods Exports to East Asia

Share of total exports, 1970-1997 (Percent)



Sources: U.S. Department of Commerce, Bureau of the Census and International Monetary Fund, *Direction of Trade Statistics.*

Table 5

U.S. Real Exports to East Asia by Industry

(Percent Change From Year Ago)

			1998			
SIC	Industry	Year	Q1	Q2	Q3	Q4
10	Metallic ores and concentrates	-34.9	-55.6	-40.1	5.8	-66.4
13	Crude oil and natural gas	-32.3	-33.2	27.5	-47.2	-55.6
24	Lumber and wood products, except furniture	-32.0	-38.9	-41.6	-29.6	-10.8
08-09	Forestry and fishing	-29.1	-26.8	-43.8	-25.9	-20.5
32	Stone, clay, glass and concrete products	-28.8	-20.4	-24.7	-27.7	-41.1
29	Refined petroleum and coal products	-27.6	-42.3	-42.0	-29.3	23.8
22	Textile mill products	-24.9	-9.0	-27.1	-34.6	-28.3
33	Primary metal products	-23.1	-13.8	-28.8	-27.7	-21.4
23	Apparel and related products	-22.6	-24.5	-23.1	-24.6	-17.4
39	Miscellaneous manufactured goods	-22.4	-23.9	-26.6	-26.5	-11.4
35	Nonelectrical machinery	-21.6	-12.5	-21.3	-25.9	-26.1
30	Rubber and miscellaneous plastics products	-21.4	-15.5	-23.8	-27.9	-18.3
25	Furniture and fixtures	-21.3	-21.3	-28.7	-17.6	-16.3
26	Paper and allied products	-21.3	-23.7	-23.4	-27.0	-10.2
28	Chemicals and allied products	-17.1	-19.8	-18.5	-20.7	-9.1
12	Bituminous coal and lignite	-14.5	-2.2	-15.8	-20.0	-21.2
01-02	Agriculture and livestock products	-13.5	-14.9	-18.5	-12.2	-8.9
31	Leather and leather products	-12.4	-23.3	-2.4	-12.3	-11.6
34	Fabricated metal products except machinery and transportation equipment	-12.4	-9.5	-22.0	-24.0	6.4
38	Scientific and professional instruments; photographic and optical goods, etc.	-10.2	-3.1	-8.2	-12.5	-16.4
36	Electrical and electronic machinery, equipment and supplies	-7.3	-3.1	-12.5	-10.1	-3.5
14	Nonmetallic minerals, except fuels	-7.3	-7.0	4.9	-15.9	-10.6
21	Tobacco products	-4.9	-5.4	0.2	-5.7	-8.5
27	Printing and publishing	-3.6	-9.6	8.8	-12.8	-1.3
20	Food and kindred products	-3.3	-3.0	-0.7	-7.7	-1.9
37	Transportation equipment	3.5	11.9	-18.8	1.3	22.5

Sources: U.S. Department of Commerce, Bureau of the Census and U.S. Department of Labor, Bureau of Labor Statistics.

of gross output during 1996, as shown in Table 6.[10] For the U.S. industries studied, 1996 exports to East Asia accounted for, on average, 3.7 percent of gross output. Though these numbers may seem small, they are not surprising. Exports of goods accounted for only 8.2 percent of U.S. GDP during 1996, with exports to Asia accounting for about one-third of the total.

Exports to East Asia accounted for 2.5 percent of the gross output of the paper and allied products industry (SIC 26) during 1996, but only 0.7 percent of the gross output of the furniture and fixtures industry (SIC 25). Exports to East Asia for both industries fell by 21.3 percent during 1998. As a result of the differences in the importance of East Asian markets, this

[10]The most recent output-by-industry data are for 1996.

Table 6

U.S. Real Exports to East Asia as a Percent of Gross Output by Industry (1996)

SIC	Industry	Percent
36	Electrical and electronic machinery, equipment and supplies	12.2
31	Leather and leather products	8.5
35	Nonelectrical machinery	8.2
38	Scientific and professional instruments; photographic and optical goods, etc.	7.5
01-02	Agriculture and livestock products	6.9
39	Miscellaneous manufactured goods	5.8
21	Tobacco products	5.1
28	Chemicals and allied products	4.5
08-09	Forestry and fishing	4.4
37	Transportation equipment	4.1
24	Lumber and wood products, except furniture	3.8
14	Nonmetallic minerals, except fuels	2.6
26	Paper and allied products	2.5
33	Primary metal products	2.5
12	Bituminous coal and lignite	2.5
10	Metallic ores and concentrates	2.5
20	Food and kindred products	2.2
34	Fabricated metal products except machinery and transportation equipment	1.8
23	Apparel and related products	1.7
32	Stone, clay, glass and concrete products	1.6
30	Rubber and miscellaneous plastics products	1.4
22	Textile mill products	1.1
29	Refined petroleum and coal products	1.0
25	Furniture and fixtures	0.7
13	Crude oil and natural gas	0.4
27	Printing and publishing	0.3

Sources: U.S. Department of Commerce, Bureau of the Census and U.S. Department of Labor, Bureau of Labor Statistics.

equal percentage decline in exports will have a much larger effect on the former industry than on the latter.

Gross Output Effects. Given the sharp decline in exports to East Asia during 1998, the effect on the gross output of several industries has been pronounced, as shown in Table 7.[11] These data indicate the potential effect of the decline in exports on the growth rate of each industry, assuming this reduction in export sales to Asia is not offset by additional sales in the United States or elsewhere. The average effect across industries was a 0.6 percent decline in the growth rate of gross output. The industries most severely affected by the decline in exports are nonelectrical machinery (SIC 35) and miscellaneous manufactured goods (SIC 39). The former industry includes such items as construction, metal working and general industrial machinery as well as computers. The latter industry includes such items as jewelry, toys, musical instruments, and office and art supplies.

In the absence of a decline in nonelectrical machinery exports to East Asia, the growth rate of gross output in that industry would have been 1.8 percentage points higher. Similarly, the decline in miscellaneous manufactured goods exports to East Asia reduced gross output growth in that industry by 1.3 percentage points. The factors accounting for these output effects differ in the two industries. The nonelectrical machinery industry is more dependent on East Asia for sales of its output (8.2 percent compared with 5.8 percent), whereas the miscellaneous manufactured goods industry suffered a slightly greater decline in exports to the region (22.4 percent compared with 21.6 percent).

The transportation equipment industry (SIC 37) received a small boost in output (0.14 percentage points) as a result of rising exports to East Asia. Of the studied industries with a decline in exports, output of the printing and publishing industry (SIC 27) has been the least affected. Declining exports lowered the growth rate by only 0.01 percentage points during 1998. The limited effect is a result of both the small amount of production that is exported to East Asia (0.3 percent) and the small decline in these exports (3.6 percent). Even the 13 percent drop in exports of this industry that occurred during the third quarter had only a 0.04 percentage point drag on growth.

The crude oil and natural gas industry (SIC 13), which had one of the largest declines in exports during 1998 (32.3 percent), was in the bottom fifth of industries in terms of the effect of the decline in exports

[11] See the shaded insert, "Another Look at Industry Output Effects," for a discussion of our cross-industry results relative to a study by Noland et al. (1998) using a different approach.

DETAILS OF INDUSTRY LEVEL EXPORT AND OUTPUT DATA

Export Data

Export data by industry for the group of countries studied are available only for merchandise trade and only in current dollars. Exports by industry are based on the two-digit Standard Industrial Classification (SIC) system. This classification of exports was chosen for consistency with the output data, discussed below.

To calculate the real value of exports by industry, the data were deflated by export price indices. Export price index data are not available on a SIC basis. Thus, we started with an export price index that groups the data based on the Standard International Trade Classification (SITC) system and matched these industries with the appropriate SIC codes. When multiple SITC codes fit one SIC category, a weighted average of the price indices for those categories was constructed to arrive at the price index on an SIC basis. The weights were based on the export share of each SITC industry within a SIC grouping for 1995 because this is the year used to weight prices in the SITC index. For example, the table in this insert provides information on the two SITC industries (SITCs 78 and 79) that correspond to the transportation equipment industry (SIC 37). Using this information, the relevant price index for the transportation equipment industry was 101.24 during the first quarter of 1997 and 101.02 during the first quarter of 1998. Thus, the export price of transportation equipment fell by 0.2 percent during this period.

Output Data

Output data by industry are based on the two-digit SIC code system. The output data are gross output by industry for 1996 (the latest year for which such data are available). Gross output measures each industry's total output, including the intermediate products used and the value added during production. These output data, in both current and constant dollars, are produced by the Department of Commerce, Bureau of Economic Analysis and are available

Conversion of SITC Price Index to SIC Price Index for Transportation Equipment Industry

1997:Q1

SITC Industry	Price Index	Weight	Price Index * Weight
78	101.63	0.64	65.01
79	100.53	0.36	36.22
Sum of Weighted Indexes (SIC 37 Index)			101.24

1998:Q1

SITC Industry	Price Index	Weight	Price Index * Weight
78	101.90	0.64	65.19
79	99.47	0.36	35.84
Sum of Weighted Indexes (SIC 37 Index)			101.02

electronically at: <http://www.bea.doc.gov/bea/dn2.htm>. Current dollar gross output is roughly equivalent to an industry's sales or receipts. Our analysis uses the 1996 current dollar gross output data for each industry.

Measuring the Effect of Changes in Exports on Output

The percentage change in the real exports of each industry to East Asia is given by Equation 1, as follows:

$$(1)\quad \left(\frac{\sum_{j=1}^{10} X_{98,t}^{i,j}}{\sum_{j=1}^{10} X_{97,t}^{i,j}} - 1 \right) * 100$$

where $X^{i,j}$ is the real exports of industry i to country j and the subscript t refers to the quarter in 1998 and 1997. The results for each industry are given in Table 5.

Exports to East Asia as a share of the gross output of each industry in 1996 is given by Equation 2, as follows:

$$(2)\quad \left(\frac{\sum_{j=1}^{10} X_{96}^{i,j}}{Y_{96}^{i}} \right) * 100$$

where $X^{i,j}$ is the real exports of industry i to country j, and Y^i is the gross output of industry i. The year 1996 is used to calculate the importance of the East Asian market for each industry because it is the latest year for which gross output data by industry are available. The results of this calculation are given in Table 6.

Combining the percentage change in exports with the share of exports in gross output indicates the effect of the change in exports on output, as shown by Equation 3, as follows:

$$(3)\quad \left(\frac{\sum_{j=1}^{10} X_{98,t}^{i,j}}{\sum_{j=1}^{10} X_{97,t}^{i,j}} - 1 \right) \left(\frac{\sum_{j=1}^{10} X_{96}^{i,j}}{Y_{96}^{i}} \right) * 100$$

The results of this calculation are given in Table 7.

on output (0.1 percent) because only a small fraction of SIC 13 output is exported to East Asia (0.4 percent). Turning to the tobacco products industry (SIC 21), the limited effect on output (0.3 percent) results primarily from the small decline in these exports (4.9 percent).

The final two columns in Table 7 provide some perspective on the significance of these output effects. These two columns show the average and range of the contribution of exports to East Asia to the growth of gross output over the period 1990-96. In five industries—metallic ores and concentrates (SIC 10), bituminous coal and lignite (SIC 12), lumber and wood products (SIC 24), primary metal products (SIC 33) and tobacco products (SIC 21)—export declines, on average, reduced the growth rate of gross output. Even in these industries, however, the effect of the 1998 decline in exports to East Asia on gross output was greater than the average effect. Thus, for example, the decline in exports to East Asia in the metallic ores and concentrates industry had a 0.86 percentage point drag on the growth of gross output during 1998. On average, over the 1990–96 period, the decline in exports to East Asia in this industry lowered the growth rate of gross output by 0.29 percentage points.

In only nine of the 26 industries studied is the current negative export effect on growth of gross output within the range of experience throughout the 1990–96 period. Moreover, eight of the industries never experienced a decline in exports to East Asia during this period. Nonelectrical machinery exports to East Asia, for example, contributed between 0.21 and 2.36 percentage points to the annual growth rate of gross output throughout the 1990–96 period.

Table 7

Export Effect on Growth by Industry – Gross Output Basis (Percent)

SIC	Industry	Year	1998 Q1	1998 Q2	1998 Q3	1998 Q4	Average 1990-96	Range 1990-96
35	Nonelectrical machinery	-1.77	-1.03	-1.75	-2.13	-2.14	0.86	0.21-2.36
39	Miscellaneous manufactured goods	-1.29	-1.38	-1.54	-1.53	-0.66	0.41	-0.23-1.30
08-09	Forestry and fishing	-1.27	-1.17	-1.92	-1.13	-0.90	0.22	-0.70-1.98
24	Lumber and wood products, except furniture	-1.21	-1.47	-1.57	-1.12	-0.41	-0.12	-0.36-0.19
31	Leather and leather products	-1.06	-1.98	-0.20	-1.05	-0.98	0.41	-0.46-1.46
01-02	Agriculture and livestock products	-0.93	-1.02	-1.27	-0.84	-0.61	0.11	-0.85-1.72
36	Electrical and electronic machinery, equipment, and supplies	-0.89	-0.38	-1.52	-1.23	-0.42	1.72	0.45-3.65
10	Metallic ores and concentrates	-0.86	-1.38	-0.99	0.14	-1.64	-0.29	-1.89-1.52
28	Chemicals and allied products	-0.78	-0.90	-0.84	-0.94	-0.42	0.19	-0.22-0.58
38	Scientific and professional instruments; photographic and optical goods, etc	-0.76	-0.23	-0.61	-0.94	-1.23	0.51	-0.04-1.16
33	Primary metal products	-0.57	-0.34	-0.71	-0.69	-0.53	-0.01	-0.82-1.23
26	Paper and allied products	-0.53	-0.59	-0.58	-0.67	-0.25	0.13	-0.17-0.45
32	Stone, clay, glass and concrete products	-0.46	-0.33	-0.40	-0.44	-0.66	0.13	0.04-0.32
23	Apparel and related products	-0.39	-0.43	-0.40	-0.43	-0.30	0.18	0.03-0.32
30	Rubber and miscellaneous plastics products	-0.30	-0.22	-0.34	-0.40	-0.26	0.11	0.04-0.19
12	Bituminous coal and lignite	-0.36	-0.05	-0.39	-0.50	-0.53	-0.16	-0.38-0.12
22	Textile mill products	-0.27	-0.10	-0.30	-0.38	-0.31	0.03	-0.04-0.14
29	Refined petroleum and coal products	-0.26	-0.41	-0.40	-0.28	0.23	0.01	-0.39-0.29
21	Tobacco products	-0.25	-0.27	0.01	-0.29	-0.43	-0.01	-0.85-1.01
34	Fabricated metal products except machinery and transportation equipment	-0.22	-0.17	-0.39	-0.42	0.11	0.12	0.01-0.24
14	Nonmetallic minerals, except fuels	-0.19	-0.18	0.13	-0.42	-0.28	0.12	0.04-0.22
25	Furniture and fixtures	-0.14	-0.14	-0.19	-0.12	-0.11	0.06	0.01-0.11
13	Crude oil and natural gas	-0.12	-0.13	0.11	-0.18	-0.21	0.04	-0.13-0.26
20	Food and kindred products	-0.07	-0.07	-0.01	-0.17	-0.04	0.11	-0.25-0.28
27	Printing and publishing	-0.01	-0.03	0.03	-0.04	0.00	0.01	-0.03-0.04
37	Transportation equipment	0.14	0.49	-0.77	0.05	0.92	0.31	-0.23-0.89

Sources: U.S. Department of Commerce, Bureau of Economic Analysis and Bureau of the Census; Department of Labor, Bureau of Labor Statistics.

Thus, the 1.77 percentage point export drag on growth in 1998 is particularly troublesome for this industry.

CONCLUSION

Throughout most of the 1990s the United States has enjoyed the benefits of rising exports, particularly those to the growing economies of East Asia. Over the past year, however, the East Asian economies have contracted and their currencies have fallen sharply against the dollar. As a result, demand for U.S. products has declined and U.S. exports to the region have fallen. In 1998 real U.S. exports to East Asia fell by 11.6 percent.

Examining the changes in exports by industry indicates the pervasiveness of the declines. Only the transportation equipment industry sent more goods to East Asia in 1998 than in 1997. This was a result of increases in aircraft exports, many of which were ordered prior to the economic problems in East Asia.

ANOTHER LOOK AT INDUSTRY OUTPUT EFFECTS

Clearly our results are rough estimates of the sectoral effects of the Asian crisis on the U.S. economy. Prior studies, such as Noland et al. (1998) and Werling and McCarthy (1998), explore the relationship between different macroeconomic environments in Asia and their trade and production effects across U.S. industries. Because our approach uses actual trade changes, our results are not strictly comparable to prior studies. Nonetheless, as a check on the reasonableness of our results, we compare our results with those generated by Noland et al. (1998).

Using a computable general equilibrium model with 17 regions, each with 14 sectors and five primary factors of production, Noland et al. explored the consequences of various macroeconomic scenarios. The Asian crisis was characterized as a combination of two types of shocks—real exchange rate depreciations and declines in GDP—in eight Asian countries. These shocks generate changes in trade flows and production.

The production changes associated with one scenario, termed the *medium-shock* scenario are listed in the table in this insert. Because the correspondence between the sectors used by Noland et al. and the two-digit SIC classification we use is rough and because their time horizon extends beyond 1998, it is difficult to make strong statements.[1] It appears, however, that the cross-industry results are comparable. Similar to our results that the nonelectrical machinery industry has experienced the largest relative decline, Noland et al. identified the machinery sector as experiencing the largest relative decline. The electronics sector also was expected to experience relatively large declines, a result consistent with our finding for electrical and electronic machinery, equipment and supplies. In addition, Noland et al. found that both the agriculture sector and the forestry and fishery sector are likely to undergo relatively large production changes—results consistent with our findings for the industries encompassing agriculture and livestock (SIC 01-02) and forestry and fishing (SIC 08-09). The most obvious difference between our results and those of Noland et al. concerns potential changes in the transportation equipment industry. Noland et al. estimated relatively large changes; to date we estimate relatively small changes.[2] Some of this difference can be attributed to the fact that Noland et al. also capture import effects that we do not.

Medium Shock Scenario — Output Effects (Percent)

Industry	Change in Production
Machinery	-2.63
Electronics	-2.38
Forestry and fishery	-1.39
Motor vehicles and parts	-1.21
Other transportation equipment	-1.13
Agriculture	-0.89
Light manufacturers	-0.82
Intermediate goods	-0.71
Textile and apparel	-0.63
Mining	-0.49
Energy	-0.01
Processed food	0.02
Services	0.39
Housing and construction	0.71
Total	**-0.07**

Source: Noland et al. (1998), Table 3.1.

[1] Noland et al. also do not include China and Hong Kong in their study. Excluding these from our sample does not change the comparability of the results.

[2] Our transportation equipment industry results are consistent with those of Werling and McCarthy (1998). They estimated below-average production declines for motor vehicles and parts. Meanwhile, for aerospace, which accounts for a relatively smaller share of the transportation equipment industry than motor vehicles, they did find above-average production declines.

Moreover, more than half the industries studied experienced declines in exports to East Asia of more than 15 percent. Such declines are highly unusual. Between 1990–96 only nine of the 26 industries experienced a year-over-year decline in exports as large as the ones they experienced during 1998. Because the effects differ across industries and within the two-digit SIC industries, these export data also suggest that certain regions of the United States may be more affected by the export declines than other regions.[12]

Focusing solely on the export data overstates the relevance of these declines to the industries in question and presents an inaccurate picture of the industries that have been hardest hit by the export effects of the Asian crisis. The effect of the decline in exports on the output of a particular industry depends on the extent to which that industry is dependent on the East Asian market to sell its output. Incorporating the export declines with the market share data indicates the extent to which each industry has been affected. For most of the industries studied, the decline in exports has lowered growth by 0.4 percentage points or less. For many industries, however, output declined by 1 percent or more. Generally speaking, our cross-industry results are consistent with the simulation results of Noland et al. (1998).

These results, however, need to be interpreted with care. They may be biased downward because they capture only the direct effects of a decline in exports to East Asia on industry output. They do not incorporate any secondary effects. Thus, for example, the stone, clay, glass and concrete products industry may be both directly affected by declining exports to East Asia and indirectly affected by reduced orders from other U.S. firms as a result of declining demand in East Asia. That is, as the amount of transportation equipment sold to East Asia declines, the transportation equipment industry's demand for window glass declines. On the other hand, increases in demand by U.S. and other foreign consumers and businesses may mitigate the effects of the decline in demand in East Asia.

Our focus on exports also ignores the potentially negative effects on some U.S. producers-decreased demand for their output stemming from increased imports. The steel industry is a specific example.[13] Imports of steel rose by 24 percent during 1998. This surge in imports can be connected to the Asian crisis in that reduced steel demand throughout Asia has reduced the world price of steel and has lead producers, especially those from Russia, Japan and Brazil, to ship their excess steel to the United States.[14]

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[12]See Valletta (1998) and Gazel and Lamb (1998) for an analysis of the regional effects of the decline in exports to East Asia.

[13]Though increased imports of steel might have adverse effects on U.S. producers of steel, the lower priced imports will benefit consumers and producers of goods requiring steel as an input.

[14]As a result of the increase in U.S. steel imports, 12 U.S. steel companies in conjunction with the United Steelworkers of America, have filed dumping charges alleging that steel producers from Russia, Japan, and Brazil were selling steel in the United States below their production costs. See Lucentini (1998) for additional details.

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Inflation-Target Design: Changing Inflation Performance and Persistence in Industrial Countries

Pierre L. Siklos

Finding a monetary regime that can deliver some form of price stability, as well as satisfactory economic performance, always has been explained more convincingly in theory than in practice. Consequently, governments have, over time, experimented with policies ranging from some metallic standard (for example, gold, silver, or bimetallic) to various forms of exchange rate pegging (for example, Bretton Woods or the European exchange rate mechanism) and the introduction of currency boards (as in Hong Kong, Argentina, or Estonia, for example). The latest fashion in monetary policy formulation is a renewed interest in inflation targeting.[1] The policy has attracted the attention of policymakers and the public alike. Although imperfect, inflation targeting seemingly lacks some of the drawbacks of other policy regimes.

The rationale for inflation targeting and the ingredients of an inflation-targeting policy are reviewed briefly in the following two sections.[2] There has, however, been relatively less emphasis placed on comparative assessments of inflation performance under inflation targeting among the group of countries that have formally adopted the policy. Does inflation targeting influence the time series properties of inflation? To explore this issue, I estimate a simple model that illustrates whether inflation persistence has changed in a significant fashion in inflation targeting vs. non inflation-targeting countries. The paper concludes by noting that it is too early for a definitive assessment of inflation targeting. Yet, from the standpoint of economic analysis and empirical performance to date, a policy of inflation control offers as good a chance as any policy regime to produce consistently good macroeconomic performance.

THE DESIGN OF INFLATION TARGETS

The Bretton Woods era of pegged exchange rates was notable for the absence of large international economic shocks (Bordo, 1993). When these did take place, most industrial countries eventually allowed their currencies to float vis-à-vis the U.S. dollar. Similarly, the shock generated by German economic reunification in 1990 produced strains in the European Monetary System that quickly illustrated its lack of flexibility. Political considerations have always loomed larger in any decision to peg or revalue an existing peg, often with significant economic consequences. From the gold standard (Eichengreen, 1992) right up to the present Asian currency crisis (Willett, 1998), political economy considerations surrounding fixed exchange rate regimes often have prevented them from becoming an adequate source of macroeconomic discipline.

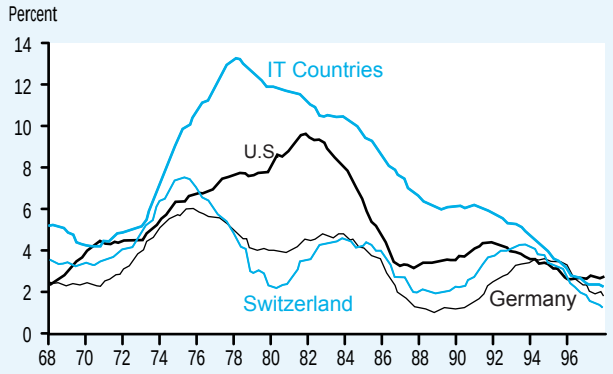
At the heart of questions involving the choice of policy regimes is the notion of credibility. An inflation target can enhance central bank credibility in many ways. First, inflation targeting can help clarify the tasks of the central bank and quantify them in an objective and

[1] See, for example, Berg and Jonung (1998) for the Swedish experience with price-level targeting during the 1930s. In the United States, there have been many attempts to reform the Federal Reserve Act to mandate some form of inflation control. In the 1920s, congressional bills that would have made price stability the target for the Fed failed, as did several bills introduced in the 105th Congress (1997).

[2] See Haldane (1995), Leiderman and Svensson (1995), Laidler (1997), Mishkin and Posen (1997), Bernanke, Laubach, Mishkin and Posen (1999), and the Federal Reserve Bank of Kansas City (1996) for comprehensive overviews.

Figure 1

The Evolution of Inflation in Selected Countries



NOTE: CPI inflation rates are defined as a 20 quarter moving average. The inflation targeting countries are the ones listed in Table 1 and the simple average of their inflation rates was used.

verifiable manner. Second, by adopting statutes that ensure the autonomy of the central bank, the location of the responsibility for meeting the targets also is well defined. Central bank accountability and transparency then take on important roles. Third, experience with an inflation-targeting regime can readily influence expectations of inflation that are central in economic agents' decision-making process.

In general, all inflation targets, as currently administered, have a few common elements such as the requirement to achieve a desired inflation rate in terms of a cost of living index, usually the consumer price index (CPI). Inflation-targeting countries specify caveats for these targets, however, usually to prevent an anomalous monetary policy shock in the event of negative aggregate supply shocks.[3] As a result, the operational guide for monetary policy is often stated in terms of core or underlying inflation—that is, total CPI inflation exclusive of food and energy prices and possibly indirect taxes.[4] Finally, the calculation period for inflation is, with one exception, the year-on-year percent change in the targeted price index. Table 1 provides a succinct summary of the basic elements of an inflation-targeting regime in eight countries that formally target inflation; that is, they announce explicit goals for inflation.[5]

Five of the eight countries specify a target as a range, and the desired target is usually the middle of the target range, even if this is not always made explicit. Only New Zealand has enshrined the target in legislation governing central bank operations. In the remaining inflation-targeting countries, the target represents an understanding between the government and usually the head of the central bank—that is, the governor or president—and is not interpreted as a legislated objective. After adopting transitional measures intended to lower inflation expectations gradually, four of the eight central banks define a term over which the inflation target is to be met. In other countries the target is either indefinite or can be changed by an amendment to central bank legislation or by government directive.

There are different procedures for deciding who actually is responsible for setting the inflation target. The target is determined by the central bank in four of eight countries, the government sets the target in two other countries, and the decision is joint in the two remaining cases. In six of the eight countries with an inflation target, central banks provide (either voluntarily or by mandate) a formal separate report on the inflation outlook in their country. Even in countries in which the central bank does not produce a formal report, some reporting requirement exist. Finally, only three of the eight central banks publish explicit inflation forecasts. An important area of current research is the role of inflation forecasts in the monetary policy process.[6]

INFLATION PERFORMANCE IN A CROSS-SECTION OF COUNTRIES

Figure 1 plots the five-year inflation rate for the inflation-targeting countries, as well as for the United States, Germany, and Switzerland, since the late 1960s using quarterly data.[7] The latter countries are considered to have the best long-run inflation performance among industrialized nations not formally adopting an inflation

[3] Because a negative aggregate supply shock would ordinarily be inflationary and reduce economic activity, a tightening of monetary policy is uncalled for under these circumstances.

[4] Whether underlying inflation rates exclude a significant portion of items from the total CPI varies, of course, across countries. For an illustration in the Canadian and New Zealand cases, see Siklos (1997, Figure A-3). For inflation targeting countries, see Haldane (1995).

[5] Israel also targets inflation but is omitted because of the ambiguity about the significance of its targets (see Bufman, Leiderman, and Sokoler, 1995). In 1998, however, the Bank of Israel began to publish an inflation report. Although not included in this study, the Czech Republic also began targeting inflation in 1998.

target.[8] The five-year horizon is used purely for expository purposes here; the short-run properties of inflation in these same countries are examined in greater detail later in this article. There are many potentially interesting features in the data. First, inflation performance in the inflation-targeting countries appears to have consistently worsened from the early 1970s until the early 1990s than in the countries compared. Second, experience in the mid-1990s reveals an apparent convergence in inflation rates among the group of inflation-targeting and noninflation-targeting countries.[9] Some authors, for example, Cukierman, 1992, and Laidler, 1997, associate the improvement in inflation performance among inflation-targeting countries with legislative changes, which clarified the responsibilities of central banks in the area of monetary policy, and the introduction of inflation-control objectives. Finally, note that during the Bretton Woods era, inflation rates across the group of countries studied were broadly similar. Nevertheless, inflation differentials were somewhat higher at the time than during the 1990s. Note also that the disinflation appears to have begun in Switzerland and Germany shortly after the first oil price shock (1972–74), albeit with some interruption in the early 1980s. The downward trend in inflation rates in the inflation-targeting countries since the late 1970s, however, is fairly continuous. The United States appears to have lagged behind the other countries in experiencing a sustained drop in inflation. Nonetheless, the rate of deceleration appears more pronounced, following the monetary reforms begun in October 1979 under (then) Federal Reserve Chairman Paul Volcker. Finally, we observe that average inflation rates in inflation-targeting countries appear to have fallen before the formal adoption of inflation targets.

Table 2 provides further summary statistics about inflation performance in selected industrial countries. Mean-annualized inflation rates are provided for a sample of quarterly data since the late 1950s or early 1960s, as well as for subsamples of data from the periods during (and after) Bretton Woods and, where relevant, the era of inflation targeting. As a rough guide to the volatility of inflation in the different samples, the standard deviation also is provided.

Among the group of inflation-targeting countries, mean inflation rates are lower in the period since inflation targets were announced than either before (or since) the end of Bretton Woods. Note, however, that average inflation rates in all sampled countries increased after Bretton Woods was abandoned, though the rise is much more pronounced in some countries (e.g., Australia and the United Kingdom) than in others (e.g., Germany and Switzerland). The improvement in inflation performance is most impressive since inflation targets were introduced, especially when contrasted with the era since exchange rates floated. (The two samples overlap somewhat, of course.) Because other institutional changes also took place around the time inflation targets were announced, it is not clear how much of the reduction in inflation can be attributed to the inflation objectives alone. Moreover, average inflation rates in the United States, Germany, and Switzerland compare favorably with those in inflation-targeting countries during the same period. Therefore, among the group of countries with formal inflation-control objectives, a contributing factor in their success at reducing inflation may be the *global* nature of the recent disinflation. In most countries, inflation volatility rose after the end of Bretton Woods, but generally has been lower since inflation targets were announced. Indeed, inflation volatility in the inflation-control era generally is lower than at any time since the late 1950s.

INFLATION PERSISTENCE

For some time economists have been interested in estimating how economic shocks will affect the future economy. The effects of such shocks can *persist* over time. The degree to which shocks have persistent effects on inflation, however,

[6] Svensson (1997) argues that inflation forecasts become the intermediate target of policy. Benanke and Woodford (1997) point out, however, that following such a policy is problematic, in part because if the inflation forecast and the target are essentially the same, the inflation forecasting exercise has no practical use.

[7] The inflation targeting countries are listed in Table 1. Poland is henceforth excluded because of insufficient data. A simple unweighted average of their inflation rates was used. Other groupings of the inflation targeting group of countries do not alter fundamentally the overall impressions given by Figure 1.

[8] Perhaps largely for this reason, these countries are, in effect, *perceived* by the public as pursuing an inflation objective.

[9] Siklos and Wohar (1997) provide a more formal assessment of the emergence of convergence in monetary policy for a group of 10 industrial countries and found convergence in the inflation rates but not in the nominal interest rates. Also, see Pollard (1995).

Table 1

The Basic Ingredients of In ation Targets

Country / Index Targeted	Inflation Objective	Calculation Period	Contingencies for Breaches of the Inflation Target	Targeting Horizon?	Adoption date (dd/mm/yy)	Separate Inflation Report?	Who Sets Target?	Publishes Inflation Forecast?
Australia CPI	Average of 2 percent to 3 percent	Over the cycle	Mortgage interest Government-controlled prices Energy prices	None	01/01/93	No[1]	Government	No
Canada CPI[2]	2 percent to 4 percent by end of 1992 1.5 percent to 3.5 percent by mid-1994 (original) (revised) 1 percent to 3 percent Dec 1993 to Feb 2001[3]	Annual	Indirect taxes Food and energy prices	Yes	26/02/91	Yes	Joint	No
Finland CPI	2 percent from 1995	Annual	Housing capital costs Indirect taxes Government subsidies	No	02/02/93	No[4]	Central bank	No
New Zealand CPI[5]	3 percent to 5 percent (Dec 1990); 2.5 percent to 4.5 percent (Dec 1991) 1.5 percent to 3.5 percent (1992:Q1-Q4) 0 percent to 2 percent (1993:Q1-Q4) 0 percent to 3 percent (1994:Q1-1997:Q1) 0 percent to 3 percent (1997:Q4)[6]	Annual	Commodity prices Government-controlled prices Interest, credit charges	Yes	02/03/90	Yes	Joint	Yes
Poland CPI	8 percent to 8.5 percent in 1999 to below 4 percent percent by 2003	Annual	"…any available information which could jeopardize the inflation target…"	Yes	01/01/99	Yes	Central bank	No
Spain CPI	3.5 percent to 4 percent (1996:Q1) 3 percent to 3.25 percent (1997: Q1) 3 percent upper limit for 1997 2.5 percent to 2.75 percent upper limit for late 1997 2 percent (1998)[7]	Annual	Mortgage interest	Yes	01/01/95	Yes	Central bank	No
Sweden CPI	2 percent 1 percent to 3 percent since 1995	Annual	Nominally none but conditional on indirect taxes, subsidies	No	15/01/93	Yes	Central bank	Yes
United Kingdom RPI	1 percent to 4 percent until June 1997 elections 2.5 percent since June 1997	Annual	Mortgage interest	No	8/10/92	Yes[8]	Government	Yes

[1] The Governor is, however, "available" to report on the conduct of monetary policy twice a year to the House of Representatives Standing Committee on Financial Institutions and Public Administration.

[2] Although the target is formally specified in terms of overall CPI, the Bank focuses on the CPI excluding food, energy, and the effect of indirect taxes. The target represents an agreement between the Minister of Finance and the Governor of the Bank of Canada and is not enshrined in the Bank of Canada Act.

[3] Renewed in February 1998.

[4] Finland reports quarterly on the inflation outlook in its *Monthly Bulletin*.

[5] Since December 1997, the CPI excluding credit services is targeted. Before that date, overall CPI was targeted.

[6] The term of the new PTA coincides with the current term of the Governor, which expires August 31, 2003. The PTAs were agreed to in December but are dated as beginning the following quarter for compatibility with subsequent empirical work.

[7] The Law of Autonomy was put in place in June 1994 and, although the inflation target was announced in December 1994, it was formally adopted only as of January 1, 1995. Between 1995 and 1997 the aim was to reduce inflation to the 2 percent range. In 1998, the aim is to keep the annual inflation rate "close to 2 percent" during the year.

[8] Only since 12 June 1997

Sources: Siklos (1997), <www.rbnz.govt.nz/bulletin/contents.htm>, Bank of England Quarterly Bulletin (May 1998), <www.bof.fi>, <www.bde.es>, <www.rba.gov.au>, Almeida and Goodhart (1998), and National Bank of Poland (1998).

Table 2

Summary Statistics on In ation for Selected Industrial Countries
(Quarterly Data)

	Annual Inflation Rate in Percent (Standard Deviation)			
Country	**Full sample**	**Bretton Woods**	**Post-Bretton Woods**	**Inflation Targeting**
Inflation-Targeting Countries				
Australia	5.60 (4.62)	3.67 (3.32)	6.89 (4.92)	2.01 (2.17)
Canada	4.52 (3.55)	2.48 (2.27)	5.43 (3.65)	1.46 (1.46)
Finland	6.41 (4.91)	5.66 (4.12)	6.74 (5.20)	1.26 (1.59)
New Zealand	6.99 (5.93)	4.53 (3.85)	8.57 (6.48)	2.13 (2.33)
Spain	8.93 (5.89)	7.04 (4.75)	9.77 (6.17)	2.76 (1.35)
Sweden	5.75 (4.45)	4.13 (3.37)	6.73 (4.74)	1.47 (1.86)
United Kingdom	6.48 (6.14)	4.00 (3.98)	7.86 (6.69)	2.64 (2.68)
Non Inflation Targeting Countries				
United States	4.35 (3.23)	2.61 (1.91)	5.30 (3.40)	3.00 (1.50)
Germany	3.04 (2.77)	2.87 (2.80)	3.15 (2.75)	2.35 (2.80)
Switzerland	3.51 (2.92)	3.50 (1.90)	3.52 (3.27)	2.41 (2.32)

Note: CPI inflation is measured at annual rates as 400 X (log CPI_t – log CPI_{t-1}). Data (not seasonally adjusted) are from OECD *Main Economic Indicators: Historical Statistics*, and updated from most recent regular issues of this publication. The United States, Germany, and Switzerland do not officially target inflation so the selection of the "post-inflation target" sample arbitrarily coincides with that of New Zealand. The full sample, before differencing, is generally 1958:1-1997:4, except for Finland and Spain (1963:1-1997:4) and Switzerland (1960:1-1997:4). The dating for the Bretton Woods and inflation-targeting eras is provided in Tables 1 and 3.

can be influenced by assumptions about the properties of the time series of interest, as we shall see. Alogoskoufis and Smith (1991), using long historical time series for the United States and the United Kingdom, argue that changes in the exchange rate regime, such as the end of the gold standard and Bretton Woods, produced significant shifts in inflation persistence. Indeed, inflation appears to have become highly persistent since the end of World War II. Persistence refers to an important statistical property of inflation, namely that its current value is influenced strongly by its past history. If the data-generating process for inflation is assumed to follow a first-order autoregressive process [AR(1)] then we can write the following equation:

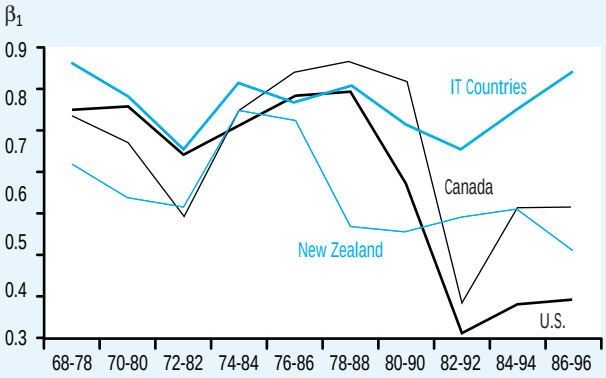
$$(1) \quad \pi_t = \beta_0 + \beta_1 \pi_{t-1} + \varepsilon_t, -1 < \beta_1 < +1$$

where π_t is the annualized rate of inflation in the CPI at time t, ε_t is the residual and inflation persistence is measured by the coefficient of lagged inflation, β_1.[10] When the AR(1) coefficient is less than but close to one, the process is said to be stationary, but highly persistent. Burdekin and Siklos (forthcoming) use a specification such as

[10]Evaluated as π_t = (log P_t – log P_{t-1})x400, where P_t is the CPI in quarter t in a given year. Data sources are provided in the tables and figures.

Figure 2

Inflation Persistence Over Time



NOTE: Estimates of β_1 in (1) were estimated for samples of ten years of quarterly data on annualized inflation as defined in Table 2 for the samples shown on the horizontal axis in the Figure. Also see note to Figure 1 for the calculation of average inflation in inflation-targeting countries.

Equation 1. They find that the end of the gold standard produced a significant change in inflation persistence for the United States, the United Kingdom, Canada, and Sweden. They also find that changes in domestic monetary institutions and oil price shocks are equally good indicators of shifts in inflation persistence since the end of World War II. The potential for inflation targeting to change inflation persistence has not heretofore been considered in empirical work.

Why might an inflation target lead to significant changes in β_1? Consider a simple variant of Equation 1 that helps illustrate the implications of adopting an inflation target.

$$(2) \quad \pi_t = \beta_0 + \beta_1 \pi_{t-1} - \beta_2 I_t \pi_{t-1} + \varepsilon_t, \quad 0 < \beta_2 < 1$$

where I_t is an indicator that takes on the value of one when last period's inflation rate, π_{t-1}, is above the inflation target and 0 otherwise. Hence, when $I_t=1$, the persistence term for inflation is $\beta_1 - \beta_2$, which is less than β_1. Now, the monetary authorities are presumed to be solely concerned in Equation 2 with whether actual inflation exceeds the targeted inflation rate. This need not, of course, be the case, but it does seem to reflect the current practice in most inflation-targeting countries. The issue then is whether the fluctuations around the middle of an inflation-target band would be expected to be asymmetric. Thus, for example, some central banks might follow a policy of benign neglect if actual inflation tends to fluctuate near the bottom of the inflation band while actively preventing inflation from reaching the top of the band. The Bank of England, for one, views the target as symmetric. "The inflation target is symmetric. The MPC (Monetary Policy Committee) will adjust as determinedly in response to prospective deviations of inflation below as those above." (Bank of England, 1998, pg iii.)

Figure 2 provides point estimates of β_1 for samples that *roll* at two-year intervals since 1968. For the most part, inflation rates have been highly persistent, a notable feature of inflation performance in many countries since the end of World War II (also see Alogoskoufis and Smith, 1991, and Burdekin and Siklos, 1999). Nevertheless, since the 1980s, persistence generally has been lowest for the United States and highest for the inflation-targeting group of countries. This result must, however, be tempered by consideration of the New Zealand and Canadian experiences, both of which have had inflation targets in place the longest. Inflation persistence in both these countries have dropped considerably during the 1980s and appear broadly comparable to the current United States experience.[11]

Given the wide variation in inflation performance across countries since the 1960s, it is not clear that the estimates shown in Figure 2 provide a complete picture. Also, it is unclear whether inflation persistence has, for example, been significantly different, in a statistical sense, across the countries considered in Figure 2. In particular, it is not obvious what the effect has been on inflation persistence of, say, changes in exchange rate regimes or the adoption of inflation targets, among other policy shifts that could be considered. Moreover, there are relatively few independent observations in Figure 2

[11] To avoid cluttering Figure 2, Germany and Switzerland are omitted but their experiences broadly parallels that of the United States.

Table 3

Inflation Persistence in Selected Industrial Countries, 1958-97: Known Break-Points

	Test for Structural Break		Inflation Persistence β_1			
Country	Inflation Targeting (1)	Bretton Woods (2)	Full Sample (3)	Bretton Woods (4)	Post-Bretton Woods (5)	Inflation Targeting (6)
Inflation-Targeting Countries (full sample)						
Australia (58:1 – 97:4)	2.14 (.06)@	1.65 (.15)	.73 (.06)@	.87 (.08)@	.67 (.08)@	.76 (.17)
Canada (58:1 – 97:4)	3.37 (.01)+	7.16 (.00)+	.77 (.05)*	.17 (.15)	.84 (.05)*	.20 (.13)
Finland (63:1 - 97:4)	1.37 (.26)	3.31 (.01)+	.72 (.06)@	.31 (.15)	.83 (.06)@	.22 (.24)
New Zealand (58:1 - 97:4)	1.24 (.29)	2.68 (.02)*	.71 (.06)@	.41 (.12)	.75 (.07)@	.45 (.17)
Spain (63:1 - 97:4)	.71 (.61)	4.75 (.00)+	.61 (.07)@	.21 (.15)	.73 (.07)@	.39 (.26)
Sweden (58:1 - 97:4)	2.89 (.02)*	2.78 (.02)*	.50 (.07)@	.32 (.13)	.51 (.09)@	.06 (.13)
United Kingdom (58:1 - 97:4)	1.54 (.18)	2.71 (.02)*	.73 (.06)@	.42 (.13)	.75 (.07)@	–.19 (.25)
Non Inflation-Targeting Countries						
U.S. (58:1 - 97:4)	n.a.	1.17 (.33)	.81 (.05)*	.67 (.10)@	.80 (0.6)@	n.a.
Germany (58:1 - 97:4)	n.a.	3.21 (.01)+	.57 (.08)@	.33 (.13)	.56 (.08)@	n.a.
Switzerland (61:1 - 97:4)	n.a.	.95 (.45)	.55 (.07)@	.47 (.14)	.57 (.08)@	n.a.

Notes: Estimates are based on Equation 1. Deterministic seasonal dummies were also added (not shown but coefficient estimates are provided in an unpublished appendix). Columns 1 and 2 give the likelihood ratio Chow test statistic (significance level in parenthesis) for a structural break in Equation 1 caused by either the introduction either of an inflation target or the ending of Bretton Woods. The samples are as follows:

	Inflation Targeting	Bretton Woods
Australia	1993:1	1974:1
Canada	1991:1	1970:2
Finland	1993:1	1973:1
New Zealand	1990:1	1973:3
Spain	1995:1	1973:1
Sweden	1993:1	1973:1
United Kingdom	1992:4	1972:2
United States	n.a.	1972:2
Germany	n.a.	1973:1
Switzerland	n.a.	1971:2

Samples shown are before differencing or lags. See Table 1 and Johnson and Siklos (1996) for sources for the above dates. In columns 3 through 6 standard errors are given in parenthesis.

Statistically different from zero:

+ at the 1 percent level

* at the 5 percent level

@ at the 10 percent level

to provide convincing evidence about the persistence question.

Therefore, columns 1 and 2 in Table 3 consider whether the ending of Bretton Woods or the adoption of inflation targets represents structural breaks in Equation 1 in a statistical sense. The relevant Chow tests reveal that for the whole relationship summarized in Equation 1, only Australia, Canada, and Sweden show signs of a statistically significant break in inflation persistence since inflation targeting began.

Inflation persistence appears more consistently affected by the end of Bretton Woods except in the case of Australia, the United States, and Switzerland. A difficulty here is that Chow tests are, strictly speaking, valid only if inflation is stationary. One reason inflation may be viewed conveniently as nonstationary (that is, $\beta_1=1$) is that the econometrician has difficulty identifying the *timing* of structural breaks in the data, and these breaks bias estimates of persistence toward an AR coefficient value of one. A related problem occurs when a change in the behavior of a time series does not coincide with the historical dating of an event. This is perhaps most evident in New Zealand's case where inflation persistence began to drop before inflation targets were formally introduced (see Figure 2).

An additional perspective also can be gained by taking Equation 1 and estimating inflation persistence over specific subsamples. Estimates (and their standard errors) are provided in columns 3 through 6 in Table 3. It immediately is clear that persistence is relatively high in the full sample. This usually is true both for the inflation-targeting and non inflation-targeting countries. All the inflation-targeting countries, with the exception of Australia, show noticeable drops in inflation persistence since inflation targets were adopted.[12] By contrast, inflation persistence usually rose in the post-Bretton-Woods period as a whole. Of course, the chosen subsamples do not exhaust the possible regime changes. Thus, for example, if we reestimate Equation 1 for the subsample following the period of the U.S. Monetary Control Act of 1980, the coefficient of inflation persistence drops to .30 (sample is 1982:1–1997:4 before differencing). A possible drawback with the preceding tests is that they are dependent on the chosen date of the regime change. If expectations are slow to evolve or the announced policy change is not immediately credible, then the timing of the break is not properly estimated. A separate appendix, available on request, presents evidence based on tests where breaks in inflation persistence are endogenously estimated using the procedures outlined in Burdekin and Siklos (1999) and references therein.

Of course, specifications such as Equation 1 do not measure directly the *credibility* of any announced policy change, especially of the inflation-targeting variety. Figure 3 shows inflation performance in the overall CPI, during the inflation-control era only, relative to stated inflation targets. Although most countries have generally come close to achieving their targets, there have been some breaches of the inflation targets even in countries where a significant shift in inflation persistence has been detected.[13] Perhaps the most celebrated case is that of New Zealand where the inflation target was first breached in 1994. As the Reserve Bank of New Zealand noted at the time, inflation targets should be interpreted as an objective that the central bank

> "[would] be constantly aiming, not necessarily a target which could, given the inevitable uncertainties in forecasting and lags in the effectiveness of monetary policy, always be certain of attainment." (Reserve Bank of New Zealand, 1996, Appendix 2, 42–4, emphasis in original).

Part of the difficulty is that accountability under an inflation target, with potential consequences for credibility, is itself subject to a lag because *actual* inflation is the metric by which success at meeting the desired objective is assessed. Accordingly, as noted earlier, accountability and credibility may require that a central bank do more than demonstrate its success or failure after the fact.

An alternative view of the credibility issue asks whether inflationary expectations changed around the time inflation-targeting policies were introduced. Figure 4 plots average annualized CPI inflation forecasts for inflation-targeting countries around the time inflation-targeting policies were adopted in each country.[14] CPI inflation forecasts for a given year are released on a monthly basis beginning in the preceding year for which the forecast applies. We see

[12] A Wald Test could not reject the null hypothesis that β_1 is the same in the inflation-targeting and post-Bretton Woods samples for Australia. The same hypothesis was decisively rejected for New Zealand, the only other country where inflation remains persistent in the inflation-targeting sample.

[13] To be fair, central banks in inflation-targeting countries assess inflation performance in terms of CPI inflation net of supply-side shocks and not inflation in the total CPI. Nevertheless, one of the credibility problems faced by inflation-targeting countries is the potential for conflict or uncertainty stemming from the differential between these two measures of inflation. See Siklos (1997).

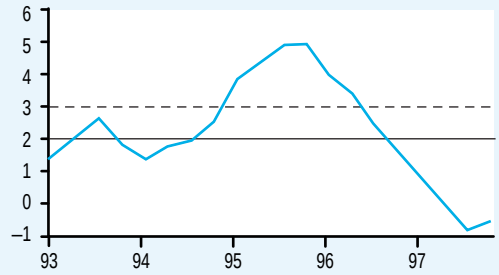
[14] No comparable data for Finland were available. The forecasts, except for New Zealand, are an average of inflation forecasts by large banks across 14 countries surveyed by *The Economist* magazine. Siklos (1997 and 1998) conducts a more extensive analysis of changes in inflation forecasts in inflation-targeting countries.

Figure 3

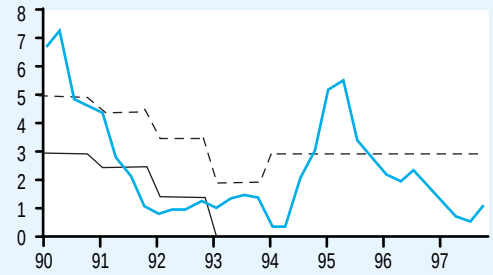
Inflation and Targets

Quarterly annualized growth rates

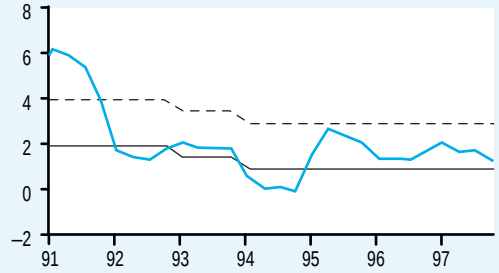
Australia



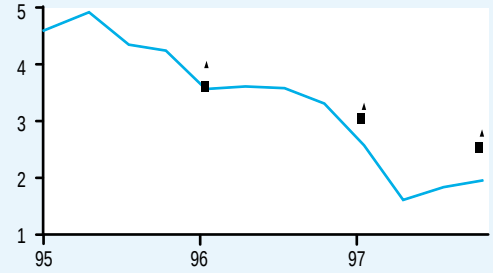
New Zealand



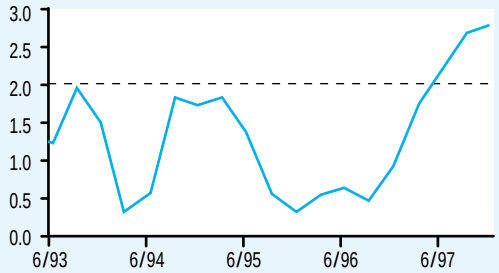
Canada



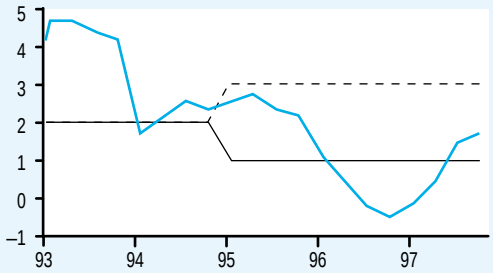
Spain



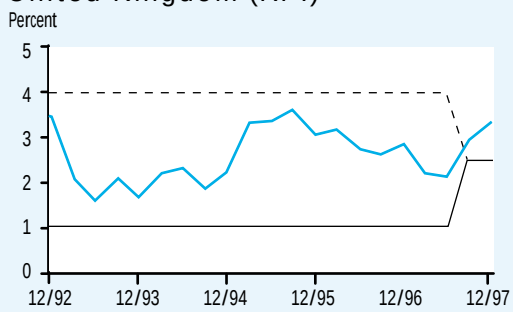
Finland



Sweden (CPI)



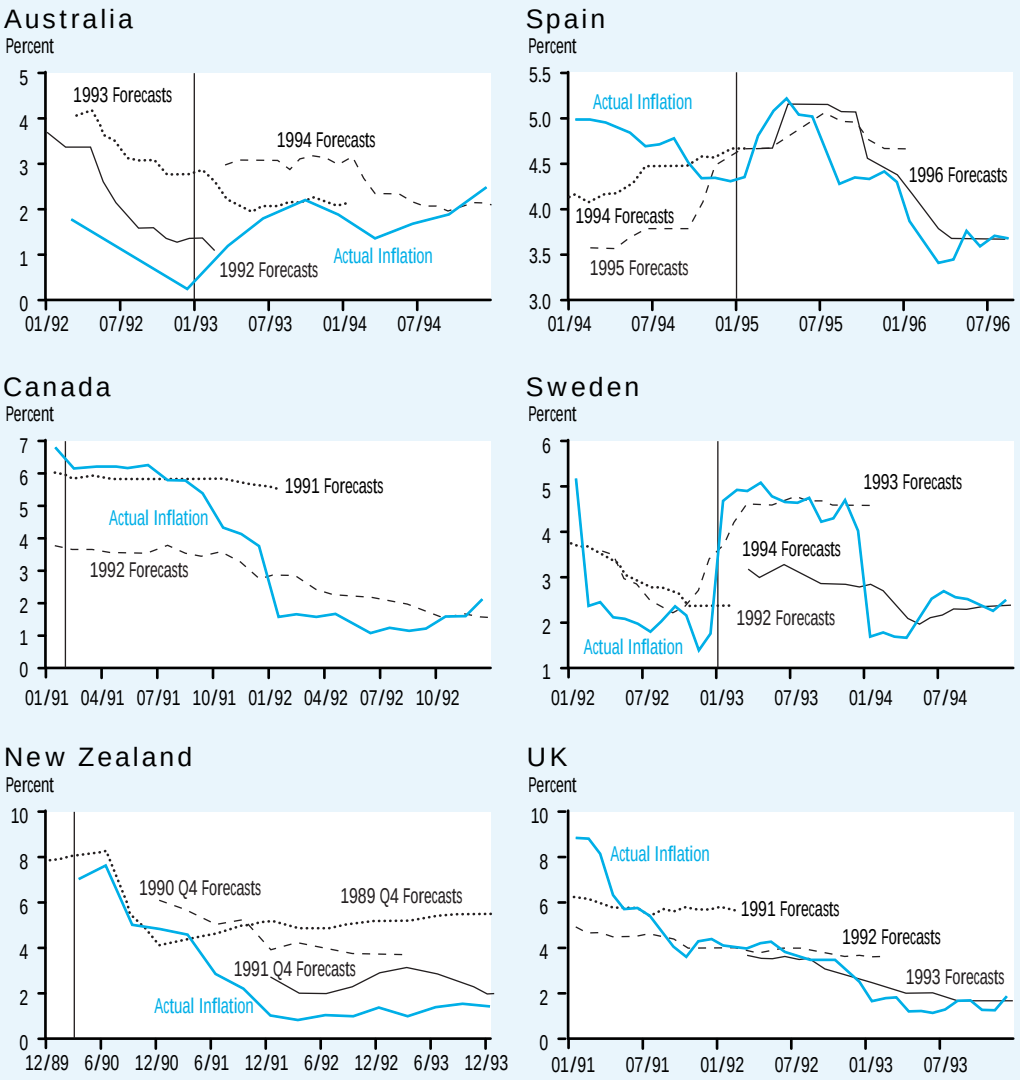
United Kingdom (RPI)



NOTE: The horizontal lines (or symbols, in the case of Spain) represent the inflation targets. See Table 1 details. Inflation rates in the CPI are at annual rates (also see Figure 1).

Figure 4

Inflation and Forecasts
Quarterly annualized growth rates



that in all countries except Australia the announcement of inflation targeting led to a reduction in private-sector expectations of future inflation with a short lag. The effect is more pronounced in some countries (e.g., Canada, New Zealand, Sweden, and the United Kingdom) than in others. It also is interesting to note that inflation forecasts for a given year often are slow to change except perhaps when there is an announcement, such as the introduction of an inflation-targeting policy. By contrast, forecasts for different years do show signs of changing rather sharply in some cases (e.g., 1992 vs. 1991 inflation forecasts for Canada).[15] Of course, some of the inflation forecasts may not take into account changes in monetary policy [see, for example, Croushore (1996)]. In general, it is difficult to replicate

[15] Indeed, Siklos (1997) reports that inflation forecasts have been more volatile in inflation-targeting countries.

the information sets forecasters use to generate their predictions about the future course of inflation (Siklos, 1998).

The failure of inflation forecasts to adjust more rapidly to the fall in actual inflation—note the persistent differential between actual and forecasted inflation in several of the inflation-targeting countries—may reflect residual uncertainty about whether the monetary and fiscal authorities are committed to the new policy regime. Mitigating this possibility is the fact that the current disinflation appears to be a global phenomenon, as noted earlier. Other evidence, not shown here, relying on estimates of the slope of the yield curve, also suggests that the introduction of targets was, for the most part, credible, (see Siklos, 1998).

CONCLUSION

This paper has considered whether the adoption of inflation targets has affected the time series properties of inflation, both in relation to the past performance of inflation in countries that have adopted such a policy, and in comparison with the policy record of the United States, Germany, and Switzerland. The latter group of countries are thought to have good inflation performance without having explicitly adopted an inflation target. Also examined was the role played by the design of the inflation target in particular and institutional considerations more generally in accounting for the success of the policy.

Descriptive and econometric evidence suggest that the mere adoption of an inflation target is sufficient neither in delivering consistently better inflation performance nor in significantly influencing inflation expectations. Nevertheless, for a subset of countries, notably Canada, New Zealand, Finland, Spain, Sweden, and the United Kingdom, inflation persistence has dropped significantly after the adoption of inflation targets. Moreover, the adoption of an inflation target in these countries has delivered significantly lower interest rates than would otherwise have been the case. (See Murchison and Siklos, 1999). Despite the apparent effect of inflation targets and of associated reform to central banking operations, the fact remains that the disinflation of the 1990s is an international phenomenon. It remains to be seen whether inflation targeting can withstand pressures stemming from sustained breaches of targets should inflation policies in the major industrialized countries begin to diverge. Also important is the question whether inflation targets can assist in delivering better long-run economic performance. The early reviews have not been favorable. For a mixture of reviews, see Fortim (1996), Freedman and Macklem (1998), Krugman (1996), and Siklos (1997).

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