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On the Way to a New Monetary Union: The European Monetary Union

LOOKING BACK IN HISTORY over the last two centuries, we will find only a few cases of a successful creation of a monetary union but a far larger number of cases which failed. As far as the final goal is concerned, it means having only one single currency for all the nations in the European Union and replacing the individual national currencies; it is a very big undertaking. It means that one has to create a monetary union ultimately encompassing nearly 400 million people and a region which would have the highest gross domestic product (GDP), the most extensive foreign trade, and so on, in the world. In other words: It is an ambitious goal which has not yet been reached, but we are on the way to reaching it.

A MONETARY UNION: IN THE BEGINNING

The goal of a monetary union must be seen as one specific objective along the road from the European Community (EC) created by the Treaty of Rome in 1957 and the European Union shaped by the Treaty of Maastricht which was ratified in 1993. The long way we have come from the beginning to the present state of the European Union is impressive; this holds true not only of the progress made, but also of the time span which has been necessary to make it, and it has not been without a number of crises, set-backs and periods of stagnation.

From the beginning, the way went along the economic integration of the national economiesin direction of a single European economy. But the real target was a political one. This was very clear at the outset. The first step was the creation of the European Coal and Steel Community in 1952. At that time, three politicians were of particular importance: Robert Schuman, Alcide de Gasperi and Konrad Adenauer. It is worth remembering that these three statesmen all came from border regions, between France and Germany or between Italy and German-speaking Austria. Schuman and de Gasperi were both bilingual, that is, they spoke French and German, and Italian and German, respectively. Adenauer came from the western banks of the Rhine River and was, to a certain extent, French-oriented. These three men, who had all

experienced the two big wars in Europe between the nations which actually belonged so close together, had the courage to create this European Coal and Steel Community as the first Community organization. To a certain extent, coal and steel were considered to be the most important strategic materials. In Germany at that time, the production of such materials was limited and under the control of the Allied Forces. Later, the production of these materials came into surplus and lost its particular strategic importance. But the Coal and Steel Community, which exists even today, fulfilled the role of a nucleus for the development of the European Common Market.

The subsequent steps towards the European Community should be well-known. I mean the creation of the Community of six nations, West Germany, France, Italy, the Netherlands, Belgium and Luxembourg, in 1957. The next important step was the extension of the Community to include the United Kingdom, Denmark, Ireland and later Spain, Portugal and Greece. At the beginning of 1993 the target to create a so-called single market had been reached. Since that time, no government barriers have been in place between the member countries as far as the trade in goods and services is concerned, as well as the movement of labor and capital. After the extension of the Community from six to 12 countries, the so-called deepening of the Community had reached an important point.

Now, Europe is on the brink of doing both: an extension of the Community to include new members comprising the Scandinavian countries and Austria, and the deepening on the way to a monetary union. Even now, the primary target is a further strengthening of the economic integration. It means achieving a large, single market for the western and central European countries and, at the end, to use only one currency in that market.

But one should not forget that the target even now is political. It should bring the European countries with a rather stable democratic constitutions closer together and allow them to develop into a political union. The end of the Cold War has given them more freedom to do so. Before that, Austria and Finland, in particular, had to take care not to provoke the Soviet Union. The development of free and democratic societies in Poland, the Czech Republic and Hungary is another new element which must be handled with care.

CONFLICTS IN MONETARY POLICY: "MONETARISTS" VS. "ECONOMISTS"

From the beginning of the EC there were differences in the attitudes in the various countries, especially in France and Germany, as far as the role of monetary policy in the economic integration was concerned. The dispute was seen as a conflict between "monetarists" and "economists," which means something different in St. Louis. The "monetarists" believed that monetary integration has to start first and that economic and political integration would follow. The "economists" believed that economic convergence between the national economies must occur before any move into very close monetary integration and a monetary union.

At the end of the 1960s and the beginning of the 1970s, the "monetarists" gained stronger influence. An EC Community study, the so-called Werner Plan, described a step-by-step introduction of a monetary and economic union. But the first step under this plan, that is, the obligation to have fixed but changeable exchange rates between the national currencies, was rather unsuccessful. The times were characterized by the end of the Bretton Woods system, and later by the first oil price hike and a world-wide recession in 1975. Only the core of hard-currency countries were able to stay together without interruption, specifically, Germany and the Benelux countries.

The real reason for the failure of this first attempt to have a system of fixed but adjustable exchange rates for all countries was the strong deviation in the rates of inflation. Between 1973 and 1979, for instance, the annual rate of inflation was 11 percent in France and 16 percent in Italy, but only 4.7 percent in Germany. For the Federal Republic of Germany, however, this was the highest rate of inflation in a medium-term average in four decades. The heavily engaged politicians in this field were following the doctrine of the so-called monetarists: Giscard d'Estaing in France and Helmut Schmidt in Germany tried to base the integration in the monetary field on a stronger institutional platform than before. They created the European Monetary System (EMS), which came into effect in March 1979 and is practically existing up to now. I do not think it is unfair to explain the common interest of the French president and the German chancellor, d'Estaing and Schmidt, respectively,

apart from very important points, with one common motive: The dominance of the deutsche mark was of particular concern for Giscard and the dominance of the Bundesbank seemed to be a big concern in the eyes of Helmut Schmidt, even though this was not actually true.

The EMS was constructed as a system of fixed but adjustable exchange rates between the EC countries, which allowed fluctuations of these exchange rates only within a relatively narrow band. And which, secondly, established a large framework of partly unlimited credit facilities for the member central banks. This credit mechanism was to make it possible to keep the exchange rates stable, even under strong pressures on one particular currency, through the obligation of central banks to intervene in the foreign exchange markets, if necessary, with unlimited amounts.

THE INHERENT WEAKNESS OF THE EMS

Looking back, the creation of the EMS was a very important step towards a European monetary union at a later date. It worked in two directions. First, all countries learned what is possible under given conditions in Europe and—where necessary—how these conditions had to be changed. Second, all member countries learned that a fixed exchange rate can stimulate the integration of trade and other transactions across the borders of the member countries of the Community. We observed that the member countries felt a systemic pressure to try to orient their own domestic development, especially as far as the price developments were concerned, to that of the best-performing countries. Taking the same countries which I have mentioned before, for the period from 1979 to 1990, we can see that the annual increase of prices in France then was only 6.9 percent, compared to 10.7 percent in Italy and 2.9 percent in Germany. The inflation rate differentials had diminished, and the average rate of inflation in the EC was lower. In the years after 1990, these differences were smaller still and partly the other way around.[1]

But we also experienced that even those smaller differences—whenever they existed over a longer period of time—create a need for a change in the exchange rate structure. In other words, they result in the need for a realignment. If one counts exactly, we have had 16 bigger and smaller realignments since 1979, namely 11 between 1979 and 1987, but there were no general realignments up to September 1992, the rest later. This seems to be a relatively good experience of a system of fixed exchange rates aimed at achieving a convergence of the economies.

But even in the period from 1987 to 1992, price differentials accumulated, with the consequence that those countries which kept their nominal exchange rates stable experienced an increase in their real exchange rates. Italy, for instance, recorded a real appreciation of its currency vis-à-vis the deutsche mark and other hard currencies in an amount of nearly 15 percent between 1987 and 1992, and the same was more or less true for the pound sterling. Such real appreciation leads to a loss of the competitive position of a country, and it depresses its exports and the overall domestic situation. The latter is aggravated by the fact that it becomes necessary to increase the interest rates in these countries far above the level in the hard-currency countries. The solution to eliminate these tensions was not ideal: The United Kingdom and Italy withdrew from the ERM in autumn 1992.

These events show the real weak flank of a fixed exchange rate system. To avoid these events, a realignment would have been necessary at an earlier stage, a devaluation of the more inflationary currencies vis-à-vis the rather stable currencies, that is, the deutsche mark, the Dutch guilder, the French franc, and so on. But realignments are highly political affairs—at least the politicians have made them into that. My long-standing experience with this—reflected by Oscar Wilde, who wrote: "Experience is the sum of the failures"—is that realignments are made only under the strongest pressure in the foreign exchange market, not on the basis of any profound backward and forward-looking analysis. This was also the case in the Bretton Woods system and one of the reasons why it broke down. In other words, this is the inherent weakness of the EMS or, to be more precise, of any system with fixed but adjustable exchange rates.

[1]See Fischer (1994).

One solution to ease the problem—having a change of the exchange rates but not necessarily a political decision about a realignment—was found by widening the band of fluctuation of the exchange rates. This was done in August 1993 by widening this band to ±15 percent, instead of ±2.25 percent and ±6 percent, respectively. In fact, since we have had this wider band, the exchange rates of the EU countries have been behaving rather calmly. No country was forced, or prepared, to use the wider band for a stronger devaluation or revaluation. Each country now has a clear responsibility for its own currency and for the exchange rate of its currency. In my opinion, this is a rather good basis for further developments on the way to a European monetary union. After a longer period, in which the exchange rate structure of the EMS currencies would have come into a longer-lasting equilibrium, the fluctuation band could be diminished somewhat.

THE CONCEPT OF THE ECONOMIC AND MONETARY UNION (EMU)

The Treaty of Maastricht, called the Treaty on European Union, the most important extension of the Treaty of Rome, is rather clear about the different steps needed for a monetary and economic union, but rather vague concerning the elements of a political union, that is, a common foreign policy, defense policy, harmonization of laws or social policy. By the way, a new intergovernmental conference is to take place in 1996 to implement the political part of the Union. Coming back to my earlier remarks, however, the Treaty of Maastricht contains more of the ideas of the "monetarists" than of those of the "economists." But this type of victory was easier to reach than anything in the purely political field. A monetary union means that all member countries have to give up their national sovereignty in this area. It means monetary union first and political union later. A monetary union is a sacrifice of sovereignty for each country. And, as French President Mitterand said before the referendum in France in 1992, the biggest sacrifice is in Germany, the country with the anchor currency in the EMS and, therefore, the country with the monetary policy that is most independent from the policies of the other member countries. Having said this, however, I should add that Germany has never been completely independent from the others in the past and that it has usually had to take into consideration the consequences of its own policy decisions for the partner countries. But, nevertheless, this has been done on its own judgment.

In the other political areas, the national sovereignty is not given up. There are some limitations, some common rules, some Community directives, but there is no direct interference, for instance, in foreign policy decisions. Even in the case of fiscal policy, the national governments are sovereign. They agreed to a process of multilateral surveillance and they agreed in the Maastricht Treaty on some soft sanctions for misbehaving countries, but each state decides in full sovereignty on its own taxation system and on tax rates and public expenditures. Of course, some rules have been formulated, but only for the public sector deficit and for the level of government debt. Agreement on common European foreign and defense policies is very difficult and can be seen in the role which the European Union played—or did not play—in the breakdown of the Yugoslav Republic and the consequences that followed.

Having said this, the monetary union described by the Maastricht Treaty is not an illusion. It takes into account many of the experiences gained in the EMS period, and it proclaims a path toward the EMU in three stages. Stage I means freedom for international capital movements; this is given now. It also calls for membership in the EMS, preferably in the ERM, but—as I have said before—the latter is not yet given for all countries. For example, the United Kingdom, Italy and Greece are not in the ERM.

Stage II started at the beginning of this year. It includes the establishment of a European Monetary Institute (EMI) as the forerunner of EMU and the European Central Bank. The Institute has started with its work and now definitely has its seat in Frankfurt, the financial center of Germany and the place where the Bundesbank has its headquarters. The EMI has to clarify the technical and operational questions for the coming European Central Bank; it has to continue and intensify the coordination of the monetary policies of the member countries and it has to control the EMS and the development of the ECU.

In the final stage, the heads of state of the European Union will meet and decide if EMU can start, in 1997 or 1999. This decision is to be made on the basis of which countries fulfill the

so-called entry criteria. This will be a very important exercise. The Treaty gives indications of how to proceed in this process of examination. They have to clarify which countries have enough and sustainable price stability, have sound public finances, and have no strong tensions as far as the exchange rates of their particular currencies are concerned.[2]

The purpose of this examination is to ensure that only those countries which fulfill these criteria can join the EMU at the beginning, thereby guaranteeing that only countries with a sound economic basis can be founding members. This means also that, at the beginning, presumably not every member country would qualify for membership in EMU. In other words, the Treaty opens the way for a two- or three-speed solution. Those countries which are not in EMU at the beginning can come in when they fulfill the entry criteria. The United Kingdom and Denmark, however, have the right to stay out under any circumstances, even if they fulfill the criteria.

I think the idea of entry criteria can be considered a "victory" on the side of the "economists," on paper at any rate. One cannot forget that the politicians will have a certain degree of discretion in their final judgement about which country should join the EMU and which should not. By the way, the room for discretionary assessment is strongly limited for the German government, because the German Parliament as well as the Federal Constitutional Court are forcing the government to be very strict in its judgements in this. Nevertheless, it is a highly political issue. Everyone knows it cannot be solved solely on the basis of statistics, and even the interpretation of the statistical criteria is now under dispute.[3]

In my opinion, the Treaty of Maastricht is a rather well-balanced document. The question is whether this concept can be filled with real life and whether this life could satisfy the wishes and hopes which many are connecting with it.

If I were to try to give an answer as far as the whole content of this new European Union, the political Union, is concerned, I would have to be very vague. I would have to start with the question of whether the nations are prepared to give up their identities. Are they prepared to forget the experience which they have had with each other during for the past hundreds of years? Can they give up whatever judgments and prejudgments they may have made and—especially—can they forget all the injustices they have inflicted on each other?

Other open points are the consequences of widening the European Union from 12 to 16 states, and what consequences would be for opening for membership for the central European states, that is, Hungary (which has already applied for membership), Poland, the Czech Republic, and so on. All these are important questions and not really new. More than 35 years ago in Germany, Ludwig Erhard, the Minister of Economics who contributed so much to the "German revival" (Henry Wallich, 1955), was strongly engaged in the European debate. Even then, he was against a Europe of only six countries. He published an advertisement in newspapers, writing only:

$$6 + 7 + 5 = 1.$$

He meant that six alone would not comprise one Europe; the seven EFTA countries and the rest of the non-communist countries in Europe should be included. In 1995, presumably 16 countries will form the European Union—only Switzerland and Iceland will be missing to complete the Erhard formula.

I do not want to go into this grand design of European questions, even if I have indicated that I have always been inclined to be on the side of Ludwig Erhard. Let me come back to the question as to how a European Monetary Union can function. The center piece of the EMU is the establishment of the European Central Bank, the only central bank which could issue the single

[2]See: "Protocol on the Convergence Criteria Referred to in Article 109j of the Treaty Establishing the European Community," Office for Official Publication of the European Communities (1992).

[3]For instance, "price stability" is given if a member state has an inflation rate not more than 1.5 percentage points higher than "the three best-performing member states." The question is, does it mean the average of these three states or that of the worst (or the best) of these three states?

European currency. In many respects, this Bank will be modeled on the German Bundesbank, which means that it will have the priority target of keeping the value of the currency stable and, for that purpose, it will:

- be independent from the national and supranational governments (not accepting orders nor being allowed to ask for any);
- have a Central Bank Council consisting of the governors of the national central banks and six members of an executive board who cannot be dismissed during their term in office for decision-making;
- be granted the necessary instruments for monetary policy, that is, open market policy, interest rate policy, minimum reserve requirements, if necessary, and so on; and
- the European Central Bank will not primarily be responsible for banking supervision, but it is possible to transfer corresponding tasks to it.

CENTRAL BANKING GOALS AND MONETARY AGGREGATES

As I have already mentioned, the monetary union is well constructed on paper and a European Central Bank could work. The European Central Bank is to be established as a federal institution, much like the Bundesbank in Germany, which has the federal elements of the United States as its "grandfather," so to speak. Why should it not be possible for such an institution to fulfill its tasks for Europe? Many people are asking whether such a new central bank comprising people from different countries with a somewhat different "culture" of monetary policy could really work. I have to answer that monetary policy decisions are never made on the basis of a full conformity of opinions among the decision makers. This is not the case in the Central Bank Council of the Bundesbank with its 16 members, nor is this the case in the Federal Open Market Committee (FOMC) of the Federal Reserve System, as we can all see from the record of policy actions. Both Councils are democratic institutions in which decisions are made through majority, but certainly these institutions have a basis of a common attitude, and have a certain consensus about what to decide and how to work.

Take the U.S. case. David Mullins, the former vice chairman, says that 4 percent inflation is unacceptably high. And Wayne Angell, a long-standing member of the Board of Governors, wrote in his letter of retirement to the President of the United States that "I am pleased... [that] the Board of Governors was enunciating a goal of zero inflation. But if the quest for price-level stability is replaced by an acceptance of an inflation rate stabilized at say 2-1/2 percent per year, then we are accepting the fact that the domestic value of the dollar will be cut in half every generation, 28 years." Thus, there is a consensus, with some room for interpretation, between both (ex-)members.

In the German case, the Bundesbank is sometimes attacked because part of its intermediate monetary target—the growth of M3—is derived on the basis of a so-called unavoidable increase of about 2 percent in the price level. Presumably, Wayne Angell would also be a little bit disappointed about this.

Which price level target will the European Central Bank formulate, if it were to formulate one at all? The 1.5 percentage points over the average of the best-performing countries cannot be a target, it is the entry criterion. Up to now, there seems to be no discussion about a price stability target for this future Central Bank. The core countries would presumably agree on a figure like that of the Bundesbank, and—if that were done—one would be also in agreement with Professor Stanley Fischer, who recently wrote "that anyone should be comfortable with a 1-3 percent target".

I do not want to go into the details of the use of a declared price stability target. Canada and New Zealand are using one, and have indeed reached and kept to it up to now. It is worth noting that the last Governor of the Bank of Canada, whose bank was successful, had to resign when a new government came into power. Price stability targets in the sense of a stable consumer price level are a very ambitious exercise. So far, New Zealand's central bank keeps it at 0-2 percent inflation, even against opposition.

Nobody would be surprised—especially not at the Federal Reserve Bank of St. Louis—if I were to suggest that the European Central Bank should start immediately with targeting on the basis of a money supply target. I must admit that this would be rather complicated at the beginning, because nobody could know exactly how the European money supply, the money demand function, and so on, will behave. But, in my opinion,

it is indispensable that this new central bank has an idea of how strongly the money stock should grow and, especially, of how far the monetary basis should be extended, the money which this new European Central Bank System will create itself. This question reminds me of the fact that after the deutsche mark had been introduced in 1948, the military government prescribed that any additional increase of currency in circulation, exceeding a total circulation of $10 billion, needed a very restricted procedure of agreements by a three-fourths majority of the Central Bank council and had to be approved by the Länder Governments. This was a primitive way of control, but it made clear that any extension of money must be limited, especially if it is a new money, which does not inspire the same confidence at the beginning than a well-proven old currency.

The discussion of whether or not to have money supply targets will be a point of controversy in the EMI. The President of the EMI, Baron Lamfalussy (1994), has formulated the different positions that will presumably be held, for example, using the money supply as an intermediate target, as is practiced in Germany and some other countries. Or, having no intermediate target but a concrete price stability target, such as New Zealand. Or neither of them, which he seems to prefer—reading between the lines—by saying "can one not use monetary aggregates at least as an information variable?". This seems to be a new formula which was described, for instance, by Benjamin Friedman (1994). I find this new label sounds good but I have to add that such eclecticism, as a matter of fact, is not new. I think that advanced central banks follow the development of the money supply aggregates everywhere and at all times, because they value the information that monetary aggregates provide and their importance to the economic developments, but they also take other factors into account.

CONCLUSIONS

When the EMI has completed its work of preparing the future European Central Bank, when the examination of the entry criteria has been made and the heads of state of the European Union have decided that the monetary union can start, then the adventure will begin. At the beginning, only the exchange rates between the different national currencies of the member countries have to be fixed without any margin and without any possibility of changing them in future. In a later stage, the single currency can replace these national currencies: This would be the fulfillment of the European Monetary Union.

It may seem to you that the way to EMU is a relatively long one, that many preconditions which have been formulated give the impression that the fathers of this program are themselves not sure about the success of the whole plan. And you could add that Europe needs too much time to find solutions comparable with the dynamics in the United States. But even here in the United States, it took quite a long time before you got a Federal Reserve System, even though one currency existed. Now, in Europe, we have central banks. In quite a number of our countries we have currencies which are relatively stable and we have a situation in which the exchange rates are no longer fluctuating very strongly, although they could. In other words: The integration of the economies in Europe and, especially, in the European Union can and will continue to progress toward more complete economic integration. For this purpose, it is not so important—either for our countries or the rest of the world—whether the European Monetary Union starts in 1997, 1999, or even a little later. What is decisive is that we replace the different European currencies with a single currency that is as stable as the best-performing national currencies.

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The P-Star Model in Five Small Economies

THE QUANTITY THEORY AND its equation of exchange provide a proven and useful framework to empirically analyze the relevance of money in the economy. During the past decade, however, doubts about this approach arose because of the perception that the links between money and prices and money and output had loosened or vanished.[1] Recently, Hallman, Porter and Small (1991)—henceforth HPS—have drawn new attention to the quantity theory by explicitly linking the determinants of long-run equilibrium prices to the short-run dynamics of actual inflation in the so-called P-star approach. In this framework, deviations of the actual price level from equilibrium push current prices and inflation in the direction of equilibrium.

The empirical results obtained so far for a wide set of countries, are supportive of the P-star approach, although it seems to work better for larger than smaller countries.[2] One neglected aspect which may explain this apparent dichotomy is the importance of the prevailing exchange rate regime for the determinants of prices and inflation. The original P-star approach assumes that the equilibrium price level is a function of the domestic money supply. Under a system of fixed exchange rates, however, the domestic price level in a small country is determined abroad and the domestic money stock becomes endogenous and demand-determined.

This article develops a generalized P-star model that accounts for this international effect by including cross-country price gaps. It is tested using annual data from 1960 to 1992 for five small European countries—Austria, Belgium, Denmark, the Netherlands and Switzerland. During the Bretton Woods period, these countries pegged their exchange rates to the United States dollar. Since then, four of the five pegged their currencies to the German mark, with varying degrees of success. Only Switzerland has had a floating exchange rate regime continuously since the breakdown of Bretton Woods. We investigate the extent to which prices in these countries have been affected by developments in Germany, as well as domesti-

[1]For an overview of past discussions on this issue, see Batten and Stone (1983), Dwyer and Hafer (1988) and Dewald (1988).

[2]See, for example, Hoeller and Poret (1991). They also indicate that there generally are superior models for forecasting inflation movements, even for countries where the P-star model is not rejected.

cally. To assess the tests used here, we also investigate the effect of U.S. price developments on the price level in these five countries and in Germany.

The results below indicate that the five small countries' equilibrium price levels are determined in Germany under the fixed exchange rate regime and that this effect has been proportional to the tightness of the exchange rate peg. In contrast, foreign-based equilibrium prices are found to be insignificant for the United States and Germany, the two countries that generally floated over the period examined here.

In the next section, the theoretical framework is developed, focusing first on the P-star model for a closed economy. Then, a generalized variant of the monetary approach to the balance of payments is used to show that under fixed exchange rates, domestic price developments in a small country are determined abroad, and that domestic money becomes endogenous. Combining these ingredients, it is shown that both their own price gap and a price gap based on equilibrium prices determined abroad can affect a country's inflation, depending on the exchange rate regime. The subsequent sections discuss the data, present the empirical results, and summarize the paper.

THE P-STAR MODEL IN CLOSED AND OPEN ECONOMIES

The Closed Economy Model

The simple Quantity Theory's equation of exchange is

(1) $P = M\ (V/Y)$,

where P denotes the price level, M is the domestic stock of money, Y is real output and V is the velocity of money. For convenience, time subscripts are omitted. Equation 1 simply pins down (nonobservable) actual velocity for given observations on P, M and Y.

HPS (1991), however, hypothesize the following long-run equilibrium relationship based on the identity in equation 1:[3]

(2) $P^* = M(V^*/Y^*)$,

where P^* denotes the equilibrium price level to which actual prices converge in the long run, Y^* is potential real output, and V^* is the equilibrium velocity of money. Following the Quantity Theory, they assume that V^* and Y^* are determined independently, and, more importantly, that both are independent of the money stock. Thus, the equilibrium price level moves proportionally with the stock of money. HPS further hypothesize that the equilibrium price gap, $(lnP - lnP^*)$, has a theoretical value of zero so that P adjusts to equal P^*. The combination of equations 1 and 2 implies that the change in the actual price level should be negatively related to the existing gap between P and P^*.

This relationship is formally indicated by the hypothesis that α_1 is negative in the second term of the inflation equation:

$$(3)\ \Delta lnP_t = \alpha_0 + \alpha_1 (lnP - lnP^*)_{t-1} + \sum_{j=1}^{N} \beta_j \Delta lnP_{t-j} + \epsilon_t.$$

The inflation lags ΔlnP_{t-j} are added to the equation to account for short-run dynamics and ϵ_t is the random error term.

If actual inflation, ΔlnP, is nonstationary, then it does not have a fixed theoretical mean, possibly leading to problems in the estimation of equation 3. To accommodate this possibility, equation 3 can be rewritten without loss of generality as

$$(4)\ \Delta\pi_t = \alpha_0 + \alpha_1 (lnP - lnP^*)_{t-1} + \sum_{j=1}^{N-1} \delta_j \Delta\pi_{t-j} + \delta_0 \pi_{t-1} + \epsilon_t,$$

where π now denotes inflation.

If inflation is not stationary (and its first difference is stationary), then δ_0 in equation 4 has a theoretical value of zero, and lagged inflation can be omitted. Thus, equation 4 would contain only stationary variables (since π_{t-1} can be omitted). Since this is not the case in equation 3 unless inflation is stationary, equation 4 is generally a more useful equation to estimate. Although it would be possible to include other transitory influences on prices, such as price-control proxies or energy price shocks, we

[3]Humphrey (1989) gives a review of the precursors of this approach and shows that a variant can be traced back to the work of David Hume.

abstract from these factors and focus on the interaction between changes in inflation and deviations from long-run equilibrium.

HPS (1991) originally applied a version of equation 4 to quarterly U.S. data. They use M2 as the money stock and assume that the corresponding equilibrium velocity is a constant.[4] HPS conclude that the model is supported by the data.[5] Hoeller and Poret (1991) extend the P-star approach to 20 member countries of the Organization for Economic Co-operation and Development (OECD). They use the Hodrick-Prescott filter to extract equilibrium time series for output and velocity from the data.[6] The evidence provided by Hoeller and Poret is mixed. The P-star approach leads to satisfactory estimated equations for most, but not all, countries. In particular, the evidence for small countries tends to reject the P-star model, while the evidence for larger countries tends to conform to the P-star model.

So far, research on the link between exchange rate regimes and macroeconomic adjustment of prices and output is quite limited. Recently, Bayoumi and Eichengreen (1992) use impulse-response functions to analyze the differences between the Bretton Woods and post-Bretton Woods period in this respect for the G7 countries (United States, Canada, United Kingdom, Germany, France, Italy and Japan). They find evidence that, under the floating rate regime, countries' aggregate demand curves become steeper so that various shocks give rise to less output variability and greater price variability than under a fixed rate regime. Tatom (1992) analyzes Austrian price behavior; the P-star model for Austria is rejected but, due to the fixed exchange rate regime, a long-run relationship between German and Austrian inflation is not rejected.[7]

Here, we intend to investigate in more detail how foreign price developments affect domestic prices under a system of fixed exchange rates and the implications of this linkage for the P-star model.

The Generalized Monetary Approach to the Balance of Payments

The starting point of our analysis is a fixed exchange rate regime in which one large country (such as Germany) is the anchor of the system and sets its monetary policy to achieve its own domestic objectives, independent of the objectives of the smaller countries within the system. The large country is assumed to be sufficiently large so that it is unaffected by policy actions and outcomes in the small countries.[8] Each small country, in contrast, takes the anchor country's monetary policy as given and is committed to a fixed exchange rate objective.

Equations 5 and 6 represent money demand and money supply, respectively, in the large foreign country:[9]

$$(5)\quad M_D^f = [V(R^f, Y^f)]^{-1} P^f Y^f$$

$$(6)\quad M_s^f = \overline{M^f},$$

where the inverse of velocity is assumed to be a function of real output (Y^f) and a vector of nominal interest rates (R^f).[10] When both output and the real interest rate are at their long-run equilibrium values determined elsewhere in the economy, money market equilibrium determines

[4]Tatom (1990) points out that M2 velocity has exhibited semipermanent trends over time, so that the assumption of a constant equilibrium velocity may be flawed.

[5]HPS also split up the total price gap in separate output and velocity gaps, but find no additional explanatory power from this less-restricted variant.

[6]Hoeller and Poret also conduct tests using simple linear trends for the equilibrium levels of output and velocity. The Hodrick-Prescott filter allows time series with stochastic trends to be detrended. See Hoeller and Poret (1991) for a discussion. King and Rebelo (1989) contains a more technical analysis. An application and an appendix with the appropriate formulas can be found in Mills and Wood (1993).

[7]The Bundesbank (1992) develops and tests a P-star model for Germany based on its M3 measure.

[8]In the P-star model, this means that the large country's potential output, equilibrium velocity and long-term inflation objectives are independent of foreign developments.

[9]A superscript *f* will be used to denote the large foreign country (Germany or the United States), while a superscript *d* will be used for the small domestic country (Austria, Belgium, Denmark, the Netherlands and Switzerland).

[10]The relationship of equilibrium velocity and equilibrium nominal interest rates is generally ignored in formulations of the P-star model. This practice is consistent with the assumptions that movements in the equilibrium real rate are not empirically significant and that movements in the expected rate of inflation have little effect on velocity; moreover, even if this latter effect is not small, it is captured in the growth of the money stock or, given the dynamics included in the P-star model, in the lagged inflation terms.

the equilibrium price level in the large foreign economy (Germany).

The exchange rate constraint in a fixed exchange rate system then determines the equilibrium domestic price level for a small country as

(7) $P^{d*} = EP^{f*}/ER^*$,

where E is the fixed nominal exchange rate, equal to the number of equilibrium domestic currency units per unit of foreign currency, and ER^* is the corresponding equilibrium real exchange rate.[11] With the domestic price level conditioned by equation 7, the domestic money stock must adjust to bring about equilibrium in the domestic money market.

P-Star in Open Economies Under Fixed Exchange Rates

The above analysis has two major implications for the short-run price dynamics in small countries under fixed exchange rates. First, a price gap determined abroad through the exchange rate constraint should be expected to influence domestic inflation. This gap can be defined as

(8) $GAP^f = (p^d - p^{d*}) = [p^d - (p^{f*} + e - er^*)]$,

where lower-case symbols denote logarithmic levels and a d superscript has been added to the logarithm of the domestic price level to distinguish it from a foreign measure. When domestic prices exceed the foreign-determined equilibrium price level, downward pressure on current domestic inflation and prices results.[12] The amount of pressure this gap exerts on current domestic inflation and the speed of adjustment toward equilibrium depend on the extent of arbitrage in goods and capital markets, and the degree to which the economies are integrated.[13]

Second, the domestic price gap should lose its influence if the exchange rate is pegged; domestic money becomes endogenous. Suppose, for example, current domestic prices are consistent with the foreign-determined P-star measure, that is, the foreign-determined gap is zero, while simultaneously the domestic gap is positive, because actual prices exceed the equilibrium measure of prices indicated by the domestic money stock. In this case, the domestic gap is expected to close by adjustment of the money stock, not by an adjustment of domestic prices and inflation. The extent to which this holds will be a function of capital mobility. The literature on sterilization and capital offset suggests that small countries may have some freedom to manipulate the domestic money supply in the intermediate run to determine monetary conditions at home to the extent that capital mobility is limited.[14]

Both of these hypotheses are tested below. In particular, the model in equation 4 is supplemented with the foreign price gap so that the appropriate equilibrium gap measure is a weighted average of the domestic gap in equation 4 and the foreign-determined gap in equation 8 or

(9) $(1-w)(p^d - p^*) + w(p^d - p^{d*})$,

where w is the weight attached to a fixed exchange rate regime. For a closed economy or a floating exchange rate regime, w equals zero and the appropriate equilibrium price level and gap measures are the conventional, domestically determined ones used in equation 4. If there is a credible fixed exchange rate regime with the domestic currency pegged to the foreign country, f, then w equals one and the equilibrium price level is that determined abroad and indicated as p^{d*} in equation 8. In this case, the appropriate P-star and its related gap measure are determined abroad. Since w may change over the sample period, but is unobservable, the

[11] In the traditional pure monetary approach to the balance of payments, the real exchange rate is assumed to be a constant and may be deleted from the analysis.

[12] Alternatively, the gap can be closed by a discrete decision to correspondingly devalue the currency. Afterwards, the peg could be resumed.

[13] Although the degree of integration may have increased over time and may also be a function of the exchange rate regime, rising with a credible fixed rate regime, the effects of these changes are ignored below.

[14] See Roubini (1988) for an overview of the literature, and Kool (1994) for a recent empirical analysis. Also, see Stockman and Ohanian (1993).

coefficients on the gaps are theoretically the mean levels reflecting the sample experience and they sum to the mean level of α_1.

While it would be desirable to characterize the prevailing exchange rate regime over time for each country and to incorporate this information in the analysis, this is not feasible. It may seem straightforward to distinguish between fixed and floating exchange rate regimes, but departures from these idealized extremes are economically and qualitatively important in practice and are hard to quantify. Moreover, changes in the degree of international capital mobility and economic integration over time may change the speed of response to existing gaps. Finally, the limited number of observations available below severely constrains the use of extensive sets of dummy variables. For these reasons, we include both the domestic price gap (defined in equation 4) and the foreign-determined price gap (defined in equation 8) in the final specification.

THE DATA AND THEIR TIME SERIES PROPETIES

Annual data for seven countries—Austria, Belgium, Denmark, Germany, the Netherlands, Switzerland and the United States—for the period 1960-92 are used to test the model. Consistent nominal and real GDP data have been obtained from the Organization for Economic Co-operation and Development (OECD, 1993) for the six foreign countries.[15] U.S. Department of Commerce data are used for the U.S. nominal and real GDP measures. These series have been used to compute the implicit GDP deflator.

Average U.S. dollar exchange rates have been taken from the International Monetary Fund's *International Financial Statistics* (*IFS*) database (line rf). Similarly, two money stock definitions from the *IFS* have been used: narrow money (line 34), which is called M1 here, and the sum of narrow money and quasi-money (line 35), which is comparable to M2 and will be denoted here as broad money, MB. The main advantage of using these series is their harmonization across countries. For Belgium, the monetary aggregates series stop in 1990.

Exchange Rate Movements

Figure 1 presents the nominal exchange rate (defined as the domestic currency price of German marks) time paths for all countries relative to Germany, with the 1960 exchange rate indexed to 100. The Bretton Woods fixed exchange rate regime is clearly visible until the late '60s. Note, that although the formal end of Bretton Woods is often set in 1973 and sometimes in 1971, exchange rates start moving already in the period 1967-70. After the breakdown of Bretton Woods, exchange rates move least for Austria and the Netherlands. These countries have most persistently sought fixed exchange rates with Germany in the '70s and '80s.

Much more exchange rate variability has been present, on the other hand, for the United States, where the exchange rate has floated and, to a lesser extent, for Denmark and Belgium. Despite a floating rate, the Swiss exchange rate has exhibited less variability than that in Denmark and Belgium. The latter two countries have had mixed exchange rate regimes. While they have been on fixed exchange rates, at least nominally, they periodically devalued to escape the exchange rate constraint on domestic monetary policy. Some degree of exchange rate stabilization appears to have set in the middle- and late-'80s for Belgium and Denmark, however, due to the effective functioning of the European Monetary System during that period.[16]

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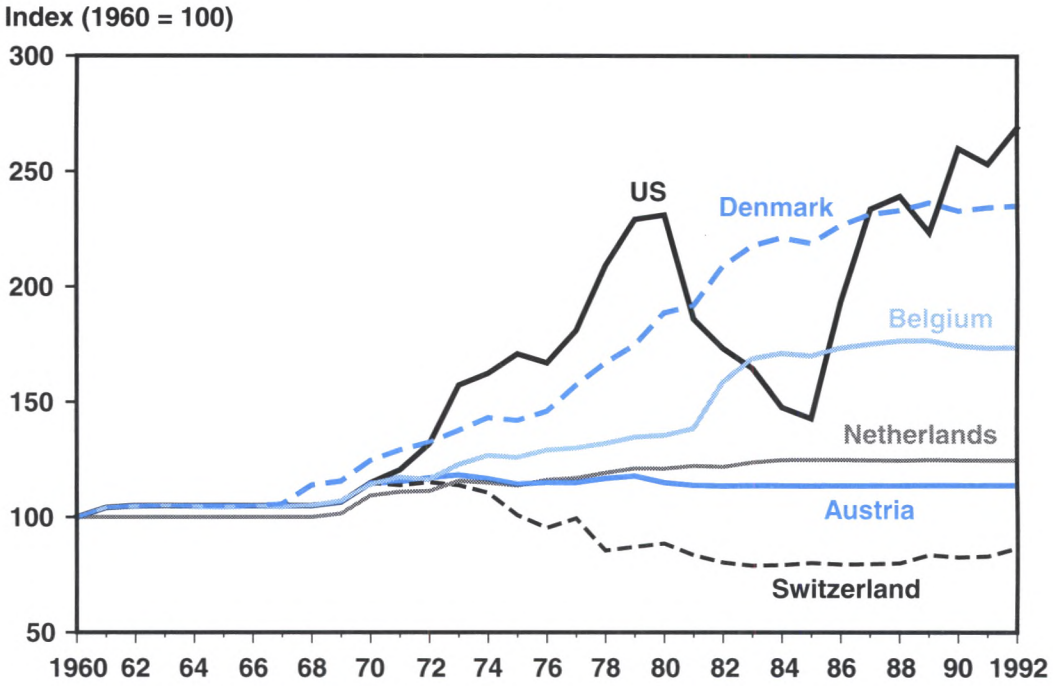
[15]Series in this publication are for 1960 and from 1963 to 1991. We are grateful to Amber DeBayser at the OECD for providing the consistent 1961 and 1962 data, which are not listed in the publication cited. Data for 1992 were computed from comparable OECD data. In Belgium, Denmark and Germany, 1992 data were not included due to lack of comparability.

[16]In August of 1993, both the Belgian franc and Danish krone were forced to accept wider fluctuation margins in the European exchange rate mechanism and experienced a considerable depreciation; subsequently, their exchange rates moved back into the narrow bands that existed earlier, although the wider margins officially still are in place. This experience is outside the sample used here.

Figure 1
Exchange Rates Relative to Germany



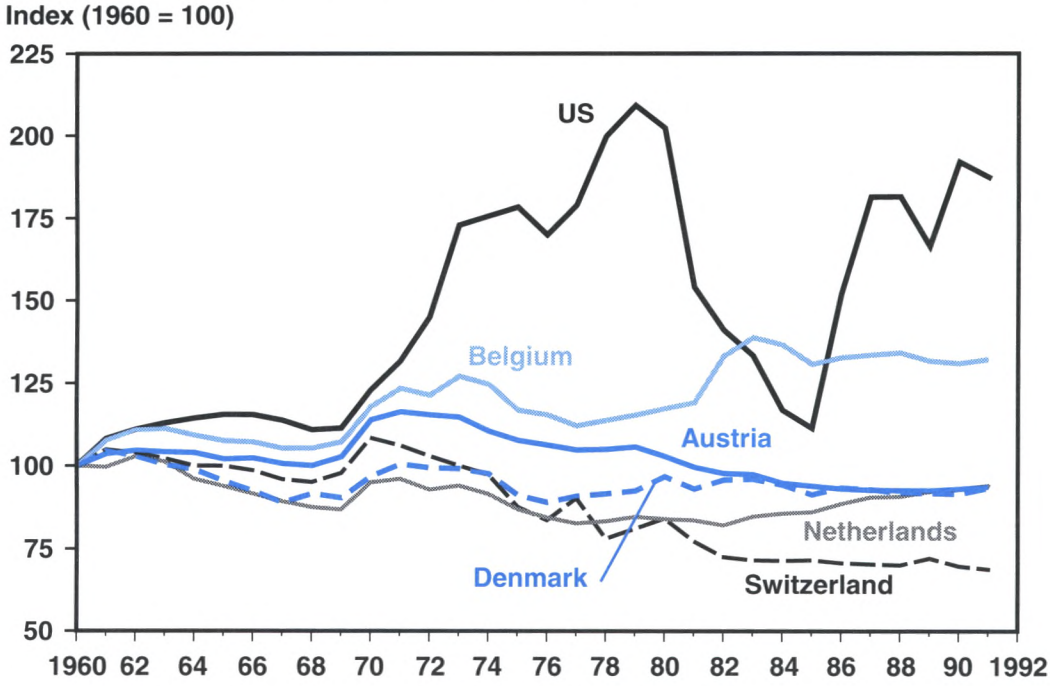
The decision by the four countries, Austria, Belgium, Denmark and the Netherlands, to peg their currencies to the mark is motivated by a desire to "import" German inflation, one of the lowest rates in the world from 1960 until recently. While the Swiss chose to float, their monetary policy has also achieved a similarly low inflation rate. The decision of the four small, open economies to peg to the mark is also presumably influenced by the fact that they are closely tied to Germany through trade. For example, in 1985-89, trade with Germany (both exports and imports) was 20 percent of Denmark's total trade, 21.4 percent of Belgium's, 26.5 percent of the Netherland's, 27.4 percent of Switzerland's and 39.2 percent of Austria's. For trade within the six-country block, the shares were 28.8 percent for Germany, 30.6 percent for Denmark, 38.7 percent for Switzerland, 41.3 percent for Belgium, 44.8 percent for the Netherlands and 51 percent for Austria.

Real exchange rates, defined as the nominal exchange rate multiplied by the ratio of German prices relative to each country's price level, are displayed in Figure 2. For the United States, Switzerland and Belgium, sizeable permanent real exchange rate changes relative to Germany appear to have taken place. Nominal and real exchange rate patterns are quite similar for these three countries. Real exchange rate movements have been smaller in magnitude for Austria, Denmark and the Netherlands. While the Danish krona has continuously depreciated in nominal terms over time, the real exchange rate has fluctuated around the same level for the entire sample.

Unit Root Tests

One important issue for the correct specification of the price equation to be estimated, is the (non)stationarity of the variables involved. Tables 1 and 2 report the results of standard augmented Dickey-Fuller (ADF) tests for both log levels and growth rates of prices, output, narrow and broad money, the corresponding velocities of narrow and broad money, and the

Figure 2
Real Exchange Rates Relative to Germany



nominal and real exchange rates.[17] In the tables, we report the *t*-statistic on the one-period lagged level for the preferred specification; this specification is given below the *t*-statistic. Significance at the 5 percent level is indicated (*) and implies rejection of nonstationarity.

With few exceptions, Table 1 indicates that the nonstationarity of the logarithm of the levels of the variables cannot be rejected. Consequently, computation of the equilibrium values of V* and Y* by means of a regression with a deterministic trend generally is incorrect. The most important implication of these results is that a procedure capable of handling stochastic trends is required to model the equilibrium levels of V* and Y*. The Hodrick-Prescott filter is used to find the equilibrium output and velocity paths.

The growth rates of output, narrow money, and narrow and broad money velocity, and the nominal and real exchange rates, all appear to be stationary according to the unit root tests reported in Table 2. For inflation and broad money growth, a unit root generally cannot be rejected.[18] Note that there are a considerable number of borderline cases. The (marginal) nonstationarity of inflation suggests that equation 4 is appropriate for the ensuing gap analysis.

TESTS OF THE P-STAR MODEL

In this section, we analyze the impact of different price gaps on short-run inflation dynamics. First, we focus on country-by-country estimation using each country's domestically determined price gap only. Then we proceed to

[17]The specification used in each case is a regression of the first difference of the series on a constant, a trend, the one-period lagged level, and up to three lags of the first-differenced variable. Insignificant lags of variables are removed step by step starting at the longest lag, for specifications that include or do not include a time trend. If the trend is statistically significant, this version is reported in the table; otherwise, the estimate without the trend is reported.

[18]Unreported results show that a unit root for the change in inflation and broad money growth can be rejected.

Table 1
ADF Unit Root Results (log levels)

Country	P	Y	M1	V1	MB	VB	E	ER
Austria	−2.19 (T,1)	−2.67 (C,0)	−1.82 (C,0)	−2.54 (T,0)	−2.08 (C,1)	−2.06 (C,0)	−1.78 (C,0)	−1.45 (C,1)
Belgium	−1.17 (C,1)	−3.26* (C,0)	−1.45 (C,1)	−3.00 (T,0)	−1.21 (C,1)	−2.95 (C,0)	−2.67 (T,1)	−3.36 (T,1)
Denmark	−1.98 (C,1)	−2.78 (C,0)	−2.93 (T,3)	−2.36 (C,3)	−2.23 (T,1)	−0.89 (T,0)	−2.07 (T,2)	−5.31* (T,3)
Germany	−2.19 (T,3)	−1.93 (C,0)	−2.61 (T,3)	1.73 (C,2)	−4.11* (C,0)	−2.24 (C,0)	NA	NA
Netherlands	−1.64 (C,1)	−4.62* (C,0)	−2.03 (C,0)	−1.72 (C,0)	−1.95 (C,1)	−2.16 (T,0)	−1.09 (C,0)	−1.77 (C,0)
Switzerland	−2.22 (T,1)	−1.67 (C,1)	−3.07* (C,2)	0.96 (C,2)	−1.79 (C,1)	−3.82* (T,1)	−1.49 (C,3)	−2.32 (T,0)
United States	−1.33 (C,1)	−2.65 (T,0)	−2.28 (T,1)	−2.25 (C,1)	−1.31 (C,1)	−3.01 (T,1)	−2.86 (T,1)	−1.93 (C,1)

Note: The entries show the relevant test statistic; the information in parentheses indicates the use of a constant only, C, or a constant and trend, T, followed by the number of lagged dependent variables included. For the longest sample period used, the 5 percent significance level critical values are −3.56 and −2.96, with and without the inclusion of a trend, respectively.

Table 2
ADF Unit Root Results (growth rates)

Country	P	Y	M1	V1	MB	VB	E	ER
Austria	−2.19 (C,0)	−4.60* (T,0)	−4.72* (C,0)	−6.33* (C,0)	−1.54 (C,0)	−4.52* (C,0)	−4.21* (C,0)	−3.25* (C,0)
Belgium	−2.21 (C,0)	−5.06* (T,0)	−3.09* (C,0)	−5.28* (C,0)	−2.43 (C,0)	−5.53* (C,1)	−3.82* (C,0)	−3.84* (C,0)
Denmark	−1.06 (C,0)	−5.66* (T,0)	−5.34* (C,0)	−5.68* (T,0)	−2.47 (C,0)	−3.58* (C,0)	−4.08* (C,0)	−4.59* (C,0)
Germany	−2.15 (C,0)	−3.82* (C,0)	−4.42* (C,0)	−5.58* (T,1)	−3.90* (T,0)	−4.07* (C,0)	NA	NA
Netherlands	−3.26 (T,0)	−3.87* (T,0)	−3.81* (C,0)	−5.04* (C,0)	−2.71 (T,0)	−5.68* (T,0)	−4.70* (C,0)	−4.01* (C,0)
Switzerland	−2.75 (C,0)	−3.01* (C,0)	−6.07* (T,1)	−6.16* (C,1)	−2.96 (C,0)	−4.55* (C,1)	−5.48* (C,0)	−6.05* (C,0)
United States	−1.66 (C,0)	−3.96* (C,0)	−3.81* (T,1)	−3.89* (T,1)	−2.83 (C,0)	−4.17* (C,0)	−3.86* (C,0)	−3.69* (C,0)

Note: The entries show the relevant test statistic; the information in parentheses indicates the use of a constant only, C, or a constant and trend, T, followed by the number of lagged dependent variables included. For the longest sample period used, the 5 percent significance level critical values are −3.57 and −2.96, with and without the inclusion of a trend, respectively.

Table 3

ADF Unit Root Results: Own Price Gaps Based on M1 and MB

Country	GAP^1	GAP^2
Austria	−3.14* (C,0)	−3.39* (C,1)
Belgium	−4.83* (C,1)	−3.68* (C,1)
Denmark	−2.75 (C,0)	−3.91* (C,3)
Germany	−3.17* (C,3)	−3.25* (C,1)
Netherlands	−3.44* (C,1)	−2.99* (C,0)
Switzerland	−6.47* (C,1)	−3.99* (C,1)
United States	−4.39* (C,1)	−4.28* (C,1)

Note: The entries show the relevant test statistic; the information in parentheses indicates the use of a constant only, C, or a constant and trend, T, followed by the number of lagged dependent variables included. The critical value for 5 percent significance level is −2.96, for the longest sample period used.

the measurement and inclusion of foreign-based price gaps.

The Domestic Price Model

The Hodrick-Prescott filter is used to determine equilibrium time paths for output (lnY), narrow money velocity ($lnV1$) and broad money velocity ($lnVB$).[19] Subsequently, two domestic price gaps are computed for each country:

$$(10)\quad GAP^1 = (p - p^{*1}) = (lnV1 - lnV1^*) - (lnY - lnY^*),$$

$$(11)\quad GAP^2 = (p - p^{*2}) = (lnVB - lnVB^*) - (lnY - lnY^*),$$

where p^{*1} equals $(lnM1 + lnV1^* - lnY^*)$, and p^{*2} equals $(lnMB + lnVB^* - lnY^*)$, the respective measures of the equilibrium price level based on domestic M1 and broad money. Table 3 shows ADF test results for these price gaps. The layout follows that of Tables 1 and 2. Overall, the price gaps appear to be stationary, with the exception of the M1 price gap for Denmark. This Danish price gap is stationary only at the 10 percent level. Stationarity of the price gap is a necessary condition for the further analysis. Short-run inflation dynamics are theoretically assumed to be influenced by the price gap because of the existence of an underlying equilibrating adjustment process. If actual prices do not converge to the computed equilibrium prices, as is the case with nonstationary gaps, the fundamental P-star hypothesis that, in the long run, prices converge to these equilibrium measures is rejected; no theoretical foundation exists for including such a measure of the gap in the inflation specification. This is the case for the Danish M1-based P-star model.[20]

Table 4 presents estimates of the domestic P-star model based on each country's own M1 (GAP^1) and broad money (GAP^2). In the general specification, one lag of the dependent variable and the lagged inflation level are included along with the gap and a constant. The reported results are for estimates in which insignificant lagged inflation variables have been dropped from the general specification.

The results are supportive of the P-star approach. Save for Denmark, the price gap with respect to broad money is significant with the correct negative sign. The price gap calculated with narrow money is significant only for the United States, Switzerland and Denmark, and

[19]Basically the trend is derived by minimizing an objective function that consists of the sum of squared deviations of actual observations from the (unobservable) trend and a multiple, λ, times the sum of squared changes of this trend. A smoothing factor λ of 100 is used here, following Kydland and Prescott's (1989) suggestion that this value is appropriate for annual data. Hodrick and Prescott (1981) show, using quarterly data, that a choice of λ of up to four times or one-fourth as large has no practical effect on the results of applying the filter. The limiting case, λ approaching infinity, is a linear trend; this case was also examined (for Y, V and the real exchange rate below). Differences arising from the use of linear trend filters are noted below because the results are sensitive to this choice.

[20]When linear trends are used to construct equilibrium measures for the broad money-based P-star variables, only the U.S. and Swiss gap measures are stationary; the domestic gap measures for Germany and for the four other countries based on these measures are not stationary. The domestic version of the P-star model based on these equilibrium estimates is rejected because these measures cannot be equilibrium levels. Thus, the failure to reject the P-star model in the text is conditional upon the method of estimating equilibrium output and velocity. The Swiss and U.S. models using linear trends do not fit the data as well as the estimates reported below.

marginally so for Germany. Since Denmark's M1-based domestic price gap is nonstationary, this result in Denmark may well be spurious. Thus, Denmark's evidence rejects the domestic P-star model, a result obtained by Hoeller and Poret (1991) as well. In the other countries, the broad money-based P-star model generally fits the data somewhat better (judged by the adjusted-R^2) and fails to reject the model (judged by the statistical significance of the negative coefficient on the price gap).[21]

For five of the seven countries there is a high coherence between the narrow and broad money price gap; the exceptions are Austria and the Netherlands.[22] Apparently, deviations from equilibrium levels for narrow and broad money velocity or, more precisely, deviations from equilibrium nominal GDP, usually are closely related. Based on the superior results for broad money in Table 4 and the close coherence of the broad and narrow gaps, only the broad money-based domestic gaps are used in the discussion of the open economy model.

Calculating An Appropriate Foreign-Based Price Gap

To examine the German influence on each of the five small European countries, the foreign (German) gap is defined as

$$(12)\quad GAP^f = [p^d - (p^{f*} + e - er^*)].$$

To compute this price gap, however, one needs a measure of the equilibrium value of the real exchange rate (er^*).[23] Two alternative measures of the equilibrium real exchange rate are presented here. The first measure assumes that the equilibrium real exchange rate is a constant, which is equivalent to assuming that purchasing power parity (PPP) holds in the long run. The second measure is based on using the Hodrick-Prescott filter to find the equilibrium component of the real exchange rate. This measure is less restrictive and more consistent with the data, but the other assumption, the PPP-based measure, has strong theoretical appeal.[24]

PPP-Based Measures

Suppose that each real exchange rate is stationary and converges to a constant long-run equilibrium level.[25] Then, the gap with this constant, equilibrium real exchange rate removed is

$$(12')\quad GAP^{f1} = [p^d - (p^{f*} + e)].$$

This gap is consistent with the pure theory of the monetary approach to the balance of payments.[26] As could be expected, however, this gap is generally nonstationary. Relevant ADF test results are shown in the first column of Table 5. This gap measure is generally not the preferred specification because the statistical

[21]Hoeller and Poret (1991) also report that the domestic P-star model is rejected for Austria and the Netherlands when the Hodrick-Prescott filter is used, but not when linear trends are used to find equilibrium output and velocity. Their study uses semiannual data and, for the seven countries examined here, uses sample periods beginning in 1962 for the United States, 1963 for the Netherlands, 1964 for Denmark, 1969 for Austria and Germany, 1971 for Belgium and 1973 for Switzerland. The last data point is in 1989 in each country. Their results also differ in choosing the monetary aggregates used for each country based on each country's target. These are generally broad measures, but not necessarily the broad measure used here.

[22]The correlation coefficient for the U.S. broad-money and narrow-money-based price gaps is 0.74 and that for the German broad-and narrow-based price gaps is 0.71. The correlations of the gaps based on narrow and broad domestic monetary aggregates are 0.79 in Belgium and Switzerland, and 0.83 in Denmark. In the Netherlands, this correlation is only 0.25 and in Austria it is only 0.09; neither of these is statistically significant at a 5 percent level.

[23]For an analysis of the U.S. impact on the six European countries, see the appendix to this article.

[24]A third measure was also investigated. It assumes that the measured real exchange rate is always the equilibrium value, so that all changes in the real exchange rate are permanent. With this measure, the foreign-based price gap is Germany's domestic price gap, which is stationary (see Table 3). The inflation model using this real exchange rate assumption is consistently dominated by the fit of the model using the Hodrick-Prescott filtered real exchange rates.

[25]Although the analysis above and the evidence in Figure 2 suggest this assumption is incorrect, it provides a convenient and insightful benchmark. Tatom (1992) uses this assumption for Austria; the constant level of the exchange rate is also removed from the foreign gap measures, so that Austrian prices are hypothesized to equal a German P-star in equilibrium. This model is rejected, however, although Austrian inflation is found to be tied to such an equilibrium German inflation measure. These results could arise from ignoring the effects of real exchange rate movements on the level of prices, but the same results—the absence of a tie of the level of prices to an equilibrium level, but a strong tie of inflation to an equilibrium inflation rate—occur for a German money (M3)-based P-star measure and German prices.

[26]For recent discussions of the evidence against PPP, see Coughlin and Koedijk (1990), Dueker (1993) and Huizinga (1987).

Table 4
Short-Run Inflation Equations Including Own Price Gaps

Country	C	$\Delta\pi_{-1}$	π_{-1}	$GAP^1{}_{-1}$	$GAP^2{}_{-1}$	$\bar{R}^2$	SEE	LM (4)	CHOW (77)	Last Period
Austria	1.40	—	−0.32	−7.78	—	0.137	1.242	0.71	0.76	92
	(2.21)		(2.41)	(1.24)						
	1.23	—	−0.28	—	−24.17	0.221	1.180	0.64	2.29	92
	(2.05)		(2.23)		(2.17)					
Belgium	1.23	—	−0.25	−14.41	—	0.148	1.610	0.89	0.75	91
	(1.84)		(2.01)	(1.41)						
	1.36	—	−0.27	—	−35.29	0.355	1.400	1.53	2.52	91
	(2.38)		(2.59)		(3.36)					
Denmark	−0.06	—	—	−11.36	—	0.111	1.381	0.53	0.72	91
	(0.26)			(2.15)						
	−0.06	—	—	—	−6.48	0.014	1.454	0.27	1.01	91
	(0.22)				(1.19)					
Germany	1.55	0.33	−0.39	−10.28	—	0.260	1.069	0.46	1.36	91
	(2.78)	(1.89)	(2.92)	(1.86)						
	1.26	—	−0.32	—	−29.01	0.511	0.860	2.57	2.36	91
	(3.02)		(3.22)		(4.82)					
Netherlands	0.82	—	−0.19	−11.18	—	0.080	1.775	0.43	1.98	92
	(1.29)		(1.71)	(1.32)						
	0.80	—	−0.19	—	−42.34	0.242	1.612	0.61	5.43*	92
	(1.40)		(1.86)		(2.84)					
Switzerland	1.87	—	−0.44	−12.83	—	0.333	1.653	3.13*	1.07	92
	(2.64)		(3.05)	(2.71)						
	2.12	—	−0.50	—	−20.28	0.523	1.400	0.89	0.78	92
	(3.53)		(4.09)		(4.63)					
United States	0.07	—	—	−21.12	—	0.349	1.027	0.40	1.46	92
	(0.40)			(4.13)						
	0.01	—	—	—	−21.00	0.408	0.978	0.68	1.58	92
	(0.04)				(4.66)					

Notes: LM (4) is a Breusch-Godfrey test on serial correlation of the residuals using four lags of the residual; it has a $\chi^2(4)$ distribution. CHOW (77) is a test on parameter stability with the break point in 1977; it follows an F-distribution.

evidence rejects the hypothesis that domestic prices have a long-run relationship to this measure of the foreign-determined, equilibrium price level. The irrelevance of this measure, except for Denmark, is consistent with the evidence for real exchange rates in Table 1, which indicates that the real exchange rate is nonstationary in all cases except for Denmark.

Equilibrium Real Exchange Rates from the Hodrick-Prescott Filter

The second alternative explicitly tries to find a statistical estimate for the time path of the equilibrium real exchange rate. To this end, we write the real exchange rate as

$$(13) \quad er = e + p^f - p^d = er^* + u,$$

where u is a stationary, unobservable error term. In this case, the actual real exchange rate is equal to its long-run value (er^*) plus a transitory deviation. Neither er^* nor u are observable. It is possible, however, to obtain an estimate of the equilibrium component of the real exchange rate, er^*, again using the Hodrick-Prescott filter. This equilibrium component, $\hat{er}^*$, is substituted into equation 8 to obtain:

$$(12'') \quad GAP^{f2} = [p^d - (p^{f*} + e - \hat{er}^*)].$$

The second column of Table 5 shows this gap to be stationary at the 5 percent level for Aus-

tria, Belgium, Denmark and the Netherlands. For Switzerland, a unit root can be rejected only at the 10 percent level.[27]

A Comparison of Alternative Foreign Gap Measures

To compare the alternative measures of the foreign-determined domestic price gap, labeled GAP^{f1}, and GAP^{f2}, respectively, equation 4 is reestimated with each of these gaps replacing the domestic gap. Table 6 contains the coefficient on the gap, the absolute value of its *t*-statistic in parentheses, and the adjusted *R*-squared of the equation in square brackets.[28] GAP^{f1} is only relevant for Denmark, where its stationarity and that of the real exchange rate are supported by the data; nevertheless, this gap has been included as a benchmark for the other countries as well. All coefficients in Table 6 are of the correct sign. Judged both by significance and the amount of explanatory power, GAP^{f2} outperforms the other measure, except in Denmark, where GAP^{f1} is better.

Table 7 similarly contains results for regressions with both the domestic price gap and the German-based price gap included. The dynamic specifications are the same as those in Tables 4 and 6.[29] In Austria, the comparison of explanatory power favors GAP^{f1} slightly, but GAP^{f1} is nonstationary and, judged by the most relevant comparison of performance shown in Table 6, GAP^{f2} again has more explanatory power. Overall, the evidence suggests that GAP^{f2} is the preferred measure for both empirical and theoretical reasons, except in Denmark, where GAP^{f1} is preferred. These gaps are shown in Figure 3 along with the domestic price gaps based on the broad money aggregate.

Table 5

ADF Unit Root Results: Price Gaps Relative to Germany (only MB)

Country	GAP^{f1}	GAP^{f2}
Austria	−1.52	−3.01*
	(C,1)	(C,1)
Belgium	−2.44	−3.36*
	(T,0)	(C,1)
Denmark	−3.72*	−3.60*
	(C,1)	(C,1)
Netherlands	−1.44	−3.02*
	(C,0)	(C,1)
Switzerland	−0.75	−2.72
	(C,0)	(C,0)

Note: The entries show the relevant test statistic; the information in parentheses indicates the use of a constant only, C, or a constant and trend, T, followed by the number of lagged dependent variables included. For the longest sample period used, the 5 percent significance level critical values are −3.57 and −2.96, with and without the inclusion of a trend, respectively.

The Impact of Foreign-Based Price Gaps

Table 8 restates the results of estimating equation 4 using the most appropriate foreign price gap for each country. For each of the five, small, European countries, Table 8 contains an equation with only the German-based gap included (from Table 6) and an equation with both the domestic gap and the German-based gap (from Table 7).

Comparing the results of Tables 4 and 8, a number of findings emerge:

[27]When linear trends are used to find equilibrium real exchange rates, output and velocity, the foreign-based gaps are not stationary, indicating that this approach to deriving the foreign-based P-star measure is inappropriate.

[28]The dynamic specifications used for the results reported in Table 6 follow those used in Table 4, although different specifications could have been used in two cases without changing the qualitative results. For Denmark, the lag of inflation is statistically significant at a 10 percent level ($t = -1.83$) when GAP^{f2} is used, but it is omitted in Table 6 to facilitate comparison to the GAP^{f1} case and to the Table 4 results. When this term is included using GAP^{f1} and GAP^{f2}, the comparable adjusted-R^2 are 0.266 and 0.240, respectively. For Switzerland, adding the first lagged dependent variable is statistically significant with either foreign gap; in this case, the adjusted-R^2 is 0.386 and 0.616 for GAP^{f1} and GAP^{f2}, respectively.

[29]For the Swiss equation, using GAP^{f1}, a lagged dependent variable is significant at a 10 perent level ($t = 1.85$), but it is omitted in the table to facilitate comparison with the equation containing the second foreign gap measure in which the lagged dependent variable is not statistically significant. When this lagged dependent variable is included with each foreign gap measure, the relevant adjusted-R^2 is 0.624 for the first foreign gap measure and 0.680 for the second foreign gap measure, so the comparison of the two remains unaffected.

Table 6

Comparison of the Impact of Two German-Based Price Gaps

	GAP^{f1}	GAP^{f2}
Austria	−11.07	−19.64
	(3.86)	(3.91)
	[0.406]	[0.411]
Belgium	−2.15	−24.02
	(0.58)	(3.52)
	[0.097]	[0.373]
Denmark	−16.73	−18.89
	(3.00)	(2.68)
	[0.216]	[0.176]
Netherlands	−10.73	−27.79
	(2.21)	(3.23)
	[0.168]	[0.288]
Switzerland	−4.52	−27.29
	(2.32)	(5.35)
	[0.293]	[0.583]

Note: In each cell, the top entry is the coefficient for the gap, the middle entry is the absolute value of the *t*-statistic and the $\bar{R}^2$ is the lowest entry given in brackets.

Table 7

Comparison of the Impact of Two German-Based Price Gaps, including Own Price Gap

	GAP^2	GAP^{f1}	GAP^2	GAP^{f2}
Austria	−14.15	−9.81	−13.18	−17.39
	(1.41)	(3.32)	(1.30)	(3.31)
	[0.427]		[0.425]	
Belgium	−35.67	−2.62	−30.19	−20.80
	(3.37)	(0.83)	(3.39)	(3.54)
	[0.348]		[0.548]	
Denmark	−11.06	−20.08	−10.40	−22.53
	(2.38)	(3.75)	(2.16)	(3.29)
	[0.328]		[0.271]	
Netherlands	−35.79	−7.83	−24.72	−20.07
	(2.39)	(1.68)	(1.49)	(2.03)
	[0.288]		[0.318]	
Switzerland	−18.96	−3.58	−11.81	−19.19
	(4.64)	(2.40)	(2.66)	(3.47)
	[0.592]		[0.658]	

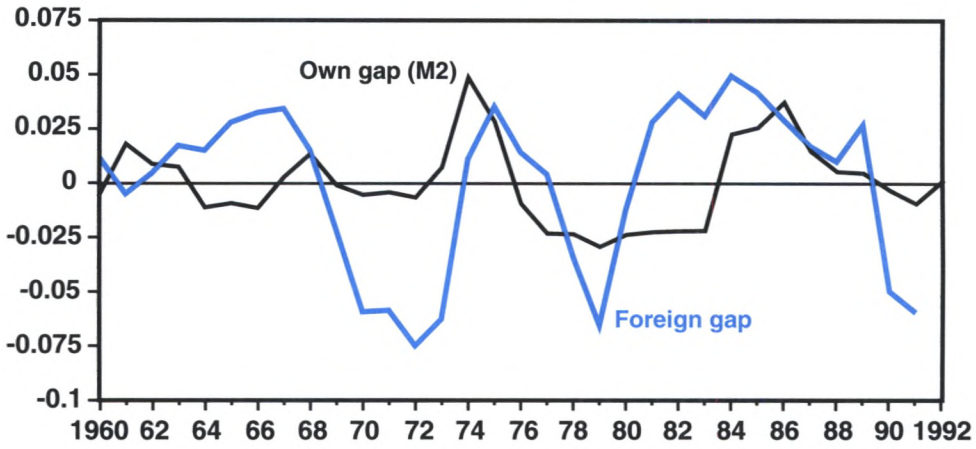
- The German-based gap provides greater explanatory power than the country's own domestic price gap when each is considered alone.
- Table 8 indicates that adding the German-based gap to a specification already containing the domestic gap (Table 4), on the other hand, always leads to a statistically significant improvement in the inflation model.
- In the case of Denmark, the addition of the foreign gap means the difference between rejecting the P-star model and not doing so. The closed economy model rejects the P-star model in Denmark, but the open economy model does not.
- Adding the domestic gap to the specification already containing the German-based gap leads to a significant improvement in the cases of Belgium, Denmark and Switzerland.
- Overall, the results are supportive of the hypothesis that the domestic price gap is of little importance under a regime of fixed exchange rates, but that, instead, current inflation developments at home are determined by monetary conditions abroad.[30]

A comparison across countries reinforces these conclusions. Austria, for instance, has been most closely linked to Germany over most of the sample, followed by the Netherlands. Consequently, no significant additional information is provided by their own domestic price gap, once account has been taken of Germany's impact. For Belgium and Denmark, on the other hand, both the domestic price gap and the German-based price gap are im-

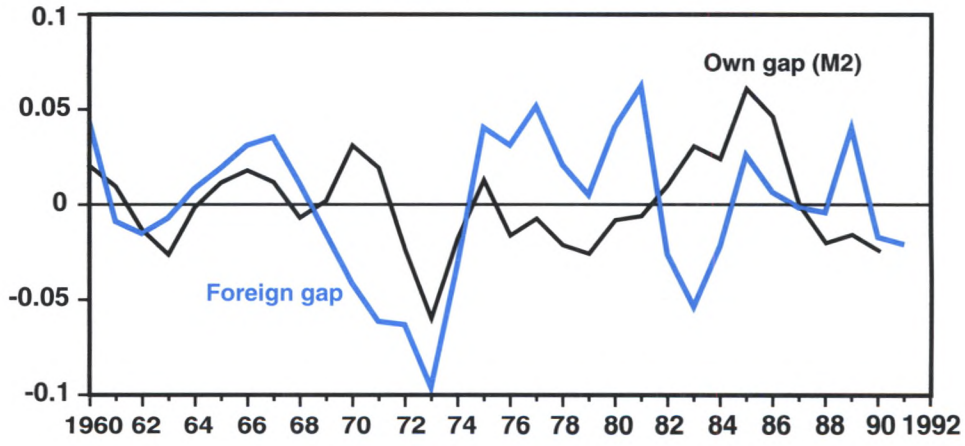
[30]The appendix shows that U.S.-based price gaps have had little impact on European inflation developments over the sample, regardless of the measure used. This provides additional support for our hypothesis that the exchange rate regime determines which price gaps are relevant, that is, to what "equilibrium" measure of prices, foreign or domestic, will actual domestic prices converge. Under floating rates, it should be domestic price gaps that matter, while under fixed rates, the foreign influence will increase. It is true that for a few years early in the period studied here, all these countries were pegged to the dollar, but the P-star influence of U.S. prices due to this experience is not statistically significant. Presumably, the period of the dollar peg in this sample is too brief for the dollar-based gap to be significant.

Figure 3
Domestic and Foreign-Based Price Gaps

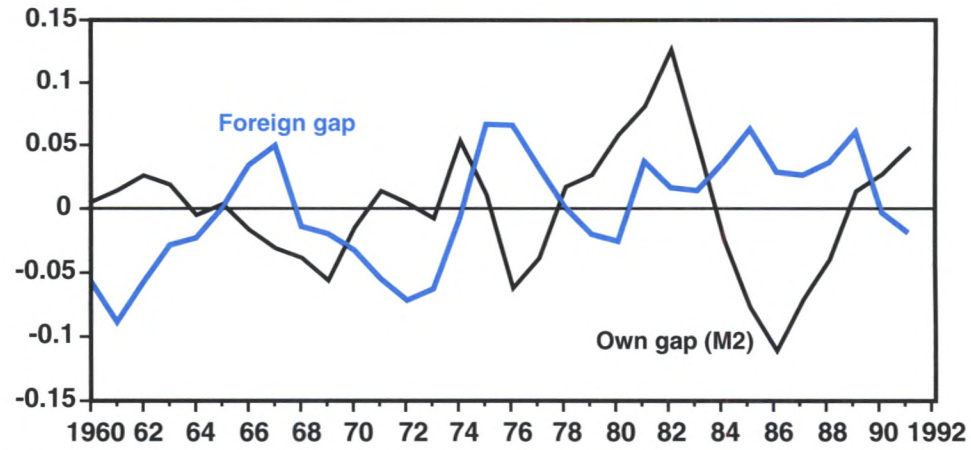
Austria



Belgium

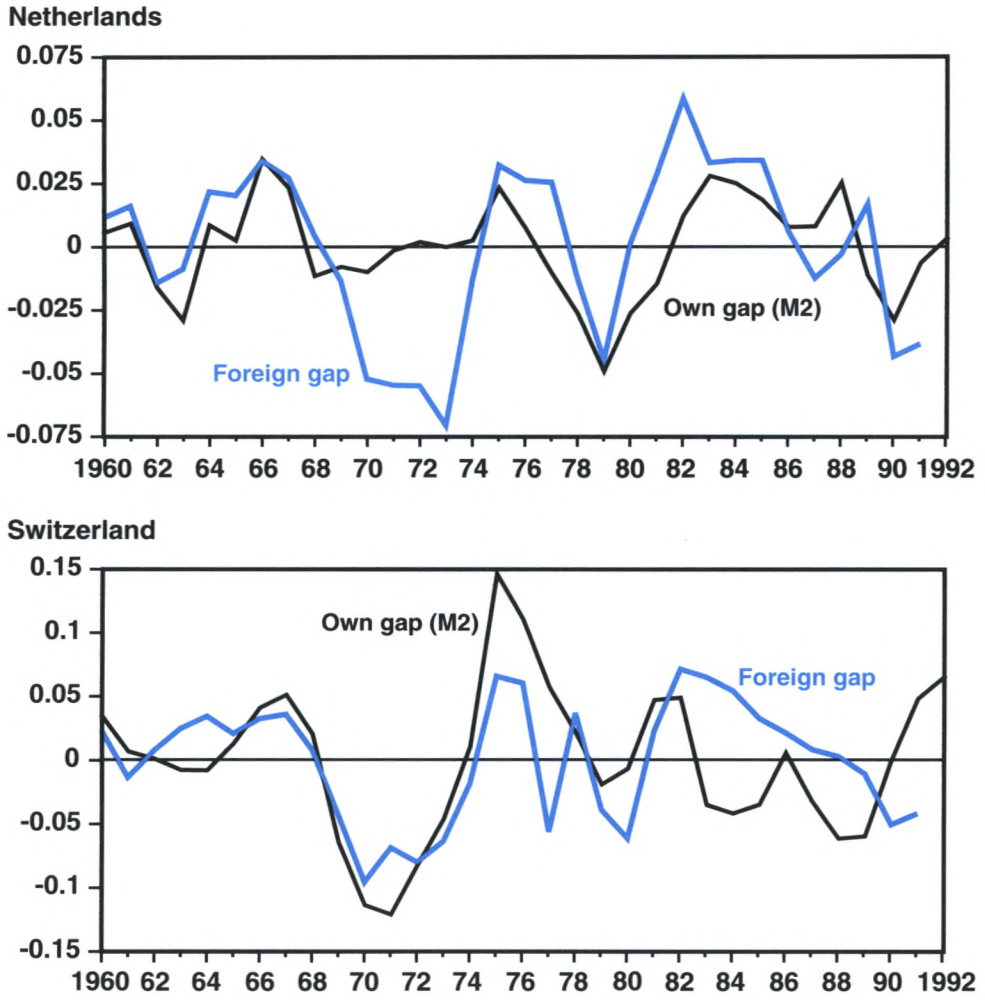


Denmark*



*The average value of the log of the real mark exchange rate for Denmark was added to the foreign gap.

Figure 3 (continued)



portant. This may reflect the difficulties these two countries have experienced during the '70s and '80s in keeping their currencies' values and their inflation rates in line with Germany's. By infrequent devaluations, they have allowed their own monetary policy—and related domestic price gaps—to affect domestic inflation. Through their continued efforts to converge to German inflation levels over time, however, German price gaps have mattered as well.

The most interesting set of results is for Switzerland. In contrast with the other four small European countries under consideration, Switzerland has followed a floating exchange rate policy since the breakdown of Bretton Woods. As a result, the impact of German-based price gaps should be insignificant, according to the hypothesis. Our estimates, however, suggest that the German-based price gap has dominated the domestic Swiss gap in the sense that the former has more explanatory power, considered alone, than the latter.

Although far from conclusive, there are some possible reasons for this apparent anomaly. First, monetary policies in Switzerland and Germany have been quite similar during much of the sample period. Both countries faced similar inflationary pressures towards the end of Bretton

Table 8

Short-Run Inflation Equations Including a German-Based Price Gap

Country	C	π_{-1}	GAP^{2}_{-1}	GAP^{f2}_{-1}	$\bar{R}^2$	SEE	LM (4)	CHOW (77)	Last period
Austria	1.72	−0.39	—	−19.64	0.411	1.026	1.50	1.33	92
	(3.24)	(3.52)		(3.91)					
	1.62	−0.37	−13.18	−17.39	0.425	1.014	1.15	1.83	92
	(3.06)	(3.33)	(1.30)	(3.31)					
Belgium	1.46	−0.30	—	−24.02	0.373	1.381	0.77	3.05*	91
	(2.59)	(2.84)		(3.52)					
	1.45	−0.29	−30.19	−20.80	0.548	1.172	1.61	1.33	91
	(3.01)	(3.32)	(3.39)	(3.54)					
Denmark	−22.06	—	—	−16.73	0.216	1.296	1.73	0.34	91
	(3.01)			(3.00)					
	−26.48	—	−11.06	−20.08	0.328	1.200	1.96	0.44	91
	(3.76)		(2.38)	(3.75)					
Netherlands	1.00	−0.23	—	−27.79	0.288	1.562	0.78	1.94	92
	(1.78)	(2.30)		(3.23)					
	0.94	−0.22	−24.72	−20.07	0.318	1.529	0.34	2.78	92
	(1.71)	(2.23)	(1.49)	(2.03)					
Switzerland	2.42	−0.55	—	−27.29	0.583	1.306	1.49	0.83	92
	(4.27)	(4.83)		(5.35)					
	2.38	−0.55	−11.81	−19.19	0.658	1.184	1.39	0.52	92
	(4.63)	(5.31)	(2.66)	(3.47)					

Notes: For Denmark, the foreign gap used is GAP^{f1} instead of GAP^{f2}. LM (4) is a Breusch-Godfrey test on serial correlation of the residuals using four lags of the residual; it has a $\chi^2(4)$ distribution. CHOW (77) is a test on parameter stability with the break point in 1977; it follows an F-distribution.

Woods, and implemented similar monetary targeting policies in the mid-'70s to reduce inflation. Second, the Swiss franc and the German mark have been attractive—and closely substitutable—investment currencies in international portfolios. The Swiss results could also be interpreted as stemming from close coordination of monetary policies under floating exchange rates.[31]

Similar tests were conducted for the United States and German domestic P-star models to examine the power of the tests of the significance of foreign gaps reported here. In particular, foreign gaps constructed like the gap measure GAP^{f2}, using the five European countries, were constructed and added to the domestic P-star model for the United States and Germany. Also, a German-based gap was added to the domestic P-star model for the United States. In no case was one of the foreign gap terms statistically significant in the domestic model for the United States or Germany. This strengthens the evidence that in floating countries the appropriate P-star model is a domestic one, while the domestic P-star is determined by the anchor country in a fixed rate regime.

SUMMARY AND CONCLUSION

The systematic link between domestic money and the general level of prices is central to the P-star model, which emphasizes this long-run

[31]This is not equivalent to fixing nominal exchange rates, as evidenced by the appreciation of the Swiss franc during the time period considered (see Figures 1 and 2).

relationship as a determinant of short-run movements in the level of prices and inflation. Monetary authorities in countries with fixed exchange rate regimes do not determine their own long-run level of prices, however. Instead, their long-run equilibrium price level is imported from the countries whose currency is the basis of the peg. To varying degrees five, small open European countries have pegged their currency to the German mark. Economic theory suggests that, to the degree they did so, these countries' long-run equilibrium price levels and their inflation rates should be dominated by the German price developments, which, in turn, are presumably controlled by the Bundesbank. An open economy model of inflation in countries with fixed exchange rates must take into account the external basis of the equilibrium price level.

This article develops such a P-star model for domestic prices from 1960 to the 1990s in five European countries: Austria, Belgium, Denmark, the Netherlands and Switzerland. These economies border Germany and have, to varying degrees, fixed their domestic exchange rates based on a peg to the German mark. The evidence presented here shows that the open economy, fixed exchange rate P-star model is not rejected for the countries considered. The inflation model's fit improves for all five countries when allowance is made for the statistically significant foreign (German) influence on equilibrium domestic price levels during fixed exchange rate periods.

Perhaps the best example is Denmark, where the domestic P-star model is rejected. In the open economy model, however, the broad money-based domestic gap and the German P-star-based gap are both highly significant and with the correct sign, showing the importance of accounting for the foreign influence. Two other countries in which the domestic gap is significant in tests of the open economy model are Belgium, the other intermediate case, and Switzerland. In Austria and the Netherlands, where currencies have been most tightly pegged to the mark, the German-based P-star model outperforms the respective domestic models and, when included with the domestic gap, the domestic gap is not statistically significant.

Overall, the results confirm the long-run link between monetary aggregates and domestic prices for both closed or large, flexible exchange rate countries, as well as for fixed exchange rate countries. In the latter case, however, the evidence shows that the long-run equilibrium price level toward which domestic prices adjust is determined by foreign monetary policy.

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Appendix
Are European Prices Influenced By U.S. Monetary Policy?

The analysis in the text focuses on the connections between Germany and a number of small European countries with strong ties to Germany. A similar analysis can, of course, be applied to the United States in relation to the six European countries. Our maintained hypothesis suggests that under the floating exchange rate regime for the U.S. dollar over most of the period, European countries should have been insulated from inflationary or deflationary pressures arising from the United States. For the '60s and early '70s, on the other hand, U.S.-determined price gaps should have influenced Europe, because the United States was the anchor country in the fixed exchange rate system of Bretton Woods.

Figure 1 shows, however, that the relevant Bretton Woods period in our sample has been too short to perform a meaningful test of the significance of U.S.-determined gaps. Our regressions start in 1962 or 1963, depending on the lags included, and nominal exchange rates start moving in 1967-68, thereby reducing the potential impact of U.S. monetary conditions abroad. Thus, for our sample, we do not expect coefficients on U.S.-determined gaps to be significantly different from zero.

Table A1

ADF Unit Root Results: Price Gaps Relative to U.S. (only MB)

Country	GAP^{f1}	GAP^{f2}
Austria	−2.70 (T,1)	−3.35* (C,1)
Belgium	−2.67 (C,1)	−3.46* (C,1)
Denmark	−1.94 (C,1)	−3.32* (C,1)
Germany	−1.83 (C,1)	−3.43* (C,1)
Netherlands	−1.56 (C,1)	−3.08* (C,1)
Switzerland	−0.77 (C,0)	−3.20* (C,1)

Note: For the longest sample period used, the 5 percent significance level critical values are −3.56 and −2.96, with and without the inclusion of a trend, respectively.

First, we present test statistics on the stationarity of the relevant gap variables in Table A1. Gap definitions are similar to those in the main text, with Germany replaced by the United States. The results are very close to those in Table 5, where unit root statistics for German-based gaps are displayed. GAP^{f1} is nonstationary, while GAP^{f2} is stationary. Tables A2 and A3 are comparable to Tables 6 and 7, respectively, and have the same layout. Estimated gap coefficients are generally small in magnitude and insignificant. Only for Belgium are small significant coefficients found for GAP^{f1} and GAP^{f2} in Table A3. Overall, the evidence rejects a link from U.S. monetary conditions to inflationary pressures in Europe. This supports our hypothesis.

To address the issue of the potential impact of the United States on other countries during the Bretton Woods period adequately, a longer sample going back to the early '50s or late '40s would be required. This is left for future research.

Table A2

Comparison of the Impact of Two U.S.-Based Price Gaps

Country	GAP^{f1}	GAP^{f2}
Austria	−0.13	−0.63
	(0.13)	(0.30)
	[0.09]	[0.09]
Belgium	0.21	0.12
	(0.14)	(0.05)
	[0.09]	[0.09]
Denmark	−1.04	0.42
	(0.91)	(0.18)
	[−0.01]	[−0.03]
Germany[1]	−0.27	−1.04
	(0.27)	(0.56)
	[0.16]	[0.17]
Netherlands	−0.74	0.59
	(0.57)	(0.20)
	[0.03]	[0.02]
Switzerland[1]	−1.39	−3.35
	(1.41)	(1.25)
	[0.28]	[0.27]

[1]The specification includes a statistically significant lagged dependent variable which was not significant and not included in that used in Table 4.

Table A3

Comparison of the Impact of Two U.S.-Based Price Gaps, Including Own Price Gap

Country	GAP^{2}	GAP^{f1}	GAP^{2}	GAP^{f2}
Austria	−25.67	−0.57	−27.86	−2.12
	(2.23)	(0.61)	(2.39)	(1.04)
		[0.20]		[0.22]
Belgium	−51.63	−3.53	−53.83	−5.71
	(4.34)	(2.37)	(4.57)	(2.65)
		[0.45]		[0.47]
Denmark	−5.71	−0.79	−7.72	1.52
	(1.02)	(0.68)	(1.32)	(0.62)
		[0.00]		[−0.01]
Germany	−29.97	−0.80	−30.60	−2.44
	(4.95)	(1.08)	(5.23)	(1.79)
		[0.51]		[0.55]
Netherlands	−50.40	−1.96	−54.13	−4.14
	(3.31)	(1.68)	(3.20)	(1.40)
		[0.29]		[0.27]
Switzerland	−19.51	−0.67	−21.80	1.64
	(4.34)	(0.85)	(4.38)	(0.67)
		[0.52]		[0.51]

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Is the Discount Window Necessary? A Penn Central Perspective

IN RECENT YEARS, ECONOMISTS have come to question the desirability of granting banks the privilege of borrowing from the Federal Reserve's discount window. The discount window's detractors cite several disadvantages. First, the Fed's control over high-powered money can be hampered. If bank borrowing behavior is hard to predict, open market operations cannot perfectly peg high-powered money, which some economists believe the Fed should do. Second, there are microeconomic concerns about potential abuse of the discount window (Schwartz, 1992). Critics argue that the discount window has been misused as a transfer scheme to bail out (or postpone the failure of) troubled or insolvent financial institutions that should be closed quickly to prevent desperate acts of fraud or excess risk taking by bank management. In response to growing criticism of Fed lending to prop up failing banks, Congress mandated limits on discount lending to distressed banks, which went into effect on December 19, 1993.

Some economists (Goodfriend and King, 1988; Bordo, 1990; Kaufman, 1991, 1992; and Schwartz, 1992) have argued that there is no gain from allowing the Fed to lend through the discount window. These critics argue that open market operations can accomplish all legitimate policy goals without resort to Federal Reserve lending to banks. Clearly, if the only policy goal is to peg the supply of high-powered money, open market operations are a sufficient tool. Similarly, the Fed could peg interest rates on traded securities by purchasing or selling them. Any argument for a possible role for the discount window must demonstrate that pegging the aggregate level of reserves in the economy, or controlling the riskless interest rate on traded securities, is insufficient to accomplish a legitimate policy objective that can be accomplished through Fed discounting.

In this article, I examine theoretical assumptions that may justify the existence of the discount window. I argue that there is little current

role for the discount window to protect against bank panics. The main role of the discount window is in defusing disruptive liquidity crises that occur in particular *nonbank* financial markets. I discuss evidence from the Penn Central crisis of 1970, which seems consistent with that view, and conclude by considering whether this evidence is relevant for today's relatively sophisticated financial environment.

Backup protection for financial markets through the discount window could be achieved at little cost if access to the discount window were confined to periods of financial disruption. During normal times, open market operations and interbank lending would be sufficient for determining the aggregate amount of reserves in the banking system and their allocation among banks.

A first step toward envisioning a role for any financial institution or policy instrument, including the discount window, must be the relaxation of the assumptions of zero physical costs of transacting and/or symmetric information. The discount window's benefit, if any, must be related to its role in helping to economize on costs in capital markets, which themselves are a function of physical or informational "imperfections." I divide the discussion of potential justifications for the discount window into two parts—assistance to financial intermediaries and assistance to particular financial markets.

THE DISCOUNT WINDOW AND BANKING PANICS

The Federal Reserve System was created in 1913 with three primary objectives: to eliminate the "pyramiding" of reserves in New York City and replace it with a polycentric system of 12 reserve banks; to create a more seasonally elastic supply of bank credit; and to reduce the propensity for banking panics. The discount window was the primary mechanism for achieving these goals. The 12 regional Federal Reserve Banks offered an alternative to the private interbank deposit market as depositories of bank reserves. The architects of the Fed expected to eliminate reserve "pyramiding," which channeled interbank deposits to New York, where they often were used to finance securities market transactions (White, 1983). Interbank lending was viewed by some as a problem because it encouraged dependency of the nation's banks on New York bankers and placed funds into the hands of securities market speculators.

The discount window also promised to reduce the seasonal volatility of interest rates and increase the seasonal elasticity of bank lending by providing an elastic supply of reserves, allowing bank balance sheets to expand seasonally without increasing the loan-to-asset ratio. Prior to the creation of the Fed, bank expansion of loans in peak seasons led to costly increases in portfolio risk (a higher loan-to-asset ratio), or costly seasonal importation of specie. This implied an upward sloping loan supply function with large interest rate variation over the seasonal cycle (Miron, 1986; Calomiris and Hubbard, 1989; and Calomiris and Gorton, 1991).

Finally, the availability of the discount window was also expected to reduce the risk of bank panics in two ways. First, by increasing the availability of reserves, the discount window limited seasonal increases in portfolio risk and reductions in bank liquidity during high-lending months, thus reducing the risk of panics. Second, the discount window would provide a source of liquidity to banks if an unpredictable withdrawal of deposits in the form of currency created a shortage of reserves that threatened the liquidity of the banking system (as in Diamond and Dybvig, 1983).[1] But the discount window offered limited protection to banks from a panic induced by adverse economic news. Because access to the discount window was

[1]If money-demand disturbances were the cause of banking panics, as envisioned in Diamond and Dybvig (1983), then open market operations, as normally defined, would be a sufficient tool for policy if the central bank were permitted to purchase bank loans. Since bank loans are not "special" in that framework (that is, there is no delegated control and monitoring function performed by the banker and, hence, no potential for adverse selection or moral hazard), it is natural to think of standard open market operations as including purchases of bank debt in the context of that model. If, however, banking panics are produced by confusion over the incidence of shocks to the value of bank assets, as argued in Calomiris and Gorton (1991), and if banks have special information about their portfolios, then a government policy of purchasing bank loans during a crisis at pre-panic prices would have the same costs and benefits as allowing banks access to the discount window.

limited by strict collateral requirements, bank borrowing was limited to the amount of eligible collateral the bank possessed.[2] Thus, Federal Reserve Banks could not use the discount window to shore up banks if their depositors lost confidence in the quality of the bank's illiquid loan portfolio. The collateral required for discount window lending was subsequently broadened in the 1930s.

The history of the pre-Fed era suggests that the early limitations on discount window lending were important. Gorton (1989), Calomiris and Gorton (1991), and Calomiris and Schweikart (1991) have argued that sudden withdrawals from the banking system occurred when depositors received news about the state of the economy that was bad enough to make them think that some banks were insolvent. Because depositors were uninformed about the incidence of this disturbance across individual banks (because of depositors' limited information about bank portfolios) all banks' depositors had an incentive to withdraw funds from their banks until they could better ascertain the risks of individual banks. Thus, relatively small aggregate insolvency risk could have large costs through disintermediation from banks.

Costs associated with banking panics can motivate a more aggressive policy than one requiring riskless collateral for all central bank lending. The central bank could provide loans to the banking system on illiquid collateral to offset the temporary withdrawal of depositors' funds. The rationale for this intervention lies in informational externalities caused by panics. Banking panics create negative externalities among banks and their customers. Banks whose assets have not declined in value, and their borrowers and depositors, suffer because of the confusion over whether they are among the banks holding low-value assets. The banks lose business, the borrowers lose access to credit, and the depositors lose interest and pay transaction costs of transferring funds out of the banking system. Banks and their borrowers benefit by keeping the banking system from shrinking.

If bank credits and deposits play special roles in financing and clearing transactions, then contractions in bank activity will be costly. The discount window can be thought of as a way to coordinate a mutually beneficial decision among depositors not to withdraw their deposits during panics. Removing the private incentive for depositors to withdraw their funds makes all depositors better off. While private deposits fall, public "deposits" made through the discount window (the indirect assets of the public) rise to compensate. Open market operations would not be an adequate substitute policy. Open market operations would simply insulate the money supply from the reduction in the money multiplier as bank deposits and bank credit fell; they would not reduce withdrawals from banks.

Thus, one could argue for central bank adoption of the following rule for use of a "backup" discount window: Under normal circumstances (when there is no general systemic banking panic reducing private deposits in banks), the central bank provides no loans to banks. During a systemic crisis, the central bank agrees to provide loans to banks up to the amount of depositor withdrawals (at an interest rate that fairly compensates the government for the default risk of the average bank). Such crisis loans must be short-term and paid in full after the crisis passes (which, if history is any guide, should be no longer than two months). The government might increase the interest rate it charges on loans to banks over time to encourage them to assist in resolving the information asymmetry more quickly (for example, by sharing information about themselves and one another). The central bank might even charge a fee to banks ex post as a function of actual losses, to further encourage good banks to bring the crisis to a

[2]These limitations were eliminated in the 1930s. For a discussion of changing collateral requirements on Fed lending, see Friedman and Schwartz (1963, pp. 190–5). Note that lending from the Fed, even on riskless collateral, can provide special assistance to banks (up to the amount of their riskless collateral) because the Fed enjoys a special right to "jump the queue" of debt seniority. By taking the best assets of the bank as collateral, the Fed effectively subordinates existing debt claims. Private creditors would not be able to do so and, thus, would not be able to lend to the bank on the riskless collateral.

speedy conclusion.[3] As deposits return to the banks, they would use them to repay the government loans. Banks that fail to attract depositors (relative to other banks) as the crisis draws to a close would be denied continuing access to credit and would be allowed to fail.

In principle, banks might be able to prevent panics by pooling resources privately without any intervention by the central bank. If the banking system were able to allocate funds to insure against banking panics by agreeing to treat deposits as a collective liability of all banks during a systemic crisis (as some groups of banks did historically), then, so long as the public was confident of the *aggregate* solvency of the banking system, there would be no threat of systemic bank runs and no need for a government-run discount window to reduce the costs of banking panics.[4] Kaufman (1991) argues that interbank markets did not operate effectively historically, but that this is no longer the case. He claims that the existence of the modern federal funds market obviates the need for the discount window during crises because open market operations, combined with interbank transfers, can funnel cash to whichever solvent banks experience large withdrawals. If banks as a group are willing to pool their government security holdings during a crisis, then Fed purchases of securities combined with interbank transfers to banks that lack sufficient government securities can keep the banking system afloat, and possibly prevent runs (if interbank insurance is credible ex ante).

Despite the existence of a delivery mechanism (the fed funds market), lending among banks during a crisis may not occur due to asymmetric information. If banks are unable to regulate and credibly monitor each other's portfolios and behavior, they will be reluctant to insure one another during a banking panic. Even though the interbank market operates quite well during normal times among most banks, it cannot necessarily be relied upon to protect the banking system from panics.

The interbank loan market can operate effectively so long as banks have adequate information about and control over each other's actions. Lending banks must be confident that borrowers are not abusing the interbank market to subsidize excessive risks or provide a bailout to insider depositors of a failed bank. Although this "incentive compatibility" requirement may be difficult to satisfy, there are many examples that show it is possible to do so. Gorton (1985, 1989), Calomiris (1989a), Calomiris and Kahn (1990, 1991), and Calomiris and Schweikart (1991) argue that information asymmetry about bank borrowers and the consequent risk of panics prompted cooperative behavior among banks historically. Coordination among banks in response to panics characterized many countries' banking systems (notably England's during the Baring Crisis of 1890, and Canada's repeatedly during the 19th and 20th centuries). But in the United States, laws limiting bank branching and consolidation effectively limited interbank cooperation. As the number of U.S. banks and their geographical isolation from one another increased, the feasibility of national cooperation was undermined. A bank's cost of monitoring and enforcing cooperative behavior rises with fragmentation, while the benefit to any bank from monitoring and enforcing declines with the number of members in the coalition (the benefit is shared by all).

Thus, the need for discount window assistance to banks is magnified by unit banking laws that make private interbank cooperation, lending and mutual insurance infeasible. Absent such regulations, the potential for costly banking panics would be substantially reduced, and the expected benefits of discount window protection of the banking system would be smaller.[5]

In closing, four points are worth noting. First, I have not assumed that the government has

[3]There must be an implied "subsidy" relative to the terms by which private lenders would be willing to lend to the bank, or else government lending cannot prevent runs. The actuarialy fair government lending will be lower than the rates banks would pay in the private market, since government intervention reduces default risk.

[4]Calomiris (1990, 1992c) argues that a nationwide branch banking system would not have experienced aggregate insolvency risk even during the worst episodes of bank failure and bank panic.

[5]See the related discussion of other countries' experiences in Bordo (1990) and Calomiris (1992a).

superior information regarding individual bank solvency—an alternative justification for government lending to banks even in noncrisis states. While such an argument can be made (based on the government's access to information by virtue of its supervisory role), the recent history of bank failures and losses, and of regulatory agencies' inabilities to anticipate, observe or prevent widespread abuse seems to argue against such a presumption. Kane (1988) argues that regulators face distorted incentives to collect and report information about banks. These incentive problems may outweigh regulators' special channels of information due to supervisory authority.

Second, discount lending can be motivated by physical transaction costs that limit interbank lending. Such physical costs mean that open market operations will have uneven effects on the supply of reserves available to different banks if the market for reserves is segmented. Although this may have been a legitimate motivation for the discount window historically, as Kaufman (1991) argues, current interbank reserve transfers are accomplished at little cost.

Third, I have not addressed the possible role of the discount window in bailing out a banking system that is insolvent as a whole. Even in a concentrated, mutually insuring banking system, interbank insurance and lending could never deal with enormous adverse asset shocks (that is, those larger than aggregate bank capital). Partial government deposit insurance (with large deductibles) for mutually insuring groups of banks can protect against this unlikely event better than wholesale bailouts through discount window "lending" (Calomiris, 1992b).

Fourth, the need for the discount window to protect the current U.S. banking system from financial panic has been substantially curtailed by deposit insurance.[6] Under the current deposit insurance system, discount window intervention would be largely redundant as protection against systemic risk. Insured depositors have little incentive to run their banks during a financial crisis. Although deposit accounts in excess of $100,000 under current law are not protected (de jure) by government deposit insurance, larger deposits may be covered if a general run on the banking system ensued. The FDIC Improvement Act (FDICIA) of 1991 establishes a formula for determining whether a systemic threat warrants the coverage of larger-denomination deposits.[7] Fed lending does retain a potentially important role in providing implicit protection for the interbank clearing system, which is discussed below.[8]

NONBANK LENDING AND THE ROLE OF THE DISCOUNT WINDOW

In an economy in which physical costs of interbank transfers are small, and interbank coordination and mutual insurance, or government deposit insurance, protects the banking system from the risk of panic, there is no additional need for the discount window to facilitate the

[6]It is beyond the scope of this article to examine all of the relative advantages of government deposit insurance or discount lending for stabilizing a fragmented (uncoordinated) banking system. Perhaps the most obvious potential advantage of discount window lending is that government intervention can be state-contingent. If a bank fails when there is no systemic panic, the bank's depositors will not be bailed out by government insurance. This reduces the moral-hazard costs of the government's "safety net." This argument for the relative desirability of the discount window as a means to insure against panics presumes that the central bank will not cave in to the political pressures of special interests to bail out banks in noncrisis times. Recent accusations by the House Banking Committee of inappropriate lending by the Federal Reserve to insolvent banks cast some doubt on the ability of current institutions to make and enforce appropriate distinctions regarding when banks should have access to the discount window (see *Business Week*, July 15, 1991, pp. 122–3). Schwartz (1992) argues that the history of the discount window is replete with such examples. Congress has mandated, and the Fed has implemented, specific new guidelines that limit Fed lending to distressed banks (*The American Banker*, August 12, 1993, pp. 1–2).

[7]Under 12 U.S.C. § 1823 (c) (4) (G) of FDICIA, for insurance to be extended to uninsured liabilities of a bank, beginning in 1995, the FDIC, the Secretary of the Treasury (in consultation with the President), and a supernumerary majority of the boards of the FDIC and the Federal Reserve, must agree that not doing so "would have serious adverse effects on economic conditions or financial stability." If uninsured deposits are covered through this provision, the insurance fund must be reimbursed through emergency special assessments. Because the nation's largest banks would end up paying a disproportionate cost of such a bailout, they would be expected to lobby against the extension of insurance to uninsured deposits, unless the criteria for assistance were truly met.

[8]The protection afforded to bank clearing houses is considered in more detail in the conclusion to this article.

operation of the banking system. But even in such an environment, problems that arise outside the banking system may motivate central bank lending through the discount window. In particular, securities markets may be vulnerable to externalities arising from asymmetric information. I will argue that these problems may be addressed effectively by channeling funds through banks that borrow from the window, rather than through direct lending from the central bank to nonbank firms.[9] The example that I will focus on is the commercial paper market "run" that followed Penn Central's 1970 bankruptcy.

As many researchers have stressed, the banking system is particularly vulnerable to confusion about the incidence of disturbances for two reasons. First, its assets (that is, bank loans) typically are not traded in centralized markets. Thus, it is difficult for an uninformed bank depositor to keep abreast of the effect of a given news item on the value of his bank's assets. Second, the fact that banks finance through large quantities of demandable debt allows nervous depositors to withdraw from the bank rather than wait to see whether their bank will survive or fail.

Although these two attributes that make banking panics possible—nontraded assets and demandable debt—seem to set the banking system apart from other markets, the banking system is just an extreme case of a much more general phenomenon. The condition necessary to generate a costly panic in a debt market is that the time horizon for rolling over debt is less than the time it takes to make accurate reappraisals of firm-specific risk during episodes of general bad news. Lenders' lack of information about the attributes of specific firms may result in the pooling of borrowers with common observable characteristics. In such circumstances, firms will face temporarily high "lemons premia" in debt and equity markets, which will increase the cost of finance and reduce investment, even for firms whose true "fundamentals" are unaffected by the bad news. Firms with short-term debts (which must be rolled over regularly) can be particularly vulnerable to systemic risk and the possibility of a run. A liquidity crisis that would prompt a general calling in of debt by creditors could lead firms with outstanding short-term debt to experience high costs of debt rollover or asset sale not experienced by other firms.

Furthermore, if intermediaries for particular markets (for example, commercial paper dealers) suffer losses from one firm's issues, they may be less able to deal in the paper of other firms. This, too, can force firms to pay higher costs for funds temporarily in the affected market, or switch to new, higher-cost sources of funds.

Firms that face liquidity problems in nonbank debt markets may have difficulty borrowing from bankers, too, particularly if they lack existing bank-lending relationships. To the extent that banks have special information about borrowers' attributes, due to their past involvement with firms and their ongoing monitoring of firm com-pliance with lending covenants, banks may be able to assist firms when their costs of funds rise in other credit markets. For firms that moved away from reliance on bank credit, however, there may be no strong banking relationship to fall back upon. Assistance from banks for these firms would be forthcoming only at higher interest rates, which would compensate banks for the transaction and information costs of drafting emergency lending arrangements. In particular, if the bank expects only a temporary relationship with the firm in need (for the duration of the "emergency"), the bank will have to charge higher interest rates to recoup its fixed costs over a shorter lending period.

Given the high cost of substituting bank credit for other credit on short notice, a credit market run may force some solvent firms into financial distress, or simply reduce their ability to invest or to lend to other firms.[10] If the social costs of such disruptions to short-term debt markets are large, Fed intervention to defuse such crises may be warranted. Specifically, the Fed could

[9]Mishkin (1991a) also argues that asymmetric information is relevant outside the banking sector. He uses data on interest rate spreads between risky and riskless debt instruments to support this view. He finds evidence of an increase in these spreads (which he interprets as reflecting an increased inability to sort borrowers according to risk) coinciding with or prior to the Penn Central crisis of 1970 and the stock market crash of 1987.

[10]Calomiris, Himmelberg and Wachtel (forthcoming) find that nonfinancial commercial paper issuers of the 1980s tended to be net lenders to other firms through accounts receivable.

supply banks with funds at low cost through the discount window for the express purpose of refinancing maturing short-term debts of firms suffering from disruption in the short-term debt market. In a competitive banking system, this subsidy would be passed on to borrowers and would mitigate high short-run costs of switching to banks for credit.

New financial markets may be particularly vulnerable to negative externalities among firms or temporary disruptions to market dealers. The lack of data on the risks and liquidity of new products, and relatively thin trading, increases the likelihood of systemic risk in new markets.

In the following section, I consider whether the commercial paper market experienced such a financial crisis in mid-1970, and whether that crisis warranted discount window intervention. The commercial paper market of mid-1970 is an especially interesting case to examine for six reasons. First, most commercial paper matured quickly—with an average maturity of under 30 days (Stigum, 1983, p. 632). This meant that a sudden disinclination by investors to hold commercial paper would entail substantial problems for firms trying to roll over their commercial paper debt.

Second, commercial paper was a new and growing method of finance during the 1960s.[11] Institutional arrangements for rating and supporting commercial paper issues were virtually nonexistent; thus, information imperfections were potentially important.

Third, commercial paper finance originated as a substitute for bank credit. Many firms that had moved to this market in the 1960s may have curtailed or terminated their relationships with commercial banks (making the disruption in the supply of paper more costly).

Fourth, during the early years of rapid growth in this market, there was a major shock to the commercial paper market, namely the failure of Penn Central in 1970, which was associated with substantial contraction of outstanding paper (that is, a "run").

Fifth, commercial paper issuers include many of the economy's largest firms, and other firms often depend upon them for credit (Calomiris, Himmelberg and Wachtel, forthcoming). Increases in the cost of funds for this class of borrowers thus may have significant second-order effects on the cost of credit for other firms.

Finally, the Fed intervened during this crisis largely by encouraging banks to come to the discount window to finance the payoff of commercial paper. Evidence from the Penn Central commercial paper crisis of 1970 allows a detailed case study of "information externalities," the potential for a run in markets for traded short-term debt, and an evaluation of Fed intervention in response to such a crisis.

Penn Central's Failure and the Liquidity Crisis of Mid-1970

The facts surrounding the commercial paper run following the Penn Central failure are commonly known (see Schadrack and Breimyer, 1970; Maisel, 1973; Timlen, 1977; Brimmer, 1989; and Mishkin, 1991a), but some important details are worth reviewing. Along with many other firms, Penn Central's financial condition deteriorated during the recession of 1969–70. Penn Central was a major issuer of commercial paper, with more than $84 million outstanding, much of which came due in June, July and August of 1970. As Penn Central's cash flow declined, its debt holders and their agents appealed to the federal government for financial assistance, which the Nixon Administration supported.

The Administration proposed a $200 million loan guarantee to a syndicate of some 70 banks, which were to provide a two-year loan in that amount. The loan guarantee would be authorized through a loose interpretation of the

[11]There had been an earlier incarnation of the commercial paper market that thrived from the 1870s and declined in importance during the 1920s. Calomiris (1992a) argues that this operated effectively as an interbank loan-sale market, moving high-quality borrowers from high credit-cost areas to low credit-cost areas. Consistent with that argument, James (1994) views the demise of this market as the result of the bank merger wave of the 1920s, which provided an alternative means to channel credit through the financial system.

Defense Production Act. Although there was increasing congressional opposition to this plan, as late as Friday, June 19, the *Wall Street Journal* reported that "the opposition doesn't yet appear strong enough to halt the $200 million loan guarantee." That article also reported the possible existence of a secret memorandum from the Federal Reserve Bank of New York, recommending "that the loan be granted, based on an investigation that bank is believed to have conducted into the credit-worthiness of Penn Central." Contrary to the *Wall Street Journal* report, no such memorandum existed, and that same Friday the Penn Central plan was rejected by Congress. The Nixon Administration then asked the Federal Reserve Board (through the New York Fed) to make a loan to Penn Central to help it meet immediate obligations. The New York Fed recommended against the loan, and it was denied. This news forced Penn Central's bankruptcy on Sunday, June 21.

The surprising news of the unwillingness of Congress and the Fed to prop up Penn Central created widespread concern over the weekend that the Penn Central failure would have repercussions elsewhere in the economy, particularly for other firms that had large outstanding commercial paper issues. It is not easy to explain this concern without invoking an "information externality" of some form. That is, one needs to explain why the bad news about Penn Central would raise doubts about other firms.

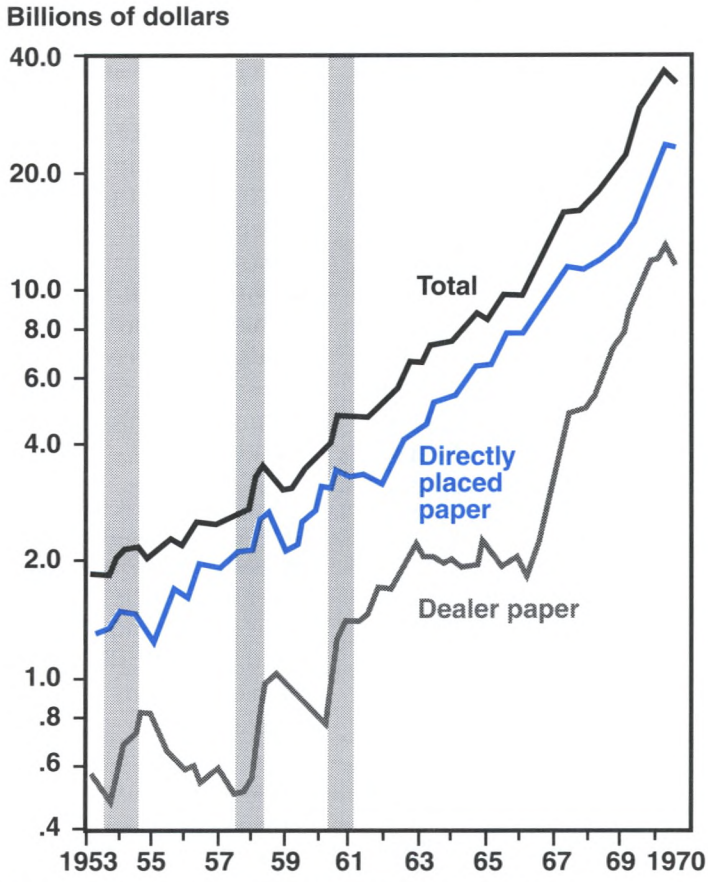
The bad news about Penn Central on June 19 had two parts. First, prior to that date, the *Wall Street Journal* reported that the New York Fed had made a favorable audit of Penn Central's underlying financial strength. After Friday, quite the opposite was known. The reaction of the market, as reported in the press, was that if Penn Central's financial state could so rapidly and unexpectedly have turned sour in the previous year, what other "blue chip" commercial paper issuers might be in the same position? This concern was fueled by the fact that the income reductions during the recession of 1969–70, which potentially affected many firms, were not known at the firm level with any precision at the time. Those concerns about other firms began to be voiced even before the revelation of the New York Fed's audit. For example, a lead article in the *Journal* on June 12 queried: "How many other U.S. corporations are so short of cash that they may soon find themselves similarly unable to pay their bills?" Until the marketplace could assess the extent to which Penn Central's financial position was the result of idiosyncratic shocks and mismanagement, as opposed to a signal of a common problem likely to be faced by many firms, Penn Central's failure would cast doubt on the financial position of other firms.

The second element of general bad news revolved around the fate of Penn Central and its creditors. It became clear that, whatever its underlying condition, the government would not guarantee Penn Central's debt and that, therefore, Penn Central's creditors faced the possibility of substantial losses. The incidence of losses on the firm's commercial paper was unknown, but it was rumored that ownership was quite concentrated. For example, on June 15 the *Journal* reported that Morgan Guaranty owned or acted as "agent" for nearly $84 million in Penn Central's commercial paper. According to Federal Reserve data on holdings of commercial paper, in early 1970 nonfinancial corporations owned about 74 percent of outstanding paper.[12] The June 12 *Journal* article cited above also asked: "If even one major corporation should become insolvent, would its failure bring down other cash-short companies because the failing company couldn't pay its bills? Could that, in turn, intensify the present severe strain on the cash resources of banks and corporations into a liquidity crisis, draining the flow of money and credit and plunging the nation into a depression?" While this "domino" scenario of economy-wide depression may seem a bit farfetched, it would have been less farfetched to imagine that one or two major commercial paper issuers (who may have been creditors of Penn Central) might also find it hard to repay their debts.

Thus, lack of information about the effects of the recession on other firms (which Penn Central's failure indicated might be large), and about the identities of Penn Central's creditors and their creditors in turn, could have produced legitimate, rational concern about rolling over the commercial paper of other firms at pre-existing terms. The commercial paper market was especially vulnerable to these sorts of doubts because it was a fast-growing new financial market, as shown in Figure 1. From 1956 to 1966,

[12]See Schadrack and Breimyer (1970, p. 283).

Figure 1
Commercial Paper Outstanding



Source: Schadrack and Breimyer (1970), Chart I.

the amount of nonbank commercial paper issued rose at a 16 percent compounded annual rate. From 1966 to 1970, it rose 29 percent per year. The number of companies issuing paper rose from 335 in 1965 to 575 in April 1970. In the later period, growth was especially concentrated in dealer-placed paper (which includes all nonfinancial commercial paper), which grew from 1966 to 1970 at an annual rate of 57 percent. Rising interest rates and regulatory restrictions on banks (especially Regulation Q ceilings) are widely cited as the cause of this boom in the commercial paper market.

The market pricing and rating of paper issues on a large scale was in its infancy (Stigum, 1983, p. 635; Standard and Poor's, 1979, p. 1), and the recession of 1969–70 was the first downturn to test the burgeoning commercial paper market. Furthermore, commercial bank lending or standby commitments for commercial paper issues did not exist at this time; thus, commercial paper holders faced greater risk than they do today.[13] It would not be farfetched to argue that learning was occurring "in real time" and that the first time a recession occurred, and a commercial paper issuer failed, the market might have found it difficult to assess the ramifications for others with any great confidence. Indeed, it may have been necessary for the market to reevaluate its methods for pricing paper generally in light of this surprising event. Professor Roger Murray of Columbia University argued that commercial paper mar-

[13]The nature of these arrangements for supporting commercial paper issues is discussed below, as well as in Calomiris (1989b).

ket pricing had been too optimistic in the 1960s. His (post-crisis) study of Penn Central's financial position in the 1960s concluded that there was much to be learned from the Penn Central collapse about the need for greater caution in valuing commercial paper: "A careful financial analyst might well have recommended...against the purchase of Penn Central commercial paper a year or more before the events of May and June 1970."[14] Murray accounted for the poor ex ante evaluation of risk by the fact that so "many new faces appeared in that market for large sums at the time and Penn Central was hardly noticed as an unusual case."

Schadrack and Breimyer (1970) provide a similar perspective. They claim that before the Penn Central failure, "the confusion of corporate size with liquidity tended to mask some deterioration during [the late 1960s] of the quality of commercial paper outstanding...the fact that a number of firms in the market by 1970 had very high debt-to-equity ratios and/or income flows of dubious quality (some conglomerate, franchising and equipment leasing companies, for example) suggests such a deterioration in the quality of outstanding paper."[15] They also argue that, in addition to the concern about other commercial paper borrowers brought on by the failure of Penn Central, the bank's failure raised concern about some of the major brokerage houses, which acted as dealers and purchasers in the market. Commercial paper dealers maintain open positions in the paper they sell either as part of an underwriting arrangement, or through a commitment to maintain a secondary market in the paper (Stigum, 1983, p. 640). The threat of a liquidity crisis for firms and their dealers led to a collapse of demand for the debt instruments of others. These fears fueled the flight to cash. Schadrack and Breimyer (1970) also argue that the crisis led to refined methods of pricing commercial paper, which is consistent with Murray's view that there was room for improvement. In particular, after the Penn Central crisis they found a wider dispersion of rates for dealer-placed paper, which they interpreted as the result of "greater investor selectivity." Also, they noted a persistent shift toward bank CDs and Treasury bills.

As Mishkin (1991a) and Schadrack and Breimyer (1970) point out, the spread between commercial paper and Treasury bills widened during and after the crisis. This widening seems to reflect a persistent revision in the evaluation of commercial paper risk. Schadrack and Breimyer (1970) report that in November 1970 the dealer paper rate averaged 103 basis points above the Treasury bill rate, compared to previous spreads of roughly half that amount. A similar pattern is visible in Table 1, which reports the federal funds rate, three-month Treasury bill yields, the discount rate, and the four-to-six-month prime commercial paper rate before, during and after the crisis.

The "flight to quality," visible in the declining yields of Treasury bills and rising short-term spreads, is also visible in long-term yields and spreads, shown in Table 2. From June 20 to June 27, Treasury bond yields fell as corporate bond yields rose. The spread between the Treasury bonds and the Aaa corporates reached a peak on July 11. Interestingly, the spread between Aaa- and Baa-rated bonds was essentially constant during the crisis, but rose afterwards. This is consistent with the view that during the crisis, increased riskiness was attributed to all securities, but that, after the crisis, investors were better able to sort firms into risk categories.

Concerns about the financial condition of commercial paper issuers and dealers proved unwarranted ex post (since no other commercial paper issuers defaulted), but seem to have been important ex ante, as evidenced by movements in the stock market and commercial paper market. Firms, especially those with large outstanding debt, saw large stock price declines in the first three days of the crisis. During that time, the Dow Jones Industrial Average lost 28 points (a fall of roughly 4 percent). Chrysler, General Motors and IBM all saw large losses as rumors circulated that they faced risks of being unable to meet their debts (*Wall Street Journal*,

[14]See Murray (1971). Whitford (1993) applied Altman's (1968) "z-score" model to Penn Central's accounts as of December 1969, and found a remarkably low z-score of 0.135. Altman had found that no healthy firms had z-scores of below 1.81 and no bankrupt firms had a score above 2.99.

[15]See Schadrack and Breimyer (1970, p. 289).

Table 1

Selected Yields and Interest Rates

Date	3-month Treasury bill yield	Federal funds rate	Discount rate	4-6 month prime commercial paper
1970				
January	7.89%	9.04%	6.00%	8.55%
February	6.88	8.41	6.00	8.50
March	6.16	7.45	6.00	8.03
April	6.59	8.43	6.00	8.00
May	7.00	7.64	6.00	8.13
June 1	6.82	7.84	6.00	8.13
2	6.76	7.98	6.00	8.15
3	6.71	7.80	6.00	8.25
4	6.51	7.21	6.00	8.25
July 1	6.46	7.23	6.00	8.38
2	6.62	7.34	6.00	8.35
3	6.46	7.59	6.00	8.25
4	6.34	7.16	6.00	8.35
August	6.25	6.34	6.00	7.70
September	5.80	6.05	6.00	7.20
October	5.84	6.11	6.00	6.63
November	4.99	5.16	5.85	5.75
December	4.83	4.82	5.52	5.75

NOTES: Data are all end-of-month, except for June and July, which are reported end-of-week. Treasury bill and commercial paper yields are quoted on June 6, 13, 20 and 27 and July 4, 11, 18 and 25. Federal funds rates are for June 3, 10, 17 and 24, and July 1, 8, 15 and 22.

SOURCES: Board of Governors of the Federal Reserve System (1976), Table 12.5B, Table 12.6B, and Table 12.7B; Federal Reserve Bank of St. Louis.

June 23-25, 1970, "Abreast of the Market"). *Business Week* quoted one stock market analyst as saying that "investors think that any company... with...debt is going bankrupt" (June 27, p. 42).

Perhaps the best indicator of the extent of these fears is the contraction in the volume of commercial paper outstanding from late June to mid-July. Total outstanding nonbank commercial paper fell from $32 billion on June 24 to $29 billion on July 15, with $2.3 billion of that decline in the first week of the crisis (see Figure 2).

Interestingly, commercial paper rates showed little change during the crisis, although the spread between paper rates and other money market rates did widen. The reason for this was the speedy reaction of the Federal Reserve to the failure of Penn Central. Luckily, it occurred over a weekend, which gave the Fed time to prepare for the opening of financial markets on Monday. The Fed pursued four courses of action.

The Fed's Discount Window Policy During the Crisis

First, the Fed contacted member banks and notified them that "as they made loans to enable their customers to pay off maturing commercial paper and thus needed more reserves, the Federal Reserve discount window would be available."[16] The meaning of "available" is of paramount importance. The Federal Reserve let member banks know that if they borrowed at the discount window for purposes of making loans to commercial paper issuers, they would be able to do so without incurring any costs other than the discount rate. The Fed was informed by banks when their discount borrowing resulted from financing commercial paper rollovers, and the total amount of such discount borrowing totaled some $500 million in the weeks immediately following Penn Central (Melton, 1985, p. 158). Beyond the amount lent through the discount window, access to the window for commercial

[16]See Treiber (1970, p. 16).

Table 2

Long-Term Yields and Spreads

Date[1]	Long-term government bonds[2]	Aaa corporate bonds[3]	Baa corporate bonds[3]	Spread between Aaa and government bonds	Spread between Baa and Aaa corporate bonds
1970					
January	6.84%	7.91%	8.81%	1.07	0.90
February	6.25	7.83	8.73	1.58	0.90
March	6.33	7.92	8.66	1.59	0.74
April	6.70	7.83	8.74	1.13	0.91
May	7.21	8.21	9.10	1.00	0.89
June 6	7.00	8.30	9.13	1.30	0.83
13	7.09	8.42	9.18	1.33	0.76
20	7.05	8.55	9.26	1.50	0.71
27	6.89	8.60	9.36	1.71	0.76
July 4	6.73	8.60	9.41	1.87	0.81
11	6.56	8.55	9.44	1.99	0.89
18	6.61	8.49	9.39	1.88	0.90
25	6.54	8.40	9.38	1.86	0.98
August	6.73	8.13	9.47	1.40	1.34
September	6.52	8.06	9.32	1.54	1.26
October	6.65	8.07	9.34	1.42	1.27
November	5.97	8.02	9.37	2.05	1.35
December	6.05	7.51	9.02	1.46	1.51

[1]All data are end-of-month, unless otherwise indicated.
[2]Maturity varies.
[3]Rated by Moody's.

SOURCE: Board of Governors of the Federal Reserve System (1976), Table 12.12B.

paper rollovers gave

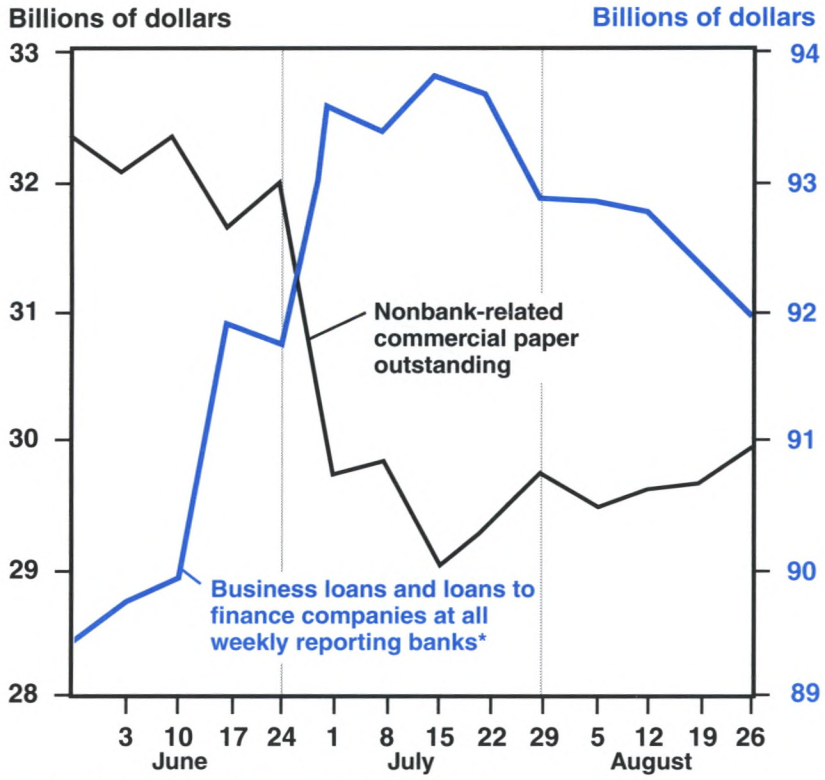
> assurance to the financial markets that the liquidity essential to their operation would be preserved. If panicky investors refused to renew their holdings of commercial paper, preferring Treasury bills, bank deposits— anything!—instead, their extreme preference for safety would not be allowed to contribute to widespread insolvency. Once everyone understood that, there was little reason for panic (Melton, 1985, p. 158).

Fed encouragement to use the discount window to finance the payoff of commercial paper was associated with reduced costs of borrowing from the Fed, even though the discount rate remained unchanged. Normally, the costs of borrowing from the discount window include the discount rate and a nonpecuniary "hassle" cost. That is, the Fed does not want to encourage abuse of the privilege of borrowing from the discount window and banks that may be seen as abusing the privilege run the risk of examination and regulatory sanctions. This penalty explains the positive difference between the fed funds rate and the discount rate. If there were no penalty, banks would be indifferent between borrowing from other banks and the Fed's discount window. In this case, the two rates would be identical. In the presence of a nonpecuniary cost of borrowing from the Fed, as long as borrowings are positive, the fed funds rate will be higher than the discount rate since, on the margin, banks will be indifferent between paying the fed funds rate in the interbank market and borrowing from the Fed (which entails a discount rate cost and a hassle cost).

Figure 3 provides a simple illustration of the simultaneous determination of the federal funds rate and borrowed reserves, which is helpful in analyzing the effect of discount window lending during the Penn Central crisis. Reserve demand is shown as a negative function of the federal funds rate. The position of the demand schedule varies with loan demand, reserve requirements, and the demand for excess reserves. The Fed determines the amount of nonborrowed

Figure 2

Commercial Paper and Business Loans
June-August 1970



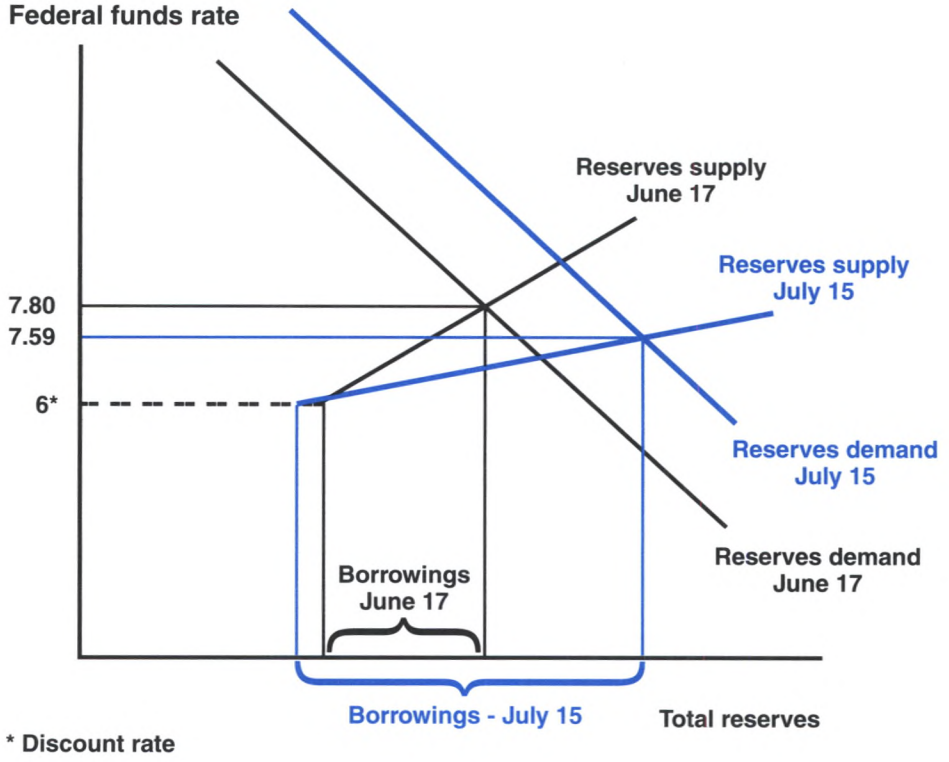
* Including business loans sold to affiliates.
Source: Schadrack and Breimyer (1970), Chart V.

reserves through its open market operations. Borrowed reserve costs are given by an upward sloping schedule, which sums a constant pecuniary cost (the discount rate) with an increasing nonpecuniary hassle cost. The more reserves that are borrowed, the more the Fed is liable to penalize borrowing. Figure 3 illustrates equilibrium in the reserve market for June 17 and July 15, 1970, using actual data on the discount rate (which remained at 6 percent throughout the crisis), nonborrowed reserves, borrowed reserves and the federal funds rate. Assuming equilibrium in the reserve market, we can identify shifts between these two days in reserve demand (as bank loans rose to compensate for the contraction in commercial paper) and in reserve supply. The reserve supply function shifted in slightly (nonborrowed reserves fell due to increased currency demand, which was only partly offset by open market operations) and rotated downward as the Fed reduced its nonpecuniary penalty for borrowing.

The downward rotation of the borrowed reserve supply function illustrates how the Federal Reserve lowered the nonpecuniary cost of borrowing from the discount window during the crisis. Other evidence on the composition of bank lending, bank borrowings from the Fed, and the different rates charged to different types of bank customers suggests that the reductions in nonpecuniary costs were linked (as the quotation above suggests it was) to indirect subsidies for commercial paper rollovers. That is, it seems that loans to member banks for this purpose were granted a special "subsidy" by the Fed (in the form of lower, or possibly zero, nonpecuniary costs).

Consistent with this account, the composition of member bank borrowings changed during the crisis. As of June 24, large commercial banks (primarily money-center banks) accounted for only 75 percent of borrowing from the Fed. The trebling of member bank borrowing from

Figure 3
Shifts in the Reserve Market
June 17-July 15



June 24 to July 15 was due to an increase in money-center borrowing, as one would expect if it was earmarked for commercial paper payoff. As shown in Table 3, total borrowed reserves rose by $1.196 billion, while borrowed reserves of large commercial banks rose $1.224 billion. These same banks were the only ones that saw a large growth in loans to businesses and finance companies during the crisis. Loans increased by $2.3 billion from June 24 to July 15, almost an exact offset of the amount by which commercial paper was reduced during this period. This rise of 2.6 percent in total loans for this group of banks was highly unusual. The average rate of increase for the preceding four years during this period of the year had been 0.03 percent, and the highest rate of growth in the preceding four years had been 0.25 percent in 1968.

Finally, there is weak evidence that large borrowers from money-center banks as of August 1970 (which would have included former commercial paper issuers) received loans on relatively favorable terms. Available data on average loan interest rates for the first two weeks of May and August 1970 by size of borrower and region show that large, short-term borrowers in Northeastern financial centers experienced the smallest increase in lending rates over this period (although differences are small). As Table 4 shows, the largest classes of borrowers in New York City actually saw slight reductions in average loan interest rates.

Other Fed Reactions to the Crisis

The discount window announcement targeting assistance to commercial paper issuers was only the first of the Fed's four policy responses to the crisis. On Tuesday, June 23, the Fed suspended regulation Q ceilings on large-denomination bank CDs. This allowed a flood of money into the commercial banks, so that maturing commercial paper could be directly recycled through CDs, which financed bank loans to former issuers. As shown in Table 3, from June 24 to July 15, large negotia-

Table 3

Banking System Changes During the Penn Central Crisis

Date[1]	Federal funds rate minus discount rate	Total borrowed reserves	Borrowed reserves of large commercial banks	Loans to business and finance companies by large commercial banks	Large negotiable CDs at large commercial banks[2]	U.S. government securities held by Federal Reserve Banks
1970						
January	3.04	$1,071	$ 807	$83,423	$10,444	$55,568
February	2.41	873	522	83,549	10,839	55,749
March	1.45	1,594	1,334	83,903	11,795	55,621
April	2.43	926	680	84,122	13,022	56,085
May	1.64	979	675	83,265	12,984	57,115
June 3	1.84	1,335	1,063	83,545	12,964	57,698
10	1.98	834	624	83,811	12,956	57,552
17	1.80	459	273	85,785	12,741	57,823
24	1.21	840	613	85,331	12,949	57,005
July 1	1.23	923	671	87,212	14,118	57,714
8	1.34	1,598	1,402	87,161	15,199	57,671
15	1.59	2,036	1,837	87,590	15,980	58,839
22	1.16	1,216	1,044	87,472	16,911	58,138
August	0.34	1,044	941	86,067	20,157	59,618
September	0.05	852	788	88,426	22,227	60,055
October	0.11	418	341	86,514	23,546	59,283
November	−0.69	1,144	1,098	86,385	25,201	61,209
December	−0.70	252	224	89,130	26,075	60,632

[1]All data are end-of-month, unless otherwise shown. Dollar amounts are in millions.
[2]These are the sum of commercial and industrial loans by large commercial banks, and loans to personal and sales finance companies, etc.

SOURCES: Table 1 and Board of Governors of the Federal Reserve System (1976), Table 4.1B, Table 10.1D.

ble CDs at large commercial banks increased from $13 billion to $16 billion, and the growth continued, with CDs of large banks in excess of $26 billion by the year's end.[17]

The third policy intervention by the Fed was open market operations. From June 17 to July 15, total U.S. government securities held by the Fed increased from $57.8 billion to $58.8 billion. As noted above, however, open market operations were not sufficient to maintain the stock of nonborrowed reserves, given the increased demand for currency by the public. Thus, borrowed reserves were relied upon as the primary vehicle for expanding reserves during the crisis.

The Fed was also prepared to use "standby procedures" so that, if necessary, it could make loans, directly or indirectly, to "worthy" borrowers who were otherwise unable to secure credit. The Fed never made such loans because its other policies proved sufficient to contain the run on commercial paper, but it is clear that the Fed was willing to provide direct lending if banks had been unwilling to make appropriate loans for commercial paper rollovers. In his statement to Congress on July 23, the Chairman of the Board of Governors, Arthur Burns, made this commitment clear. He viewed the discount window as the key to preventing a liquidity crisis, and saw direct lending by the Fed to firms in need, if necessary, as an appropriate fail-safe measure:

> Credit demands on the banking system at large can be accommodated by open market operations,

[17]An unintended cost of Regulation Q was that it removed an "automatic stabilizer" from the financial system by making it less attractive for investors to hold bank debt at times of crisis in other markets.

Table 4

Average Loan Rates on Short-Term Loans

Loan amount	New York City		Other Northeastern financial centers	
	May	August	May	August
All sizes	8.24%	8.24%	8.86%	8.89%
$ 1,000- 9,000	9.05	9.07	9.23	9.41
10,000- 99,000	8.91	8.95	9.34	9.42
100,000-499,000	8.53	8.59	9.01	9.01
500,000-999,000	8.31	8.23	8.72	8.68
1 million and over	8.13	8.12	8.45	8.49

SOURCE: Board of Governors of the Federal Reserve System (1976), Table 12.9A.

> while the needs of individual banks can be met through the discount window...We have found, also, that minor adaptations of conventional monetary tools can provide solutions to special financial problems...it was made clear that the discount window would be made available to assist banks in meeting the needs of businesses unable to roll over maturing commercial paper, and member bank borrowings for this purpose subsequently have risen...These conventional tools are buttressed with standby procedures to permit the Federal Reserve to make funds available to creditworthy borrowers facing unusual liquidity needs through 'conduit loans'—that is, loans to a member bank to provide funds needed for lending to a qualified borrower...Furthermore, the Federal Reserve could—under unusual and exigent circumstances—utilize the limited power granted by the Federal Reserve Act to make direct loans to business firms on the security of Government obligations or other eligible paper, provided the borrower is creditworthy but unable to secure credit from other sources.[18]

Here, Burns explicitly allows for Fed loans backed by commercial paper or other eligible collateral.

In dealing with the Penn Central crisis, the Fed did not simply focus on controlling the money supply or an interest rate, which it could have done easily through open market operations. Rather the Fed coaxed deposits into banks by relaxing Regulation Q ceilings, and used the discount window to encourage banks to make loans to customers experiencing distress—especially commercial paper issuers. The logic of the Fed's combined approach was that monetary aggregates, bank credit and assistance to the commercial paper market could be targeted independently by using three instruments. Relaxation of Regulation Q, rather than expansionary open market operations, allowed bank credit growth without (narrow) money growth. The discount window was directed toward the special difficulties in the commercial paper market. The Fed left open the possibility of lending directly to firms in need if they were turned down by bankers.

Evaluating Discount Window Policy During the Crisis

It is not self-evident that the Fed's policy response was correct. Schwartz (1992) has argued that the Penn Central crisis was not a "real" financial crisis and that discount lending served no useful purpose. Of course, the absence of a financial collapse in mid-1970 may have been attributable to Fed intervention itself, a possibility Schwartz does not take into account. But even if Schwartz is too quick to dismiss the potential seriousness of the Penn Central crisis—particularly given the evidence on yield-spread movements and contraction of the volume of commercial paper—that does not prove that the discount window was a necessary instrument for dealing with the crisis. If the failure of Penn Central increased doubts about the solvency of *all* firms in the economy, then a temporary expansion of open market operations or a Regulation Q relaxation—to increase the supply of credit available to all borrowers through relatively informed financial intermediaries—would have been a desirable response to an economy-wide need for liquidity, and there would have been no need to use the discount window.

On the other hand, if the crisis involved a special reappraisal of the creditworthiness of commercial paper issuers and commercial paper dealers in particular, and a reassessment of the desirability of lending through the commercial paper market, then increasing the supply of loanable funds from banks may not have been as effective as targeting temporary assistance (a short-run subsidy for bank loans to commercial

[18]See Burns (1970, pp. 624–5).

paper issuers) using the discount window as a means to smooth issuers' costs of rollover.[19] In this case, open market operations or Regulation Q relaxation would have been a blunt instrument for dealing with a run on commercial paper *per se*, while discount window subsidies for the payoff of commercial paper would have provided targeted assistance without affecting monetary aggregates or interest rates on all traded assets. If some combination of an economy-wide reassessment of firms and a commercial paper run characterized the crisis, then policy could have combined an aggregate increase in open market operations or Regulation Q relaxation with targeted assistance to commercial paper issuers.

Thus, to assess the desirability of the use of the discount window during the crisis, one must examine the incidence of the crisis across firms. Was it purely an economy-wide phenomenon or did it pose a special threat to commercial paper issuers?

An Event Study of the Penn Central Crisis

To investigate the extent to which the Penn Central crisis posed a special threat to commercial paper issuers, I examine data on firms' abnormal stock returns during the crisis. Did firms with outstanding commercial paper suffer abnormal negative returns relative to other firms during the onset of the crisis, and were those negative returns reversed by Fed intervention? To answer this question, I combine CRSP data on daily stock returns with Compustat data on annual income and balance sheet variables for nonfinancial corporations to measure cross-sectional differences in abnormal returns over various dates, and to link them to firm financial characteristics measured at the beginning of 1970. I employ standard measures of abnormal returns, using residuals from forecasts of market returns based on estimates of firms' betas (from a 100-day pre-sample period) and the aggregate contemporaneous movements in the market.

Specifically, consider a standard model of firms' stock returns, which decomposes returns into systematic and idiosyncratic factors:

$$(1) \quad R_{it} = a + b_i R_t + e_{it},$$

where R measures returns, i indexes firms, t denotes the date, and a and b are parameters to be estimated. The error term e measures abnormal returns—the firm-specific, idiosyncratic daily return at each date—or, in other words, the part of the stock return that is not forecastable using the simultaneous aggregate return for the market and the firms' estimated correlations with the market (b). Each firm's b is estimated using observations on daily stock returns for 100 trading days prior to the event (in this case, June 12).

Cumulative abnormal returns over any "window" are the accumulation of abnormal returns for each of the dates included in the window. Cumulative returns generated from the above forecasting equation are "standardized" such that they can be interpreted to have been drawn from a unit normal distribution.[20] This adjustment results in a cross-section of standardized cumulative abnormal returns (SCARs) for each firm in the sample over the event window.

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[19]The moral hazard costs of government pass-throughs were minimal, since the banks, not the government, bore the default risk on the loans. This statement requires some qualification. If the pool of borrowers faced large aggregate default risk, then bank failures might have resulted from the loans, in which case the government would have borne some of the losses. Moreover, if some banks had been on the brink of failure, they might have been willing to make subsidized loans to the riskiest firms, thus concentrating overall default risk and making the government's indirect default risk greater. The central assumptions underlying my claim that the government's share of the risk was small are that banks were not on the verge of failure at the time, and that the average quality of the commercial paper borrowers pool was high. The relaxation of Regulation Q ceilings on CDs was also helpful in limiting the government's risk, since it limited the amount of borrowing from the Fed. CDs also provided a natural vehicle for financing fixed-term commercial paper, and did so without affecting the money supply.

[20]For details, see Wall and Peterson (1990).

The event windows are defined as June 12-June 22 and June 23-July 9. Early concerns about commercial paper issuers reported in the *Wall Street Journal* date from June 12. June 22 is the date after which Fed intervention should have improved the position of commercial paper issuers. By the second week of July, the contraction in outstanding commercial paper began to be reversed.

The goal of the event study is to examine whether (likely) commercial paper issuers suffered abnormal negative stock returns during the Penn Central crisis, and whether Fed intervention reversed those costs to commercial paper issuers, after controlling for other measures of cross-sectional differences among firms. To control for other influences that would not have been specific to the commercial paper market, I add a variety of balance sheet and income statement variables taken from the January financial reports of these nonfinancial firms. All firm balance sheet and income data are measured as of the beginning of 1970.[21] The control variables included are: the ratio of debt to assets; the ratio of short-term debt to assets; the size of the firm (market value of capital); the ratio of net income to market value of capital; the ratio of inventories to sales; and the squares of each of these variables. These variables are included to control for the possibility that the share prices of firms with high exposure to macroeconomic shocks (firms with high leverage, or with large financing needs relative to sales) may have responded more strongly to economic news, irrespective of whether or not they were commercial paper issuers. For example, if Penn Central's failure increased the cost of debt for all firms, then leverage ratios or inventory-to-sales ratios would identify cross-sectional differences in SCARs.

Isolating the effect on SCARs of reliance on the commercial paper market is not straightforward, since data on outstanding commercial paper issues of firms are not available for this period. The regular reporting of commercial paper ratings was largely a consequence of the Penn Central crisis. Standard and Poor's began publishing some commercial paper ratings in *The Bond Outlook* in July 1970, but these ratings were for only a handful of issuers, most of which were financial firms. *Moody's Industrial Manual* and other similar publications, which today provide some data on commercial paper issues by firms, did not provide such data in 1970. Outstanding commercial paper cannot be inferred by looking at firms' reported balance sheets. Commercial paper can appear in firm balance sheets either as long-term or short-term debt. Although it is usually included in short-term debt, even in that case it cannot be separated from other short-term debt (loans from banks, finance companies, and so on). The Board of Governors of the Federal Reserve System did not collect firm-level data on issuers, only on aggregate amounts of outstanding issues, based on dealers' reports. Despite searches of various publications by the rating agencies, I have been unable to uncover any comprehensive listing of firms which issued commercial paper in 1970.

Given the lack of data identifying issuers, I use bond ratings to sort firms according to whether they were likely to have issued commercial paper in 1970. In the 1970s, commercial paper issuance was usually restricted to the firms with the highest bond ratings (Standard and Poor's, 1979, p. 47). Having a AA or AAA rating in 1970 is likely to be the best proxy for the likelihood of being a commercial paper issuer. Eight of the 11 nonfinancial firms whose ratings were published in Standard and Poor's *Bond Outlook* in 1970 and 1971 were rated AA or AAA (the remainder were A-rated). Also, data from later years indicate a close relationship between high bond ratings and commercial paper access. Standard and Poor's first comprehensive listing of rated commercial paper issuers, *The Commercial Paper Ratings Guide*, was published in 1978. Of the 90 nonfinancial firms that had AA or AAA bond ratings in 1970, 64 were issuing commercial paper in 1978. Of the 146 nonfinancial firms listed in Compustat with AA or AAA bond ratings in 1978, 93 were commercial paper issuers. In 1978, 94 of the 207 A-rated nonfinancial firms in Compustat were commercial paper issuers, and only 43 firms with bond ratings below A issued commercial paper (all of these were firms with BBB or BB ratings). Using the AA rating as our cutoff, therefore, seems

[21]This was dictated by the superior data available on the annual Compustat tape. Quarterly Compustat data for this period are often incomplete.

advisable. Based on available data, it seems reasonable to assume that a majority of AA or AAA nonfinancial firms were commercial paper issuers in 1970, and that a much smaller percentage of remaining firms were issuers.[22] The total number of nonfinancial firms in our sample (that is, those without missing observations, and covered by both CRSP and Compustat in 1970) is 1,482. Of these, 90 had bond ratings of AA or AAA.

If commercial paper issuers experienced a special problem during the crisis, and if Fed intervention reversed the strain on issuers, the coefficient on the high-rating indicator variable should be negative during the onset of the crisis and positive after Fed intervention. The use of AA or AAA bond ratings as an indicator of a commercial paper issuer provides a "conservative" measure of the problems in the commercial paper market, for three reasons. First, measurement error (the existence of some A-rated commercial paper issuers, and of non-issuers with AA or AAA ratings) biases the coefficients on the high-rating indicator variable toward zero. Second, the excluded A-rated commercial paper issuers likely would have experienced the largest adverse effects of the crisis, since their debt was riskier to begin with. Third, the flight to quality during a financial crisis should produce a relative improvement in the value of high-rated firms, which would imply positive effects on AA and AAA firms, after controlling for other firm characteristics, during the onset of the crisis.

Table 5 reports regression results for SCARs for two windows around the Penn Central crisis—June 12 to June 22, and June 23 to July 9.[23] It is important to emphasize three points before reviewing Table 5. First, coefficients on the control variables in this regression must be interpreted cautiously. For example, while relatively high leverage ratios may have created problems for firms during the crisis, high debt ratios may themselves have been associated with firm attributes (like creditworthiness) that helped firms weather the crisis better (and led to relatively higher stock values). Thus, it is not possible to infer "structural" relationships from these cross-sectional findings. The main point of including the control variables is to separate the effect of commercial paper issuance per se from factors unrelated to commercial paper issuance. Second, the abnormal returns measures are purged of cross-sectional differences in firms' betas that might be correlated with the various regressors. For example, higher debt ratios might be associated with lower returns cross-sectionally because leverage increases a firm's beta. But, by construction, the abnormal returns used in Table 5 are uncorrelated with the firm's beta. Third, squared terms were added for all regressors, but they do not affect the direction of the results. In no case does a squared term more than offset the linear effect of the same variable when both coefficients are evaluated at the mean of the regressor (given in Table 6). The direction of association between SCAR and any regressor is that of the linear effect.

The results reported in Table 5 indicate that the ratio of debt to assets and the ratio of income to net worth (both measured at the beginning of the year) may have been associated with more negative returns cross-sectionally during the onset of the crisis. Firm size per se had no effect on returns in the presence of squared terms for debt ratios. For the period after June 22, the total debt ratio and the profit ratio are associated with a positive effect on returns, indicating a reversal of the stock price movements during the period prior to Fed intervention. The inventory-to-sales ratio and the short-term debt-to-assets ratio are both negatively associated with abnormal returns after June 22.

[22]It is less clear whether the data on A-rated firms in 1978 is representative of A-rated firms in 1970. From 1970 to 1978, market analysts argue that the growth in commercial paper issuers brought more firms with lower ratings (A or BBB) into the market; thus, it might not be appropriate to assume that 1970 saw the same high proportion of A-rated firms issuing paper as in 1978 (45 percent). For purposes of constructing an indicator variable, given the uncertainty about the number of issuers with A ratings in 1970, it is best to exclude A-rated firms from the group of likely issuers because A-rated firms are a small fraction of total firms with ratings below AA, but a large fraction of AA or AAA firms.

[23]The results reported below are not sensitive to whether June 22—which arguably could have been included in the second window—is included or excluded from either window. The results of the first period are driven by pre-June 22 returns, and the results of the second window are driven by post-June 22 returns.

Table 5

Event Study Regression Results for Standardized Abnormal Returns (standard errors in parentheses)

	6/12/70 - 6/22/70		6/23/70 - 7/9/70	
	(1)	(2)	(3)	(4)
Intercept	−0.81	−0.42	−1.57	−2.39
	(1.19)	(1.20)	(1.30)	(1.31)
Debt/Assets	−0.81	−0.68	0.58	0.31
	(0.55)	(0.55)	(0.60)	(0.60)
(D/A)-sq.	0.61	0.50	−0.50	−0.26
	(0.74)	(0.74)	(0.81)	(0.81)
STD/Assets	−0.71	−0.80	−2.14	−1.96
	(0.99)	(0.99)	(1.08)	(1.08)
(STD/A)-sq.	2.39	2.51	4.31	4.06
	(2.30)	(2.30)	(2.52)	(2.50)
Size(MVE)	0.09	0.01	0.12	0.29
	(0.21)	(0.21)	(0.23)	(0.23)
(MVE)-sq.	0.00	0.01	0.00	−0.01
	(0.01)	(0.01)	(0.01)	(0.01)
NI/MVE	−0.86	-0.82	1.67	1.60
	(0.33)	(0.33)	(0.36)	(0.36)
(NI/MVE)-sq.	0.82	0.80	−0.64	−0.59
	(0.43)	(0.43)	(0.47)	(0.47)
INV/SALES	−0.39	−0.51	−1.85	−1.59
	(0.40)	(0.41)	(0.44)	(0.44)
(INV/SALES)-sq	−0.04	0.04	0.76	0.59
	(0.41)	(0.41)	(0.45)	(0.45)
AA or AAA	—	−0.30	—	0.64
		(0.15)		(0.16)
Adj. R-squared	0.040	0.042	0.080	0.089

After controlling for observed balance sheet and income characteristics, firms with AA or AAA bond ratings experienced significant, negative, abnormal returns during the onset of the crisis and significant, positive returns after Fed intervention. The addition of this indicator variable increases the adjusted R-squared in both regressions. The evidence provides support for the notion that, in addition to the economy-wide liquidity crisis during the Penn Central crisis, commercial paper issuers faced a special problem. This, in turn, lends support to the argument that discount window subsidization of lending may have been useful in targeting assistance to the commercial paper market. Thus, the Fed may have been correct to divide policy into two components: Regulation Q relaxation to provide liquidity to all firms through banks, and discount window lending to target subsidized assistance to commercial paper issuers to offset the special disorder in that market. That is *not* to say Fed policy achieved the right mix. For example, negative returns for firms with high inventory-to-sales ratios or high short-term debt after June 22 may indicate that credit supply was too tight overall.

Changes in the Commercial Paper Market After the Crisis

The commercial paper market changed as a result of the Penn Central crisis. In addition to increased diligence in evaluating credit risk, two other changes have reduced the possibility of a similar problem in the future. First, in August of 1970, the Fed passed a regulation to restrict the growth of bank commercial paper. Bank paper would be treated, for reserve requirement purposes, the same way as demand or time deposits, depending on the maturity of the paper. This eliminated the advantages of off-balance sheet financing through bank commercial paper and led to the contraction of bank paper. This had little effect on banks or on the growth of the commercial paper market, which has been robust (Post, 1992). It simply propelled banks toward relying on negotiable CDs (virtually identical to commercial paper) as an alternative source of funds.

Of greater importance were institutional changes in the way commercial paper is marketed. First, rating agencies made finer distinctions in their ratings of commercial paper issues (Stigum, 1983, p. 637). An important element in the rating became evidence of commercial bank backup arrangements behind commercial paper programs. Commercial bank support for commercial paper programs was a private innovation. After, and largely as a result of Penn Central, commercial paper issuers increasingly sought "hurricane insurance" in the form of backup loan commitments (Stigum, 1983, pp. 633-4; Standard and Poor's, 1979, p. 47). Most of these loan commitments (roughly 85 percent in 1989) are not credit guarantees to commercial paper holders, but rather promises for assistance during a general liquidity crisis if the borrower remains creditworthy (Calomiris, 1989b). Within a few years of the Penn Central

Table 6

Means, Standard Deviations, and Correlations Among Regressors

	Mean	Standard deviations	Correlations (p-values in parentheses)				
			STD/A	MVE	NI/MVE	I/S	AA+
D/A	0.28	0.21	0.52 (0.000)	−0.11 (0.000)	0.28 (0.000)	−0.05 (0.05)	0.11 (0.000)
STD/A	0.07	0.09	—	−0.28 (0.000)	0.06 (0.03)	0.26 (0.000)	−0.08 (0.003)
MVE	11.2	1.6	—	—	−0.03 (0.22)	−0.13 (0.000)	0.32 (0.000)
NI/MVE	0.17	0.13	—	—	—	−0.13 (0.000)	0.07 (0.004)
I/S	0.17	0.13	—	—	—	—	−0.19 (0.000)
AA+	0.06	0.23	—	—	—	—	—

crisis, backup lines were almost always 100 percent of outstanding issues, except for large, top-rated, highly liquid issuers like GMAC or large commercial banks. These loan commitments were issued by banks for the same reason bank assistance had been relied on during the Penn Central crisis: Banks have access to the discount window and believe that they can rely on the Fed (which maintains no official policy in this regard) to temporarily suspend normal non-pecuniary discount window penalties to grant lending subsidies during an emergency. Institutionalizing Fed discount window protection through explicit bank loan commitments, one could argue, reduces the time to process credit rollover during a crisis. Furthermore, the existence of clear commitments to lend during a crisis may itself reduce the threat of a general liquidity squeeze and, thus, make crises less likely.

Currently, the use of backup lines of bank credit, "backed" by access to the discount window, has virtually eliminated risk of another Penn Central crisis in the commercial paper market. But this does not imply an end to the role played by the discount window. The protection offered through backup lines of credit depends on banks' potential access to funds through the discount window.

EVALUATING OTHER POSSIBLE FED INTERVENTIONS

Thus far, I have argued that both economy-wide policy (open market operations and Regulation Q relaxation) and targeted discount lending may have been desirable interventions during the Penn Central crisis. But the Fed was willing to go beyond these interventions, if necessary, as Chairman Burns' comments cited above indicate. Was the Fed right to have provided for the possibility of direct lending to firms, or should it have been willing to rely only on the discount window and open market operations? Was the Fed right to have allowed Penn Central to fail in the first place?

The Fed's decision not to prevent the failure of Penn Central is easy to defend. The success of the capitalist system requires that firms face "hard" budget constraints. As reformers in Eastern Europe and the Soviet Union have been saying for years, protecting large corporations from bankruptcy through assistance from the state imposes large costs on more successful growing enterprises. More fundamentally, allowing corporations to fail is what encourages them to succeed. It is worth emphasizing that the public policy rationale for insulating financial markets from temporary information externali-

ties during panics does not in any way justify bailing out discernably insolvent institutions.

With regard to the other question—whether direct Fed lending to corporations is ever justifiable—it is also hard to justify intervention. As Mishkin (1991b) notes, it is better to decentralize the decision over who receives how much, and place it in the hands of relatively informed bankers who have incentives to avoid making bad loans. If banks had been unwilling to finance the payoff of the commercial paper of certain firms, even on highly subsidized terms, that would have indicated the likely insolvency of those individual issuers.[24] Discount window protection should not be used to save individual firms which are viewed as insolvent by their creditors. Of course, creditors are not always right, but part of the rationale for corporate reorganization under bankruptcy law (increasingly popular since the 1978 changes in the bankruptcy code) is to minimize unnecessary costs of liquidating defaulting firms who turn out to be solvent. Given the availability of the reorganization option, it may be best for the government to allow private markets to decide whether individual corporate borrowers are viable.

COULD A SIMILAR CRISIS HAPPEN TODAY?

Although I have argued that the possibility of another Penn Central crisis today in the commercial paper market is remote, in other new and growing financial markets the potential for a crisis similar to Penn Central may loom larger.[25] For example, within the banking system a large overdraft default in the Clearing House Interbank Payments System (CHIPS) might lead to a general run of uninsured liabilities of CHIPS members, due to problems of unraveling which banks stood to lose from the default. Subsidized lending to CHIPS members might be warranted to prevent a panic.[26] The Fed is cognizant of its potential role in assisting banks in the event of a systemic crisis in the payments system, and it regulates the payments system accordingly. Like many other central banks, the Fed limits overdrafts of bank accounts with the central bank and requires private bank clearing systems to limit overdrafts among their members. Such limits include collateral requirements, quantity limits on overdrafts, and pre-established loss-sharing arrangements. These regulations are meant to ensure that the potential protection afforded by the Fed is not abused.

It is also conceivable that discount window intervention could be used to target assistance to markets for financial derivatives. In the swap market, for example, if a major swap provider became insolvent, its counterparties, and third parties who have contracted with those counterparties, could experience unpredictable changes in their market risk exposures and, consequently, in their default risks. Because of the interrelatedness of the various positions and

[24]Of course, the Fed could have done even more to encourage banks to make pass-throughs than it did during Penn Central by making its subsidy larger. The subsidy that the government can grant is potentially very large. By lowering the discount rate to zero and discriminating in imposing nonpecuniary penalties across banks (for example, charging a zero hassle cost to banks borrowing for targeted pass-throughs and a prohibitive rate on other borrowing), the subsidy can be increased to the level of the equilibrium fed funds rate without affecting monetary control.

[25]Gorton and Pennacchi (1992) argue that there is no evidence for "contagion" among commercial paper issuers or finance companies. They examined the failures of several issuers and finance companies and found that a failure did not lead investors in securities markets to lower the price of other issuers' or finance companies' securities, ceteris paribus. It is premature, however, to interpret this as evidence that issuers or finance companies are now immune to panics, or more broadly, that financial technology has improved so much that intermediaries are not potentially vulnerable to panics. Gorton and Pennacchi's sample of events is small, and the events they examine may simply have been transparently idiosyncratic (unlike, for example, the Penn Central crisis). It is possible that events unlike those in their sample could produce panics.

[26]Of course, the discount window is not the only way to deal with such a problem. Alternatively, deposit insurance could be extended to the CHIPS clearinghouse as a whole. For example, the government could offer insurance to CHIPS with a large deductible, with the liability for the deductible shared by all clearing members.

uncertainty as to which swap contracts will survive the crisis, it might be difficult for counterparties to gauge their true exposure to market risk. This could produce a flight to cash by all parties. Furthermore, a reversal of market opinion about the reliability of swaps as hedging devices could suddenly affect the market's perception of firms with large swap positions. In this case, temporary disruptions to the supply of credit to certain classes of firms could conceivably result. These problems could motivate discount window subsidies as in the Penn Central crisis.

The lesson in this dismal scenario is not that swaps are a bad idea. They offer real long-run systemic risk reduction as a low-cost vehicle to hedge interest rate risk. But reaping the advantages of this and other financial innovations requires a period of learning about how to measure and control the risks created by new financial instruments. The existence of the discount window provides a safety valve to protect the financial system from growing pains like the ones it suffered in 1970. Recent financial innovations in derivatives and asset securitization may have increased the need for the discount window as an instrument of public policy. Its role is not just to protect the banking system from systemic runs on commercial banks (indeed, it may have little importance here in the presence of deposit insurance); rather, its role is to effect occasional, contingent and focused credit subsidies to particular markets through banks during moments of temporary disruption, like that of the Penn Central crisis.

Another example of a potential application of the discount window is a run on a futures clearing house. Individual clearing members stand between all contracting parties and the clearing house provides mutual insurance among all members against default. To limit the risk of default by clearing members, clearing houses impose reserve requirements in the form of cash or Treasury bills on open positions and frequently monitor those positions. Still, it is conceivable that a very large, sudden price drop (say, in the stock market) might bankrupt a clearing member with a large open position and conceivably threaten the clearing house. This could cause a run on the futures market as holders of contracts, wary of the credibility of the clearing house's solvency, try to sell their contracts. This could amplify the losses to the clearing house and legitimize the initial concerns that prompted the run, leading to further cashing-in of positions. If the clearing house were to fail, many hedges would disappear with its demise, increasing the risk of many financial claims and causing confusion about the incidence of the increased risk in ways that might provoke a general liquidity crisis.

The Fed could reduce the chance of a run on a futures clearing house and the negative externalities attendant to such a run by agreeing temporarily to lend through the discount window without penalty to banks making loans to clearing house members, and could even lower the discount rate if necessary to encourage such subsidies. Indeed, this seems a reasonable characterization of the Fed's response to concerns about futures markets posed by the stock market collapse of October 1987.

There is a more difficult policy question, however, that so far has not been addressed. If banks are unwilling to lend to a clearing house—even on highly subsidized terms—should the Fed let the clearing house fail? On one hand, ad hoc direct lending by the Fed runs the risk of encouraging lax self-regulation within the clearing house. On the other hand, the financial disruption from a clearing house failure might generate substantial negative externalities in the financial system. It might be desirable for the Fed to decide whether it would stand behind the liabilities of failed futures clearing houses. If so, the Fed should consider whether existing private risk-management devices (like margin rules) are adequate. If not, it might recommend changes to the Commodity Futures Trading Commission, which regulates these exchanges. As the volume of derivative transactions expands, so does the need to develop policies for dealing with possible systemic risks related to these markets.

Identifying a potential benefit from a "backup" discount window does not justify the current form of the discount window. There may be no benefit from Fed lending to banks during normal times, and as Schwartz and others have argued, such lending may be costly. There also remains the risk that government agencies will abuse even a "reformed" discount window by defining noncrises as crises to make loans to favored parties. The evidence presented in this paper, therefore, does not prove that the discount window has been a net benefit as a policy tool, only that it has the potential to provide benefits as well as costs.

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Can Deposit Insurance Increase the Risk of Bank Failure? Some Historical Evidence

LOAN LOSSES ASSOCIATED WITH declines in energy and agricultural prices, and the collapse of commercial real estate markets were the proximate cause of the high number of bank and savings and loan (S&L) failures of the past 12 years. Many researchers also blame government policies, however, such as restrictions on branch banking and limitations on the services that banks and S&Ls may offer. Such restrictions hamper diversification, thus leaving depository institutions particularly vulnerable to downturns in the regions which they serve.

Deposit insurance has probably been the most criticized government policy related to bank and S&L failures. Many economists believe that deposit insurance encourages banks and S&Ls to take excessive risks, thereby increasing their chance of failing.[1]

This article investigates empirically the connection between deposit insurance and bank failure. Today, virtually all banks are insured by the Federal Deposit Insurance Corporation (FDIC) and, consequently, isolating the effects of insurance from other regulations and exogenous economic conditions that affect bank performance is difficult. We study the effects of deposit insurance by drawing on historical evidence from a voluntary insurance regime that operated in Kansas between 1909 and 1929. Because membership in the Kansas deposit insurance system was optional, we are able to compare insured and uninsured banks facing otherwise similar regulations and economic conditions in a way not possible with modern data. We estimate a model of bank failure to test for the impact of insurance on the likelihood of failure.[2] We find that insured banks were less well capitalized and, in some years, less liquid

[1]Kane (1989) examines the problems of the S&L industry and the role of government policy. Mishkin (1992), Keeley (1990) and O'Driscoll (1988) discuss the relationship between deposit insurance and bank failures in the 1980s.

[2]Wheelock (1992b) also investigates how deposit insurance affected the probability of failure for Kansas banks in this era, but employs a different methodology and somewhat different data. Wheelock and Wilson (1993) use the same data set as the present study, but while considering the effects of insurance, focus largely on whether or not measures of managerial inefficiency help distinguish failing from surviving banks. Grossman (1992) also investigates the effects of deposit insurance by comparing insured and uninsured S&Ls during the 1930s.

than uninsured banks, and that capitalization and liquidity were important determinants of failure.

The next section discusses how deposit insurance might increase the likelihood of bank failure. Next, we describe the Kansas deposit insurance system and the effects of a collapse of commodity prices in 1920 on commercial banks. The final sections develop the econometric methodology used to model failure, specify the model, and present results and conclusions.

DEPOSIT INSURANCE AND BANK FAILURE

Federal deposit insurance was enacted in response to the bank failures of the Great Depression. Thousands of banks failed from 1930 to 1933, wiping out the funds of depositors, producing a collapse of the money supply, increasing the costs of intermediation and interfering with the clearing of payments.[3] Although large banks and many economists vigorously opposed deposit insurance, and President Franklin Roosevelt was reluctant to accept it, Congress deemed deposit insurance necessary to protect small, unsophisticated depositors from losses due to bank failures, and the payments system from a wholesale banking collapse like that of 1930-33.[4]

Until the 1980s, deposit insurance was generally hailed for eliminating the possibility of widespread bank failures.[5] Merton (1977) and Kareken and Wallace (1978) showed, however, that when insurance premiums are unrelated to the expected cost of failure to the insurance system, banks have an incentive to take greater risks than they otherwise would. Because depositors are protected in the event of bank failure (to the limit of insurance coverage), they have little or no incentive to monitor their banks' activities or to demand risk premiums on deposit interest rates. Deposit insurance thus raises the expected return to banks from investing in risky loans and investments and encourages them to substitute debt, in the form of insured deposits, for equity. Consequently, unless regulations inhibit risk-taking, the presence of deposit insurance could lead to more bank and S&L failures than there would otherwise be.

Many economists blame deposit insurance, coupled with inadequate regulation and supervision, political interference and a failure by regulators to promptly close insolvent institutions, for the high number of S&L failures and bankruptcy of the Federal Savings and Loan Insurance Corporation during the 1980s.[6] The banking industry's problems were, by comparison, less notorious. Banks faced higher capital requirements and were more stringently supervised than S&Ls, which lessened banks' incentive and ability to take excessive risks. But deregulation of deposit interest rates, initiated by the Depository Institutions Deregulation and Monetary Control Act (DIDMCA) of 1980, the gradual removal of barriers to branch banking, more liberal chartering polices and increased competition from foreign banks and from nonbank financial institutions, all worked to lessen charter values and increase the incentive for banks (as well as S&Ls) to take greater risks.[7] Moreover, in 1980, deposit insurance coverage was increased from $40,000 per account to $100,000 for both banks and S&Ls, while the failure resolution policy known as "too-big-to-fail" effectively extended insurance to all deposits at the largest banks, thereby enhancing their incentive to take risks.[8]

As is all too often the case, the bank and thrift debacle of the 1980s stemmed in part from the failure of policy makers to heed lessons from the past. Flood (1992) argues that when deposit insurance legislation was being considered in 1933, policy makers understood the temptation that insurance gives bankers to take excessive risks. Accordingly, coverage was

[3]Studies of the causes and effects of bank failures during the Depression are too numerous to list. Friedman and Schwartz (1963), however, is the seminal investigation of the impact of bank failures on the money supply, and Bernanke (1983) is the most important investigation of nonmonetary effects of bank failures.

[4]Golembe (1960) and Flood (1992) investigate the rationale for federal deposit insurance.

[5]For example, see Friedman and Schwartz (1963, pp. 434-42).

[6]For example, see Kane (1989).

[7]Keeley (1990) draws the connection between increased competition, deposit insurance and increased risk-taking.

[8]Too-big-to-fail was implemented to reduce the possibility that the failure of a very large bank could produce a systemic crisis, with depositor runs on many banks. Mishkin (1992) and Boyd and Gertler (1993) argue that this policy increased risk-taking by very large banks.

limited to $2,000 per account and regulations were imposed to constrain risk-taking. Deposit interest rate ceilings prevented weak institutions from growing rapidly by bidding up interest rates, and regulators gave bankers added incentive to act conservatively by limiting the issuance of new bank charters. Many of the sources of increased competition for banks and S&Ls that had emerged by 1980, such as money market mutual funds and the commercial paper market, were the product of technological changes that could not be foreseen in 1933.[9] But deregulation of bank and S&L deposits and the expansion of deposit insurance coverage at a time when the industry was facing increased competition contradicted the regulatory principle that underlay deposit insurance legislation in 1933.

The insights that policy makers had in 1933 about deposit insurance came partly from prior state experiences with deposit insurance. Six states had experimented with insurance in the pre-Civil War era, as did eight others between 1908 and 1930.[10] None of the 20th-century systems was able to fully protect depositors of failed banks from loss, and each closed before the onset of the Great Depression. The commodity-price collapse of 1920-21 triggered a wave of bank failures throughout the Midwest and the South, including seven of the eight states with deposit insurance. Although loan losses associated with the decline of state incomes was the proximate cause of bank failures, insured banks generally suffered higher failure rates than uninsured banks facing similar exogenous conditions.[11] Contemporaries believed that deposit insurance had contributed to the high number of failures because it protected incompetent and dishonest bankers from market discipline.[12] In the following sections, we investigate empirically how deposit insurance might have contributed to the failure of banks operating under the deposit insurance system of Kansas during the 1920s. We study this case because just three of the eight state insurance systems had optional membership for state-chartered banks and, hence, permit comparison of insured and uninsured banks facing otherwise similar conditions. Of these, only the Kansas system lasted for many years with a large number of banks electing to join the system and a significant number remaining uninsured.

DEPOSIT INSURANCE IN KANSAS

The Kansas deposit insurance system began operation in June 1909 and officially closed in 1929. Kansas was the second state to enact insurance legislation following the Panic of 1907, and was motivated partly by the adoption of an insurance system by Oklahoma in 1908.[13] In contrast to the Oklahoma system, in which all state-chartered banks were required to carry insurance, the Kansas system was made optional for state banks because of complaints that insurance forces conservatively managed banks to insure depositors of banks that are more likely to fail.[14] The state of Kansas, like other states with deposit insurance systems, did not guarantee insurance payments. In contrast to the experience

[9]See Wheelock (1993).

[10]The 20th-century states and the years in which their insurance systems operated are Oklahoma (1907-23), Texas (1909-25), Kansas (1909-29), Nebraska (1909-30), South Dakota (1909-31), North Dakota (1917-29), Washington (1917-29) and Mississippi (1914-30). Cooke (1909), Robb (1921), American Bankers Association (1933), Federal Deposit Insurance Corporation (1956) and Calomiris (1989) compare the features and performance of the systems.

[11]Thies and Gerlowski (1989) and Alston, Grove and Wheelock (1994) find that a state's bank failure rate during the 1920s was higher if it had a system of deposit insurance, holding constant other possible causes of failure. Wheelock (1992a) reports similar evidence at the county level for Kansas.

[12]Commenting about the effects of the Kansas deposit insurance system, Harger (1926, p. 278) wrote that insurance "gave the banker with little experience and careless methods equality with the manager of a strong and conservative institution. Serene in the confidence that they could not lose, depositors trusted in the guaranteed bank. With increased deposits, the bank extended its loans freely." See also American Bankers Association (1933), Association of Reserve City Bankers (1933) and Robb (1921) for contemporary views about insurance.

[13]Robb (1921) describes previous attempts to enact deposit insurance legislation in Kansas and other states, and notes that Kansas banks located near the Oklahoma border were especially strong proponents of deposit insurance in Kansas (pp. 107-12).

[14]The Comptroller of the Currency ruled in 1908 that national banks could not join state deposit insurance systems.

with federal insurance in the 1980s, depositors, not taxpayers, suffered from any insurance fund deficiencies.[15]

Kansas banks were required to operate for at least one year and undergo an examination by state authorities before being admitted into the insurance system.[16] Insured banks were also required to maintain total capital of at least 10 percent of total deposits, and surplus and undistributed profits of at least 10 percent of total capital.[17] At first, deposit insurance was restricted to noninterest bearing accounts, savings deposits of $100 or less, and time deposits of between six and 12 months maturity. Banks with insured deposits were not permitted to pay more than 3 percent interest on any deposit, whether insured or not.[18] Regulations were relaxed in 1911; insurance was extended to all deposits not otherwise secured, including savings accounts in excess of $100, and the state banking commissioner was given authority to adjust interest rate ceilings as he deemed appropriate.

Insured banks were assessed annual premiums equal to 1/20 of 1 percent of their insured deposits less total bank capital. Although a bank could reduce its premium by increasing its capital, the saving was small. A bank with $100,000 of insured deposits and $10,000 of capital was assessed an insurance premium of $45, whereas a bank with $15,000 of capital had a premium of $42.50. Additional premiums could be assessed to cover shortfalls in the insurance fund, but total annual premiums were capped at 1/4 of 1 percent of insured deposits less capital. Banks also were required to place cash or eligible bonds with the state banking commissioner equal to 0.5 percent ($500 minimum) of their insured deposits to guarantee insurance premium payment. Banks could withdraw from the insurance system at any time, but remained liable for any premiums needed to reimburse depositors of banks which failed while the withdrawing bank was insured, including the six months following notice of withdrawal.

Deposit insurance proved popular in Kansas, and before 1920 the deposits of insured banks grew more rapidly than those of uninsured state and national banks. Figure 1 plots the participation rate of all Kansas banks and of those eligible for deposit insurance. Figure 2 illustrates the shares of all bank and eligible bank deposits held by insured banks.[19] The percentage of the state's bank deposits held by insured banks peaked in 1921 at 43.8 percent, and membership in the system peaked at 65.6 percent of eligible banks in 1923. In that year, 681 banks, holding $168 million of deposits, belonged to the insurance system, while 357 state banks, holding $64 million of deposits, did not.

THE CHARACTERISTICS OF INSURED BANKS

This section identifies some important differences between insured and uninsured banks that may explain why the failure rate of insured banks exceeded that of uninsured banks.

If depositors believe that they will be protected from loss in the event of bank failure, they will be willing to accept a lower rate of return on their deposits than they would in the absence of such protection. Because it lowers the cost of deposits, deposit insurance encourages banks to rely more heavily on deposits to finance their activities, as opposed to equity and nondeposit liabilities, than they otherwise would. Economic theory suggests that banks also will choose to hold riskier assets when deposits are insured.[20] Insured banks in Kansas had a higher failure rate than uninsured banks, which might have been caused by "moral hazard," that is, by high-risk behavior encouraged by deposit insurance. Alternatively, because risky banks would stand to gain the most from insurance in terms of lower deposit costs, the

[15]Mississippi, however, ultimately issued bonds to retire the deficit of its insurance system.

[16]The requirement of one year of operation was waived if no other bank in the applicant's town was an insurance system member.

[17]The former requirement was eliminated in 1917. Warburton (1958, p. 21) argues that, if maintained and enforced, the requirement could have prevented much of the rapid growth of banks that ultimately resulted in large losses to the insurance system.

[18]For comparison, the annual average interest rates on prime four-six month commercial paper and on call loans in 1909 were 4.69 and 2.71 percent, respectively.

[19]All banks include those with federal charters, trust companies and unincorporated banks. The source of these data is the FDIC (1956, p. 68).

[20]See Merton (1977) or Kareken and Wallace (1978).

Figure 1
Proportion of Banks Participating in the Deposit Insurance System

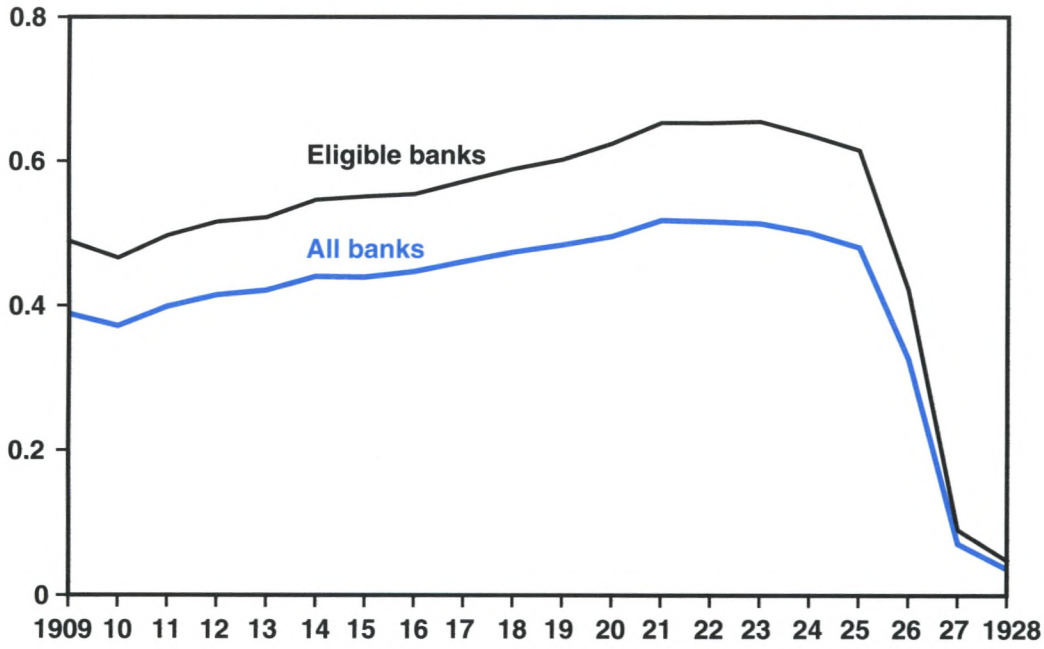
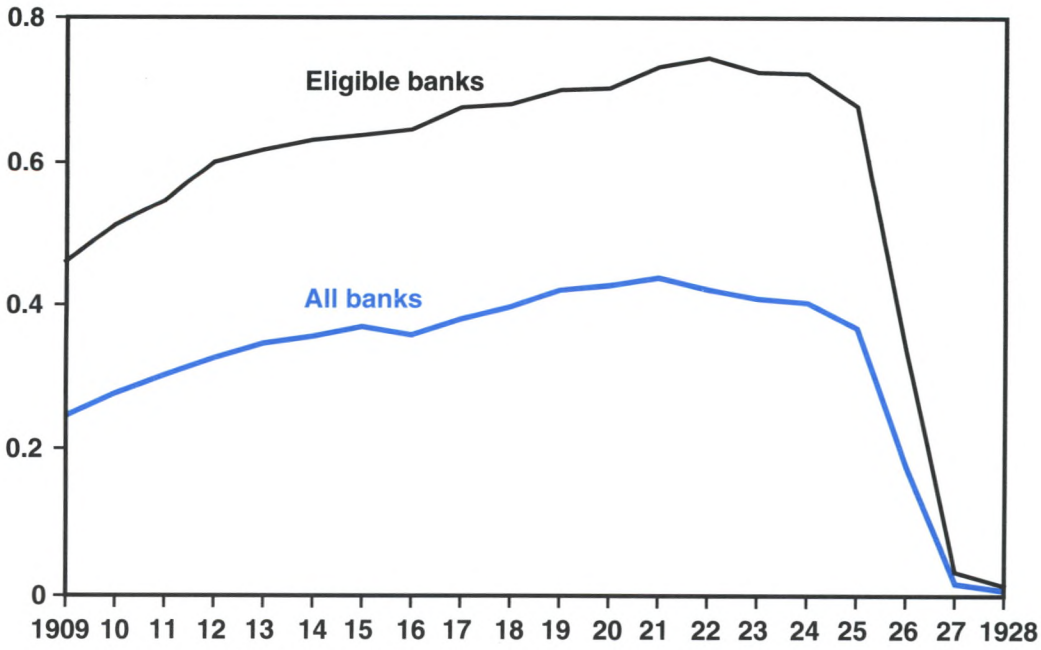


Figure 2
Proportion of Deposits in Insured Banks



failure rate of insured banks might have been higher simply because risky banks were more likely to join the voluntary insurance system, that is, because of "adverse selection." Of course, both effects might have been present and contributed to the higher failure rate of insured banks.

The troubled history of the Kansas deposit insurance system raises the question of whether depositors expected an insurance payoff in the event of bank failure. If they did not, then depositors would have had an incentive to monitor their banks' activities and to demand the same terms from a member of the insurance system as from an uninsured bank with equal likelihood of failure. Indeed, if depositors thought that insured banks had, on average, a higher probability of failure and that an insurance payoff was unlikely, then they would have had an incentive to transfer deposits from insured banks to uninsured banks. No doubt some depositors did so, as the relative share of deposits in insured banks fell after 1921. Large numbers of depositors left their funds in insured banks, however, and because of the difficulty of assessing the extent of protection from deposit insurance at any point in time, might have expected at least partial reimbursement in the event of bank failure.[21]

To investigate the relationship between deposit insurance and bank behavior, we compare various financial ratios of insured and uninsured banks in our sample in different years. Table 1 reports the mean capital/assets, deposits/assets and cash reserves/deposits ratios of insured and uninsured banks in our sample in each year for which data are available.[22] In general, insured banks maintained less capital relative to assets than uninsured banks and, hence, were more likely to fail as a result of loan losses or other declines in asset values. The hypothesis that the mean capital/assets ratios of insured and uninsured banks are equal can be rejected (at the .10 level or better) in each year.

The greater reliance of insured banks on deposits is indicated by the fact that, except for 1924, insured banks had higher deposits/assets ratios than uninsured banks. Insured banks also held fewer liquid assets ("reserves"), defined here as cash, cash items and the liabilities of other banks, relative to deposits than uninsured banks in 1910, 1914 and 1924. Thus, for some of the period, insured banks were less liquid than their uninsured competitors. We find the reserves/deposits ratio to be particularly useful for distinguishing failing and nonfailing banks. The comparatively low capital/assets and reserves/deposits ratios of insured banks indicate that they were more risky than uninsured banks and, hence, the higher failure rate of insured banks is not surprising. We further examine the impact of deposit insurance on the probability of failure, and seek to identify other characteristics which distinguish failing from nonfailing banks in the following sections.

THE BANKING COLLAPSE OF THE 1920s

The number of banks and total bank deposits grew rapidly throughout the United States in the first two decades of the 20th century, especially during the inflationary boom of World War I. Kansas experienced a 30 percent increase in the number of banks between 1910 and 1920, when it had 1,096 state-chartered banks, 266 national banks and 18 unincorporated banks (Kansas, 1920, and Bankers Encyclopedia Company, March 1921). After 1920, the number of banks in the United States fell sharply, especially in the Midwest and the South, where waves of bank failures followed a collapse of commodity prices. Between June 1920 and January 1921, an index of wholesale commodity prices fell from 167 to 114; by January 1922, it had fallen to 91 (Board of Governors, 1937, p. 174). Sharply lower incomes left many farmers who had borrowed to

[21]Wheelock and Kumbhakar (1994) argue that before 1926, depositors had a reasonable expectation of an insurance payoff, and show that deposit insurance enabled members of the insurance system to hold lower capital ratios than uninsured banks until that year.

[22]The biennial reports of the state banking commissioner (Kansas, various years) provide balance sheet data for all state-chartered banks and trust companies on August 31 of each even-numbered year (except 1912 and 1916).

Table 1

Mean Financial Ratios of Insured and Uninsured Banks

Year	Type of bank	Capital/ assets	Deposits/ assets	Reserves/ deposits	Number of banks
1910	Insured	.188***	.793***	.320***	41
	Uninsured	.238	.728	.424	186
1914	Insured	.205**	.755***	.303**	124
	Uninsured	.227	.717	.341	128
1918	Insured	.124***	.864***	.328	149
	Uninsured	.142	.824	.308	97
1920	Insured	.133**	.836**	.207	158
	Uninsured	.148	.806	.200	84
1922	Insured	.162**	.784*	.205	159
	Uninsured	.179	.755	.206	74
1924	Insured	.163*	.808	.224***	150
	Uninsured	.179	.798	.282	63
1926	Insured	.150**	.835**	.227	135
	Uninsured	.172	.810	.233	63

Note: ***, ** and * indicate that the difference in the means for insured and uninsured banks is statistically different from zero at the .01, .05 and .10 levels (two-tailed tests).

finance land acquisition and improvements before 1920 unable to repay their loans. Loan losses, in turn, caused the failure of many banks in commodity-producing regions, including 220 in Kansas between 1920 and 1929.

The impact of agricultural distress on individual Kansas banks reflected the portfolio choices they had made prior to the collapse and as it unfolded. Between September 1920 and September 1926, 122 state-chartered Kansas banks failed. Of those, 94 had been members of the insurance system (a 4.6 percent failure rate) and 28 had not (a 2.3 percent failure rate). By contrast, just six national banks failed (a 0.8 percent failure rate). Over the life of the insurance system, depositors of just 27 failed banks recovered the entire amount of their insured deposits, and those of two other banks received 93 and 95 percent of their deposits, respectively (Warburton, 1958, pp. 27-9). No insurance payments were made to depositors of 88 member banks that failed (FDIC, 1956, p. 58). On average, holders of insured deposits received 53 percent of their funds from liquidation of bank assets and 18 percent from the deposit insurance fund (7 percent of which came from the reorganization of one bank, the American State Bank of Wichita). The remaining 29 percent of insured deposits were never recovered.

The sharp increase in bank failures beginning in 1920 quickly swamped the resources of the Kansas deposit insurance fund. When a member of the Kansas insurance system failed, its depositors were given interest-bearing certificates immediately upon closure, and received reimbursement only after the bank's assets had been entirely liquidated. If the proceeds from liquidation were insufficient to reimburse insured depositors, the insurance system was supposed to make up the difference. Depositors of the two banks that failed before 1920 were eventually fully reimbursed, but inadequate insurance funds meant that depositors of most banks that failed after 1920 were not as fortunate.

Because depositors were not reimbursed until after liquidation of a failed bank's assets, the condition of the fund and the prospect that depositors of failed banks would eventually receive full reimbursement were difficult to determine at any point. The failure in June 1923 of the American State Bank of Wichita, the state's largest insured bank, presented the insur-

ance system with its greatest challenge. Eventually, the bank was reorganized with other insured banks assuming $1.4 million of the loss and depositors accepting, on average, 40 percent of their deposits in the form of stock in the new bank. The event marked a turning point in the history of the Kansas insurance system, however, as the number of banks and the deposits held in insured banks began to decline.[23]

Although a special insurance assessment was collected in 1922 and insurance premiums were set at their legal maximums beginning in 1924, losses from bank failures exceeded insurance system revenues from 1921 onward. In 1925, the state bank commissioner stopped making payments on all insurance claims, and in 1926 a state supreme court decision effectively ended the system. The court decision resulted from the refusal of several banks that had withdrawn from the insurance system to pay additional insurance premiums. The court ruled that banks could withdraw without additional liability by simply giving up the bonds they had pledged to guarantee premium payments. This led many banks to withdraw and, by 1927, insurance system membership had fallen to less than 10 percent of eligible banks.

Kansas appears to have suffered many of the problems that have been associated with the bank and S&L debacle of the 1980s. In the 1980s, many depository institutions, especially insolvent S&Ls, bid up deposit interest rates and grew rapidly by issuing deposits through brokers.[24] In the 1920s, some banks appear to have evaded deposit interest rate ceilings in order to grow rapidly. In his report for 1922 (Kansas, 1992, p. 5), the state bank commissioner also felt it desirable to limit deposit insurance to only the original holder of a deposit, and not to any assignee. Supervision was also reported to have been weak in Kansas, especially during the worst failure years, and for a time state banking authorities permitted weak and insolvent banks to remain open rather than closing them immediately upon recognition of trouble (Warburton, 1958, p. 19). Whether any such banks recovered is not known, but the lack of mention in the biennial reports of the state banking commissioner suggests that, like the attempts at forbearance during the 1980s, the policy was probably not successful.

MODELING TIME-TO-FAILURE

While many Kansas banks failed during the 1920s, a majority of banks survived the decade. What characteristics distinguish the survivors from the failures? To identify important characteristics of failing banks, we employ an econometric technique that explicitly models time-to-failure. The analysis of duration data is relatively new in economics. Engineers and biomedical scientists have analyzed time-to-failure for electrical and mechanical components of machinery and the survival times of subjects for many years, but economists have only recently begun to apply similar models, primarily in the area of labor economics with a focus on the duration of spells of unemployment.[25] Although models developed to analyze duration data are sometimes called time-to-failure models, the event of interest need not be characterized as a "failure"; all that is necessary is that the event be well-defined.

Duration models differ from standard discrete choice models (such as probit or logit models) in that duration models use information about how long banks survive in the estimation of the instantaneous probability of failure for a given set of observations on the independent variables. Parameter estimates thus indicate whether an increase in the value of an individual independent variable will reduce or extend the expected time until failure occurs. By contrast, discrete choice models typically ignore information about the timing of failures, and provide an estimate only of the probability of failure within a given interval of time. Discrete choice models treat all banks that fail during an interval the same, as they do all surviving banks. Thus, for example, a bank that fails on the first day of a two-year in-

[23]See Wheelock and Kumbhakar (1994) and Warburton (1958) for additional detail about this failure.

[24]See Kane (1989).

[25]Kiefer (1988) provides a good introduction to the analysis of duration data; Kalbfleisch and Prentice (1980) and Lancaster (1990) provide more advanced treatments of the subject.

terval is treated the same as a bank that fails on the last day, and a bank that survives the interval but fails one day after that period ends is treated the same as a bank that survives an additional 10 years. Duration models explicitly incorporate such information, and thus yield more efficient parameter estimates.[26] A detailed description of the duration model used in this article is presented in the appendix.

In the present application, we observe the charter date for each bank in our sample. For some banks, we observe a failure date, where failure is defined as the date on which the bank was ordered closed by the state banking commissioner. For the remaining banks, no failure date is observed if a bank had not failed by the end of our observation period (1928) or if it liquidated voluntarily, merged with another bank or switched to a federal charter. These observations are considered censored; information about these banks is available for part of their lives, but we do not observe them failing. Censoring is common in duration data of all types and must be addressed within the statistical model used to examine the data.

Figure 3 illustrates the types of censoring that may occur in duration data. Assume that the interval over which banks are observed runs from time t_1 to t_2. The horizontal lines in the figure represent the time between the charter date and the date of failure for individual banks. Given the observation period (t_1, t_2), the observation for Bank A will be both *left*- and *right*-censored. For this bank, neither the charter date nor the failure date occur within the observation interval. The observation for Bank B will be left-censored; the charter date does not occur within the observation interval, but the failure date does. For Bank C, both the charter and failure dates occur between t_1 and t_2, and so the observation is uncensored. Finally, the observation for Bank D will be right-censored; the charter date occurs within the observation interval, but the failure date occurs after t_2.

EXPLANATORY VARIABLES AND ESTIMATION RESULTS

Other researchers have employed hazard and discrete choice models to identify characteristics that distinguish failing and surviving banks in a variety of settings. White (1984), for example, estimates a probit model to distinguish failing from nonfailing banks during the Banking Panic of 1930. Wheelock (1992a) uses a similar model to study Kansas bank failures between 1920 and 1926. Both studies found that banks were more likely to fail, the lower their capital/assets, surplus/loans, bonds/assets, reserves/deposits, or deposits/assets ratios.[27] Banks were more likely to fail, the higher their loans/assets or short-term borrowed funds/assets ratios.[28]

Many Kansas banks experienced significant loan losses following the collapse of agricultural prices and incomes in 1920-21, and banks with low capital/assets ratios were less well-cushioned against declines in the value of their assets. Banks with little cash and other reserve assets were less able to meet deposit withdrawals, and the smaller a bank's reserves/deposits ratio, the more likely it was to close due to illiquidity. Often a lack of cash was the first sign that a bank was in trouble, and would prompt closure by state banking authorities.

Just as a low level of reserves signaled trouble, so too did a heavy reliance on borrowed funds such as rediscounts of loans with other banks or with the Federal Reserve. Banks that relied heavily on borrowed funds to finance their operations, or that had to resort to borrowing because of loan losses or deposit withdrawals, appear to have been relatively more likely to fail.

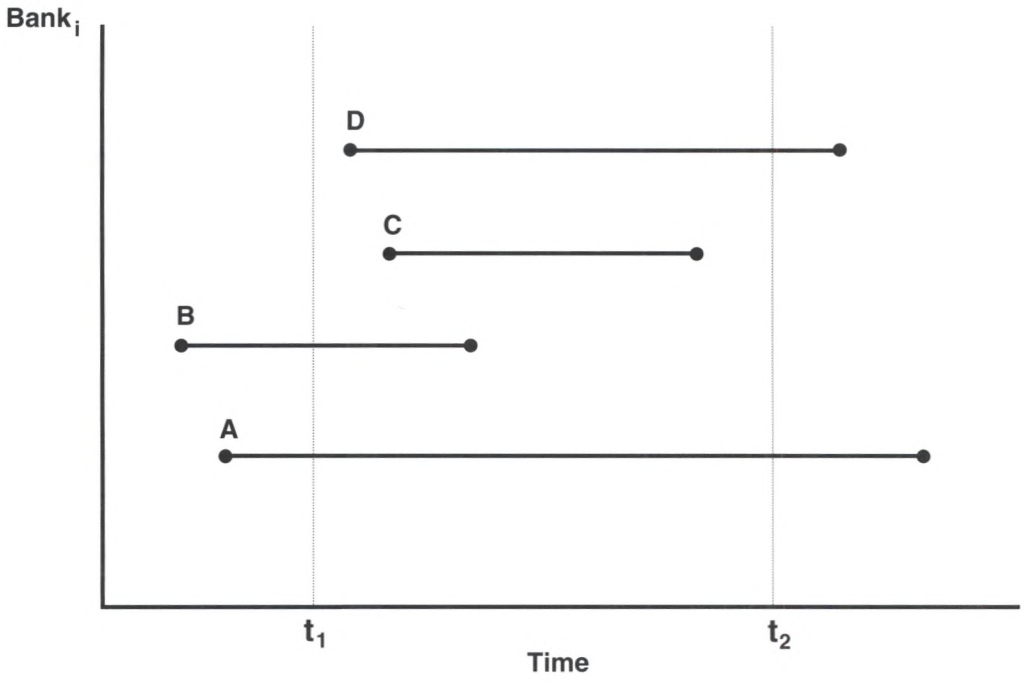
Loans are generally the most risky and least liquid of bank assets, and the loan portfolios of the rural unit banks of Kansas were undoubtedly not well-diversified. Accordingly, the higher a bank's loans/assets ratio, the greater the likelihood that it would fail. On the other hand, banks with substantial bond holdings might

[26]While deriving a direct relationship between the parameters of a duration model and a discrete choice model would be difficult, in principle one could integrate the hazard function estimated from a duration model to obtain the probability of failure within a given interval of time.

[27]Surplus refers to paid-in capital beyond the par value of a bank's stock plus undistributed profits. Reserves refer to cash, cash items and the liabilities of other banks.

[28]Borrowed funds consisted largely of rediscounted loans with the Federal Reserve or other banks.

Figure 3
Possible Types of Censoring



have been less likely to fail, especially since U.S. Government bonds and bonds of the state of Kansas and of Kansas municipalities probably comprised most of the bond holdings of Kansas banks in this era.[29]

Wheelock (1992b) includes bank size and a dummy variable indicating whether or not a bank was a member of the state deposit insurance system as additional explanatory variables. If larger banks were better diversified, or could capture economies of scale, they might have been less likely to fail. Wheelock found, however, no significant relationship between size and failure. Deposit insurance, on the other hand, did significantly affect the probability of failure. Even though the capital/assets ratio and other measures of risk-taking should reflect whether or not a bank had insured deposits, the full impact of insurance may not be captured by observable variables. The deposit insurance dummy variable might reflect the incentive that insurance gives banks to hold riskier loans and investments than they otherwise would.

Wheelock (1992b) did not test for interaction effects between deposit insurance and the financial ratios. One might expect, however, that the effect of a change in a financial ratio on the likelihood of failure would depend in part on whether or not the bank had deposit insurance. For example, the depositors of an insured bank might have been less concerned with a decline in the capital/assets ratio of their bank and, hence, less likely to demand a higher deposit interest rate than depositors of an uninsured bank. The scope for risk-taking and, thus, the probability of failure, resulting from a change

[29]The state banking commissioner accepted only U.S. Government, state of Kansas and Kansas municipal bonds to guarantee payment of deposit insurance premiums. Unfortunately, we do not have information on the composition of each bank's bond holdings.

in a financial ratio might therefore depend on whether or not a bank was insured. We test this hypothesis here.

Estimation Results

Our data consist of a panel of Kansas banks for which we have collected balance sheets and other information as of August 31 of each even-numbered year from 1910 to 1926 (except 1912 and 1916, when these data were not published).[30] Our sample includes 259 banks (approximately one-fourth the total operating in 1914).[31] Of these, 47 (18 percent) had failed by September 1, 1928. Banks that merged with other banks, liquidated voluntarily or switched to a federal charter are treated as censored on the date of merger or change in charter. Banks that did not fail or otherwise ceased operating prior to August 31, 1928, are treated as censored on that date.

In addition to the independent variables used by Wheelock (1992b), we include dummy variables for each interval of 1920-22, 1922-24, 1924-26 and 1926-28 to investigate whether the probability of failure differed across periods for a given set of bank attributes. Only two banks in our sample failed before 1920 and, hence, we do not include dummies for those years. In one specification we also include interaction terms of deposit insurance and the financial ratios.[32]

Table 2 reports estimates of the failure model that include alternative combinations of explanatory variables. In column one, the coefficient on the capital/assets, bonds/assets and reserves/deposits ratios indicate that the higher each of these ratios was, the less likely a bank was to fail. Better capitalized banks, and those with substantial bond holdings and significant reserves, could better absorb the shock of loan losses and deposit withdrawals accompanying the agricultural downturn in Kansas. Banks that had substantial borrowed funds relative to assets had a greater chance of failing while, contrary to expectations, it appears that the higher a bank's loan/assets ratio, the less likely it was to fail. This finding appears due to multicollinearity, however. The loans/assets ratio is highly correlated with the reserves/deposits ratio. If the latter is omitted, as in the specification reported in column two, the sign of the coefficient on the loans/assets ratio is positive, though not statistically significant.

The coefficient on deposit insurance is not statistically significant, suggesting that any effect that insurance had on the probability of failure is captured by its relationship with the financial ratios also included in the model. If the dummies for the biennial observation intervals are omitted, the coefficient on insurance is larger and statistically significant. It may be that the strain on the portfolios of all banks caused by the collapse of commodity prices overwhelmed the effect of deposit insurance on the unobserved portfolio risk of insured banks, which could explain why the coefficient on insurance is not significant when the time dummies are included. Not surprisingly, for given values of the financial ratios, banks were more likely to fail after the collapse of commodity prices and onset of severe agricultural distress in 1920. Finally, none of the coefficients on the interaction terms of deposit insurance and the financial ratios is statistically significant. Again, it appears that any impact of deposit insurance on the likelihood of failure is captured by differences in the financial ratios between insured and uninsured banks.

CONCLUSION

Researchers have blamed federal deposit insurance for contributing to the high numbers of bank and thrift failures and large deposit insurance payoffs since 1980. Unless insurance premiums increase proportionately with risk, banks will be encouraged to take greater risks than they otherwise would. This article presents

[30]The source of our data is Kansas (various years).

[31]We dropped seven banks because of missing data. Others fall out of the panel after failing, closing voluntarily, merging with other banks, or switching to a national charter.

[32]Few state-chartered Kansas banks were members of the Federal Reserve System during this era. None of the failed banks in our sample was a member, and so differences in supervisory agency or regulation, except those pertaining to deposit insurance, cannot explain variation in failure probabilities across banks.

Table 2

Failure Model Estimates

Variable			
Insurance	0.17 (0.43)	0.35 (0.90)	−0.23 (0.03)
Capital/Assets	−12.10 (2.76)***	−13.42 (3.02)***	−17.48 (2.52)**
Bonds/Assets	−7.98 (1.84)*	−1.56 (0.35)	−14.84 (1.19)
Loans/Assets	−6.05 (2.18)**	2.12 (0.96)	−4.82 (0.53)
Reserves/Deposits	−9.80 (3.79)***	—	−9.83 (1.20)
Borrowings/Assets	8.10 (5.16)***	8.34 (5.45)***	5.31 (1.80)*
Total Assets	−0.78 (0.84)	−1.00 (1.00)	−0.77 (0.83)
1920-22	1.10 (1.18)	1.33 (1.43)	1.07 (1.14)
1922-24	2.30 (2.68)***	2.66 (3.12)***	2.29 (2.65)***
1924-26	2.46 (2.75)***	3.10 (3.57)***	2.47 (2.77)***
1926-28	3.08 (3.44)***	3.67 (4.15)***	3.11 (3.46)***
Ins × capital/assets	—	—	6.66 (0.74)
Ins × bonds/assets	—	—	8.32 (0.63)
Ins × loans/assets	—	—	−1.53 (0.16)
Ins × reserves/deposits	—	—	−0.26 (0.03)
Ins × borrowings/assets	—	—	3.79 (1.09)
Psuedo-R^2	.29	.26	.30
Log-likelihood	−138.25	−144.61	−137.16

Notes: Absolute values of *t*-statistics are in parentheses; ***, ** and * indicate statistically significant at the .01, .05 and .10 levels.

some historical evidence of how deposit insurance can alter bank behavior and increase the likelihood that a bank will fail. As in the 1980s, when falling incomes in agricultural and energy-producing states caused large loan losses and led to many bank and thrift failures, a sharp decline in agricultural incomes in the early 1920s caused the failure of many commercial banks in rural areas. Not all banks failed, however; in fact, most survived the collapse. Banks that carried deposit insurance had a higher rate of failure than other banks. Our findings, along with those of similar historical studies, show that insured banks were less well capitalized and less liquid than other banks. Estimates of a model of time-to-failure indicate that among banks in our sample, those with high ratios of capital to assets, reserves to

deposits, large bond holdings relative to their total assets, or that relied little on borrowed funds, were less likely to fail. In short, conservatively managed banks were less likely to fail and, at the same time, banks that carried deposit insurance were more risky and, hence, more likely to fail than their uninsured competitors.

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Appendix
The Proportional Hazard Model

This appendix describes the proportional hazard model estimated in this article in some detail for interested readers who are unfamiliar with duration models, but have some understanding of econometrics or statistics. We wish to estimate the effect of deposit insurance and other variables on the probability of failure at particular times for the n banks in our sample. Let T_i, $i = 1, \ldots, n$, represent the failure time for the ith bank in our sample; where T_i is not observed, we say that the observation is censored. Time is measured relative to the individual bank's charter date, with a zero value at the charter date. Hence, for each bank in the sample, the corresponding time scales will have different values for a given calendar time. If T is a continuous random variable with a continuous probability distribution $f(t)$, where t is a realization of T, then the cumulative probability is

$$(1)\quad Prob(T < t) = F(t) = \int_0^t f(u)\,du.$$

The function $F(t)$ gives the probability that a bank fails before time t (subscripts are omitted where no ambiguity results). Alternatively, the same information may be expressed in terms of the survival function

$$(2)\quad S(t) = 1 - F(t),$$

which is merely Prob($T \geq t$).

Given that a bank has survived until time t, what is the probability that it will fail during the next short interval of time, Δ? The function characterizing this aspect of the problem is the hazard rate, given by

$$(3)\quad \lambda(t) = \lim_{\Delta \to 0} \frac{Prob(t \leq T \leq t + \Delta \mid T \geq t)}{\Delta}$$

$$= \lim_{\Delta \to 0} \frac{F(t + \Delta) - F(t)}{\Delta S(t)}$$

$$= \frac{f(t)}{S(t)}.$$

The hazard function gives the instantaneous rate of failure per unit time period at time t.

The density function $f(t)$, the cumulative density function $F(t)$, the survival function $S(t)$ and the hazard function $\lambda(t)$ each characterize the duration of banks. Furthermore, all four functions are related. From equations 2 and 3, it follows that

$$(4)\quad \lambda(t) = \frac{-d \log S(t)}{dt}.$$

Also, rearranging terms in equation 3 yields

$$(5)\quad f(t) = S(t)\lambda(t).$$

Another useful function is the integrated hazard function,

$$(6)\quad \Lambda(t) = \int_0^t \lambda(u)\,du.$$

Then, from equations 4 and 6 the survival function may be written as

$$(7)\quad S(t) = e^{-\Lambda(t)},$$

and from equation 7 we have

$$(8)\quad \Lambda(t) = -\log S(t).$$

Estimation of the failure time relationship requires specifying a functional form for either $f(t)$, $F(t)$, $S(t)$, $\lambda(t)$, or $\Lambda(t)$. Note that a functional form need only be specified for one of these functions; the relations in 1 and 4-8 will imply a functional form for the remaining functions.

We use the proportional hazard relationship developed by Cox (1972), where

$$(9)\quad \lambda(t|x,\beta) = \lambda_0(t)e^{x\beta},$$

where x is a row vector of measured covariates and β is a column vector of parameters with the appropriate dimensions. This model assumes a baseline hazard, $\lambda_0(t)$, which in principle amounts to an unidentified parameter for each bank in the sample. Thus, $\lambda_0(t)$ accounts for any unobserved heterogeneity among the banks that might otherwise bias the parameter estimates. The covariates in x influence the overall hazard for each bank through the exponential terms in equation 9 (the choice of an exponential form here is common throughout the literature on hazard estimation and simplifies the estimation problem relative to choices of other functional forms). The model is semiparametric since the exponential in 9 is a parametric form, while the baseline hazard involves an unspecified form

and, hence, is nonparametric. Consequently, the model is more flexible than models in which the failure time distribution is assumed known except perhaps for a few scalar parameters.

Given the hazard specification in equation 9, the corresponding survivor function (which gives the probability of survival up to time t) may be written as

$$(10)\quad S(t|x,\beta) = \exp\left[-\int_0^t \lambda_0(u)e^{x\beta}\,du\right].$$

For uncensored observations with failure at time T, the contribution to the likelihood is $f(T|x)$; for observations censored at time T, the contribution to the likelihood is $S(T|x)$, that is, the probability of survival until time T.

Cox (1972, 1975) suggests a partial-likelihood approach which can be used to estimate the parameters of the hazard function in 9. Assume, for the moment, that no observations are censored, and that the observations are ordered by their completed, untied durations such that $t_1 < t_2 < \ldots < t_n$. The conditional probability that observation 1 fails at time t_1, given that any of the n observations could have failed at time t_1, is

$$(11)\quad \frac{\lambda(t_1|x_1,\beta)}{\sum_{i=1}^{n}\lambda(t_1|x_i,\beta)} = \frac{e^{x_1\beta}}{\sum_{i=1}^{n}e^{x_i\beta}}.$$

The equality results from the assumption of the proportional hazard in 9; the baseline hazard $\lambda_0(t)$ cancels out of the expression on the left in 11. The expression in 11 gives the contribution of the first observation to the partial likelihood. Analogously, the contribution of the jth observation to the partial likelihood is

$$\frac{e^{x_j\beta}}{\sum_{i=j}^{n}e^{x_i\beta}}.$$

The partial likelihood is given by the product of the individual contributions and, hence, its log is

$$(12)\quad L(\beta) = \sum_{i=1}^{n}\left\{x_i\beta - \log\left[\sum_{j=i}^{n}e^{x_j\beta}\right]\right\}.$$

Andersen and Gill (1982) and Johansen (1983) show that the partial likelihood can be treated as an ordinary likelihood concentrated with respect to λ_0.[33]

The model represented by equation 12 can be easily adjusted to accommodate censoring in the data. For the data used in this study, each bank i in the sample is observed at J_i different times $t_{i1} < t_{i2} < \ldots < t_{iJ_i}$, with either failure or censoring occurring at time t_{iJ_i}. Note that times here refer not to calendar time, but to time relative to the date of charter for bank i so that $t_{i0} = 0$ where t_{i0} is the date of charter for the ith bank. The balance sheet information used in x corresponding to time t_{ij}, $j = 1, \ldots, (J_i-1)$, are assumed to reflect the position of bank i over the interval $[t_{ij}, t_{i(j+1)})$. The model estimated in this paper is time-varying in the sense that covariates in x are assumed constant for intervals of time $[t_{ij}, t_{i(j+1)})$, but may vary across different intervals. Thus, for the ith bank there are (J_i-1) observed intervals; the first (J_i-2) are both left- and right-censored, and the last is left-censored and also right-censored if failure time is not observed for the ith bank.

To accommodate the censoring in the data, let $x_i(j)$, $i=1, \ldots, n$, $j=1, \ldots, J_i$ denote the vector of covariates for bank i during period j. Covariates are fixed within a given period, but may vary over different periods. Let d_i equal 1 for banks that are observed to fail at some time within the entire observation period, and zero otherwise. Assume that banks are ordered by increasing date of failure. Then, the log-partial likelihood becomes

$$(13)\quad L(\beta) = \sum_{i=1}^{n}\left\{d_i x_i(J_i)\beta - \log\left[\sum_{k=i}^{n}e^{x_k(J_i)\beta}\right]\right\}.$$

Kiefer (1988) suggests that the intuition behind the partial-likelihood approach used here is that, in the absence of any information about the baseline hazard, only the order of the durations provides information about the unknown parameters of the model. In both 12 and 13, the instantaneous probability of failure is normalized by the sum of instantaneous probabilities of failure for all other banks that could have failed at the same time as the ith bank.

[1]Alternatively, one could specify a parametric form for the baseline hazard in equation 9 and maximize the corresponding likelihood function. Although the partial-likelihood approach avoids the need for an arbitrary parametric specification of the baseline hazard, there is a loss of efficiency in the resulting estimates relative to those obtained by maximizing the full likelihood. See Efron (1977) for a discussion of this efficiency loss.

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